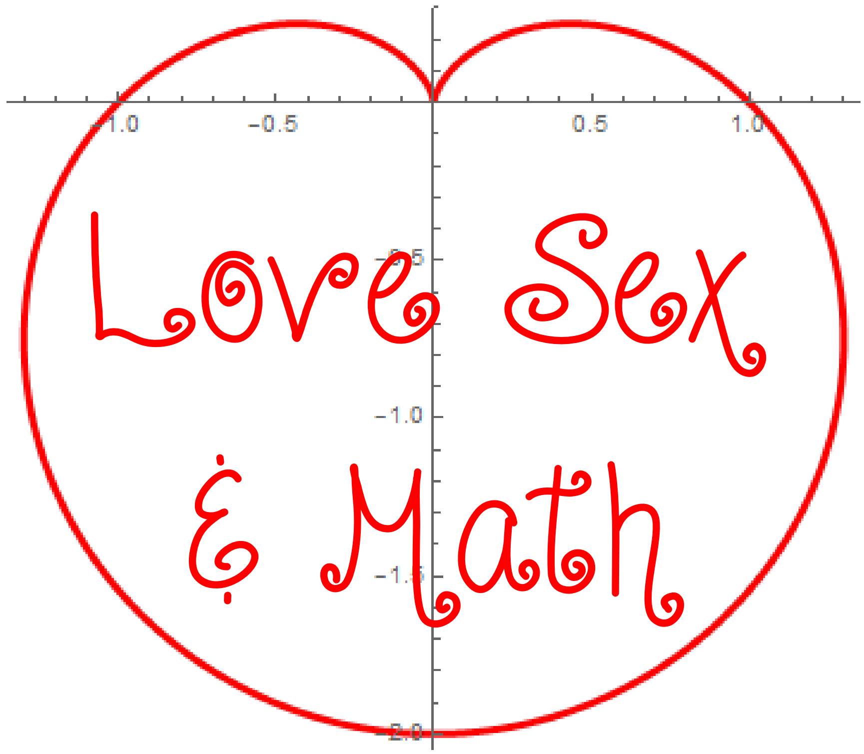
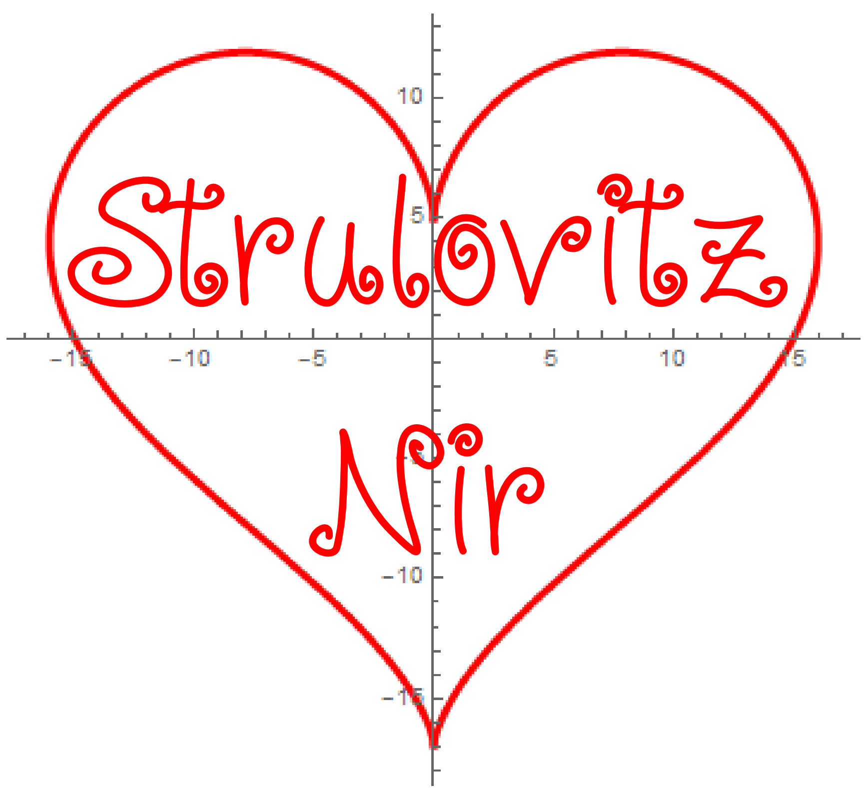
```
PolarPlot[1 - Sin[θ], {θ, 0, 2 π}]
```




```
ParametricPlot[{16 (Sin[t])^3, 13 Cos[t] - 5 Cos[2 t]
   - 2 Cos[3 t] - Cos[4 t]}, {t, 0, 2 π}]
```



In loving memory of my grandpa Michael (“Puiu”) Strulovici.

He deals the cards to find the answer

The sacred geometry of chance

The hidden law of a probable outcome

The numbers lead a dance

– Shape of My Heart by Sting (from Léon: The Professional)

To love is to be delighted by the happiness of someone, or to experience pleasure upon the happiness of another. I define this as true love.

– Gottfried Leibniz

His language had a special vocabulary ... "bosses" (women), "slaves" (men), "captured" (married), "liberated" (divorced), "recaptured" (remarried) ...

– (about) Paul Erdős

Marriage is for women the commonest mode of livelihood, and the total amount of undesired sex endured by women is probably greater in marriage than in prostitution.

– Bertrand Russell

From the back cover:

This book is a two-way phrasebook between the language of the universe – mathematics – and the universal language of love and sex. Instead of learning all the complicated syntax rules which aren’t useful in everyday life, here we will learn by doing, applying the mathematical ideas to emotional situations and intimate relationships scenarios from real life.

With the language of words, we’re limited to thinking only about things we can describe with words. With a few words in the language of mathematics we can decipher the codes of passion, and open the door to better love and better sex!

Preface

There are other books that apply math to romance, see for example the beautiful mathematicians Dr Clio Cresswell (Mathematics and sex) and Dr Hannah Fry (The Mathematics of Love). So does the world really need another book about the connections between romantic relationships and math?

First of all, these two subjects are so rich and interesting that we might just tumble into some yet undiscovered gem.

Second of all, while I admit I did not read those books, by leafing through them I got the impression that their main goal was to attract and entertain the reader. As a byproduct they also educate. My goal is reversed. I want to teach the basics of math in an orderly fashion, but with words instead of numbers, little stories instead of equations, and so on.

My imaginary reader is the daughter I always wanted but I never had. I'd call her Shir (which means song in Hebrew). So Shir likes the humanities but dislikes math. She says: I'm a "people person", so I don't need math at all (Except for shopping which is primary school arithmetic). I just pick the useful products of science and technology from the shelf. Just as I use my smartphone without the slightest idea of how it's programmed. And even if I needed to know programming, I still wouldn't need to know electronics, and even if I needed to know electronics, I still wouldn't need to know chemistry like what atoms the phone is made of, and so on. And at the bottom lies math so math is so far away from my reality that I simply have no use for it, math for me is abstract and irrelevant.

So now I owe Shir an explanation of why knowing math is good for her:

Imagine if you could speak with a vocabulary of 100 words only. You could get along in life just fine, but you wouldn't be able to think the more complicated thoughts that you're thinking now, because you can't express them to yourself and to others. It's true that all the more complicated words are built from these simpler words, so if you're very smart (of course she's smart – she's my daughter!) you could build them "ad hoc", but your sentences will then become so long and cumbersome that by the time you finish a sentence you won't remember how it started. It would practically force you to be dumb, like in that funny mockumentary by Naor Zion about the Israeli "ars" tribe that communicates using a single syllable "aaa"[1].

[1] "Ars" is the Israeli version of "redneck". It's usually used to describe rude part of MENA (Middle East and North Africa) Jews. You can watch the funny video in English here: https://www.youtube.com/watch?v=6gysRe_d3I8

Now imagine a reversed situation that you learn to speak a super language in which 1 word equals 100 of our normal words. You will be able to think so much more deeply and clearly about things that right now you have only a faint and vague idea about. So who knows how it will change your life. Math is not about numbers. it's a thought amplifier and speech focuser. It liberates your mind to think freely and enables you to be smart.

Also notice that your "math is the bottom layer" model isn't accurate. Math isn't just at the basis of elementary particles. Math also lies at the basis of every layer above that, the physics, the chemistry, our biology, the electronics, the programming. In each of them, if you want to go more deeply and to communicate with others on that level you need math. So you see if something is found everywhere, it's the most worthwhile subject to study, because you learn it once and use it everywhere.

But Shir is clever so she'll answer something along the following lines:

Maybe if someone was stuck alone on a desert island and needed to reinvent everything, then you're right, she'd need math. But in our society today, the real environment is people, and the obstacles and opportunities, and problems and solutions require understanding of people.

So I give Shir the ultimate example that it's possible to use math to manipulate people:

Remember the United States presidential election in 2016? Hillary Clinton was the perfect candidate, she had official experience (Secretary of State under Barack Obama), she had unofficial experience (the brains behind Bill Clinton), she had support from the administration, from the upper class and from all the women and all the liberals, she was experienced in running a presidential campaign from running against Obama. She was the ideal candidate, the best person in the world for this job. So like her book title says: "What Happened?". The answer is Linear Algebra happened.

Cambridge Analytica used math to take personal data from 50 million users of Facebook, and to make a mathematical model of them and their friends. Note that this is not public demographic information of how old are you and where are you from. This is personal psychographic activities, interests, and opinions. The person who made this model is Dr Michal Kosinski in his papers: "Private traits and attributes are predictable from digital records of human behavior"[2] and "Computer-based personality judgments are more accurate than those made by humans"[3]. It's all math: make a user-like matrix and singular value decomposition from linear algebra, linear regression from statistics. Also in a later

[2] https://www.pnas.org/content/110/15/5802
[3] https://www.pnas.org/content/112/4/1036

paper he further explains what they did: “Psychological targeting as an effective approach to digital mass persuasion”[4], and it’s also filled with statistics.

Was Vladimir Putin behind this? Sure; but Putin was just operating the engine, the engine itself was linear algebra and statistics. So if math is powerful enough to make a buffoon into the strongest person in the world, then it’s the ultimate demonstration of the ability to understand and control people using math.

So now Shir is forced to admit that by analyzing “likes” you can know people better than their own mother does, but she has one final ace up her sleeve:

Touché daddy, but I know some mathematicians, and they can barely communicate at all. In fact, most mathematicians have an average social success at best, in terms of getting what they want, such as love and sex...

This time Shir threw me a curve-ball, and I can no longer answer in a few lines. This one calls for a whole new book, let’s call it – “Love Sex & Math”!

Nir Strulovitz, July 2020.

That’s me in the picture with a little box of Kellogg’s Rice Krispies, because the higher derivatives of position are named after the advertising mascots Snap, Crackle, and Pop.

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[4] https://www.pnas.org/content/114/48/12714.full

Contents

Chapter 1 – Linear Algebra or “What women want?”

Subchapter 1.01 – Vectors as qualities that women desire in men

In his book “The Lies They Tell” from 2016, Tuvia Tenenbom found out that Americans don’t dare to say which political party they support (which is ironic in “the land of the free and the home of the brave”). But he found out something even more interesting. He asked 2 questions “do you think the climate change is real?” and “do you support the Israelis or the Palestinians?”. These 2 questions almost ALWAYS had the same “direction”. A person who believed climate change is a lie supported the Israelis. A person who believed climate change is true, supported the Palestinians. So of course if both of these answers are in the same “direction”, you know what the person votes.

What do we mean by “direction”? We picture in our mind an arrow pointing somewhere. Linear algebra is all about arrows. Only we call them “vectors” because it sounds more impressive. Vector means arrow.

Ok so we can put each personal quality (trait, characteristic) that a person has on an axis.

[in history axis means the Nazis from WWII but in mathematics it’s a little less scary, it means one ruler of right versus left (x axis), another ruler of up vs. down (y axis), and so on. All these axes (or rulers) meet in their zero point – the origin.]

So we have an axis of rich versus poor; We have another axis for sociable vs. introverted; we have yet another axis of athletic vs intellectual and so on.

Now every person has 2 vectors (arrows). One vector is what kind of person he is. The other vector is what he’s looking for. An ideal relationship will be if he finds a partner with two arrows which are exactly congruent (completely overlapping) but switched.

For example, let’s say there a woman who is short and a good cook, and she’s looking for a man who is tall and works as an engineer. And let’s say there’s a man who is tall and works as an engineer and he’s looking for a woman who is short and a good cook. Then these two have a perfect match, we can see it in the angle between their vectors which is zero – they are at the exact same direction.

In this specific example are both perfect for each other, both in the direction of how much she wants him, and in the direction of how much he wants her. But if she would find a tall engineer who is looking for a tall woman who is a bad cook, then the angle between the vectors of how much she wants him would be in the same direction, but the angle of the vectors of how much he wants her will be in opposite directions which means 180°.

When we multiply a vector it means how much of that quality is there. For example if a man's vector is pointing only in the direction of "rich" and there's another man with a vector that's also pointing only in the direction of "rich" but is 3 times as long, then he's 3 times richer than the first man.

When we add vectors it means we are adding men. We talked about each vector (arrow) is a man (a collection of qualities in different "aspects" – the aspects are the axes). One example can be if a woman wants to see what "journey" she made with all the men she have been with, so she adds the vectors (arrows) to each other. each new vector is added so that its beginning (its non pointy side) is in the point where the previous vector's end (the pointy tip) is.

So if the woman connects all the arrows she arrives at some point in where she is now. If there was a hypothetical man that was the average of all the men in her life, she could be with him the whole time and reach that same point she is now in. this is called the sum of all the vectors.

By the way the woman may notice that when she moves on from one romantic partner to the next, she tries to correct the direction towards her ideal type (which is the arrow we talked about earlier – what she wants – like a tall engineer). For example if the main problem with her current husband is that he's addicted to sport, then in her next partner she will try to pick someone who shies away from sport etc.

What is a linear combination? It's when we both multiply AND add vectors.

for example someone who has twice (2 times) the salary (compared to the average man's salary) and thrice (3 times) as many friends (compared to the average man's amount of friends).

What is the unit vector? it's like multiplying in 1 (meaning it doesn't change the size) but also it tells us in what direction the arrow points. It's like asking does that man earn more than the average man or less than the average man, but without asking how much he earns.

We write a unit vector with a small hat above like this $\hat{\imath}$ or like this $\hat{\jmath}$

here they are again in bigger font size so you can see the little hats above them:

$$\hat{\imath} \text{ or } \hat{\jmath}$$

Ok so far we talked about vectors as arrows which is true but now let's present a different way to describe the same vectors which is an ordered list.

Think of your report card in school. In each subject that you studied you had a grade. I know in the USA you have grades in letters like A plus B minus etc, but let's say we are in Europe so your report card has numbers. You got 10 in history and 7 in biology and so on.

So a vector is just like that but the order of the subjects is very important. The first number, the second number, etc.

So in our system which we are making up now, each number is what we called an axis until now. So if the man got exactly the average grade of the classroom in biology, then on the biology axis he has plus one unit (like a unit vector pointing towards "knowledge in history") and in the first number of the ordered list (the report card) he has plus one.

Why don't we say the man has got 70 in biology like he really did? Where does the plus one come from?

Because we need to normalize his achievements (his qualities) with each other.

Comparing history to biology is easy because in both of them, the teacher must give a number between zero and ten. But in the real world we need to compare "apples to oranges". Like the salary is measured in thousands (dollars) and the height in centimeters and so on. We need a unified system so that the arrows (qualities) are not very long or very short, but they are normalized. So we compare to the average of each quality.

So a vector is an ordered list of grades. so let's build our actual vector that we will work with.

These are the main qualities that a woman looks for in a man arranged by groups of qualities: looks, money, popularity, sex and "manly":

physical appearance (height, eye color, weight, muscularity, penis size)

Economic Status (salary, house price, car price, family assets)

Social Status (number of friends, ethnicity, rank in peers' group)

Sexual Performance (dominance, foreplay duration, intercourse duration, kinkiness)

Masculine Traits (handyman, car mechanic know-how, sports fan)

When a man has a negative number in his vector (a minus number next to one of the "subjects" in his "report card"), it means he has a quality in the opposite direction. For instance, if he has MINUS 3 in "sociable" this means he secludes (loner, recluse) himself 3 times as much as the average man.

In order to work with negative numbers we need to treat the average (the person who has exactly the average number of friends) as sometimes towards the positive (like if someone has so many friends that he's got 3 times more than the average), and sometimes towards the negative as -1 (when someone has 3 times less than the average).

Please note that this little bit is different from normal linear algebra, it's required so we can quantify the qualitative qualities of people into numbers:

So because of this normalization my system has a disadvantage because it requires us to do a little extra work in how we define the action of multiplication:

Ok so we see that in our system if someone is exactly average in some quality, we say he's zero 0 in that quality. If we want to multiply it "upwards" we then consider it to be not zero but plus 1. And if we multiply it "downwards" we then consider it to be not zero but minus 1.

On the other hand, if someone is completely average in some qualities, we don't see them at all, we see only the things that are special about him, which is an advantage. In my model if someone is completely average joe all around (like in the excellent movie Idiocracy), then he will simply be a point (without any arrows). And when we multiply him (compare him with another guy) we treat him as a "ball" or hedgehog of short unit arrows in all directions.

Subchapter 1.02 – Combinations as desirable men

Ok let's go back to linear combinations (multiply and add vectors). For simplicity we'll talk now as if our vectors (men) contain not 5 components (qualities: looks, money, popularity, sex and "manly") but only 2 components (qualities): money and popularity.

So, we can imagine any possible combination of these 2 qualities.

Someone who was lots of money and is very popular, let's say 10 money and 10 popularity; someone who has 0 popularity (the average number of friends, etc.) and earns $\frac{1}{2}$ (half) of the money of the average man which in our system means he has money of -2 (minus two); someone who has -5 in popularity, and has 3 times as much money as the average person; and so on.

Each combination like this is called a linear combination. Together all these possible combinations (out of which we only considered a few examples) cover all the theoretical combinations of money and popularity. We know that in reality some combinations are more likely, for example when you are poor no one wants to be your friend. But in theory anything is possible.

Women like to analyze all the possibilities. So we call all these possibilities together a plane.

For example, the socio-economical plane, which we've just discussed (socio is the social status and economic is the money status). So in theory there can exist people in every point (linear combination) on the socio-economical plane.

By the way we've just seen a new way to look at vectors which is like points (where the pointy tip of the arrow reaches; or the coordinates of the components of the ordered "grades" list). When we will change many vectors at once, it will be easiest to describe them as points.

Now let's talk about using other coordinates. coordinates are the marks on our ruler. Changing the coordinates we use is like switching from using centimeters marks to inches marks or vice versa.

Now our " basis for comparison " for comparison is not the average person (unit vector) in each quality, but instead our " basis for comparison " is something else. For example in Israel we have a phrase "mythological ex" which means your best ever former sexual or romantic partner. I don't know if this is the same expression in English, but I hope you understand.

So suppose that a woman compares each new man that she meets to her mythological ex-boyfriend. So let's say her mythological ex earned 2 times the average salary, and had 3 times as many friends as the average guy.

And now she meets a new guy with an average salary and a dozen (12) friends. So in money this new guy will have $\frac{1}{2}$ (half) because that's half of what her mythological ex had, so it translates in our system to -2 (minus two). And in the popularity the new guy will have 4 because he has 4 times as many friends as her mythological ex.

We can still meet this theoretically any possible combination of qualities, but each new guy will be described in different numbers than the numbers he would have if we would have measured according to the average person and not the mythological-ex. Of course the qualities of the new guy, in actual fact, did not change. The only thing that changed is our basis for comparison, our couple of bases, or in other words our coordinate system.

Just as we could talk about the socioeconomic plane we can talk about many other combinations of qualities that don't have an "official" name. for example the plane of dominance in the workplace versus dominance between the sheets. For example maybe a CEO that controls a large company likes to be spanked with a whip by his mistress. And maybe a loser at the bottom of the social ladder dreams about tying his girlfriend to the bed. And we can have any other combination. All the theoretically possible combinations span the (I'm just making up an "official" name for the explanation) plane of dominance.

Could it be that we chose two qualities and they don't span a plane?

Yes. This happens when the two qualities that we chose are in fact the same quality. same thing in a different guise (something that on the surface appears different but in reality is the same).

For example the qualities "house price" and "car price" are connected to each other. We can't theoretically have a continued state of things where someone owns a Ferrari but he is homeless and lives on the streets with debts. If he will be in debt he will sell the car to return some of the debts. Or the creditor will get a writ of execution, and take the car away and sell it.

So we see that that these two qualities are not independent, but rather always go in the same direction even theoretically. So when we combine both of them we do NOT get a plane of all the possible combinations. For example the following combination makes no sense: rich in houses and poor in cars; and the following combination also doesn't make sense: rich in cars and poor in houses.

On the other hand, this following combination makes sense: rich in houses and rich in cars. And also, this following combination makes sense: poor in houses and poor in cars. So that means that these qualities are always dependent on each other. We can imagine a man saving up and enough to buy a car, and then keep on saving up until he can buy an apartment too. For example the factor between the price of an apartment and the price of a car is about 50. (In Israel an average car costs $ 30,000 in US dollars and an average apartment costs $ 1,500,000). So an apartment costs 50 times as much as a car.

So these two qualities are always on the same line. The line between rich and poor.

In this case the progress on the line was in the same direction: when the man's apartment price grew, so did the price of the car he owns. But two qualities can be on the same line (which means they are in fact the same quality) but they grow in opposite directions:

Muscularity and weight are an example because they are on the same line, the line between thin and fat, but the number that connects them is negative. If someone is more athletic his body has less percent of fat. Always. And also the opposite is true. As someone has more and more percent of fat then he's less athletic.

So when we need to tie together these qualities using a number then the number will be negative (minus something) because these two qualities are in opposite directions on the same line that connects between thin and fat.

I don't know much about nutrition, so in the chance that I picked here a bad example, and you can be fat and an athlete (and I'm not talking about sumo wrestlers who also die young because of this) , then I apologize. So take for example dark skin color with light eye color. Black people don't have blue eyes.

Let's say we know the following qualities about a man: rank in the workplace; rank of the workplace; salary.

That's too much information. Why? Because if someone tells us for example that a man works in a government job (let's say the space agency NASA), and he's an engineer there (let's say a mechanical engineer), then we can know roughly his salary from NASA's website (about $ 80,000 a year).

In the same manner if we were told his salary (say $ 100,000 a year), and the rank of the workplace which is government job (say NASA space agency) we could roughly know his rank at work (project manager).

So these three qualities are partially overlapping, because it's enough to know two of them in order to know the other one.

This situation of "too much information" is linked to a new term:

Span – the "minimal" group of qualities that make up a certain plane.

For example if we continue our last example, suppose we want to span (describe all the possibilities) of the socio-economic plane. For example you want to send a SMS message to a friend and consult with her very briefly.

So the minimum that she needs to know in the SMS is the salary of the man and the number of friends of the man.

Or the minimum that she needs to know in the SMS is the rank of the workplace (government job) and the rank of the man in the workplace (project manager) and in addition the number of friends of the man.

Each one of these SMS messages contains the span, the bare minimum that is needed in order to describe all the possibilities in the plane (in this case the socio-economical plane).

We said that when two qualities are on the same line, like the line between rich man and poor man, the discussion is one-dimensional, we cannot describe a whole plane of combinations. We can only describe men who are more and more rich or more and more poor.

That happened because we chose two qualities which are eventually on the same line for example "house price" and "car price".

But there's another situation where we cannot talk about combinations, and that is if the man is exactly zero (in our system this means exactly the average) in that quality. He's neither here nor there.

For example we can talk about a man that will increase or decrease his assets and be more and more rich or more and more poor. But we can't talk about a man becoming more and more average. There is nothing to increase or decrease there. He's already exactly on that spot.

This is equivalent to someone who is exactly average in all walks of life, and we try to pressure him to pick and go into the subject that he's especially good at, but he can't go anywhere because he's right in the middle.

So if we try to talk about all the possibilities he can achieve then somebody who is exactly on the fence (on the zero which in our system means on the average) can not reach anywhere because he has no tendency in any direction. There is a proverb "behind every successful man there stands a woman", which I guess means that the woman supports and pushes the man to succeed, but in this case the woman does not know in which direction to push him! He's so "so-so" (in Hebrew this is called "Pareve") that he doesn't have a will of his own neither here nor there and he just agrees with you on anything. Boring!

So let's say we want to talk about the socio-economical plane and we want to examine all the possibilities in that plane, then we need two independent qualities which are NOT ZERO.

In the rare case where in both qualities the man is exactly on the ZERO point (in our system this means he's exactly average in both qualities) then he's just stuck there, and we can only span the discussion on that single point.

But usually if take two qualities of a man then their span is a plane. Which means all their combinations cover all the possibilities you can imagine.

If we are talking about more then 2 qualities, let's say about 3 qualities or more, this is called a space (instead of a plane).

For example the space of men who are "father material" (can be a potential good dad for your future children) : there's importance to the economical status because the man needs to provide; but also there's importance to the social status so he's honorable and decent; and there's importance for manly qualities so he can take the kids to watching sport games.

So in order for us to talk about the all these possibilities we need 3 qualities: "salary", "number of friends", "sport fan" – and this is a space. 2 qualities span a plane. 3 qualities span a space.

You can imagine the Sybian female sex toy

https://en.wikipedia.org/wiki/Sybian

which you can ride on like vibrator set on a saddle, and it has a remote control that is connected with a cable to the machine. And the remote control has 2 knobs or dial buttons, one for the speed of rotation and another for the speed of vibration. And you can control each of these qualities separately

http://www.angelfire.com/weird2/sybian/sybian-manual.pdf

so in the same way you can imagine the qualities of the man where you can control each quality with an imaginary dial that controls this specific quality:

A dial for increasing or decreasing the salary.

A dial for increasing or decreasing the number of friends.

A dial for increasing or decreasing the sport fandom.

And you control each one of the qualities separately and all the combinations of the qualities that we can imagine create the space (in this case the "father material" space).

By the way, here also a quality can be degenerated (atrophied) if this quality is actually an expression of other qualities that we already have, and then we no longer have a space but we have instead something less than a space. 3 independent qualities span a space; 2 span a plane; 1 spans a line; 0 spans a point.

Let's take for example a man who earns his income ("salary") from the number of friends – a nightclub promoter. If he meets a woman who decreases his number of friends, for example insisting on him not going out with friends but instead only him spending romantic evenings with her every time, then he will not have income. So in his case these two qualities (salary; number of friends) are actually along the same line.

When we have qualities that we can't tweak them separately because they are dependent on each other, and we can't change one quality without changing the other quality, then these qualities are called "linearly dependent".

Linear dependency – when one quality can be expressed as the linear combination of other qualities.

On the other hand, when a quality adds new interesting possibilities for us to discuss, for example expanding the socio-economical plane into the "father material" space, this is called qualities that are "linearly independent".

If we pick a random guy (not a party organizer of a sports fan club) then the qualities "salary" and "number of friends" are linearly independent. You can play with the dial knob of each of them separately.

Basis

https://en.wikipedia.org/wiki/Basis_(linear_algebra)

When linearly independent qualities span a certain space, we call them the basis of this space. For example one quality from the "economical" group, together with one quality from the "social" group together with one quality from the "manly" group – all of these 3 together form the basis for the "father-material" space.

Subchapter 1.03 – Transformations as changes of opinion (explains PMS!)

"La donna è mobile" wrote Verdi, and indeed, woman is fickle.

In June 24th 1999 Nature published a famous article explaining a monthly transformation:

"Menstrual cycle alters face preference"

Penton-Voak, I. S., Perrett, D. I., Castles, D. L., Kobayashi, T., Burt, D. M., Murray, L. K., & Minamisawa, R. (1999). Menstrual cycle alters face preference. Nature, 399(6738), 741–742. doi:10.1038/21557

The article says that most of the time women are attracted to men who are a little feminine because they are gentle and caring and will be good fathers. But in the time when the woman ovulates (when she is most fertile) the woman is attracted to macho men who have more testosterone and can make a stronger (and with better immune system) offspring. By the way this means that the woman's strategy is wired to cuckold the loyal husband with some manly "bull" and let the cuckold raise the child thinking it's the cuckold's own child.

10 years later in October 7th 2009 , another article published by Cell explained longer (a-few-decades-long transformation) :

" Does the contraceptive pill alter mate choice in humans?"

Alvergne, A., & Lummaa, V. (2010). Does the contraceptive pill alter mate choice in humans? Trends in Ecology & Evolution, 25(3), 171–179. doi:10.1016/j.tree.2009.08.003

What the article is saying is that although normally hormones cause women to a macho during the woman's most fertile time a macho, ever since the birth control pill in the 60's women are not controlled by the hormones (the pill disrupts them), so they don't prefer the machos but the gentlemen.

So women go from 1960's macho tough guys like Kirk Douglas and Sean Connery to the 1990's more feminine (pretty and delicate) Brad Pitt and Johnny Depp.

Currently, researchers are relying on evolutionary psychology, so they think like this:

The human body is a machine that was built for a specific task – to survive and to reproduce.

Although there is no conscious "engineer" like God, the natural process of evolution arrives after a long time to results that look as if there is an engineer who had goals, who removed that property and added this property.

But evolution doesn't work this way. Instead, it takes what exists and changes it TRANSFORMs it into something a little different and then something more different etc.

Evolution is less of an engineer and more like MacGyver – improvising with what there already is.

Positive discoveries – features

So the researchers are able to verify (or disprove) what they consider as the logical thing to happen.

You can read here about Ovulatory Shift Hypothesis:

https://en.wikipedia.org/wiki/Ovulatory_shift_hypothesis

(I think it's called hypothesis only because the interference of women and political correctness, because women don't like to think of themselves as creatures who are influenced by hormones even though it's natural).

So in the part about "changes in cognition and behavior" we have sexual desire, dissatisfaction with the current man, and flirting with men especially scoundrels ("sexy cads"). The women don't remember them later, because the mechanism is built to have sex with them and then exploit the good man (the steady partner) to raise the child.

In the part about "attraction and preferences" we see the woman is attracted to symmetry (good looks), masculinity (machoism), dominance, creativity, and compatible genes (which means genes different than the woman so that the child will have a diversified immune system).

The woman also beautifies herself and dresses "sexier" in order to be attractive. The woman eats less and is more energetic to meet suitors, and the woman is more competitive towards other women. This competitiveness is used by commercials – that's why commercials display beautiful women.

But there is a whole category of phenomena that you can't discover like that:

Negative discoveries – bugs

These negative discoveries are all sorts of "bugs" that we wouldn't want there, but they are the by-product of adding the new feature. All the things we wouldn't expect to happen but they do, because evolution doesn't operate with a scalpel or a screwdriver, but instead it works with buckets of chemicals and fuzzy logic. So the changes don't change just what evolution "wanted", instead they are sweeping more things that evolution didn't "mean" to.

Do I have a prove of such a thing? Yes. In our case it's called premenstrual syndrome (PMS). To see it more clearly, we will look into the more severe version which is called Premenstrual dysphoric disorder (PMDD).

https://en.wikipedia.org/wiki/Premenstrual_dysphoric_disorder

The general idea that I present here can be summarized in the idiom: "what goes up must come down":

(figuratively) All trends will end; a rise (in the stock market, in a person's political or social influence, etc.) will be followed by a fall.

(figuratively) Substance induced euphoria is followed by withdrawal (often used to describe stimulants though same applies to many other drugs).

Now we can look at this as switching sides along the same straight line: the line between good mood and depression, or the line between energetic and lethargic.

But then we miss a lot. So instead, let's look at all the changes that happen "sideways", which are all the changes that are not along these lines. This way we will gain an understanding for how the transformation happens.

During PMS:

Craving for foods with sugar and fat especially chocolate. This is an extension of what the woman likes best in ordinary times (in regular day-to-day).

During Ovulation:

Desire for short term relations with bad guys, opposite from the one she's with in ordinary times.

So when we think about it like this, suddenly it becomes clear that nature is trying to change the taste of the woman (in general: in food, in men, in everything) between the time of the PMS and the time of the ovulation.

Note to self - begin

Regarding the graphs of hormones in "Popular Science" and Wikipedia (the bottom graph in the picture):

https://www.popsci.com/science-of-pms-food-cravings/

https://en.wikipedia.org/wiki/Menstrual_cycle

https://en.wikipedia.org/wiki/Menstrual_cycle#/media/File:Figure_28_02_07.jpg

check out maybe in the chapter about calculus or in the chapter about number theory (in the context of Euler's Identity that is composed of sine plus cosine)

Is there a relation between:

The graphs of LH and FSH hormones which have their maximum in the critical point, and in this are similar to the cosine function with its maximum in the origin.

And between:

The graphs of feminine sex hormones estrogen and progesterone, which in the critical point are in their middle height, neither maximum nor minimum, and in these are similar to the sine function, which cuts at the origin in the middle.

Could it be that it doesn't just look like sine and cosine, but instead just like the parametric graphs of sine and cosine create a circle (like the most beautiful equation of Euler) so do these 2 groups of hormones create the menstrual cycle? Maybe physiologically the presence of the yellow yolk hormone and the follicle stimulating hormone, is causing the feminine sex hormones to produce a different result, and this is how the cycle works.

Note to self - end

Ok so let's see if instead of mirror reflection (stretch in the negative direction) we actually have here a rotation:

Now we will make an "experiment", we will check if we can predict something that will happen in reality – I predict that here will be a change in the musical taste (preference) of the woman – and indeed searching in Google points out that scientists discovered something like that in 2018:

For Men, High Testosterone Means Low Interest in Classical Music

https://psmag.com/news/our-hormones-appear-to-influence-our-musical-preferences

Negative correlation between salivary testosterone concentration and preference for sophisticated music in males

https://www.sciencedirect.com/science/article/abs/pii/S0191886917306980

True, no research has checked women in different times of the menstrual cycle, but if we equate the low levels of female hormones as if it's a presence of male hormone (the graph which I talked about in the note to myself) then it's reasonable that we will see the same phenomena in women at ovulation.

Their taste in music will also change and be more "macho" like rock instead of sophisticated genres like classical music and jazz.

Nature's amplification of the attractivity of the woman for the "alpha males" brings to mind how before the law forbade it, the TV soundmen used to make the TV programs low volume and the commercials high volume.

CALM Act

https://en.wikipedia.org/wiki/Commercial_Advertisement_Loudness_Mitigation_Act

(by the way nowadays they are doing the same thing in a different technique called dynamic range compression

https://en.wikipedia.org/wiki/Dynamic_range_compression#Marketing)

so nature does the same thing with the woman. The biological price for the good tempting things during ovulation is the miserable creature we call a woman during PMS.

OK. So we talked about the model that psychology works with, where there's simply a flip (switch sides) or mirror image (stretching with switching sides) of what the woman has got at home.

But a slightly more complex model gives us multi-dimensional perspective and what I call "Casanova Effect":

in each stage the woman is trying to get away from what she already knows. The reason is just like the immune system, she is trying to "cover all bases" (she makes many combinations, i.e. children with all the possibilities; I.e. with all types of men) so the chance for her children to survive a pandemic (or some other catastrophe) grows larger.

So now we assume she is not just choosing something in 180° , because then in her next attempt she will come back 180° again and again.

So instead she choses the direction at right (90°) angle what we call in geometry perpendicular and in linear algebra we call it orthogonal. For example if the X axis is the good guy versus the bad guy, so now she will choose along the Y axis which is for example the creative guy, which is something completely different. And if she already tried these 2 axes (X good versus bad, Y creative versus " financially secure ") then she will now try a new axis which is like the Z axis, which is maybe the adventurer axis. Another axis can be the activist axis, and so on.

I don't have proof for that, but I think this was the magical charm of the greatest lover of all time - Giacomo Casanova - the real-life Don Juan[5].

Casanova was expelled from seminary (priest school). After this he was a soldier, a preacher, a spy, a musician, a card gambler, an alchemist, and made his living mainly thanks to women who fell under his spell.

So we see that he is very varied (diverse) so there is "something" for every woman. For a woman who wants a tough guy – he was a soldier. For a woman who wants a good guy – he

[5] An interesting piece of trivia is that Casanova was the basis for Don Giovanni (Italian for Don Juan) the amazing opera by Mozart, and some say he even helped writing the lyrics!

was a priest/preacher. For a woman who wants a creative guy – he was a musician. For a woman who wants a mysterious guy he was an alchemist and a spy. For a woman who wants an adventurer – he was a gambler.

Another circumstantial evidence to the fact that after a woman exhausted one type of man she moves to a different type is "boy band". A boy band has a "pool" of such types in order to "catch" the most girls. They are deliberately composed of a few completely different types, so that each girl can find the "character" that fits with the stage she is in and with what she's looking for at that time.

https://en.wikipedia.org/wiki/Boy_band

... 2gether played off of the idea that every successful boy band must have five distinct personality types: the bad boy, the shy one, the young one, the older brother type, and a heart throb

This can also explain why women are attracted to mysterious guys. Logically the women should think he's hiding things that means there are bad things. But since the criterion is negative, i.e.: "what I am NOT looking for is…", then as long as the man is still mysterious there is a potential that he is an unknown new type.

Another situation where we see the woman trying to find something different from the previous one partner is when she dumps the man because there was some problem and she might try to look for something completely different. This happens because she doesn't know how to foresee (predict) the problem and because in the previous turn she was dealt a bad hand (like in cards), so she tries now to receive new hand filled with random cards, hoping to have better luck with someone completely different from the previous man.

Ok so after all this long explanation I hope you saw an example of when we use rotation (90 degrees which means perpendicular or in higher dimensions we call this orthogonal), and when we use stretching (doing a mirror image is also considered stretching but in the opposite direction).

Ok so now imagine there are many many men and each of them is an arrow that starts from the origin point (the zero point), where the arrow's non-pointy end is; and his pointy end reaches a certain point in space. We said we can think of each single vector like a single point. (the point where that vector's sharp pointy end is). So we will treat all these different vectors as points in space.

Now the woman makes a small change in herself, and all these points in space move from their places. And how can this be? For she changes the vector of what she's looking for. We talked about this vector in the beginning remember? We said each of us has one vector of what he is, and another vector of what he's looking for. We gave an example of a woman who is short and a good cook, and she's looking for a tall engineer, etc.

So now we are talking about the vector of what she's looking for. What the woman is looking for is like the compass (navigation instrument), and all the points in space of various men are like a map. So if from some reason the needle of the compass (i.e. the vector of what the woman is looking for) changes its direction a little, we must change all the points in the map (which means all the men are changing) in order to fit the compass.

In a map made of paper, the change can be only by rotation. But in a map on the screen for example, we can also stretch and do zoom in or zoom out. And if we had photoshop we could also do a mirror image of the map.

A linear transformation is like a map. In fact, if you search Wikipedia in English for linear transformation you get to linear map which is another name for the same thing. So each point on the map is the pointy sharp end of an arrow, by this I mean each point is a man, and the orientation of the map how to rotate how to stretch it is set according to the woman who is a compass and a stretch-o-meter all at one.

What do I mean when I say all the men change? The qualities of each man stay the same as before, but the way that the woman interprets him changes. We can think about it in the following way:

The definitions of the qualities of men are relative and therefore flexible. There is no objective scale. This is true in general. Let's say we entered an online dating service (and let's suppose people are honest) and someone describes himself as messy. What does it mean? It may be that he is a very neat and tidy person, but if there is one sock on the floor, in his terms that's called a mess. So he considers himself by his own standards as messy and disordered.

So in the same way the judgment of the woman when it comes to the qualities of men is subjective and changeable. The compass can show a different "north" as if we put a magnet next to the compass and the needle moved – the compass's needle is the vector of what the woman looks for.

Linear transformations include all kinds of psychological defense mechanisms (for example rationalization, repression, denial). Anything that distorts or manipulates reality. Examples:

(1) Pendulum motion back and forth between two states.
(2) The woman identifies her previous man with quality X and tries to look for the opposite in her next man.
(3) Sliding gradually deeper and deeper into BDSM. What's extreme today tomorrow is normal.
(4) An example for a rotation is displacement or transference in psychology. Transferring the investment in one thing (love) into another thing (career). Or another example for a rotation is transferring being impressed from one thing (creativity) into something else (career). So a woman can think "my talented husband", but actually he only knows how to make money. This isn't called talent.

> This is called going with the flow and land a cushy job in the establishment. This quality is pretty much the opposite of talent.

The woman recalibrating the direction and scale of her impression from the man.

So to understand what is rotation in linear algebra we return back to the idea of the angle between two vectors.

We mentioned earlier that if the vector of what the man embodies and what the woman is looking for are the same, then this is her dream man.

Now let's return to this same idea in the terms that we learned in the plane.

We've seen all sorts of reasons why a woman wants to gradually distance her "wish vector" away from the man's "quality vector".

This is done during a rotation. Why am I saying a rotation and not a stretch? Because the absolute size (the length of the vector) of the desires of the woman is not shortened in any stage of the process.

The situation is NOT that the woman wants less and less qualities from the man until she wants nothing (she reaches the zero or the most average man) and then she increases her desires more and more for qualities in the new direction.

Instead, what happens is that her desires stay in the same strength/size but now point in a new direction gradually, because of a change in the angle (rotation) and not a change in size (strength).

Now we know that when a rotation happens it happens around certain axis (like the axle of a car's wheel), and the point that actually moves (like any point on a tire of a car's wheel) is doing so while being trapped inside a certain two-dimensional plane. In the car's wheel example, the car's wheel disk surface IS the plane.

So inside what two-dimensional plane does the rotation of the woman's desires happen?

Let's start with the simplest example where the woman has a good man at home and now from some reason, she's looking for a bad man.

So the plane of rotation is defined by the two straight lines. One line is the line between the good man and the bad man. But what is the other line?

The other line is the rationalization line and is determined in retrospect according to what is easiest for the woman to falsely accuse the man.

We see this in porn movies of the cuckold genre, that the woman finds an excuse to blame on the husband. If he's uneducated she finds a doctor or a professor. If he's poor she finds someone rich and successful. If he has a small dick, she finds a man with a huge dick. If he's a junior employee she finds his boss at work. If he's physically weak she finds an athlete. Etc.

Each woman creates the plane where she's most comfortable rotating her "wishes vector", but the ultimate goal of the rotation is to finally reach the macho dominant and forceful man with whom the woman wishes to have sex with.

The other vector we can call the "excuse vector", because it's determined as a rationalization of what she can lay the husband's blame on. The husband's blame for the "fact" that the woman was forced to cheat on him because the husband supposedly did not deliver the goods.

Let's take for example the dick size because in porn this is the classic example. The woman literally measures with a ruler and so on.

https://en.wikipedia.org/wiki/Small_penis_humiliation

so we imagine a plane, and just so it's easier to think let's think of a plane where the axes are perpendicular to each other, one horizontal axis and one vertical axis. So the horizontal axis is the wimp to the right and macho to the left. The vertical axis is the bigger dick than average upwards and smaller dick than average downwards.

In all the explanations now we will use the convention that to the right is 0 degrees – this is where we start to count the degrees, up is 90 degrees, left is 180 degrees, and down is 270 degrees. So the numbers grow counter-clockwise. And if we need a negative angle (negative number of degrees) this means we should go clockwise.

So let's suppose the husband's vector is in the right-and-down direction, which means minus 45 degrees (south-east; the hours hand of the clock when it's half past four). What does this tell us with the axes we defined? That he is both a wimp in his character and has a small dick in his body.

Now the tendency of the woman is simply the left direction – macho. She doesn't care about the dick's size. But she needs a rationalization, a story to tell herself, because the thought of the real reason "I'm looking for a shitty man" is unpleasant to her. So she accuses the size of her husband's dick, and she's looking for someone who will be 180° in the opposite direction to her husband. So she reaches the left-and-up direction, which means 135° when starting to count from the right and going anti-clockwise (North-west; the hours hand of the clock when it's half past ten). So she is looking for someone who is both a macho in his character and has a big dick in his body.

We can see that the operation she's doing in her head is equivalent to rotation, by the fact that in the intermediate state (for example in the man she will date right after she got sick of her husband) she will look for some of the qualities of her husband. In our example, she will pass through the intermediate state of plus 45° (North-east; the hours hand of the clock when it's half past two), which means someone who is a wimp in his character and has a big dick in his body. This of course doesn't satisfy her, because what she really wanted was a macho. But this absurd result in reached because this is done by rotation. The rotation is caused because she is not honest with herself.

I can give you a real-life example for just such a situation. My mythological-ex, after she dumped me dated someone whose name was Nir and he's a lawyer (my name is Nir and in my profession I'm a lawyer although I don't work in this profession). So of course she did not stay with this man, but this is equivalent to the intermediate point of the big dicked wimp that we just discussed. In this real-life example of my ex, the false quality she claimed she is looking for is someone who works in an ordinary job etc (which is equivalent to the lie where the woman in the imaginary example seeks a big dick). In reality this is the only quality she managed to find that I clearly lacked. Why is this an excuse? Because she knew this from day one, and I have enough money so it didn't bother her. What she really wanted was to get to a man who is a self-absorbed macho who doesn't care about her, and indeed today she lives with exactly that kind of man.

Okay so now I will show you a numerical example of how to rotate a point in the plane. Don't be scared, you don't need to understand this in order to understand the book, you can simply skip this part. I just add this here in case someone wants to see how it's done with numbers instead of words. Notice how much shorter it is.

https://en.wikipedia.org/wiki/Rotation_matrix

$$x_{new} = x_{old}\cos\theta - y_{old}\sin\theta$$

$$y_{new} = x_{old}\sin\theta + y_{old}\cos\theta$$

Isn't this so much shorter then tons of text? Right now it's Greek to us. The funny looking character is called theta and it IS Greek, this is our angle, for example 45° etc.

but try to feel on an intuitive level how powerful this is, if we can shorthand so much text into 2 lines.

Okay this was in the language of equations. Here is the same thing in the language of matrices, which we will discuss in the next sub-chapter. Even more short and elegant:

$$Matrix = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}$$

$$Vector = \begin{bmatrix} x_{old} \\ y_{old} \end{bmatrix}$$

When we multiply the vector by the matrix this gives us the same result as the equations, but it's much shorter. Instead of all the cosines and sines we can just say "matrix". Of course, this is just one example. There are many kinds of matrices, so we need to give them names, we can't just call any matrix we see "matrix". So in Wikipedia you see that they called the matrix R (just a name, because it does rotation), and the vector they called $\boldsymbol{v}$.

It's customary to write vectors in **bold**, so that we know it's not a variable like x or y (a number) but instead it's a vector (an ordered list of numbers).

I don't want to explain the trigonometry of why this specific combination of sines and cosines rotate a point.

https://en.wikipedia.org/wiki/Rotation_(mathematics)#/media/File:Coordinate_system_rotation_svg.svg

If you're curious take a look in this picture by Jochen Burghardt in Wikipedia, and he also explains it with a nice short explanation below the picture.

The reason I'm not going into this myself is not because I don't think it's cool. I want to keep your energy and focus for the next big idea we are going to see – what is the matrix?

Subchapter 1.04 – Matrices as women's minds

OK so at first I tried to make this sub-chapter for you as an extension of the previous sub-chapters talking about qualities. So I defined "i hat" as the vector of the man's worth (what grades the woman gives him in her mind), and I defined "j hat" as the vector of the woman's worth (what grades the woman gives herself in her own mind) which is the woman's self image. Each of these vectors is prone to change after a conversation between the woman and the woman's girl friends.

So I was able to explain why "i hat" changed and why "j hat" changed after the conversation with the woman's girl friends. But I got stuck when I tried to explain what does it mean MINUS "i hat" and what does it mean TWICE "j hat". Why would anyone flip over the man's qualities? Why would anyone double the woman's qualities?

So now I will turn to an idea we had since the beginning with the "wish vector" or "desire vector". Instead of 2 qualities vectors, the woman now holds in her mind 2 "motivation vectors" or "goal vectors". We need to change accordingly the axes. Instead of beauty and brains which I used with qualities, I will now use career and family as the 2 axes.

So the woman has 2 "motivation vectors" in her mind. "i hat" describes the man's motivations or goals as the woman sees them. "j hat" describes the woman's own motivations or goals as the woman herself sees them. Again since both "i hat" and "j hat" describe subjective estimations in the woman's mind, they both can be changed by a talk with the woman's girl friends.

But now there is also meaning to negative factor and multiple factor. If the woman is spiteful (doing something just to spite, to hurt or annoy the man) then this is the negative. If the woman estimates the man wants something she will want to do MINUS that something, or in other words the opposite of that something. And the multiplication factor is how importance the woman gives to that vector. If the final vector $\vec{v}$ is the sum of MINUS $\hat{\imath}$ plus 2 times $\hat{\jmath}$ this means that the woman is spiteful to what the husband wants, and in addition her own goals are twice as important for her (in comparison to the husband's goals).

So these 2 vectors together when we add them span the entire "common goals" plane. If we will need to interpret in the future a MINUS $\hat{\jmath}$ we can attribute this to the woman punishes herself or being masochistic somehow. You have to admit that the MINUS $\hat{\imath}$ scenario with the woman being bitchy or shrewish seems more realistic! 😊

OK so here goes I'm revising my original text:

How do we describe the linear transformations (changes in women's minds) ?

The easiest way is to keep track (follow) what happens to the basis vectors.

[I'm reminding ourselves that the basis vectors are minimal vectors that span a specific plane (for example the socio-economical plane) or a specific space (for example the "father material" space).

If we will know what happens to the basis vectors in the transformation, we can make the changes only in them, and because we can build any vector in this plane (or space) from the basis vectors, then the changes (of the transformation) will be expressed in all the vectors in that plane (or space).

Note: I am writing this part of the book following the wonderful videos of 3Blue1Brown in Youtube "Essence of linear algebra". We are now in minute 3:32 in the third video:

"Linear transformations and matrices | Essence of linear algebra, chapter 3"

The person who makes that Youtube channel is Grant Sanderson. He's very good at explaining. He explains with numbers and graphics, and here I try to explain in words.

By the way, if this book ever reaches that point, according to Wikipedia, Grant Sanderson made videos about multivariable calculus for Khan Academy, so maybe those will help if I'll make a chapter about that.

Anyway, what I wanted to say is that he is using the unit vectors ($\hat{\imath}$ and $\hat{\jmath}$) as the basis vectors, so I will do the same thing here now.

So in our examples from now on, the main woman has 2 vectors inside her head:

One vector which we will call "i hat" which is what the woman thinks that the man wants. Because it's an estimation inside the woman's mind, the vector can change after a talk between the main woman and a girl friend of hers.

Yes I know we said that "i hat" is the unit vector, and it's like our unit of "centimeter" or "inch", but the video in 3Blue1Brown is talking about the base vector and shows the unit vector. If you think about it it's clearer this way because you can "build" using the unit vectors any "composite" vector, and so the unit vectors are the most basic basis.

So we use this arrow (vector) that symbolizes the "grades" (like in a "report card") that the woman is giving to this specific man's motivations towards certain goals (in the beginning, before talking to her friends) as our ruler of measure unit. This is our base for comparison after the woman's conversation with her friends.

If after the conversation we say that this specific man (in the woman's mind) is 3 times " i hat ", this means that his motivation towards these goals (in the woman's mind) is 3 times as much as she originally thought.

What does it mean? Let's take ambition. What I will write here is not based on scientific study but on my own impressions through the years but I'm very certain about this. Ambition is the single best predictor to financial success. Since woman's favorite thing in man is his financial success, it follows that trait that woman find most appealing in a man is ambition. Sometimes it's written black on white what that the woman is looking for someone ambitious, and other times it's lightly camouflaged as a description of a man who is "going places", "knows what he wants", "sets goals and achieves them" etc.

There is a theoretical possibility that this is true only about Israeli girls, because obviously I only looked for Israeli girls all these years, since I can't catch a flight for every date. But I'm pretty sure that because women's desire for rich men is global, and since also globally the best predictor for who will be rich is ambition, then rule of women love ambitious men holds true also around the world. Again, this is a predictor, so if a woman has a chance to get someone who is a billionaire but isn't ambitious (for example he inherited his rich family's wealth) then the woman would prefer this to a man who is just ambitious, because here it's not probability, it's a certainty.

Do women want the man to be infinitely ambitious? Or is it at some point too much? For example in my original example I talked about height. When it comes to men's height, women are very attracted to height up to 1.87 meters which is the ideal, but after that it's starting to be too much, like a man who is 2.5 meters will have a very hard time to find a woman. But do women find people from the Forbes list billionaires like Jeff Bezos or Bill Gates too ambitious? I don't think so.

As for how do we measure ambition it's a lot harder than my original example of height, but it's clear that here also we need to use a logarithmic scale. This means that the woman doesn't want a man who aspires to be a janitor, and much prefers a man who aspires to be in a managerial position. But from some point if he will be the CEO or the chairman of the board, or the President of the company, I don't think it matters that much to the woman, each further ambition for the next promotion is less critical for the woman.

Also I'm pretty sure that women want to see the man makes concrete steps towards (or ideally achieving already) that high goal. If a man lies napping in bed all day daydreaming about becoming the manager of some company that's not ambition that's fantasy.

OK so how do we quantize this property where the first promotion is very crucial, the second promotion is important, the third is nice to have and so on, and by the time you are in the highest steps in the ladder the woman is less and less impressed by the increments that initially impressed her a lot in the first steps?

So we calibrate the scale accordingly so the grade will have meaning. We do this according to a logarithmic scale, which means the more you go up the harder it is to "score" points.

Examples of logarithmic scale in other areas:

Richter - scale to measure the strength of earthquakes.

Decibel (in acoustics) - scale of sound pressure level (how loud is the "volume" we hear).

pH - a scale used to specify the acidity or basicity of a watery solution in chemistry.

Magnitude (in astronomy) - scale of the brightness of stars.

Here is another example: in the psychometric test in Israel (which you need to enter the university) the closer you get to the maximal perfect score (800) the more each little mistake lowers your score.

Our mechanism of calculating the "score" in our case will include also Standard Deviation.

https://en.wikipedia.org/wiki/Standard_deviation

This means that if we plot the graph of normal distribution (or bell-shaped curve) which looks like the way kids draw a hill, then most of the people will be close to the middle of the hill, there are fewer and fewer the more we go from the middle to the right side (very high scores) and also there are fewer and fewer the more we go from the middle to the left side (very low scores).

If we want this more accurately we have the " 68–95–99.7 rule " :

https://en.wikipedia.org/wiki/68%E2%80%9395%E2%80%9399.7_rule

See this picture:

https://en.wikipedia.org/wiki/Standard_deviation#/media/File:Standard_deviation_diagram.svg

68% of the people will be less than 1 Standard Deviation (dark blue area in the picture) from the average (the center of the "hill").

95% of the people will be less than 2 Standard Deviations (dark blue and light blue together in the picture) from the average (the center of the "hill").

99.7% of the people will be less than 3 Standard Deviations (dark blue and light blue and very light blue together in the picture) from the average (the center of the "hill").

So we will have some kind of a logarithmic scale of standard deviations. I don't know how to build such a "ruler" right now, but for a mathematician I'm sure it's not hard. And after a mathematician builds such a "ruler" for us, we can use that "ruler" which is easy to do.

Ok now what about " j hat " ?

So "j hat" will be the vector of "self-image" of the woman's own ambitions. Which means what the woman thinks she wants. Why don't I simply say "what the woman wants"? Because people are not aware of what they really want. For example I said we'll use the quality of the woman's tendency to go against the husband's wishes, be it a rebellion for independence in the relationship, or be it as a way of revenge against the husband for feeling mistreated, or maybe the woman just likes to show dominance in the relationship. Whichever is the case, we see a lot of it the older the couple gets.

So I don't think that in these situations the woman takes a conscious decision to be a bitch, she just does this on "auto-pilot" without even thinking. Maybe she's not even aware that she's being a bitch. So this vector talks about her "legitimate" ambitions that she is aware of.

As I said before, we will take into consideration the part that she isn't aware of (her spitefulness) into the total calculation of her wishes, when we introduce the MINUS sign when we add the vectors "i hat" (man's motivation) and "j hat" (woman's motivation).

The axes in our current example will be two kinds of motivations that women like to discuss a lot: career and family.

The horizontal axis is the career axis. The more someone is to the right, the more he or she has professional ambition to get the next promotion, to make more money etc. The more to the left side they are like "The Dude" from The Big Lebowski. (by the way I don't understand why this movie became a success).

The vertical axis is the family-oriented axis. You can read here what it means:

https://www.wikihow.com/Be-More-Family-Oriented

The higher someone is upwards, the more he or she will want to find a wife or a husband, to have children together, to spend time with their loved ones, to go out on trips together etc. The lower someone is downwards the less he or she wants to marry and raise kids and spend time with them etc.

So now back to the motivations' vectors " i hat " and " j hat ".

Both these vectors are in the woman's thoughts so they can be influenced by talks with her lady friends.

Let's say for example that a young woman is very dedicated to her career and works non stop flying all around the world to business meetings. Then her friends tell her: you should slow down with your career and dedicate part of your effort into settling down and starting a family, because you are going to miss this later, and later will be too late because you will be too old and picky. So hopefully the woman listens to her girl friends and change her motivations so they are more balanced.

So when we say that the "conscious motivations " of the woman is 2 times "j-hat", this means that her own motivations (the way the woman sees herself) after the conversation with the girl friend, are 2 times more than what the woman initially was before the conversation with the girl friend.

These 2 basis vectors ("i hat" the vector of the man's motivations (as the woman sees them); and "j hat" the vector of woman's motivations (again as the woman sees them)) together span a plane which we'll call the "woman's actual total motivations" plane. The vectors (this much "i hat" plus that much "j hat") we get in this plane will tell us what the woman will actually try to achieve in the real world after all the calculations in her head (both conscious calculations and unconscious calculations).

If she is a good wife the " i hat " plus " j hat " will have a positive sign before the " i hat " which means she takes the husband's wishes into consideration when she plans what she wants. If it has a negative sign before " i hat " then she is a bad wife. If she is punishing herself from some reason (like if she's self-destructive maybe) she will put a negative sign before the " j hat " (her own formal/declared wishes). If she is a normal (not self-destructive) person she will have a positive sign before the " j hat ".

OK now let's take a situation from a video in the 3Blue1Brown YouTube channel,

Linear transformations and matrices | Essence of linear algebra, chapter 3 (in time 3:50 minutes)

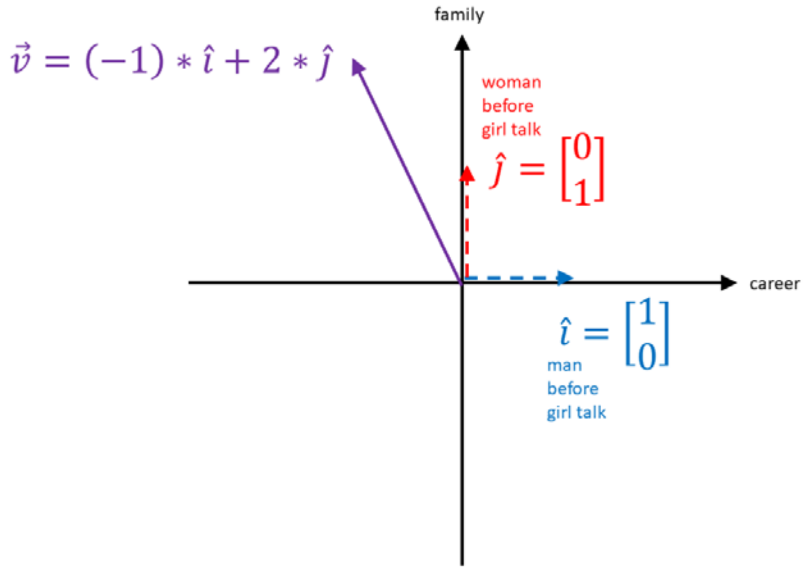
https://www.youtube.com/watch?v=kYB8IZa5AuE

And we'll try to interpret this situation using our new tools.

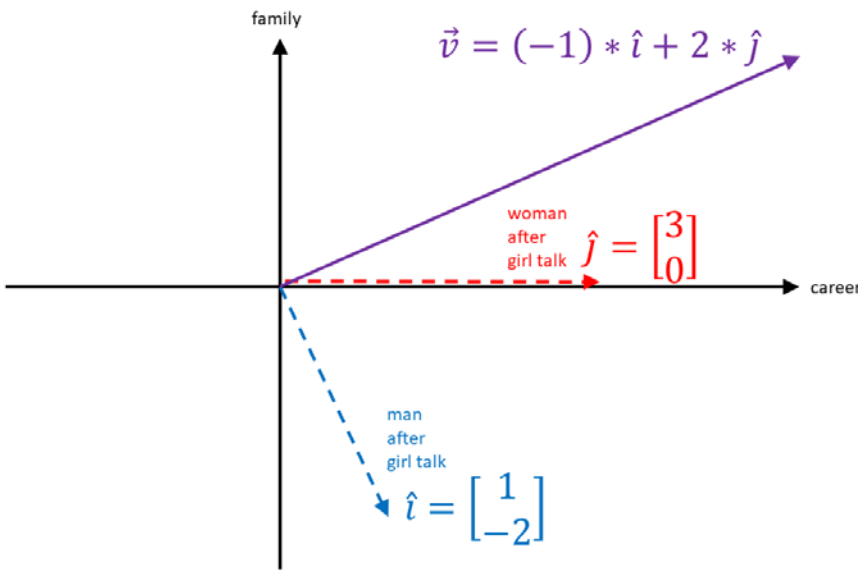
Let's call our main woman Alice. Her boyfriend is a man called Bob. Then she calls her woman friend Carol on the phone and asks for Carol's advice about what Alice's and Bob's goals should be.

Both before the talk with Carol and after the talk with Carol, all the time Alice's "total actual motivation" is the vector $\vec{v}$ which equals minus 1 "i hat" (Bob's goals) and plus 2 "j hat" (Alice's goals). BUT before the talk with Carol the " i hat " and " j hat " have specific values; and after the with Carol the " i hat " and " j hat " have completely different specific values.

BEFORE the talk:



AFTER the talk:



Before the conversation with Carol, Alice thinks that Alice is focused on family, and Alice thinks that Bob is focused on career. Alice is being spiteful towards Bob and in addition Alice puts twice the emphasis on her own goals. So the result is that the total actual motivation of Alice (before the talk with Carol) is away from career of the couple and strongly towards starting a family of Alice and Bob as a couple.

Carol tells Alice that in order to achieve what Alice wants (raising a family) Alice and Bob first need money in the bank, and so Alice needs to push Bob to get ahead in his career. So the "formal" goal of Alice shifts towards their couple's career.

In addition Carol tells Alice that Bob's internal orientation towards career means that Bob indeed wants a career but it also means that Bob has no desire to be a family man at all. So Alice is now interpreting Bob's internal motivation as putting effort into work and not putting any effort into family.

The addition that Alice is doing is still the same addition: she is spiteful towards bob plus putting twice the emphasis on her own wishes. So the result is that the total actual motivation of Alice (after the talk with Carol) is towards tons of career and a lot of family.

In conclusion Carol's action on Alice boils down to rotating Alice's two vectors (i hat and j hat) clockwise and stretching them (like zoom in), and as a result of this also the $\vec{v}$ vector which is the vector of Alice's total actual motivation.

At the end of the previous subchapter we talked about the rotation matrix. We saw that a matrix is a way to describe doing something (transformation) to a vector. Just like we can do this transformation of rotation to this vector and that vector and any vector we want, so we can do this transformation of "Carol" to any vector we want.

In our example Alice's "recipe" for her total actual motivation (the purple vector) was MINUS 1 times Bob plus 2 times Alice.

So we "Carolized" the purple vector $\vec{v} = \begin{bmatrix} -1 \\ 2 \end{bmatrix}$ (left and up up) and turned it into $\vec{v} = \begin{bmatrix} 5 \\ 2 \end{bmatrix}$ (right right right right right and up up).

But what if tomorrow Alice has another "recipe" for her total actual motivation: x times " i hat " (Bob's motivation) and y times " j hat " (Alice's motivation) ?

$\hat{\imath} \rightarrow \begin{bmatrix} 1 \\ -2 \end{bmatrix}$ where " i hat " lands.

$\hat{\jmath} \rightarrow \begin{bmatrix} 3 \\ 0 \end{bmatrix}$ where " j hat " lands.

So if Alice tomorrow has some other purple vector $\begin{bmatrix} x \\ y \end{bmatrix}$ then it will go to:

$$\begin{bmatrix} x \\ y \end{bmatrix} \to x \begin{bmatrix} 1 \\ -2 \end{bmatrix} + y \begin{bmatrix} 3 \\ 0 \end{bmatrix} = \begin{bmatrix} 1x + 3y \\ -2x + 0y \end{bmatrix}$$

A matrix is just a way of writing this without the cumbersome x's y's and plus's :

$$\begin{bmatrix} 1 & 3 \\ -2 & 0 \end{bmatrix}$$

This is the matrix Carol. Each girl friend of the woman is a Matrix. A matrix is a description of a transformation. What does the matrix transform (changes)? Each matrix does a different change to Alice's purple vector.

In order for a transformation (like that described in the matrix Carol) to be LINEAR transformation, we have two requirements:

"Additivity"

Carol of (first vector plus second vector) should equal Carol of (first vector) plus Carol of (second vector).

For example:

$$Carol(\hat{\imath} + \hat{\jmath}) = Carol(\hat{\imath}) + Carol(\hat{\jmath})$$

In simple words:

The purple after Carol did her action on the purple EQUALS the blue after Carol did her action on the blue, PLUS the red after Carol did her action on the red.

Roughly speaking: The whole is equal to the sum of its parts.

"Scaling"

Carol of (some number times a vector) should equal that number times Carol of (that vector).

For example (not shown in our above drawing):

$$Carol(2 * \hat{v}) = 2 * Carol(\hat{v})$$

In simple words:

If we doubled the purple (before Carol) and then Carolized, we would get the same result Carolizing the purple and then doubling it (after Carol).

Roughly speaking: The "stretch" of the whole is the "stretch" of its parts.

Subchapter 1.05 – Matrix multiplication as girl talk

We said talking with a girl friend changes the woman's vectors. Let's say the main woman Alice has more than one girl friend, and she is asking advice on the phone from Natalie and then from Erin.

After the talk with Natalie, Alice's vectors (Alice's opinions about Bob's motivations and Alice's own motivations) change. And then when Alice calls Erin, the changes that Erin do to Alice start from the point the Natalie finished, and not from the beginning of Alice before Natalie. So after the talk with Erin, Alice was changed by Natalie and from there changed even more by Erin.

We can also think of a hypothetical friend NataliErin who does the changes of both of these girls in one talk in this order. We can also think of ANOTHER hypothetical friend EriNatalie who does the changes of both of these girls but in the other order. We will see that we get a different result! This means Alice reaches a different opinion if she phones Natalie first and then Erin second as compared to her opinion if she phones Erin first and then Natalie second.

Let's say Erin is a " counter clockwise rotation by 90° " matrix, and Erin is a shear matrix (which you can see here https://en.wikipedia.org/wiki/Shear_mapping).

Let's see what this means in the context of the motivations' vectors of Alice and Bob.

I will be using the example in 3Blue1Brown 's 4^{th} video:

Matrix multiplication as composition | Essence of linear algebra, chapter 4

https://www.youtube.com/watch?v=XkY2DOUCWMU

$$Erin = Rotation\ 90° = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$$

Why is this matrix a rotation? Let's say we start with some vector $\begin{bmatrix} x \\ y \end{bmatrix}$

Then when the matrix multiplies the vector the result is:

$$x * \begin{bmatrix} 0 \\ 1 \end{bmatrix} + y * \begin{bmatrix} -1 \\ 0 \end{bmatrix}$$

So the transformation in a nutshell is:

$$\begin{bmatrix} x \\ y \end{bmatrix} \to \begin{bmatrix} -y \\ x \end{bmatrix}$$

You can try this on paper and you'll see that it rotates the vector counterclockwise (we will start with pointing to the right which is 1 in the positive direction of the x axis and 0 on the y axis):

$$\begin{bmatrix} 1 \\ 0 \end{bmatrix} \to \begin{bmatrix} 0 \\ 1 \end{bmatrix} \to \begin{bmatrix} -1 \\ 0 \end{bmatrix} \to \begin{bmatrix} 0 \\ -1 \end{bmatrix} \to \cdots$$

This was Erin. Now we will check out Natalie.

$$Natalie = Shear = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

Why is this matrix a shear? Let's say we start with some vector $\begin{bmatrix} x \\ y \end{bmatrix}$

Then when the matrix multiplies the vector the result is:

$$x * \begin{bmatrix} 1 \\ 0 \end{bmatrix} + y * \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

So the transformation in a nutshell is:

$$\begin{bmatrix} x \\ y \end{bmatrix} \to \begin{bmatrix} x + y \\ y \end{bmatrix}$$

You can try this on paper and you'll see that it shears the vector or like he says in the video "fixes i hat and smooshes j hat to the right".

Let's check the four directions of the "compass rose" right, up, left, and down:

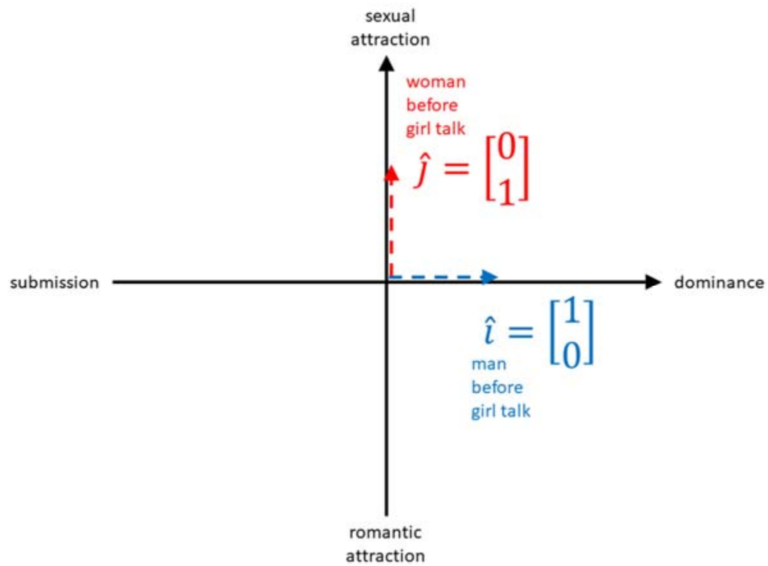
$$\begin{bmatrix} 1 \\ 0 \end{bmatrix} \to that's\ it$$

$$\begin{bmatrix} 0 \\ 1 \end{bmatrix} \to \begin{bmatrix} 1 \\ 1 \end{bmatrix} \to \begin{bmatrix} 2 \\ 1 \end{bmatrix} \to \begin{bmatrix} 3 \\ 1 \end{bmatrix} \to \cdots$$

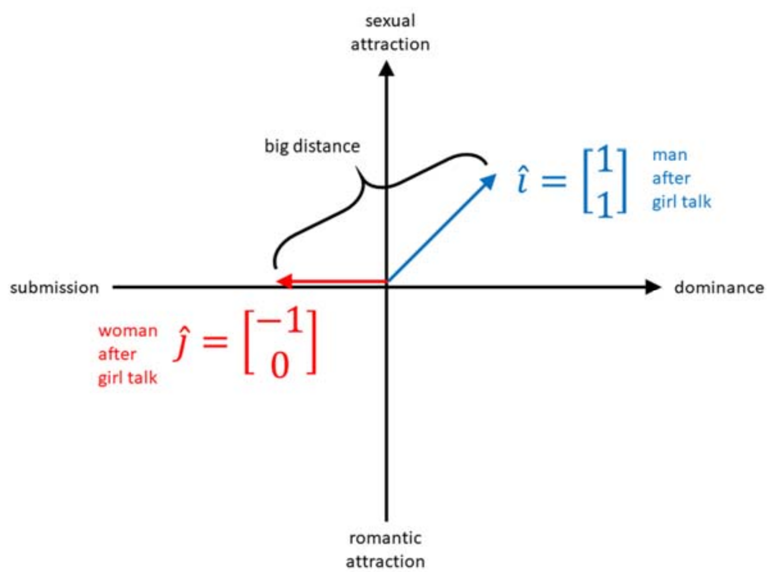
$$\begin{bmatrix} -1 \\ 0 \end{bmatrix} \to that's\ it$$

$$\begin{bmatrix} 0 \\ -1 \end{bmatrix} \to \begin{bmatrix} -1 \\ -1 \end{bmatrix} \to \begin{bmatrix} -2 \\ -1 \end{bmatrix} \to \begin{bmatrix} -3 \\ -1 \end{bmatrix} \to \cdots$$

Before Rotate and Shear (EriNatalie)



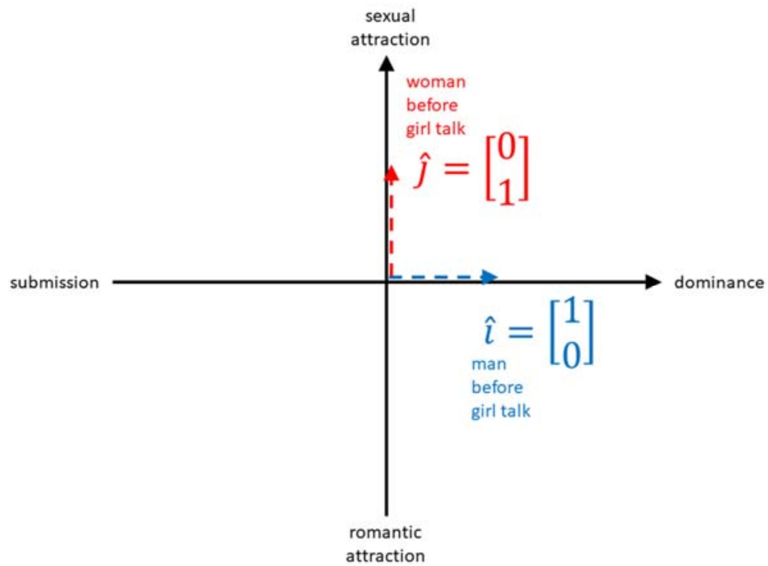
After Rotate and Shear (EriNatalie)



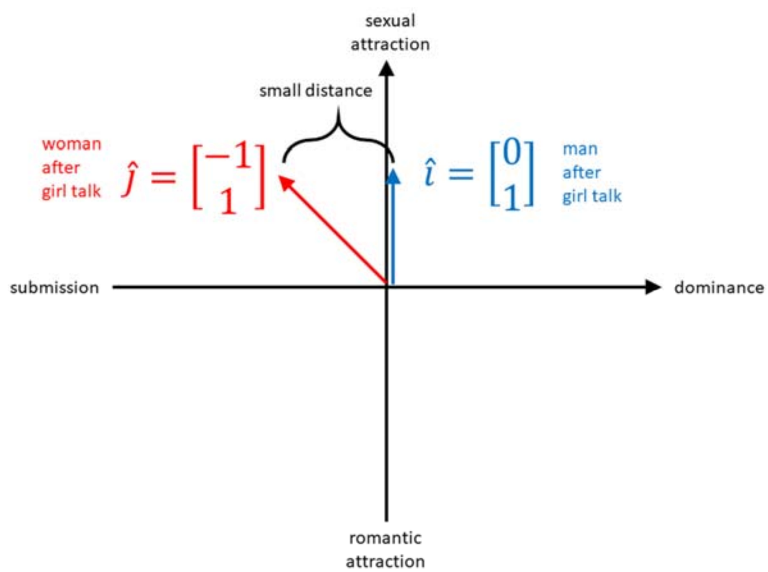
Note: big distance between the " i hat " and " j hat ".

So the man and woman want things in different directions so it's a bad match.

Before Shear and Rotate (NataliErin)



After Shear and Rotate (NataliErin)



Note: small distance between the " i hat " and " j hat ".

So the man and woman want things in similar directions so it's a good match.

So what's the story?

By the way this is based on a true story. This was basically the discussion between my mythological-ex and her two best friends right at the beginning of our relationship when she was contemplating whether to go on dating with me or to dump me. What happened was that my mythological-ex and me talked on the phone, and I even remember where I was when it happened, in the bedroom of my grandma's apartment back when my grandma was still alive. So anyway my ex asked me about something: "are you a masochist?" and I answered "no, if anything just the opposite". So my ex said "now it's getting interesting". On the one hand this was a good thing, because she kept on dating with me (she liked the light BDSM stuff). On the other hand she only saw me as a sex thing and then dumped me after 6 months when she wanted something serious. Of course I was super serious but there was nothing I could do.

I still remember how "Natalie" interpreted my love and affection towards "Alice" as "put her on a pedestal" ("Natalie" actually used the English word pedestal by the way). For "Natalie" this was also a sign that I am abusive and my motivation is to talk to "Alice" as if she was a goddess while I treat her like a sex slave (of course ALL of this in "Natalie"'s imaginary world!).

By the way, when "Alice" dumped me after 6 months, she got "help" (as if she needed help) by that same twisted "Natalie" and her boyfriend who is a homicide detective at the police (at least at the time). Which according to "Natalie" herself that profession shows that her boyfriend is a "closet" psycho. By the way also "Natalie" works as a social worker with dangerous violent people because she is attracted to them (again according to "Natalie"'s stories through "Alice"). Do you see how twisted and harmful people can be?

OK so Alice is talking to Erin who is a rotation matrix and to Natalie who is a shear matrix.

Natalie came from an abusive relationship where she was a sex slave to a cruel guy. So Natalie sees sexuality as dominance and the desire to control. In Natalie's opinion the woman has no way to exit from submission once she gets there (like when we said "that's it" because the vector is "stuck"). And in the same way the man has no way to exit from dominance once he gets there.

Erin came from divorcing an ex-husband of hers who turned out to be bipolar (manic depressive). Erin sees BDSM as developed sexuality. Erin thinks that each partner in the couple goes through the rotation one time on top on time on the bottom one time attracted physically another time sexually so we have a repeating circle (rotation).

The axes in our example are:

Horizontal axis: Dominance vs Submission (the more you go to the right the more dominant over your partner you want to be. The more you go to the left the more submissive to your partner you want to be).

Vertical Axis: Sexual attraction vs Romantic attraction (the more you ascend up the more you are attracted to your partner on the basis of sexual desire. The more you descend down the more you are attracted to your partner because of romantic feelings).

So my guess is that in my case in real life "Alice" phoned to "Natalie" and only after "Alice" phoned to "Erin". So at the end of these two phone calls "Alice" saw herself like in a partner dance where she follow and man leads, and she saw the man as very sexual.

And so by lucky order of phone calls "Alice" decided to go on dating with "Bob".

If the phone calls order had been first Erin and then Natalie, then Alice would see herself as submissive well beyond the point where she's enjoying it sexually, and she would have seen the man as a sex crazed beast who just wants to dominate her and she would have dumped "Bob" on the spot.

Conclusion: the order of multiplication of matrices MATTERS A LOT!!!

$$Erin\ * Natalie\ \neq Natalie\ * Erin$$

As for how to do the actual multiplication I think the video describes it much better than I can.

The important thing to remember is that the one who is written on the left most is the last one to be done (the opposite of English where we go from left to right). Here we first multiply the vector by the matrix Natalie. So we get a new vector which is the result. And this result vector we then multiply by the matrix Erin:

Erin * Natalie * $\begin{bmatrix} x \\ y \end{bmatrix}$

Subchapter 1.06 – Higher dimensions as in-laws

Three-dimensional linear transformations | Essence of linear algebra, chapter 5

https://www.youtube.com/watch?v=rHLEWRxRGiM

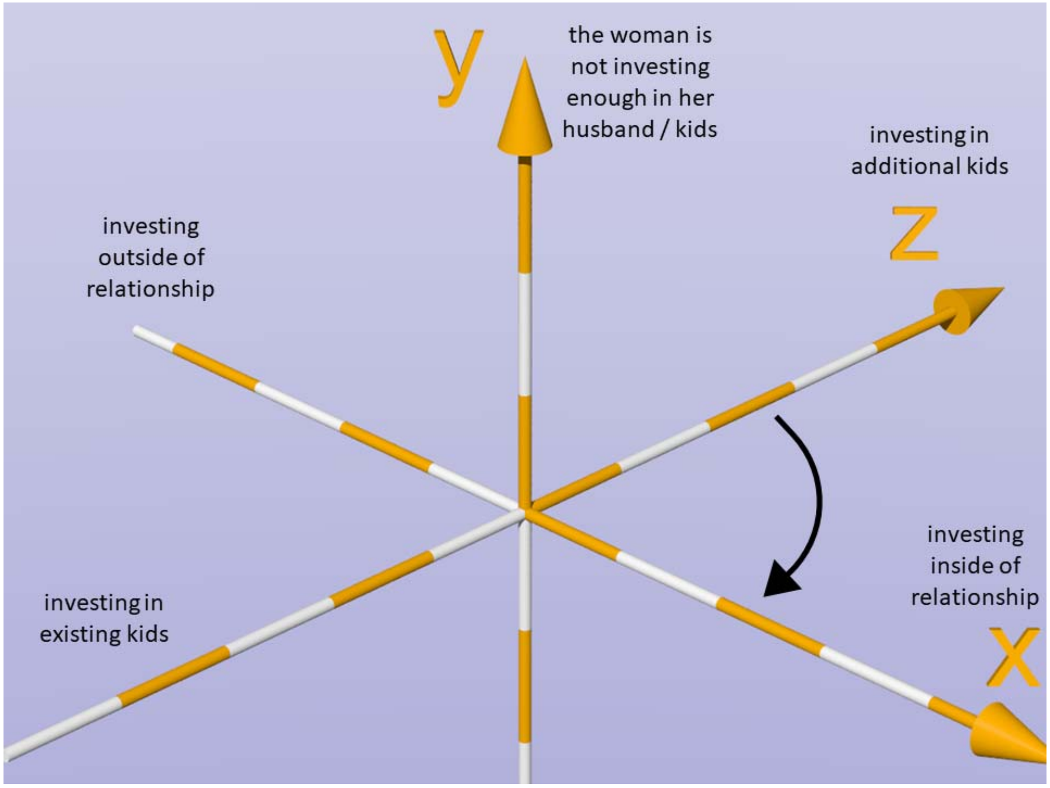
Thank you very much to POV-Ray (Persistence of Vision Ray Tracer) software!

https://en.wikipedia.org/wiki/POV-Ray

The circle (in time) which we will describe goes like this:

Step Number	**Motivation of woman**	**Motivation of man**
1	Woman flirtatious and seeks sex.	The man seeks sex with his wife.
2	The woman is a mom concentrated on raising children.	With his female no longer "in heat", the man loses interest and does NOT invest in the relationship.
3	She is not in the mood for sex.	The man seeks sex with a concubine.
4	The woman wants to get pregnant and have another child.	Since his female is "in heat" again, the man regains interest and DOES invest in their relationship.

Our axes look like in the following picture:



Positive horizontal (X to the right) axis means "investing inside of relationship".

Negative horizontal (X to the left) axis means "investing outside of relationship".

Positive vertical (Y upwards) axis should mean "woman should invest more in husband"

Negative vertical (Y downwards) axis should mean "woman should invest more in kids"

BUT FOR THE SAKE OF SIMPLICITY WE WILL IGNORE THE Y AXIS COMPLETELY!

So just think of a mean mother in law who is always unhappy with what they are doing and always wants something different then what the couple wants.

Positive near-and-away (Z into the screen away from us) axis means "investing in making additional children"

Negative near-and-away (Z coming out of the screen closer towards us) axis means "investing in already existing children"

The direction of the rotation we will keep doing (90 °) is shown in a curved black arrow from positive Z (12 o'clock) to positive X (3 o'clock) and so on clockwise.

The woman each time leads and the man follows.

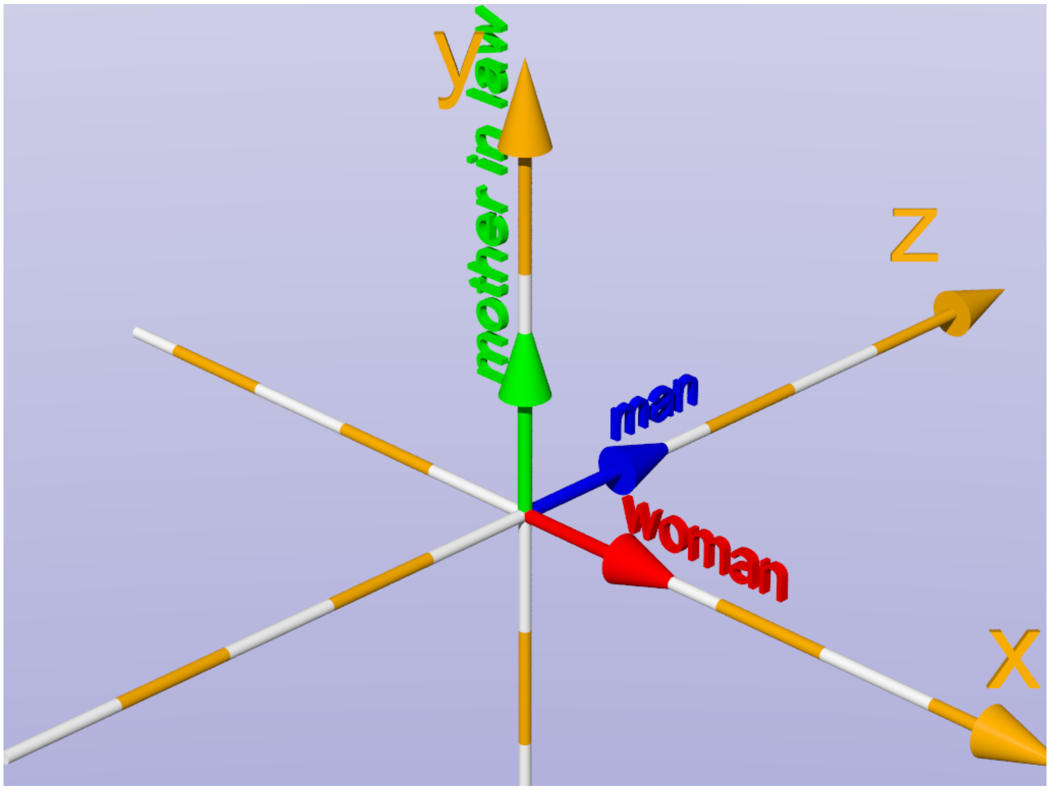
When the woman moves to the next step the man catches up with the previous step. For example:

When the woman is in step 1 (flirty) and moving to step 2 (mom) it takes time for the man to adjust to the new situation, he doesn't understand how this fun-loving woman of yesterday is the one minded dedicated mom "machine" of today. By the way once the baby is born the hormones make the woman 100% concentrated on the baby, so the term "MILF" in porn is totally unrealistic.

Step 1:

The woman leads the change and she's pointing towards positive X direction (investing in the relationship).

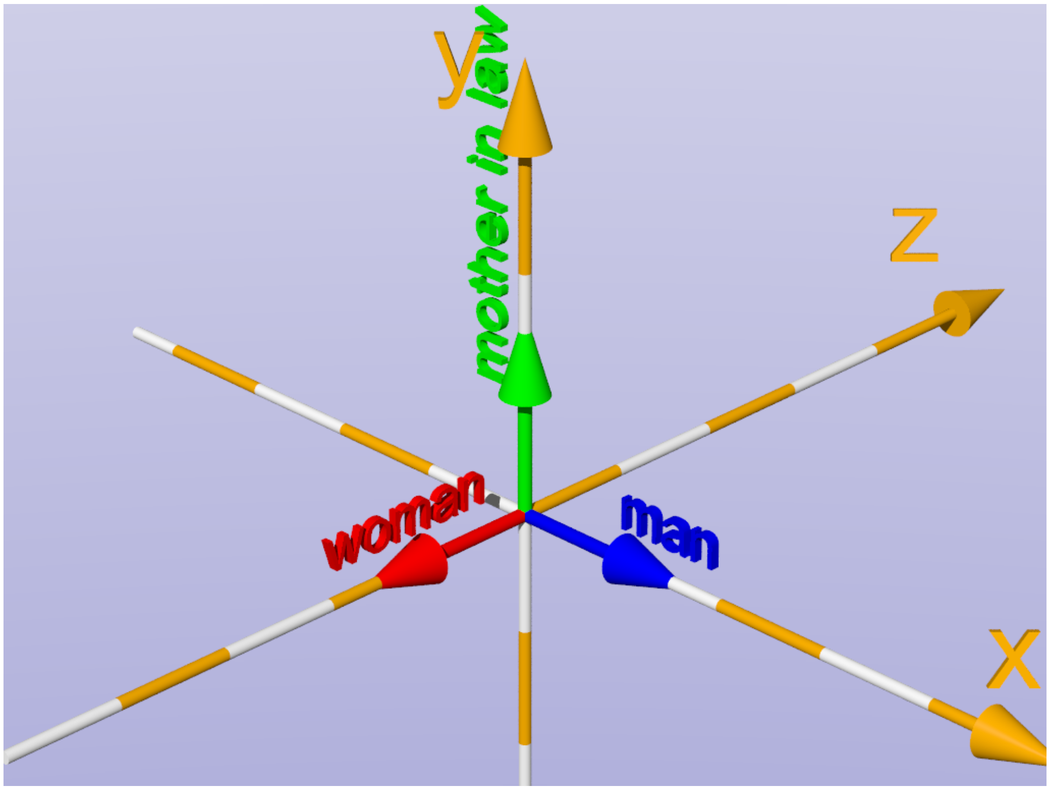
The man follows her and he's pointing towards positive Z direction (investing in additional children).



Step 2:

The woman leads the change and she's pointing towards negative Z direction (investing more in the now existing child).

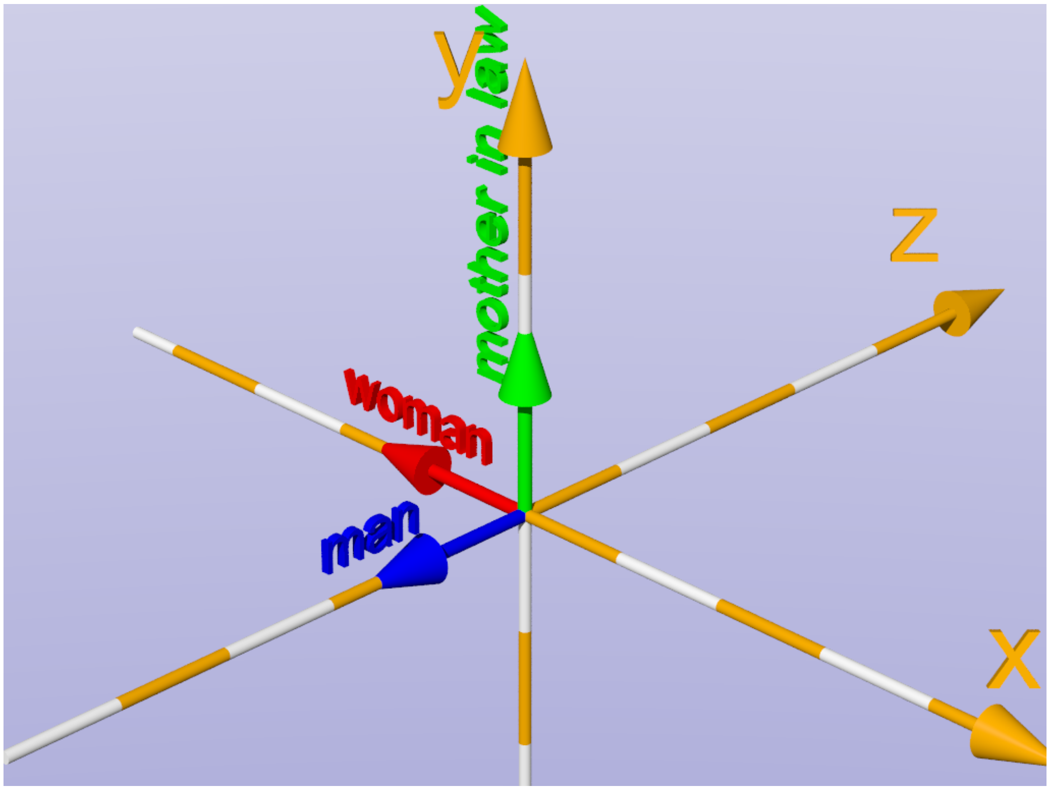
The man follows her and he's pointing towards positive X direction (investing in the relationship).



Step 3:

The woman leads the change and she's pointing towards negative X direction (investing outside of the relationship which in her case means she cares only about herself and the baby).

The man follows her and he's pointing towards negative Z direction (investing in the now existing child).



In English this is called "baby brain". In Hebrew we're rude so it's called "pregnancy dumbness". You can read the scientific explanation here:

Pregnancy leads to long-lasting changes in human brain structure

https://www.nature.com/articles/nn.4458

Nature Neuroscience volume 20, pages287–296(2017)

Pregnancy resculpts women's brains for at least 2 years

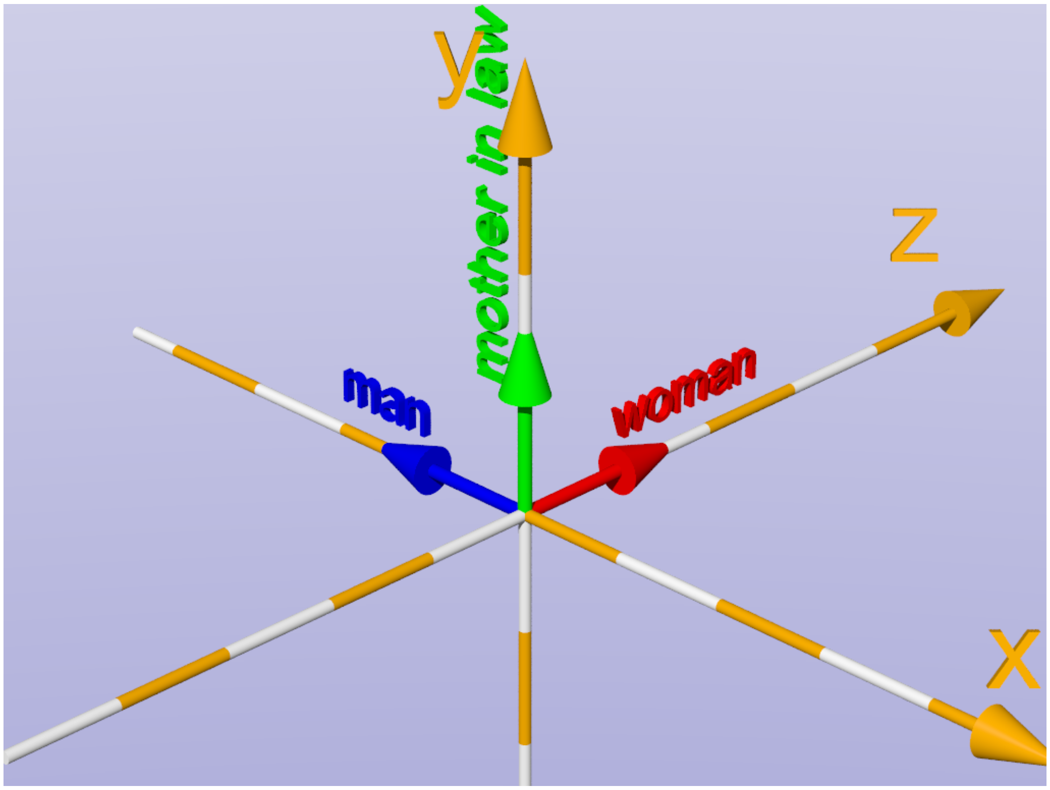
By Meredith Wadman

https://www.sciencemag.org/news/2016/12/pregnancy-resculpts-women-s-brains-least-2-years

Step 4:

The woman leads the change and she's pointing towards positive Z direction (investing in additional children). So now after two years the woman wants to make another child.

The man follows her and he's pointing towards negative X direction (investing outside of the relationship which in his interpretation means cheating on his wife with another woman).



Subchapter 1.07 – Determinant as who's the boss?

Thank you very much to:

Friedrich A. Lohmüller, 2007

http://www.f-lohmueller.de

and specifically for:

http://www.f-lohmueller.de/pov_tut/a_geo/a_geo62e.htm

http://www.f-lohmueller.de/pov_tut/a_geo/a_geo70e.htm

In this subchapter we will talk as an example about dominance, who's got more "say" (have the right or power to influence or make a decision about something) in mutual decisions that the couple makes.

The relativity (that nothing is objective and everything is subjective to what you're measuring it against) between the man's and the woman's "strength" can be in many different fields.

Here is the example that got me thinking: My mythological-ex has amazing light green eyes, which I thought of as blue. She insisted that her eyes are green (Thinking back now, I guess she has blue-green eyes). But for me it was hard to accept it, because if I acknowledged that her eyes are what's considered now to be green, then my own eyes (which are probably "green-hazel " as I check it now:
https://en.wikipedia.org/wiki/Eye_color#Eye_color_chart_(Martin_scale))

Would be considered brown (or more accurately "amber") and I really like light colored eyes so this was a bummer to me. So that's why I "defined" her eyes as blue, so as to keep me from being shifted to brown.

Here is a much more common example which I got after more thinking:

If the man makes more money then the woman, the woman says it's unfair and so on, but the man's income is satisfactory and the relationship is satisfactory. But notice that if the man stays just the same, and the woman gets a promotion (which is supposed to be a good thing) and then she earns more than the man, what happens then? Even if the woman earns just a little more than the man this disrupts his "manhood" in her eyes, and she is not satisfied any more. His salary which until now was ok is no longer ok. He's no longer man enough for her. In real life, women who earn more are not happy. You can see the same conclusion here:

https://en.wikipedia.org/wiki/Breadwinner_model#Issues_with_the_decline_of_the_bread winner_model

So we see something that was ok (the woman's salary) "multiplied" with something that was good (the man's salary) at first we have a positive result – happy marriage. But once the ok thing (the woman's salary) becomes excellent (promotion), then the good thing (the man's salary) suddenly looks relatively bad (compared to the woman's salary) and now we get a negative result – unhappy marriage.

So now we will see another example that at the beginning the man is considered to be ok (this time he's dominant) and the result of their "multiplication" is positive. But later in life when the woman's arrow overtakes or passes the man's arrow (the woman is becoming more dominant) then now the man is considered submissive and the result is negative – the woman is unhappy with him. So now the "multiplication" result is negative.

Each of them (the man and the woman) is like the hand of the speedometer in your car, measuring how "strong" he/she is.

https://en.wikipedia.org/wiki/Speedometer

We will now concentrate less on the cartesian coordinates (how much we go to the left or right and how much we go up or down, to make the vector/arrow)

https://en.wikipedia.org/wiki/Cartesian_coordinate_system

Instead we will concentrate on polar coordinates (how much we rotate around the center (like the hand of a clock rotates around the center of a clock), and how many steps we go in that direction from the center "outwards" (radially). For example, the hours hand is short and the minutes hand is long, so the minute hand's tip is further from the center).

https://en.wikipedia.org/wiki/Polar_coordinate_system

I know this will seem strange to you, because up until now we only talked about "straight" or rectangular things and now we're talking about "curved" or round things, but it's just another way to see the same objects. Please see here in Wikipedia:

https://en.wikipedia.org/wiki/Complex_number#Modulus_and_argument

normally EVERY course in linear algebra starts with an introduction to complex numbers. I didn't want to scare you (and I guess 3Blue1Brown had the same reason) so I didn't start with that. Complex numbers are like little spinning hands of clocks. We measure their modulus which is how long they are, and we measure what angle they rotated, just like 3 o'clock is 90 ° and just like 6 o'clock is 180 ° and so on. The only difference is that in complex numbers the beginning is not from the 12 o'clock but instead from the 3 o'clock position (the positive horizontal X axis going to the right). And also another difference is that the hands are rotating in the opposite direction from a watch – in mathematics we rotate anti-clockwise.

OK I hope I didn't scare you with the last paragraph, I just want to clarify that rotations and measuring the length of arrows and looking at the angle between them is just as natural as what we did before, and it will help us understand determinants, because the bigger the angle between the arrows, the bigger the area there is between them. And later we will "trap" this area inside a parallelogram so we will be able to measure it.

OK, as you know there is a difference in the balance of power between the man and the woman before the wedding and after the wedding. This is sometimes dictated by culture like in Japan where the woman is very submissive and timid before the wedding, and then after she's married takes over managing the couple's financial property and the husband's life like a "dragon lady":

https://en.wikipedia.org/wiki/Dragon_Lady

In the west I guess this is dictated from the law which gives the woman huge power over the husband. I don't know much about the law in other countries, but at least in Israel if the married couple have a divorce, then the woman is entitled to a lot of money monthly from the husband even if she earns a lot and he earns a little or nothing, and even if this ruins his life completely (I saw a program about how divorced ex husbands are so desperate they think of selling a kidney, and they have to buy falafel with a coupon from a charity organization because they can't even afford that after the woman "skinned" them).

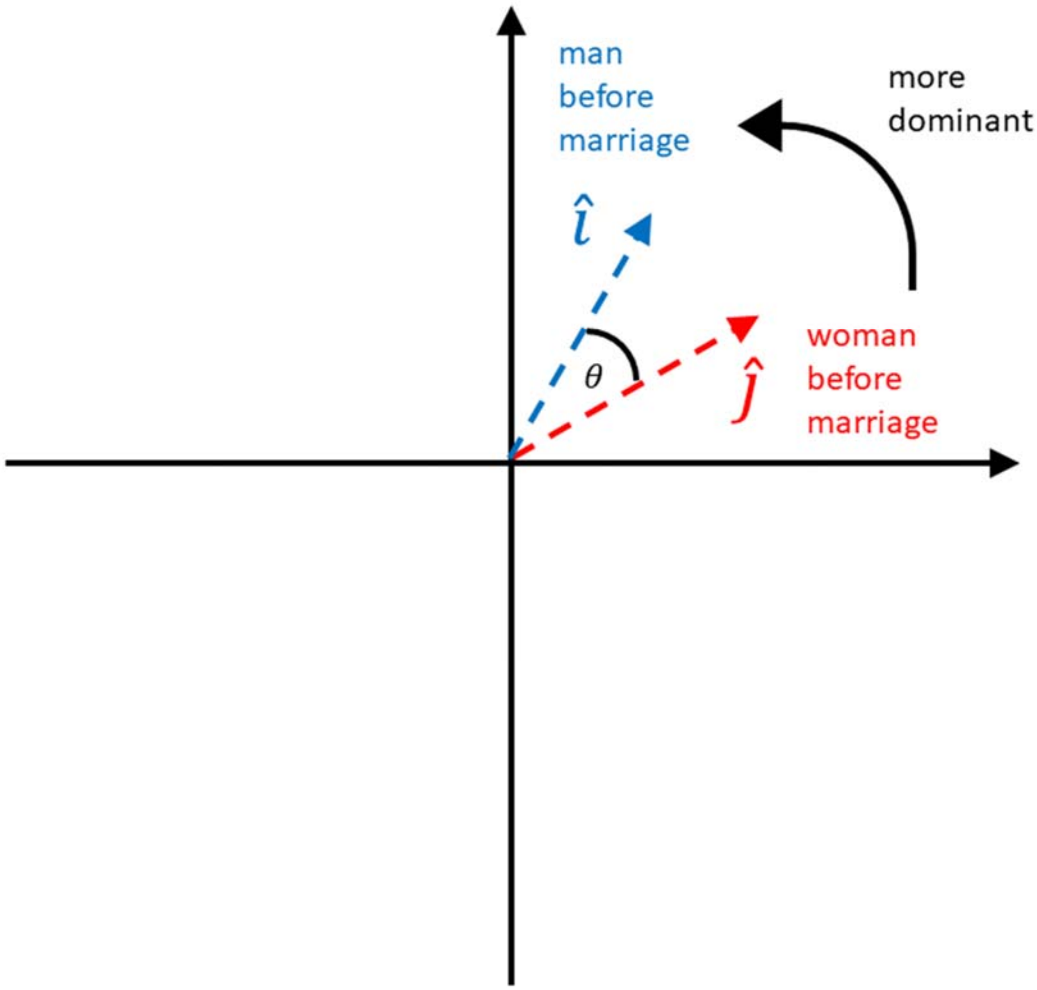
Unfortunately I don't have an English translation to this, but to make a long story short the Israeli law (legislated by extreme man-hating feminist bitches), creates a situation where the woman takes the kids, doesn't let the husband see the kids at all, poisons the kids' minds against the husband, and of course gets all the money (monthly money for herself and money for the kids until they're 18 at least, and that's after taking half of all the property) of the husband so he can't go on living.

https://www.youtube.com/watch?v=XpRmYbyzBQc

If you ask why am I telling you these cases where the couples divorce, well in Tel Aviv half of the couples divorce (other cities in Israel are more distorted because they live and suffer together because the woman is afraid to get divorced like in orthodox Jewish communities (where she will be outcast and in religious Muslim communities where she will be killed).

But a more important reason is that this has implications on the life of the married man and woman too because the woman holds powerful leverage on the husband. If she so wishes she divorces him and makes him her slave. So in a way even before she does that he's her subordinate because of this constant threat.

Here is our first mental picture:

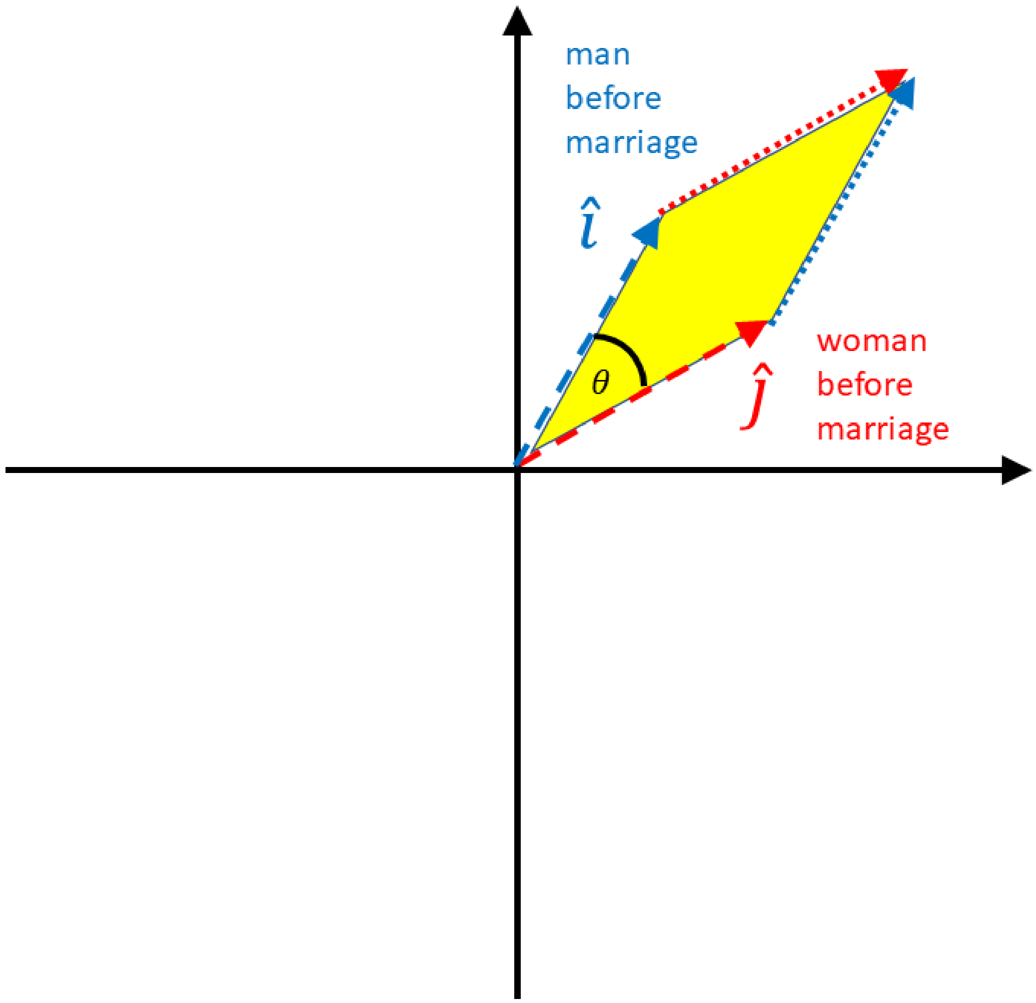


The more an arrow is rotated counterclockwise, the more he/she is dominant. In this case the man is more dominant then the woman (before marriage).

I did not put labels on our axis because we don't care what they are now. As far as the determinant (which is what we are trying to learn now) is concerned, the two arrows could be in another "quadrant", or even in separate quadrants. The only thing we care about is who is more "rotated" then who (counting from the beginning which is the right side or "3 o'clock" in the counterclockwise direction).

The angle between the arrows is theta (it's a Greek letter that looks like this θ). If the angle theta is big then there is a big difference between the man's and woman's relative dominance.

Here is a second mental picture. We built a parallelogram.



How did we build the parallelogram? We copied the blue (man) arrow and put its beginning where the red (woman) arrow ends. OR another way would be to copy the red (woman) arrow and put its beginning where the blue (man) arrow ends.

All the area that is closed inside is the area of the parallelogram, which we can calculate by multiplying base times height.

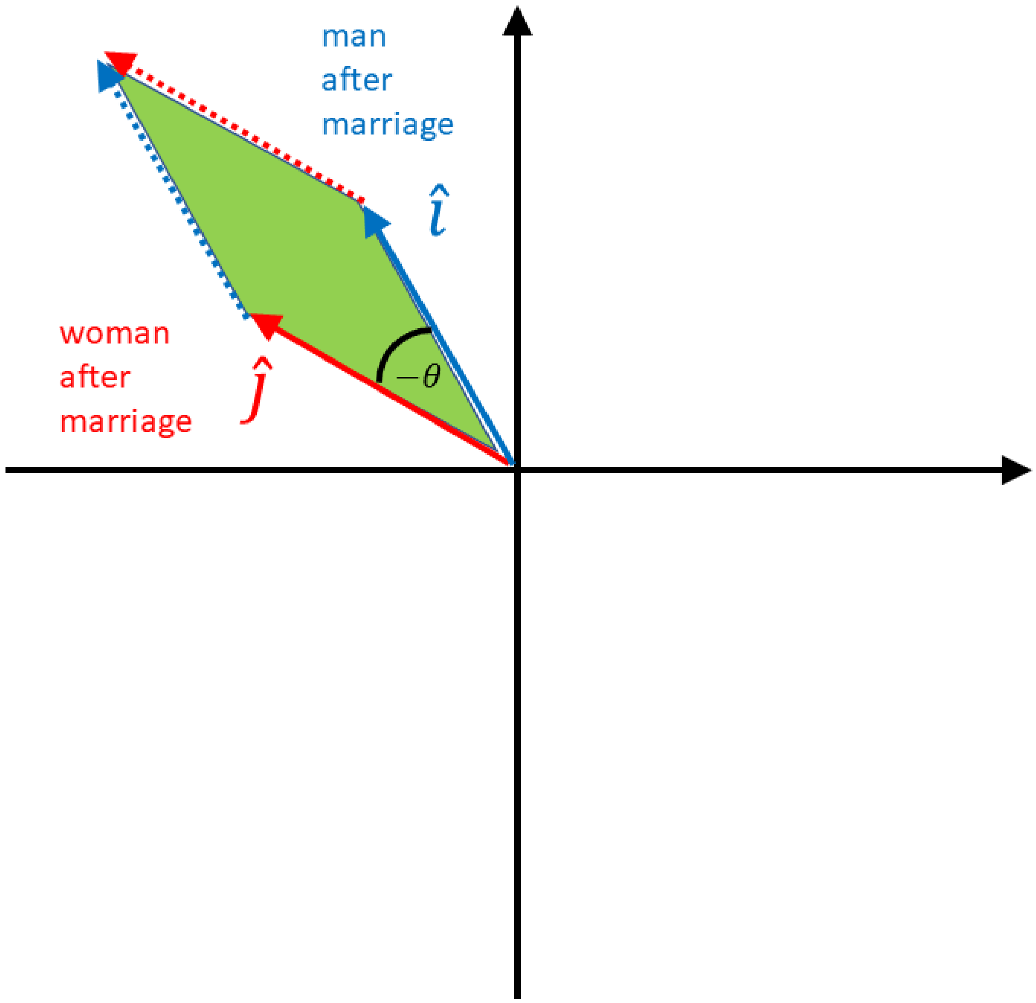
https://en.wikipedia.org/wiki/Parallelogram#Area_formula

In our case multiply the length of the arrows.

We consider the result positive as long as the man is more dominant, because then it's a happy couple.

This result is the determinant. The determinant now (before the marriage transformation) is positive.

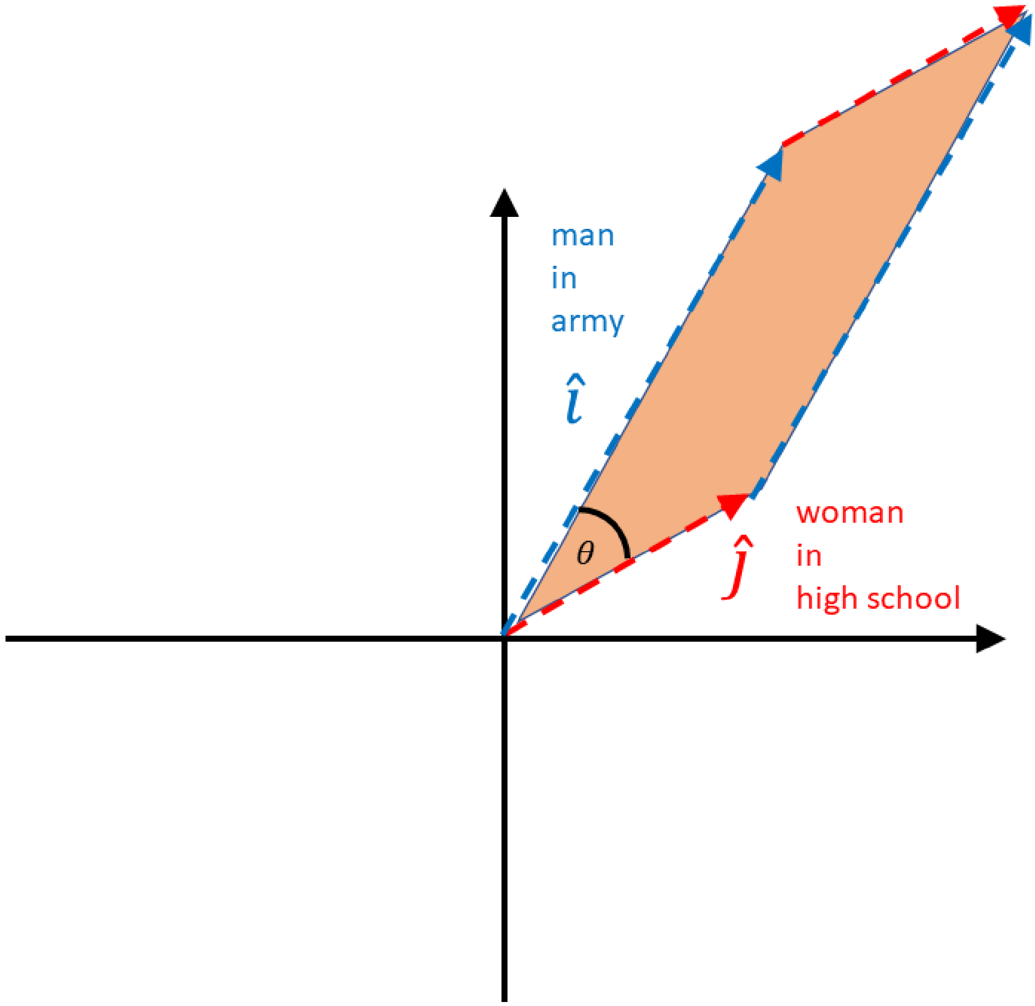
Third mental picture. After the marriage transformation.



We see that after some time the roles switched and the woman is controlling the situation. The man also became more dominant then before (rotate counter-clockwise from the second picture to the third picture), but the woman advanced even more, so relatively to the woman, the man is less dominant now.

The area of the parallelogram is now negative because the couple is unhappy. I made it green so you see a difference in color also. Even if it's exactly the same area but now it's different because it's negative. In reality we don't have such a thing as a negative area for an object. But here we imagine it as the flip side (the back hidden side after we flipped it over) of the object (the power balance of the relationship).

The area (the determinant) can grow and shrink if the man (or the woman) grows or shrink.



In this example let's say the man is a little older then the girl, she is in her last year of high school and he now enlisted to the army. Let's make it more extreme and say he's joined something that the public holds in high esteem like he's training to be a pilot in the air force. As a side note I think it's ridiculous that these guys are considered the top of the IDF, while a marine commando for example needs to go through so much more, while the pilots just play with a joystick and protected by a million-dollar mostly automatic machine, but never mind.

Okay so the girl is convinced now that the guy is a demigod. This also enlarges the disparity between them but in the good direction so the couple is happy. The determinant is both big (in area) and positive (in the sense of POSITIVE area).

What is the meaning of the size of the arrow? Let's say in our example it's the public's view of that thing. If the public think of pilots as "the right stuff" with slow motion walk, then it's a factor that multiplies the impression.

So far we talked about rotations in the XY plane. Let's say this plane is the relationship dominance, which before the marriage means which restaurant they will go to, or which country they will travel to, and after the marriage means who controls financial decisions.

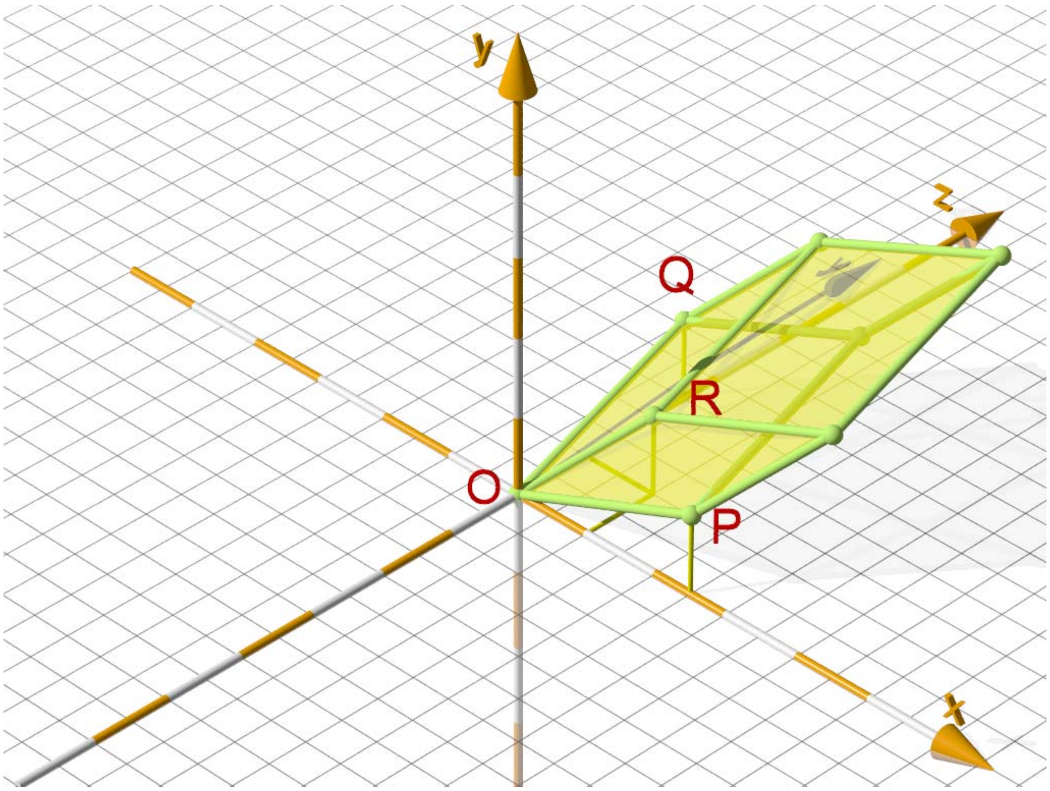
Let's say we have another plane the plane of YZ , and now in this YZ plane whoever is more "rotated" from the beginning point (the direction of the positive Z axis into the screen far away from us) is more dominant in bed.

After the marriage the woman feels freer to experiment in bed. So let's say that she will want to try stuff like BDSM like asking for feet worship from the husband, face sitting, giving "golden showers" to the husband etc. So this different kind of dominance-submission, which is in sex, will be in the YZ plane.

Let's assume for simplicity in our example that before the marriage the girl is submissive in both areas (in and out of bed), and after the marriage the girl is dominant in both areas (in and out of bed).

This is no longer and area, this is volume, because it's now 3 dimensional. The 3D parallelogram is called parallelepiped. It is defined by 3 vectors that come out from the origin point O . These 3 vectors are $\overrightarrow{OP}$ (the woman in the XY financial plane), $\overrightarrow{OQ}$ (the woman in the YZ sexual plane), and $\overrightarrow{OR}$ (the man in both these planes).

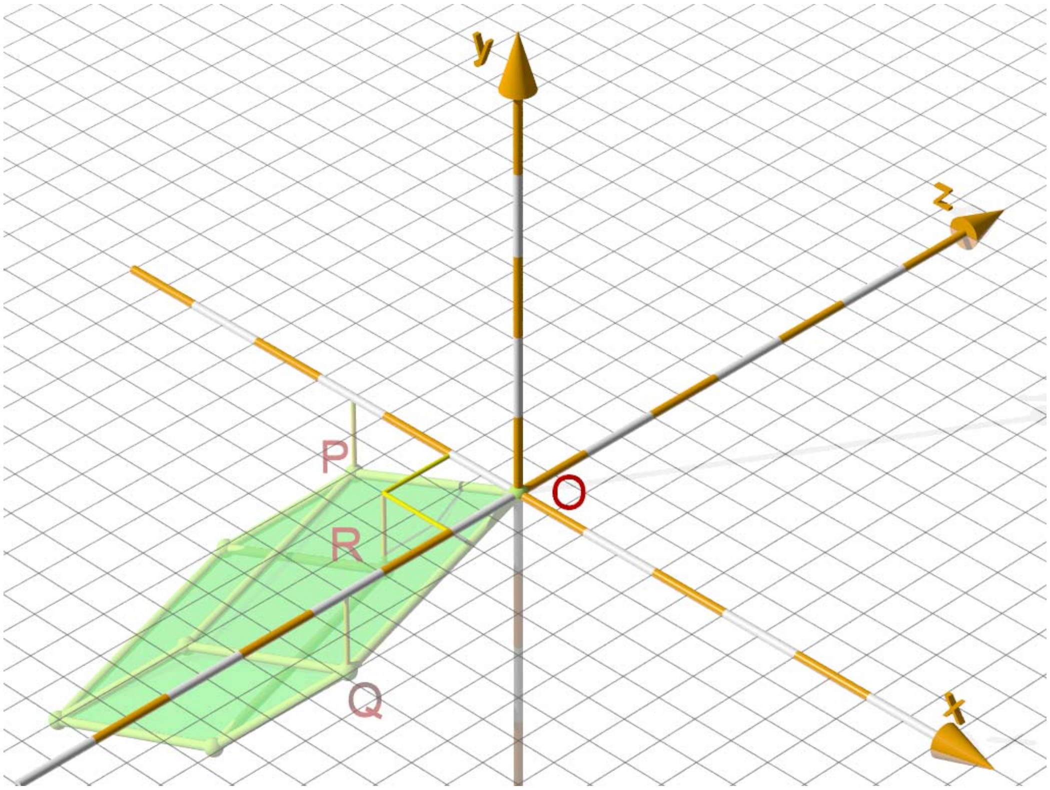
First 3D determinant picture:



What does it mean that the third vector $\overrightarrow{OR}$ is the man in BOTH planes (XY and YZ) at the same time? This means that we had (not seen in the picture) a vector for the man in the XY financial plane (like the blue vector in the previous examples) and a similar vector (also not seen in the picture) of the man in the YZ sexual plane, and we made an AVERAGE. The average between them is $\overrightarrow{OR}$. it's X coordinate is the first (XY) vector's X coordinate plus the second (YZ) vector's X coordinate divided by 2 (just the way you average two numbers). And we do this procedure to their Y coordinates and to their Z coordinates. If we need to put it into words it would be "how dominant is the man" (without the specification of "…in bed" or "…in financial decisions").

And here is the 3D case after the marriage transformation:

Second 3D determinant picture:



As you can see the color of the parallelepiped turned from yellow to green to remind us that the volume is now negative. We never see negative volume in real life, but in linear algebra we do (because the volume does not represent here physical space but instead it represents here the inequality between the couple and this time towards the "wrong" side – a girl that whips his ass with her paycheck outside of bed, and with her whip in bed!). So remember the determinant can be negative.

Note: in my drawings I made it easier for myself: the negative version is rotated so that it mirrors the positive version (in my version let's say we start with 30 degrees above the east (0 degrees) and finish in 30 degrees above the west (180 degrees) which is 150 degrees, so it's about 120 degrees rotation). Of course transformations can do rotations in any number of degrees.

OK continuing with this subchapter's video by 3Blue1Brown:

https://www.youtube.com/watch?v=Ip3X9LOh2dk

at the time of 3:06 he talks about what happens if the transformation (marriage) squishes the two vectors (man and woman) into one line (super fair (equitable) relationship), or even to a single point in space (the man and woman have zero length vectors, and since we said that the length of the vector means the public opinion (like with the fighter pilot) this means the public thinks NOTHING special of them, both the woman and the man are supremely average, they are like the Joe and Rita in the amazing film Idiocracy 😊). In both of these cases the determinant is ZERO (the area of a line is zero and the area of a point is also zero).

We can have many dimensions: for example the first dimension who's more dominant in money, a second dimension who's more dominant in sex, a third dimension who's more dominant in social connections, a fourth dimension whose more dominant in kids' education, a fifth dimension who's more dominant in medical decisions, and so on…

So in a multi-dimensional case, a ZERO determinant means we go to a smaller number of dimensions, for example from 5 dimensions to 2 dimensions. In our real life analogies this means that the transformation (that lowered the number of dimensions) made the couple think in a more narrow and materialistic way on their relationship. The "battle of the sexes" comes down eventually to more and more basic needs in the Maslow's pyramid

https://en.wikipedia.org/wiki/Maslow%27s_hierarchy_of_needs

such as food and shelter (money) and reproduction (sex).

About the part with the orientation, I will use here a "left hand rule" (unlike 3Blue1Brown's "right hand rule", but it's the same idea).

By the way, the starry background is a wall mural that I printed and glued together from the Hubble space telescope's website, I have a few of these around my home (this one is in the living room).

First 3D determinant picture (for the "First 3D determinant picture" – the one colored yellow) :

I turn my middle finger so that it points (to your right) in the direction of $\overrightarrow{OP}$ (the woman in the XY financial plane).

And I turn my index finger so that it points (away from you) in the direction of $\overrightarrow{OQ}$ (the woman in the YZ sexual plane).

So the result is that my thumb points (upwards from you) in the direction of $\overrightarrow{OR}$ (the man in both these planes).

So our result is that the thumb FITS.

Second 3D determinant picture (for the "Second 3D determinant picture" – the one colored green) :

I USE THE SAME HAND. I'm allowed to rotate it, so in this case I just turned over. The important thing is that EACH FINGER STAYS THE SAME RELATIVE TO THE OTHER FINGERS. It's like the palm of my hand "freeze" and then I can rotate myself and my arm, and my palm remains "frozen".

I turn my middle finger so that it points (this time to your left) in the direction of $\overrightarrow{OP}$ (the woman in the XY financial plane).

And I turn my index finger so that it points (this time towards closer to you) in the direction of $\overrightarrow{OQ}$ (the woman in the YZ sexual plane).

So now let's see what's the result - does my thumb points (downwards from you) in the direction of $\overrightarrow{OR}$ (the man in both these planes) ?

No. My thumb points in the wrong direction (upwards). So our result is that the thumb DOESN'T FIT. This means that the determinant changed sign (in our case the determinant changed from positive in the first 3D picture to negative in the second 3D Picture).

This is the graphic/geometric intuition. If we want to get a "story" intuition, I'm not sure but I think (take this with a grain of salt!) that we need to count how many times this "flip" of dominance happens (in total in all the planes). In other words, we need to count how many times ANY of the woman's arrows overtakes or passes the THE RELEVANT man's arrow (the woman is becoming more dominant).

Why? Because the "flip" from positive to negative has two phases. It's like a light switch on lamps that have the same button for on and off. Let's say we start with positive (ON) determinant. Then we flip the switch and it's negative (OFF). then another flip and it's positive again (ON)… etc etc.

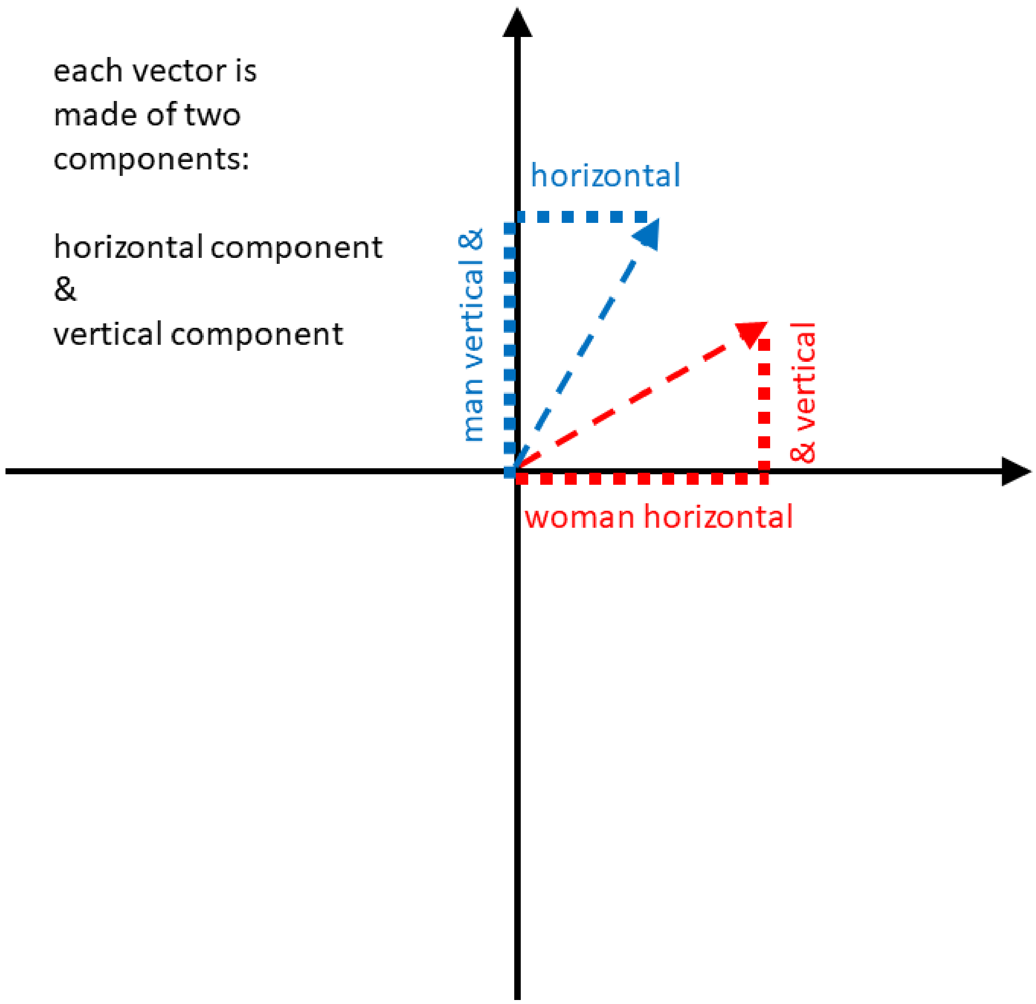
So in our 3D example there were 3 flips, so it begins with ON, and then 1st flip and it's OFF, and the 2nd flip and it's ON, and finally the 3rd flip and it's OFF. so the determinant is OFF or in other words negative.

As for the way you calculate how much is the determinant (not just its sign positive or negative), it's something along the lines of this:

$$det\left(\begin{bmatrix} woman_{horizontal} & man_{horizontal} \\ woman_{vertical} & man_{vertical} \end{bmatrix}\right)$$
$$= (woman_{horizontal} * man_{vertical}) - (man_{horizontal} * woman_{vertical})$$

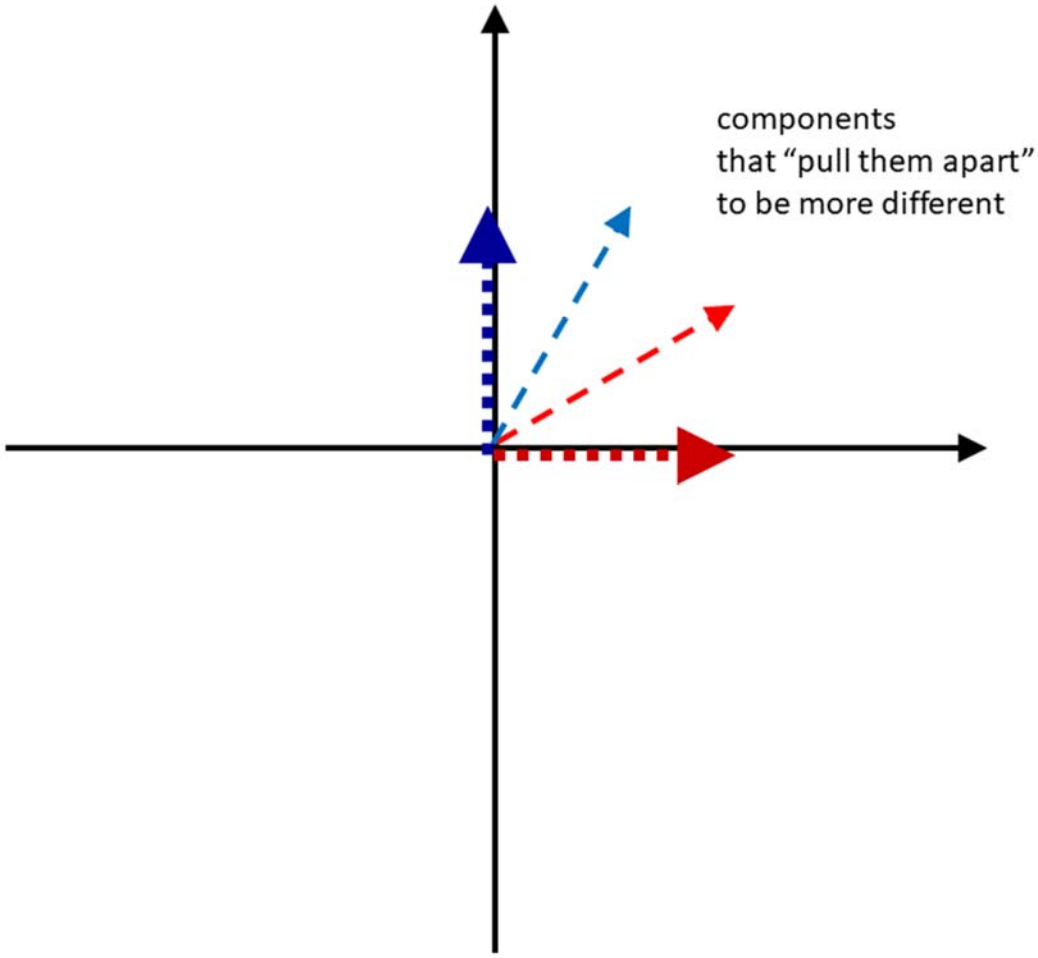
What does this mean in our "story" intuition?

Let's look a little deeper in our "first mental picture":

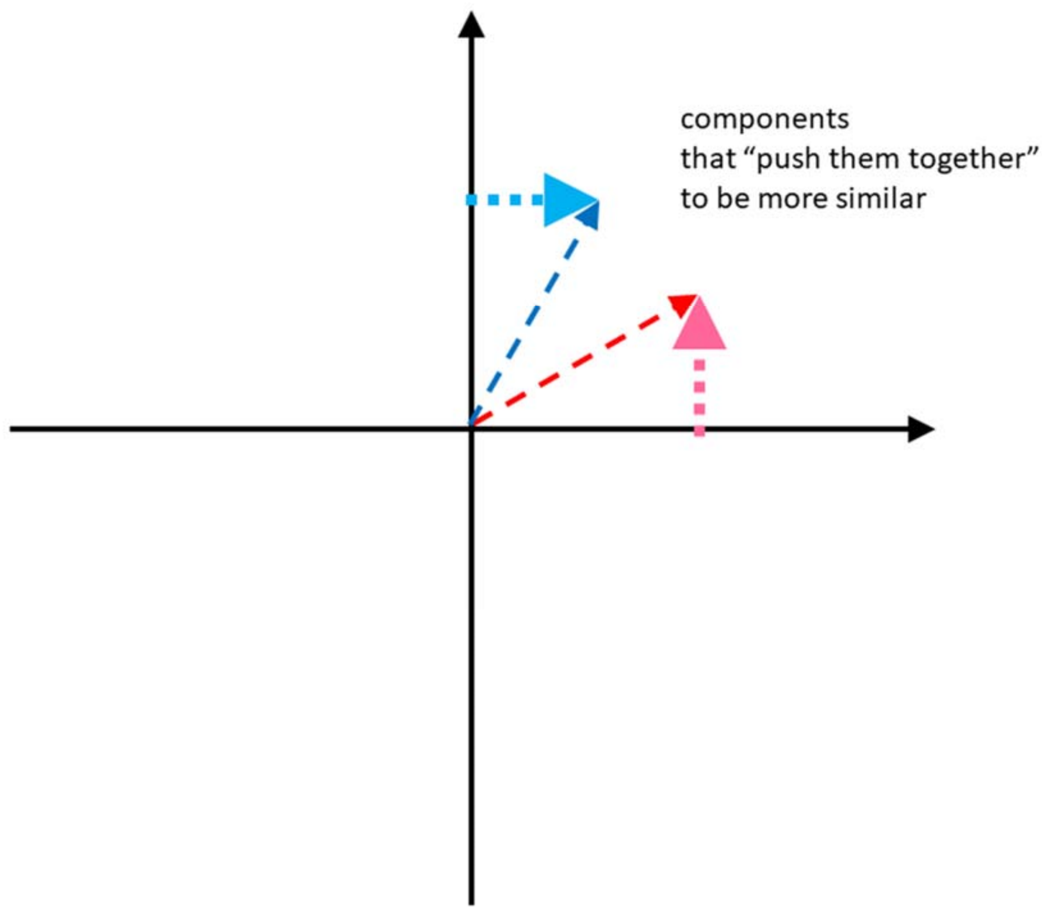


I colored them a little different for you in our "story":

the darker components (the dark red which is $woman_{horizontal}$ and the dark blue which is $man_{vertical}$) make the man and the woman more different from each other, they pull them further apart.



the lighter components (the light red which is $woman_{vertical}$ and the light blue which is $man_{horizontal}$) make the man and the woman more similar to each other, they push them closer together.



So if we will color the equation it will become in colors:

$$det\left(\begin{bmatrix} woman_{horizontal} & man_{horizontal} \\ woman_{vertical} & man_{vertical} \end{bmatrix}\right)$$

$$= (woman_{horizontal} * man_{vertical}) - (man_{horizontal} * woman_{vertical})$$

Or in words: determinant equals "darks" minus "lights".

DETERMINANT (the area, or in other words how far apart are the tips of the man and the woman if both of them start in the origin)

EQUALS

How strong are the "forces" that pull them further apart (DARK components)

MINUS

How strong are the "forces" that push them close together (LIGHT components)

Think about it like if Master Yoda was giving couples therapy, seeing their differences as a battle between the dark side of the relationship and the light side of the relationship.

Subchapter 1.08 – System of equations as rating lovers in tables

In this sub-chapter we will talk about ideas from the 7th video in the "essence of algebra" series by 3Blue1Brown:

Inverse matrices, column space and null space | Essence of linear algebra, chapter 7

https://www.youtube.com/watch?v=uQhTuRlWMxw

Grant Sanderson a.k.a. 3Blue1Brown tells us what linear algebra ("matrix writing") is good for: describing a (linear) system of equations. But we can't start there, because you'll rightfully ask me: okay then, what is a (linear) system of equations good for?

So we need to return to what we defined "matrix" to be which was "a woman's mind". Okay so the vectors (columns of the matrix) are people (as the woman sees them in her mind). We also said that MINUS is the woman being spiteful (doing the opposite of what that person wants) or self-destructive (doing the opposite of what she herself wants).

Here are a few equations from minute 1:25 of this video we just mentioned, let's play with them and fit them to our story.

$$2x + 5y + 3z = -3$$

$$4x + 0y + 8z = 0$$

$$1x + 3y + 0z = 2$$

Let's say that the woman Alice has three lovers, or three potential dates she wants to decide who to marry or who to go out on a date with: Bob, Charlie and Dave.

Let's say x means romance motivation. Wishing to bring flowers, write poems for her…

Let's say y means sex motivation. Wishing to make out with her or even more…

Let's say z means friendship motivation. Wishing to get to know her, talking philosophy…

So the first equation (the first line) is Bob.

Bob is mildly romantic ($2x$) and he's very sex driven ($5y$) and he's averagely into-her-as-a-person ($3z$). All these put together moderately repulse Alice (-3).

So the second equation (the second line) is Charlie.

Charlie is pretty romantic ($4x$) and he's not at all sex driven ($0y$) and he's extremely into-her-as-a-person ($8z$). All these put together leave Alice indifferent (0).

So the third equation (the third line) is Dave.

Dave is slightly romantic ($1x$) and he's moderately sex driven ($3y$) and he's not at all into-her-as-a-person ($0z$). All these put together leave Alice somewhat interested (2).

OK, so you know how when you're in a university and you take an exam, and the next week they publish they scores. They don't give you back your exam with the calculations on it, they just print and put on the faculty's wall a table of all the scores of all the people who took the same exam, and it's without names so each line in the table looks like: I.D. number (of some student) and then a score number (how much did that student score on the exam).

OK so here Alice likes to thorough about such things (and to show off her spreadsheet skills) so she makes tables of all her suitors (the guys that are wooing her) comparing their scores in different subjects. It's for her eyes only, so she simply uses their names:

Guys' romantic motivation towards Alice scores	
Bob	2
Charlie	4
Dave	1

Since Alice wants to write it in a compact fashion, she thinks of it as the **"red"** or X vector:

$$\vec{x} = \begin{bmatrix} 2 \\ 4 \\ 1 \end{bmatrix}$$

Guys' sexual motivation towards Alice scores	
Bob	5
Charlie	0
Dave	3

Since Alice wants to write it in a compact fashion, she thinks of it as the **"blue"** or Y vector:

$$\vec{y} = \begin{bmatrix} 5 \\ 0 \\ 3 \end{bmatrix}$$

Guys' "friendly" motivation towards Alice scores	
Bob	3
Charlie	8
Dave	0

Since Alice wants to write it in a compact fashion, she thinks of it as the **"green"** or Z vector:

$$\vec{z} = \begin{bmatrix} 3 \\ 8 \\ 0 \end{bmatrix}$$

Alice's motivation to date the guy scores	
Bob	-3
Charlie	0
Dave	2

Since Alice wants to write it in a compact fashion, she thinks of it as the "black" vector. Each number in this vector is a final result which is not associated with anything (X, Y, Z). So it's also called the free numbers vector.

$$\begin{bmatrix} -3 \\ 0 \\ 2 \end{bmatrix}$$

Then Alice thinks of a better way to arrange this. She looks at the equations:

$$2x + 5y + 3z = -3$$
$$4x + 0y + 8z = 0$$
$$1x + 3y + 0z = 2$$

She can write it like this according to the vector's colors:

$$x \begin{bmatrix} 2 \\ 4 \\ 1 \end{bmatrix} + y \begin{bmatrix} 5 \\ 0 \\ 3 \end{bmatrix} + z \begin{bmatrix} 3 \\ 8 \\ 0 \end{bmatrix} = \begin{bmatrix} -3 \\ 0 \\ 2 \end{bmatrix}$$

Now remember what we said in the sub-chapter about "Matrices as women's minds" that:

A matrix is just a way of writing this without the cumbersome x's y's and plus's ?

back then we packed the colorful vectors next to each other in a matrix, and we packed the X and Y (now we also have a Z) into a vector, and we multiplied the matrix times the vector, and got the result as a new vector. Back then it was where the purple arrow will go to after the girl talk). Now instead we call it the black arrow (because we no longer mix just two colors blue and red, this time we added green).

So here is the "multiplication between a matrix and a vector" way to write this:

$$\begin{bmatrix} 2 & 5 & 3 \\ 4 & 0 & 8 \\ 1 & 3 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} -3 \\ 0 \\ 2 \end{bmatrix}$$

First of all it's very short and it saves the Amazon rainforest compared to all the tables that Alice has been printing. We will also see more advantages in this kind of writing soon. But in return (There ain't no such thing as a free lunch 😊) we now need to learn a little more jargon.

The matrix is called A and its inhabitants (the colorful numbers) are called COEFFICIENTS.

The X Y Z vector is called $\vec{x}$ and its inhabitants (the X Y and Z letters) are called VARIABLES.

The black result vector is called $\vec{v}$ and its inhabitants (the numbers with the black background) are called CONSTANTS.

This is so we would speak in the same language as 3Blue1Brown (and the rest of the world).

So now we can write our whole matrix time vector equals another vector like this:

$$A\vec{x} = \vec{v}$$

Yay Amazon rainforest! I recommend that you watch minute 2:38 in the video of 3Blue1Brown (argh! With your permission I will abbreviate this to 3B1B from now on, thank you!). This is where 3B1B explains the geometrical meaning:

The matrix A is doing a transformation to the vector $\vec{x}$ so it becomes $\vec{v}$. This is the meaning of the equation we just wrote.

What does this mean in our story explanation?

First of all remember what the matrix's columns (vectors) mean:

IF we started with the "unit" vectors: $\hat{\imath}$ and $\hat{\jmath}$ and $\hat{k}$

THEN after the matrix A transforms them:

The **red** vector is where $\hat{\imath}$ lands. The **blue** vector is where $\hat{\jmath}$ lands. The **green** vector is where $\hat{k}$ lands.

How does this translate to the story explanation?

Let's say a new guy comes along, his name is Frank.

IF Frank was one unit of romantic motivation (and that's it)

THEN Alice will see Frank in her mind's eye (because women always twist and complicate things) as the **red** vector which is $\begin{bmatrix} 2 \\ 4 \\ 1 \end{bmatrix}$. And that means she would see him as mildly romance-driven, pretty sex-driven, and slightly friendship-driven.

In the same way, IF he was one unit sex seeker and that's it THEN she views him as the **blue** vector which is $\begin{bmatrix} 5 \\ 0 \\ 3 \end{bmatrix}$. And that means that she would see him as very romance-driven, not-at-all sex-driven, and moderately friendship-driven.

And in the same way IF he was one unit platonic friend and that's it THEN she would view him as **green** vector which is $\begin{bmatrix} 3 \\ 8 \\ 0 \end{bmatrix}$. And that means that she would see him as averagely romance-driven, extremely sex-driven, and not-at-all friendship-driven.

BUT FRANK IS NOT A "ONE UNIT GUY"! instead the "original" Frank is still a mystery to us. So how do we figure out what Frank started from?

We know what he finished up like in Alice's mind's eye after all the "twisting and complicating" (Alice's transformation). He finishes up as the "black" vector which is $\begin{bmatrix} -3 \\ 0 \\ 2 \end{bmatrix}$ which means he ends up as moderately ANTI-romantic-driven, and not-at-all sex-driven, and mildly friendship-driven;

And we know what kind of "twisting and complicating" Alice does to one-unit-guys;

and from these two things that we know, we will soon have a method to solve the mystery what Frank started like, or in other words what's Frank really like in reality.

By the way I apologize for the unreasonable numbers, I tried to use the numbers exactly as they appear in the video of 3Blue1Brown.

OK now we are in the video in minute 3:14 (tee-hee, sounds like the numbers of Pi!)

We start simple with 2 equations (guys) and 2 unknowns (motivations).

$$2x + 2y = -4$$

$$1x + 3y = -1$$

We have Bob in the first equation who is mildly romantic ($2x$), and mildly sexual ($2y$). All these put together leave Alice pretty repulsed (-4).

We have Charlie in the second equation who is slightly romantic ($1x$), and moderately sexual ($3y$). All these put together leave Alice slightly repulsed (-1).

Now let's do it "matrix" style – you are the one Neo! 😊

$$\begin{bmatrix} 2 & 2 \\ 1 & 3 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -4 \\ -1 \end{bmatrix}$$

Again we call the matrix A , we call the variables vector $\vec{x}$, and we call the result vector $\vec{v}$.

Inside the matrix A we see:

the first vector column (from the left) is what we called " Guys' romantic motivation towards Alice scores ".

the second vector column (from the left) is what we called " Guys' sexual motivation towards Alice scores ".

The X Y vector is our mystery guy Frank as he is BEFORE the transformation in Alice's mind.

The last vector (the result) is how Frank looks to Alice AFTER she transformed him.

In minute 3:25 in the video 3Blue1Brown tells us that when we try to find the solution (the original Frank) we need to know whether Alice's transformation is "squishes all of space into a lower dimension, like a line or a point" or if it leaves the number of dimensions the same is it was before the transformation.

This translates in our story explanation to the number of motivations. (in our explanation dimensions equals motivations). Right now we have 2 motivations (romance motivation and sex motivation) in our system.

Here's one example: If let's say Alice was frigid (not interested in sex at all)

https://en.wikipedia.org/wiki/Hypoactive_sexual_desire_disorder

Then in the result vector (what we called " Alice's motivation to date the guy scores ") the sex component will always be zero. So if we are trying to draw that vector (in the previous example we called it the "black" vector) it will not have a Y component (it doesn't go up or down, so it's "flattened". Whatever the guy was (whether he is very sexual or very asexual) Alice couldn't care less, for her he's always ZERO. So we lose the information of what the guy was. We can't look at the result and guess what the guy originally was before the transformation.

Here's another example:

If let's say Alice was an autistic person. These people find it difficult to interpret the other person's feelings. So again Alice's mind loses that information, and her "image" of the guy is getting "flatter". This time the "black" vector is losing its X component, so we can't go left or right. Whatever the guy (whether he was very romantic or very unromantic) Alice doesn't know this, for her he's always ZERO.

Remember when we talked in the last subchapter about the determinant (the area between the vectors in 2D, or the volume between the vectors in 3D) ?

We made a story then who's get stronger motivation, who is more dominant in the relationship. So if they are not the same, then one is the leader and the other is following. We know for example that if a decision was made by the couple it was decided by the leader. But what if they are both leaders to the same extent? We will never know (suppose we can't ask them) who made the decision. We lose this information.

So visually this is the case where the 2 arrows in 2D are on top of each other. We could have an area between the arrows (if they were apart), but instead we flattened the area into just a line with zero area. So the determinant became ZERO.

So now back to this chapter with motivations of the guys being our dimensions – romantic motivation, and sexual motivation. Let's take a situation where Alice can't pick up clues about sex (she's very naïve or frigid or whatever). So now Alice has less information, she lost all the information in the sexual dimension. Her result always gives any guy's sex-drive the score of ZERO.

Before the transformation (which means the way the guys are in real life) they differ from each other both by their romance-motivation AND by their sex-motivation. DIMENSION = 2.

But after the transformation (which means the way they are viewed by Alice in her mind) they can differ only by how romantic they are (they move only along a single line which is the romantic line). DIMENSION = 1.

If on top of this Alice was autistic this would mean she lost the romantic information as well and any guy you would present her (including Bob and Charlie) will get in her mind to the same point. They are all the same. DIMENSION = 0.

We are in minute 3:59 in the video.

What does it mean "play the transformation in reverse?"

This means to go from Alice's "image" of the guy AFTER the transformation, back to the reality of what the guy really is like BEFORE the transformation.

The way to do this is by an inverse matrix. This is like an anti-Alice that does exactly the opposite transformation.

There is a very cute film "The Parent Trap" with the super beautiful (and talented!) Lindsay Lohan. I love Lindsay, she's drop dead gorgeous as an adult (in Playboy portraying Marilyn Monroe, and in Machete), but in "The Parent Trap" she's a little girl and she's adorable.

So anyway the film is about two identical twins both played by Lindsay, and after they're parents got divorced they were raised in different environments so one is like noble from England and used to very fancy and luxurious things, and the other is a farmer from California and is used to simple things, and so on. Of course they become best friends and bring their parents back together, but in the beginning they are like opposite enemies.

So let's say our Alice goes to a camp and discovers she has a twin sister, and they are like the complete opposite in everything, even in the name, the twin sister name is Ecila, the opposite of Alice.

Ok so Ecila does the opposite transformation from Alice.

This means that suppose Alice met Bob and transformed him one way in her (Alice's) mind, and then goes and tell her image of Bob to Ecila (who's never seen what Bob's like in reality), then Ecila transforms that image the other way around in her (Ecila's) mind, and Ecila's image of Bob is exactly like the original Bob in reality.

Like clockwise rotation and anti-clockwise rotation. One is doing and the other is undoing.

And of course just like Ecila is the opposite of Alice, so is Alice the opposite of Ecila.

If Alice never met Bob and Ecila did, we can run the thing backwards: undoing and then doing. (like anti-clockwise rotation and then clockwise rotation).

This means that suppose Ecila met Bob and transformed him one way in her (Ecila's) mind, and then goes and tell her image of Bob to Alice (who's never seen what Bob's like in reality), then Alice transforms that image the other way around in her (Alice's) mind, and Alice's image of Bob is exactly like the original Bob in reality.

It is customary to write this in the same way as "raised to the power of minus one". But it doesn't mean exponent, it means inverse of that matrix. For example:

The original matrix is A

The inverse matrix is A^{-1}

If we multiply them together ("apply" one twin sister and then the other twin sister) we will eventually get the same result as if we "applied" a transformation that does nothing.

If you want to continue the story imagine this sister as yet another twin (let's say they were an identical triplet) and this third sister was sent to a hippie uncle so he named that girl "Identity" and she was raised to be lazy and do nothing. Her symbol is I .

$$AA^{-1} = I$$

This equation means applying Alice and then Ecila is equal to applying only Identity.

$$A^{-1}A = I$$

This equation means applying Ecila and then Alice is equal to applying only Identity.

And just like 3Blue1Brown says in minute 5:11 , it leaves both $\hat{\imath}$ and $\hat{\jmath}$ each where they are, unmoved. So its columns are one zero and zero one.

$$I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Ok so remember what we wanted to do: Find out how Frank was originally before Alice. So we can "apply" Ecila on the result of Alice and Ecila will undo this result and give us the original Frank!

"Alicized" Frank is the result vector $\begin{bmatrix} -4 \\ -1 \end{bmatrix}$

"Un-Alicized" Frank is Ecila times that:

$$A^{-1} \begin{bmatrix} -4 \\ -1 \end{bmatrix}$$

This gives us the original Frank or in other words how Frank is in reality!

So 3Blue1Brown shows us a matrix equation

$$A\vec{x} = \vec{v}$$

Which is Alice times original frank equals Alicized Frank.

Since it's an equation we are allowed to do the same thing to both sides and they will remain equal.

So since we want to "undo" Alice's action then we multiply (from the left) BOTH sides of the equation by the matrix that "undoes" Alice, which is the matrix Ecila.

$$A^{-1}A\vec{x} = A^{-1}\vec{v}$$

Now what do we get? In the left side of the equation Ecila times Alice equals Identity. On the right side of the equation Ecila is "Un-Alicizing" Frank.

$$I\vec{x} = A^{-1}\vec{v}$$

What do we get? On the left hand side of the equation, the Identity matrix doesn't change $\vec{x}$ so we can simply ignore her.

$$\vec{x} = A^{-1}\vec{v}$$

This may not look like much but if we plug in the numbers (3Blue1Brown says usually we find the inverse matrix Ecila using a computer; and $\vec{v}$ we already know $\begin{bmatrix} -4 \\ -1 \end{bmatrix}$).

So we did what we wanted to do – we found the original Frank!

So now I hope you understand what's the connection between these two questions:

Is there an area? ($det \neq 0$)

and

is there an "undo" matrix? (A^{-1} exists) the connection is that if Alice is such that she "flattens" a dimension (loses completely one or more printed "guys motivation scores" table, and hence to lose Frank's "motivation score" in that subject) there is no way for anyone to "undo" this. So there is no "undoer" (Ecila the inverse matrix that can find the original Frank or any other guy) for this Alice.

So the connection is "IF… THEN…".

IF there is an area ($det \neq 0$)

THEN there is an "undo" matrix (A^{-1} exists)

OK now we are at minute 8:02 in the video and we have a new word: RANK.

Rank is "how many dimensions ("motivations") Alice ends up with".

If our matrix transformation (Alice) started with 3 dimensions (printed "guys motivation scores" tables: romantic, sex, friendship) and lost the information of 1 dimension (let's say the sex), then now she has rank 2.

In the geometric representation (watch the video) rank 3 is a 3D space, rank 2 is a 2D plane, rank 1 is a 1D line, and rank 0 is a (zero dimensional) point.

OK now we are at minute 8:47 in the video and we have another new word: COLUMN SPACE.

Column space is "What are all the possible vectors (printed tables) that Alice can produce with the vectors (printed tables) she ends up with ".

For example if in the beginning there were 3 printed tables but after Alice's transformation there are only 2 printed tables, let's say the printed tables of romance and of friendship, then Alice can print to herself all kinds of combinations of these. Like a new table that writes in each line (guy) how much is 7 times his romance PLUS 8 times his friendship motivations.

Remember we talked about SPAN in the subchapter "Combinations as desirable men", so here Alice's "column space" are all the possible vectors (printed tables) that Alice's final information can span.

Column space = Span of columns = all possible "printed tables" combinations.

Ok so in minute 9:24 in 3B1B he says that

"a more precise definition of RANK would be that it's the number of dimensions in the column space".

So it's NOT enough for us to count how many columns and say ok we have red and green and blue and it's 3 columns so we just guess the rank is 3. WHY?

Because one of the vectors (printed tables) might be "producible" using some combination of the other vectors (printed tables). If for example "romance" would equal "friendship" plus "sex", then we would no longer have information of 3 vectors, because 2 vectors would be enough to produce all the 3 and all their combinations.

We talked about this in the sub-chapter "Combinations as desirable men", where we could guess from the man's company (NASA) and position (engineer) his salary ($80,000). So one of these three pieces of data is redundant.

In these situations (romance=friendship+sex; salary=some combination of company and position), the rank of the matrix (the number of informative=independent vectors) is NOT the whole number of the columns, it's less.

On the other hand:

FULL RANK – this is a situation where all the columns are independent of each other. Each column brings fresh new information, that we couldn't get from the other columns.

Okay next 3B1B says (minute 9:38) that the ZERO vector is always included in the column space. How so?

WHEN THE TRANSFORMATION IS FULL RANK (THE NUMBER OF DIMENSIONS STAYS THE SAME BEFORE AND AFTER) :

Visually you'd better see in in 3B1B 's video, if it's "full rank" then every vector after the transformation moved, except the ZERO vector which starts in the origin point and since in a linear transformation we are not allowed to move the origin, so the ZERO vector also ends up in the origin point.

Storywise, in the NASA-engineer-$80000 story, the ZERO vector is a the case of the bagger where it's always true that he is in no company and in no position and he earns no money (ZERO). The ZERO vector is the "bagger". After the transformation he's still ZERO.

Storywise, In the Alice-printing-score-tables-of-suitors scenario, it's the case of a list full of ZERO scores. What does this mean? let's say that all guys are lawyers and we are measuring chivalry.

Remember the movie "Life Stinks" by Mel Brooks:

Ten years.

You've been with me ten years.

How could you turn on me?

Where's your sense of loyalty,

honesty, decency?

Mr. Bolt, we're lawyers.

So obviously in the "chivalry table" all the guys get ZERO score. Since any guy can reach the score of ZERO (meaning achieving an absolute failure) in a subject whether he tries to fail (on purpose) or that's all his ability can achieve (unintentionally), then this doesn't change the "pool" of guys that Alice ends up with if she adds this "demand". The ZERO vector is the "total failure scores printed table".

This ZERO vector is called the trivial case in the sense that anything plus ZERO is the same thing it was before. ZERO is always included.

WHEN THE TRANSFORMATION IS _NOT_ FULL RANK (THERE ARE LESS DIMENSIONS AFTER THE TRANSFORMATION THAN BEFORE IT) :

Visually here a whole line of vectors before lends on the ZERO point after. Or even a whole plane lends on the ZERO point.

Storywise, this is like Alice is frigid and no longer caring for the sex-drive column (the sex-drive table of scores) and it's like all the various scores on that table go to ZERO which means this dimension is lost. We can also lose more than one dimension like we said if Alice is both frigid and autistic, she loses the information in two dimensions (sex-motivation and romance-motivation). So these 2 dimensions which made the plane sex-romance shrink into ZERO.

New words: "null space" and "kernel"!

All the vectors that we can produce with what landed on the origin (that go to ZERO) are called the NULL SPACE or the KERNEL of the matrix.

In our last example:

Alice's "null space" is the sex-romance plane.

Alice's "kernel" is the sex-romance plane.

Subchapter 1.09 - Nonsquare matrices as a nymphomaniac

I hope you are following 3Blue1Brown videos. Each of my sub-chapters is a video of his. So this sub-chapter is this video:

Nonsquare matrices as transformations between dimensions | Essence of linear algebra, chapter 8

https://www.youtube.com/watch?v=v8VSDg_WQlA

First let's summarize what it means visually (geometrically).

One example: all the "action" is happening inside a tilted 2D plane, inside a 3D plane. It's like we have a skateboard rider that's riding up and down a tilted plane (like a primitive ramp that he built by leaning a wide wooden board (like a discarded wooden door) against the top of a short vertical brick wall on the high end, and the paved floor on the other hand. When he rides forward or backward or sideways, it's all on the tilted plane.

The "forward" automatically contains also "upwards". This extra more information, is because the coordinates change not only in 2D but they change in 3D. The movement is not "richer" in information than if the wooden board would lay flat, but the description needs to be "richer" in information because he also changes height (one more dimension).

Another example: all the "action" is happening inside a tilted 1D line, inside a 2D plane. It's like we have a tilted handrail of a section of a staircase (flight of stairs) and the guy is by now more experienced with his skateboard and he "jumps" (ollie)

https://en.wikipedia.org/wiki/Ollie_(skateboarding)

from the paved floor up onto the handrail, and he then "slides" down the handrail with his skateboard.

https://en.wikipedia.org/wiki/Grind_rail

this is very common in street skateboarding

https://en.wikipedia.org/wiki/Grind_(skateboarding)

okay so we are only interested now in his movement along the handrail. How can we describe it? It's along a straight line, but the line isn't just horizontal or vertical, it's in "diagonal". It's tilted (if you look from the side).

The "forward" automatically contains "downwards". Again, this extra information forces us to describe a 2D (forward in the skateboarder's world) movement, in terms of a 3D (forward and down) movement from a viewer perspective.

Okay enough skateboarding, although my whole childhood can be described in riding both streets and the small ramp in "Yamit" in downtown Haifa (I was never good enough to climb the half pipe!) and not daring to do an "ollie" after my first one when I broke my nose and lay in a pool of my own blood. But still I dreamt of doing it and read a lot of "Thrasher" and "Skateboarding" magazines. To this very day I think it's cool, for example I'm watching these days "Tony Hawk Masterclass". But enough skateboarding!

We need the action to happen not along the axes, but along a tilted line or a tilted plane!

Our axes were motivations (romance-driven, sex-driven, friendship-driven).

Let's say that Alice is a nymphomaniac

https://en.wikipedia.org/wiki/Hypersexuality

We have a historical precedent in Catherine the Great:

Legends of Catherine the Great

https://en.wikipedia.org/wiki/Legends_of_Catherine_the_Great

Wikipedia says:

Some called her the "Messalina of the Neva", while others termed her a nymphomaniac…

And an earlier historical precedent in Messalina:

https://en.wikipedia.org/wiki/Messalina

A powerful and influential woman with a reputation for promiscuity…

By the way in Wikipedia in "female promiscuity" you find a picture of this Empress of Russia!

https://en.wikipedia.org/wiki/Promiscuity#Female_promiscuity

Empress Catherine II is remembered in popular culture for her sexual promiscuity.

Ok so let's suppose Alice also is sexually insatiable. This means for us that she will interpret signs for sexual motivation as indeed sexual motivation, but in addition she will interpret any signs of interest in her as sexual motivation albeit to a lesser degree.

"if all you have is a hammer, everything looks like a nail"

https://en.wiktionary.org/wiki/if_all_you_have_is_a_hammer,_everything_looks_like_a_nail

How much less to a lesser degree? We can find the formula. Let's say it's a linear formula: let's say 2 signs of romance-motivation equal 1 sign of sex motivation.

Can you see what will happen? This is like the skateboard example if the staircase (and the handrail with it) goes 2 meters to the right and 1 meter upwards. This – one half – is the slope of the line. So in the case of the two romance over one sex it's less visual but it's the same thing.

Let's say there is also a (different) trade-off from friendship-motivation into sex-motivation in Alice's horny mind. If a guy shows 3 signs of interest in her as a person for her it's like he has shown 1 sign of sex-interest in her body. So that's a different slope.

If we combine both trade-offs, we have a sloped plane, the only plane that can host both of these lines ("romantic to sex" line, and, "friendship to sex" line). This is like instead of the skateboarder door just resting with two of its closest corners on the ground, and two of its other closest corners on the short wall, instead of this, only ONE corner of the door will be touching the ground, and the door's middle section will be resting on the wall in an asymmetrical way, so that we have a slope of 1 to 2 along the door's longer axis (in the door's length) and simultaneously another slope of 1 to 3 along the door's shorter axis (the door's width).

So Alice indeed "flattens" the guys' motivations, from romantic to sex, and from friendship to sex, and she only uses 2-D plane, not a 3-D space, BUT because the 2D plane is tilted in 3D space (i.e. because her superficiality / shallowness is formula based and this formula concerns ALL 3 motivations) which means the 2D plane is not simply in X-Y or Y-Z or X-Z but in one formula that combines two of them (romance-sex) and also simultaneously another formula that combines the third one (friendship-sex), this is why we need all 3 motivations.

There is a "flattening", we do lose information (the skateboard can only move on the surface of the door it can't fly in ANY point in the air; the sex-driven motivation translation can only be according to the pre-defined ration of 1:2 (romance) and 1:3 (friendship) and not in ANY point in the romance-sex-friendship space).

After we have a "flattening" we CAN'T retrieve the lost information that we had before. So Alice's inverse twin Ecila doesn't exist.

3Blue1Brown's video starts with saying that DETERMINANT is ONLY in SQUARE matrices.

How can we put this into our story?

First of all let's try to understand the formal reason in the beautiful answer by Dan Fox:

https://math.stackexchange.com/questions/854180/determinant-of-a-non-square-matrix

He says that we want the determinant of (A times B)

to be the same as the determinant of (B times A).

This is true in square matrices but not in non-square matrices.

When we talked about determinants in our "Determinant as who's the boss?" sub-chapter, we talked about one transformation which was the enlisting to the army (the guy gets more important and impressive role) and w talked about another transformation which was marriage (the guy is turned into a slave of the woman financially by the laws of the country).

So let's say that they start with the guy and girl exactly the same dominance (for simplicity) so there is no boss.

Should it matter if we apply army (empowering the guy) first, and then marriage (empowering the girl) second, OR if we do it the other way marriage (empowering girl) and then army (empowering guy)?

No! it shouldn't matter! The total "who's the boss" (or determinant of the multiplication) should tell us which process is more powerful. The order of the processes doesn't matter. The final result will be the same. Just like $3 + (-2) = (-2) + 3$

BUT IN NON-SQUARE MATRICES THE ORDER THAT WE MULTIPLY THE MATRICES (I.E. THAT WE APPLY THE TRANSFORMATIONS) DOES INDEED MATTER!

The fact that sometimes we are NOT EVEN ALLOWED to multiply the matrices in the other way, would be like if instead of the army the guy and girl enlisted first to being a priest and a nun. It's possible to do marriage and then do religion, but it's impossible to do religion and then to do marriage.

If it's allowed but we simply get a totally different answer it's like processes that alter your mind so that one process shield you or make you vulnerable to the other process.

What process empowers the man, but it's different if it happens before or after marriage?

For example going on an adventure trip with friends in a foreign country, if the guy is married he is not likely to cheat on the wife, so he will not have this extra boost to his "boss" feeling from sleeping with other women on the trip, local girls and girls who are also tourists. So the big "after the army" trip which is something every Israeli does, has very different impact on "who's the boss" if the trip is before the marriage or after the marriage.

Subchapter 1.10 – Dot product as cooperation vs competition

The bible tells us why God made the woman:

Genesis 2:18, KJV: "And the LORD God said, It is not good that the man should be alone; I will make him an help meet for him."

In English all the translations (from Hebrew) are very POSITIVE: suitable for him (NIV), fit for him (ESV), suitable for him (NASB), just right for him (NLT), corresponding to him (CSB).

But all these translations are wrong. In Hebrew it's NEGATIVE "ezer ke-negdo". "Ezer" means help. "ke" means as. "negdo" means against him ("neged" means against). "ke-neged" means opposing.

Rashi the greatest bible interpreter ever, understood it like this: the woman can help for the man, but she can also be against.

https://en.wikipedia.org/wiki/Rashi

OK so imagine if we had a mechanism to measure this property:

just how much the woman is heading in the same direction that the man is heading (helpful) which we will consider as POSITIVE,

Or,

Just how much the woman is heading in the opposite direction (adversarial) which we will consider NEGATIVE,

Or

just how much the woman is heading in the "irrelevant" direction away from where the man is heading ("something completely different") which we will consider as ZERO,

Wouldn't it be nice to have such a mechanism?

DOT PRODUCT is exactly that mechanism! It checks how much one arrow (the woman) is pointing in the same direction as the other arrow (the man), and after taking only the net part where the woman "supports" or "opposes" the man, it multiplies them to see where we get when they "reinforce" each other in the POSITIVE case, or where they get when they "weaken" each other in the NEGATIVE case.

When the woman's action is simply "in another parallel world", not interrupting the man's wishes but also not contributing to them, this is when the woman's arrow is perpendicular to the man's arrow, and then the "dot product" is ZERO.

By the way, competition is not more natural or effective. See the books of Lynn Margulis (which I really hope to read):

https://en.wikipedia.org/wiki/Lynn_Margulis

By the way she was the wife of Carl Sagan.

The way we operate this mechanism of DOT PRODUCT, is we cast a shadow of one vector (the woman) onto the line of the other vector (the man).

The cool thing is that you get the same result if you cast the man's shadow on the woman.

3Blue1Brown explains why this is so in a cool way of symmetry in his video:

Dot products and duality | Essence of linear algebra, chapter 9

https://www.youtube.com/watch?v=LyGKycYT2v0

We can also think of the symmetry and make up a story around it:

Our axis is the horizontal axis. On the right direction there is living in the city where everything is paved and concrete and you buy all your food in the supermarket or restaurant, and the only green thing you see is if you grow a pot plant in your apartment. On the left direction there is living in a secluded farm, immersed in nature and all alone, where you grow all your food by yourself etc.

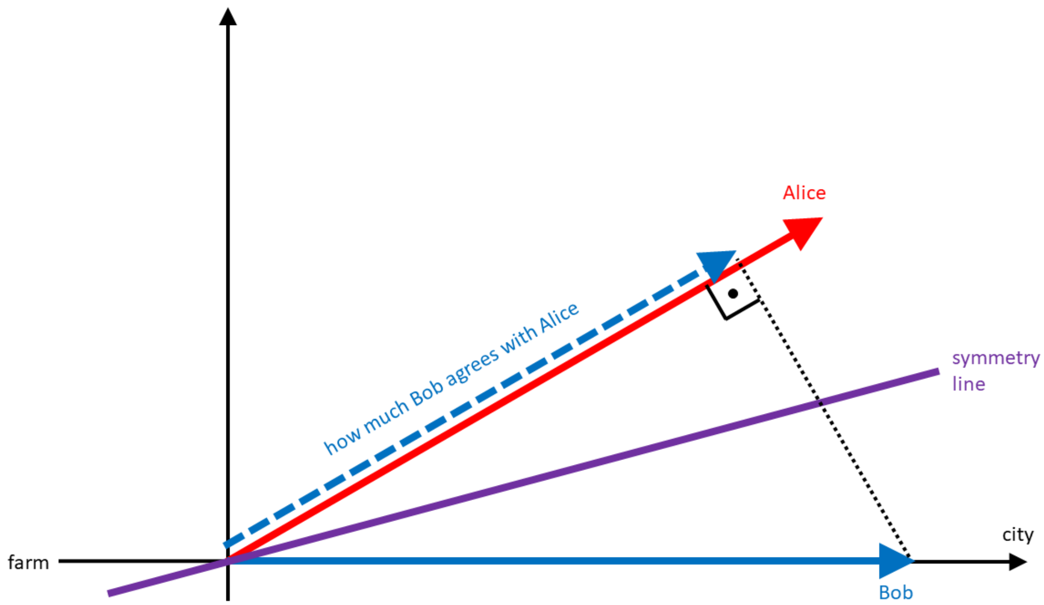
Let's create a line that is the middle ground between them. Like if they are arguing about whether to buy a house in the city or in the countryside (in a village).

Let's say Alice is a nature girl she likes to roam free with her pet dogs taking hikes in the wilderness, starting the morning by hearing the sounds of nature etc.

Let's say Bob is a city boy who likes to get his caffein fix from one of few coffee shops on his street where he got everything at reach like shops and services etc. he likes the hustle and bustle of the city and its lively atmosphere at night.

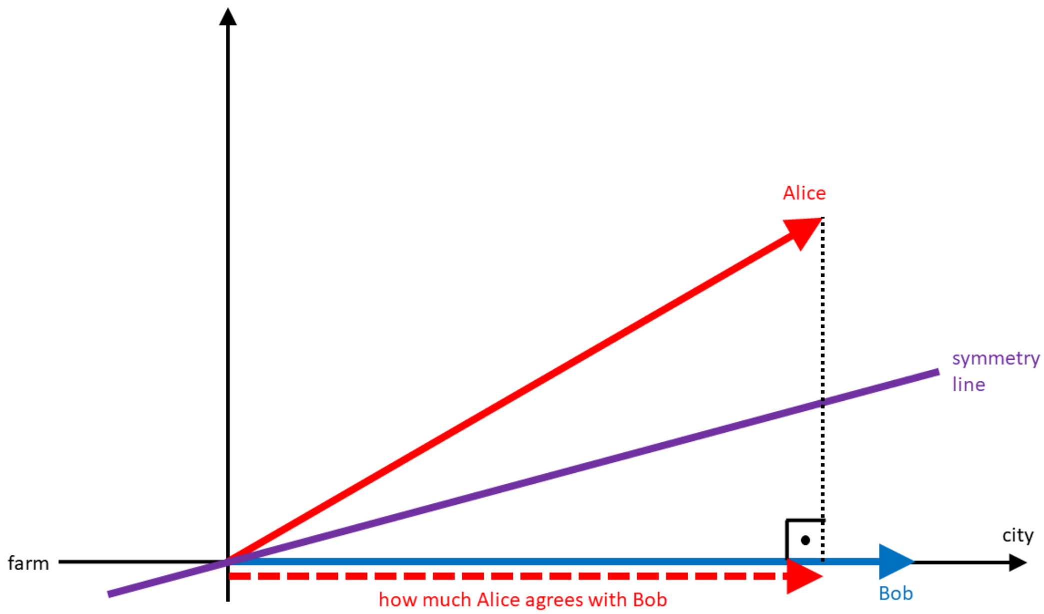
Ok so the common ground (symmetry line) between these two not-that-different world views would be to find a house in the edge of the city. This way they can still reach work without driving for hours every morning and every evening. The woman will have one pet for example a dog and they walk him twice a day in the nearby grove.

Picture 1 – how much Bob agrees with Alice (dashed blue arrow)



This dashed blue arrow is the projection ("the shadow") of Bob (unbroken blue line) on Alice (unbroken red line). Notice that it's hard for us to easily estimate how long this dashed blue arrow is.

Picture 2 – how much Alice agrees with Bob (dashed red arrow)



This dashed red arrow is the projection ("the shadow") of Alice (unbroken red line) on Bob (unbroken blue line). Notice that we can easily estimate how long this dashed red arrow is: it's the "X" (horizontal or in this case "city") direction component of the complete Alice (unbroken red line).

Now I'm showing you the nice intuition that 3Blue1Brown did starting in minute 7:21 of his video.

He made a symmetry line between Alice and Bob (the purple line) and so you can see visually that Bob casting his shadow on Alice, is the same as Alice casting her shadow on Bob.

You can also get to the same conclusion without the symmetry line by proving to yourself that these two triangles (triangle in picture 1, and triangle in picture 2) are congruent.

https://en.wikipedia.org/wiki/Congruence_(geometry)#Congruence_of_triangles

NOW IGNORE THE PURPLE SYMMETRY LINE.

They have the same angle near the origin, which is common to them (in my drawing 30 degrees). They each have a right angle (90 degrees). Since the sum of all the angles in any triangle should be 180 degrees, then we know the third angle is also the same (in my drawing 60 degrees).

Now all we need is a "side" of the triangle which is the same in both triangles, and this would be: the size of Alice is equal to the size of Bob.

So we can use the ASA (Angle-Side-Angle) to prove to ourselves that the two triangles are the same (but in this case flipped). As you see in Wikipedia, the ASA Postulate was contributed by Thales of Miletus (Greek) about 2600 years ago! Thanks Thales! 😊

So since the two triangles are the same, then also their matching parts are the same, and in particular the two dashed lines (how much Alice agrees with Bob, and how much Bob agrees with Alice) are the same!

So remember we had trouble estimating how long is the blue dashed line? Well, it's exactly as long as the red dashed line, which we now know is the "X" component of Alice.

As a side note, in our story we could figure that out by seeing that the common ground between two people is common to both of them.

This explained to us why the $\hat{\imath}$ (the unit vector in the horizontal "X" direction) ends up in $Alice_x$ the horizontal component of Alice. This $Alice_x$ is a simple number (not a vector).

When we multiply by Bob's length (which is also a simple number), we get how much they agree on this subject/axis of city vs. farm.

[Bob's horizontal length] TIMES [Alice's horizontal length] = some POSITIVE number (same direction).

This case was special (Bob lies exactly along the X axis) so that you can see why we multiply his horizontal component by Alice's horizontal component. But the mechanism of DOT PRODUCT works in the same way with ANY two arbitrary direction vectors.

Also it works in 3 dimensions and higher dimensions:

$$Alice_x * Bob_x$$

$$Alice_y * Bob_y$$

$$Alice_z * Bob_z$$

$$\vdots$$

And in the end, we sum all these products and that sum is the DOT PRODUCT.

In each line of this process each one of them (Alice and Bob) casts a shadow on the same axis (to check how much they are in the same direction with each other), and we multiply the projections to see how mutually reinforcing Alice and Bob are along that axis:

We cast their x direction and we multiply. We get a simple number.

We cast their y direction and we multiply. We get a simple number.

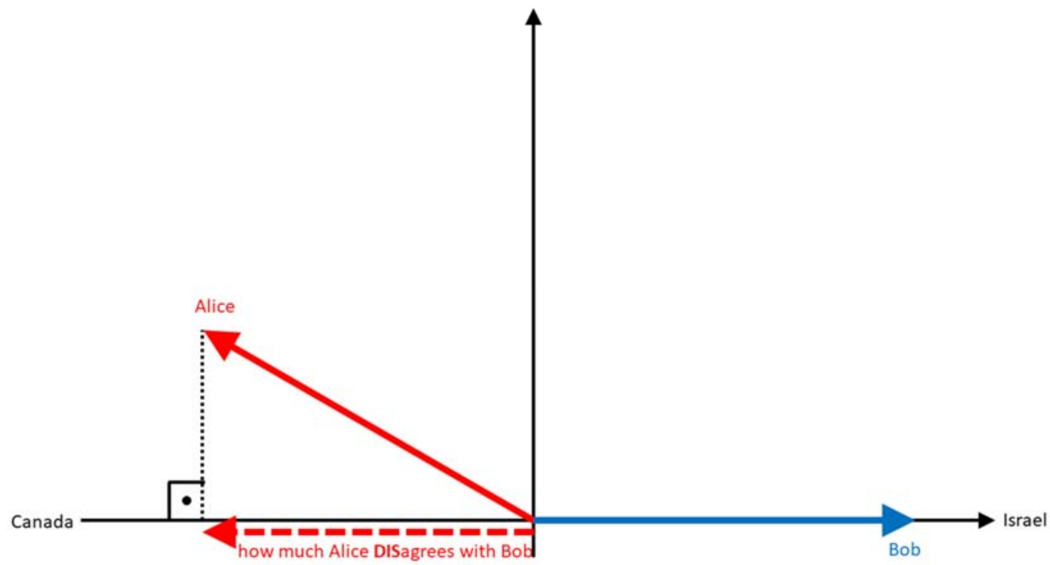
We cast their z direction and we multiply. We get a simple number.

And so on.

The total sum of all these simple numbers is the DOT PRODUCT which is a simple number.

OK now let's see what it looks like when the "dot product" is NEGATIVE.

This happens when Alice and Bob are in generally opposing directions.



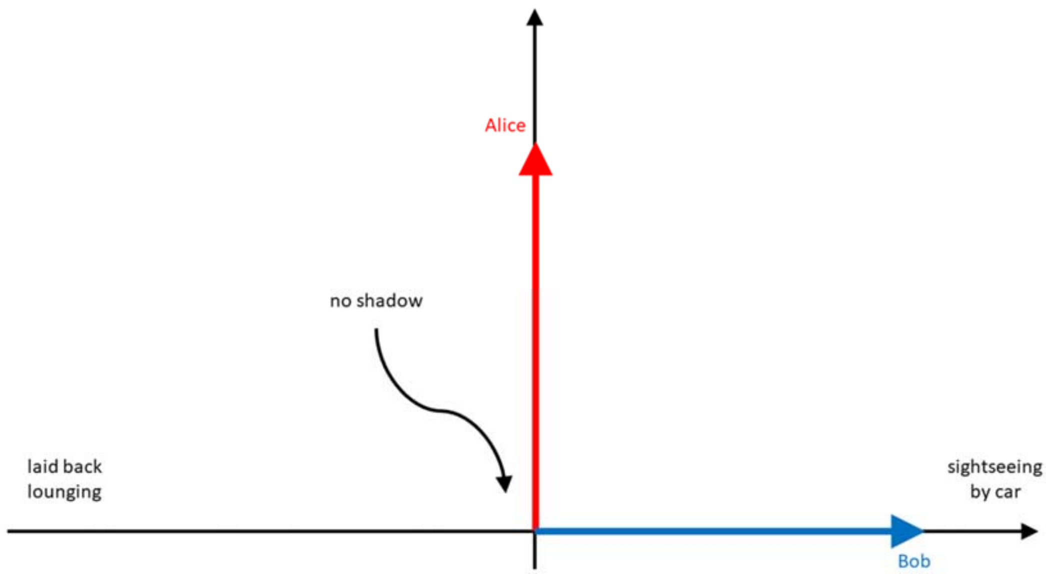
In this example let's say Alice pretty much prefers to immigrate to Canada and Bob wants to stay in his homeland in Israel. These are opposite directions, Alice's shadow will be in an opposing direction to Bob, and the "dot product" is NEGATIVE. Meaning in this subject they don't cooperate; in this subject they compete with each other.

Finally let's see what it looks like when the "dot product" is ZERO.

This happens when Alice and Bob are in directions that have nothing to do with each other.

In this example we're talking about their preferences when travelling on a trip. Bob likes to see as many attractions as possible, taking a picture and then moving on to the next attraction. Trying to collect as many "specific to that area" attractions to the trip as possible. On the other hand most people like to "chill" on their trips: going to shopping malls instead of ancient temples; going to haggle in markets instead of driving to a nice scenery spot; sunbathing on the beach instead of walking through a local museum and so on.

But in this example Alice's only "turn on" is to do extreme sports like rappelling, kayaking, mountain biking, etc. This isn't even on the scale, so it's a completely different direction. So if we look at Alice's shadow it's completely perpendicular to Bob so it leaves NO SHADOW on Bob. So the "dot product" is ZERO.



All these examples are from a girlfriend which I dated for one month, and she was really strange.

Like for example she volunteered as a "foster care" for tons of dogs and cats (she didn't do that for a living, she worked as a software engineer in GE), so in her tiny apartment in the "moshav" not far from Haifa, she had 4 big dogs (each one problematic in his own way, otherwise they would have been adopted already) and like 10 cats. Until I arrived all the animals would climb on her bed at night. So luckily, she agreed to my demand to shut the dogs out of the bedroom at night when I was there. So at night it was just us and the cats (some of them street cats climbing from outside through the open window to eat).

Or another example: On our very first date she told me she is actually looking for a "Canadian housewife". Yes, using the female form! (in Hebrew). Yes I know I should have left right there and then, but I was desperate for a girlfriend. Never mind, at least we got some examples for our subchapter. 😊

Subchapter 1.11 – Cross product as children of a narcissistic parent

The video for this sub-chapter as always by 3Blue1Brown is this video:

Cross products | Essence of linear algebra, Chapter 10

https://www.youtube.com/watch?v=eu6i7WJeinw

Ok remember when we talked about what is a determinant, we said it's the area of the parallelogram that is made by the man's arrow and the woman's arrow.

That area's meaning in our story was what is the difference between the man's and woman's dominance in the relationship. If the man is very dominant and the woman very submissive that makes a big area (big POSITIVE determinant) because women seek that situation, despite their claims. If the woman is very dominant and the man is very submissive then we get a big "flipped" area (big NEGATIVE determinant) because the woman is very unhappy from this situation (in actual life, not in feministic propaganda).

CROSS PRODUCT is that area TIMES a direction (vector) that is perpendicular to both the man and the woman.

As you may guess we need 3D for this direction, because for example the man and the woman are both in the plane of our screen (or our page if you read this on printed paper), and since the CROSS PRODUCT vector should be perpendicular to both of them, it should either (in this example) stick out of the screen (towards you) or stick into the screen (away from you).

What can this arrow be in our story? It's a direction opposes both of them, and gets further away from them when they are very unequal. I think a good example is the child of a narcissistic parent.

https://en.wikipedia.org/wiki/Narcissistic_parent

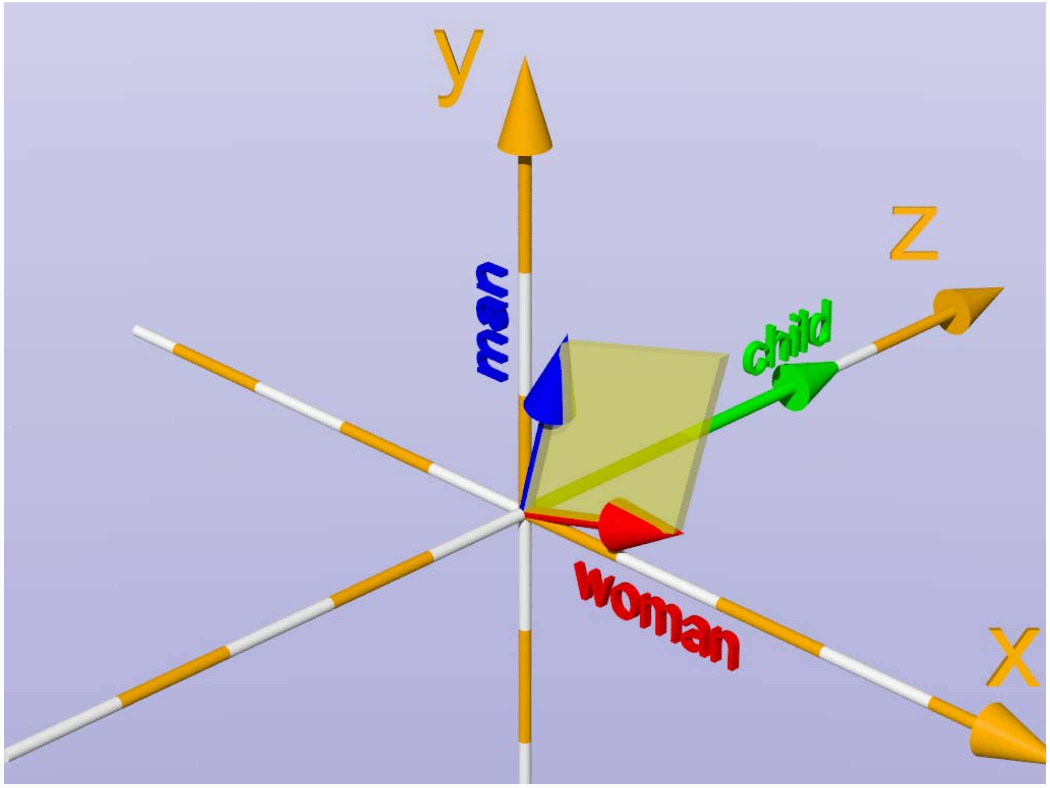
Unlike the satisfaction of the woman who is content to be married to be in a situation like she's a commoner married to a king (in fact many girls literally dream of a prince), the kids of parents with who are very unequal suffer. The kids suffer either way:

If the educating parent (usually the mother) is very dominant the kids are pushed relentlessly to succeed in the area where the dominating mother decided that they have the best chance in. The child gets "love" but it's too much pressure and it's suffocating.

If the non-educating parent (usually the father) is very dominant then the kids don't get attention from him and he's virtually absent in their lives. Even if this leads to compensation in materialistic things, the end result is the same of a child with low self esteem and feeling as a failure.

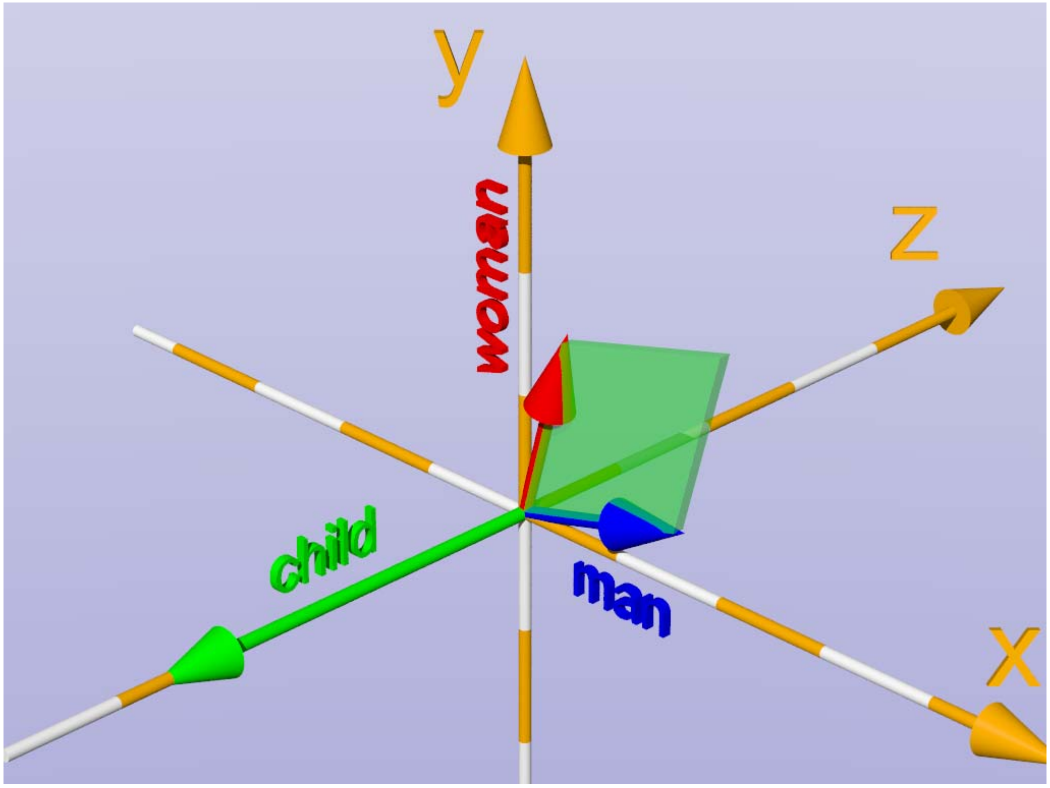
In both cases the child (and later the adult) doesn't like his parents for doing that, so the child feels distant and aloof whether the child ends up as a success or failure.

Picture 1 – dominant educating parent



I tried to make it like a 3D version of the 2D example we had in the subchapter about determinant. The extra dimension is needed because the new vector ("child" which is the CROSS PRODUCT) is perpendicular to the parents' plane.

Picture 2 – dominant non-educating parent



Notice how the man and woman roles "flipped" so now the direction of the CROSS PRODUCT (the child) is still perpendicular to the parents but also "flipped" from the first picture.

In my simplified examples the man-woman plane is the X-Y plane, but it's ok for them the man-woman plane to be tilted in any way in 3-D space, and the child is always perpendicular to their plane.

Notice also that like in our 2-D version of this parallelogram (when we explained determinant), the yellow color in the first picture (POSITIVE, man more than woman) turned to green color in the second picture (NEGATIVE, woman more than man).

Subchapter 1.12 – Cross product as child support in divorce

Ok so I will try to explain in our story language the geometric interpretation from:

Cross products in the light of linear transformations | Essence of linear algebra chapter 11

https://www.youtube.com/watch?v=BaM7OCEm3G0

in minute 9:21 (now for the cool part!)

What 3D vector named P has the special property, that when you take a DOT PRODUCT between P and some other vector [X Y Z] , it gives the same result as you took the signed volume of a of a parallelepiped defined by this vector [X Y Z] along with V and W ?

Ok now let's translate to our words: instead of vector let's write person; instead of DOT PRODUCT let's write cooperation; instead of volume of parallelepiped let's write "dominance gap"; instead of V let's write man and instead of W let's write woman.

What person has the special property that his cooperation with someone, is the same as the dominance gap between the man, the woman, and that someone?

I think an example is the judge that is ruling in a "child support" (child maintenance) when the parents divorce.

https://en.wikipedia.org/wiki/Child_support

ok now I'm referring to minute 7:12 in the video.

THE RIGHT SIDE OF THE EQUATION:

The judge is representing only the best interests of the child. So he is "indifferent" to the interests of the parents. If the parents are equally dominant and earn equally, then the child will be half of the time with each of them and they pay ZERO "child support".

On the other hand, if the judge sees for example that the father is very rich but the child will have better life with the child's mother, then the judge will force the rich (more dominant) father to pay the poor (less dominant) mother every month. If there is greater inequality between them then it makes sense that the payment will also be greater.

So we get a result that the bigger the area of the determinant, the bigger the arrow that represents the child support (the judge's ruling).

Of course if the mother is very rich and the judge determines that the child is better off with his poor father then the payment "flips" and the more dominant mother pays the less dominant father. Let's say the mother runs a huge corporation and has lots of money but no time to raise a child.

THE LEFT SIDE OF THE EQUATION:

BEFORE the judge, the child is getting to the judge in an initial state which is not good, the child suffered neglect because of the parents' struggle for dominance etc.

After the judge, the judge embodies the knowledge of how much the parents should/could pay and when this DOT PRODUCT'ed by the child's wishes this gives the child's best interests.

Let's also translate to the story what 3B1B says in minute 10:24 in the video:

Start by taking the area of the parallelogram defined by MAN and WOMAN. Now multiply it not by the length of [X Y Z],

(xyz is the child before the judge)

But by the component of [X Y Z] that's perpendicular to that parallelogram

(that component in the judge's direction)

But this is the same thing as taking the DOT PRODUCT between [X Y Z] ,

(child before judge)

And a vector that's perpendicular to MAN and WOMAN with a length equal to the area of that parallelogram

(the complete judge vector).

OK I hope I did "more good than harm" in this sub-chapter 😊

Subchapter 1.13 – Cramer's rule as polyamory

The video from 3Blue1Brown is:

Cramer's rule, explained geometrically | Essence of linear algebra, chapter 12

https://www.youtube.com/watch?v=jBsC34PxzoM

I apologize that I can't come up with new plausible scenarios for this sub-chapter. Believe me I tried all sorts of ideas (from infidelity and STDs to BDSM play party) but the old ones still work best.

In this sub-chapter we need to put together ideas from previous sub-chapters:

- Determinant - man and woman competing for dominance; transformation is marriage.
- System of equations - tables of scores for qualities of men (no woman); transformation is woman's mind.
- Dot product – man and woman cooperating; Transformation is marriage.

So I think the best way to combine these will be a polyamorist woman (the "wife"), who has a "harem" of men (the "husbands").

We will be dealing all the time with what is going on in the woman's mind.

The transformation will be the "marriage": the change from BEFORE the specific man joins her "harem" (when they are just dating) to AFTER he joins her "harem".

Now we can bring an idea we used in the sub-chapter: "Matrices as women's minds" about the woman being spiteful (towards a husband's wish/goal vector) as MINUS (that husband's wish/goal vector). And also that the sum of all the husbands' wishes/goals as "the wish of the harem".

So our vectors are only the "husbands". The "wife" is not one of the arrows.

Together they are this "family cell" which I guess functions like a commune. Like they do chores together, etc.

So also between the "husbands" there is a pecking order, I guess it's according to the more the "wife" wants that specific "husband" the higher his standing in the "family".

So the area of the parallelogram (or the volume of the parallelepiped) between the husbands is how much this husband is more dominant (his "wish" counts more in the final decision of the woman) than that husband. This is the DETERMINANT between two husbands.

Now let's try to translate 3Blue1Brown's explanation into the words of our story.

So annoyingly we need to really calculate things, so we need to invent some axes for the husbands' wishes/goals about everything they do in their shared commune.

The axes will be the motivations:

x horizontal axis will be SHARING THE WIFE.

From the cuckold who enjoys it (as we go to the right) to the jealous guy who suffers from it (as we go to the left).

y vertical axis will be TRAGEDY OF THE COMMONS. (how much you exploit public resources).

From the altruistic who give his food to others and clean their mass (as we go upwards) to the parasitic who takes everything and doesn't contribute anything (as we go downwards).

z depth axis the TEAM PLAYER.

From the total conformist (as we go away from us) to the total individualist (as we go towards us).

The unit vectors will be units of "pure" motivation:

$\hat{\imath}$ will be the unit of wife-sharing motivation.

$\hat{\jmath}$ will be the unit of chores-doing motivation.

$\hat{k}$ will be the unit of follow-the-majority motivation.

In minute 1:45 he gives us these two equations:

$$3x + 2y = -4$$
$$-1x + 2y = -2$$

Let's say the first equation is the first "husband" Bob.

So Bob (in Alice's mind) is 3 times $\hat{\imath}$ (moderately wife-sharing) and 2 times $\hat{\jmath}$ (mildly chores-doing). The result is that Alice is disgusted by him and she's pretty spiteful (-4). This means that when the time comes to consider the wishes of the harem, Alice will add 4 parts ANTI what Bob (who disgusts her) wishes.

Let's say the second equation is the second "husband" Charlie.

So Charlie (in Alice's mind) is -1 times $\hat{\imath}$ (slightly jealous; or in other words slightly ANTI-wife-sharing) and 2 times $\hat{\jmath}$ (mildly chores-doing). The result is that Alice is disgusted by him too (but to a lesser degree). So she's mildly spiteful (-2). This means that when the time comes to consider the wishes of the harem, Alice will add 2 parts AGAINST what Charlie (who disgusts her) wishes.

OK now the matrix way of thinking. Alice prints (and hangs in their home to give them incentive to improve) score tables for her "husbands" motivations.

The table of wife-sharing looks like this: $\begin{bmatrix} 3 \\ -1 \end{bmatrix}$.

And the table of chore-doing looks like this: $\begin{bmatrix} 2 \\ 2 \end{bmatrix}$.

She then wants a more compact way to write all this, so she packs these tables (vectors) into a matrix.

$$\begin{bmatrix} 3 & 2 \\ -1 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -4 \\ -2 \end{bmatrix}$$

The matrix is what the "marriage" (joining the harem) does to guys.

Where do pure $\hat{\imath}$ ($\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ or in our story slightly cuckold guy) finishes after joining the harem?

He becomes $\begin{bmatrix} 3 \\ -1 \end{bmatrix}$ which is moderately cuckold and slightly parasitic when it comes to chores doing.

Where do pure $\hat{\jmath}$ ($\begin{bmatrix} 0 \\ 1 \end{bmatrix}$ or in our story slightly altruistic guy) finishes after joining the harem?

He becomes $\begin{bmatrix} 2 \\ 2 \end{bmatrix}$ which is mildly cuckold and mildly altruistic.

And now along comes a new "husband" Frank and we know that after joining the harem he became $\begin{bmatrix} -4 \\ -2 \end{bmatrix}$ which is pretty jealous and mildly parasitic.

And we want to calculate: what was Frank in the beginning $\begin{bmatrix} x \\ y \end{bmatrix}$ (before the "marriage") ?

Ok now we're in minute 5:42 of the video.

WHAT REMAINS UNCHANGED BEFORE AND AFTER THE TRANSFORMATION?

Now please jump with me to minute 7:51 of the video, where 3Blue1Brown explains:

As you apply some sort of matrix transformation, the areas of the parallelogram don't stay the same (they might get scaled up or down), B-U-T and this is the key idea of determinants, ALL THESE AREAS GET SCALED BY THE SAME AMOUNT!

OK so now we arrange things so that we have one parallelogram that tells us what X is, and another parallelogram that tells us what Y is.

Now please jump with me back to minute 5:42 of the video:

The area of the parallelogram that is created from the first unit vector $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ and the mystery input vector $\begin{bmatrix} x \\ y \end{bmatrix}$.

In the terms of our story:

The difference in dominance (which husband's "wish" counts more in the wife's final decision) between two husbands. In this case the husbands are: a generic " slightly cuckold guy ", and the original Frank.

The area of this parallelogram is the base 1, times the height Y (perpendicular to that base). Or simply Y.

In the terms of our story:

The difference in dominance what "separates" these two men (these two vectors).

No remember what we said in the sub-chapter "Determinant as who's the boss?":

DETERMINANT (the area, or in other words how far apart are the tips of the [two arrows] if both of them start in the origin)

EQUALS

How strong are the "forces" that pull them further apart (DARK components)

MINUS

How strong are the "forces" that push them close together (LIGHT components)

So in the same way, what pulls the "slightly cuckold guy" and Frank further apart is how much "cuckoldy" is the "slightly cuckold guy" to one side (the cuckold side), and how much "chores-doer" is Frank to the other side (the chores-doing side).

This is because the "slightly cuckold guy" has only one motivation, and Frank has both, so the difference between them will be what Frank has in the other motivation.

Now here is supposed to come MINUS what brings them close together. But since this would be how much the "slightly cuckold guy" does chores WHICH IS ZERO BECAUSE HE JUST WANTS TO BE CUCKOLD THAT'S ALL times how much Frank wants to be cuckold WHICH IS IRRELEVANT BECAUSE THE MULTIPLICATION WILL BE ZERO ANYWAY BECAUSE OF THE OTHER GUY, so we skip the MINUS ZERO, because the result will not change.

So in summary we have in minute 6:00 in the video:

$$Area\ BEFORE = 1 * y$$

In the terms of our story:

difference in dominance

EQUALS

"slightly cuckold guy"'s wife-sharing

TIMES

Frank's chores-doing.

I remind you the key idea: ALL THESE AREAS GET SCALED BY THE SAME AMOUNT!

So in order to use this we need to calculate another area. We just calculated the Frank's Y, now we will calculate Frank's X.

So we are now in minute 6:35 of the video:

The area of the parallelogram that is created from the second unit vector $\begin{bmatrix}0\\1\end{bmatrix}$ and the mystery input vector $\begin{bmatrix}x\\y\end{bmatrix}$.

In the terms of our story:

The difference in dominance (which husband's "wish" counts more in the wife's final decision) between two husbands. In this case the husbands are: a generic " slightly altruistic guy ", and the original Frank.

The area of this parallelogram is the base 1, times the "height" X (perpendicular to that base). Or simply X.

(I'm writing "height" with double quotation marks because the height is now sideways, see minute 6:51 in the video).

In the terms of our story:

The difference in dominance what "separates" these two men (these two vectors).

No remember what we said in the sub-chapter "Determinant as who's the boss?":

DETERMINANT (the area, or in other words how far apart are the tips of the [two arrows] if both of them start in the origin)

EQUALS

How strong are the "forces" that pull them further apart (DARK components)

MINUS

How strong are the "forces" that push them close together (LIGHT components)

So in the same way, what pulls the "slightly altruistic guy" and Frank further apart is how much "altruistic" is the "slightly altruistic guy" to one side (the altruism side), and how much "cuckoldy" is Frank to the other side (the cuckold side).

This is because the "slightly altruistic guy" has only one motivation, and Frank has both, so the difference between them will be what Frank has in the other motivation.

Now here is supposed to come MINUS what brings them close together. But since this would be how much of a cuckold is the "slightly altruistic guy" WHICH IS ZERO BECAUSE HE JUST WANTS TO HELP WITH CHORES THAT'S ALL times how much Frank wants to be altruistic WHICH IS IRRELEVANT BECAUSE THE MULTIPLICATION WILL BE ZERO ANYWAY BECAUSE OF THE OTHER GUY, so we skip the MINUS ZERO, because the result will not change.

So in summary we have in minute 6:45 in the video:

$$Area\ BEFORE = 1 * x$$

In the terms of our story:

difference in dominance

EQUALS

"slightly altruistic guy"'s chore-doing

TIMES

Frank's cuckoldry.

Ok now in minute 6:52 of the video, 3Blue1Brown goes to 3D. We can do this later (by adding the axis of TEAM PLAYER which we already prepared). But for now I'm asking you to jump to minute   in the video, so that we discuss the 2D scenario straight in a row while it's fresh in our heads so that we don't forget.

OK so we got 2 equations with Area BEFORE. But we don't know the area BEFORE. We only know the area AFTER the marriage. (the marriage is the transformation). We only know what Frank is AFTER which is $\begin{bmatrix}-4\\-2\end{bmatrix}$

B-U-T here we watch minute 7:53 in the video.

ALL THESE AREAS GET SCALED BY THE SAME AMOUNT!

That amount is the DETERMINANT of our transformation matrix.

Okay the last line is NOT familiar to you from my book, because 3Blue1Brown mentioned it when he talked about DETERMINANTS and I didn't think it was important enough and I just didn't bother with it. I'm sorry. I feel like Jackie Chan in the movie Drunken Master 1978 where he didn't bother to practice the kung fu style of "Drunken Miss Ho". OK so like in the movie I will try to improvise here.

OK so we are talking in parenthetically (as an aside; in parenthetical clause;) now:

Remember in the sub-chapter "Determinant as who's the boss?", the transformation was marriage between the man and the woman, so BEFORE the marriage, the man was more dominant then the woman, and then the marriage ROTATED the woman more then the man, so AFTER the marriage, the woman was more than the man. So I want you to imagine this just like your flight lands in a new country and you set your hand-watch (imagine you have an analogue watch, I mean with "hands" of the clock, the man is one "hand" and the woman is another "hand").

Einstein once joked that in relativity theory, he placed a clock at every point in the universe, each one running at a different rate, but in real life he didn't have enough money to buy even one.

So we will do the same: we imagine that all these clocks are automatically synchronized. When you set your hand-watch (which is the origin of the axis) all the other watches everywhere are going through the same transformation. So if there is another "battle for dominance" in another place, any place, the point where the man's and woman's arrows at that point will also do the same transformation, so the woman there will also become more dominant in exactly the same proportion. The proportion of how much you (the transformation) empowered the women everywhere.

OK this was a little "hand-waving" – but it worked for Jackie Chan! Ha ha no seriously, this specific point is hard for me to translate this into the story language but it's very clear visually. Just watch it in 3Blue1Brown.

Ok so end of sidebar, now we are getting back to the issue at hand:

B-U-T here we watch minute 7:53 in the video.

ALL THESE AREAS GET SCALED BY THE SAME AMOUNT!

That amount is the DETERMINANT of our transformation matrix.

Here 3Blue1Brown makes a ANOTHER transformation matrix that just stretches the area towards the right so that the parallelogram's area doubles.

This is like a situation where we have the first vector (the left-most column that tells us where $\hat{\imath}$ will land) of the matrix is $\begin{bmatrix} 2 \\ 0 \end{bmatrix}$. That's where $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ lands AFTER the transformation. In our story that would mean that the "slightly cuckold guy" BEFORE marriage, will become a "mildly cuckold guy" AFTER the marriage.

And since his cuckoldry doubled, so the dominance gap between him and Frank also doubles.

Ok all this is meant to convince you that

$$Area\ AFTER = \det(A) * y$$

So now we divide both sides of the equation by $\det(A)$ and we get y BEFORE.

$$y = \frac{\text{Area AFTER}}{\det(A)}$$

WHICH IS PART OF WHAT WE WANTED!

This is how much of a chore-doing guy Frank was before his "marriage" to Alice!

In the same way we have the equation:

$$Area\ AFTER = \det(A) * x$$

So now we divide both sides of the equation by $\det(A)$ and we get x BEFORE.

$$x = \frac{\text{Area AFTER}}{\det(A)}$$

WHICH IS THE OTHER PART OF WHAT WE WANTED!

This is how much of a wife-sharing guy Frank was before his "marriage" to Alice!

OK so annoyingly in minute 10:38 in the video 3Blue1Brown brings a whole different matrix (marriage) and a whole different result vector (Frank AFTER).

But the idea is the same, so I made a "schematics" for you:

difference in dominance between cuckold score table and Frank AFTER

Frank's altruism BEFORE

$$y = \frac{Area}{\det(A)} = \frac{\det\left(\left[\begin{array}{cc} \text{First column of matrix} & \text{Result column} \end{array}\right]\right)}{\det\left(\left[\begin{array}{cc} \text{First column of matrix} & \text{Second column of matrix} \end{array}\right]\right)}$$

difference in dominance between cuckold score table and altruism score table

As you can see from the colors, when I say difference it works like ration (dividing, not subtracting). So the turquoise in the numerator (up) cancels with the turquoise in the denominator (down).

In the top part we have Frank AFTER (includes Frank's altruism AFTER marriage). In the bottom part we have the altruism score table (how a general man's altruism changes from BEFORE marriage to AFTER marriage).

So imagine that the red "AFTER"s cancel each other, in the top and bottom. So we are left with the BEFORE information.

Subchapter 1.14 – Change of basis as mythological ex's comparison

Ok this sub-chapter is related to this video by 3Blue1Brown:

Change of basis | Essence of linear algebra, chapter 13

https://www.youtube.com/watch?v=P2LTAUO1TdA

I'm quoting myself (not a good sign I know ha ha) from the sub-chapter "Combinations as desirable men":

///// BEGIN QUOTE //////

Now let's talk about using other coordinates. coordinates are the marks on our ruler. Changing the coordinates we use is like switching from using centimeters marks to inches marks or vice versa.

Now our " basis for comparison " for comparison is not the average person (unit vector) in each quality, but instead our " basis for comparison " is something else. For example in Israel we have a phrase "mythological ex" which means your best ever former sexual or romantic partner. I don't know if this is the same expression in English, but I hope you understand.

So suppose that a woman compares each new man that she meets to her mythological ex-boyfriend. So let's say her mythological ex earned 2 times the average salary, and had 3 times as many friends as the average guy.

And now she meets a new guy with an average salary and a dozen (12) friends. So in money this new guy will have $\frac{1}{2}$ (half) because that's half of what her mythological ex had, so it translates in our system to -2 (minus two). And in the popularity the new guy will have 4 because he has 4 times as many friends as her mythological ex.

We can still meet this theoretically any possible combination of qualities, but each new guy will be described in different numbers than the numbers he would have if we would have measured according to the average person and not the mythological-ex. Of course the qualities of the new guy, in actual fact, did not change. The only thing that changed is our basis for comparison, our couple of bases, or in other words our coordinate system.

///// END QUOTE //////

So this is exactly what 3Blue1Brown means when he says another basis.

Like 3B1B says in minute 3:40 into the video:

Space itself has no intrinsic grid.

In our story language let's say we have our familiar Alice, who works with our familiar basis vectors:

$$\hat{\imath} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$\hat{\jmath} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

And so on.

So far we thought about these unit vectors as our "God-given" building blocks, but there is nothing "God-given" about them.

In our story, we will use the same interpretation from the previous sub-chapter, with motivations of the men in the harem of a polyamorous woman:

x horizontal axis will be wife-sharing.

y vertical axis will be chores-doing.

Now comes the main point: Alice DEFINES what is $\hat{\imath}$ and what is $\hat{\jmath}$

According to specific mythological-ex's of Alice (ex-boyfriends that Alice compares every new guy to, these mythological guys set the standard):

Let's say Bob is DEFINED as $\hat{\imath}$ so whatever wife-sharing motivation Bob had, this is called the unit of 1 wife-sharing. And from now on everyone in Alice's mind is compared to him. Bob becomes the "ruler" (measuring device) along the X axis.

The same with the vertical axis:

Let's say Charlie is DEFINED as $\hat{\jmath}$ so whatever chores-doing motivation Charlie had, this is called the unit of 1 chores-doing. And from now on everyone in Alice's mind is compared to him. Charlie becomes the "ruler" (measuring device) along the Y axis.

And now when Alice is looking at a new guy – Frank – he is like 3 times BOB and 2 times CHARLIE so he is:

$$Frank_{for\ Alice} = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$$

So in the video there is another girl – Jennifer – and Jennifer has other mythological ex-boyfriends – Dan and David. (she has a thing for guys with a big 'D' ha ha).

And now Jennifer is looking at this same new guy – Frank – and he is like ${}^{5}/_{3}$ times DAN and ${}^{1}/_{3}$ times DAVID so he is:

$$Frank_{for\ Jennifer} = \begin{bmatrix} 5/3 \\ 1/3 \end{bmatrix}$$

Okay so what happened? It's the same guy Frank, he doesn't change, but the two girl describe him on basis of their personal past experiences, so they have different descriptions (it's like different languages, in the nice metaphor that 3B1B uses) which describe the same thing – Frank.

Which description is right? They both are right. We use whatever description is more comfortable for us.

In minute 2:45 in the video, 3Blue1Brown tells us that if Jennifer "translated" her mythological ex-boyfriends (in other words, Jennifer's base vectors) into the "language" we are used to, which is Alice's mythological ex-boyfriends (in other words, Alice's base vectors), then in Alice's "language", Dan $\overrightarrow{b_1}$ and David $\overrightarrow{b_2}$ will be:

$$Dan_{for\ Alice} = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$$

$$David_{for\ Alice} = \begin{bmatrix} -1 \\ 1 \end{bmatrix}$$

But like the video says in minute 2:58 , for Jennifer these same vectors are described as:

$$Dan_{for\ Jennifer} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$David_{for\ Jennifer} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

They are what define the meaning of the basis vectors in Jennifer's world.

The ORIGIN $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$ IS THE SAME FOR ALL THE GIRLS. It's the thing that you get when you scale any vector by ZERO. Or in our story language, it's the guy that you a girl gets when she gives ZERO "importance" to a guy. (in the motivation calculation of the whole harem).

BUT THE DIRECTION OF (EACH GIRL'S) AXES AND THE SPACING OF (EACH GIRL'S) GRIDLINES WILL BE DIFFERENT.

What does this mean in our story? That each girl has different past experience, different 2 mythological ex-boyfriends (if we are talking about 2 motivations like wife-sharing and chores-doing).

The mythological ex-boyfriends are not in the same direction (they are made of different mix of these motivations) and different length (different "strength" of their motivations).

And for each girl, her past experience (her mythological ex-boyfriends) define what is considered "standard" or "usual".

Minute 4:13 in the video:

How do we translate between these coordinate systems (between these girls) ?

Ok so Jennifer tells Alice about this new guy that Jennifer met who is Dylan. (Dylan is a newer name, unlike Dan and David he's not from the bible, so you can remember he's Jennifer's new guy). So Dylan is:

$\begin{bmatrix} -1 \\ 2 \end{bmatrix}$ and by this Jennifer means he is 1 times ANTI-Dan, and 2 times David.

Of course this doesn't mean much to Alice. What can Alice do to understand what Jennifer is talking about?

But like we said, Alice knows Dan and David, let's say she met them at Jennifer's "wedding".

So Alice knows what Dan and David are in Alice's language:

$$Dan_{for\ Alice} = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$$

$$David_{for\ Alice} = \begin{bmatrix} -1 \\ 1 \end{bmatrix}$$

The first line means that for Alice, Dan is 2 times Bob and 1 times Charlie.

The second line means that for Alice, David is 1 times ANTI-Bob and 1 times Charlie.

So now we are in minute 4:49 of the video.

Alice can compute from this what Jennifer meant by:

$$Dylan_{for\ Jennifer} = \begin{bmatrix} -1 \\ 2 \end{bmatrix}$$

(which in Jennifer's language means 1 times ANTI-Dan, and 2 times David).

Alice simply needs to substitute ("plug in" into the equation) Alice's view of Dan and David.

Dylan (for Jennifer)

EQUALS

1 times ANTI-Dan (for Jennifer), and 2 times David (for Jennifer)

EQUALS

$$-1 \begin{bmatrix} 2 \\ 1 \end{bmatrix} + 2 \begin{bmatrix} -1 \\ 1 \end{bmatrix}$$

Okay so far we just plugged in what we know as "Dan for Alice" and "David for Alice". If we're ok let's continue. Now Alice does the simple multiplication and addition first in the "upper floor" and then in the "lower floor" and Alice gets the result which is "Dylan for Alice"!

$$Dylan_{for\ Alice} = \begin{bmatrix} -4 \\ 1 \end{bmatrix}$$

Now Alice understands what Dylan is like, he is 4 times ANTI-Bob and 1 times Charlie. So Alice says to her friend: Jenny he's pretty jealous! He's not the right guy for a polyamorous relationship. So Alice encourages Jennifer to break up with Dylan.

Minute 5:08 in the video:

This process that Alice did is familiar to us, we could write it like a matrix times a vector:

$$\begin{bmatrix} 2 & -1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} -1 \\ 2 \end{bmatrix}$$

The matrix is made of the "Dan for Alice" and "David for Alice".

But the real meaning of the matrix is "TRANSLATION FROM JENNIFER TO ALICE".

The vector that the matrix is multiplying is "Dylan for Jennifer".

And the final result is "Dylan for Alice"!

I'm trying to think of a real world example of what this "TRANSLATION" matrix can be. It's just that part in Alice's head which "models" Jennifer's "quirks" and adjust them to Alice's way of thinking.

For example if Jennifer only dates black guys, and they all have bigger dicks and can't shoot their cum closer; and Alice only dates white guys, and they all have smaller dicks and can shoot their cum further away; Then when Jennifer tells Alice "Dwayne has an OK dick and an OK cum-shooting", then the "TRANSLATION" into Alice's terms is like Jennifer would say in Alice's terms: "Dwayne has a big dick and poor cum-shooting".

OK so now let's forget Dwayne and we go back to Dylan (Jennifer's new guy).

Let's say Alice needs to rotate Dylan's motivation for something.

In the sub-chapter "Transformations as changes of opinion" here is a quote reminder:

////// BEGIN QUOTE //////////

Let's start with the simplest example where the woman has a good man at home and now from some reason, she's looking for a bad man.

So the plane of rotation is defined by the two straight lines. One line is the line between the good man and the bad man. But what is the other line?

The other line is the rationalization line and is determined in retrospect according to what is easiest for the woman to falsely accuse the man.

We see this in porn movies of the cuckold genre, that the woman finds an excuse to blame on the husband. If he's uneducated she finds a doctor or a professor. If he's poor she finds someone rich and successful. If he has a small dick, she finds a man with a huge dick. If he's a junior employee she finds his boss at work. If he's physically weak she finds an athlete. Etc.

Each woman creates the plane where she's most comfortable rotating her "wishes vector", but the ultimate goal of the rotation is to finally reach the macho dominant and forceful man with whom the woman wishes to have sex with.

The other vector we can call the "excuse vector", because it's determined as a rationalization of what she can lay the husband's blame on. The husband's blame for the "fact" that the woman was forced to cheat on him because the husband supposedly did not deliver the goods.

////// END QUOTE ///////////

Here's another quote from the same sub-chapter:

////// BEGIN QUOTE //////////

An example for a rotation is displacement or transference in psychology. Transferring the investment in one thing (love) into another thing (career). Or another example for a rotation is transferring being impressed from one thing (creativity) into something else (career). So a woman can think "my talented husband", but actually he only knows how to make money. This isn't called talent. This is called going with the flow and land a cushy job in the establishment. This quality is pretty much the opposite of talent.

The woman recalibrating the direction and scale of her impression from the man.

////// END QUOTE ///////////

So let's do the same here. Suppose Alice doesn't like Dylan. Let's say Dylan sounds like a good guy (from Jennifer's descriptions which Alice TRANSLATED from Jennifer to Alice) and Alice is attracted only to bad guys. But it's not "politically correct" thing to say. Alice does not want to acknowledge to Jennifer or even to herself that she collects shitty guys. So she does a rotation like I just quoted.

(if you want a scenario let's assume that the two girls along with their harems throw a swinger party and during the party Alice needs to explain to her friend Jennifer so that Jennifer will understand (in Jennifer's language) why Alice doesn't want to have sex with Dylan).

But the point is that Alice CANNOT do the rotation in Jennifer's language (Jennifer's coordinates).

So how can Alice rotate Dylan?

(1) TRANSLATE from Jennifer to Alice.
(2) Rotate "Dylan for Alice" using Alice's language (Alice's coordinates).
(3) TRANSLATE back from Alice to Jennifer.

We already learned how to do the first TRANSLATION (from Jennifer to Alice). And we also already learned how to do the rotation of a vector (back in that sub-chapter "Transformations as changes of opinion"). All that's left for us to do is to find out how to do the last step: TRANSLATION of the "rotated Dylan in Alice's world" back to Jennifer's world.

But we already did that too! Remember the sub chapter "System of equations as rating lovers in tables"

There we talked about THE IDEA of inverse matrix.

In that specific sub-chapter we wanted to get the inverse action of Alice and we called her "twin sister" Ecila which did the opposite transformation from Alice.

The original matrix was A

The inverse matrix was A^{-1}

Okay so in this sub-chapter now, we do not want the inverse of Alice. But we are using the SAME IDEA of an inverse matrix.

Now we want the inverse of the matrix of "TRANSLATION FROM JENNIFER TO ALICE":

$$JTOA = \begin{bmatrix} 2 & -1 \\ 1 & 1 \end{bmatrix}$$

Which will give us the matrix of "TRANSLATION FROM ALICE TO JENNIFER"!

This is done in minute 7:31 of the video.

3Blue1Brown tells us what the inverse matrix is in minute 8:04 in the video.

I don't think it adds anything to your understanding but here it is in case you are curious:

$$ATOJ = \begin{bmatrix} 1/3 & 1/3 \\ -1/3 & 2/3 \end{bmatrix}$$

The much more important is how we use these two matrices "Jennifer to Alice" and "Alice to Jennifer".

We already said it in the (1) (2) (3) stages "how can Alice rotate Dylan?" above, but let's write it in equation form:

Now we are in minute 10:22 of the video:

So I tried to give each "player" a color: Alice is a blonde so she's yellow, Jennifer is a redhead so she's red, Dylan is blue because "blue is for boys" 😊

Alice (yellow) and Dylan (Blue) makes green;

Jennifer (red) and Dylan (Blue) makes purple;

In the places where we "shift" from red to yellow or vice versa, we have orange between them.

Also please notice that the ATOJ and the JTOA are not the same. They differ in the -1 that is written in superscript.

$$\overbrace{\underbrace{\begin{bmatrix}2 & -1\\1 & 1\end{bmatrix}^{-1}}_{ATOJ}\overbrace{\underbrace{\begin{bmatrix}0 & -1\\1 & 0\end{bmatrix}}_{Rotation_{for\ Alice}}\overbrace{\underbrace{\begin{bmatrix}2 & -1\\1 & 1\end{bmatrix}}_{JTOA}\underbrace{\begin{bmatrix}-1\\2\end{bmatrix}}_{Dylan_{for\ Jennifer}}}^{Dylan_{for\ Alice}}}^{Rotated\ Dylan_{for\ Alice}}}^{Rotated\ Dylan_{for\ Jennifer}}$$

$$\underbrace{\begin{bmatrix}2 & -1\\1 & 1\end{bmatrix}^{-1}\begin{bmatrix}0 & -1\\1 & 0\end{bmatrix}\begin{bmatrix}2 & -1\\1 & 1\end{bmatrix}}_{Rotation_{for\ Jennifer}}$$

Please notice the bottom line has a brace which is ALL RED. This means it's NOT specific to Dylan. Alice can rotate ANY of Jennifer's guys using this ALL RED rotation.

Subchapter 1.15 – Eigenvectors and eigenvalues as obsessive love and the Baroness Munchausen

The video for this sub-chapter from 3Blue1Brown is:

Eigenvectors and eigenvalues | Essence of linear algebra, chapter 14

https://www.youtube.com/watch?v=PFDu9oVAE-g

An EIGEN-VECTOR is a vector that is NOT ROTATED in the transformation.

We've seen transformations as changes in the woman's opinion.

So if something stays the same in her mind, no matter how her mind changes, we can say it stays fixed. In common language we would call this obsession, but psychologists have more accurate terms like a few kinds of obsession: Fixation, Idée fixe or if it's extreme then Fanaticism.

https://en.wikipedia.org/wiki/Fixation_(psychology)

https://en.wikipedia.org/wiki/Id%C3%A9e_fixe_(psychology)

https://en.wikipedia.org/wiki/Fanaticism

So your whole world ROTATES AROUND IT, but this idea doesn't move, it is fixed in your head.

Because what we are dealing with (our vectors) are men, then this obsession here is about a man, which Wikipedia calls: obsessive love.

https://en.wikipedia.org/wiki/Obsessive_love

In the case of two dimensions, this also include a case of the vector getting longer or shorter, but NOT changing direction. So growing is equal to the man becoming more of the same, intensifying in the exact same qualities that he already has. And shrinking means becoming less of the same, again keeping all the proportions of all his qualities but they all waken.

Since we are inside the woman's mind, this means the man is more attractive to her (he has more of that thing she's obsessed about). So his arrow (vector) in her mind is bigger if she desires him more.

I'm quoting from the sub-chapter "transformation as changes of opinion":

/////// BEGIN QUOTE ////////////

The article says that most of the time women are attracted to men who are a little feminine because they are gentle and caring and will be good fathers. But in the time when the woman ovulates (when she is most fertile) the woman is attracted to macho men who have more testosterone and can make a stronger (and with better immune system) offspring. By the way this means that the woman's strategy is wired to cuckold the loyal husband with some manly "bull" and let the cuckold raise the child thinking it's the cuckold's own child.

/////// END QUOTE ////////////

Now this is not just this one man, this is a whole LINE of men who is exactly in this special direction that SHE (the specific woman) are crazy about.

ANY guy from that very specific type will be the object of this obsession because they are all positioned on the same special line (the line of man she is obsessed about).

So our imaginary girl (Alice) is now Japanese and all her life she has an obsession about 2 different kinds (LINES) of guys (VECTORS) and now she is on her first trip ever to Europe and she sees both of these "dream guys" of her on the streets.

- Tall blonde fair-skinned blue-eyed guys which she sees in Scandinavia.
- Cheeky hairy dark-skinned black-eyed guys which she sees in Italy.

We need to assume that she has no reason for picking ONE guy in particular (because then she is falling in love with him specifically). We are talking about a "general" obsession for all guys with that appearance.

So these are her two different EIGEN-VECTORS.

Let's say she is even more obsessed with the blonde Scandinavian guys. So when she is horny their "value" (how great their vectors are) grows by a factor of 3. In other words the same blonde guy (I imagine Chris Pine from Star Trek, I'm not familiar with the entertainment world), would "hold" a certain sex appeal when she IS NOT "horny", and he'll "hold" 3 TIMES that sex appeal when she IS "horny". Her ovulating/arousal is the transformation.

In the same transformation, the dark guy (I imagine Orlando Bloom from Lord Of The Rings, again I don't know actors), grows by a factor of 2.

The EIGEN-VALUE of the blondes is 3. The EIGEN-VALUE of the dark guys is 2.

This is the amount that vectors (guys) on a specific line (of specific kind) stretch or shrink.

If we are talking about NEGATIVE values, these are the kinds (LINES) of guys (VECTORS) that she is repulsed by, and repulsed by more when she is "horny". Let's say for example that she hates Chinese (Japan and China were always at wars), so when she is "horny" she is even more disgusted by Chinese guys. (If I picked a wrong example then I apologize and please think of an Israeli girl who is afraid of Arab guys which is 100% accurate).

The EIGEN-VALUE of the "bad guys" will be NEGATIVE let's say MINUS 7.

The important thing is that the obsessively-hated guys like the Chinese/Arabs also stay on the same line that they were (the same DIRECTION) they also don't rotate. FLIPPING DIRECTION 180 ° IS NOT CONSIDERED ROTATION.

Any kind of guys (vectors) who stay on the same line (direction or flipped direction) is EIGEN-guy (I mean EIGEN-VECTOR).

I read now that "eigen" means proper or characteristic, so when she is "in heat" these are the proper guys for Alice to either LOVE or HATE (180 ° of love). This is what "defines" or what is characteristic of her taste in men while she is "in heat". These different kinds (LINES) of guys (VECTORS) are characteristic of her "in heat" (TRANSFORMATION).

Any OTHER guy (vector) will be rotated during the transformation (ovulation/horniness), because he is NOT "protected" by the obsessive love.

So for example Japanese guys will change DIRECTION (we don't care about length now). They are no longer in any of the two DIRECTIONs that she desires.

So any Japanese guy, through no fault of his own is ROTATED sideways and no longer "aligns" with what Alice desires when she is "in heat".

3Blue1Brown keeps calling the "being on the same LINE" in the words "being on the SPAN of the vector" so I guess I should call it in the same way, so that you will get used to it.

There is a famous anecdote about John von Neumann:

a physicist asked him:

"I'm afraid I don't understand the method of characteristics"

John von Neumann replied:

"**Young man, in mathematics you don't understand things. You just get used to them.**" 😊

In the chapter "Combinations as desirable men" we said what SPAN means:

SPAN – the "minimal" group of qualities that make up a certain plane.

So in this case it's the same thing but instead of a 2D plane it is 1D LINE.

SPAN – the "minimal" group of qualities (for example: blonde hair, blue eyes… in the case of the Scandinavians) that make up a certain LINE (type of guys that Alice is obsessed with).

The same word SPAN is used every time that we want to describe the LINE/PLANE/SPACE that a few vectors can create by all these vectors' combinations.

When we talk about a LINE (a line has only one dimension) then one vector is enough to describe it.

In minute 4:04 3Blue1Brown tells us that EIGEN means that which doesn't rotate, and in 3D rotation, the EIGEN VECTOR is THE AXIS OF ROTATION.

In a rotation the EIGEN-VALUE is 1 , because the object is not stretched and not shrunk.

OK now we are in minute 5:16 and 3Blue1Brown tries to give us some of the nitty gritty:

$$A\vec{v} = \lambda\vec{v}$$

What does this mean? Here comes the "number" version. (Coming soon: The story version).

on the left side of the equation, we have the vector $\vec{v}$ after the matrix A did some changes to him.

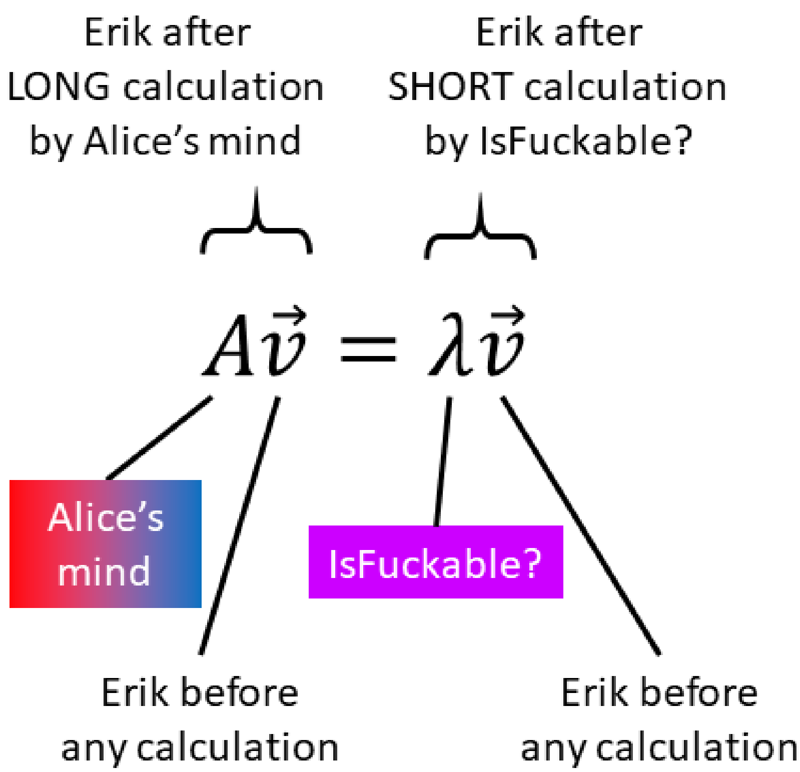
On the right side we have the vector $\vec{v}$ after the SIMPLE number (like 3 or minus 7 or ½) named LAMBDA (which is the Greek letter λ) did some SIMPLE change to the vector: stretched it or flipped it or shrank it.

The equal sign means that we get the same result.

Oh and mathematicians call a SIMPLE number a SCALAR.

The effect of this equation is like "to make a long story short". We want to know what happened to the vector after he went through the transformation (the transformation is described by the matrix) but that's a long story. So instead of calculating this "long story" we have a QUICK SUMMARY of just multiplying the vector by this SIMPLE number. We cannot summarize what happened to just ANY vector this way, only to the special vectors who are on the lines that don't rotate. The EIGEN-VECTORS.

OK now the story version (Erik is like a Swedish blonde guy's name):



OK there is a skit " Bar One " by the rapper Dr. Dre. I confess that I don't like this kind of "music" at all, it was brought to my attention by a friend called Markman like 20 years ago.

So anyway two girls are at the bar with their backs toward the crowd. Then one of them spots a group of guys, but tells her friend not to look (so as not to appear too interested). So the girl who didn't get a chance to look at them, wants some information fast. So she asks only about the parameter that she's obsessed about: " is they fuckable "?

So here I tried to paint this with color. The long calculation (multiplying the guy's vector by the girl's matrix) takes too long. But since these guys are SPECIAL in the sense that they are her "type", they are on the LINE (the line of her EIGEN-VECTOR) that she is obsessed by (supposedly black foul-mouthed men), so she asks just how far they are on that LINE. A lot or a little (or flipped which means she is repulsed by them a lot or a little).

Alice's mind contains many complicated red and blue colors hues/shades. When added together (long calculation) they will give us purple color. IsFuckable gives us the purple color immediately.

In the skit it's like binary information: yes or no. fuckable or unfuckable. But if the girl would ask grade them by a score like $+3$ or -7 or $\frac{1}{2}$ then this score would be the EIGEN-VALUE.

OK so in minute 6:11 in the video, 3Blue1Brown says the left side of the equation is in this shape " a matrix times a vector " and we want the right side of the equation to also be in this shape. How do we do this?

$$A\vec{v} = \lambda\vec{v}$$

We write instead of LAMBDA (which is the EIGEN-VALUE or the "how much fuckable" score in our story), a matrix which does the same effect. The effect is to scale each component (quality) of the vector (guy) by the same factor (LAMBDA).

So remember in the sub-chapter " System of equations as rating lovers in tables ", we talked about the third twin in the triplet (Alice the original, Ecila the inverse, and Identity which equals Alice TIMES Ecila)?

Well now we need the Identity matrix because when we multiply a vector by her, the vector doesn't change. And if we multiply the Identity by a simple number and THEN multiply her by the vector, it's like we multiplied the vector by that simple number.

In our story, if the sister named "Identity" has in her mind (matrix) the columns ("rules") which tell her what to do with the guy's components (qualities):

On the 1st "quality" (let's say eye-color), the 1st rule tells her: leave the guy's eye-color just the way it is now (don't make his blue eyes any "bluer"). Because the 1st column ("rule") is $\begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}$

On the 2nd "quality" (let's say hair-color), the 2nd rule tells her: leave the guy's hair-color just the way it is now (don't make his blonde hair any "blonder"). Because the 2nd column ("rule") is $\begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}$

On the 3rd "quality" (let's say height), the 3rd rule tells her: leave the guy's height just the way it is now (don't make his height any higher). Because the 3rd column ("rule") is $\begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$

So you understand why at the end of this she doesn't change the guy.

Identity TIMES Erik

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \vec{v}$$

WE ARE LOOKING NOW ONLY ON THE RIGHT SIDE OF THE EQUATION:

Let's suppose there is another sister who we will call "The Baroness" because she is like Baron Munchausen, exaggerating and "stretching" what was in reality.

So the Baroness is like Identity except she multiplies INSIDE herself each "rule" (column) by 3. (The Baroness is like Identity times the SIMPLE number 3).

Then her "rules" will become: "scale that guy's 1st component by 3", "scale that guy's 2nd component by 3", "scale that guy's 3rd component by 3".

Identity (with each of her columns TIMES 3) TIMES Erik.

$$\begin{bmatrix} 3 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 3 \end{bmatrix} \vec{v}$$

And we are allowed to take the 3 OUTSIDE and write it before the matrix:

3 TIMES Identity TIMES Erik.

$$3 \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \vec{v}$$

So the Baroness "stretches" the man: you give her Erik and she will return Erik TIMES 3, who is threefold in all of Erik's qualities.

So in the same way let's think of the Baroness in more general terms, instead of 3 she "stretches" by the number LAMBDA

$$\begin{bmatrix} \lambda & 0 & 0 \\ 0 & \lambda & 0 \\ 0 & 0 & \lambda \end{bmatrix} \vec{v}$$

Or in other words:

$$\lambda \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \vec{v}$$

The Baroness acts as a shortcut for us, because with her it's a lot easier to understand what happened (she "stretched" that vector) and what was before (when the vector wasn't "stretched" yet). Alice can do a lot of things (for example rotations) which we can't easily understand. We have to do the hard work of calculating. The Baroness makes it easier.

OKAY NOW LET'S SUBSTITUTE THIS RIGHT SIDE INTO THE WHOLE EQUATION:

$$A\vec{v} = (\lambda I)\vec{v}$$

I stands for Identity.

If we need to say this in story version it will be:

Erik after he was changed by Alice EQUALS Erik after he was stretched by the Baroness.

Why are we allowed to make this shortcut? Because Erik is exactly on one of Alice's obsession lines.

Now we are in minute 6:45 in the video.

Now 3Blue1Brown is doing algebraic "tricks", so we will do them in our story version.

We can subtract the right side (move the $(\lambda I)\vec{v}$ to the left side of the equation) so on the right-hand side we have the ZERO vector.

$$A\vec{v} - (\lambda I)\vec{v} = \vec{0}$$

This means that IF Alice and the Baroness were pulling in OPPOSITE directions at the end, THEN the final result is that Erik will be SQUISHED to ZERO.

And then we can factor out the $\vec{v}$ and on the right-hand side we have the ZERO vector.

$$(A - \lambda I)\vec{v} = \vec{0}$$

This means that IF Alice and the Baroness were pulling in OPPOSITE directions at the beginning, THEN the final result is that Erik will be SQUISHED to ZERO.

So now we are looking for what 3Blue1Brown calls the "sweet spot" – the only value of λ (our EIGEN-VALUE , or "how much the Baroness stretches the man") which will make this last equation true. This magic value will make the Baroness' effect the same as Alice's effect, or in other words this magic value will make the Baroness EXACTLY as powerful as Alice.

OK so all this talk about SQUISH a vector to ZERO, and a power struggle, should remind us the subchapter " Determinant as who's the boss?"

/////// QUOTE BEGIN ///////////

at the time of 3:06 he talks about what happens if the transformation (marriage) squishes the two vectors (man and woman) into one line (super fair (equitable) relationship), or even to a single point in space (the man and woman have zero length vectors, and since we said that the length of the vector means the public opinion (like with the fighter pilot) this means the public thinks NOTHING special of them, both the woman and the man are supremely average, they are like the Joe and Rita in the amazing film Idiocracy 😊). In both of these cases the determinant is ZERO (the area of a line is zero and the area of a point is also zero).

/////// QUOTE END ////////////

OK so this is our way of knowing when vectors are SQUISHED to ZERO – it happens only when the DETERMINANT is ZERO!

(we ignore now the boring case of Erik himself is ZERO).

$$(A - \lambda I)\vec{v} = \vec{0}$$

So what we want is the determinant of this "Alice MINUS Baroness" matrix.

IF WE FIND WHEN THE DETERMINANT IS ZERO, THEN WE FOUND THE MAGIC LAMBDA!

It's like a "tug of war" competition, between Alice and the Baroness. Each matrix tries to pull (stretch) the vector Erik (and the whole of space) in her direction. If the end result is that Erik is exactly ZERO it means that Alice and the Baroness are equally powerful (and so when they are pulling in opposite directions they SQUISH the whole of space onto a LINE so space has an area/volume of ZERO).

And this LAMBDA value (that sweet spot or magic value of LAMBDA) solves the equation that interests us (remember? LAMBDA equals "how much fuckable"):

$$A\vec{v} = \lambda\vec{v}$$

OK now we are in minute 9:28 of the video.

So now 3Blue1Brown walks us through the calculation of the numbers.

The original matrix Alice is $\begin{bmatrix} 3 & 1 \\ 0 & 2 \end{bmatrix}$

We have the Baroness $\begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix}$

Then we subtract: Alice MINUS Baroness , multiply by Erik and compare to the ZERO vector

$$\begin{bmatrix} 3-\lambda & 1-0 \\ 0-0 & 2-\lambda \end{bmatrix}\vec{v} = \vec{0}$$

Now we calculate the DETERMINANT of this matrix (Alice MINUS Baroness)

$$det\left(\begin{bmatrix}3-\lambda & 1-0\\0-0 & 2-\lambda\end{bmatrix}\right)=0$$

By the way this is a simple ZERO and not the ZERO vector, because a DETERMINANT's result is a simple number.

After the calculation (which by the way is done like this: upper-left TIMES bottom-right, MINUS, upper-right TIMES bottom-left) we get:

$$(3-\lambda)(2-\lambda)-(1-0)(0-0)=0$$

In order to make the equation true, so that the left side will EQUAL ZERO, we have two different options (EIGEN-VALUES):

1st option: $\lambda = 3$ (which "stretches" the Scandinavian guys in our story).

2nd option: $\lambda = 2$ (which "stretches" the Italian guys in our story).

To find out what are the guys themselves (EIGEN-VECTORS), we plug one of these numbers into the matrix (Alice MINUS Baroness):

For example the Italian guys $\lambda = \mathbf{2}$

Now we will write the vector (let's call this Italian archetype Francesco) not as $\vec{v}$ now but as $\begin{bmatrix}x\\y\end{bmatrix}$ because we want to calculate his x and y.

$$\begin{bmatrix}3-\lambda & 1-0\\0-0 & 2-\lambda\end{bmatrix}\begin{bmatrix}x\\y\end{bmatrix}=\begin{bmatrix}0\\0\end{bmatrix}$$

We plug in this number (EIGEN-VALUE) that we know:

$$\begin{bmatrix}3-\mathbf{2} & 1-0\\0-0 & 2-\mathbf{2}\end{bmatrix}\begin{bmatrix}x\\y\end{bmatrix}=\begin{bmatrix}0\\0\end{bmatrix}$$

So if we solve this we will find which Francesco (that archetypal Italian guy type that Alice is obsessed with) is sent to ZERO (SQEASHED to ZERO in the battle between Alice in the Baroness).

So let's solve, remember the first column tells X where to go, and the second column tells Y where to go:

$$x\begin{bmatrix}3-\mathbf{2}\\0-0\end{bmatrix}+y\begin{bmatrix}1-0\\2-\mathbf{2}\end{bmatrix}=\begin{bmatrix}0\\0\end{bmatrix}$$

Or more simply:

$$x\begin{bmatrix}1\\0\end{bmatrix}+y\begin{bmatrix}1\\0\end{bmatrix}=\begin{bmatrix}0\\0\end{bmatrix}$$

So we can make two equations out of this:

1st equation: $x+y=0$

2nd equation: $0+0=0$

Of course the 2nd equation is not useful. But the 1st equation means $y=-x$

So this is the line equation of the line from up-left to down-right. It is the SPAN of the vector $\begin{bmatrix} -1 \\ 1 \end{bmatrix}$ which is the Italian EIGEN-VECTOR ("Francesco").

In minute 10:45 3Blue1Brown says:

A TRANSFORMATION DOESN'T HAVE TO HAVE EIGEN-VECTORS!

For example he shows that a transformation that rotates the whole 2D plane rotates everything so nothing remains un-rotated. So no vector can be called EIGEN-VECTOR.

He shows us why numerically, because in that special case, if we try to calculate we get

$$\lambda^2 + 1 = 0$$

Which means

$$\lambda^2 = -1$$

Which means

$$\lambda = \sqrt{-1} \quad \text{or} \quad \lambda = -\sqrt{-1}$$

THIS IS ILLEGAL IN REAL NUMBERS.

In minute 11:35 there is a very interesting (written for a very short time) remark about the connection between imaginary numbers (numbers with the square root of minus one) and rotations.

In minute 11:36 he talks about SHEAR which we talked about in the sub-chapter " Matrix multiplication as girl talk ".

In this kind of SHEAR the vectors that lie along the x axis stay in the same direction before and after the transformation. So they are the EIGEN-VECTOR of the SHEAR transformation.

I found nice examples of SHEAR in real life in this very recommended video by Study.com courses platform (I only watched the first 1:30 minute which is free):

https://study.com/academy/lesson/what-is-shear-stress-definition-equation-units.html

basically they show you that every time you cut something (in this is especially clear with scissors) that's a shear stress.

Another example that 3Blue1Brown gives is when there are many EIGEN-VECTORS and they all have the same EIGEN-VALUE so there is just one single EIGEN-VALUE even though there are many EIGEN-VECTORS.

His example is a matrix like the Baroness that stretches every vector she encounters. (imagine like arrows that were drawn on the surface of a balloon, and then the Baroness inflates her "balloon" of tales).

OK now in minute 12:43 of the video, 3Blue1Brown wants to talk about a new thing called EIGEN-BASIS using old ideas from our previous sub-chapter " Change of basis as mythological ex's comparison ".

WHAT IF BOTH BASIS VECTORS ARE EIGEN-VECTORS?

$\hat{\imath}$ (the vector on the x axis whose y equals 0) is scaled by -1 , and $\hat{\jmath}$ (the vector on the y axis whose x equals 0) is scaled by 2 .

So in this case the EIGEN-VECTOR $\hat{\imath}$ has the EIGEN-VALUE -1 and the EIGEN-VECTOR $\hat{\jmath}$ has the EIGEN-VALUE 2 .

Let's say it's an Israeli girl on her big trip after the army, she shuns Israeli guys (because when she's abroad she sees them as below her class) and she is eager to sleep with American/European guys.

So when we write where the basis vectors finish as the columns of Alice:

$$Alice = \begin{bmatrix} -1 & 0 \\ 0 & 2 \end{bmatrix}$$

Ok so this is called DIAGONAL matrix, where all the numbers are ZERO except on the DIAGONAL.

In minute 13:49 in the video we see another DIAGONAL matrix:

$$\begin{bmatrix} -5 & 0 & 0 & 0 \\ 0 & -2 & 0 & 0 \\ 0 & 0 & -4 & 0 \\ 0 & 0 & 0 & 4 \end{bmatrix}$$

So in this case Alice's 1st column shows she doesn't want to sleep with Arabs, the 2nd column shows she doesn't want to sleep with Israelis, the 3rd column shows she doesn't want to sleep with blacks, and the 4th columns says she wants to sleep with Americans.

The columns are EIGEN-VECTORS and the numbers on the diagonal are their EIGEN-VALUES.

DIAGONAL matrices are easy. I'm not implying that Alice is easy (except for for Americans 😊). What I mean is these matrices are easy to multiply by a vector:

$$\begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 3x \\ 2y \end{bmatrix}$$

And they are easy to "raise to the power of" some number.

For example if we multiply the matrix times the same matrix, which is raising the matrix to the power of 2 , we will get:

$$\begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix} = \begin{bmatrix} 3^2 & 0 \\ 0 & 2^2 \end{bmatrix}$$

Which equals:

$$\begin{bmatrix} 9 & 0 \\ 0 & 4 \end{bmatrix}$$

So let's imagine that we have 100 Israeli girls and the first girl talks to the seconds girl who talks to the third girl, and so on until the 99th girl talks to the 100th girl. Each time they reinforce more the same tendencies of "hell no" to Arabs, "no" to Israelis, "yes please" to Americans and so on, so by the 100th girl she will have a "hell no" raised to the power of 100 to Arabs, and "no" raised to the power of 100 to Israelis, and "yes please" raised to the power to Americans. Or in the simpler example above:

$$\overbrace{\begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix} * \cdots * \begin{bmatrix} 3 & 0 \\ 0 & 2 \end{bmatrix}}^{100\ times} = \begin{bmatrix} 3^{100} & 0 \\ 0 & 2^{100} \end{bmatrix}$$

Multiplying a non-diagonal matrix a hundred times is a nightmare to calculate. In our story language, if we take a normal girl (not an Israeli girl) let's say 100 clones a British girl talking to each other, they are not as simple minded as Israeli girls so with the British girl it would take a lot of effort to calculate what the 100th clone girl is thinking about guys. unlike the 100th Israeli girl clone.

In minute 14:36 in the video, 3Blue1Brown explains that it's a very rare case that the EIGEN-VECTORS (obsessions) just happen to be the basis vectors (rules) of the transformation (girl).

BUT he says that if we have a transformation (girl) with many EIGEN-VECTORS (obsessions), enough that you can choose a set that spans the whole space (you can describe everything about this girl using these obsessions), then we can change our coordinate system so that these EIGEN-VECTORS (obsessions) WILL BE our basis vectors (the girl's rules).

Basis vectors which are also EIGEN-VECTORS are called an EIGEN-BASIS.

In minute 16:02 of the video, 3Blue1Brown builds on an idea from the sub-chapter "Change of basis as mythological ex's comparison":

///////// QUOTE BEGIN ////////////

But the point is that Alice CANNOT do the rotation in Jennifer's language (Jennifer's coordinates).

So how can Alice rotate Dylan?

(1) TRANSLATE from Jennifer to Alice.

(2) Rotate "Dylan for Alice" using Alice's language (Alice's coordinates).

(3) TRANSLATE back from Alice to Jennifer.

///////// QUOTE END ////////////

So we have an a calculation (transformation) that is easier on another basis, so we TRANSLATE to that other basis, then we do the calculation (transformation), and then we TRANSLATE back to our basis.

So in the same way, if we have a matrix that is NOT DIAGONAL, and we need to raise her to the power of a big number, then we should to TRANSLATE that matrix into being DIAGONAL, and then do easily the raising to power action, and then TRANSLATE the result back into being a NOT DIAGONAL matrix.

NOT ALL MATRICES CAN BECOME DIAGONAL

(for example a shear matrix doesn't have enough EIGEN-VECTORS for us to find an EIGEN-BASIS).

Subchapter 1.16 – Abstract vector spaces as sex robots

Abstract vector spaces | Essence of linear algebra, chapter 15

https://www.youtube.com/watch?v=TgKwz5Ikpc8

So far in this book we talked about love between people. But there can also be love between people and objects (and maybe in the future between objects and objects).

We see in movies that people can fall in love with robots:

In the movie Her (2013) and in the movie Ex Machina (2014) people fall in love with Artificial Intelligence (AI) beings. To be honest I didn't watch "Her" (I did watch Ex-Machina and it's great!) but we are talking about the concept.

So far we saw vectors as men.

For example we had a romance-driven man, and we had a sex-driven man, and when we added them together, this would mean a man who is both romance driven and sex driven.

We could multiplied the sex-driven man and it would be like a new man who is twice as horny.

If something is obeying both of these qualities it's called LINEAR. And since everything that is linear behaves like vectors, then everything that we talked about applies as well.

Think of a chat bot on the internet, like a sex chat (text) but with a robot.

The robot can be very effective and arousing. A lot more than a man or a woman, because the robot knows exactly what to say. How does it know? From statistics about many other people, and also from statistics about you personally.

For example, in the dating website OKCupid they had this questionnaire including sexual questions. And their data mining algorithm would find all sorts of inferences. Like if you mentioned "avocado" then chances are you are looking for love, and if you mentioned "steak" then you are looking for sex.

Now take this ability throw in a powerful Artificial Intelligence (AI) and mix. You will get the most smoth "mind reading" (like the "What Women Want" movie) lover. Women are more verbal and effected by what their lover whisper in their ears, but it's not limited for text. In virtual reality (and in the future with the advances in robotics also in real reality) men who are more visual and effected by how fertile their woman lover looks, could have their made-to-order woman of their dreams all made by AI.

So of course the AI can sense things like your heat and the eye's pupil widening, and your heart rate, and with advances in fMRI also your thoughts, but let's take a very simple example of just a chat bot that reads text and writes text.

Something like GPT-3

https://en.wikipedia.org/wiki/GPT-3

Okay so let's rephrase this as input text (from the human) and output text (to the human), because this machine is what in math we call a function.

What a function is is a machine that has input, and the machine processes it and spits out an answer which is the output.

Now this is how a user would think about the program, it takes input (what are you wearing?) and it gives output (high heels, thigh-high stockings etc). But a programmer will build it from separate modules. For example a "kink" module that takes the user's text and figures out what kind of perversion the user is into today. Let's say it calculated and decided the output of the "kink" module is "sexy lingerie". Another module let's say the "history" module will take this as "sexy lingerie" as input and compare it to previous conversations with the user so that the user will not get the same answer always, let's say this time the algorithm will diversify with "spandex leggings". So this is the output of the "history" module. Next we have a "mood" module which figures out how to phrase this answer: is the user more into BDSM, and if so which kind exactly? So let's say after a few modules the output is "I'm wearing shiny yoga pants that accentuate my sweaty butt".

In reality the modules are probably exchanging between them "big data" chunks, but for simplicity let's say it's input text and output text.

So we can add programs/modules like we just did and get an output that represents the combination of them.

We can also give them weights which is like if the algorithm decided that the man liked femdom (female domination) it could add what the man would do with his tongue and the lady's big buttocks: let's say a small factor ("weight") of femdom would mean kiss her ass, a bigger factor would mean lick her ass, and so on.

Ok so we see that these things (modules are sub-programs) can come together (be added) and can be multiplied (given weights).

This means they are behaving LINEARLY so we can apply to them (mutatis mutandis) everything that we talked about in the previous sub-chapters.

For example we can develop a concept of determinant to decide which module/program is the boss and to what extent. We could do transformations like if the guy's taste changes the modules can be changed and tweaked for his new taste.

The space that we talk about with this modules is the "chat space" it's all the possible sentences that you can make in English. And of course there are sub-spaces like "femdom plane" and "foot fetish plane" and their intersection can be a line which is "foot worshiper" etc.

I'm not explaining 3Blue1Brown's example with how to do a derivative using matrices, because I think we first need to explain what is a derivative in the next chapter about calculus, and maybe after that I will get back to here when I have the proper metaphors.

Chapter 2 – Calculus or "What makes women tick?"

Subchapter 2.01 – Inventing calculus as slicing and dicing love

In this chapter we are following 3Blue1Brown again, but this time a different YouTube playlist: The Essence of Calculus.

OK so now we are in his first video:

The Essence of Calculus, Chapter 1

https://www.youtube.com/watch?v=WUvTyaaNkzM

he is showing is a geometric proof for why the area of a circle is πr^2

https://en.wikipedia.org/wiki/Area_of_a_circle#Triangle_proof

But as usual I want to show it to you using some metaphor from the subject of love and sex to make it more interesting.

Since the "triangle proof" is a "sister" of the "onion proof"

https://en.wikipedia.org/wiki/Area_of_a_circle#Onion_proof

then we will use something from psychology that works like an onion:

https://en.wikipedia.org/wiki/Social_penetration_theory#Onion_metaphor

By the way, this was a "behind the scenes" look on my process, I always do this in everything. I like to peer behind the veil myself and I think a person of real merit doesn't mind revealing his cards too. I think that's why (because I'm doing this on first dates as well) it's so hard for me to find a girlfriend! 😊

This also reminds me of the famous exchange of quips between two of the greatest mathematicians ever.

Niels Henrik Abel said famously of Carl Friedrich Gauss's writing style, "He is like the fox, who effaces his tracks in the sand with his tail." Gauss replied to him by saying, "No self-respecting architect leaves the scaffolding in place after completing his building."

Abel criticizes Gauss because Gauss gives only the final conclusion while "the road leading to the discovery remains veiled". So you see I'm 100% with Abel.

OK back to our topic. As you can see in this picture of an onion, we can see the dates (1st date, 2nd date and so on) as stages and in the first date the couple are doing only small talk – polite conversation on unimportant things.

https://en.wikipedia.org/wiki/Social_penetration_theory#/media/File:Onion_Metaphor_-_Social_Penetration_Theory.png

like when I met my first girlfriend in a dance club (it was an "alternative rock" club although neither of us liked the music, each of us came there with his/her friends), I asked her what's her name, and whether she would like to drink anything. Then she said no, and I asked whether she would like to eat anything. So that's like the 1st "shell" or inner-most layer of the onion (don't think of how you peel an onion from the outside inwards, instead think of how the onion grows in nature, from the inside outwards).

Then I bought her whatever she wanted and we sat and talk exchanging biographical details like where do I work which is still in the innermost ring (in the picture the inner-most ring looks like a circle, so imagine a point in the middle, and the ring encircles that point). So this is like our 1st date and it's the "orientation" stage.

Then in our 2nd date, we sat in a coffee shop and she told me she has celiac disease (coeliac disease) so I asked her what this means and got to the conclusion that if she is careful to avoid these foods then it's not so bad. So that's something more intimate that she told me, but aside from that I guess we talked about movies and music and stuff like that which is the normal 2nd shell. So this is the "casual friendship" stage

Then in the 3rd date (I don't remember what we did, maybe we watched a movie or something) we get to the 3rd level which is goals and aspirations, at the time I worked as a programmer, and she told me she wanted to learn something scientific too (I think it was biotechnology and I think nowadays she is a math teacher), and she told me about her family and so on. So this is the "close friendship" stage.

Then in our 4th date we went on a trip to a stream (brook) in the north of Israel and we got to talking about intimate things like she never kissed before so now we were in the "intimate partners" stage.

Then from our 5th date onwards we were in the outermost part of the onion where we know each other well including deepest fears and fantasies and so on. This the "union into one self" stage.

In the following pictures I copied the colors from Newton:

https://en.wikipedia.org/wiki/Rainbow

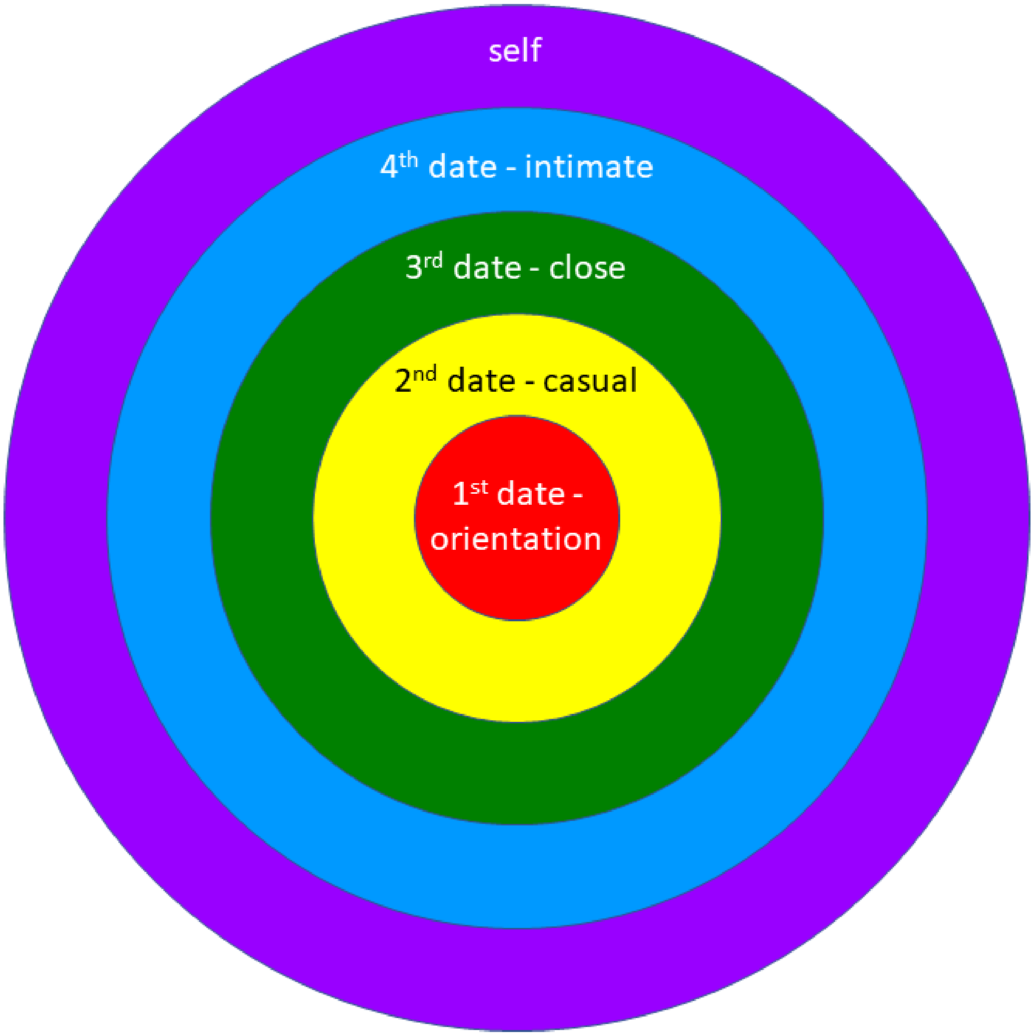
(Newton's first colours, Newton's later colours)

OK so as you can see the first "onion" is what we just talked about. This onion is crude with thicker layers and fewer layers.

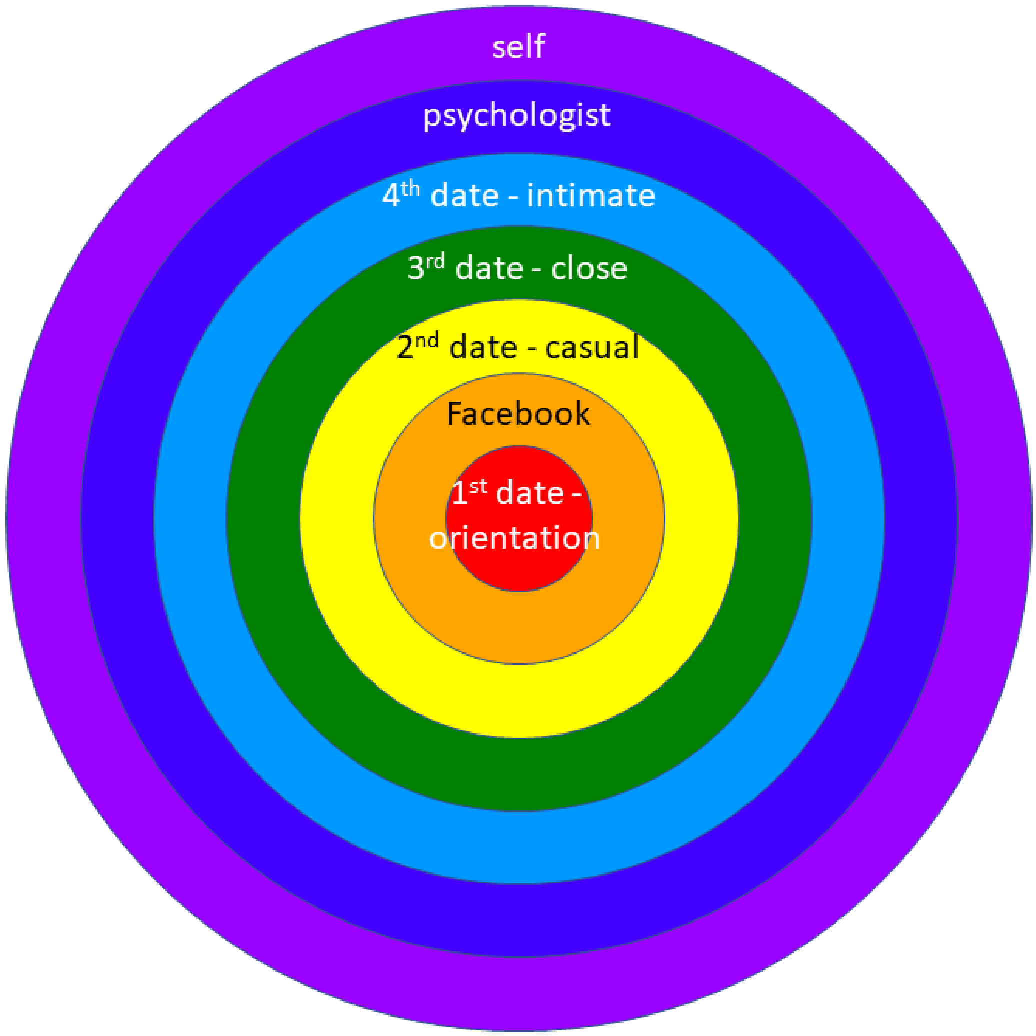
The second "onion" is more refined, it has narrower layers and more layers.

Both onions have the same total size but the inner division of layers ("shells") is different.

Picture 1 – crude “onion” – 5 shades of rainbow



Picture 2 – refined "onion" – 7 shades of rainbow



The second onion (The refined onion) has two more layers where the couple can learn more about each other between dates. For example they become friends on Facebook and can see a lot of information on each other and who their friends and family are etc.

Another way to learn more intimate things about each other is if they go to couple therapy with a psychologist and the psychologist reveals to them more insights about each other.

As we move to bigger shells (progress to the next date/stage) we have more intimacy (more personal information). The thickness of each shell ("ring") in the crude onion is the same (thick slices). The thickness of each shell ("ring") in the refined onion is the same (thin slices). In the refined onion we sample/measure the process more frequently, because there are more "events" in the same total time.

The THICKNESS of the shells ("rings") means TIME.

The LENGTH of the shells ("rings") means INTIMACY.

If we flatten a shell ("ring") we get more or less a rectangle. If we want to know the rectangle's area we multiply length times thickness (the thickness is the height of the rectangle when it lies flat on the ground).

The AREA of the shells ("rings") means LOVE.

$$Time\ * Intimacy = Love$$

If this sounds silly to you look at this article " To Fall in Love With Anyone, Do This " by Mandy Len Catron in the New York Times:

https://www.nytimes.com/2015/01/11/style/modern-love-to-fall-in-love-with-anyone-do-this.html

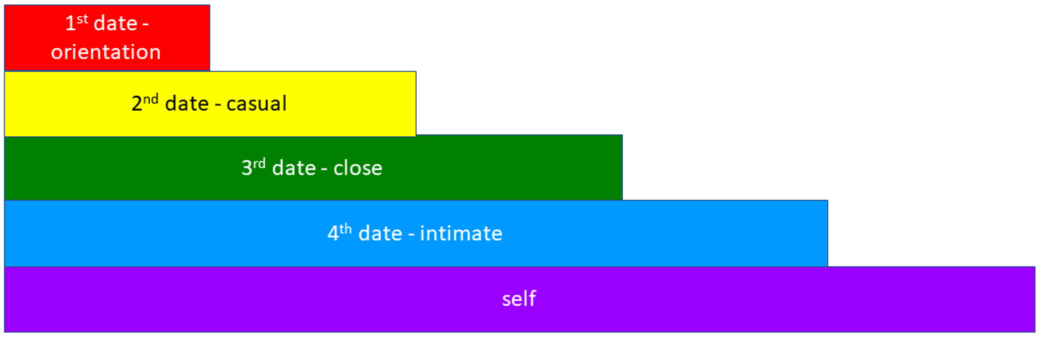
which explains a research by professor Arthur Aron that is much more tiresome to read paper " The Experimental Generation of Interpersonal Closeness " here:

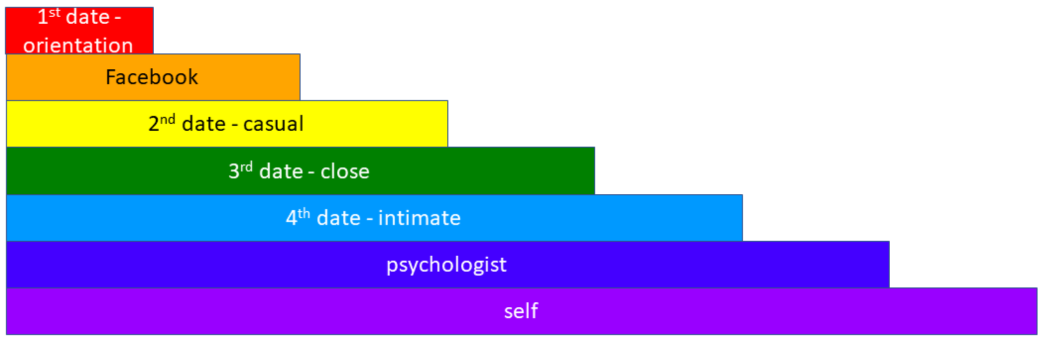
https://journals.sagepub.com/doi/pdf/10.1177/0146167297234003

By the way in "The Big Bang Theory" they made an episode about this called "The Intimacy Acceleration"

https://bigbangtheory.fandom.com/wiki/The_Intimacy_Acceleration

Picture 3 – flattening the onions layers and piling into triangles





Please note that the triangles should be longer but I didn’t have room in the page. But the proportions of the stripes are correct.

So we see that both triangles have the same total height. The height represents the total TIME that the man and the woman are together.

Also the length of the base of both triangles (purple stripe length) is the same. This was the circumference of the circle (it’s the same in both circles, the crude and the refined).

This is the biggest INTIMACY they achieve. It happens when they become as one "extended self" (as Prof. Aron who's paper I mentioned would call it).

OK so we talked about the area of each stripe (rectangle) which is the LOVE at that point. But what is the total amount of LOVE throughout their relationship? It's the area of all the stripes (rectangles) added together. This is the area of the triangle. An area of a triangle is:

$$\frac{Length\ of\ Base\ * Height}{2}$$

This is the area of the triangle, but this is also the area of our circle (onion) because both the triangle is made from all the stripes of our circle (onion)!

OK. Now the circumference (the distance around) of a circle is $2\pi r$

Now in this point you might have an uneasy feeling of why did we "smuggle" π into this, but remember what π means: it gives us the ability to move between straight things and circular things (and vice versa). We had a circular outermost shell ("ring") in the onion (how big is the onion in terms of radius? Its radius is r. how big is the onion in terms of perimeter? Its perimeter is $2r$). And if you remember from school, π is the ratio between the circumference of any circle and that circle's perimeter. Now instead of the word perimeter we can write [twice the radius].

In words: the circumference is [TWICE the radius] times PI. The order of the multiplication doesn't matter, so it's the same as TWICE PI TIMES THE RADIUS. Or in math: $2\pi r$

OK so now back to calculating the AREA of the circle (total amount of love) which in our case is the same as the AREA of the triangle (because we built the triangle from the stripes of the circle).

In our case the circumference (the distance around) of the circle is the purple stripe's length (how much intimacy the couple have at the most intimate stage of their relationship). In the triangle this is the LENGTH OF BASE.

In our case the radius (like a "spoke" of a bicycle wheel) of the circle is the total thickness of all the stripes (the total time that couple spent together in all the stages/dates put together). In the triangle this is the HEIGHT.

So this is our formula for the area of a triangle:

$$Area = \frac{Length\ of\ Base\ * Height}{2}$$

And IN OUR SPECIAL CASE it becomes:

$$Area = \frac{circumference\ * radius}{2}$$

And remember instead of circumference we can write [TWICE PI TIMES RADIUS]

$$Area = \frac{2 * \pi * radius * radius}{2}$$

Now the two twos cancel each other out and we are left with

$$Area = \pi * radius * radius$$

This is simply: love EQUALS intimacy TIMES time. The [PI times RADIUS] is half of the circumference (the circumference is the intimacy).

Finally, we can write in a shorter way: $Area = \pi r^2$.

If you want it in words: the [total amount of love throughout the relationship] EQUALS [the constant PI] (PI is a cosmic "exchange rate" between intimacy and time that is the same in every relationship always), TIMES [the total amount of time the couple spent together SQUARED].

So we see in the formula that there is a lot of importance for the time (what signifies this importance is the fact that the time is squared so the time is very influential. For example we know in real life that a woman needs some minimum amount of time to admit that she loves a guy.

OK now we can watch the video of 3Blue1Brown and interpret things according to our now already established story language.

OK so in minute 2:30 of the video:

We take one of the rings ("shells") for example the 3rd date “close friendship” but try to think more generally about "any one date". Let's call the radius (the distance from the center) r .

so the r means how much time passed from the beginning of the couple's relationship (center of the circle) until this specific date/stage.

We straighten up this ring ("shell"). And we see it's approximately a rectangle.

The length of the rectangle is the circumference of the original ring ("shell"), which is $2\pi\mathrm{r}$.

The thickness of the rectangle (height) depends on how fine we chopped it in the first place. In the "crude" onion the thickness is bigger, in the "refined" onion the thickness is smaller. And if we take another onion we can chop it very very fine (thinnest shells ("rings")).

Let's call this thickness dr which remind us it's a tiny difference (from one ring's radius to the next).

So let's think of $dr = 0.1$

Ok so now we are in minute 3:28 of the video:

What is the area of this stripe (ring/rectangle)?

$$Area \approx 2\pi r * dr$$

In the language of our story this means the love in a certain stage (between two dates or between two "events"), roughly equals the intimacy the couple have then, TIMES, how much time this stage lasts. (again, the idea of love EQUALS intimacy TIMES time).

And the finer and finer (thinner and thinner) the onion is chopped in the first place, the more exact this approximation is, because the top of the rectangle will be more similar to the bottom of the rectangle (which means if only little time passes between events, then the intimacy doesn't change much until the next event).

It gets more accurate for smaller and smaller choices of dr . (tiny time difference).

OK now in minute 4:07 of the video:

We sliced and diced the area of the circle (onion/love) into all these rings (shells/stages). And we approximate the area (love) in each one of those stages by (I'm trying to write it like 3Blue1Brown):

$$Area \approx 2\pi r dr$$

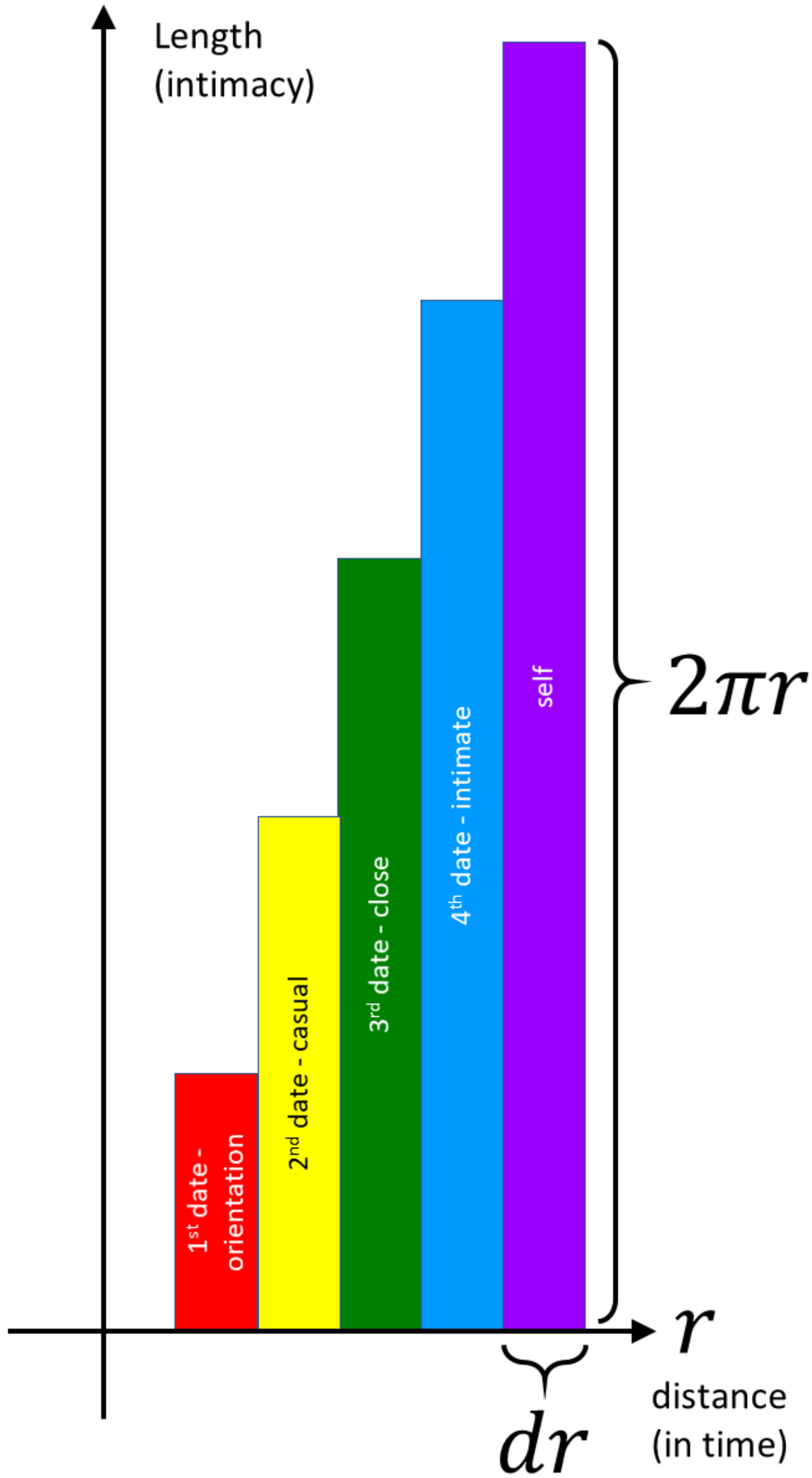
OK so now 3B1B tells us that in this specific example the radius of the whole circle is 3. We can think of it in our story as 3 months that the couple is dating until they know each other perfectly and have the maximum intimacy.

And these rings/stages are spaced out by whatever thickness of dr (the tiny time difference between events/dates) that we chose in the beginning.

OK now in minute 4:33 of the video:

He turns the triangle upright, so let's do that too.

Picture 4 – the same triangle but this time "lying" on its side:



The horizontal axis is r (how far we are from when they first met - in other words - how much time they know each other).

The vertical axis is how much intimacy they have in this specific time (this specific r). For example, let's say they have a date (or anyway pass a "stage" in the relationship) once every week. So when r is 3 weeks, this means they are in the 3rd date/stage. So when we are that far into the relationship. Think of 3 as our distance in time from the beginning. Or simply distance. How long is the stripe above the point "3"? (how much intimacy they have in their 3rd date)? We know the length of any stripe in this drawing: it's $2\pi r$. in this example if $r = 3$ then $2\pi r = 2 * \pi * 3$.

We can calculate it since we know that PI is about 3.14, then the answer is about 18.84 .

In the same way we can find the length of the stripe (intimacy) in any distance from the beginning (time from first meeting).

And since in our system the area of dr (tiny time difference) TIMES the length of the stripe EQUALS love (at that date/stage):

$$Area\ of\ stripe \approx 2\pi r * dr$$

Then we can say in this little example that the area is about 18.84 TIMES dr .

If we stick to what 3Blue1Brown told us about $dr = 0.1$

Then in this little example $Area\ of\ stripe \approx 1.884$.

This is how much love there is on the 3rd date.

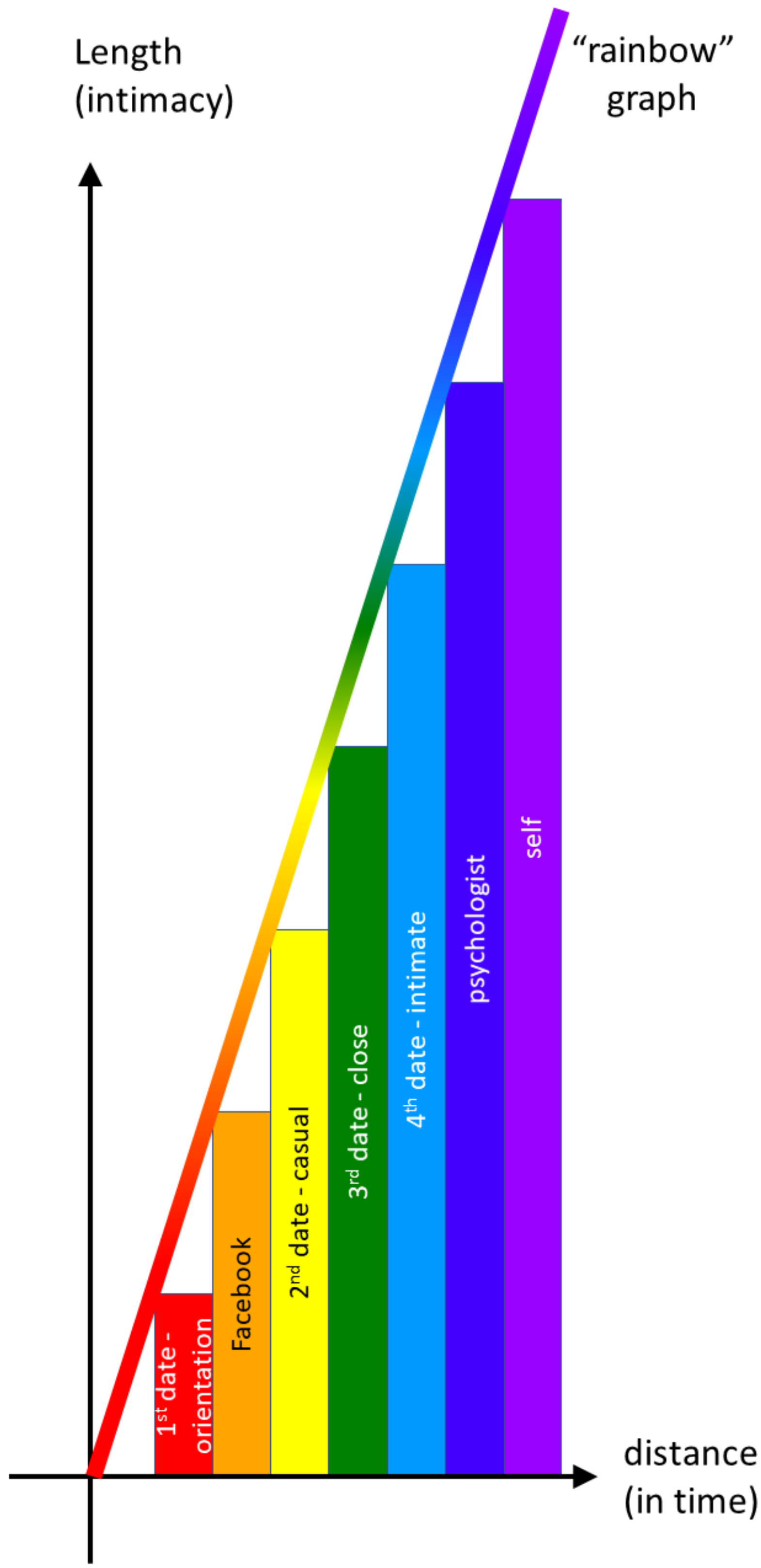
You may think it's silly to quantify feelings using numbers, but researchers in psychology do this all the time. Think of it as if we asked the couple on their way out from the restaurant to take part in a short survey and score how was their date, how they feel towards each other, etc. It's not useful as an absolute number, but if we check the same couple on their 4th date and ask them the same questions again, then we can compare the answers to their previous date and now it has meaning, let's say they love each other twice as much, etc.

On the other hand, if we don't use numbers, we will start to sound like a "lovey-dovey" couple: " – I love you!", " – I love you more!", " – I love you even more!"… and these fuzzy "estimates" are too vague for us to work with.

In minute 5:10 in the video, 3Blue1Brown explains that the picture is too high for the screen, so he is "squishing" the proportions of the picture. In this book I do the same.

OK so let's think about how accurate is this total area (love), not just this specific stripe, but all the stripes together: The smaller the thickness (the dr), the more stripes we will have in the same triangle, and the more accurate our calculation of the area (love) will be. Why? Because we have more "mini" events, like "Facebook" or "psychologist" that give us information between dates/stages, so if we have many small events, the intimacy grows gradually, instead of in big "jumps" from one date to the next.

Picture 5 – the area under the "rainbow" graph



(I call the colorful oblique line in the picture – "rainbow graph")

This graph (in the specific case the line $r = 2\pi r$), sits exactly on the tops of the stripes. If we imagine INFINITELY thin stripes, their tops will be EXACTLY the line. So we can say that the area (love) is all the area that is "trapped" under the line.

So in minute 6:16 in the video, 3Blue1Brown tells us how to calculate that area, which is a triangle, so the area of a triangle is:

$$\frac{base * height}{2}$$

Since we know the base is r and the height is $2\pi r$, we can plug these in and get:

$$\frac{r \; * 2\pi r}{2}$$

So

$$Area \; of \; all \; stripes = \pi r^2$$

Cool! 😊

Note that we mean all the stripes from the beginning ($r = 0$) up to the point (date/stage) that we decide. If we decide to check from the beginning up to $r = 3$ we will get:

$$Area \; of \; all \; stripes = \pi * 3^2 \approx 28.26$$

This is the total amount of love they had from the moment they met until the 3rd date.

OK.

In future sub-chapters we will find areas under other (more interesting) graphs.

Note that we summed up to a point which interested us (in our example the 3rd date) but the "machinery" that we build allowed us to sum up to any point that we wish. This "machine" of summing will be the $\int$ which we will call "integral". This symbol looks like a big "S" from the Latin word "summa" which means "sum" or "total".

OK so in minute 11:18 in the video, 3Blue1Brown is starting to talk about the graph of the function:

$$y = x^2$$

This is not driven by anything, so here we will talk about the graph of LOVE that we talked about, so it's the function:

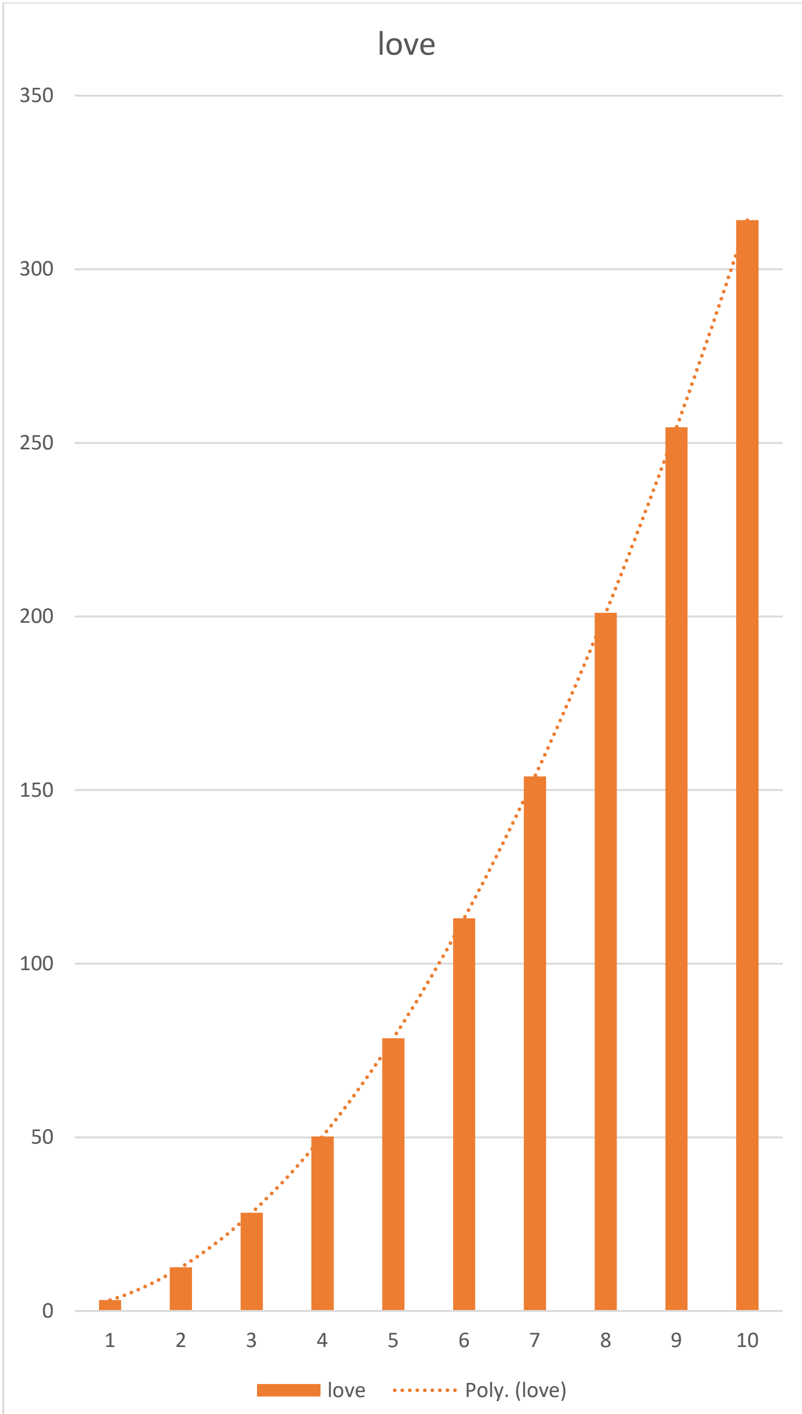
$$y = \pi x^2$$

Please notice that it's NOT the line of INITMACY over "time" (dates/stages), instead now it's the curve of LOVE over "time".

Also you probably noticed that we changed from r to x but that's just the name we're giving to the horizontal axis. We also changed the name of the vertical axis from "length" to y but it still works the same way. Like Shakespeare wrote in Romeo and Juliet: "What's in a name?". I just want it to be similar to 3Blue1Brown's description. It's still the same graph.

OK so far I used PowerPoint for the drawings in this sub-chapter, but now I need to use Excel in order to draw a curved graph.

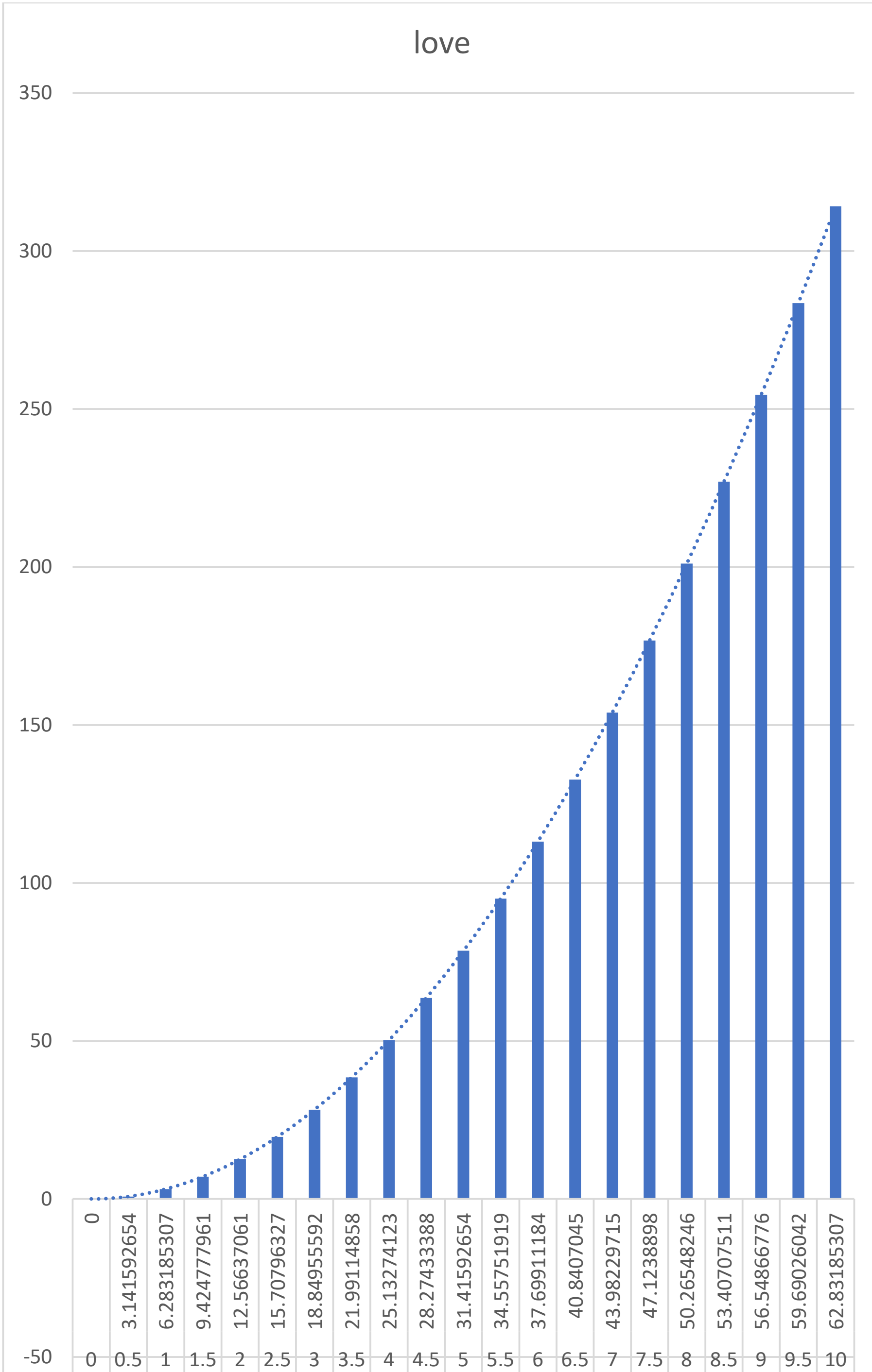
Picture 6 – the area under curve of LOVE (with 10 stripes)



The graph is curved, as we go to the right, the graph grows up faster and faster.

Again this is NOT the intimacy, this is love. So each stripe's length (height) now is the number that was the area in the intimacy graph. For example the 3rd date length here is 28.26 because that was the area of the 3rd stripe in the intimacy graph.

Picture 7 – the area under the graph of LOVE (with 20 stripes)



With 10 stripes (orange color) the tops of the stripes are roughly along the curved graph.

With 20 stripes (blue color) the tops are more accurately along that graph.

We want to know exactly what the area is, so we will thinner and thinner stripes until we have infinite stripes.

So what we care about is the area below the curved graph.

What does this area below the curve of LOVE means?

We need to think what the area of each stripe means, each stripe is roughly a rectangle but this time, the rectangle's measures are NOT intimacy times time, instead the rectangle's measures are love times time.

I think it's safe to say that love times time gives you happiness.

$$Time \ * Love = Happiness$$

So if you have a very big love over a little time (6 months) like I had with my mythological-ex, then you got a lot of happiness. Her current partner loves her much much less, but they are together for almost 10 years now, so they got maybe the same amount of happiness (area of love times time) but in their case it's very small love times very big time.

The area of each stripe is:

$$Area\ of\ each\ stripe \approx \pi x^2 * dx$$

Now dx is the little difference in time (the thickness of each stripe).

In minute 11:48 in the video, 3Blue1Brown talks about this and he keeps using his function x^2 instead of our function πx^2 . so I think it's better if we will imagine that our function is shorter by a factor of about 3.14 (like a "midget" graph) and we can take the PI out. You will still understand the basic ideas and you will be able to follow with 3Blue1Brown.

So I'm correcting myself, now the area of each stripe is:

$$Area\ of\ each\ stripe \approx x^2 * dx$$

See? I dropped the PI. You can think of this new situation that love doesn't get so high, as a relationship between people who are both "stoned" so they are "high" anyway, and love doesn't "elevate" them so much.

So in minute 12:34 in the video, 3Blue1Brown takes this equation:

$$Happiness = Love * Time$$

Which he writes in symbols like this:

$$dA = x^2 * dx$$

(dA is the AREA of the rectangle (stripe) which is HAPINESS, x^2 is the LENGTH of the rectangle (stripe) which is LOVE, and dx is the WIDTH of the rectangle (stripe) which is TIME).

Then he divides by the time. This gives us the RATE. How much happiness they get in each "step" of the relationship. And from the equation we see this RATE equals LOVE.

$$\frac{Happiness}{Time} = Love$$

In my example before I loved my mythological-ex girlfriend very very much so the love was huge, so the rate of happiness was also huge. We got a lot of happiness per day. As opposed to me, with her current partner she gets very little love, so she gets very little happiness per day.

If we put this equation into the symbols that 3Blue1Brown is using it will be:

$$\frac{dA}{dx} = x^2$$

The ratio between the tiny change in A (area of rectangle) and the tiny change in x (width of rectangle) is the x^2 (length of rectangle) at that point.

This approximation gets better and better as we take tinier and tinier dx (tiny change in width of rectangle, in our drawings thinner stripes).

Now we are in minute 12:52 of the video.

So we don't know yet how to find the "area under the graph" (total HAPPINESS) but we do know the "daily" RATE of (growth in) HAPPINESS is more-or-less how much LOVE we have at that specific day. If we measure with infinitely thing stripes then this rate of HAPPINESS becomes exactly how much love we have at that instant.

In minute 12:52 in the video, 3Blue1Brown shows us an example for this with numbers.

He calls $A(x)$ the "mystery function".

What is a function anyway? A function is like a small machine that take is a number (input), then it does some calculation, and finally it spits out the result which is another number (output).

For example the "square" function, if we enter the input 3 it spits out the output 9 (because 3 squared equals 9).

People can also be seen as functions or as machines, for example in this quote by Alfréd Rényi:

"A mathematician is a machine for turning coffee into theorems."

So we can view many processes in this manner, if we don't look what's going on inside the person, and we only see him/her as a "black box" with what's going in and what's going out.

The difference between mathematical functions and between people as functions, is that people, even if you give them each time the same input, don't give you the same output. I'll give you an example of my mythological-ex girlfriend: the first time that I washed the floor in her apartment she was so ecstatic, like a lot happier than sex (and she loved sex). The second time I washed the floor she was mildly happy, and by the third time she took it for granted. So here we see like "dampening" of oscillations.

On the other hand things that annoyed her, like when I "looked" at other girls (which was for the exact same amount that any other guy in the world looks at other girls when they walk along the street with their girlfriend by their side) I loved her with all my heart and her fears were 100% imaginary, but anyway her response got more and more severe to the same stimulus.

So from these two phenomena we can see that the difference (from one call to the function to the next call to the function) is history. People remember the history of previous "call to the function" and either have positive feedback (like getting more and more angry about something bad) or negative feedback (like getting less and less happy about something good).

So a mathematical function will behave like a person who has no memory of the previous day and "reset" each day to a fresh start, like in the masterpiece movie "Groundhog Day". so that person reacts in the exact same way to the same stimulus.

In "Groundhog Day" all the other people behave like known functions except the hero, because he has memory from the past while all the others get "reset" each day. How the time loop happens is not explained in the movie (I read somewhere that in an early version of the script it was a voodoo curse).

But there is a real way for this to happen without voodoo: Anterograde amnesia. It's a condition where you remember everything that happened before but you can't create new memories, your memory "resets" each day.

https://en.wikipedia.org/wiki/Anterograde_amnesia

you can see examples in movies and tv series:

https://en.wikipedia.org/wiki/Anterograde_amnesia#Fictional_cases

if you like romantic comedies:

https://en.wikipedia.org/wiki/50_First_Dates

where the woman "resets" each day, and she meets this guy who loves her despite her condition and at the end of the movie we see that he made for her a note with a video of their weddings and she then goes to eat breakfast and discovers that by now she has a daughter.

Or if you like science fiction:

https://en.wikipedia.org/wiki/Twilight_(Star_Trek:_Enterprise)

the woman T'Pol stays out of loyalty to live with the man Archer, and each day she needs to explain to him everything that happened after his memory loss, and in the next morning the same thing.

And the "reset" can be a lot shorter like a few minutes in the case of Dory in "Finding Nemo"

https://en.wikipedia.org/wiki/Finding_Nemo

Or in the case of Leonard in the movie Memento where he tattoos on himself so he won't forget (and writes also on the back side of pictures that he takes using Polaroid camera).

https://en.wikipedia.org/wiki/Memento_(film)

So in all these cases if the person (or the fish in Dory's case) gets the exact same stimulus, he will give the exact same response. Of course you can't make things exact because there are hidden variables, but statistically we get a very predictable response.

OK so all this detour was to make the idea of a FUNCTION more familiar to us. If we say the exact same input "hello what's your name?" to these people with this special memory problem, they will give us the same answer, no matter if we asked them for the first time, or if we asked them already yesterday.

Let's focus on "50 First Dates" because it's most appropriate for this book's theme.

FUNCTION means Lucy.

INPUT what Lucy sees and hears (in other words: what Henry does).

OUTPUT means how Lucy responds.

So for example if Lucy the FUNCTION gets input of Henry faking not being able to read the menu, then Lucy's OUTPUT is to invite him to her table because he's so desperate she feels sorry for him.

Also notice that two similar (but different) INPUTs might result in two very different OUTPUTs for example when Henry makes a hinge for her waffle house using a toothpick while being genuine and shy, she likes it and they talk; When he comes the next day and does it again in a cocky fashion she dislikes it and reproach him for touching her food.

This also happens in mathematical functions in a point where there is a "jump" in the function's graph, for example a graph that looks like a staircase.

Another thing that we are learning from "50 First Dates" is that the order of events is important, if Henry offers a nice conversation and then offers Lucy to smell his fingers (her father and brother are fishermen so she likes the smell of fish) it gives a positive result. If he does in the reverse order – first offer Lucy to smell his fingers and only then starting a nice conversation she freaks out and thinks he's a pervert.

This happens also in mathematical functions, if we take a number and then add 3 and then square the result, it's not the same as taking the number squaring and then adding 3 to the result.

OK so a function in mathematics

https://en.wikipedia.org/wiki/Function_(mathematics)

is just like that activity which I'm sure you did once in your childhood of matching items, by drawing a line between them.

For example here is a list of countries and a list of capital cities that you can match, by drawing a line with a pencil for example: France → Paris.

France •	• Rome
Greece •	• Berlin
England •	• Athens
Germany •	• Amsterdam
Spain •	• Paris
Netherland •	• Madrid
Italy •	• London

Notice that we could keep track of all the dates of Lucy and Henry and make a list on one side of what Henry did (the INPUT) and the response (the OUTPUT) of Lucy (the FUNCTION).

Now we can do the same thing with a mathematical function, for example the function of "square root". We put in a number like 3 and get out another number like 9.

Then we can write a list of all the numbers (inputs) and another list of all their squares (outputs) and the function "square root" does a similar work to what we did with our pencil, of matching each number in the inputs to its proper number on the outputs.

Sqrt(1) = 1

Sqrt(2) = 4

Sqrt(3) = 9

Sqrt(4) = 16

And so on. As you can see it's customary to say the name of the function and then in parenthesis, we write the INPUT. And the result, what this all thing is equal to – is the OUTPUT.

As I hope you remember from school, we can draw the graph of any function, by laying the INPUT numbers so that they get bigger the more we go to the right, and erecting the OUTPUT numbers so that they get bigger the more we go upwards, and then drawing a dot on the paper where the horizontal input meets the vertical output.

Here we will get a graph like in

Let's take another quick example: the function "sine" (the INPUT here is in degrees):

$$Sin(0) = 0$$

$$Sin(30°) = \frac{1}{2}$$

$$Sin(45°) = \frac{\sqrt{2}}{2}$$

$$Sin(60°) = \frac{\sqrt{3}}{2}$$

$$Sin(90°) = 1$$

Now you might get the wrong impression that as the INPUT gets bigger, so does the OUTPUT keeps getting bigger, but for example:

$$Sin(120°) = \frac{\sqrt{3}}{2} \approx 0.866$$

So you see the OUTPUT can also get smaller.

This is also true in real life: for example when Henry goes over the top and gives Lucy a personal drawing in the first moment that she meets him, this is too much and she pretends to not speak English. So he gave more and get less from her.

There are also functions that only go downhill, like the situation after Lucy concluded that Henry is a pervert (when he assumed that she remembered him and talked about petting his walrus) so the big guy came with the meat clover and luckily Sue intervened.

A function of this kind is $\frac{1}{x}$

As the input gets bigger and bigger – the output gets smaller and smaller.

Think of this function we just talked about: "one over ex".

$$\frac{1}{1} = 1$$

$$\frac{1}{2} = 0.5$$

$$\frac{1}{3} = 0.333 \ldots$$

But what if we check at the point $\frac{1}{0}$?

Remember this is a forbidden point, it's illegal to DIVIDE BY ZERO!

But we can put in smaller and smaller fractions like $\frac{1}{2}$ and $\frac{1}{3}$ and $\frac{1}{4}$ and $\frac{1}{10}$ and $\frac{1}{100}$ and and $\frac{1}{1000}$ and $\frac{1}{1000000}$ and so on, and get a feel of what happens at the forbidden point.

So let's put these numbers (INPUT) in our machine $\frac{1}{x}$ (FUNCTION) and see what we get (OUTPUT) without breaking the machine at exactly DIVIDE BY ZERO.

$$\frac{1}{1/2} = 2$$

$$\frac{1}{1/3} = 3$$

$$\frac{1}{1/4} = 4$$

$$\frac{1}{1/100} = 100$$

$$\frac{1}{1/_{1000000}} = 1000000$$

So we can imagine that when the INPUT will be exactly ZERO, then the OUTPUT will approach infinity (the FUNCTION will blow up)!

If you wish we have the equivalent in real life when the cop gives Lucy a ticket for her expired license plates which leads to shaking Lucy's grasp on reality, and she freaks out. So in a sense this INPUT broke the machine (the FUNCTION Lucy) and it has no meaningful OUTPUT at all, at the end of this chain of events she ends up in a mental institution which in real life is like a "black hole" you don't get out of there, and we have no idea what's going on in these places. So we call it "singularity".

Lastly, think of how we talk about this:

we say the "square root" of … (some number) equals … (some other number).

we say the "sine" of … (some number) equals … (some other number).

OK so now I hope you have some idea of what function is and how it works (like a little machine that eats an input and spits an output) and we can return to where we left off:

In minute 12:52 in the video, 3Blue1Brown shows us an example for this with numbers.

He calls $A(x)$ the "mystery function".

So in words this means:

What is the result of the function A (in other words what is the area of the stripe), if we moved x steps to the right?

So we know the INPUT is x, and we want to know what is the OUTPUT.

Since we don't know yet what FUNCTION (machine) we're dealing with, we don't know yet. But what 3Blue1Brown tells us is that we can safely assume that the FUNCTION doesn't break down. So we assume that as the INPUT changes a little bit then the OUTPUT changes a little bit.

(we saw for example that the function $\frac{1}{0}$ breaks down in the point ZERO. But in calculus we are dealing with functions that behave themselves and don't get crazy (the professional term for this is continuous and differentiable), or at least that we know which special points will make them go crazy and we're taking extra special care to go around these problematic points).

Now 3Blue1brown gives us a numerical example of "change a little bit":

OK so far we talked about significant stages in the relationship such as the period of time between the 3rd date and the 4th date. Now we are like this song by Sting "every breath you take every move you make", we are talking about very small events. Like an eye contact and a smile. So the time is between 3 and 3.001 and the length of time is 0.001 , so we are measuring the momentary change in happiness (which like we said equals how much love there was in that specific moment).

$$\frac{dA}{dx} \approx x^2$$

So we calculate the difference between the "mystery function" (what we call happiness) evaluated in 3.001 and evaluated in 3.000 (in other words – the OUTPUT when the INPUT 3 and the OUTPUT when the INPUT is a moment later 3.001).

Then we take this change and divide by the time it took (which is the difference in the INPUT values): 0.001

This should be roughly equal to the OUTPUT value of the FUNCTION in the starting INPUT:

$$\frac{A(3.001) - A(3)}{0.001} \approx 3^2$$

And this is not unique to the point $x = 3$, and it's not unique to the function x^2 .

In any function at any point:

$$\frac{dA}{dx} \approx f(x)$$

Which means in our story language: the momentary change in HAPINESS divided by the duration of the moment, equals the LOVE at that moment.

The thinner the stripes (like Sting's song) the more accurate this approximation.

Now we are in minute 14:11 of the video.

This ratio is a very important idea and it's called DERIVATIVE.

The tiny change in x divided by the tiny change in A .

We call this the DERIVATIVE of A .

In our story language it is the rate of change of happiness (at that specific moment). And in our story language it equals the OUTPUT of the love FUNCTION (at that specific moment). In our story the DERIVATIVE of happiness is love.

The DERIVATIVE tells us how sensitive the FUNCTION is to small changes in the INPUT. If for example the girl is very much in love then one flower will increase her happiness. If the girl is not in love then even a huge bouquet of flowers will not change her happiness that much.

In minute 14:57 in the video 3Blue1Brown introduces the other very important idea of calculus which is INTEGRAL.

INTEGRAL is the sum of the total area under the graph of some function.

In our case the INTEGRAL is the sum of happiness under the graph of the love function.

So in the future we will learn how to start from the DERIVATIVE FUNCTION (love) and end up finding out the ORIGINAL FUNCTION (happiness).

In minute 15:20 in the video 3Blue1Brown gives us " The Jewel in the Crown " of calculus which is the fundamental theorem of calculus (which we will understand in future sub-chapters) :

DERIVATIVE is the inverse of INTEGRAL!

Subchapter 2.02 – The paradox of the derivative as "I'll have what she's having."

OK. So now we are in 3Blue1Brown's video:

The paradox of the derivative | Essence of calculus, chapter 2

https://www.youtube.com/watch?v=9vKqVkMQHKk

OK so now we are in minute 1:20 of the video. 3Blue1Brown's scenario is a car that travels a distance of 100 meters, during the time of 10 seconds.

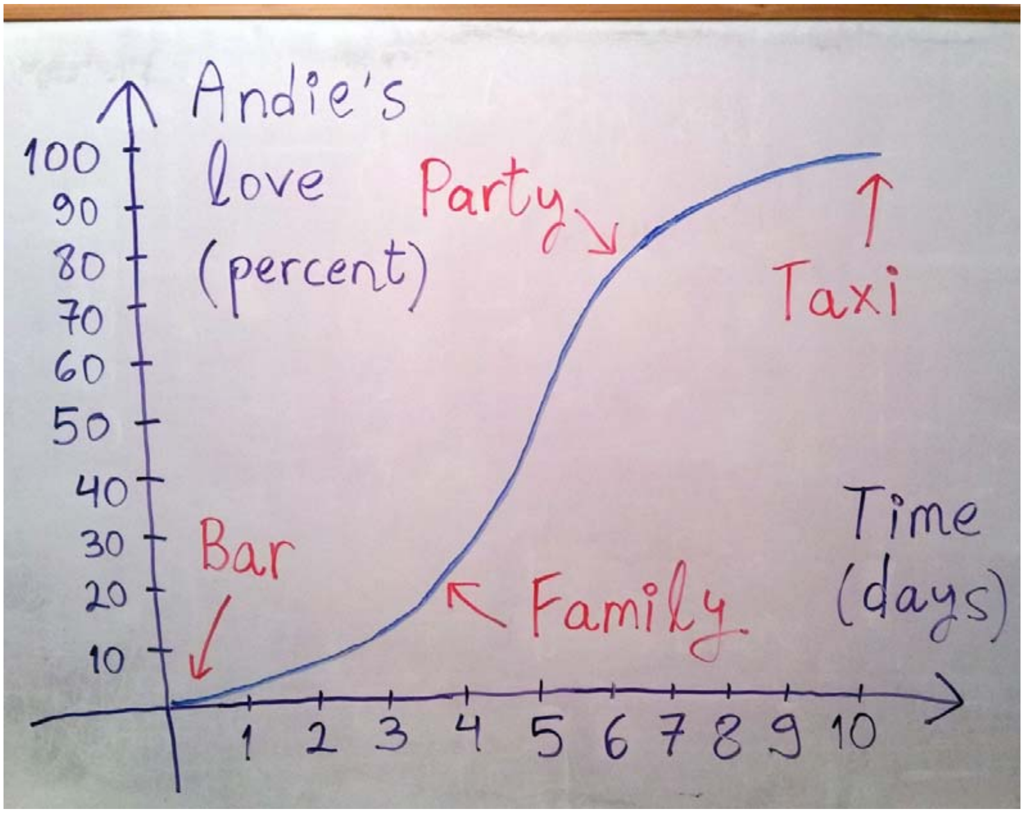
Our scenario will be like this romantic comedy: "How to Lose a Guy in 10 Days"

https://en.wikipedia.org/wiki/How_to_Lose_a_Guy_in_10_Days

OK so in the movie Andie is the girl and Ben is the guy, and they have opposite "missions". After they hook up, Andie's mission is to do annoying things and to cause Ben to dump her (she's writing an article "how to lose a guy in 10 days" for the women's magazine she's working for. With Ben it's a little longer to explain but bottom line he made a bet with his boss that if he can make Andie fall in love with him in the course of 10 days, then he gets some big job promotion. Until the party towards the end of the movie, both Andie and Ben don't know about each other's motivation.

So the time in our scenario is 10 days. The distance is the distance from when they first met to the point when she falls in love with him.

Picture 6 – Love graph



OK so the horizontal axis is TIME (in days), and the vertical axis is Andie's LOVE towards Ben (in percent: 0 means not in love at all at the beginning in the bar scene, 100 means totally in love at the end in the taxi scene).

The height of the graph above some point, let's say the point "day 6" tells us how much in love Andie is at that time let's say 80% .

We will call Andie's love function $s(t)$ so that we can follow the video easily.

If it's hard to remember try to think "sympathy", as how much she sympathizes/likes him at a given time (t).

Initially at the first day the graph is shallow because Andie's love starts slowly, remember it's against her will (this is equivalent to the inertia of the car of 3Blue1Brown).

Then in the next days, the amount of love added in each day gets larger.

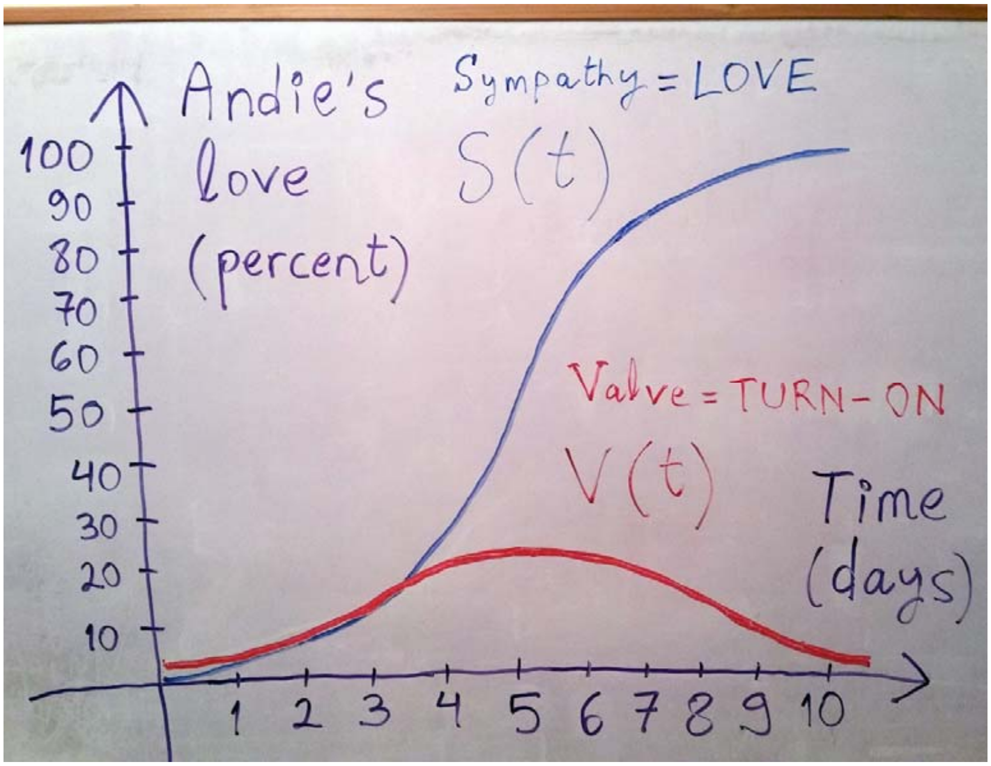
This corresponds to a steeper slope of the graph.

And then towards the end when it slows down (after the party) the graph becomes shallow again.

In minute 2:27 he draws the velocity (which is the DERIVATIVE of the position, because the velocity is the rate of change of the position). In our case I need to draw for you the turn-on of the girl Andie, which is the DERIVATIVE of her love, because her turn-on is the rate of change of her love. I will draw this DERIVATIVE in red like we are used to.

Instead of Velocity here we have turn-on and he calls it $v(t)$ so if it's hard to remember think like she's doing the ACTION of turning a "Valve" and all these hormones are pumped into her blood and into her brain (and other parts).

Picture 7 – Turn-on (the DERIVATIVE of love) graph



See the blue love graph which is $s(t)$ and the red turn-on graph which is $v(t)$.

At the first day the "turn on" is very small, then towards the middle of the 10 days, the girl Andie builds up to a maximum of "turn on" as we can see she also has sex with the guy Ben in the shower, well we can't really see, but we imagine.

Then after the party it's a "turn off" to see that he fooled her, but she still keeps loving him only her love grows slower and slower until her love reaches the maximum in the taxi scene at the end of the movie. After that we can't "turn on" the valve more, it stays the same, so there is no ACTION of "turn on" anymore. Once she reached the maximum LOVE she doesn't change the valve anymore so the TURN ON is ZERO. The DERIVATIVE is the rate of change (of LOVE in this case), so if in some moment there is no change (in LOVE in this case) then the DERIVATIVE in that moment equals ZERO.

Minute 3:30 in the video – what is the "turn on"? (the red graph that looks like a low "hill" in picture 7).

For those of us who are not comfortable with fuzzy feelings – it's hard to quantify them - Let's give a little more tangible explanation.

The love (blue graph) is where the guy is. in gestures of girl's love – things that the girl does (for example her body language showing that she likes the guy):

https://www.wikihow.com/Know-if-a-Girl-Likes-You

The turn-on (red graph) is how much the guy "advanced" like what he is allowed to do to the girl (like what they call in American teens slang: reaching "first base" = kiss, "second base" = fondling breasts, "home run" = sex). So here we ignore the first night when they met, because then Andie only dangled the "bait" which is herself, and supposedly they had sex that night, so we ignore that night. After that night the "bad" Andie calls Ben's dick "Princess Sophia" so he can't even function from the humiliation, so that's our ZERO point in the "turn on". And after Ben "defends" Andie's honor in the cinema scene, and he gets knocked out, she allows him to put his head on her breasts, so that's a small "advancement" for him.

So each time he "advances" a little, that's a little CHANGE so the "turn on" is little.

Each time he "advances" a lot, that's a big CHANGE so the "turn on" is big.

So even in this simplified explanation after they had sex in the shower, which is the peak of the "turn on" (his biggest advancement, let's suppose around day 5), the "advancements" become smaller and smaller (maybe some kinky stuff in bed, but it's not as big as sex). And at the end at day 10 they reach a plateau from which he cannot "advance" any more. From that stage the "advancement" (I mean CHANGE) is ZERO although the distance remains the greatest it's ever been (she loves him 100% and she has sex with him as his girlfriend).

So make sure you understand the difference between the function (how much she loves him) and the DERIVATIVE which is the rate of CHANGE of the function ("taking it to the next level").

Like remember when they repeatedly said on the first night they had sex: "it's too fast"? well this "fast" is the big DERIVATIVE on that night (big CHANGE/"advancement" in short time of one night).

So each time 3Blue1Brown talks about "velocity" (speed) think about this "it's too fast it's too fast" in the movie, so you'd have something concrete to think about 😊

Velocity is distance per unit of time (hour), "turn on" is the result of love per unit of time.

OK. So in minute 3:35 3Blue1Brown says we can't think of the CHANGE in a single moment, because CHANGE is always between one moment to another moment. I guess he's trying to motivate us for why we need the formalism of "limit" that we will encounter soon. We will cross that bridge when we come to it.

$$velocity = \frac{change\ in\ distance}{change\ in\ time} = \frac{50\ meters - 30\ meters}{5\ seconds - 4\ seconds}$$

Similar example in our language:

$$turn\ on = \frac{change\ in\ love}{change\ in\ time} = \frac{80\%\ in\ love - 50\%\ in\ love}{day\ 6 - day\ 5}$$

So how does the DERIVATIVE work with just a single moment of time?

In minute 5:12 in the video, 3Blue1Brown says that a speedometer of the car measures between two very close moments. That tiny difference in time we call dt

(just like in the previous sub-chapter we had tiny difference dr and dx).

So let's say they're having sex right now, and they are trying something they've never tried before and he asks her: "do you like it?". The "it" in the question refers to whatever the passing very short moment. That very short moment is dt

The guy is actually asking the girl: "should I continue?" – does she want him to continue at the same rate of CHANGE that was a moment ago (momentarily rate of CHANGE/advancement).

In minute 5:31 in the video, 3Blue1Brown says it's like we zoom in and see a specific moment along the graph. How much we go to up is the "rise"; how much we go to the right is the "run". And the slope is $\frac{rise}{run}$

This makes sense: if the guy advanced a lot, like tried anal sex with the girl for the first time, over that short moment that passed, that's a huge turn on. On the other hand, if the guy advanced very little, like instead of kissing her mouth he's kissing her neck, over that same short moment that passed, that's a minor turn on.

Remember the graph of the love function is called S we remember it like Sympathy.

So the guy's tiny advancement at that moment is ds

And the duration of that tiny moment is dt

So the slope of the graph at a specific "zoomed in" tiny part is:

$$slope = \frac{ds}{dt} = \frac{rise}{run}$$

In each moment along the entire graph (her love over the 10 days), there is some other slope. At the beginning the slope is shallow, then more and more steep, then becoming shallower and shallower again until it's flat.

This means in terms of "turn on" (or the blunter sexual "advancement") that she gets more and more turned on up to a certain maximum on the 5th day, and then gradually like B.B. King sings "the thrill is gone".

So because each moment has a different value of "turn on", the "turn on" (the DERIVATIVE) is also (like the love) a function of time. That's why we write it $v(t)$. remember we said it's like a valve (imagine your faucet/tap in the bath – the amount of hot water in the bath is the love; how much you turn this valve is the rate of CHANGE of the amount love). So it helps us to remember the v like Valve.

Ok now we are in minute 7:00 in the video, 3Blue1Brown explains the DERIVATIVE.

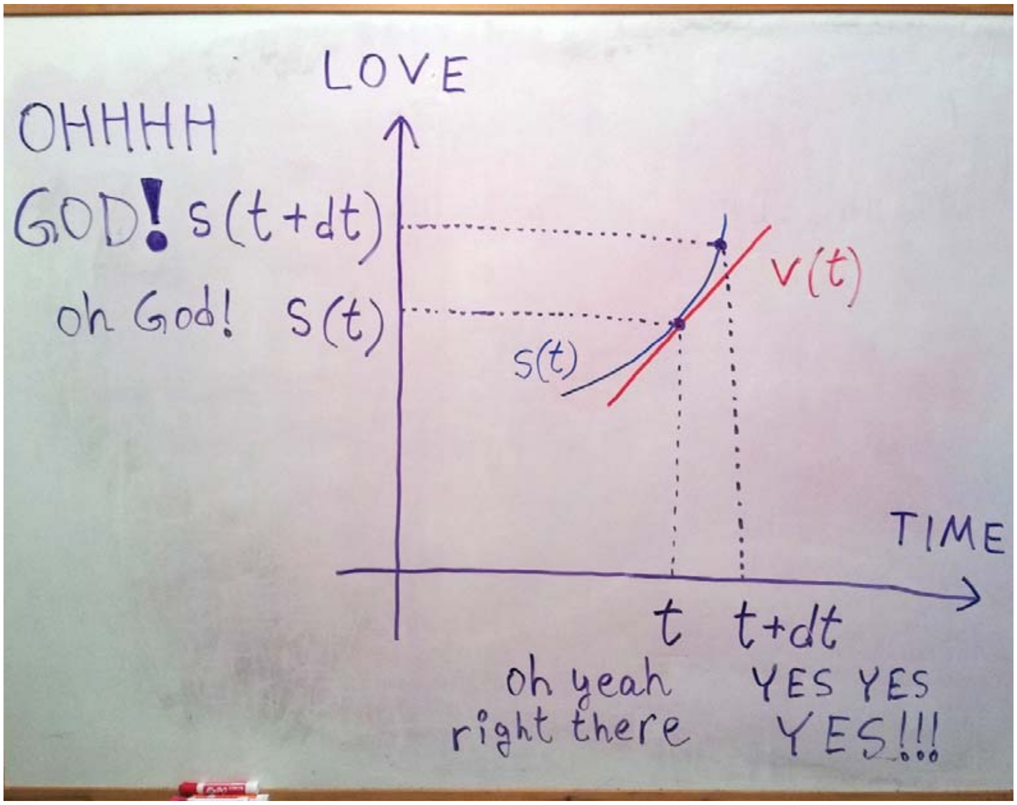
I'm sure you remember that mythological scene from the movie "When Harry Met Sally..." when Sally (Meg Ryan) fakes an orgasm in the restaurant. I don't think many movie scenes have their own discussion in Wikipedia!

https://en.wikipedia.org/wiki/When_Harry_Met_Sally...#Katz's_Delicatessen_scene

So anyway if you managed to miss it somehow, just Google: when harry met sally restaurant.

OK so assuming you watched this classic movie scene, let's draw a graph of it.

Picture 8 – When Harry Met Sally...



So in moment t the guy is clearly doing something very right, because she asks him to continue EXACTLY in that way ("oh yeah right there"). Let's say he is stimulating her clit by vibration. OK. so the OUTPUT result $s(t)$ of that INPUT t is a still self-controlled "oh God!".

I assume that "yes" and "right there" are instructions for the actions (INPUT of function) of her mortal partner, while her references for divinity are the results (OUTPUT of function) of her partner's actions.

OK. the next moment is after a tiny change in time dt , so we call this next moment $t + dt$. since the guy is apparently doing the right thing for this moment ("YES YES YES!!!"), so the OUTPUT result $s(t + dt)$ of that INPUT $t + dt$ is a no holds barred "OHHHH GOD!!!".

So now you understand why she wanted him to continue on that same line ("direction") that he way going at moment t . this line is the slope at time t , or in other words it's the DERIVATIVE of her (love) function at time t .

If we measure closer and closer moments (smaller dt) then we calculate this slope more precisely.

What's the equivalent of the paradox?

If we "freeze" the picture. So there is no vibration on the clit. No movement between one moment and the next.

Then you cannot have this measure of movement's results because you don't have the movement (INPUT) so you don't have the results (OUTPUT). It's like that old lady order to the waiter: "I'll have what she's having.". if it was the result of a single specific INPUT like eating the chocolate cake of the Merovingian in "The Matrix Reloaded" movie, that is programmed to cause the woman an orgasm, then sure, one input is enough. But in real life a woman needs movement (CHANGE in position) / process (CHANGE in time) to reach orgasm. if we want to measure CHANGE we need to measure how much the output is in one moment, and how much the output is in the next moment.

What is the equivalent of the slope?

The slope is a straight RED line that is tangent to the BLUE graph at that specific moment (point in time).

So in " When Harry Met Sally " the slope is the continuation of the same stimulus that her imaginary partner is giving her at a specific moment. And indeed, in real life a woman needs at least a few seconds of the exact same kind of stimulus in order to concentrate and reach an orgasm.

OK now that we're ready, let's see the same thing in an equation:

Minute 9:25 in the video:

$$\frac{ds}{dt}(t) = \frac{s(t+dt) - s(t)}{dt}$$

On the left side of the equation we have the slope which equals "rise over run" at some moment t.

On the right side in the numerator (above the fraction line) we have a difference (subtraction) or in another word the CHANGE between the result (OUTPUT) in the later moment ("OHHHH GOD!!!") and the result (OUTPUT) in the earlier moment ("oh God!"). So the numerator will be "HHH!!" 😊 that's what been added during that tiny length of time.

On the right side in the denominator (under the fraction line) we have that tiny length of time (which in the movie is like 20 seconds).

Ok now from about 10:30 to 15:00 I'm just recommending you to see 3Blue1Brown's video, I can copy the equations here, but I can't add anything useful.

He takes a function $s(t) = t^3$ and then puts this in our latest formula

$$\frac{ds}{dt}(t) = \frac{s(t + dt) - s(t)}{dt}$$

So the formula becomes:

$$\frac{d(t^3)}{dt} = \frac{(t + dt)^3 - (t)^3}{dt}$$

Which is the messy:

$$\frac{d(t^3)}{dt} = \frac{t^3 + 3t^2dt + 3t(dt)^2 + (dt)^3 - t^3}{dt}$$

But after the plus and minus t to the 3rd power cancel each other, and the dt down at the denominator cancels out with some of the "diti" that were left in the numerator, and finally after we have no denominator anymore, we let "diti" to tend to ZERO (get closer and closer to zero) so that each product of something times "diti" becomes something times ZERO which is ZERO, then…

It all becomes the simple:

$$\frac{d(t^3)}{dt} = 3t^2$$

See? I told you it's better to watch this part in 3Blue1Brown's video!

Subchapter 2.03 – Derivative formulas through geometry as The Big Bang Theory

OK so in this video 3Blue1Brown is doing everything geometrically.

Derivative formulas through geometry | Essence of calculus, chapter 3

https://www.youtube.com/watch?v=S0_qX4VJhMQ

Still I will try to give you a "feel" for why things work, through scenarios of love and sex.

So anyway the video begins with x^2 which is square, so in old slang "square" means "conventional and old-fashioned" and it's the opposite of "hep" or "in the know".

https://en.wikipedia.org/wiki/Square_(slang)

so basically it's like an old nickname for nerds. So I started thinking about nerds and I got to

"The Big Bang Theory" a funny sitcom that I'm currently watching with my parents.

So in the show there are a few romantic couples, which we can rank by how "normal" they are. By "normal" I mean having social skills.

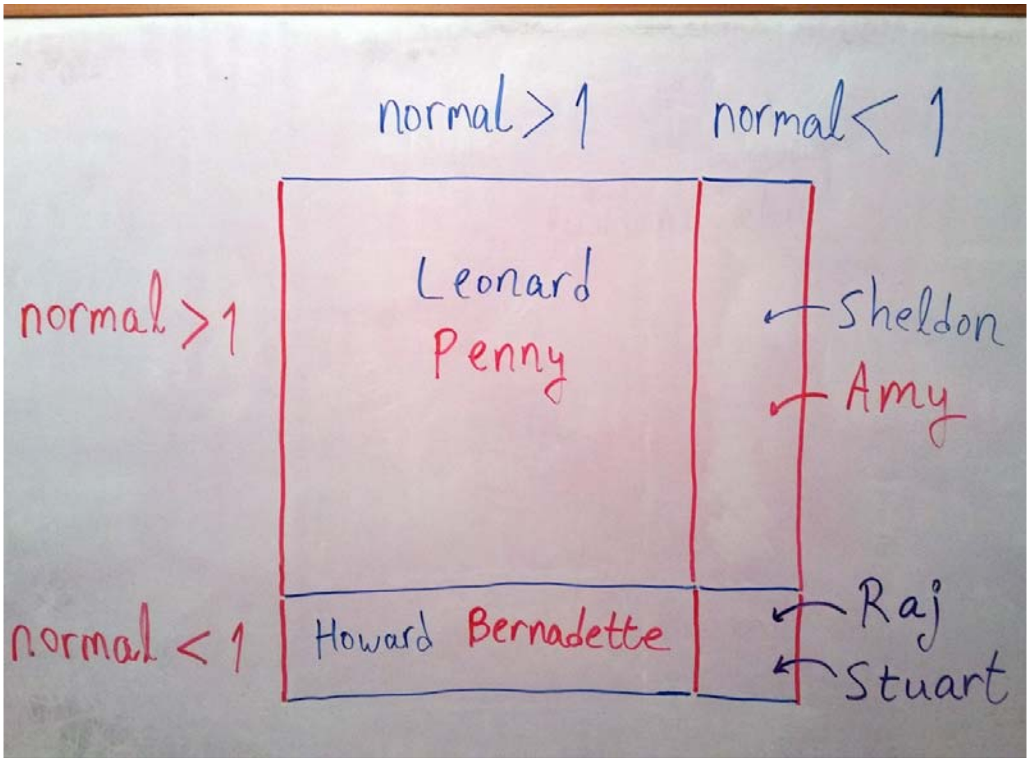
Penny and Leonard Hofstadter are the most normal couple. So when we multiply them by each other we get a lot of "normality". So they are more or less equal so they form a square.

Howard Wolowitz and Bernadette after they get married they practically flip: Howard turns from a creep that hits on every girl into the more containing of the two, and now the previously likable Bernadette becomes so short tempered and ruthless that even her boss is afraid of her. So they are not equal so they form a rectangle.

Sheldon Cooper and Amy Farrah Fowler. Here it's the opposite: the guy is horrible and evil and the girl is nice and containing. So they are not equal and they form a rectangle.

The next two guys Raj and Stuart are not really a couple but they are so weird and for a time (at least in the episodes that I'm watching now) they both live as unpaid babysitters in the home of Howard and Bernadette, that I'm treating them as a couple here. Being equally strange (though in different ways) they form a small square.

Picture 1 – "Big bang theory" of x^2



So back in the beginning of the series, the main couple each had sidekicks:

Boys EQUAL Leonard PLUS his roommate Sheldon.

Girls EQUAL Penny PLUS her coworker Bernadette.

(For the sake of argument here let's think of Bernadette as the later "dark" Bernadette. So in our model, within each couple the normal person is the hero and the abnormal person is the sidekick).

So you see the symmetry:

The boys EQUAL hero PLUS sidekick

The girls EQUAL heroine PLUS sidekick

So later on the creators of the show wanted to thicken the plot so that each single-dimensional individual becomes a two dimensional couple) we get:

So they multiply the boys TIMES the girls

Because the boys and the girls have the symmetry we talked about, it's like:

Squaring the [hero PLUS sidekick] construct.

So we get all 4 combinations:

1. Hero TIMES heroine – that's Howard and Penny.
   So here they are both normal (have social skills). So each one is the other's hero.

2. Sidekick TIMES heroine – that's Sheldon and Amy.
3. Hero TIMES sidekick – that's Howard and Bernadette.
4. Sidekick TIMES sidekick – that's Raj (bizarrely close Bernadette helping with the baby, so Raj is a sidekick to Bernadette how is herself the sidekick of Penny) and Stuart (important to Sheldon who is addicted to comics, so Stuart is a sidekick to Sheldon who is himself the sidekick of Leonard). So this is a couple of "sidekicks of sidekicks".

So to sum it all up:

The LEFT side of the equation is $(hero + sidekick)^2$

The right side of the equation is $(hero)^2 + 2(hero * sidekick) + sidekick^2$

Ok so now we are in minute 2:35 of the video. The video is showing things visually which is the clearest way, but let's try to give them what Bruce Lee called "emotional content".

So our function is $f(x) = x^2$ this function does the action of squaring, turning the lonely characters into parts of relationships and thus giving them another dimension.

So we have a square whose side length is x this represents Leonard who is normal (has social skills) and also Penny who has social skills. So each of them is full length x .

now we increase x by some tiny nudge, which we call dx this is giving Leonard his sidekick Sheldon (who saved Leonard's life with the elevator)

https://bigbangtheory.fandom.com/wiki/The_Staircase_Implementation#Extended_Plot

Penny gets a sidekick of her own in the form of Bernadette.

What's the resulting CHANGE in the area of the square?

So this translates in our story language to: what other couples formed?

We already had "hero of hero" couple (Leonard and Penny). So all the other couples are the CHANGE.

So in the video we have 2 thin rectangles and a little square. The thin in our story means thin in social skills, so in each rectangle one side of the couple is normal which means full length x which means interprets reality correctly and reacts reasonably (Amy, Howard) and the other side is highly unpredictable and borderline psycho (Sheldon, Bernadette) which we call dx that is short on normality.

So if we want to calculate the couples (what can happen when the man and the woman interact):

The thin rectangles are x TIMES dx and we have 2 such rectangles, so the two rectangles' area together is $2x * dx$ or simply $2xdx$.

NOTE: the "diex" is one entity, it's like one letter, it's not 'd' TIMES 'x'.

OK. The little square means thin dx multiplied by thin dx , which gives us dx^2 . This is the very small normality "couple": Raj and Stuart. As you know if you multiply things that are bigger than 1 such as 1.5 the result gets bigger:

$$1\frac{1}{2} * 1\frac{1}{2} = 2\frac{1}{4}$$

But when we multiply things that are smaller than such as 0.5 the result gets smaller:

$$\frac{1}{2} * \frac{1}{2} = \frac{1}{4}$$

So these two guys "normality" is smaller then the normal one, so when we multiply them we get crazier and crazier things like the scene where Raj sneaks into Howard and Bernadette home to use the hot tub (Jacuzzi) and then it turns out Stuart already did this and is submerged in the water and suddenly Stuart pops out of the water! 😊 not to mention it later turns out Stuart is naked.

https://bigbangtheory.fandom.com/wiki/The_Hot_Tub_Contamination#Extended_Plot

so in reality the little square is really tiny square, like a thousandth TIMES thousandth EQUALS millionth:

$$\frac{1}{1000} * \frac{1}{1000} = \frac{1}{1000000}$$

OK. that's why we ignore anything with dx raised to a power greater than one. (like here dx^2 this is power two so we can ignore this strange couple – they are negligible).

So in conclusion:

We started with the original couple $f(x) = x^2$

And the CHANGE is $df = 2xdx$

Again the d means "tiny difference in…".

In the last equation we can divide each side by "diex" (the tiny unit length added) and get:

The DERIVATIVE (which is the momentary CHANGE) is $\frac{df}{dx} = 2x$

You really should watch the video of 3Blue1Brown around minute 4:00. He also gives numerical example which clarifies.

We instead will say the bottom line in words:

THE DERIVATIVE OF "X TO THE POWER TWO" IS "TWO X".

The DERIVATIVE of "x to the power of TWO" is "TWO x to the power of ONE".

Function	Derivative
x^2	$2x$

So you see what happens with the 2. We will later see there is a pattern here.

OK now in minute 4:43 of the video, 3Blue1Brown wants us to do another simple function this time a cube:

$$f(x) = x^3$$

Cubing the [hero PLUS sidekick] construct.

We used the cubing formula at the end of our previous sub-chapter (in the "messy" bit):

https://en.wikipedia.org/wiki/Binomial_theorem#Examples

OK so let's use it again.

$$(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

In our example here a is "hero" (large on normality) and b is "sidekick" (small on normality).

First we have a 1 really big cube:

$$Hero^3$$

Who is the hero of our heroine of our hero?

So instead of Wil think of someone positive like Penny's father who loves her and Leonard and wants them to be together.

https://bigbangtheory.fandom.com/wiki/Wyatt

As you can see now I'm treating VOLUME as FUN (or getting along together).

OK next we have 3 wide flat boxes:

So let's take the couple Sheldon and Amy (ShAmy). So where do they meet "normal" characters?

1st is Sheldon's mother who helped them get back together.

https://bigbangtheory.fandom.com/wiki/Mary_Cooper#Amy_Farrah_Fowler

2nd is Professor Proton who is Sheldon's hero and advices him about Amy

https://bigbangtheory.fandom.com/wiki/Professor_Proton

3rd is Leonard's mother who likes Sheldon very much and gives him good advice (unlike she treats Leonard)

https://bigbangtheory.fandom.com/wiki/Beverly_Hofstadter#Sheldon_Cooper

OK so in all these 3 fairly large boxes, two of the characters (Sheldon and …) get along very well and they are supportive of the third (Amy), so it's pretty FUN.

OK next we have 3 narrow flat boxes:

So let's take the couple Howard and Bernadette (HowDette). So where do they meet "abnormal" characters?

1st is Howard's mother who Howard has to yell on in his wedding that only Bernadette can yell on him from now on. Clearly Howard's mother is not adding happiness or normality to this couple's life.

https://bigbangtheory.fandom.com/wiki/Debbie_Wolowitz#Bernadette_Rostenkowski

2nd is Bernadette's father who sees Howard as a sissy and hopes that Howard will die in space and Bernadette will find someone else instead.
https://bigbangtheory.fandom.com/wiki/Mike_Rostenkowski

3rd here we can put any girl that Howard dated before, for example Emily who's toilet he clogged and escaped by the window. Needless to say all these adventures don't add any FUN to his relationship with Bernadette.

https://bigbangtheory.fandom.com/wiki/Howard_Wolowitz#Romantic

OK so in all these 3 fairly small boxes, two of the characters get along very poorly and despite the third character acting nice, it's HARDLY FUN.

Lastly we have a 1 really tiny cube:

$$Sidekick^3$$

Who is a sidekick of our sidekicks of our sidekicks? Let's say Kripke (or shall I say Kwipke?)

https://bigbangtheory.fandom.com/wiki/Barry_Kripke

I'm not sure if he can be called their friend, but he did try to help them get more physical with fencing. So that's sort of a sidekick. Anyway he annoys everybody. He also competed with Stuart on Amy when she was available. So in short this three guys Raj and Stuart and Kripke together are almost no fun at all. NEGLIGIBLE fun.

OK so now I will try to draw this for you in a picture.

If you think of this picture as a map with different meanings to different colors, here is the legend/key to the map:

"LIGHT"

1. Leonard (orange)

2. Penny (dashed orange)

3. Penny's father (pink)

"COLD"

4. Sheldon (blue)

5. Amy (blue dashed)

6. Sheldon's mother (green)

7. Professor Proton (light green)

8. Leonard's mother (light blue)

"HOT"

9. Howard (red)

10. Bernadette (dashed red)

11. Howard's mother (magenta)

12. Bernadette's father (dashed magenta)

13. Emily (purple)

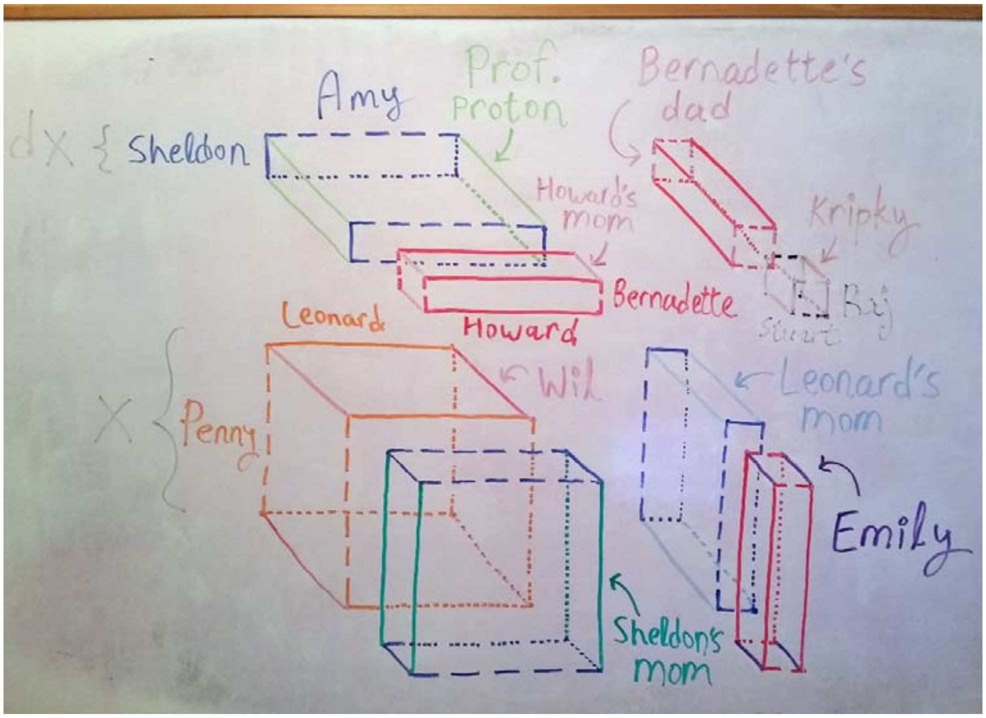
"DARK"

14. Raj (Brown)

15. Stuart (brown dashed)

16. Kripke (light brown)

Picture 2 – "Big bang theory" of x^3



Here I tried to draw minute 5:07 in the video with "dried out" erasable markers.

(as you can see the brown and the black markers died on me, but to the left near "Penny" it's supposed to say x and near "Sheldon" it's supposed to say dx).

(also the tiny cube on the right is supposed to be "Raj" and "Stuart" and "Kripky").

Please note: Initially I made a mistake and wrote Wil as the third side of the Penny and Leonard cube, which later I realized was totally wrong

https://bigbangtheory.fandom.com/wiki/The_Wheaton_Recurrence

Wil is being super NOT NICE to Leonard and Penny and causes Penny to break up with Leonard! ☹

https://bigbangtheory.fandom.com/wiki/Leonard_and_Penny

So instead of Wil think of someone positive like Penny's father who loves her and Leonard and wants them to be together.

https://bigbangtheory.fandom.com/wiki/Wyatt

Since I already erased the drawing from the whiteboard and it took a lot of time to do the first time, I apologize to you the reader! ☹

So in conclusion:

We started with the big cube $f(x) = x^3$

And when we enlarged that cube's sides we got:

$$x^3 + 3x^2dx + 3xdx^2 + dx^3$$

So the difference between them, what we call the CHANGE is:

$$df = 3x^2dx + 3xdx^2 + dx^3$$

Again the d means "tiny difference in…".

Now remember what we said:

… we ignore anything with dx raised to a power greater than one. (like here dx^2 this is power two and dx^3 this is power three – so these are negligible).

$$df = 3x^2dx$$

In the last equation we can divide each side by "diex" (the tiny unit length added) and get:

The DERIVATIVE (which is the momentary CHANGE) is $\dfrac{df}{dx} = 3x^2$

So the bottom line in words:

The DERIVATIVE of "x to the power of THREE" is "THREE x to the power of TWO".

Function	Derivative
x^3	$3x^2$

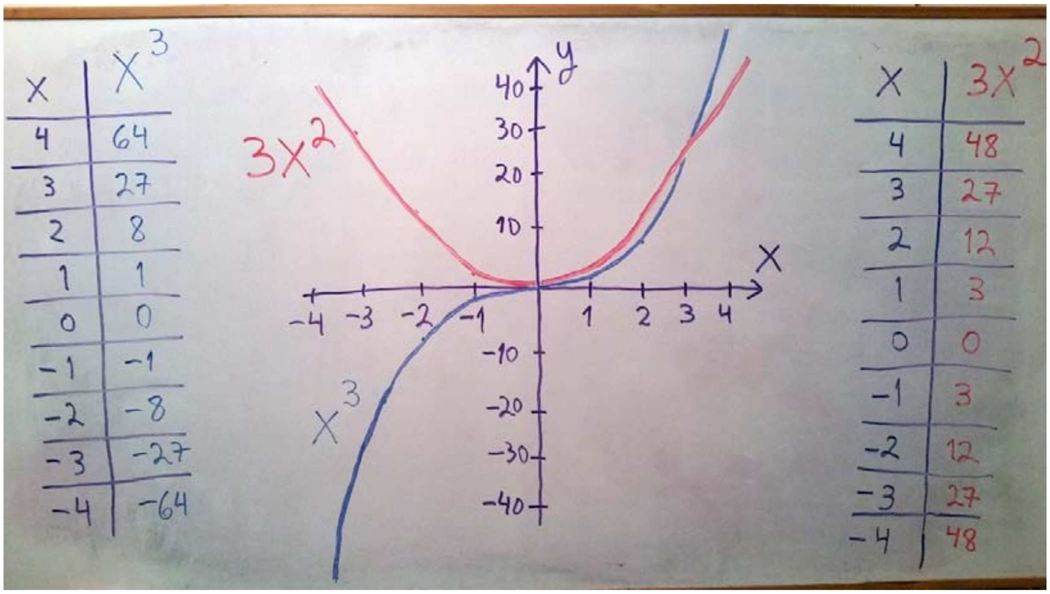
So you see what happens with the 3. Can you guess the pattern from the previous example and this example? The pattern is always like this: We take the power of the 'x' and put it as the factor we multiply by. And then we decrease the power of the 'x' by 1.

In minute 5:19 of the video, 3Blue1Brown explains that the "ShAmy" boxes (the wide and flat boxes of Sheldon and Amy) are the ones that contribute almost all of the added volume.

Each of these "ShAmy" boxes has its volume comprised of "Amy" TIMES "Another positive character" TIMES "that tiny (in terms of normality and fun) Sheldon".

We ignore the narrow flat boxes of Howard and Bernadette (HowDette) because they're too small (not much fun or normality there), and we ignore the tiny cube of Raj TIMES Stuart TIMES Kripky (almost nonexistent fun or normality in the tiny cube).

Picture 3 – comparison of the function x^3 and its DERIVATIVE $3x^2$



This is my attempt to draw the minute 6:39 of the video.

What does it all mean?

On the right half of the picture we see in the BLUE curve the communication skills or "FUN to be with".

On the left half of the picture we see in the BLUE curve what happens when there is NEGATIVE FUN which is like "suckiness" and we will call this BUMMER (a thing that is annoying or disappointing).

On the right half of the picture the RED curve shows the rate of CHANGE in communication skills or "fun to be with", which means KISS ASS (behave in an obsequious or sycophantic way).

On the left half of the picture we see in the RED curve what happens when there is NEGATIVE KISS ASS which is like "diss" (speak disrespectfully to or criticize).

So imagine the X is the time, and the BLUE is the "FUN" and the RED is "KISS ASS".

When we change the time a little bit (like one day forward to tomorrow), how will the whole group's "FUN" will change? Since the most normal and friendly people are Leonard and Penny, they have the most fun now and a change in them will contribute most to the group's total fun.

For example Amy and Sheldon, they have very few moments of happiness together (for example the sex is once a year on Amy's birthday). So let's say we make some small change from today to tomorrow, like double each couple's sexual encounters frequency (so they make twice as much sex every year). So assuming Leonard and Penny have a lot of sex (let's say every day) and Amy and Sheldon have almost none – which couple will ramp up the "score" (pardon the pun 😊) of the whole group? It would be Leonard and Penny.

So this is an example that is very easy to explain, and now with the same logic we can think of a more refined example that will include ass kissing (although sex should include that too ha ha).

Let's say Amy and Sheldon have very few moments of happiness together (Sheldon insults Amy with his arrogance and ignoring her feelings like 10 times an episode).

So let's say we make some small change from today to tomorrow, like decrease each couple's unintended insults by 1 (so Sheldon will insult Amy 9 times in every episode). So assuming Leonard and Penny rarely insult each other (let's say once in each episode) and Amy and Sheldon do this a lot – which couple will contribute more to a happy insult-free relationship count of the whole group? It would be Leonard and Penny.

OK so in terms of our boxes from before, the CHANGE in the big cube (Leonard and Penny) is the most significant. That's why the DERIVATIVE "cares" only about that. So we got a qualitative feeling of the RATE OF CHANGE (the DERIVATIVE). But as you can see with the mathematical method we have a much more accurate way of knowing exactly the RATE at which the function (in this case the "FUN to be with" of the group) will CHANGE.

OK now let's think of the SLOPE.

For simplicity let's just consider Penny's and Leonard's ("Pennard") FUN as the BLUE curve, and let's think of "Pennard"'s "KISS ASS" (actively being nice towards each other) as the RED curve.

So we are looking at the time, which let's say is going now in weeks or months around the breakup (middle or ZERO) both before this event (the left side of the picture) and both after this event (the right side of the picture).

Here is a quote that will help:

"Uh, well, I feel like you guys make each other better. Penny brought Leonard out of his shell. And it seems like Leonard makes Penny think more deeply about the world. I don't know. Together, you two kind of make one awesome person."

—Stuart Bloom, The Mommy Observation

OK so let's try to build the timeline of the BLUE curve as their communication level from the points of time in here:

https://bigbangtheory.fandom.com/wiki/Leonard_and_Penny

The communication between them is very low at first (they hold back things from each other) and become more and more open and deep as time goes on (this process halts during the separation).

And we will see their "kiss ass" between them is positive and then ZERO and then positive again.

OK so we start by mapping the "separated" period to the flat part from $x = -1$ up to $x = 1$.

https://bigbangtheory.fandom.com/wiki/Leonard_and_Penny#Separated

So in this period Howard is not doing nice things for Penny, in fact he is dating Priya who is Raj's sister. Penny is also not doing nice things to Leonard she is dating Zack.

So no nice things are being done so the "kiss ass" red graph is at ZERO. [slope is zero in the flat plateau.]

They do have a one-night stand but it's not successful so we will ignore it.

OK now let's look at the left part (from "meeting and first date" to "first relationship") of picture 3:

https://bigbangtheory.fandom.com/wiki/Leonard_and_Penny#First_Meeting_and_Date

https://bigbangtheory.fandom.com/wiki/Leonard_and_Penny#First_Relationship

Howard is courting Penny which is kissing her ass, from the moment he sees her, and then less and less we can see they have fights.

OK so the red graph is positive all the time (Howard kisses Penny's ass) but less and less so.

What about the blue graph?

They learn about each other and explore the limits of their relationship so the blue graph of communication is going upwards all the time. [slope is positive all the time]

But at first they learn about each other very fast so it rises from minus infinity (When they don't know anything about each other when they just met) to knowing more and more about each other, until the process slows down (but still continues) until the end of their first relationship (minus one, which we already talked about). [slope is steep at in the beginning and then more and more gentle towards the end until we reach the flat part.]

Ok so now the right side of the picture:

Second relationship (Leonard and Penny 2.0) to Engagement to Marriage to Pregnancy.

Okay so I have to admit this is a lot of work and I think you got the point. Also I don't want to spoil the series for myself (I'm at season 10).

But in general they learn about each other more and more as time goes by, and in harder periods like pregnancy and I guess having a baby and taking care of it they learn about each other even more. [the slope is gentle at first but then gets steeper and steeper.]

The "kiss ass" factor also goes up but I guess now it will be in things like who is waking up to feed and calm the baby and change diapers in the middle of the night etc. But it still counts as nice things they do towards each other although now it's routine.

A special point is the point $x = 3$ where the blue graph and the red graph cut each other at $y = 27$. That's the point where the momentary "kiss up" equals the absolute communication. To understand what this sort of means we will think of a very special case: the exponential function e^x.

In that special case, the DERIVATIVE is the same as the FUNCTION, so the more the value of the function ("communication") climbs up, it climbs faster and faster. In other words the RATE OF CHANGE gets bigger and bigger very fast. Remember the DERIVATIVE ("kiss ass") is the RATE OF CHANGE.

So what can we understand from the fact that our DERIVATIVE (red) does NOT go up as fast as our FUNCTION (blue) ? It means that our FUNCTION is slower than the exponential function.

So you can imagine Howard with the girl from Battlestar Galactica in his masturbation fantasies, that goes in an exponential rate (although for a short time until Howard reaches orgasm 😊).

https://bigbangtheory.fandom.com/wiki/Katee_Sackhoff

ok now let's try to think what the slope means.

You know like when people say there is a "learning curve".

https://en.wikipedia.org/wiki/Learning_curve

This is a little bit confusing; I like the explanation by ShreevatsaR in the summary here:

https://english.stackexchange.com/questions/6209/what-is-meant-by-steep-learning-curve

The popular meaning of "steep learning curve" is "difficult to learn"; the technical meaning is "quick to learn".

How do we reconcile them together?

Imagine if you have to do a lot of learning in a short time at the beginning, and from there on you are more or less "on the horse". That "compressed" learning at the beginning is both quick in terms of time and difficult in terms of effort.

So an example to a "steep learning curve" is if Leonard wants to get along with Sheldon, because Sheldon is more or less like a machine, Leonard just needs to read the manual, which is the "roommate agreement". This task is hard but can be done in a short time for example Priya read it all and triumphed over Sheldon:

https://the-big-bang-theory.com/roommate_agreement/

On the other hand if we say something has a "gentle learning curve" it means that you can have some encouraging results after learning very little, and then gradually more and more results as you learn more and more.

So an example for a "gentle learning curve" is if Sheldon wants to get along with Leonard this is very long process for Sheldon maybe even endless process. For example Sheldon at some point even has a technical aid from interpreting correctly human emotions because it's so hard for him.

https://bigbangtheory.fandom.com/wiki/The_Emotion_Detection_Automation

A recurring theme is that Sheldon can't understand sarcasm when other people use it.

https://bigbangtheory.fandom.com/wiki/Contradictions

so in short for Sheldon understanding the person in front of him – be it Leonard Penny or anybody else really – is a task he gets better and better at very gradually. This is "gentle learning curve". At the beginning he can tell when the person is smiling or frowning but after years together Sheldon develops all sorts of rules to understand if the person is really happy or sad etc.

OK so all this explanation was to explain the SLOPE in terms of RATE OF CHANGE of communication skills (the ability to "lick ass"). Sheldon has a very gentle SLOPE his communication skills (understanding of the other person) grows very slowly;

Leonard understands Sheldon very fast by reading the laws that Sheldon writes explicitly on paper and gets along with him (kisses Sheldon's ass easily) as long as Leonard obeys to Sheldon's rules. So Leonard communication skills towards Sheldon grows very fast which means a steep SLOPE.

If you want this in the romantic relationship version you can think of Amy understanding Sheldon's quirks through "the relationship agreement"

https://bigbangtheory.fandom.com/wiki/The_Relationship_Agreement

Versus Sheldon's very slow understanding of Amy by trial and error.

Ok so in minute 7:04 in the video, 3Blue1Brown tells us about the pattern that we saw in our little tables:

The DERIVATIVE of "x to the power of TWO" is "TWO x to the power of ONE".

Function	Derivative
x^2	$2x$

Or another way to put it:

$$\frac{d(x^2)}{dx} = 2x^1$$

The DERIVATIVE of "x to the power of THREE" is "THREE x to the power of TWO".

Function	Derivative
x^3	$3x^2$

Or another way to put it:

$$\frac{d(x^3)}{dx} = 3x^2$$

Conclusion:

The derivative of "x to the power of SOMETHING" is "SOMETHING x to the power of that SOMETHING MINUS ONE".

$$\frac{d(x^n)}{dx} = nx^{n-1}$$

This is called "THE POWER RULE".

On the left side of the equation we have the RATE OF CHANGE of the current "thing" x^n

On the right side of the equation we have the previous version of the "thing" TIMES the current dimensions. Why dimensions? Because the previous "thing" grows in all directions to become the current "thing". If it's a cube that grows, it grows in all 3 directions. How much does it grow in each direction? Like a thin "slice" of the cube which is a square. So this square is the lesser dimensional version of the cube.

In the same way when we were looking at how a square grows in all the directions of a square (width and length) we added a line in each direction, the line is a thin slice of the square, and it's the lesser dimensional version of the square.

I hope this, along with the drawings, makes some sense.

Let's try to translate this into our story:

How does the normality of our base couple changes with time?

If our "thing" is the square "Leonard and Penny",

These are the 2 directions of the square: the boys' direction and the girls' direction.

Sheldon is a "slice" (a tiny fraction) of the normality of Leonard.

Bernadette is a "slice" (a tiny fraction) of the normality of Penny.

So:

The RATE OF CHANGE of "Leonard and Penny" EQUALS TWO TIMES "slice of the square".

OK let's do the same in the 3-D version:

How does the fun (communication) of our base "trio" changes with time?

If our "thing" is the square "Leonard and Penny and Penny's dad",

These are the 3 directions of the cube:

Prof. Proton, Leonard's mom, Sheldon's mom. So let's say they are all supportive characters for the different directions (characters) of our previous cube.

So Leonard's mom likes Penny, and Sheldon's mom likes Leonard, and let's imagine the Prof. Proton likes Penny's dad. Lol. I know I'm sorry it's hard to be tied in a "procrustean bed" of metaphors and make sense mathematically at the same time. Try it sometimes!

Remember that Prof. Proton loves Penny

https://bigbangtheory.fandom.com/wiki/Professor_Proton

Prof Proton: "Is the blonde girl really your girlfriend?"

Leonard: "Yes Sir."

Prof Proton: "You're the genius!"

https://www.youtube.com/watch?v=zMj6AuycRfE

The Big Bang Theory - Bob Newhart clip

Warner Bros. TV

And Penny's dad is also loves Penny, so I guess that Prof. Proton would have supported Penny's dad (if they ever met) for raising such a great daughter. Phew… I managed to make it somewhat plausible! 😊

So the original cube or "Leonard – Penny – Penny's dad" grows in all these 3 supportive directions (all possible unique directions for a cube). And in each direction how much does the cube grows? The cube grows by a "slice" of the "fun" of the original character.

OK.

In minute 7:58 in the video, 3Blue1Brown explains very nicely why the equations work the way they work symbolically.

In our story it would translate to something like: the biggest influencer on the CHANGE is the combination of all the "supportive" characters up to that point, MINUS the main character in that direction (let's say Leonard). That's because the main character in that direction (e.g. Leonard) was there before (in the smaller "thing") and he's there after (in the bigger "thing") so he's not part of the CHANGE.

That's the "mostly xs with a single dx , that 3B1B talks about.

In minute 8:42 he explains that since there are n different lines like these:

We can choose the dx from the 1st (   ) and then choose all the x from all the other (   ) .

We can choose the dx from the 2nd (   ) and then choose all the x from all the other (   ) .

We can choose the dx from the 3rd (   ) and then choose all the x from all the other (   ) .

And so on.

So that's why we multiply by n .

Ok. in minute 10:10 in the video, 3Blue1Brown talks about the function

$$f(x) = \frac{1}{x}$$

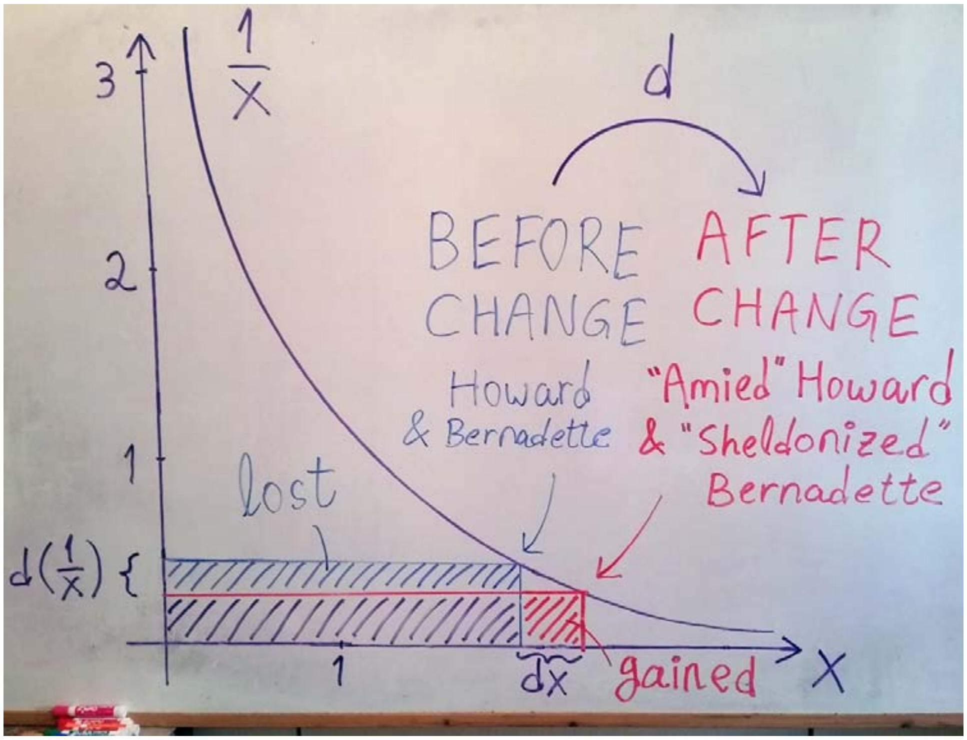
OK this is like compensating values. So let's imagine a table of on the one hand the domineering and annoying spouses, and on the other hand their patient and psychologically containing spouses.

"hard" and "soft"	Hard partner's "hardness"	Soft partner's "hardness"
Penny and Leonard	1	$1/_1$
Bernadette and Howard	2	$1/_2$
Sheldon and Amy	3	$1/_3$
Lucy and Raj	4	$1/_4$
Howard's mom and Stuart	5	$1/_5$

Ok so you get the idea, the more terrible the "hard" partner, the wimpier and more submissive the other partner must be.

So 3Blue1Brown talks about it geometrically as a rectangle.

Picture 4 – one over x



This picture is my version of minute 11:55 in the video.

So imagine that at the beginning (before the change) there was a BLUE rectangle of

$$2 * \frac{1}{2} = 1$$

This means Bernadette (hardness 2) TIMES Howard (hardness ½) EQUALS one (relationship).

So let's imagine this more generally so instead of 2 we will use x.

So BEFORE the CHANGE the BLUE rectangle is:

$$x * \frac{1}{x} = 1$$

With time people CHANGE, so Bernadette becomes a little harder, and in order to keep the relationship Howard needs to become a little softer. But we want to talk in terms of hardness, so Howard becomes a little less hard.

So after the little CHANGE they are the RED rectangle:

$$(x + dx) * \frac{1}{x + dx} = 1$$

The area of a relationship is always 1. What they lost (the BLUE in the drawing) is replaced by what they gained (the RED in the drawing). The PURPLE is the overlapping area that stayed the same BEFORE and AFTER the CHANGE.

Please notice in the fraction that because we added something (dx) to the denominator, and the numerator stayed the same (1) then the whole fraction is now smaller. The fraction is the height of the rectangle. The RED rectangle is shorter (less high) then the BLUE rectangle).

If you want the "story" version, to get some meaning to the area.

In metals hardness is changed with heat treatment. Like heating the blade of a sword and then cooling it quickly by dipping it into cold water. This process also works with glass.

https://en.wikipedia.org/wiki/Quenching

So let's "borrow" this and say that in order to make someone less hard (soften someone) you need to give heat a lot of heat in a short time, and in order to make someone hard you need to take away a lot of heat (give coldness) in a short time.

So a big CHANGE in "human warmth" over a short time makes hardness. Let's give an example: a gesture that is very heartwarming "melts" someone's heart and make him softer. On the other hand a traumatizing experience of deprivation of human touch for example being locked in a dungeon, hurts the person and he becomes suspicious towards humanity and it's hard for him to give or receive love so we call this hard.

So the BLUE area is the warmth that Howard lost, and the RED area is the warmth that Bernadette gained. And of course it's the same amount of warmth because the area in our function remains the same all the time (for all couples) which means area of 1.

We could calculate this using the "POWER RULE" because we could write:

$$\frac{1}{x} = x^{-1}$$

And we know already what to do with the exponent -1 :

The derivative of "x to the power of SOMETHING" is "SOMETHING x to the power of that SOMETHING MINUS ONE".

So we get:

$$-1 * x^{-2}$$

Or written more aesthetically:

$$-x^{-2}$$

OK. now we are in minute 12:37 of the video. 3Blue1Brown talks about the "sine" function.

https://en.wikipedia.org/wiki/Sine

Now we can talk about sine in the geometric sense. For example Romeo is standing in the garden. Juliet is standing on her upper floor balcony. And Juliet is saying "Wherefore Art Thou Romeo". (which really means "why" are you (from the enemy family) Romeo?).

But let's suppose Juliet is asking how far are you Romeo? So what is the aerial distance between them?

Note: I don't want to confuse us with the a person's height – are we talking about the distance from their feet or from their heads and so on – so we will think of both Romeo and Juliet as very small. Like in Disney's "The Princess and the Frog" when they are both little frogs.

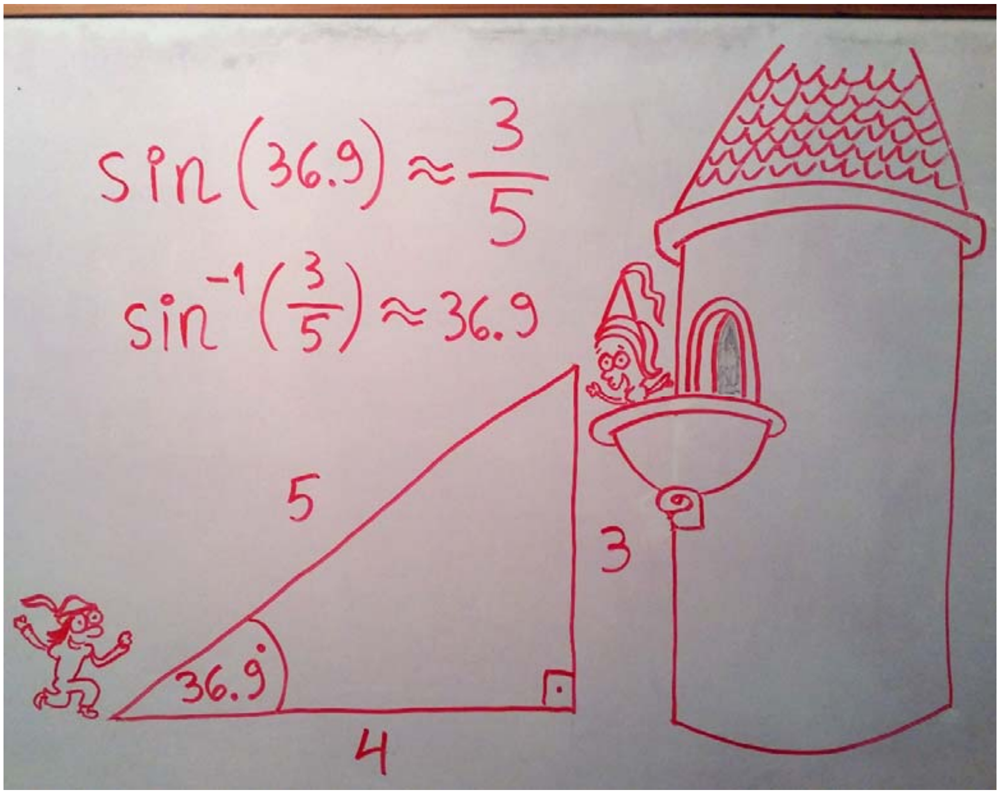
OK. In order to answer her question Romeo can use the Pythagorean theorem: how far is Romeo standing from the base of the building's? and how high is the balcony from the base of the building?

But what if Romeo can't approach the building and measure the ground distance? (because their families are sworn enemies).

Let's say he knows the height distance because the building standards in their city Verona are very strict. So let's say the second floor's balcony where Juliet is standing is 3 meters high from the ground.

So Romeo can use the ANGLE between his line of sight to Juliet and the ground, in order to calculate the aerial distance to Juliet, using the "sine" function. Let's draw a picture:

Picture 5 – sine in a triangle



Ok so here I gave a numerical example, where let's Romeo has a goniometer (a tool to measure angles), and he measures the angle from his line of sight to Juliet down to the ground (which is like zero angle) to be: $36.9°$;

And also he knows that the height of Juliet's balcony is 3 meters above the ground (as we explained);

So Romeo can call the unknown aerial distance x use the first equation in the picture:

$$\sin(36.9) \approx \frac{3}{x}$$

now we multiply both sides by x and then divide both sides by sin(36.9) :

$$x \approx \frac{3}{\sin(36.9)}$$

And now we can see in the pocket calculator (or in trigonometric tables) that sin(36.9) equals about 0.6 so we write:

$$x \approx \frac{3}{0.6} = 5$$

So we found out that the distance from Romeo to Juliet is about 5 meters!

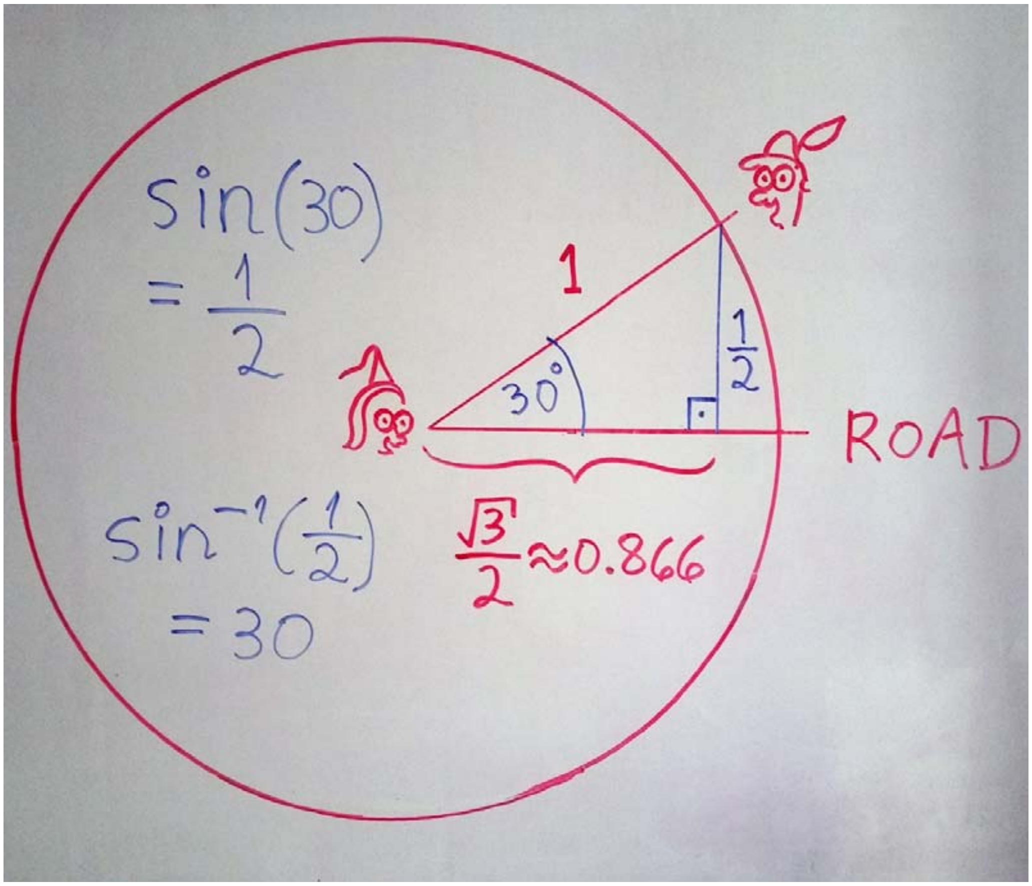
All this works pretty much the same way if we stick the triangle inside a circle, but then it's useful to scale down the triangle so that the hypotenuse (the side opposite the right triangle) is exactly 1.

Now let's think about Romeo and Juliet's situation from a bird's eye view – the weather vane in the shape of a rooster (or cock ha ha) that's sitting on the roof of Juliet's home.

https://en.wikipedia.org/wiki/Weather_vane

let's say one side is special, that's the side where the road reaches the house. The road is coming from the east, so on our bird's eye view map it would be on the right side.

Picture 6 – sine in a circle



So as you can see Romeo is hanging around all day around Juliet's house. NOT too close because her family would kill him, but not too far because his love for her binds him to her.

Also note that each time a carriage is coming on the road (with Juliet's father for example) Romeo keeps his distance from the road.

Let's say he is all the time 1 kilometer away from Juliet. So he's running circles around Juliet house, So if Juliet wants to ask "Wherefore Art Thou Romeo" (and let's pretend it's not WHY but WHERE) then Romeo is now $\frac{1}{2}$ a kilometer from the road. Even if Juliet is locked in the house she knows this because she knows her trigonometry, and so she knows that if she measures $30°$ from her line of sight to Romeo to the line of the road, then this means that Romeo's distance to the road is half of Romeo's distance to her.

Now we can establish a cyclic behavior. Let's say Juliet's father is the bell ringer in the nearby church so he come and goes once every hour.

https://en.wikipedia.org/wiki/Bell-ringer

And to avoid him Romeo synchronizes his position so he's at the back of the house ($180°$ from the road) around the few minutes when this danger is coming and going on the road.

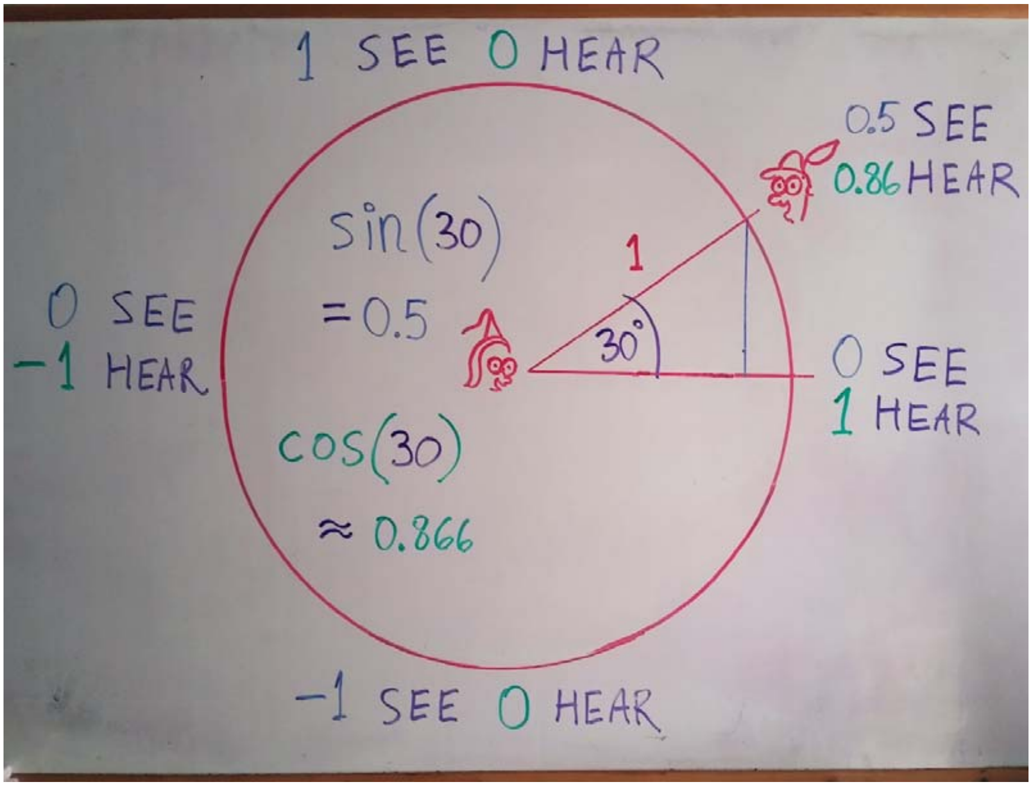
OK so let's say that in her room Juliet is trying to keep track of where her boyfriend is at each moment. So she knows all about his cycle, and she draws Romeo's position as a graph.

So now let's imagine that Juliet balcony's direction is to the north. And the balcony has closed windows which she can't open. So the VISIBILITY the lovers is high when he's in the north (on the upper side of the map) and negative (she can't see him and he can't see her) when he's on the south (on the lower of the map).

Also let's imagine that there is a high open window to let the chimney's smoke of the fireplace, and all these are on the east wall of her room. So when Romeo is on the east side (right side of the map) she can positively hear him doing bird love songs in her honor, but when he's on the west side of the house (left side of the map) their hearing is negative. He can't whistle to him and she can't whistle back.

Let's draw a picture of the situation first and then a picture of the graph that Juliet sketches.

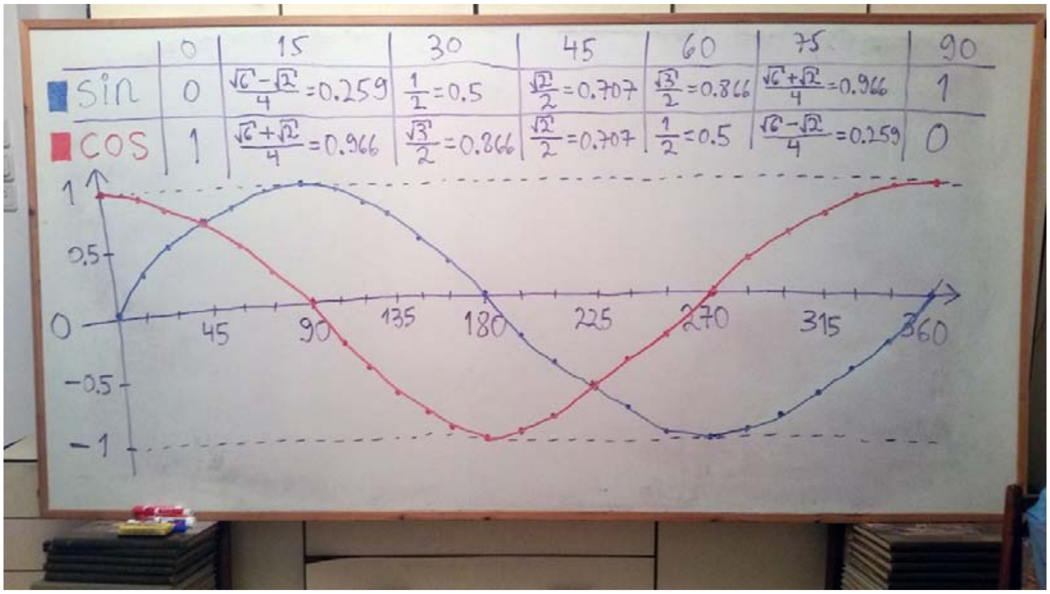
Picture 7 – Sine (seeing) and Cosine (hearing (écoute in French remind us of cosine)) in a circle



OK so during each hour Romeo makes a full circle around Juliet's home and both the seeing (sine) and the hearing (cosine like écoute) go through all their possible values from $+1$ to -1 , but there is a phase difference between them. Notice that if we go counter clockwise from the beginning (where the road is it's our ZERO angle), the seeing (sine) begins as ZERO gets more positive and then more negative, and the hearing (cosine) is following but in a quarter of a circle delay: when we are in $90°$ only there the hearing (cosine) begins as ZERO and from there on gets more positive and more negative, but always in a "quarter of a circle" delay behind the seeing (sine).

OK so I also owe you a picture of the sine (seeing) and cosine (hearing) as waves.

Picture 8 – Sine and Cosine in a graph:



OK so in this graph we see in sine function in blue and the cosine function in red.

If we go towards the right, the cosine (red) is always one step behind the sine (blue).

Up until now we talked about a geometric interpretation (which is easier to understand), Romeo physical position around Juliet's home (going around a circle). But can we describe sine and cosine as something that has to do with love and sex?

Scenario 1 – mental "horniness":

OK so first I suggest we will interpret the picture as mental horniness level (sexual arousal).

How do the man gets turned on? He gets an erection from visual stimulation from some stimulus. Maybe it's the woman bending over, or her scent or something. The man knows (feels physically) he was aroused consciously when he feels his dick hard. So he is now aware of his physical horniness and this causes his mental horniness to rise. So let's just follow the blue line from the beginning (left). He was neutral towards sex which is 0 (height) at time $0°$ (left most) and now he's getting more and more horny until we reach the maximum of $+1$ at time $90°$.

(Now for the moment ignore what happens to the woman from time at time $0°$ to time $90°$. We will get back to this time and explain in the next cycle).

OK so what happens between $90°$ and $180°$?

There's a mutual feedback between the woman not yet in the mood (neutral meaning 0) , and the man who was super in the mood 1 , but now gets cold signs from the woman.

For example when she is reluctant she is tickled by his touch (when she is aroused the same area of the body interprets the sensation as pleasurable and sensual not tickling).

So the man cools down to 0 , and the woman is verging on annoyed at -1 .

OK so what happens between $180°$ and $270°$?

Ok so now the man is a little put off by the woman's less than enthusiastic response, so the man gets to his low point -1 . This might mean his dick softens and he gradually touches the woman's body less.

BUT his touching initiated the desire response in the woman (as foreplay) so at the same time the woman stops being antagonistic and even might put his hand back on her ass or breasts or whatever he was doing. So the woman stops being anti sex and she is now neutral 0 .

OK so what happens between $270°$ and $360°$?

OK the man encouraged and happily surprised by the woman's reassuring gesture is getting turned on again, this takes him a little time because he's gone soft by now, but they are both on the way up now, the woman reaches her maximum at $+1$

And the man reaches his mid level as we mentioned it takes time to get things going, so he's at 0 .

OK so we finished the first whole cycle from $0°$ to $360°$

So now we are at the second cycle, the graph visually looks the same, you just add to each point in time the first cycle which we just finished meaning $+360°$

OK so what happens between $360°$ and $450°$? (this is what I owe you from before by the way)

Let's say they are both in bed and the woman is hot at maximum but then she sees that the man's dick is only half erect and that gets her down to neutral level 0 .

But on the other hand the man still excited from what she encouraged him before gets over this time span a full hard on and he's fully horny in the level of $+1$.

OK what happens between $450°$ and $540°$?

Here we see the result of the chilling effect that the half-erected dick had on the woman, and also in turn the result of this chilling on the man, so they are both going down. The man goes to 0, and the woman to -1.

OK what happens between $540°$ and $630°$?

Now the man engages in more foreplay to get the woman started again. For example he might lick her pussy, this is not a turn on for the man usually but it's a major turn on for the woman.

So we see them "switch" places, the man gets turned off (the ass and breasts are secondary sex characteristics, the pussy although it's the main characteristic is not arousing the average man by itself, for example man enjoy staring a long time at breasts and asses, not pussies).

OK so at the end of this part the man is at his lowest with shriveled dick so he's -1, and the woman is getting fired up to 0.

By the way a nice "trick" to get the woman going, is to let her taste (on a finger) her own pussy juices. This is equivalent for the man feeling his own dick getting hard, but the woman's juices are a lot more subtle, so she might not notice them, and she might not know that her body got aroused and horny. Once she knows, her mind gets horny too!

OK what happens between $630°$ and $720°$?

Here the woman reaches her peak $+1$ perhaps even reaches an orgasm from his manual stimulus or tongue and lips. The man is turned on by her encouraging reaction and is getting turned on but he started from MINUS ONE so by the end of this part he reaches 0.

OK so we finished the second whole cycle from $360°$ to $720°$

So now we are at the second cycle, the graph visually looks the same, you just add to each point in time the first and second cycle which we just finished meaning $+720°$

By the way something not related to sex, but that I find cool, So I just watched recently " Tony Hawk Teaches Skateboarding - MasterClass". It's really cool, I heartily recommend it. So anyway on the lesson 12th lesson " Playback The 900 ", he explains how exactly he achieved this amazing feat of skateboarding, 720 means two rotations, and 900 means two and a half rotations, so now we are trying to outperform the legend Tony Hawk and go for 1080! 😊

(All through my teenage years I was riding Powell Peralta skateboards (Tony's main sponsor back then) both street and ramp (Although I was never any good: at my first attempt to "ollie" I fell and broke my nose and lay there in a puddle of blood, until an Arab woman neighbor saw me and brought my mom. After that I never gathered enough courage to perform the basic "ollie" 😊).

OK so what happens between $720°$ and $810°$? (this is what I owed you when we started by the way)

The man is penetrating the woman, although exciting at first the intercourse is difficult and painful, she might ask him to slow down or be gentle until her muscles get used to the stretching and pounding etc.

So the man here reaches his maximum $+1$ while the pain makes the woman go down to 0.

OK what happens between $810°$ and $900°$?

Here the woman pushes away the man and asks him to go slowly which chills him and she gets a chilling effect like why isn't he considerate enough to do this in the first place etc, so they both go down, the man to 0 , and the woman to -1 .

OK what happens between $900°$ and $990°$?

OK this is when they switch places, the man is not allowed to fuck her hard the way he wishes so the stimulus is less intense, so his frustration causes him to get down to his minimum which is -1 on the other hand the woman enjoys the gentle love making so she's getting aroused from this so she comes back up to 0 .

OK what happens between $990°$ and $1080°$?

Now the woman is ready for rough sex and even wants it like saying "fuck me hard" etc. They both enjoy is and it brings them both up from where they were, the woman to her maximum $+1$ and the man goes up from where he was to 0 .

OK so we finished the third whole cycle from $720°$ to $1080°$

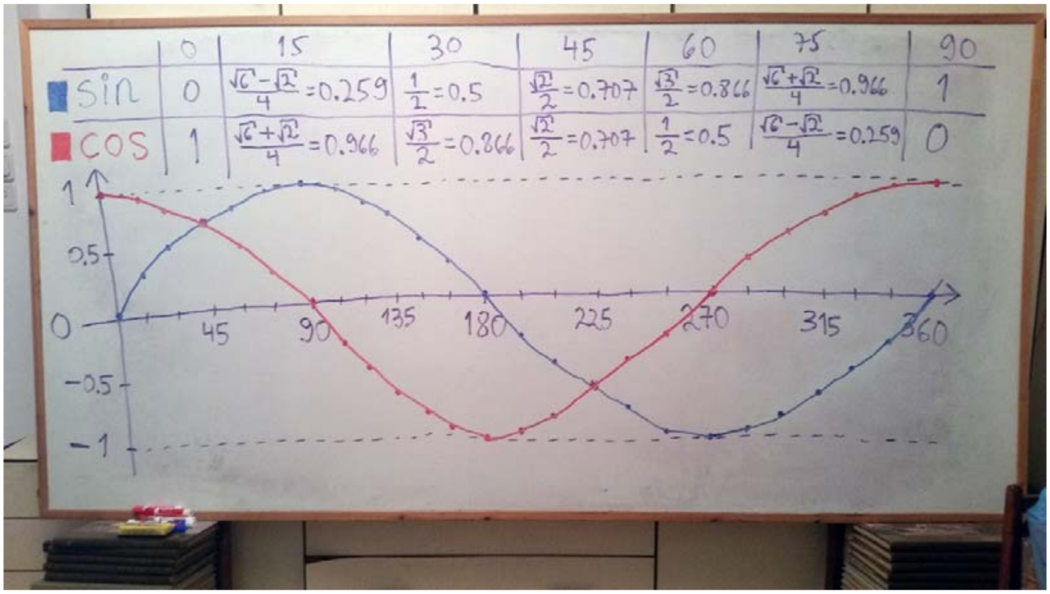
This is exactly the beginning of the cycle so if they cum (have an orgasm) they can go through the cycle again and again (have "seconds" like second course etc).

Scenario 2 – desire for pussy licking (cunnilingus):

OK so as I mentioned I personally (and I think most men) don't find eating the woman's pussy pleasurable per se (unless I love her or I'm extremely aroused).

So let's map the man in red (cosine) and the woman in blue (sine), and see how much they enjoy this action (I will copy the picture again so we don't have to scroll the page that much):

Picture 8 – Sine and Cosine in a graph – AGAIN!



Please note: this time the MAN is the RED cosine graph, and the WOMAN is the BLUE sine graph!

OK so what happens between 0° and 90° ?

The man (red) starts out as being very horny (otherwise he probably wouldn't agree to lick her in the first place), so he starts at his maximum which is PLUS ONE but quickly descends to 0 , because the actual action is not arousing at all.

The woman (blue) is enjoying the very touch and "pampering" of her pussy in the beginning and reaches her maximum which is her first orgasm quickly so she reaches $+1$.

OK so what happens between 90° and 180° ?

As the action goes by the man enjoys this even less so he goes down to his minimum -1 .

The woman (blue) has a hard time concentrating so she's also going down. But she started higher so she reaches the "not good and not bad" point 0 .

OK so what happens between 180° and 270° ?

Here they "switch". The woman (blue) becomes frustrated and a little embarrassed for taking so long especially if she can't concentrate enough to cum again. So she goes down to her minimum which is -1 .

The man (red) if he didn't get tired of it thus far now sees it as a challenge. By now he got used to the taste and the smell (although once I had sex with a girl who HAD NEITHER TASTE NOR SMELL in her pussy which was SUPERB!).

So the man (red) has more "drive" if not passion to diversify the way he's licking or place or "tempo" etc, going to her thighs and "Mons Venus" and then coming back to her clit, or "fucking" with his tongue and then coming back etc. So it's more like a game now where you try to win the reward. So he doesn't mind doing this anymore so he's back up to 0 .

OK so what happens between $270°$ and $360°$?

Thanks to the man's efforts (and time that "resets" her orgasm mechanism probably) the woman (blue) is finding her concentration again and "has hope" for an orgasm, so she is starting to enjoy this again so she is going up to 0 .

The man (red) is enjoying her positive feedback be it moans or short encouragement like "yes right there" etc. so this is very erotic for him to see her approaching closer to an orgasm so he's getting to his peak of his enjoyment from this activity. So he's $+1$.

(at the next cycle his tongue begins to get tired and hurts so he's starting to get down from this maximum although that's where the woman (blue) will cum again and reach her $+1$).

OK. I'm back now after a very long break from writing, I tried to help the protest against Bibi in various ways, but all my initiatives fell on deaf ears. So please forgive me if there will be some continuity errors.

https://en.wikipedia.org/wiki/Continuity_(fiction)

OK. so where were we?

Derivative formulas through geometry | Essence of calculus, chapter 3

https://www.youtube.com/watch?v=S0_qX4VJhMQ

In about minute 14:20 of the video, 3Blue1Brown tells us that the derivative of sine is cosine. This means in our drawing that the derivative of the blue graph is the red graph.

Okay so we explained the sine and cosine in 2 different scenarios:

Scenario 1 – mental "horniness":

mental horniness level (sexual arousal).

we mapped the man in blue (sine) and the woman in red (cosine)

Scenario 2 – desire for pussy licking (cunnilingus):

how much they enjoy this action

we mapped the man in red (cosine) and the woman in blue (sine)

but now we need something that can be measured much more precisely. Libido is not something that we usually quantify, so let's refer to another "roller coaster" between the two sexes, where two functions "chase" each other up and down, which is in the first phone call that the guy calls the girl after the first date.

Exactly how much time did he wait before calling?

For example, in the great sci-fi series The Orville, this specific phone call becomes very important for the fate of the whole human race! I will not ruin the plot for you, so let me just talk about the phone call and not it's meaning.

Ed calls Kelly in the morning and tells her he had a really great time out last night (on their date).

This is interpreted as a very awkward time to call – presumably because he did not "act cool" and wait until the evening.

Okay so as we can see from the phone call example, too much interest is not good. This will make the girl less interested, and if it's really exaggerated it will tip the scales and the girl will just not be interested at all.

Okay so to make this more two sided instead of just the boy chasing the girl, let's make this a text message conversation.

how many smileys were there in the message, and how long the message is, and exactly which smileys, and did the message talk about feelings and exactly how did he refer to you (if at all) in the beginning and how it's "signed" etc.

You can see that although these details are "subject to interpretation", you could make a scale of them (this emoji is worth 10, that emoji is worth 7 etc) and once you "calibrated" your partner, you'd know how much he or she is interested in you.

So let's make our function the "how much interested in the conversation" each side (the man side and the woman side) is, and we will measure this level of interest in some single parameter: how long is the message, or how many smileys, etc.

So now we are in minute 14:53 of the video of 3Blue1Brown,

Now he talks about the unit circle and instead of measuring the angle in degrees, he measures the angle in radians.

You know how in American slang you have these codes for how far the guy went with the girl:

https://en.wikipedia.org/wiki/Baseball_metaphors_for_sex

- Strikeout – a failure to engage in any form of foreplay or other sexual activity;
- 1^{st} base – mouth-to-mouth kissing, especially French kissing;

- 2^{nd} base – skin-to-skin touching/kissing of the breasts; in some contexts, it may instead refer to touching any erogenous zones through the clothes (i.e., not actually touching the skin);
- 3^{rd} base – touching below the waist (without sexual intercourse) or manual stimulation of the genitals; in some contexts, it may instead refer to oral stimulation of the genitals;
- Home run (home base or scoring) – "full" (penetrative) sexual intercourse

OK. so let's define them more numerically:

0^{th} = nothing

1^{st} = kissing

2^{nd} = make-out above the belt ("surface stimulation")

3^{rd} = make-out below the belt ("deeper stimulation")

4^{th} = sex ("penetration")

After one round, the next round maybe describes anal sex for example:

0^{th} = nothing

1^{st} = the guy rimming the girl's ass (with his mouth)

2^{nd} = the guy fingering the girl's ass (with his fingers)

3^{rd} = the guy preparing the girl's hole for penetration (with sex toys)

4^{th} = anal sex

And another round maybe describes BDSM sex for example:

https://en.wikipedia.org/wiki/Sensation_play

0^{th} = no progress with girl at all in BDSM sex

1^{st} = "face": Two partners exploring the sensations of kissing or other intimacy while blindfolded

2^{nd} = "tits": Contact with intense temperatures, such as ice or hot wax / Clamping parts of the body with clothespins, forceps, nipple clamps or similar devices.

3^{rd} = "ass": Whips, flogging, bondage suspension and other BDSM related activities.

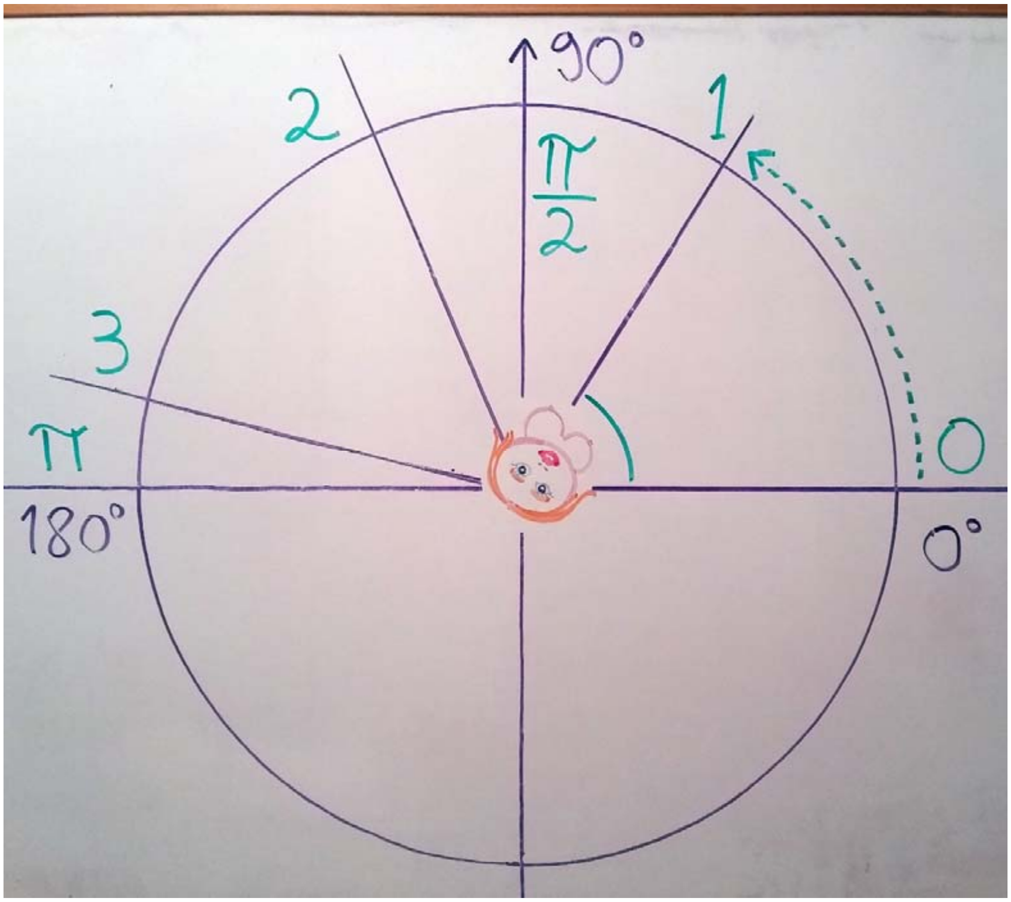
4^{th} = "pussy": bondage sex with penetration.

So you can see there is a circle. We start with the girl completely "closed" to some activity and then gradually she "opens" up to this activity, and simultaneously the guy makes progress as he goes further and further to the next "base" in that activity.

In a metaphoric way (and in the first half circle also in a physical way), we can imagine the girl's legs spreading. At first the girl is "closed" with her legs close together, and the more she gets aroused and "opens" up, the more she spreads her legs for her lover.

So our "camera" view point is from above the woman's head.

Picture 9 – Radians as guy's progress and girl's opening



OK so we are looking at the girl from above her head, and we check the angle that she spreads her legs. Let's say her right leg is all the time pointing to the right, towards the ZERO.

(imagine the purple straight lines coming from the center of the circle in the picture, as the girl's legs position at different times. Her right leg always points to the right in the ZERO direction, while her left leg is free to rotate "spread open" more and more).

Then with the guy's progress (which we see as the dashed green arc from ZERO to ONE, this is how much the guy progressed, so at the same time the girl's legs open apart (the green angle near the girl) in the angle that matches this arc length.

So we called this "1st base", but the actual name for this in mathematics is a RADIAN.

1 Radian equals roughly 57 degrees, and also equals this arc length in dashed green.

If we progress to "2nd base", then we have an angle (or arc it's the same with radians) of 2 radians which is about 114 degrees.

If we progress to "3rd base", then we have an angle (or arc) of 3 radians which is about 171 degrees.

The special thing happens when we have an angle of π radians - as you know π is about 3.14 so HALF a circle equals exactly "Pi" radians.

And because of this a QUARTER of a circle is: $\frac{\pi}{2}$ radians

And TWO HALVES of a circle (in other words, ONE WHOLE circle) is: 2π radians

OK so this was a little detour to explain why you see in the video:

$\frac{\pi}{2}$ instead of $90°$

π instead of $180°$

2π instead of $360°$

And so on. It's just another way of describing angles. In the future we will see why this new way (radians) is more natural in calculus.

OK so back to 3Blue1Brown's explanation in minute 14:00 of why cosine is the derivative of sine.

So we can understand intuitively the two "waves" chasing each other:

one function is "how much the guy is interested in the girl"

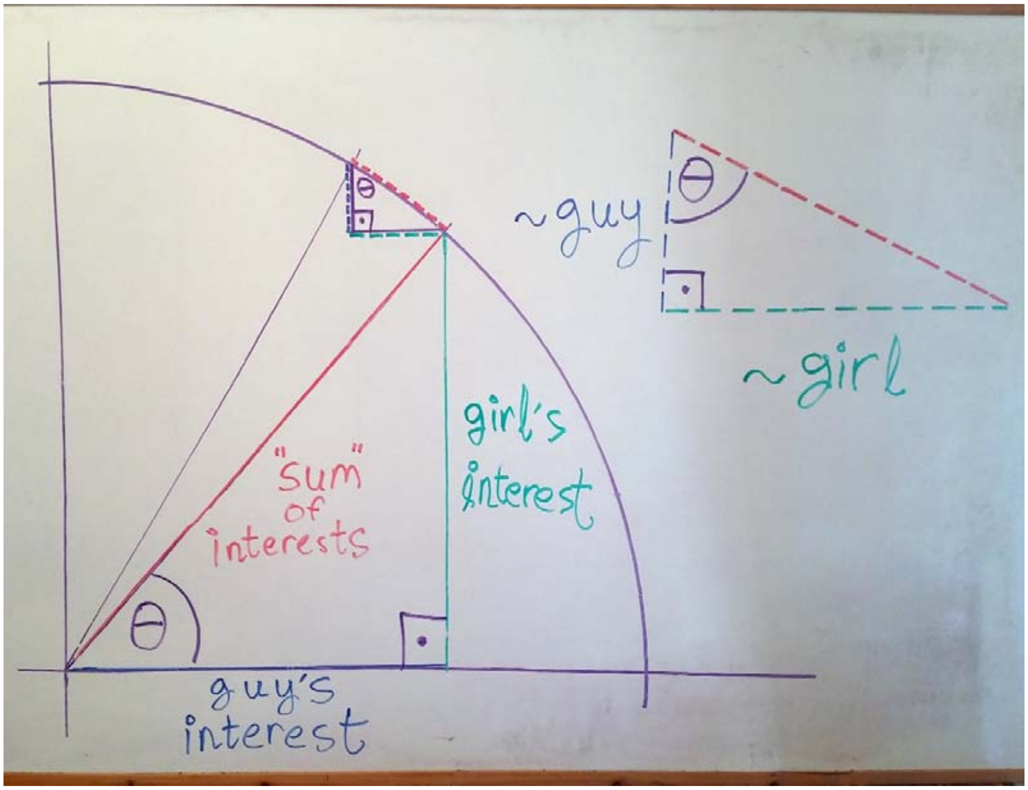
the other function is "how much the girl is interested in the guy"

If he writes with at length with a lot of smileys then she sees him as over eager, and she is starting to lose interest in the conversation, which results in her writing shorter messages with less smileys. Then if he sees this he starts to lose interest too, and invests less energy and creativity in his writing. This turns the girl on, because she sees he's not that eager after all and her interests is rising again, and in return his interest will rise again etc.

I'm not doing this "by the numbers", we did a couple of examples like this.

Let's give more human labels to the geometric explanation in minute 14:52 in the video:

Picture 10 – why the CHANGE of sine (girl's interest) is cosine (guy's interest)



We are now looking inside the circle, and we have there two similar triangles: The big triangle (where θ is on the lower left) and the little triangle (where θ is on the upper left).

Also you can see the little triangle "zoomed in" (scaled up so we can see more clearly), on the right side of the picture.

OK now we look at the big triangle inside the circle.

The green vertical side is the girl's interest [in the guy], the blue horizontal side is the guy's interest [in the girl], and the red hypotenuse side is a complicated "sum" of the guy's and the girl's interests, so to avoid complication we define it to be 1 at all times.

So in words you could say we have the girl's level of interest [in their relationship], and the guy's level of interest [in their relationship], and this make together one whole relationship.

Now the most important thing to the girl, and this I can tell you by painful experience from my mythological ex-girlfriend, is for the relationship to be "balanced". Apparently, I loved her TOO MUCH (Yes amazingly there is such a thing).

The girl is not assessing you by how much you worth but instead by how much you want her. Yes I know it's amazingly stupid but this is the truth.

There is a famous quote by Groucho Marx

"Please accept my resignation. I don't want to belong to any club that will accept people like me as a member".

So every girl's mind, even a very smart girl like my ex, works in this way!

The picture shows how a guy SHOULD behave if he wants to keep the girl:

Now imagine the angle θ as time going by, like the hand of a clock, except it's progressing in the opposite direction of a clock (anti-clockwise).

Also imagine 3 different concepts:

Enthusiasm (or when it's negative: contempt) – which will be like the force that pushes you, your drive to do something.

(if we were in physics this was the acceleration of the pendulum).

Habit (or when it's negative: vice) – which would be like the momentum that you already have to move or behave.

(if we were in physics this was the velocity of the pendulum).

Behavior (or when it's negative: misbehavior) – which would be like how are you treating your partner in the relationship.

(if we were in physics this was the position of the pendulum).

We start on the right when the angle is ZERO,

What happens to each of them during the 1st quadrant ($0°$ to $90°$) ?

The guy:

His enthusiasm starts at negative MAX and goes to ZERO. ↑

His habit starts at ZERO and goes to negative MAX. ↓

His behavior starts at positive MAX and goes to ZERO. ↓

The girl:

Her enthusiasm starts at ZERO and goes to negative MAX. ↓

Her habit starts at positive MAX and goes to ZERO. ↓

Her behavior starts at ZERO and goes to positive MAX. ↑

What happens in the 2nd quadrant? ($90°$ to $180°$) ?

The guy:

His enthusiasm starts at ZERO and goes to positive MAX. ↑

His habit starts at negative MAX and goes to ZERO. ↑

His behavior starts at ZERO and goes to negative MAX. ↓

The girl:

Her enthusiasm starts at negative MAX and goes to ZERO. ↑

Her habit starts at ZERO and goes to negative MAX. ↓

Her behavior starts at positive MAX and goes to ZERO. ↓

What happens in the 3rd quadrant? ($180°$ to $270°$) ?

The guy:

His enthusiasm starts at positive MAX and goes to ZERO. ↓

His habit starts at ZERO and goes to positive MAX. ↑

His behavior starts at negative MAX and goes to ZERO. ↑

The girl:

Her enthusiasm starts at ZERO and goes to positive MAX. ↑

Her habit starts at negative MAX and goes to ZERO. ↑

Her behavior starts at ZERO and goes to negative MAX. ↓

What happens in the 4th quadrant? ($270°$ to $360°$) ?

The guy:

His enthusiasm starts at ZERO and goes to negative MAX. ↓

His habit starts at positive MAX and goes to ZERO. ↓

His behavior starts at ZERO and goes to positive MAX. ↑

The girl:

Her enthusiasm starts at positive MAX and goes to ZERO. ↓

Her habit starts at ZERO and goes to positive MAX. ↑

Her behavior starts at negative MAX and goes to ZERO. ↑

In mechanics:

The rate of change of position is velocity.

The rate of change of velocity is acceleration.

In love:

The rate of change of behavior is habit.

The rate of change of habit is enthusiasm.

In terms of waves like we drew the sine and cosine in the past, we know that they look the same except things happen first to the sine and then the same thing happens (after another quarter of the circle) to the cosine. We can see this in the small up and down arrows that I added after each line.

We can connect pencil to one pendulum that represents the guy's behavior swings, and also connect another pencil to another identical pendulum that represents the girl's behavior swings, and roll one sheet of paper below the same two pendulums at constant speed, and release the girl's pendulum and then the guy's pendulum, quarter of a cycle later.

So how do we see that the guy's pendulum (cosine) is the RATE OF CHANGE of the girl's pendulum (sine) ?

We see the guy's pendulum as the

So first we notice that the higher the guy's interest gets, the lower the girl's interest gets.

By how much the guy's interest (continuous green line in the big triangle) grow each moment?

By an amount proportional to the girl's interest. This amount is the blue dashed line in the little triangle. (the actual girl's interest is the blue continuous line at the bottom of the big triangle).

So the more the guy interest grows, the slower it grows, because it grows by (something that's like) the girl's interest, and the girl's interest is getting smaller and smaller.

As you remember the sine is the ratio

$$\sin(angle) = \frac{the\ length\ of\ the\ side\ that\ is\ opposite\ that\ angle}{the\ length\ of\ the\ longest\ side\ of\ the\ triangle}$$

Which here is like saying

$$\sin(\theta) = \frac{guy's\ interest}{"sum"\ of\ interests}$$

And because the "sum" of interests here is 1 , because this is the unit circle so the radius is one everywhere, then the denominator (red) is 1 , so we are dividing the guy's interest (green) by one, and anything that you divide by one stays the same, so we have:

$$\sin(\theta) = guy's\ interest$$

And in similar way we have:

$$\cos(\theta) = girl's\ interest$$

So let's repeat our conclusion with the words sine and cosine:

So the more the SIN grows, the slower it grows, because it grows by (something that's like) the COS, and the COS is getting smaller and smaller.

This "dance" of these two functions, where each one of them [I'm ignoring plus/minus sign for now] is the rate of change of the other,

Note: I kept saying "sum" of interests, for simplicity, but I'm sure you know about the Pythagorean theorem

https://en.wikipedia.org/wiki/Pythagorean_theorem

so what I should have said all along is sum of the squares:

$$guy^2 + girl^2 = 1$$

Subchapter 2.04 – Chain rule and product rule as pregnancy and success on Facebook

Ok so now we are in the fourth video of 3Blue1Brown:

https://www.youtube.com/watch?v=YG15m2VwSjA

Visualizing the chain rule and product rule | Essence of calculus, chapter 4

He says there are 3 ways to combine functions:

- Add them together
- Multiply them together
- Applying the **second function** on the **first function**, which means throw the **first one** inside the **second one**, like so $g(f(x))$

This is also called the **second function** on the **first function** like so:

g on f

And other names that you can read in Wikipedia:

https://en.wikipedia.org/wiki/Function_composition

OK so the first 3Blue1Brown gives examples of simple function, like x^3 whose derivative is $3x^2$, and also another example $\sin x$ whose derivative is $\cos x$

By the way I'm trying to learn how to write in LaTeX for my main project "haproyekt". The equations in here are done inside Word with Microsoft Equation Editor, not LaTeX, but the LaTeX learning brought to my attention that sine and cosine should NOT be written in *italic* . Which means I did it wrong throughout this book. So please forgive me, I will try to do it right from now on if I'll remember.

How can we "humanize" these functions?

So let's think in terms of what happens in social networks, for example Facebook.

Our function would be the person's status: how "successful" the person is what is the public opinion about him, good public opinion would be positive, bad public opinion would be negative.

So each of the different fields in his life will be an "engine" towards this: job (money and stability but here it's prestige), ladies (love and sex for him but desirability and envy for others), and friends (help and comfort but in our context they equal popularity).

So the function is x^3 . Why isn't the function $3x$? because each side of this success strengthens the others. When you have money from the job it's easier to get a girl, when you have a girl it's easier to find friends, when you have many friends it's easier to find a job and other connections between the job axis the ladies axis and the friends axis. So they are really multiplying each other, so if two lines multiply each other they are the sides of a square. If three lines multiply each other they are the sides of a cube.

If he becomes more successful any growth of one of the sides of his "success cube" brings growth of success in the other two sides as well.

What does negative mean in this context?

If the cube is getting smaller and smaller to 0 and then becomes more and more negative, this would also be a cube but a negative cube. Bad work for example crime, bad immoral woman, friends who are bad influence and lead him to go astray.

This bad cube also reinforces itself. So we paint the good cube in pink (rosy future), and the bad cube in black (dark future).

So his status grows like x^3

Why is the derivative of this $3x^2$?

That's the influence between the different sides (these influences make the faces of the cube).

Work-woman , woman-friends , friends-work .

These influences are the reason why the growth happens, so they are the rate of growth. For example the woman pushes him to get a better job, the better job attract the woman to him more, and so on.

The woman is more friendly than him so she helps to keep contact with his friends, or she has pretty female friends and then your male friends want to keep close to you so that she will set them up with one of her pretty female friends. And your friends think more of you because you succeeded to "get" your girlfriend and so on. And on the other hand the more friends you have the woman sees you're popular and thinks you're more attractive and so on.

And the friends-work connection we've talked about before (searching a job by word of mouth, like "bring a friend" referral marketing).

So you see how each face grows x^2 and there are 3 faces that determine the surface of the cube (it's true that a cube has 6 faces, but think of a dice laying on the table, you see 3 faces that face you and you know the other hidden 3 are just the same, so you understand that the other 3 are not free to be whatever size they want, they have to be exactly the same as the sides that you see, so that's what I mean that these 3 faces of the box that you see, they determine the box. In our specific case the box is a cube so all the faces grow and shrink together).

So hence $3x^2$

By the way, what does an exponential function like something to the power of x means? (for example e^x) in this explanation?

This would mean that you invented something that is so cool and “viral” that every person that sees it becomes an “engine” and pushes it further on his own. For example, I thought of a technology of 3D printed and texture painted custom made at home. My mom was really appalled from this idea so nothing came out of this, but you can read a short description as an appendix for this book.

Later note: I just saw that people already thought about this here:

Make a sex robot AT HOME: 'Hyper realistic' 3D printed cyborgs to hit the market

THE world’s first sex robot 3D printed at the touch of a button will herald the “evolution of our society” – and it’s coming soon, Daily Star Online can exclusively reveal.

By Joshua Nevett

https://www.dailystar.co.uk/news/latest-news/sex-robots-3d-printed-cost-16999491

Anyway if you can make a success that grows as an exponential function e^x the growing rate is also e^x because the derivative of e^x is e^x itself.

(each time it grows, by how much it grows? It multiplies everything that has happened so far (like from square to cube)).

In the example of our “success cube” you put energy into your job and girlfriend and friends, and they contribute to each other, but you are the engine.

In an example of a viral success like the 3D printed customized sex dolls could have been, each person becomes an engine and tell others who become engines etc. So your success grows a lot faster.

OK now 3Blue1Brown also talks about sine and cosine.

Here we think of pendulums, things that come and go like a wave, the way fashion changes. Together the sine and cosine create a circle which is also like fashion that repeats itself every few years (in the case of fashion it’s because they can’t really invent something new).

What “fashions” do people consider that affect status?

Sine function

For example thin look or fat look. Once fat was considered healthy and beautiful, nowadays thin is considered healthy and beautiful.

It depends on whether it's a historical time and place of shortage and hunger (and then plump is the ideal) or a historical time and place of abundance like right now in the global "north" (and then slim is the ideal).

And as we know these periods throughout history come and go in waves.

Cosine function

For example if someone is gay (homosexual), not so long ago it was considered taboo, today on the other hand, there are areas where gays "rule" like design and fashion (unfortunately – that's why the grown-up female models look like male teenage-boys).

This depends on whether it's a time and place in which the society is tolerant towards minorities and let them advance and succeed. This also comes in waves.

For example if someone's genetics dictate that he will be thin and gay, then there are times when the society will treat him better or worse depending on the "fashion" (Zeitgeist) in that society.

The process we see time and time again in history is that following economic hardships (like when people are without jobs and hungry) there is a flourish of nationalist "strong" leaders (in democracies this is called right wing) who find a scape goat for the public's rage which is the unlucky minority who happen to be there, like Jews or gays or whatever.

Then after the treatment becomes very bad for that minority, the totalitarian regime treats everybody else harsh as well (it's easy to become an enemy of the state in such regimes, it's enough that someone snitches or lies that you did or said something), and the wide population suffers.

Then, after a term of suffering, this regime collapses, and is replaced by a better regime, which is more liberal towards everybody (including minorities), and then the country flourishes, until the next bad economic time, and then the period starts again etc.

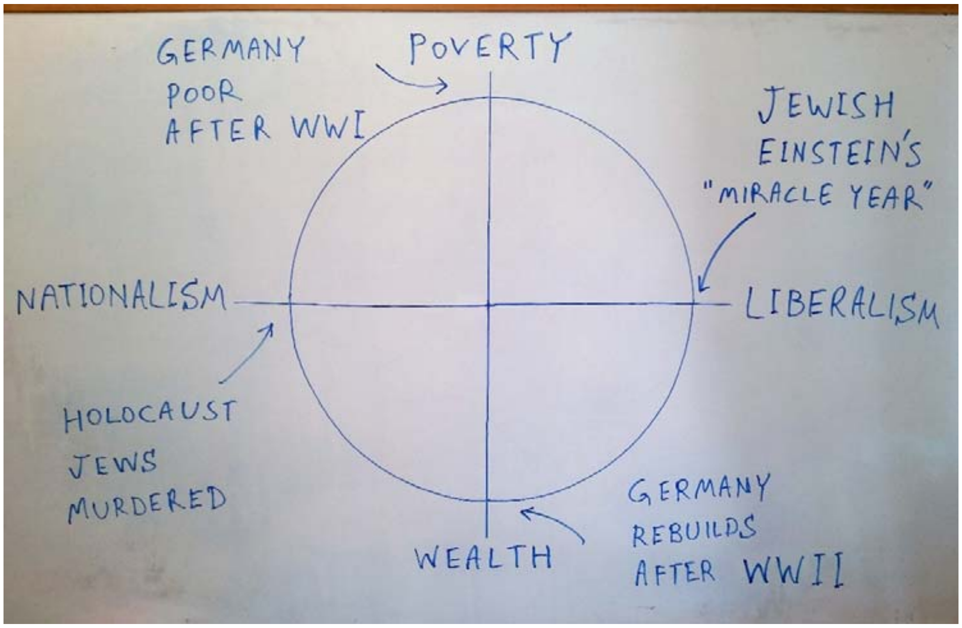
These two pendulum motions are related, one is pushing the other and vice versa. Since today in Israel is Holocaust day

https://en.wikipedia.org/wiki/Yom_HaShoah

I apologize for the depressing example but I will give you an example from Jews under the Nazi regime in Germany.

Picture 1 – attitude towards Jews (cosine) and Germany's condition (sine)

Please note: The circle is NOT war-peace!



OK so what do we see in the picture?

The up-down is the SINE pendulum movement, and it measures shortage (when it's up) and anti-shortage which is abundance (when it's down).

The left-right is the COSINE pendulum movement, and it measures tolerance towards minorities (when it's to the right) and anti-tolerance which is intolerance towards minorities (when it's to the left).

So we start at the right, and we follow the circle anti-clockwise (the angle from the center of the circle to where we are means time, like the hand of the clock except this clock progresses forward in time anti-clockwise).

Quadrant 1 (top right):

We begin on the right most side it's the year 1905 the "annus mirabilis" (marvelous year) of Albert Einstein. So there was a good treatment for Jews and Einstein added to the glory of Germany. This is before world war I. from this point on the tolerance (SINE) towards Jews gets less and less.

So when we begin the shortage situation is ZERO not good and not bad, but during the time progress along this quadrant, the economic situation gets bad because of World War I (WWI) until the end of 1918 when WWI ended and German people were left angry and frustrated (many died of hunger in the war). So the shortage (COSINE) grows until it reaches maximum.

Quadrant 2 (top left):

So as we said we are now at the end of 1918. Tolerance (SINE) is at ZERO which means in the middle, not as good as praising Einstein and not as during World War II (WWII), when the Germans (As I'm sure you know) murdered 6,000,000 (SIX MILLION) Jewish people, so if

Einstein didn't escape to the U.S.A. he would have been murdered too. So along this quadrant the tolerance (SINE) toward Jews become extreme intolerance until the Holocaust when the tolerance (SINE) will reach its minimum.

The shortage is getting better mainly because the Germans rob all the money and possessions of the Jews for example the Jews houses and who knows what still lies in Swiss bank accounts. Also the German war machine uses slave labor by Jews right until they murder them. So this also is a way to save money. So the shortage (SINE) is shrinks gradually to ZERO.

Quadrant 3 (bottom left):

OK let's say now we are in 1945 after WWII ended. The winning countries (United Kingdom, Soviet Union and United States), allow Germany to recover and invest money in Germany. So during this quadrant Germany's has growing anti-shortage, that is to say economic flourish. So the shortage (SINE) goes from zero all the way to minus one which is the minimum amount of shortage.

The tolerance (COSINE) during this quadrant goes from its minimum of minus one to ZERO which is the not-good-not-bad state of things.

Quadrant 4 (bottom right):

This starts in 1989 right before the Berlin wall was toppled down (West Germany took an economic blow because after Germany's unification it now had to invest in the poorer East Germany).

So today we see a process where Germany (and other advanced countries in Europe like Sweden), actually commit suicide because they are SOOO tolerant towards minorities that they flipped and took into them people who are not even from their people, nor their culture, nor their work ethics etc. Of course I refer to Muslim people from Asia and Black people from Africa. You can read in the book by Douglas Murray:

The Strange Death of Europe: Immigration, Identity, Islam

https://en.wikipedia.org/wiki/The_Strange_Death_of_Europe

Of course this is the complete opposite of what happened with the Jews: the Jews were totally European, they lived there for generations and were integral part of the (Christian) community, they wanted to be just like everybody else, they worked hard and were educated and motivated to the success of Christian Germany, there rate of reproduction was just like everybody else and so on.

So we see what it means to put one function inside another.

For example if Einstein had a Facebook, his success (how much he worked hard at the patent office and on his fabric-of-the-universe breaking articles, how much he worked on his relationship with his wife Mileva Marić (later he was cruel to her you can watch in the documentary https://en.wikipedia.org/wiki/Genius_(American_TV_series)#Season_1:_Einstein_(2017)

how much he worked on his relationship with his friends like Michele Besso,

So we can make a function like we did before with x^3

And this function will be put inside the bigger function of what happens in the whole country with Jews, which takes whatever success Einstein gets and grows or shrinks it like $\sin(something)$ in our example (attitude towards Jews).

So we would get one inside the other:

$$\sin(x^3)$$

OK.

Now you might ask yourself what if the SINE was inside and the X^3 was outside like so:

$$(\sin(something))^3$$

Will the result be the same? Does it matter which function is outside and which function is inside? YES it does matter.

It's like:

If you put on your SOCKS and then your shoes

or you put on your shoes and then your SOCKS.

Suppose we take the number 3 and plug it into both different scenarios:

$3^3 = 27$ which is almost 30 .

The sine of 30 is $\frac{1}{2}$. So the sine of 27 will be about $\frac{1}{2}$. So if $x = 3$ then:

$$\sin(x^3) \approx 0.5$$

On the other scenario, let's put 3 instead of "something".

So the calculator tells us that $\sin(3) \approx 0.05$ which is ten times smaller than half.

Now if we take this and raise it to the power of 3 we get something very small!

$$(\sin(something))^3 = 0.000125$$

By the way if we need to make up a story for that something the inner SINE function, we can say that the health of the person is oscillating, like Van Gogh had bursts of energy when he could paint a lot, and bursts of depression or madness when he couldn't paint and maybe even ruined paintings.

OK so we dealt first with the most complicated thing: putting one function inside the other.

What about the simpler stuff of adding and multiplying?

Multiplying is like “force multiplier” in the army:

https://en.wikipedia.org/wiki/Force_multiplication

They give the example that using satellite navigation (GPS) the same number of troops can be much more effective.

So let’s say he bought a car, then it allows him to drive to a better job in the big city, and take his girlfriend to trips in the weekends, and visit more events with friends who live far away, so it multiplies his production.

Adding is just two separate powers working on the same thing, like the man sharing on Facebook in the morning plus in the evening, or the man shares plus the woman shares etc.

How should we think of the graphs? Let’s think of it like a couple in bed, and the couple are covered with a blanket:

Adding functions:

Like a heap (pile) the graphs sit one on top of the other, the positive peaks (summits) join each other and become higher, and the negative bottoms join each other and become lower.

Let’s say an extreme example is Acrobatic Yoga (Acroyoga)

https://en.wikipedia.org/wiki/Acroyoga

When you want the DERIVATIVE of the SUM of two functions,

This is exactly the way you do it: you put their graphs on each other!

The change of the SUM of the functions

EQUALS

the SUM of the change in one function plus the change in the second function.

(like for example how much the blanket’s height changed

EQUALS

how much the man lengthened his arms plus how much the woman lengthened her arms).

Unfortunately, this logic only works in the case of a SUM (adding together) of two functions.

We will see that in the case of multiplying two functions we will have the PRODUCT RULE,

And in the case of applying one function on the other we will have the CHAIN RULE,

Which are more complicated ☹

Multiplying functions:

Like an amplifier. One graph is standing and another one is lying down and we measure the "box" volume that they create together. From two 2-dimensional shapes we create one 3-dimensional shape.

Let's say the man in the Acroyoga stays just the way he is, but the woman, while staying in the same body pose is changing her location and orientation, instead of in the air she is lying on her side next to the man, and her nape (the back of her neck) is towards the man.

Putting one function into the other

Like a baby in his mother's belly during pregnancy. In this case the baby inflates the mom, and the mom bounds the volume of the baby.

Each graph causes the other graph to behave partially like him, and so a hybrid creature is created that combines the qualities of both of them.

For example the mother has "baby brain". Or another example the expecting mother has a craving for a weird food in the middle of the night (like pickles) because the baby needs some mineral to construct himself.

The blanket will get the combined form, like in the wonderful book "The Little Prince" by Antoine de Saint-Exupéry. The picture of the snake (boa constrictor) digesting an elephant that of course to the grown ups look like a hat 😊

We gave now a very simple example. Actually when you put one function into the other, strange and unexpected things can happen.

I want you to remember the scene in the amazing movie First Reformed when she is lying on top of him and then they float in the air!

When you apply one function to the other (here we apply her mind to his, he's inside her mind and she's guiding him) that's when the magic happens!

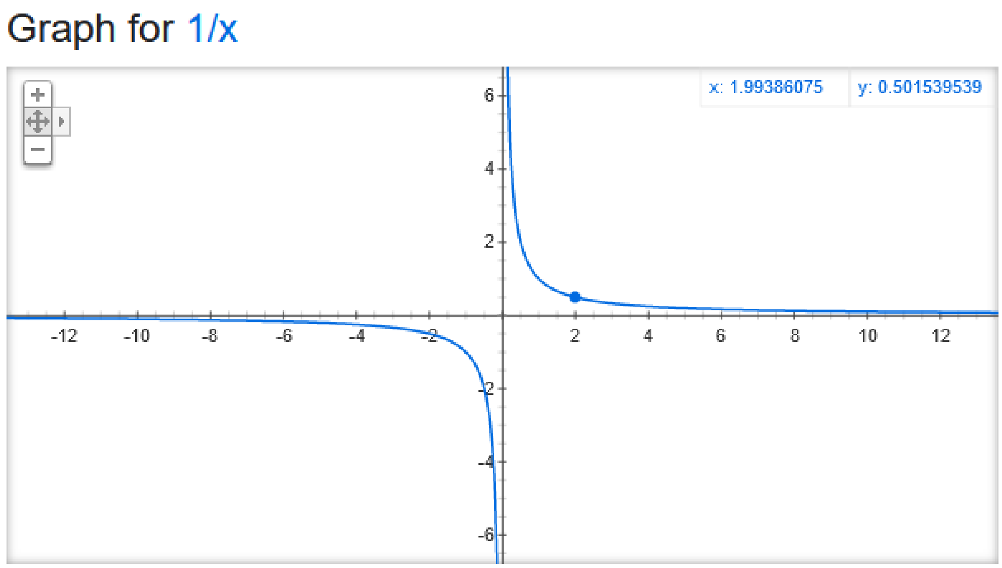
OK so after this long preparation let's watch 3Blue1Brown's video already.

https://www.youtube.com/watch?v=YG15m2VwSjA

In minute 1:01, 3Blue1Brown says that subtracting is like multiplying (the second function) by -1 and then adding the functions.

About dividing 3Blue1Brown says that it's like applying $\frac{1}{x}$ on the function that you want to be down in the denominator, and after that you multiply by the function that you want to be up in the numerator.

So both of these lower (reduce) the man's status but in different ways. If we Search in Google: y=1/x we get this:



We see that when $x = 2$ then $y = \frac{1}{2}$ and so on.

So in the case of $\frac{1}{x}$, the more energy you put into it, the more it will grind you down to ZERO.

So this is like something that kills your engine.

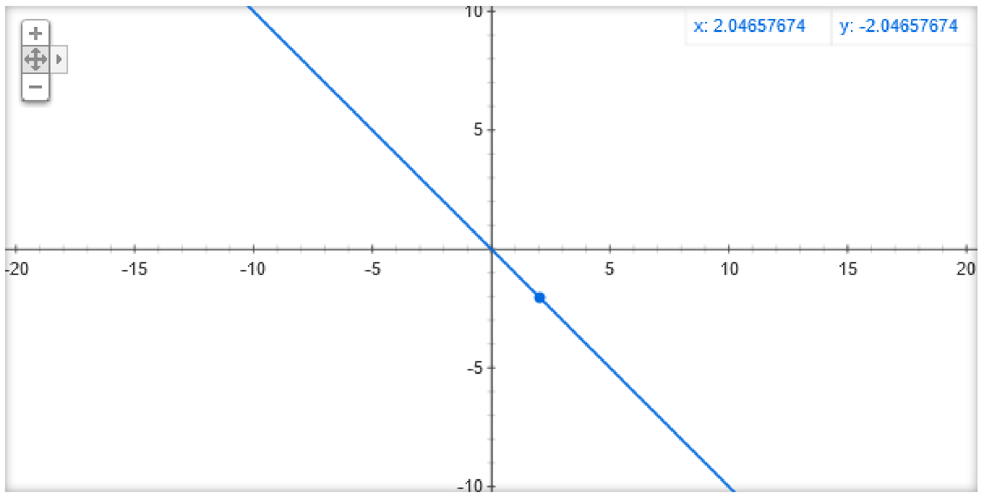
So let's try to put this into our story of the guy's "success-cube" in the social network.

What can bring the guy to ZERO? For example if he has a very bitchy girlfriend that wouldn't allow him to go out with the guys (brings his friends "engine" slowly to zero) and she is envious that he is staying late at work so she calls a lot on the phone etc. (brings his work "engine" slowly to zero), and she doesn't allow him to be friends with other girls because she's jealous (brings his girls "engine" slowly to zero).

So the more he puts energy into her the more exhausted he will be until he is at ZERO energy and ZERO volume of his "success-cube".

On the other hand if we “Google”: y=-x we get this:

Graph for -x



We see that when $x = 2$ then $y = -2$ and so on.

So in the case of $-x$, the more energy you put into it, the more it will drag you down to minus infinity, that’s a bottom-less pit.

So this is like something that turns your engine against you.

So let’s try to put this into our story of the guy’s “success-cube” in the social network.

So like we said earlier this is for example the crime life. The more energy the guy will put into the crime “work” and getting connected with more shady friends and ill repute women then for the general population the more he will be an outcast, until the point when he will be in jail or worst (killed by the police, or death sentence etc).

So that’s the dark future cube getting bigger and bigger like we already talked about.

OK. Let’s put all this preparation work into “storifying” this video.

In minute 1:51 in the video 3B1B is talking about the sum rule, for example:

DERIVATIVE of (the first function PLUS the second function)

EQUALS

DERIVATIVE of (the first function)

PLUS

DERIVATIVE of (the second function)

Or in math writing which is simpler :

(in this example the first function is $\sin(x)$ and the second function is x^2)

$$\frac{d}{dx}(\sin(x) + x^2) = \cos(x) + 2x$$

So what can this mean in our story?

So let's say for example the SINE is the woman suffers from manic depression.

https://en.wikipedia.org/wiki/Bipolar_disorder

By the way according to Wikipedia in the U.S.A. 3% of the population will suffer from this throughout their lives, there are many celebrities that have/had it:

Rosemary Clooney (the singer who sings "Mambo Italiano" was a spokesperson for the illness), Carrie Fisher (Princess Leia in the Star Wars) , Stephen Fry (he made a documentary about this illness), Catherine Zeta-Jones (Velma Kelly in Chicago), Mariah Carey and others.

https://en.wikipedia.org/wiki/Bipolar_disorder#Notable_cases

I read now in Wikipedia about a real organization called Me2/ that includes two orchestras which are made entirely from people with mental illness and the people who love them. I think this is really touching and amazing! Their music director and conductor is Ronald Braunstein and he suffers from bipolar disorder. He and his wife Caroline Whiddon founded the organization:

https://me2orchestra.org/

OK back to our imaginary story. So let's assume the woman suffers from this condition, so sometimes she can't get out of bed, and sometimes she hardly needs to sleep. So we can see that her productivity in what she does will go up and down like the SINE function.

So in our "success cube" story, there will be 3 engines for the guy's success in facebook: work, woman, friends. But this time the work and friends are steady engines pushing forwards all the time towards more success, while the woman is changing direction, sometimes to the positive and sometimes to the negative. The more the guy is involved in his career and social life the harder it is for him to care for his wife who has the condition. So the "up"s of her condition contribute to his success, while the "down"s of her condition turn his whole positive success cube into a negative failure cube.

OK so that was multiplying functions. The first function was the roller-coaster woman, while the second function is the resources-invested-in-work TIMES resources-invested-in-friends.

DERIVATIVE of (woman PLUS work*friends)

EQUALS

DERIVATIVE of (woman)

PLUS

DERIVATIVE of (work*friends)

So the woman productivity is like SINE and this is moved by the illness which is like COSINE.

The psychiatrist Jean-Pierre Falret who first described it called it "folie circulaire" which means “circular insanity”.

The neurologist and psychiatrist Jules Baillarger described it as recurrent oscillations between mania and melancholia.

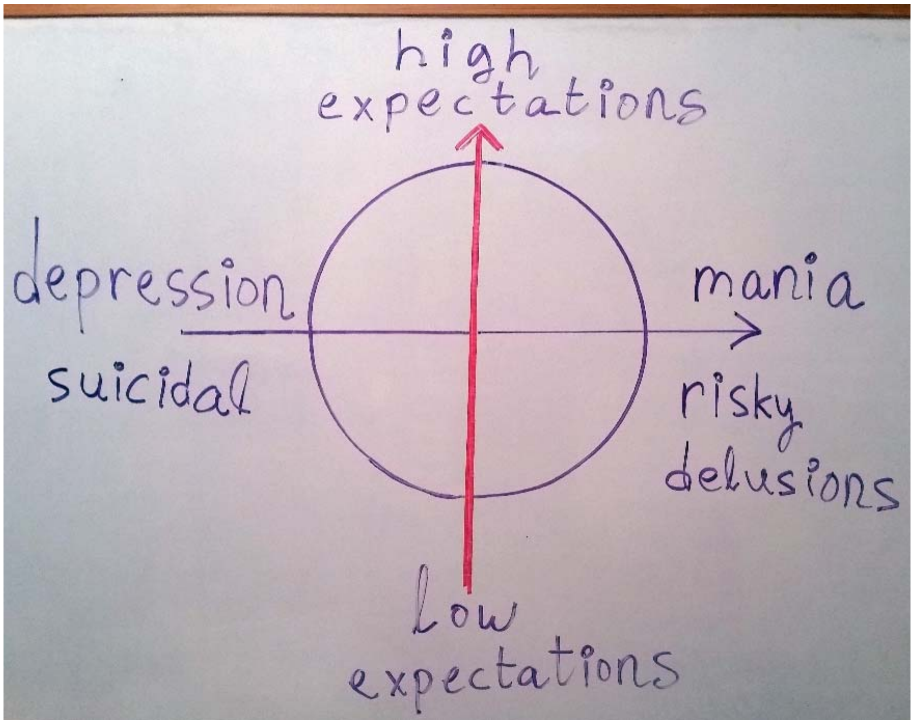
The psychiatrist Emil Kraepelin noted that periods of acute illness, manic or depressive, were generally punctuated by relatively symptom-free intervals where the patient was able to function normally. [which are like our ZERO].

Doesn’t all this sound like a sine or cosine?

COSINE (left-right movement) will be the manic excitement to the right and depression to the left.

SINE (up-down movement) In the top it will be the very high expectations from herself that she has when she’s “high” (which later bring disappointment and depression); And in the bottom it will be the very low expectations from herself when she’s “down” (which make every accomplishment look encouraging so she’s motivated and gain confidence, which later bring the mania).

Picture 2 – woman's mood as COSINE and woman's expectations as SINE



OK so in this picture we see the woman's expectations as the red axis which behaves like the SINE function (up and down), the expectations are positive on the top of the picture (which means expecting to succeed), and negative on the bottom of the picture (which means expecting to fail).

The thing that tells us how the SINE changes is the COSINE. Another way to say this is that the COSINE is the rate of change of the SINE.

Another way to put it is: COSINE is the DERIVATIVE of SINE.

COSINE in our example is the mental illness, which moves between mania (elevated mood etc) and depression (crying etc).

So if we begin on the right at "3 o'clock" and going counter-clockwise:

The woman is in "mania" state she feels she can accomplish anything, so for example she might push the man to do something "fishy" at work, like taking bribe or something. but the expectations for big money are unreasonable and the man gets is caught with the criminal act and gets fired from work.

So now we are at the upper part of the picture, the woman now sees things clearly (she's neither "manic" nor "depressed") but the damage is already done (the man got fired), and she gets more and more depressed.

So now we are at the left side of the picture, her mood is at its lowest, but her expectations are neither positive nor negative.

So now we are at the lower part of the picture. The woman's expectations cooled off, and her ambition for the husband's job is very modest, and she encourages him to take a new job in whatever he can find, never mind how much money he earns. And let’s say he finds an entry level job in some other company.

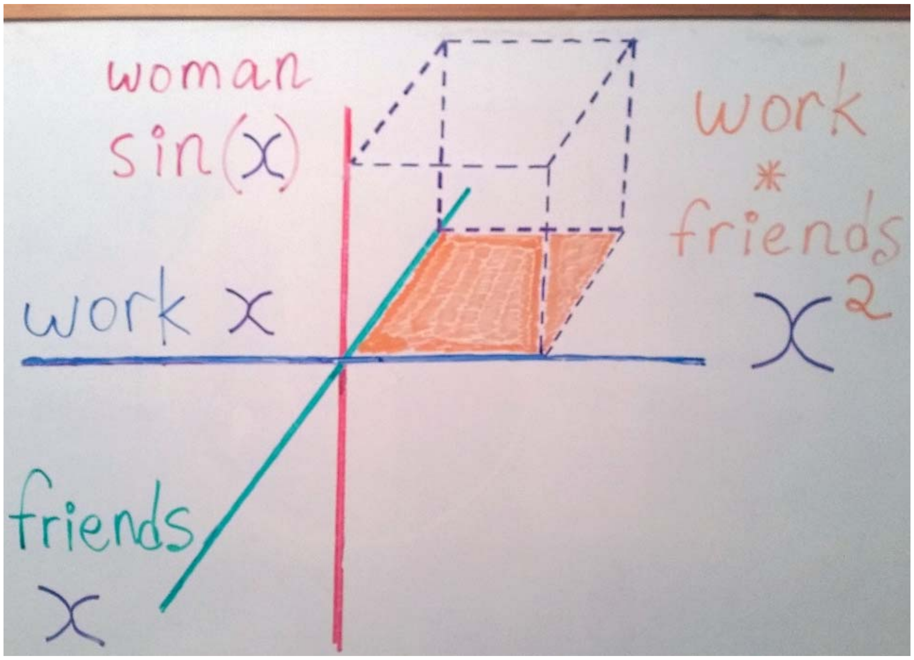
From this point he climbs the ladder of rank at work, and she gets more and more encouraged and ambitious, which brings us back to mania, and the circle starts again.

OK so now we will explain what 3Blue1Brown tells us in minute 4:30,

about how we think of multiplication as the area.

(in the next picture we will start with a volume (box), but in the picture after it we will squash it down to an area (rectangle)).

Picture 3 – The man's "success cube": woman TIMES work TIMES friends.



So as we've talked before, the man's "success cube" is built from these 3 engines: his success at work, his success with the woman, and his success with friends.

So here we see each of the engines as a different line along the cube. The "floor" of the cube is painted in orange, and its area is "work" TIMES "friends".

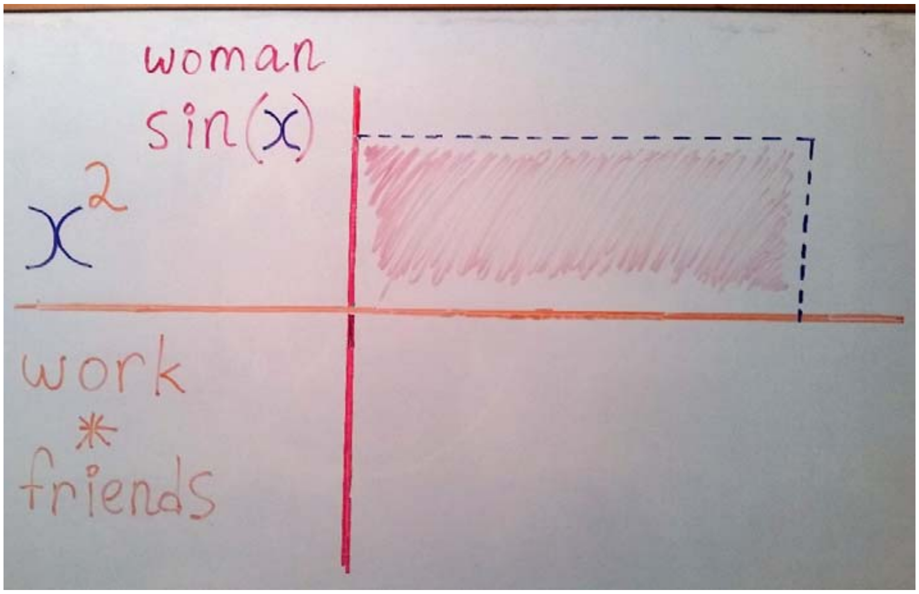
This orange square (it looks like a parallelogram because of the perspective, but remember it's a cube), is then multiplied TIMES the red woman with her SINE ups and downs.

So half of the time the volume of his success cube is POSITIVE when his conduct is legal, and half of the time the whole cube is flipped to being NEGATIVE when she pushes him to do something criminal at work.

So this cube is the visual representation of:

$$\sin(x) * x^2$$

Picture 4 – The man's "success rectangle": woman TIMES [work TIMES friends]

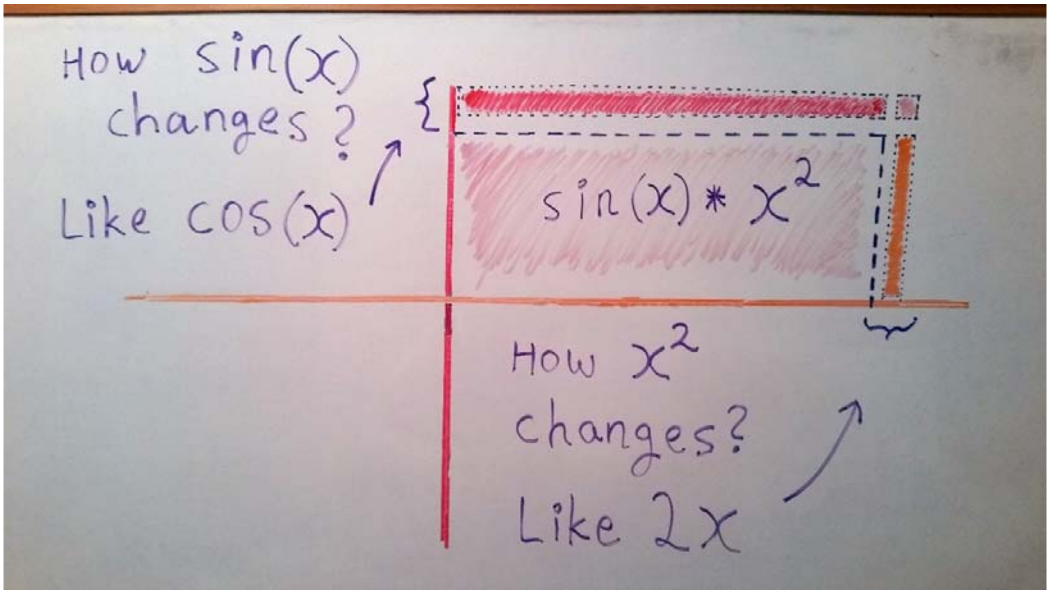


Here we simplified the situation by combining the work and friends together. So instead of the area of the floor of the cube from before, we now have the length of the orange line (from ZERO to the dashed purple on the right), which is the floor of the rectangle.

So now the pink area is the success rectangle of the man.

The vertical side of the rectangle (along the red line, from ZERO to the purple dashed line), is what the woman contributes.

Picture 5 – how the "success rectangle" changes if it grows a little?



OK so here we made the rectangle a little bigger (it grows upwards and sideways keeping the same proportions as before).

So what sets the rate of change of the vertical side (red) ? the vertical side here is SINE, so it's changing according to COSINE, because SINE's rate of change is COSINE.

So what sets the rate of change of the horizontal side (orange "floor") ? The horizontal side here is x^2 , so it's changing according to $2x$,

Because x^2 's rate of change is $2x$

OK. So the big success rectangle grew by adding 2 small rectangles:

The (finely dashed) red rectangle on top: as high as COS (X) and as wide as X^2, so the red rectangle's area is:

$$\cos(x) * x^2$$

PLUS

The (finely dashed) orange rectangle on the right: as high SIN (X) and as wide as 2X, so the orange rectangle's area is:

$$\sin(x) * 2x$$

The (finely dashed) little pink square at the corner at the corner is negligible because it's a tiny change times a tiny change so it's very very tiny. So it's like ZERO area.

So let's put together everything that contributed to the big pink rectangle's rate of change:

$$\cos(x) * x^2 + \sin(x) * 2x$$

But everything we did so far can be generalized:

Although in our example the "wall" of the success rectangle is SINE, it could be another function.

Although in our example the "floor" of the success rectangle is X SQUARED, it could be yet another function.

So let's write our final formula in a generalized way:

derivative of first function TIMES second function as is

PLUS

first function as is TIMES derivative of second function.

Or in mathematical writing:

https://en.wikipedia.org/wiki/Product_rule

$$(f * g)' = f' * g + f * g'$$

Or in another mathematical writing:

$$\frac{d}{dx}(f * g) = \frac{df}{dx} * g + f * \frac{dg}{dx}$$

Since in multiplication we're allowed to change the order of things, a*b=b*a , then let's rephrase the second line, so the "product rule" will be:

derivative of 1st TIMES 2nd PLUS derivative of 2nd TIMES 1st

OK so that was the product rule.

Now let's try to interpret the chain rule in our "story" language.

OK so now in 3Blue1Brown's video, we are in minute 8:41

Let's put this into our "success cube" story:

First let's take a more conventional example, of physical movement:

Let's think of an unborn baby inside his mother's womb

https://www.youtube.com/watch?v=r5V-VfLTp70

Foetal Development: Unborn Baby Movement at 24 Weeks | WIRED

WIRED UK

So let's say the baby swallows some amniotic fluid, this amount is x

So the baby is the inner function $\quad ^2$

INPUT: how much he swallowed (which is X). OUTPUT: how much he kicks (which is X^2)

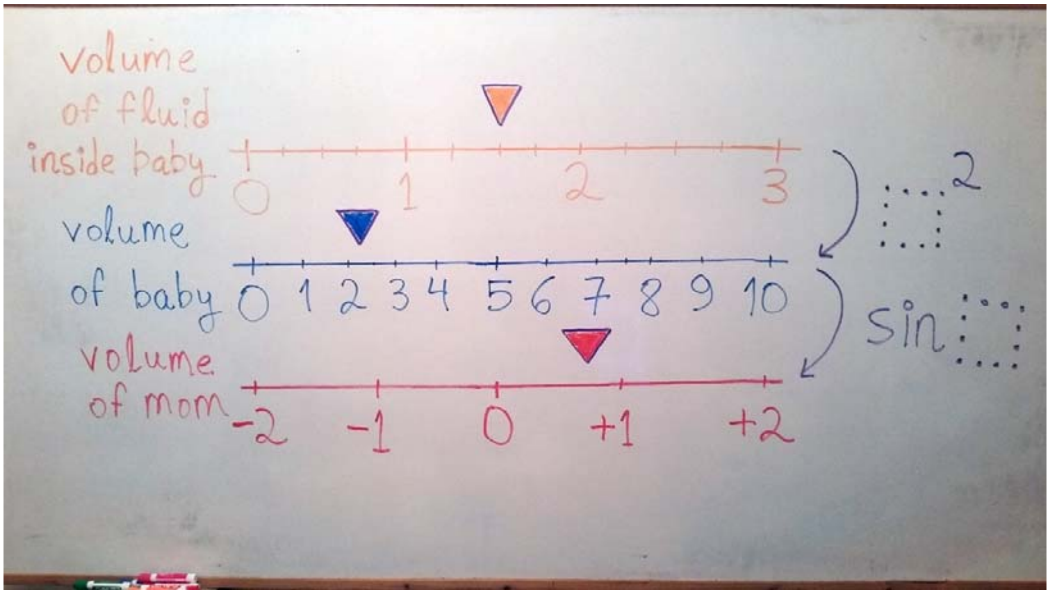
And the mother is the outer function $\sin$

INPUT: how much the baby kicks (which is x^2). OUTPUT: how much bump on her belly.

which is sin(x^2)

So if the baby swallows a tiny amount (tiny movement) let's say this causes him to flex his legs ("kick") which is a big movement, which causes a tiny movement ("bump") outside on the mother's belly, because the baby's movement is "dampened" by the surrounding amniotic fluid.

Picture 6 – volume of swallow, volume of baby, volume of mom



OK so we see that the amount of fluid inside the baby is 1.5 (let's say we measure this in units of tablespoons). And we see that the volume of the baby is 1.5 squared which is 2.25 (let's say we measure this is units of liters). And we see that the volume of mom is now a little bigger (if it was negative maybe the baby curled into a "ball" in fetus position), so the volume of mom is sin(2.25) and the 2.25 is RADIANS (remember? Reaching first base, second base…?) so this is about 0.788 so it's closer to +1 .

OK. Assuming that the mom is "medium" size in her clothes, her belly wrap size is about 104 centimeters at the end of her pregnancy. So if mom was just a ball (of course she isn't but let's suppose for simplicity), The radius of this circle which perimeter we just measured will be 2*PI*radius. her radius will be this divided by PI. So her radius will be 16.552 centimeters. What is the volume of a ball whose radius is 16.552 ? it's (4/3) * PI * radius^3 . Which is 18995.033 cubic centimeters. Which is like 19 liters. So if you want a "measure" for mom's belly here imagine a unit which is half a beer keg.

In the next step 3Blue1Brown will call the inner function in a new name h , as if the baby is the basic thing that changes (and not bothering with his inner workings and swallow of fluid).

OK now let's take see more "story-like" and less physical examples:

The x is one of the "engines" of his success cube (work, ladies, friends).

We can describe this number (how much success he gets from his job alone) on a number line.

So x^2 will be the work*friends that was the orange “floor” of the success cube, and then the orange “floor” of the pink success rectangle.

So we can also describe this number (how much success he gets from work*friends) on a number line.

And the $\sin(x^2)$ will be how much the bi-polar wife “chokes” (like a throttle) or even puts into the reverse (like reverse gear) the power of the “work*friends” engine.

So this time the situation is not multiplying that orange floor of the cube by the wife. Instead, this time we “feed” that orange floor of the cube to the wife, and she produces from it whatever she can at that moment. In our example she is the $\sin$ function, so it doesn’t matter what they give her, she can only give you back a number between $+1$ and -1 .

So you can suppose the wife needs to “deliver” the work that the husband did, like for example she’s a reporter or author, and she can depict it as is (which is the best option) or if she’s in a bad mood depict it in a negative way (which is the worst option) but let’s say she can’t exaggerate either way because than it will not appear credible. So if her depiction is more positive than one, it’s set to simply one. If her depiction is more negative than minus one, it’s set to simply minus one. If it’s somewhere in between we get the actual depiction that she wrote.

Or for example in the wonderful movie Amadeus there is a scene (which is probably not true) where the wife Constanze Mozart

https://en.wikipedia.org/wiki/Constanze_Mozart

Is blackmailed by the bad guy Salieri to sleep with Salieri, and in exchange Salieri will give his recommendation to the emperor.

https://en.wikipedia.org/wiki/Antonio_Salieri

Eventually Salieri backs off from the deal and humiliates Constanze to be seen by him and the servant half naked, and the evil Salieri gives a negative recommendation (on what Mozart does with his “friends” the Libretto writer, the singers, etc) to the emperor.

But let’s suppose this deal was genuine: Then based on the wife’s “performance” in bed, the husband’s work will either be wholly positively recommended (if the wife satisfied him), or wholly “negatively recommended” in other words condemned and disapproved (if the wife did not satisfy him), or something lukewarm in the middle (which is like ZERO).

So no matter how amazingly positive Mozart and his friends’ work is, and no matter how negative Salieri’s evil dark motives are, if Salieri is fair (which is a big if) then Constanze’s efforts can only produce a result between $+1$ and -1 .

Here's another example lately I finished watching the English version of the excellent anime series (and reading the manga series) "Prison School". If you like either femdom or Bakunyū "exploding breasts" (or if you like both as I do) then you're going to LOVE this!

https://en.wikipedia.org/wiki/Prison_School

So anyway the guy Kiyoshi and his friends Gakuto, Shingo, Joe, and Andre are trying to break out of prison.

So Chiyo (who is Kiyoshi's girlfriend) helps Kiyoshi and his friends in their escape plan.

She enables them to carry on their plan, so all their efforts hinge on her support. At the end it comes to Chairman Kurihara's decision, either to free the boys $+1$ or to expel them from school -1. And of course he's the boss so he's at liberty to make all sorts of in-between results, like he can not expel them but give them more time in prison, which we will consider ZERO, for example.

Why do we have to multiply by the derivative of the inner thing?

For example:

$$d(\sin(h)) = \cos(h) * dh$$

In words this means:

The small change in sine of h EQUALS cosine of h TIMES the small change in h.

Because we already know that sine's derivative is cosine, we can say cosine is the rate of change of sine. So the previous sentence becomes:

The small change in sine of h EQUALS the rate of change of sine h TIMES the small change in h.

This is needed because on the left side of the equation, we ask how "sine of h" changes, and then we need to ask: changes with respect to what?

If we want to know "change with respect to h", then for us what's inside changes in a rate of 1 so it's like we multiply at the end by 1

BUT

If we want to know "change with respect to x", then what's inside (the h) actually changes in a very specific way when we change x. In what way (in other words at what rate) does h changes when we change x ? exactly by the derivative of h with respect to x . That's why we need to multiply by it in the end.

You can read this nice explanation by Jonas Kibelbek to the question "Chain Rule Intuition" in StackExchange Mathematics (asked by someone named "alok") :

"Remember that derivatives are rates, the Chain Rule explains how to meaningfully multiply these rates together. A cheetah is 4 times as fast as a man, and a man is 10 times as fast as a snail. You can see right away how to compare the cheetah to the snail-- the cheetah is 40 (that is, 4x10) times as fast."

You can read the rest of his answer in the link:

https://math.stackexchange.com/questions/62614/chain-rule-intuition

After that 3Blue1Brown replaces (substitutes) everywhere there is h with x^2

And in the same way everywhere there is the DERIVATIVE of h with the DERIVATIVE of x^2 which is $2x$.

And then he gets the CHAIN RULE in this specific example:

$$derivative\ of\ \sin(x^2) = \cos(x^2) * \color{red}{2x}$$

In our example the outer function is $\sin$ and the inner function is ^{2} .

So finally let's write this in general:

<u>CHAIN RULE</u>

DERIVATIVE of (OUTER on INNER)

EQUALS

(DERIVATIVE of OUTER) on INNER * DERIVATIVE of INNER.

$$\frac{d}{dx} g\big(h(x)\big) = \frac{dg}{dh}\big(h(x)\big) * \frac{dh}{dx}(x)$$

Or in our “pregnancy” terminology:

rate of change of mom (in this baby value) with respect to fluid

EQUALS

rate of change of mom (in this baby value) with respect to baby

TIMES

rate of change of baby (in this fluid value) with respect to fluid

Subchapter 2.05 – Euler's number e as Economies of Scale in sexy attitude and LOG as diminishing returns in sexual positions

OK we are now at 3Blue1Brown's fifth video:

What's so special about Euler's number e? | Essence of calculus, chapter 5

https://www.youtube.com/watch?v=m2MIpDrF7Es

The idea here is Economies of Scale:

https://en.wikipedia.org/wiki/Economies_of_scale

the bigger a company becomes, the easier it is to profit (and to become even bigger).

For example if I want to produce by myself a single ice cream scoop ("ball"), I need to buy an ice cream maker machine. So that's a lot of money for just one scoop. So if only use it very little then producing at home is more expansive than going to the ice cream parlor.

But from the moment I already have the machine, the amount of money needed to make each scoop is a lot less. The cost per unit is lower. If I make A LOT of ice cream at home then it's cheaper than going to the ice cream parlor. A big ice cream factory uses the machine to make LOTS AND LOTS of ice cream, so the cost per unit for them is very low.

So we see that THE MORE you have, THE EASIER it is to make more.

This is true in many places in love and sex.

For example it's a well known fact that self-confidence is attractive, if a girl feels sexy then she radiates it, and then in reality she IS more sexy, which brings more compliments which also reinforce her self-esteem and good image of herself in her own mind, which is a magic circle of positive feedback. Like Kelly Bundy explains: "it's attitude… If you think you're hot – other people will too".

So for example in one of the sitcoms that are most loved by my parents and me – Married with Children – there is an episode "Do Ya Think I'm Sexy?"

https://marriedwithchildren.fandom.com/wiki/Do_Ya_Think_I%27m_Sexy%3F

In this episode Al Bundy helps a neighbor move a sofa across the street without his shirt, and then he gets feedback that he looks good, and then he starts taking showers and wearing elegant clothes and gets more female fans and so on and so on.

There are similar phenomena, for example if people see that someone is popular, then they want his company and he becomes more popular. For example a friend once explained to me that there is a certain number of "likes" already then they will be willing to spend money, I think the number was something like 30,000 likes. But anyway my point is that they will tend to also "like" that page themselves, so someone (or some business) which is popular above a certain threshold will become more and more popular.

In that episode I told you about, a pretty woman comes to Al Bundy and says she baked him a cake, so he tells her to put it with the rest, so assuming that by this time Al is “tuned” to say the most attractive thing on any occasion, this means that a woman wants to be yet another one in the “harem” of a “stud” who many other women find attractive.

Another thing is that if a guy for example had lots of women he is more experienced and can better handle the next one. Like he is more “polished” on how not to offense, and how to approach a woman, what desires they commonly have, what kind of woman requires what approach etc.

So far we talked about the economies of scale on the level of one person, but it works on any level. For example a big city like Tel Aviv will have a lot more options in chances to meet potential mates than a smaller town, where the geographical isolation forces you to pick from a very limited supply. Not only that, but the options will actually be better, because the more attractive young people will flow to the big city and the process reinforces itself. There will be better dance clubs, better venues for men and women to meet, etc.

Also in terms of paid sex in general in niche perversions in particular (like BDSM or bit tits and so on) the variety is bigger, the “goods” are better, and the prices are lower in the big city as compared to outlying areas. Also depending on the city itself there’s a tolerance for that kind of community like in Tel Aviv many people are gay because people are more tolerant to gay people there. Again these kind of things create positive feedback, more supply causes more demand and so on.

Okay now we’ll try to follow 3Blue1Brown’s explanations. He talks about some animals populating some island, so it’s a series:

$1 , 2 , 4 , 8 , 16 , 32 , 64$ and so on.

So we will think about the same thing but in the context of a piece of information that is spread, each person tells two friends, so this would also be:

$1 , 2 , 4 , 8 , 16 , 32 , 64$ and so on.

So the first person shares on Facebook with TWO of his friends, and each one of them shares with TWO of their friends, so now these TWO and TWO share with their friends so it would be TWO and TWO and another TWO and TWO, and so on.

So you notice that the formula is 2^x because each time we multiply by two.

So the x here is like time, so 3B1B writes t instead, like 2^t

You also see that exponential functions grows very fast. How fast?

In this example they double in size each time.

In the charming documentary: Two Raging Grannies (2013) the ladies talk to physicist Albert Allen Bartlett shortly before his death

https://en.wikipedia.org/wiki/Albert_Allen_Bartlett

whose quote famous quote was:

"The greatest shortcoming of the human race is our inability to understand the exponential function."

So you can see this lecture by professor Bartlett (which he gave more than 1700 times!), perhaps the most important lecture there is for the survival of humanity!

Arithmetic, Population, and Energy

https://www.youtube.com/watch?v=sI1C9DyIi_8

So the exponential function is a very big deal! For example he explains that when we see a headline in the newspaper that something doubled during a decade, it means that each year it grew by 7% from the previous year, which doesn't sound like much – if someone wrote a headline that something grew by 7% this year we aren't impressed at all.

Where does this 7 come from? For this you need to watch the lecture 😊

But I'll hint that it has to do with the natural logarithm which is something that we'll learn in this subchapter.

Okay so we talked about 2^x which is something that doubles itself each time.

By the way this is a very interesting fact that shows you how ill-equipped we humans are in thinking about exponential growing things – If you were able to fold a piece of paper not just once or twice but 45 times, the thickness would be so big it will reach the moon!

Exponential Growth: How Folding Paper Can Get You to the Moon

TED-Ed

https://www.youtube.com/watch?v=AmFMJC45f1Q

And I'm sure you know about this legend of the Wheat and chessboard problem.

https://en.wikipedia.org/wiki/Wheat_and_chessboard_problem

OK so back to 3Blue1Brown's video, we are now in minute 1:28

We want to know what is the rate of change.

So let's say we have something very viral like your very curvaceous girlfriend broke up with you and you have nude pictures of her on your phone and you decide to "get revenge" and share these with 2 of your friends. And lets assume that all the guys are as immoral as you and each one shares this with 2 friends etc.

So suppose every minute this thing doubles.

At time $t = 0$ minutes, it's just 2^0 people which is just you.

By the end of time $t = 1$ minute, it's 2^1 people which is your two friends.

By the end of time $t = 2$ minutes, it's 2^2 people which is your friends' friends.

By the end of time $t = 3$ minutes, it's 2^3 people which is your friends' friends' friends.

By the end of time $t = 4$ minutes it's 2^4 people which is your friends' friends' friends' friends.

How much did it grow (what's the rate of change) from the end of minute 3 to the end of minute 4 ?

It was 8 at the end of minute 3, and then by the end of minute 4 it was 16, so it grew by 16-8 which is 8.

So when it's 8 it grows by 8

Likewise when it's 16 it grows by 16 (to be 32 at the end of minute t=5) and so on.

So it might look like the rate of change is exactly equal to the function at that point.

BUT

in minute 2:22 into the video 3Blue1Brown tells us that when we say DERIVATIVE we really say MOMENTARY rate of change. And here the rate of changes (gets faster) all the time. So we can't just say that over a day or over a minute it's grows so and so. We need to find a DERIVATIVE that is correct in every INSTANT.

OK here 3Blue1Brown's metaphor of a mass of the population of some animals is better than mine, because it grows not in integer numbers but in floating point numbers.

In my metaphor, what does it mean when 8.5 people look at the pictures?

Well you can imagine that you posted 10 pictures of your ex-girlfriend and the current person have seen half, and since there are more people the further we go we can create fractions this way, but suffice it to say that I apologize, I just wanted to use another example, it’s enough that in this sub-chapter I don’t have much insight to contribute over 3B1B so I feel guilt as it is. So I had to use another metaphor, which is closer to love and sex.

By the way I didn’t know that my immoral hypothetical example is something very realistic called “revenge porn”. I guess that’s the plus of not being friends with sleazy people.

https://en.wikipedia.org/wiki/Revenge_porn

Also it turns out it’s illegal in many countries including Israel.

In minute 3:39 into the video, 3Blue1Brown apologizes that in this video he couldn’t find some graphical intuition.

So we step up for the challenge and look in the Wikipedia and StackExchange for graphical intuition and simple examples, which I’ll try to translate to our “love and sex” story language.

Intuitive Understanding of the constant “e”

asked by Sova from StackExchange Mathematics

https://math.stackexchange.com/questions/26037/intuitive-understanding-of-the-constant-e

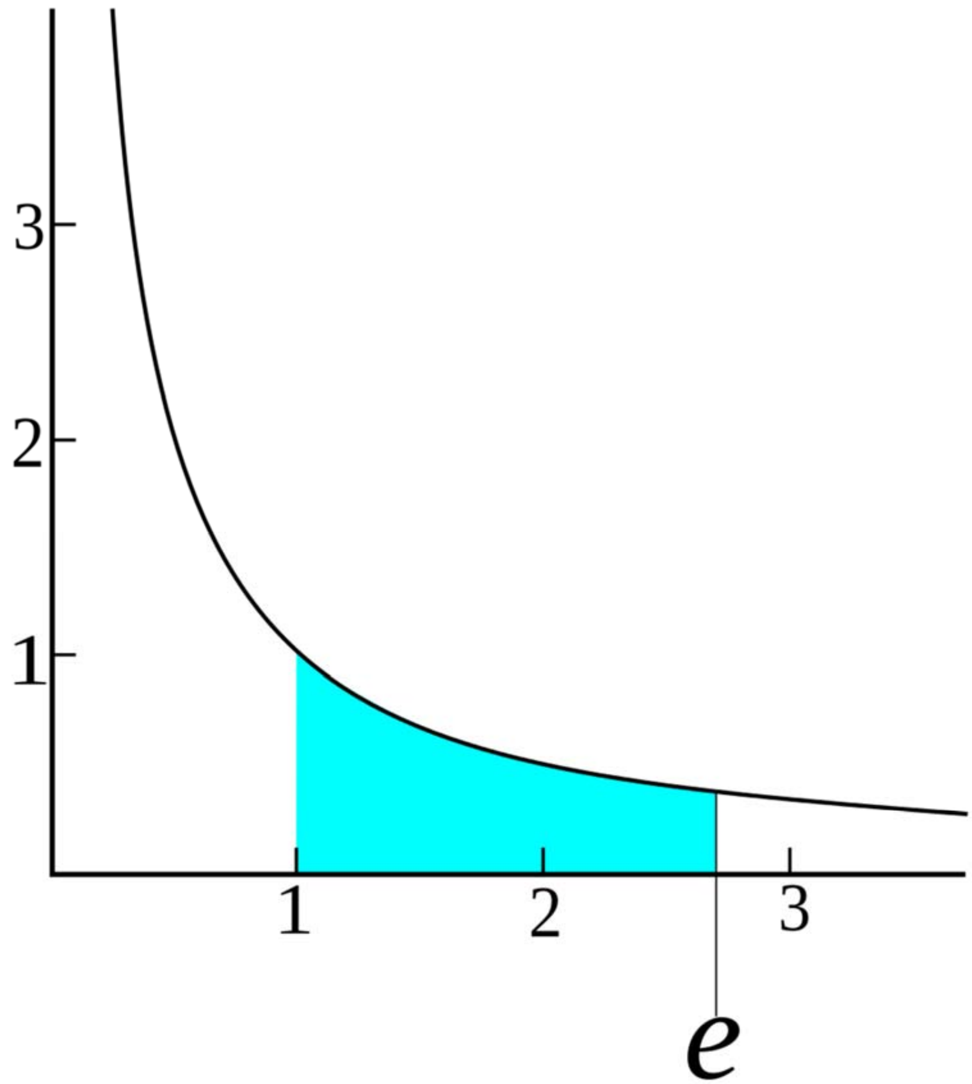
The first explanation is that if you draw the function $y = \frac{1}{x}$

then the area under this curve between $x = 1$ and $x = e$ is exactly 1

Here is the picture from e (mathematical constant) in Wikipedia:

(thanks to Cronholm144 and Silly Rabbit from Wikipedia!)

https://en.wikipedia.org/wiki/E_(mathematical_constant)



The CYAN colored area equals to 1

Let’s say the height of the “dwindling curve” graph is how attractive a pretty woman is over time. So x is the time in 5 years “units” and y is what percentage of the men wish to marry her.

So at our time ZERO (left most point where the height of the graph approaches infinity) is when the woman is in about 20 years, at her peak, then 100% of the men will wish to marry her. Then at 1 she is 25 years old, Then at 2 she is 30 years old, Then at 3 she is 35 years old, So the magic number e is when this pretty woman is about 33.5 years old.

If we interpret the horizontal axis as how desperate are the woman is to marry the man, and the vertical axis as how desperate is the man to marry the woman, we will see that when they are at the age 25 they are equal, this is a special point in the graph: $(1,1)$

Let's now think what the square from the origin $(0,0)$ to $(1,1)$ means.

At the age of 20 these are the proposals from the 10% "best" suitors those who are popular themselves, so they are the least eager (they are the lowest on the "how desperate is the man to marry the woman"), but they do wish to marry her.

So let's say that between the ages 20 and 25 she got 100 such proposals ONLY from such "alpha" males. (not including all the "inferior" males who are much more). This is her square with the area of 1×1.

Now most of these desirable males are taken by other quicker girls, and we between the ages of 25 and 33.5 which is the CYAN shape.

Remember in our story the 33.5 is the magic number e

So what is magical about it? That in CYAN years she will get the same number of proposals, let's say 100 but now it will be from ALL men together! (alpha males, beta males, gamma males, delta males, and so on).

So the first square was the amount of men who wanted her equally as she did in terms of quality, and the CYAN shape is the same amount of men in terms of quantity but the quality is nearly gone. So she needs to pick the best of the bunch NOW (at the age 33.5) and marry him – this is the last moment to get some quality man!

Also in Wikipedia there is a very cool explanation about Bernoulli trial.

https://en.wikipedia.org/wiki/E_(mathematical_constant)#Bernoulli_trials

Suppose that a gambler plays a slot machine that pays out with a probability of $\frac{1}{n}$ and plays it n times.

Then, for large n, the probability that the gambler will lose every bet is approximately $\frac{1}{e}$

For $n = 20$, this is already approximately $\frac{1}{2.79}$

OK so let's translate this into our story language.

When I was young I used to go to night clubs (back then they were called discotheques)

https://en.wikipedia.org/wiki/Nightclub

and since I'm not good in getting which girl wants me (until I talk to her), I would do what my friend Yuval "Yuvi" Nevo used to call "Law of large numbers" which means I approached every girl that I thought was pretty or even just nice looking in the club (and wasn't dancing with her boyfriends). So basically Yuvi would try to "find" one girl that liked him, while me I assumed there were too many hidden variables for me, and if I estimated for example that 1 in every 20 girls will say yes, then this means I should try my luck with 20 girls.

So I would dance for a minute next to a girl, and try to shout to her over the loud music, "Hi!" and then "What's your name?" and then "Do you want to drink something?", and then if I got lucky we she would come with me (sometimes after that song) and I would buy her a drink and we'd talk. By the way this is how I met my first and my second girlfriends.

So now let's suppose that in Israel the chance that a girl will agree to let you buy her a drink is $\frac{1}{20}$ which means only five percent of the girls agree which sounds pretty accurate.

And then let's suppose I were a busy bee that night and approached 20 girls.

(Actually once I tried to encourage my shy friend Moran to hit on girls, so we made an agreement, that for every 10 girls that I try to talk to he would try to talk to 1 girl. And I think I reached 20, so it's not THAT far-fetched. By the way the experiment ended when one "agreed" then asked for the most expensive drink Jägermeister and then in the conversation it turned out she has a boyfriend, so I took the drink from her hand and walked away, then Moran didn't feel like drinking it, and I was driving so I couldn't drink, so I had to spill it on the ground outside 😊)

So on such a night the chances of me not getting ANY girl to talk to me are $\frac{1}{e}$

So about one third (one night out of every three nights that I do this) that NON OF THE GIRLS would talk to me, and from experience that sounds about right!

OK here I will give you a little mathematical explanation if you're curious what is the reason that the magic number e is here as well. You can skip this part if it's too frightening.

////////////// begin of skipping part ///////////////

The reason is because the formula for such Bernoulli trials is

$$\binom{n}{k}\left(\frac{1}{n}\right)^{k}\left(1-\frac{1}{n}\right)^{n-k}$$

What does this yellow formula mean???

n is how many times I tried. k is how many times I succeeded.

The first (left most) parentheses is called “n choose k”

(the number of ways, disregarding order, that k objects can be chosen from among n objects)

And it’s calculated like this:

$$\binom{n}{k}=\frac{n!}{k!\,(n-k)!}$$

The exclamation mark means FACTORIAL which is 1 times 2 times 3 times… all the way up to that number.

for example:

$$5!=5\cdot 4\cdot 3\cdot 2\cdot 1=120$$

So in our example,

$n=20$ is how many times I tried. $k=0$ is how many times I succeeded.

So

$$\binom{n}{k}=\frac{n!}{k!\,(n-k)!}$$

Is actually (here I need to tell you that ZERO FACTORIAL is equal to ONE)

$$\binom{20}{0}=\frac{20!}{0!\,(20-0)!}$$

So

$$\binom{20}{0}=\frac{20!}{1\cdot(20)!}$$

And as we know if we divide something by itself, then that always equals one, so here we don't even care how much is 20! = 1 times 2 times 3 times … 19 times 20 ,

Because there's the same thing in the numerator and the denominator, so the whole fraction is equal to 1

OK.

So the first (left most) parentheses in the yellow formula is equal to 1

The second parentheses in the yellow formula is

$$\left(\frac{1}{n}\right)^k$$

So in our example,

$n = 20$ is how many times I tried. $k = 0$ is how many times I succeeded.

So we don't even need to calculate how much is 1 divided by 20 because ANYHING raised to the power of ZERO equals to 1

So the second parentheses in the yellow formula is also equal to 1

So the yellow formula can now be written like this:

$$1 \cdot 1 \cdot \left(1 - \frac{1}{n}\right)^{n-k}$$

Of more simply like this:

$$\left(1 - \frac{1}{n}\right)^{n-k}$$

Because one multiplied by something is that same something.

And because $k = 0$ is how many times I succeeded, we can ignore him (because something minus ZERO is that same something):

$$\left(1 - \frac{1}{n}\right)^{n}$$

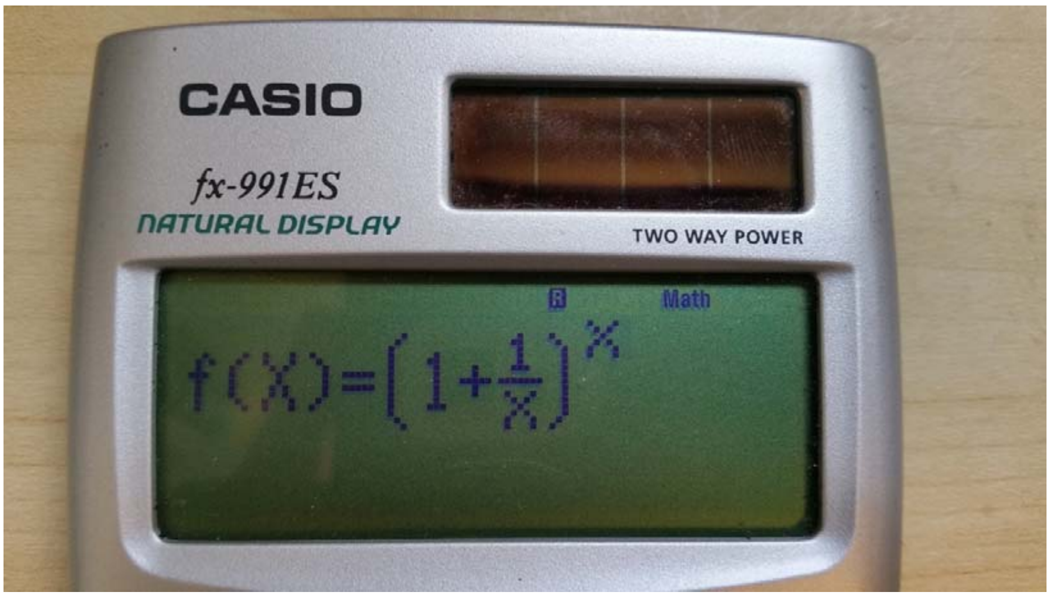
So if we look now at the yellow formula we see it's very similar to the definition of e which is plugging bigger and bigger values of n into this **purple** formula:

$$\left(1+\frac{1}{n}\right)^n$$

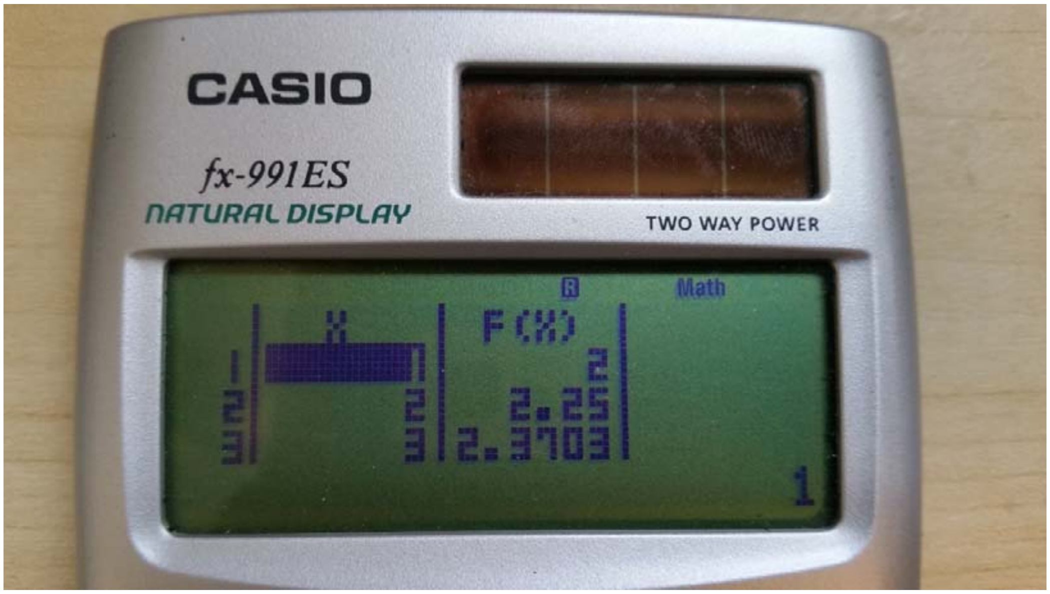
The only difference between the is the plus $+$ and the minus $-$

So let's try to draw them and see what's the difference visually.

So if you have a calculator that can do tables, you write the formula like so:

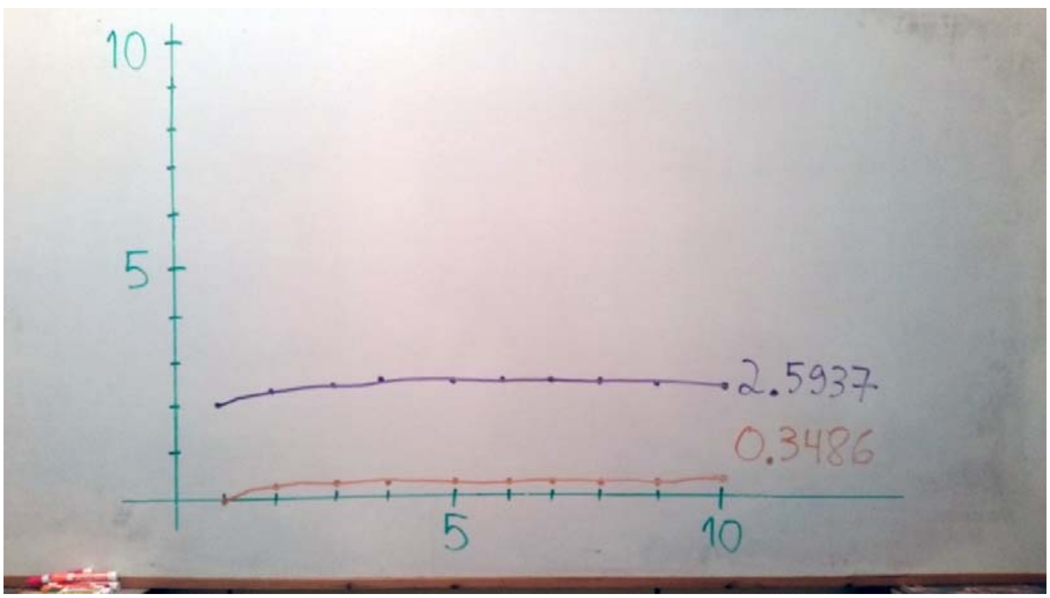


And then you tell the calculator where to begin (1) and where to end (10) and what the step size should be (1) and it makes a table like so:



And on the calculator you can scroll down to see the next lines.

So then I did the same for the other formula, and I drew a graph on the whiteboard for the two formulas that we saw:



So the purple curve approaches $e \approx 2.718281828$

And the yellow curve approaches $\frac{1}{e} \approx 0.3678794412$

/////////////// end of skipping part ////////////////

So we can summarize how we "use" e

$$e = (just\ over\ 1)^{huge}$$

As opposed to:

$$\frac{1}{e} = (just\ under\ 1)^{huge}$$

And what gives us the "just" (very little) part is the "dwindling curve",

which is $\frac{1}{n}$ or $\frac{1}{x}$

And the huge part is how many times this thing is multiplied by itself.

OK. Another nice example that people explain in StackExchange is exponential decay, which is when you have a certain amount, and after a time you have only a half of that amount, and after the same amount of time only a quarter of that amount and so on.

There are many examples in nature for this:

https://en.wikipedia.org/wiki/Exponential_decay#Applications_and_examples

The classical example is radioactive material. We don't know which specific atom will disintegrate, but we know that half of them will disintegrate after a specific time (this time depends on the material). So for example in Carbon 14 this time is 5,730 years.

https://en.wikipedia.org/wiki/Carbon-14

So by checking how much carbon 14 is in bones for example we know how long ago the person died, because as long as he lived he breathed and replenished the carbon 14 in his body, but once he died it's starting to disintegrate at this known rate that we can calculate.

Here's a more light hearted example: There is a prize called Ig Nobel Prize. It's a parody of the Nobel Prize. It's given for "achievements that first make people laugh, and then make them think."

So this guy Arnd Leike proved that beer froth (the white foam on top of beer) behaves like exponential decay. At first it decays rapidly (half what was in the beginning), then more slowly (half of what remains), and as time goes on it decays slower and slower (because half of half of half… is very little).

OK. where do we encounter exponential decay in love and sex?

In the fact that people are having less sex!

See this article from 2018:

Why Are We All Having So Little Sex?

By Belinda Luscombe from Time Magazine

https://time.com/5297145/is-sex-dead/

First of all why do I say **exponential** decay?

Because for example she writes:

In 2016, 4% fewer condoms were sold than the year before, and they fell a further 3% in 2017.

By the way if you are curious why indeed we have less sex, they explain that less people are married, so they have less readily available sex, and also people bring their smartphone to bed so they are stressed, and people watch porn and people are depressed because there is more inequality, and people are more overweight so they function less and feel less attractive, and there's even a point where they explain that sharing the house chores can be a turn down for example if the husband does more cleaning and laundry then his wife it kills her libido.

This reminds me how women don't like it when they earn more than the man. In theory they want it very much, but in practice if the woman earns even a little bit more than the man, she is then less attracted to him.

OK now back to the intuitive way to see e

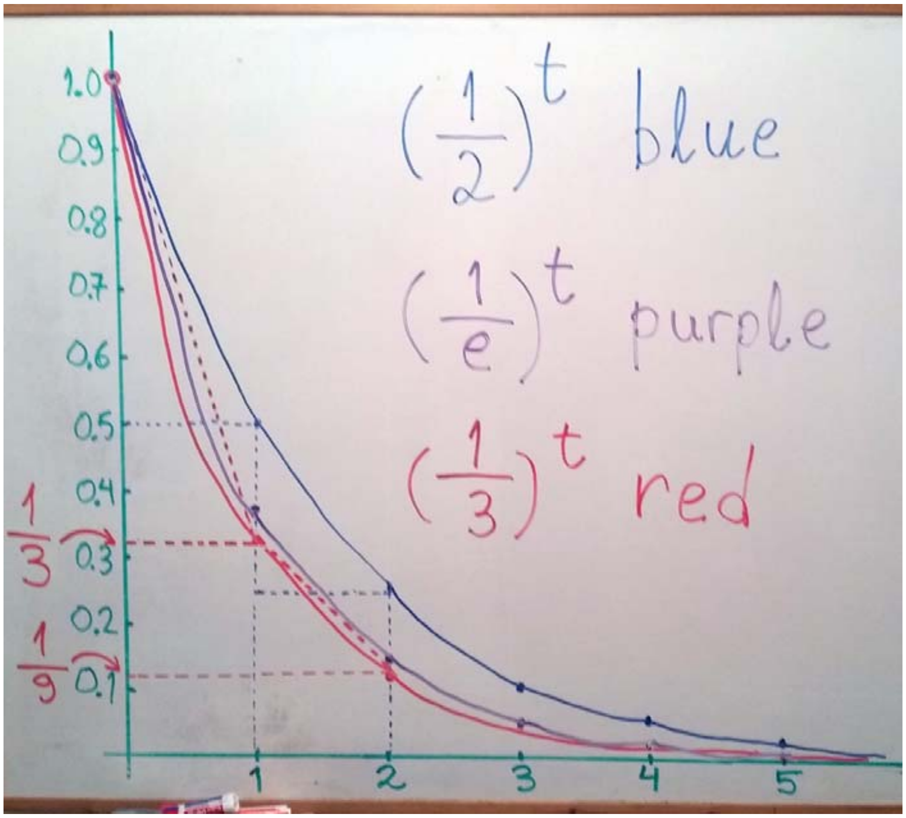
https://math.stackexchange.com/questions/26037/intuitive-understanding-of-the-constant-e

Will Orrick has the best explanation in my opinion so I will shamelessly copy it here 😊

If you can please see the original it's so much better than mine:

https://math.stackexchange.com/a/54459

Will Orrick explanation



OK so what do we have here?

At first he draws the blue graph $(\frac{1}{2})^t$

He shows that the area below this graph is more than 1 using the areas of the blue rectangles below this graph:

$$\frac{1}{2}+\frac{1}{4}+\frac{1}{8}+\ \cdots\ =1$$

See the area below this graph is more than one (because there's also the area above the tops of the blue rectangles and below the blue graph).

At first he draws the red graph $(\frac{1}{3})^t$ which goes down faster.

He shows that the red graph is below this graph is less than 1 using the areas of the red trapezoids above this graph (each trapezoid is made from a red rectangle plus a red triangle above it. The first one is the rectangle with width one, and the height of one third, plus the triangle that sits on top of it, with base width one, and the height of two thirds).

So he does this nice calculation of all the red trapezoids' total areas:

$$\left(\frac{1}{3}+\frac{1}{2}*\frac{2}{3}\right)+\left(\frac{1}{9}+\frac{1}{2}*\frac{2}{9}\right)+\cdots=$$

Then he takes 2 out as a common factor:

$$2*\left(\frac{1}{3}+\frac{1}{9}+\cdots\right)=1$$

If you're not sure about this last line just add the following:

$$\frac{1}{3}+\frac{1}{9}+\frac{1}{27}+\frac{1}{81}=\frac{40}{81}=0.4938271605$$

So you see that what's inside the parentheses gets closer and closer to HALF so when you multiply it by TWO the whole left side of the equation equals ONE.

So this nice graphical calculation showed you that the red graph is below (inside) all these rectangles, so the area below the red graph is less than one (because there's also the area below the tops of the red trapezoids and above the red graph).

OK so a quick summary up until now: What did we see?

area below $\left(\frac{1}{2}\right)^t > 1$

area below $\left(\frac{1}{3}\right)^t < 1$

so can we find something between 2 and 3 that will give exactly:

area below $\left(\frac{1}{magic\ number}\right)^t = 1$

So as you no doubt have guessed this magic number is e

area below $\left(\frac{1}{e}\right)^t = 1$

So Will Orrick explains this a lot more elegantly and he also writes with negative exponent (I was worried that this might confuse you), so his example looks like this:

Area under 2^{-t} is more than one

Area under e^{-t} is exactly equal to one

Area under 3^{-t} is less than one

OK so what can this be in our story of love and sex?

So we can use our previous example with the exponential decay in sex.

Se we can assign to e the main reason that moderately decays the sex drive with most people which is in my opinion that it's harder for people to make a living.

People work very long hours in bad jobs and have little resources (money time energy) to maintain a relationship.

So next we assign to 2 a reason which is not the main reason and which lightly decays the sex drive for example the equality and the sex roles which are less stereotypic you can read this many times in the dating websites that the girl wants a manly man who like a handyman with a coffee kit and she probably imagines the cowboy like in the cigarette commercials, but in reality I don't think this plays a big role. After she tastes the real life the woman wants someone who is more "rounded" and not some buffalo hunting caveman.

So finally we assign to 3 a reason which is not the main reason for most people, but to those it affects it strongly decays the sex drive. So I found this article:

Why Are Young People Having So Little Sex?

by Kate Julian from The Atlantic

https://www.theatlantic.com/magazine/archive/2018/12/the-sex-recession/573949/

So in this article the writer blames mainly porn. She brings examples from Japan where the young generation have strange hobbies and see sex as tiresome and instead do physical masturbation and mental masturbation (this is her message but in different words).

So it becomes more and more legitimate for people to dwell in fantasy instead of the real thing. Even the porn is becoming unreal like Hentai and less personal like bukkake. Men and women have more different expectations from sex.

I'm adding to this the other side of the internet which is that women get a lot of attention which previously was face to face but now a girl can have thousands of "potential mates" online and she is overwhelmed by this. It's not in the article but I think this is the equivalent for women. So if in the past a girl needed to go down to the local pub to get her fill of attention now she can get it virtually. If she needed a man not to be lonely, now she can live in the social networks and she doesn't feel that she's actually lonely.

So this INTERNET reason is not affecting most people, but the ones that it affects (porn addicted men and social networks addicted women) have much less desire to be with another person. The lack of desire is worst than having no time or energy, because for example in the weekend even busy people have some time and energy, while the people who are hooked to the INTERNET are there 24/7.

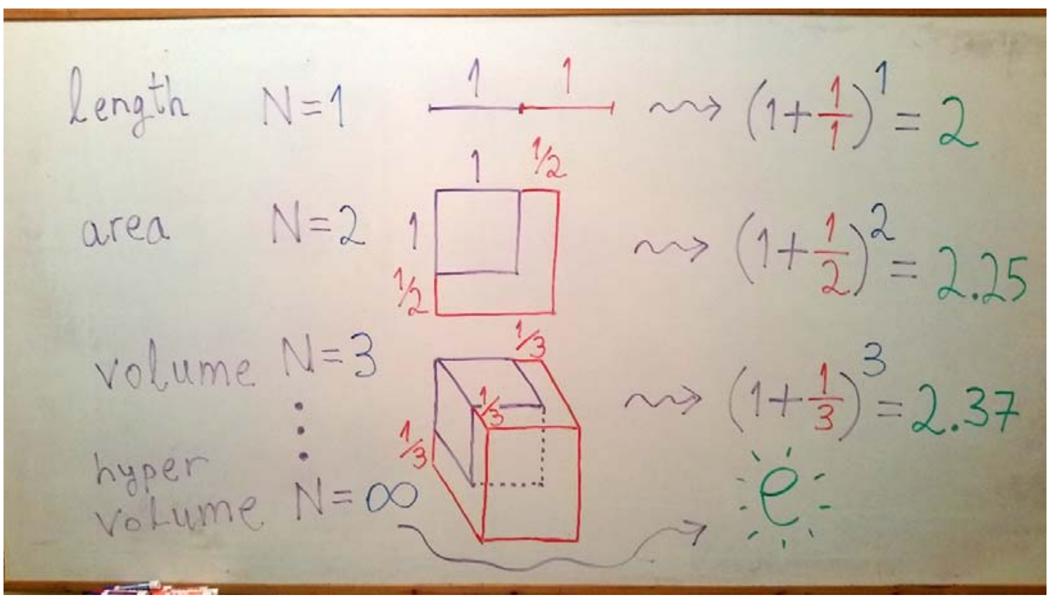
It's a shame I don't have the patience to read the rest of the article because it looks very interesting. ☹

OK so I'm getting to the drawing that looked the coolest in my opinion which is of course MULTI DIMENSIONAL (I think you noticed by now that I have a fetish for that!)

This answer is by Marco Trevi , I'll try to recreate it for you on the whiteboard, but do yourself a favor and see the original here it's wonderful!

https://math.stackexchange.com/a/3580106

So this is my lame version to this super cool sketch:



So you see in each stage he resizes the shape less and less but he "extrude" the shape more and more, like "pulling" the line downwards so he makes a square, and then later "pulling" the square towards us so he makes a cube, and so on.

So e is the extreme case where he resizes practically nothing but extrudes practically everything.

Where can we see this in love and sex? To handle the the multiple dimensions I will go to my old "Facebook" efforts trick – remember the success cube?

So let's suppose the guy is seeking a girlfriend, and he decides to spread his efforts in many venues like his friends from the military, and his friends from university, and his friends from the work, and his friends from his hobby, and so on. So if each group of friends is an independent "engine" then it would be 4 times "engine".

But let's suppose that they reinforce each other, so for example he made some short and funny video with each group about his quest for a girlfriend, so let's say he's like superman in everything so let's suppose he was in the marine commando in the military so his friends from there describe him that he was a warrior now he's ready to make love not war; and let's suppose he was in a prestigious university like the Technion so his friends from there describe that he knows all the formulas and now he's after the formula for true love; and let's suppose he works in a respectable place like Rafael so his friends from work will describe that he build anything but what he really wants is to build a home for his future wife; and let's say that he has a hobby of volunteering in first aid paramedic, so his friends from there will describe that he can heal practically anything by himself except a lonely heart where he needs that special someone which might be YOU bla bla.

So if he's gone through all that trouble and he's posting that combined video and asks his friends to help him, so anybody who sees it will be also impressed by the other groups that participated, and they will be more willing to share and help, and also it raises his value that he has multi-faceted skills and resources so you see this are separate dimensions that will all reinforce each other.

So his "hyper cube of success in finding a girlfriend" can't be very deep in any one direction, because he is dividing himself over all these different groups but it's very diversified.

So this is a metaphor in love and sex for an exponential growth.

So I hope something from all this helps you think about e in a less numerical way.

OK. So now let's go back to 3Blue1Brown's video and try to tackle the numerical way to think about e .

What's so special about Euler's number e? | Essence of calculus, chapter 5

https://www.youtube.com/watch?v=m2MIpDrF7Es

Okay I watched it again, I don't think I can make it easier because it's all about these special constants (that later in the video turn out to be the natural log (Lan) or this or that number).

So I think maybe instead I will try to explain what is the Log function, so at least I will soften that blow for you, and maybe I will come by some insight on how to make the rest of the video easier for you.

OK so log function.

I remember when I was in the Technion's preparatory school ("mechina") in 2008 there was a legendary teacher named Giora Charuvi. Sadly he passed away that very year, but luckily for me there were old VHS video tapes that you were able to rent and watch at home.

So one sentence that I remember from Charuvi is about log:

“log is our tool to for ‘fruit picking’ exponents”

So what Charuvi meant is that we have something to the power of some exponent, and that exponent is up there, and we don’t know how to reach it, like a fruit up on a tree, and this is when we use our special tool to get that exponent down so we can handle it, and this is log.

Why am I telling you this story?

Because what Charuvi said is of course 100% true and helpful. But it helps when you are using log for DOING MORE MATH.

This is also the case in other places which try to get you interested in log, like in Numberphile they tell you about “Table of logarithms” and “Slide rule” and how they make calculations simpler, by changing hard multiplication into easy addition.

The clearest and friendliest explanation that I have seen is:

How I Feel About Logarithms

by Vihart

https://www.youtube.com/watch?v=N-7tcTIrers

which is amazing like everything that Victoria Hart does, it shows you where logarithms come from in the most natural way.

(her father George W. Hart is also a mathematician who does beautiful sculptures, so I guess the talent runs in the family: https://www.georgehart.com/sculpture/sculpture.html)

But here we want to use log for THINKING, so we will see where it’s useful conceptually and hopefully graphically, and even more hopefully combine it into our story language.

So first we go to Wikipedia and look for examples:

https://en.wikipedia.org/wiki/Logarithm#Applications

So one example we have in psychology is the Weber–Fechner law:

https://en.wikipedia.org/wiki/Weber%E2%80%93Fechner_law

Weber's Law - Numberphile

with the beautiful Hannah Fry

https://www.youtube.com/watch?v=hHG8io5qIU8

OK so in simple words this law means:

“the more you have of something, the less sensitive you are to the exact amount”.

Like the first time of something (like love or sex) is the most significant, and the second is almost as significant, but if you have more and more affairs, each of the newer ones is less significant.

The change from having none to having something is very important to you. The change from having one to having two (double what you have) is also quite important to you. But if you had a lot than the change from the number 20^{th} to the number 21^{st} is hardly important in your mind, although in reality it was the exact same act.

So Weber law tells us why our first kiss is so memorable.

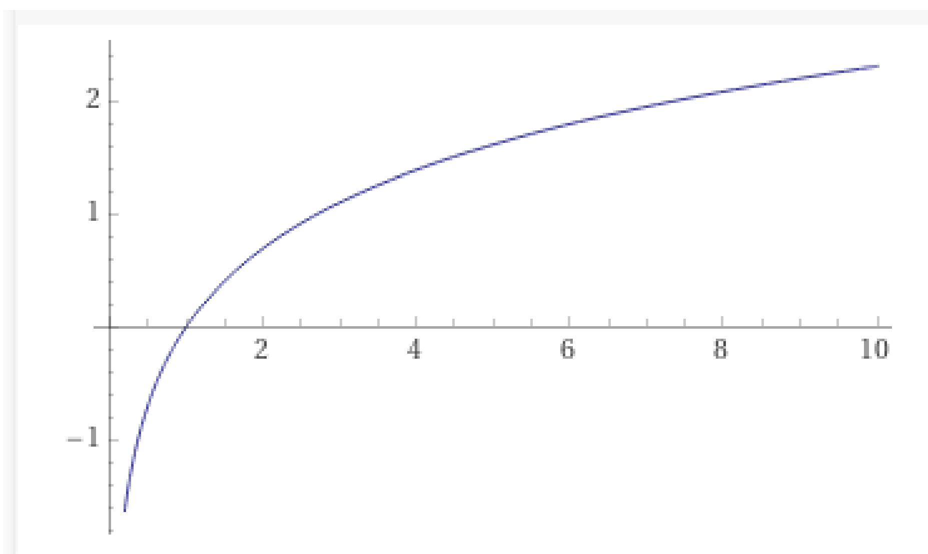
It’s because the feeling is very strong in the beginning but after that each next time adds weaker and weaker feeling.

All log functions look pretty much the same: they start off very energetic and then get lazier and lazier. You see why LOG is the inverse function of the EXPONENTIAL function, because the EXPONENTIAL function starts off very lazy and then gets more and more energetic.

To see what the log function looks like we go to Wolfram Alpha website and write:

log(x) between 0 and 10

and press <ENTER> we get this graph:



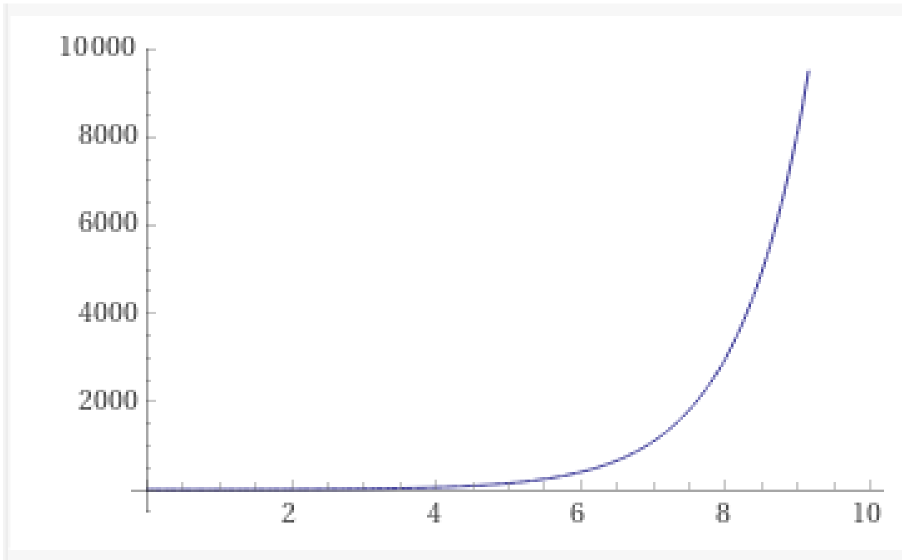
You see that when x is small (in the left part of the picture) the log function grows very fast but afterwards the as x gets bigger and bigger (as we go the right part of the picture) the log function keeps growing but slower and slower.

(Please note: LOG never stops growing to infinity, it gets higher and higher all the time! It’s just that at the beginning the growth is fast and later it’s slower.)

As opposed to the exponential function, which if we ask Wolfram Alpha’s website what that looks like, so we’ll write:

e^x between 0 and 10

and press <ENTER> we get this graph:



This time, you see that when x is small (in the left part of the picture) the exponential function grows very slowly but still keeps growing, but afterwards the as x gets bigger and bigger (as we go the right part of the picture) the exponential function grows faster and faster.

So let's say the exponential function will be how good is my memory is for sessions with erotic masseurs (massage plus "extras") or call girls (escorts) with huge natural boobs. I discuss them here together.

(you can imagine in your life any love or sex or any past event).

Each meeting with such a girl in reality is equally amazing (the stimulus is the same), but of course the first time is the most exciting, the second is the second most exciting and so on, because I unfortunately get a little jaded with another one more and another one more of these wonderful experiences (the perception is less). So the thrill is like the LOG function.

On the other hand, my memory when I try to remember things that happen recently is a lot better than when I try to remember things that happened a long time ago. And when I look back in time the details fall fast, so I remember perfectly what I did one second ago, I remember very well what I did one hour ago, I remember quite well what I did one day ago, I remember pretty much what I did one week ago, I remember more or less what I did one month ago, I remember vaguely what I did one year ago, and it keeps going down and down as I go back in time. So as I go forward in time, the details are like the EXPONENTIAL function.

But my point is that these two inverse function, one is bending this way and the other is bending that way, CANCEL each other out, and my memories from all these wonderful experiences feel to me like they are equally memorable, so for me they are on a straight line like each of them contributed to my life the same amount of good feeling.

That's because with the first such girls (Smadar and Karin) it was very exciting, but on the other hand it was a very long time ago (in the year I worked at the bank in Jaffa, which I think is about ten years ago. So it cancels each other out: The details faded but the thrill back then was huge, so the whole experience is equally memorable to the last girl I was with which was a year ago (Sherry) with whom the whole experience is equally memorable to those first two girls, but with her it's because the memory is still fresh so I remember a lot of details, in spite of subjectively not being that hyper thrilled like in my first experiences (although objectively she was just as amazing).

So if I draw my memories (the experiences as I remember them) each one is equally memorable, so it's like a straight line. For example if we suppose I met a girl like that each year (I wish) then each year's meeting added the same amount of happy memories to my life line.

There are also many other non-mathematical ways that we use LOG according to Wikipedia. Let's try to make sense of some more ways:

https://en.wikipedia.org/wiki/Logarithm#Applications

If something ranges from very small to very big, we use logarithmic scale.

So let's say in terms of love and sex, how many people did you have sex with?

https://en.wikipedia.org/wiki/Promiscuity#Cross-cultural_studies

in Wikipedia on Promiscuity, it says that most man (55%) have between 2 and 20 sexual partners throughout their lives. So let's say the average is between these two numbers which will be 11 partners.

It looks like everywhere in the world women have less partners (except New Zealand). I don't see how this can be unless the homosexual (gay men) population is having sex with themselves and raise the men average. I guess lesbians tend to seek more love and gay men tend to look more for sex and this causes the asymmetry between the average for man and the average for women.

Now obviously there are rare cases of people who are very promiscuous (have sex with a lot of partners).

The record holder in history will probably Genghis Khan and similar people

1 in 200 Men Are Direct Descendants of Genghis Khan

It can all be traced in Y chromosomes.

by Razib Khan from Discover Magazine

https://www.discovermagazine.com/the-sciences/1-in-200-men-direct-descendants-of-genghis-khan

Can we calculate how many women Genghis Khan had sex with?

Let’s try! we start with when he lived (1158 – 1227) but obviously he was most fertile when he was young so let’s say 30 so it’s the year 1188

and when the research was made in 2003.

The Genetic Legacy of the Mongols

by all these people:

Tatiana Zerjal, Yali Xue, Giorgio Bertorelle, R. Spencer Wells, Weidong Bao, Suling Zhu, Raheel Qamar, Qasim Ayub, Aisha Mohyuddin, Songbin Fu, Pu Li, Nadira Yuldasheva, Ruslan Ruzibakiev, Jiujin Xu, Qunfang Shu, Ruofu Du, Huanming Yang, Matthew E. Hurles, Elizabeth Robinson, Tudevdagva Gerelsaikhan, Bumbein Dashnyam, S. Qasim Mehdi, Chris Tyler-Smith

www.cell.com/AJHG/retrieve/pii/S0002929707605874

so this gives us 815 years.

Let’s say a generation is 20 years.

So this gives us about 40¾ generations. So let’s say 41.

The article talks about 16,000,000 men today (when the research was done).

The article only talks about men because they carry the Y chromosome (which was used for the genetic check).

So assuming today each of these men have a wife (from the general population who is not descendant of Genghis Khan) and they are a COUPLE,

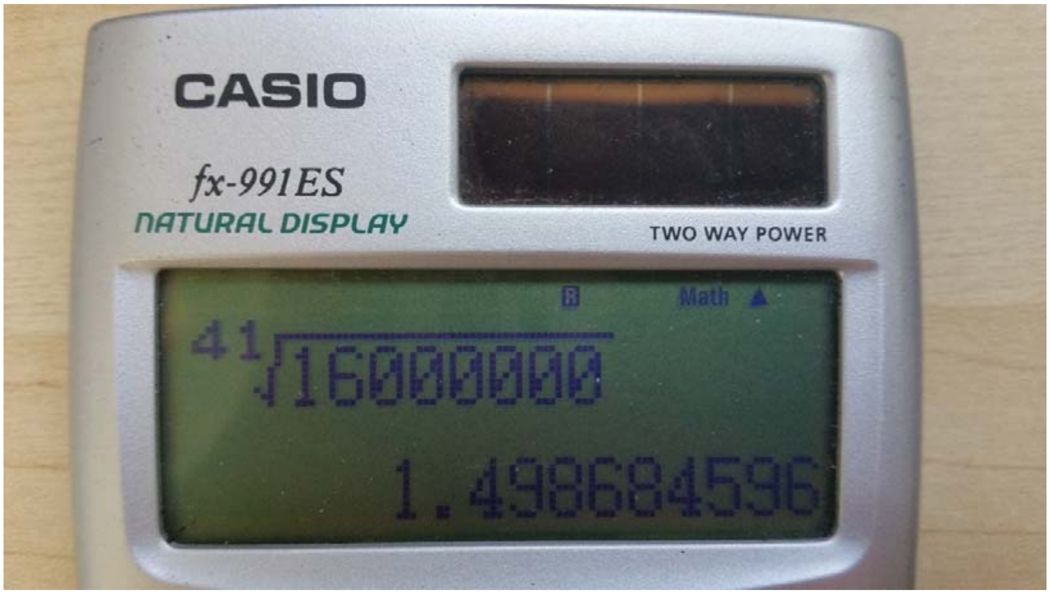
That’s how many COUPLES we end with.

We want to know how many COUPLES we started with

(in the beginning each COUPLE means “Genghis PLUS some poor captured woman”)

OK so what number if you multiply it by itself 41 times, gives you 16,000,000 ?

We need to take the 41th root of 16,000,000 .



So as you see in the calculator this number is almost 1.5

So if in each generation each COUPLE became one and a half COUPLES then we will get 16 million after 41 generations.

Now you say: What are you talking about? Genghis Khan had hundreds of children at least! His hobby was sleeping with several different women every night! Also not every sex act ends up creating a baby, so he slept with a lot more!

And you are right.

My simple model doesn't take into account people that die (like in battle or plague) before making a family, many princes in history are murdered young by ambitious competitors, some people don't get married and have a family at all, and so on.

That's on the down side of procreation.

My simple model also doesn't take into account that Genghis Khan and his close relatives were rulers who had the first pick at the most beautiful (healthy and desirable) women captives.

So this means that at least in that generation they would be impregnated more and be able to raise more children (and some of the beauty and health is inherited so probably also in the next few generations).

That's on the up side of procreation.

So WE DON'T KNOW enough to calculate how many women Genghis Khan slept with.

Probably at the beginning there were MANY children by FEW people (Genghis and his closest male relatives) and the more the generations go by there are FEW children by MANY people (like in China's one child policy today).

By the way, we used a ROOT function here (in this example 41th root of something).

We always knew that the “opposite” of EXPONENTIAL is ROOT.

And now we are being told that the “opposite” of EXPONENTIAL is LOG.

So which one is true?

Which function is the “opposite” of the EXPONENTIAL? ROOT or LOG?

BOTH are. ROOT and LOG are just different ways to write the same things.

Let’s take a simple example:

Root way of writing $\sqrt[6]{64} = 2$

Exponent way of writing $2^6 = 64$

Log way of writing $\log_2 64 = 6$

THE ABOVE THREE WAYS ARE ALL THE SAME!

Now let’s take another example:

Root way of writing $\sqrt[3]{2^6} = 4$

Exponent way of writing $2^{\frac{6}{3}} = 4$

Log way of writing $\log_2 4 = \frac{6}{3}$

THE ABOVE THREE WAYS ARE ALL THE SAME, BUT…

when we write in LOG (unlike when we write in ROOT) we can write the fraction (6 divided by 3) more simply as 2. Also we can write (only in LOG, not in ROOT) a number which CANNOT be written as a fraction, for example any irrational number cannot be written as a fraction.

SUMMARY: LOG way of writing is better than ROOT way of writing.

Okay let's return to more juicy stuff: who is the biggest "slut" in history? 😊

We saw it's probably Genghis Khan, but we don't have enough information, so let's sake more recent examples:

Celebrities Reveal the Number of People They've Slept with — and the Numbers Go as High as 20,000

By Diane J. Cho from People

https://people.com/celebrity/celebrity-sex-partners-mick-jagger-lamar-odom-simon-cowell/?slide=7678843#7678843

and also another list from the website nine:

https://celebrity.nine.com.au/latest/celebrities-reveal-number-people-slept-with/5812ae47-a845-4310-b426-a2c022eb7c76#7

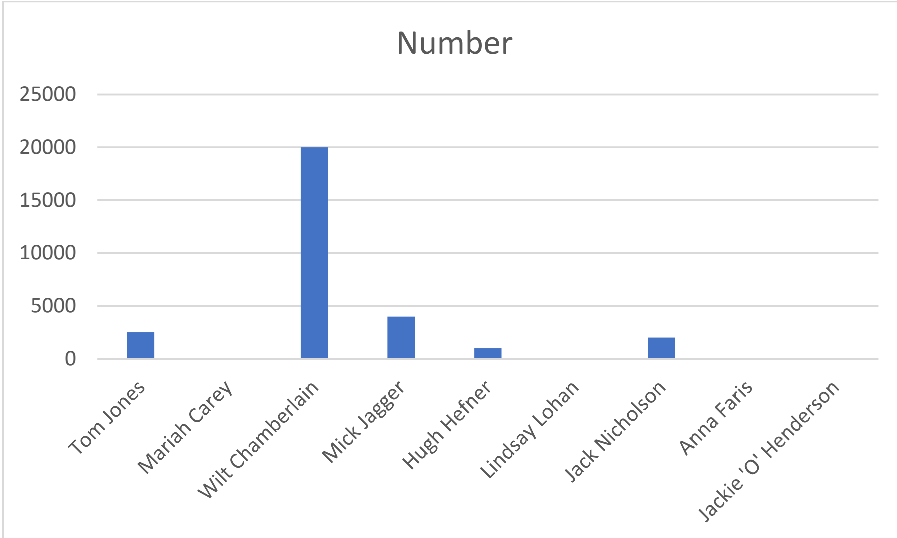
So if you'll notice the women's numbers are tens (like 5 to 50), while the men's numbers are mostly in the thousands. One basketball player tops the list with 20,000 !

So let's see what happens if we try to plot a graph of the results.

how many sexual partners did celebrities have?

Name	Number	Log of number
Tom Jones	2500	3.39794
Mariah Carey	5	0.69897
Wilt Chamberlain	20000	4.30103
Mick Jagger	4000	3.60206
Hugh Hefner	1000	3
Lindsay Lohan	36	1.556303
Jack Nicholson	2000	3.30103
Anna Faris	5	0.69897
Jackie 'O' Henderson	7	0.845098

So first let's plot the numbers as we would normally do (linear scale) :



Houston, we have a problem!

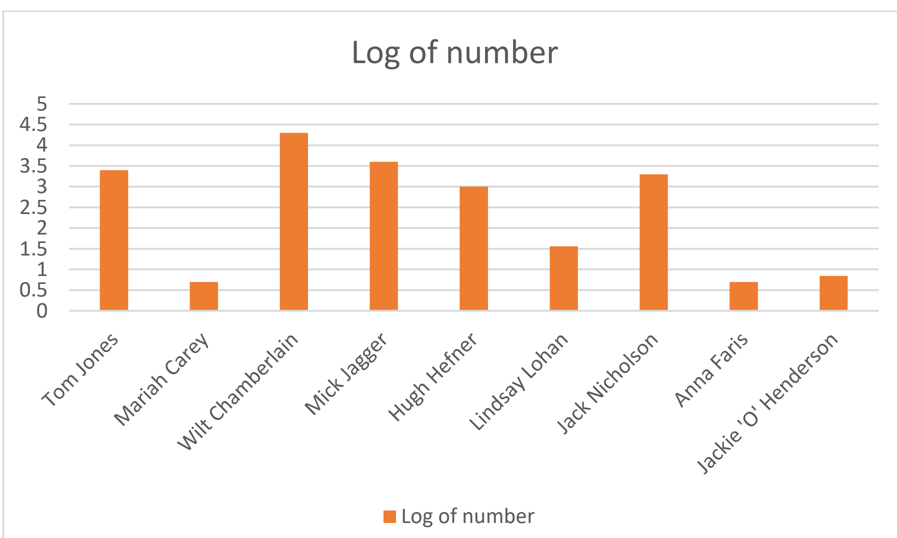
Sex machine Wilt Chamberlain is over-shadowing everyone else, so we can barely see them.

We have no way of telling how many partners the women had from the graphs, in fact we can hardly see the women.

The problem happens because out columns are drawn to scale (which means all the parts the right size in relation to each other).

So for example Wilt Chamberlain is 10 times more hussy than Jack Nicholson, it's hard to fit them in the same picture together.

So now let's plot the LOG (base 10) of each number (logarithmic scale) :



OK that's better. Now each step on the left means "TEN TIMES" so Wilt Chamberlain with 20,000 is one step higher than Jack Nicholson with 2,000 .

So LOG 10 is actually counting the ZEROES in each number. Wilt has one more ZERO than Jack, so Wilt is one step higher in the LOG 10 scale.

So on the down side, psychologically we need to remember all the time that now the proportions are “wrong”. So although a column looks slightly higher than the other, it actually represents a much bigger number than the other in reality.

But on the up side, we see details clearly: All the women are back!

we can tell apart even small differences like between Anna Faris’ 5 and Jackie ‘O’ Henderson’s 7. How cool is that?

So we said LOG 10 is like counting the 0 ‘s ,

Did you ever hear someone (for example during a date) bragging about his salary?

One guy might tell you: “I make 5 figures” – this means “at least 10,000”

Another guy might tell you “I made 6 figures” – this means “at least 100,000”

And so on.

So that’s a simple example of using LOG in everyday life.

So I hope you get the feeling that whenever we have very big numbers and we want to bring them to our scale, like deflating a balloon, then we use LOG.

And wherever we have very small numbers and we want to bring them to our scale, like inflating a balloon, then we use EXPONENTIAL. Like all the models with the climate change do this: a small change now in one degree in world temperature, will mean very extreme results of human extinction in the future.

like the difference between 1 and 2 doesn’t sound like much at first, but 1x1x1… remains 1, while on the other hand 2x2x2… blows up to infinity as we saw in the chessboard and the grains story. So we can calculate with the EXPONENTIAL and see what will happen in the future when the “balloon” will inflate.

So Wikipedia says about Exponential function:

The exponential function arises whenever a quantity grows or decays at a rate proportional to its current value.

And about Logarithm:

logarithm is the inverse function to exponentiation...

logarithm reverses exponentiation...

Here’s an example from love and sex:

When we are falling in love with someone all the quirks (an unusual habit or part of someone's personality) of that person seem to us as cute, they are even idealized.

Like you can see in the movie Hitch

https://en.wikipedia.org/wiki/Hitch_(film)

But after you become a couple and no longer in love, as time goes by you are repeatedly annoyed more and more by these repeated peculiarities until they become unbearable (if you do not love your partner) it’s like you become allergic to them.

Like for example I am too polite (at least for Israel). So with my mythological ex-girlfriend, at first she found this very charming, for example she pointed out that I always close the door when I go to pee. But after a few months when she was getting ready to dump me, all these good things turned sour in her mind, like she reproached me because she doesn’t feel comfortable farting in my presence. She brought this as an indicator of how close you are to a person. This subject never came up before, so I assured her that I have absolutely no problem at all if she farted next to me (I pointed out that I even watched “fart porn” sometimes especially starring Cassandra Calogera). I also suggested that although I feel more comfortable if I personally fart in the toilet, if it makes her feel better I can fart in her presence instead.

Of course nothing helped, because the main problem was not my quirks but ME as I already told you about earlier in this very book.

So why am I telling you this anecdote?

Because all these quirks are there from the start (If you are sharp enough to notice, or if your partner is not hiding them (I never hide anything that’s one of my quirks! 😊)).

So in the first date many girls are exaggerate every little “mistake” that you do, this is brought to an extreme during “Speed dating”, which you can also see in that movie.

https://en.wikipedia.org/wiki/Speed_dating

So this is like the EXPONENTIAL function. The woman takes small differences and amplify them:

After just 3 seconds most people make their decision!

So all they have is the external things: your looks, your clothes, your body language, and possibly your voice if you were quick enough to say “Hi”.

In another research almost half the women decided within 30 seconds.

https://en.wikipedia.org/wiki/Speed_dating#First_impressions

So more information do they have in the next 27 seconds? I guess some of these:

https://www.speeddate.co.nz/tips/questions/

“The most frequently asked questions on a speed date are - ‘What do you do?' ‘Where do you live?' ‘Have you been speed dating before?'”

In a woman’s mind, the first question really means: “How much do you make a month?” and the second question really means: “How much have you accumulated?” and the third question really means “Are you popular with other ladies?”.

So again the differences between the men in this stage can be tiny, like a quarter of a second more of eye contact, or a millimeter of widening of the pupil, not to mention that if the man is a “player” he can also trick her knowing what she’s looking for, similar to the way people trick each other in poker game. But still the woman takes these minute differences and “inflate” them mentally so this guy is A LOT more attractive than that guy. So what’s operating in her mind is the EXPONENTIAL function.

So after the women stupidly choose bad men, they end up years later going to couples therapy (marriage counseling)

https://en.wikipedia.org/wiki/Couples_therapy#Basic_practices

Here the method is basically to try as much as possible to ignore the very prominent bad things, and concentrate on the unnoticeable good things (that people take for granted).

Like “active listening” is trying to understand what the other person wants and verify it back with him/her. This is basically trying to filter out negative comments etc, and concentrating on constructive criticism, things that can be changed and improved.

Or like “Emotionally focused therapy” which focuses on the basic emotional needs we get from the partner:

three basic needs: acceptance, predictability, competence;

and three needs that build upon them: trust, control, self-esteem/status;

and all of the above together build: self-coherence.

So again all this boils down to focus on getting the most important things from your partner (that people don’t value enough), and try to ignore or accept the bad things (that you notice the most).

So hopefully after therapy what’s operating in her mind is the LOG function.

(let’s say: ignoring the few “big bad wolf” and paying more attention to the many “good little sheep”).

OK let's look for another example where LOG helps us:

https://math.stackexchange.com/questions/35810/intuitive-use-of-logarithms

Fabian from StackExchange Mathematics asked for Intuitive use of logarithms:

I am trying to gain a more intuitive feeling for the use of logarithms...

So the most upvoted answer there is by Raskolnikov and it starts like this:

Logarithms come in handy when searching for power laws...

So now let's search what "power law" is:

https://en.wikipedia.org/wiki/Power_law

Here I have to admit that at first I didn't understand what a "power law" is AT ALL!

I recommend that you read this for a clear explanation and then we will return to Wikipedia.

What is the difference between "power law" and "exponential function"?

There's a excellent explanation by Michael Hardy in StackExchange Mathematics:

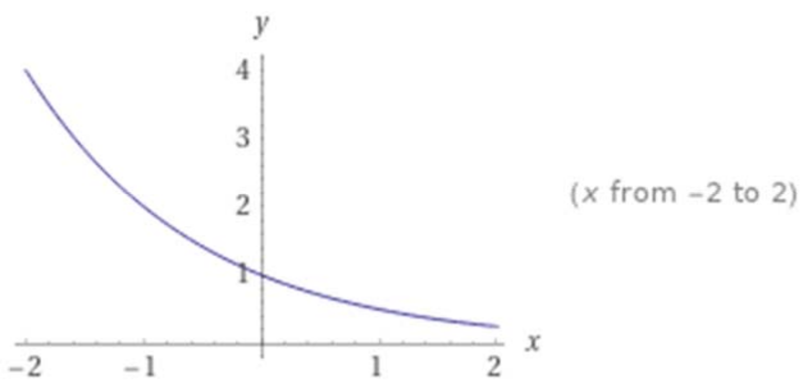
https://math.stackexchange.com/questions/164436/difference-between-power-law-distribution-and-exponential-decay

Power Law: $$y = x^{(constant)}$$

Exponential function: $$y = (constant)^{x}$$

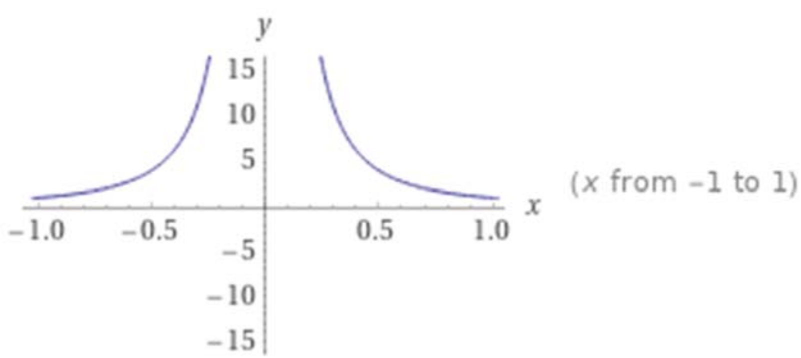
Power law example: $y = \left(\frac{1}{2}\right)^{x}$

This power law looks like this:



Exponential function example: $y = x^{-2} = \frac{1}{x^2}$

This exponential function looks like this:



He explains that although the right side of the both graphs look a little similar (because they are both positive and go asymptotically to ZERO),

The exponential function is “cut in half” every time we increase x by 1 , so it goes down towards ZERO height faster.

On the other hand the power law goes down towards ZERO height slower:

for example when x equals “a million” we are at height $\frac{1}{(1000000)^2}$ and when we move to the next x which is “a million and one” we are going down to height $\frac{1}{(1000000+1)^2}$ The difference between these two tiny fractions is very very tiny.

So the bigger the x , the less height we are losing in each step,

While in the exponential function we lose half of our current height in each step.

That’s it for the clearest explanation that I found.

For MOTIVATION on why should we bother with this “power law” thing at all, you can watch here there’s a nice British physicist explaining a power law in biology.

Geoffrey West - Why Do Power Laws Work So Widely?

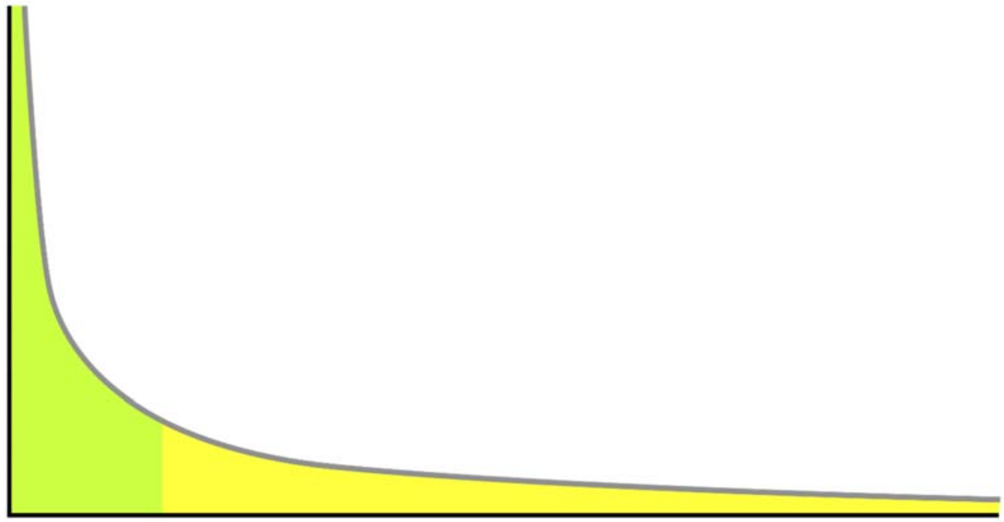
By Closer To Truth

https://www.youtube.com/watch?v=6Gw07lDU8-Y

OK so now we can go back to Wikipedia to their explanation of “power law”.

So from the picture there, we see two principles that will be more tangible (concrete) for us:

Thank you very much to the user Husky from Wikipedia for the picture!



https://en.wikipedia.org/wiki/Long_tail

https://en.wikipedia.org/wiki/Pareto_principle

Pareto principle

also called: 80/20 rule, the law of the vital few

in rich-poor gap:

20 percent of the people (the richest) own 80 percent of the resources (land, money, factories)

in business:

80% of sales come from 20% of clients

In sports:

where leading players often take the majority of wins.

In safety:

20% of the hazards account for 80% of the injuries

And so on, this law happens all around us. So why not in love and sex?

In this example we will talk about OnlyFans

https://en.wikipedia.org/wiki/OnlyFans

The service is popular with and commonly associated with sex workers

in the site Influencer Marketing Hub there is an article:

OnlyFans Statistics – Users, Revenue and Usage Stats

https://influencermarketinghub.com/onlyfans-stats/

Average Earnings from OnlyFans is $180/month (this doesn't include tips)

However, as XSRUS observes, the revenue of content creators follows a classic **power-law** distribution. The top performers earn substantially more than everybody else. The top 1% of accounts make 33% of all the money, and **the top 10% of accounts make 73% of all the money**.

Look at the part I highlighted, It's almost like the 80/20 rule!

Let's see an example that is closer to home.

Viren Swami and Seishin Barrett, "British men's hair color preferences: An assessment of courtship solicitation and stimulus ratings," Personality and Social Psychology, Scandinavian Journal of Psychology, 2011, 1-6.

https://pubmed.ncbi.nlm.nih.gov/21883260/

The total number of men's approaches (to the same woman with different hair color dye):

Blonde: 60

Brunette: 42

Redhead: 18

Nicolas Guéguen, “Hair Color and Courtship: Blond Women Received More Courtship Solicitations and Redhead Men Received More Refusals,” Psychological Studies, 2012, Vol.57(4), 369-375.

https://link.springer.com/article/10.1007/s12646-012-0158-6

The total number of men who approached (this time the same woman is wearing different colored wigs and the nightclubs are in France but you’ll see it’s the same thing)

Blonde: 127

Brown: 84

Black: 82

Red: 29

There is another study by the same guy Nicolas Gueguen

Women's bust size and men's courtship solicitation

Body Image 2007 Dec;4(4):386-90.

doi: 10.1016/j.bodyim.2007.06.006. Epub 2007 Sep 21.

https://pubmed.ncbi.nlm.nih.gov/18089285/

number of men's approaches:

Experiment in nightclub:

bra cup size A: 13

bra cup size B: 19

bra cup size C: 44

Experiment in pavement area of a bar:

bra cup size A: 5

bra cup size B: 9

bra cup size C: 16

And also Nicolas Gueguen made similar studies on a hitchhiking

Guéguen, N. (2007a). Bust size and hitchhiking: a field study. Perceptual and Motor Skills, 105, 1294–1298.

https://pubmed.ncbi.nlm.nih.gov/18380130/

Percent of male motorists who stopped:

bra cup size A: 14.92

bra cup size B: 17.79

bra cup size C: 24.00

And he also did one with hair color and hitchhiking

Guéguen, N., & Lamy, L. (2009). Hitchhiking women's hair color. Perceptual and Motor Skills, 109, 941–948.

https://pubmed.ncbi.nlm.nih.gov/20178293/

percent of male motorists who stopped

blonde: 18.9

brown: 14.3

black: 13.1

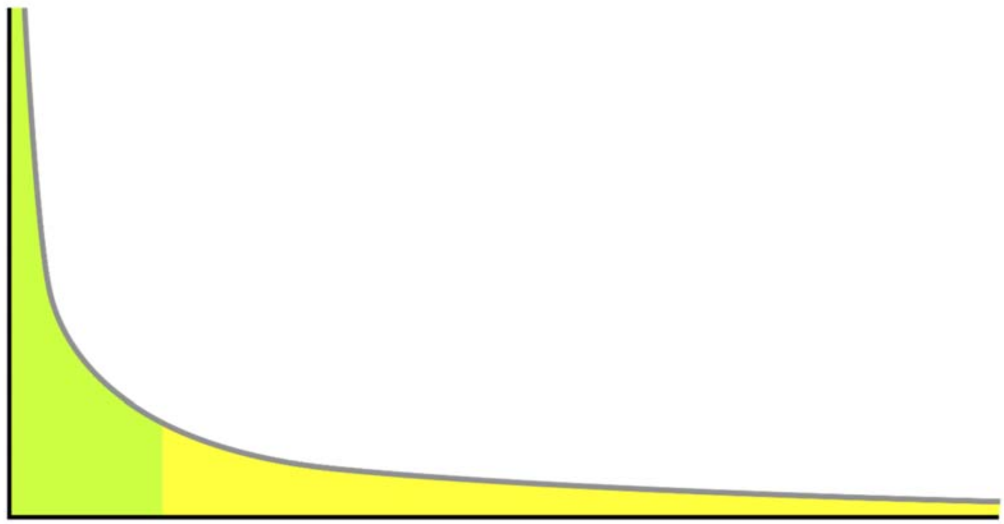
So if we compare busty blondes (who are a small percent of all the girls) to all the other girls, here also, a small part of the women is getting the attention of the big part of the men.

From my experience it's also like this, in the two times I had busty blonde girlfriends, other men approach them practically everywhere.

When we talked about Pareto principle we talked about the left side of the picture, where very few have very high value. Now we will concentrate on the rest of the picture (the bottom of the picture on the center and on the right of the picture) which is called the long tail.

OK. So I'm copying again this picture, so that you don't have to scroll.

Thank you very much to the user Husky from Wikipedia for the picture!



https://en.wikipedia.org/wiki/Long_tail

The Long Tail

This term was first used by Chris Anderson in the example of selling music to home listeners.

In the 20th century, people went to a physical store in their neighborhood to buy a record or a cassette or a compact disc.

So since the storage room is limited, the physical stores brought mainly the big hits (blockbusters, best-sellers) and so most of the money in music came from big hits.

But in the 21st century, people buy online, so the store can have practically unlimited room for all sorts of "niche" tastes, unknown artists, and these are the long tail, and if the store has enough variety, all of these rare products together make more money for the store than the popular hits!

Anderson wrote a book that's named:

The Long Tail: Why the Future of Business is Selling Less of More

for example, Netflix finds that in aggregate, "unpopular" movies are rented more than popular movies.

So in the context of our busty blondes, the long tail tells us that in places where there is a large enough variety, not everybody likes busty blondes. In fact most people prefer other things, including many many small niche perversions like old women and bizarre (piss and shit) and snuff and pedophiles and all the darkest and strangest things that you can imagine.

I found a nice explanation in a website called “Farnam Street”

Power Laws: How Nonlinear Relationships Amplify Results

https://fs.blog/2017/11/power-laws/

this article explains through diminishing returns.

https://en.wikipedia.org/wiki/Diminishing_returns

What is diminishing returns?

Here is the example for the producer from Wikipedia in English:

Let’s say a factory needs 50 workers to operate the machines. So we begin with no workers (ZERO) and add one more worker each time. So in the beginning with every additional worker we produce much more. Then around 50 workers, with each new worker we still produce more but not much more. After that the more workers we add, the less each additional worker helps us.

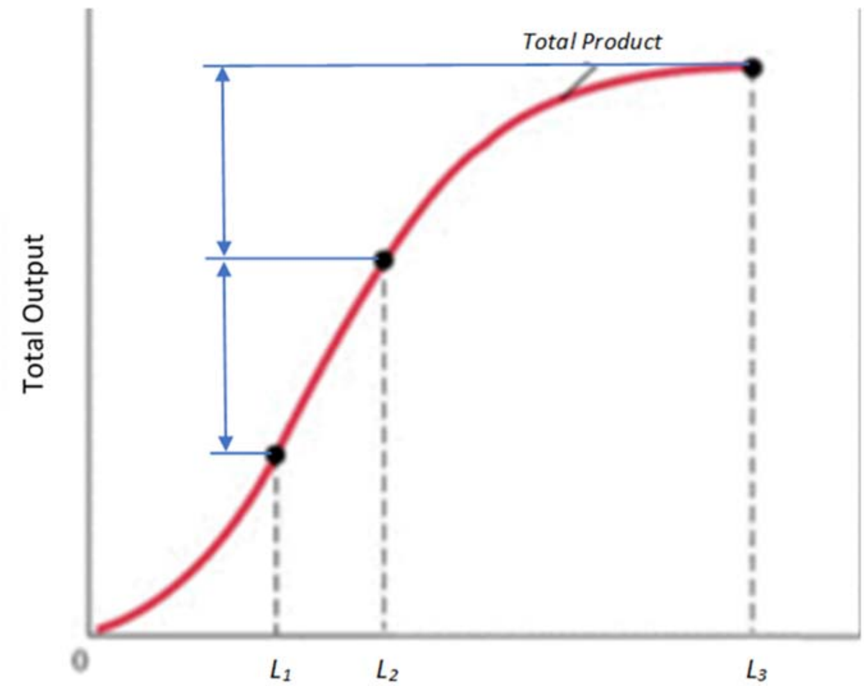
Here’s another example for the consumer from Wikipedia in Hebrew:

If you listen to the same piece of music again and again in the same day, you feel that each additional listening is less enjoyable than the previous one. Each additional unit of the product adds less benefit for the user.

Here is a picture from Wikipedia, only look at the red graph after the point L1 (where the factory has ideal number of workers, or when you listened to the song an ideal number of times), so after that, the red graph it looks similar to LOG.

Thank you very much to the user GreenTharp!

(please note: LOG doesn’t stop growing EVER. It just grows slower and slower. If we go more and more towards the right, until we reach infinity, then LOG’s value there will be infinitely high. This is DIFFERENT from the graph of diminishing returns, so we are only comparing the SIMILAR part where the at the beginning both graphs (LOG and “diminishing returns”) grow fast, and then slower.)



So the nice article I found explains in terms of physical training, like even though you put the same effort in each session, at first you improve and become stronger, but after a while you improve less and less, until you reach a plateau.

So this is very apparent in everything in a relationship that at first is exciting and after a short while becomes routine, like I think I've told you already, the first time I mopped the floor in my mythological ex's apartment she was so thrilled like for her it was better than sex! Then the next time she was moderately glad, and by the third time she practically took it for granted.

But I want to have an example for you that we can quantify into numbers.

So I was thinking let's do this explanation with sex. You know how people change sexual positions after a while, which means it's still adds to their enjoyment but less and less, and then they move to another position like from missionary to doggy or cowgirl or whatever, and then they start a new "graph".

So I was thinking of calculating this by watching porn videos, where they change position after some time and especially in gonzo films, there is less intervention from the director, so the actor and actress basically control the scene, and assuming that the actress enjoys the sex less than the man, we can gather that the man in such films dictate the action, including the changing of positions.

By the way If you think women enjoy in porn, you should watch an interview on PrimeTime with the woman who is in my opinion the greatest porn star of all time: Michelle Anne Sinclair, better known in her stage name – Belladonna.

https://en.wikipedia.org/wiki/Belladonna_(actress)

here is the interview on Youtube in two parts (thanks BigBoseMan!)

Belladonna Interview from PrimeTime Live (1 of 2)

https://www.youtube.com/watch?v=OBtLst3espU

Belladonna Interview from PrimeTime Live (2 of 2)

https://www.youtube.com/watch?v=UriHw41mIAY

When Belladonna is asked by her husband what is her secret of success she says: "people like to watch something that's very real", which I personally think is EXACTLY her magic, her inherent honesty courage and giving 100% of herself are what makes her the best female porn star in history!

The disappearance of Belladonna

https://www.youtube.com/watch?v=QPao32UJPUs

This last one on the list from BellaDonna's own Youtube channel – you can watch her in normal life!

https://www.youtube.com/channel/UCtaxISAQL5bQuumojAF0dSQ

She says this message again (how you feel a piece of meat in the lions cage and how you get Sexually Transmitted Diseases) in the documentary Aroused 2013, where she and other famous female pornstars tell us the secrets behind the camera – very sad ☹

Okay so let's try to analyze (ha ha pun intended! 😊) this anal movie by the girl with the best body ever in hard porn: Lucie Wilde.

Lucie Wild Anal Pro Video SZ366

https://www.analvids.com/watch/27840/lucie_wild_anal_pro_video_sz366

REMEMBER WE ONLY LISTEN TO THE MALE ACTOR NOW

voices "legend":

o = small oh/ah

O = big oh/ah

g = small mention of God

G = big mention of God

m = small hum

M = big hum

y = small yeah/yes

Y = big yeah/yes

t = small other text (usually instructions)

T = big other text (usually instructions)

I'M NOT INCLUDING ALL THE PARTS WHERE THEY "PREPARE" LIKE ORAL SEX

<u>POSITION #1</u>

11:46 begin fucking pussy missionary (vaginal)

OOooO

minute 12:

oooGtOOooYYymtoOoTTTyyyymmT

minute 13:

OOOmYoOoOYOGTTyTOOoYOo

minute 14:

yYYyyyotooT

14:29 end fucking pussy missionary

TOTAL: 65 voices , 2:43 minutes , AVERAGE 23.9 voices per minute.

POSITION #2

14:43 begin reverse cowgirl pussy (vaginal)

OGtoOYToGT

minute 15

YyYOToYYOYYTTMMMotToTOOoYOTTTY

minute 16

YYOYYTtTTyyooOyTYOOoYYoYoOYYOOtTTTTy

16:48 end reverse cowgirl pussy

TOTAL: 75 voices , 2:05 minutes , AVERAGE 36 voices per minute

POSITION #3

16:52 begin reverse cowgirl anal (asshole)

OTTYOTO

minute 17

TYTTttttTtyOyTyttTyYTTMOTYTtTOo

minute 18

OOTTToYTTTMTTTTYTTTTOOTYYYY

minute 19

YYYTmToOOOOOYOOOOOYOTOYOYYTmOYOYOY

minute 20

OOOOTTTTyyyyyTytytYYOYYOOYYT

20:45 end reverse cowgirl anal

TOTAL: 127 voices , 3:53 minutes , AVERAGE 32.7 voices per minute

<u>POSITION #4</u>

20:58 begin reverse cowgirl pussy (vaginal) II

minute 21:

YoOTTTTTTTTTYTYTTTYOYOy

21:35 end reverse cowgirl pussy (vaginal) II

TOTAL: 23 voices , 0:37 minutes , AVERAGE 37.3 voices per minute

<u>POSITION #5</u>

21:37 begin reverse cowgirl anal (asshole) II

YTYOYTYOYOyYoOOO

minute 22:

YTTTooootttTTYYYYYOOOOYTTYYTTOOOYTTTTYOOYOOOY

minute 23:

OOYOOOYOootOOOOOOO

23:26 end reverse cowgirl anal II

TOTAL: 78 voices , 1:49 minutes , AVERAGE 42.95 voices per minute

POSITION #6

23:42 begin "spoons" anal (asshole)

OOOTYTyOYOOYOO

minute 24:

OOOOYTOTYMOOoOOYOYYTOYYTTTooOOOOOYO

24:55 end "spoons" anal

TOTAL: 49 voices , 1:13 minutes , AVERAGE 40.29   voices per minute

POSITION #7

25:09 begin "doggy" girl lie on her side anal (asshole)

TTYOTYOOOOYOOOYOTTTTTYTYTyTY

minute 26:

YYOYTTTTTYOYOOYyTTOOO

26:26 end "doggy" girl lie on her side anal

TOTAL: 49 voices , 1:17 minutes , AVERAGE 35.19 voices per minute

POSITION #8

26:48 begin doggy pussy

OTTYOOOOOT

minute 27:

YYYMOOOOTTYTTMOOOOOOOOYTO

27:39 end doggy pussy

TOTAL: 34 voices , 0:51 minutes , AVERAGE 40 voices per minute

POSITION #9

27:47 begin "standing" reverse cowgirl pussy (vaginal)

OYOOYOOOoOY

minute 28:

OTTtYOOOOOTYTTTOOYOOOOYOOOYOOYO

28:35 end "standing" reverse cowgirl pussy

TOTAL: 42 voices , 0:48 minutes , AVERAGE 52.5 voices per minute

NOW HE’S LICKING HER ASSHOLE (LUCKY BASTARD) SO HE CAN’T MAKE MUCH SOUNDS SO I DON’T COUNT THAT

Now there’s a scene that’s hard to quantify:

POSITION #10

29:26 begin missionary both holes (pussy and asshole alternating)

OOTOOYOOOOYTTYTTTTTYTYTTTYYTYTYO

minute 30:

OYOYOTOOOOYOYOoOoOYTTTTTTT

minute 30:31 going for ATM (ass to mouth) minute 30:48 returns to her holes

YOYYTOOYTYYTOTTYTOOYYTYYTYYYY

minute 31

OYyOOY

31:07 again ATM

TTOoTOOY

31:20 end missionary both holes + ATM

TOTAL: 101 voices , 1:54 minutes , AVERAGE 53.16 voices per minute

POSITION #11

31:37 begin cowgirl pussy (vaginal)

TTYTTYTYOOTTTTTOOOYT

minute 32:

TTYTYOOOYTTTYTOTTTTT

minute 32:20

(Lucy squirts)

OYtYYTTTTTTTOOOYTOOOTTOO

32:47 end cowgirl pussy (vaginal)

(Lucy squirts a little more)

OY

TOTAL: 66 voices ,   1:10 minutes , AVERAGE 56.6 voices per minute

POSITION #12

32:54 begin cowgirl anal (asshole)

OYOOT

minute 33:

TYYYTTYYTTTOYOOYTTTTTYTTOOOY

33:30 switches to her pussy

TYTYYOOOOYOTT

33:45 switches back to her asshole

YTYYTTTYTOOoYoO

minute 34:

OYOOOOYoOOOY

31:30 switches to her pussy

TOYOOOOOTOOY

34:50 switches to her asshole

YOYYOOYT

minute 35:

TTTYTTTooyoyo

35:19 Lucy is cumming

OOOYOTTYTYOOOOO

35:32 end cowgirl anal (asshole)

Lucie can't take it anymore after she came, so he tells her to suck his cock.

TOTAL: 121 voices , minutes 2:38 , AVERAGE 45.95 voices per minute

36:34 he says he wants to come in her asshole, so we assume this is the last position

POSITION #13

36:46 begin doggy anal/pussy (asshole/vaginal)

OYOOOYYTTTYOTY

minute 37:

YTytoYTTYTTTTYTOOOOYTYyooY

37:22 Lucy looks suffering so they cut to pussy

OOTTYYTTYOOYTTOOOTTYOYMTooOOO

minute 38:

OYOYTTOOTTTYTTytootOYoyOOOOOOOYoOyOY

38:40 switches back to asshole

YYYOOOOYOYOOOOYOTOOYOTTYOOO

minute 39:

39:02 end doggy anal/pussy (asshole/vaginal)

TOTAL: 132 voices , 2:16 minutes , AVERAGE 58.25 voices per minute

he backs off and we see his cum on her asshole

he's spreading her asschicks and shoves his dick in her asshole a few more times.

Lucie waves goodbye

THE END

So what can we figure out from this movie besides that Lucie's body is the embodiment of perfection? (before her pregnancy and breast reduction)

OK. So thinking back it would have been much smarter to sample at higher rate than one minute, like maybe every 10 seconds would be much better. But it's too much work to do this all over again.

Another thing looking back, is that giving instructions like "arch your back", "sit straight", "open your legs", are not voices that show enthusiasm, so in retrospect I shouldn't count all the T's and t's but nevermind.

Another thing is that I don't need to include the last position (#13) in the calculations, because after this he didn't change position because he got tired from the current one, on the contrary, he was the most excited so he came.

Let's put all the positions into a table:

Position	Middle minus one	Middle minute	Middle plus one

#1	27		22
#2		30	
#3	31	27	34
#4			
#5		44	
#6			
#7			
#8			
#9			
#10			
#11			
#12	56		32

In position #4 , #6 , #7 , #8 , #9 , #11 , we don't have even a complete "round" minute. In other words these are too short.

#10 is hard to quantify because he's using all her holes.

#13 is irrelevant as I just explained before the table.

OK so in the first one and in the last one we get the feeling that he enjoys each position less as the time goes by:

In position #1 he goes from 27 down to 22 voices.

In position #12 he goes from 56 down to 32 voices.

But in position #3 it looks like we got our data wrong!

So I went back to that scene and I noticed two things:

(1) This is the first position in the movie that he penetrates Lucie's ass (anal) so it's obviously painful so he is going very slowly and gently so he is not enjoying that much at this position. Towards the end of the position he enjoys more (because her asshole is more relaxed so he can fuck her a little harder), which spoils our data and showing as if he enjoys more towards the end of the position, but now we understand why.

(2) This guy has a tattoo on his fingers that reads: "hard life". Fucking the best-looking girl in hard porn EVER (that looks like a real life hentai idol) in the ass and he has the nerve to complain about his life – let me switch places with you 😊

OK, on second thought, position #12 is also not such a good example because Lucie is cumming.

It's amazing from almost 40 minutes of a raw material porn movie gonzo style (only sex without plot etc), how little useful product we are left with for our experiment.

OK so we are left with position #1 which is not even anal, but we will try to redo this in 10 seconds chunks and plot the number of voices in a graph.

Position #1

TOTAL: 65 voices , 2:43 minutes , AVERAGE 23.9 voices per minute.

OK so here is position #1 analyzed again in higher resolution:

11:46 --> 11:56

OOoo

11:56 --> 12:06

OoooG

12:06 --> 12:16

tOOo

12:16 --> 12:26

oYY

12:26 --> 12:36

ymtoOo

12:36 --> 12:46

TTTy

12:46 --> 12:56

yyymm

12:56 --> 13:06

TOOO

13:06 --> 13:16

mYoOo

13:16 --> 13:26

OYO

13:26 --> 13:36

GTTy

13:36 --> 13:46

TOOo

13:46 --> 13:56

YO

13:56 --> 14:06

o

14:06 --> 14:16

yYYyy

14:16 --> 14:26

yo

14:26 --> 14:29

There is an “anomaly” when it’s too few voices here (3 voices) :

12:16 --> 12:26

oYY

And too many voices here (6 voices) :

12:26 --> 12:36

ymtoOo

That’s because at 12:20 he’s pulling his dick out of Lucie’s pussy and then goes and plays with her pussy which isn’t very arousing, and then goes to play with her tits which are the most arousing in the world. So you have this low to high anomaly.

I could even split this position into BEFORE this event and AFTER this event. And then in fact the numbers make more sense, he’s fucking her pussy then gets tired, then plays with her boobalicious boobs and recharges his desire and then fucks her pussy some more and then gets tired again.

In 13:22 again he’s pulling his dick out of Lucie’s pussy, vibrates her pussy with his hand for a few seconds and then and gets back to fucking her pussy only in 13:37.

This is the reason for another much more disturbing “anomaly”:

The unexpected “peak” we encounter in 14:06 --> 14:16 (during the end where he’s otherwise “bored” with the position) is that he spits into Lucie’s mouth and she likes it and becomes more intimate (a few seconds later she caresses the back of his head). So it turns him on for a few seconds that she is enjoying. So without Lucie’s enjoyment I guesstimate we would have between 1 and 2 voices (average of previous and next) so let’s say 1½ .

So unfortunately we don’t have the average hi-resolution from many positions, so we will have to draw conclusions according to this one.

Let’s make a table of the 3 parts of position #1 and correct anomalies where needed. We are now sampling in 10 seconds chunks of time.

	Part 1	Part 2	Part 3
1st timeslice	OOoo	ymtoOo	TOOo
2nd timeslice	OoooG	TTTy	YO
3rd timeslice	tOOo	yyymm	O
4th timeslice	oYY	TOOO	Yy [corrected]
5th timeslice		mYoOo	y [corrected]
6th timeslice		OYO	–
7th timeslice			

OK now we will translate all the different sounds to a common value (like we can translate prices all over the world to U.S. Dollars).

So our common “coin” will be the lower-case ‘o’.

1 upper-case ‘O’ is worth 2 lower case ‘o’.

1 upper-case ‘Y’ is worth ½ lower case ‘o’.

1 lower-case ‘y’ is worth ¼ lower case ‘o’.

Other letters we will ignore completely for now because they are too “cerebral” so they might not be genuine.

Here is the same table after the “currency conversion”:

(it’s visual: ‘o’ is a circle , ‘c’ is half a circle , and ‘i’ is a quarter of a circle)

	Part 1	Part 2	Part 3
1st timeslice	oooooo	ooooi	ooooo
2nd timeslice	ooooo	i	ooc
3rd timeslice	ooooo	ci	oo
4th timeslice	oo	Oooooo	ci
5th timeslice		ooooc	i
6th timeslice		ooooc	
7th timeslice			

So you see that part 2 which begins at minute 12:26 and ends 13:26 , I guess playing with Lucie’s tits can mess up any statistic measure.

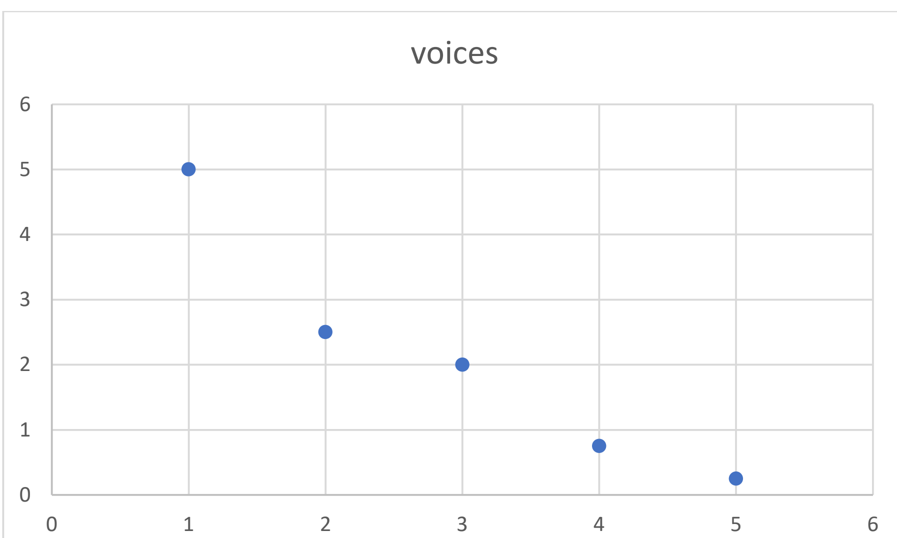
In part 1 there is a decay but it’s too short and abrupt for what we need.

BUT

Part 3 looks great: It’s long and smooth decay, let’s count how many o‘s we got:

$$5\,,\,2\frac{1}{2}\,,\,2\,,\,\frac{3}{4}\,,\,\frac{1}{4}$$

So I plotted these points in a scatter graph in Excel, linearly like we usually do:



Is this a power law? Or is this exponential? Or none of them? Let’s check it out.

OK. So what I hope we can do now after all this preparation is to tackle Raskolnikov's intuitive explanation to where we use LOG. I'll quote his whole answer and then we will try to explain (it looks a little scary but we will decipher it together don't worry 😊)

https://math.stackexchange.com/questions/35810/intuitive-use-of-logarithms

///////////// Intuitive use of logarithms BEGIN ////////////////

Logarithms come in handy when searching for power laws. Suppose you have some data points given as pairs of numbers (x, y) . You could plot a graph directly of the two quantities, but you could also try taking logarithms of both variables. If there is a power law relationship between y and x like

$$y = ax^n$$

then taking the log turns it into a linear relationship:

$$\log(y) = n\log(x) + \log(a)$$

Finding the exponent n of the power law is now a piece of cake, since it corresponds to the slope of the graph.

If the data do not follow a power law, but an exponential law or a logarithmic law, taking the log of only one of the variables will also reveal this. Say for an exponential law

$$y = ae^{bx}$$

taking the log of both sides gives

$$\log(y) = bx + \log(a)$$

Which means that there will be a linear relationship between x

and $\log(y)$

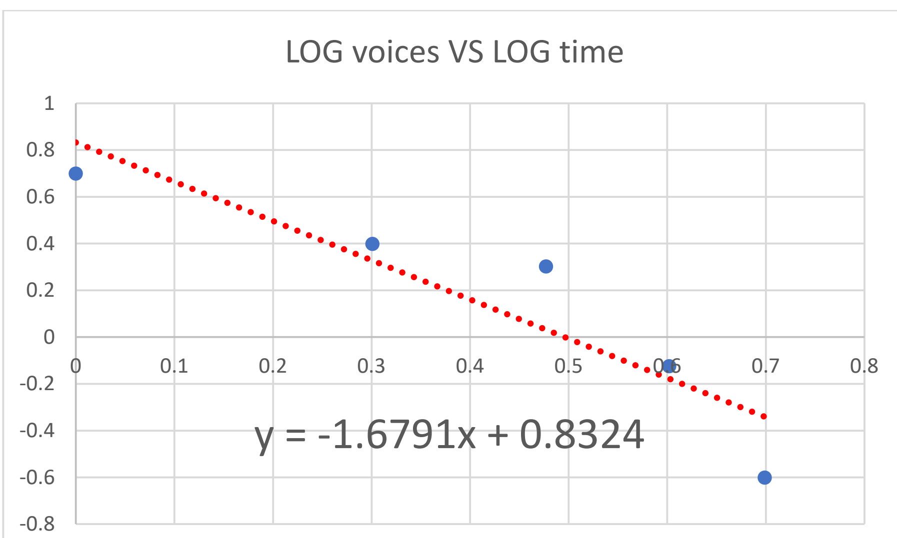
///////////// Intuitive use of logarithms END ////////////////

OK so what I did was plug our points into Excel:

time	voices	LOG time	LOG voices
1	5	0	0.69897
2	2.5	0.30103	0.39794
3	2	0.477121	0.30103
4	0.75	0.60206	-0.12494
5	0.25	0.69897	-0.60206

And then I did one scatter graph where both axes are scaled with LOG

(in other words: LOG of vertical axis VS LOG of horizontal axis)

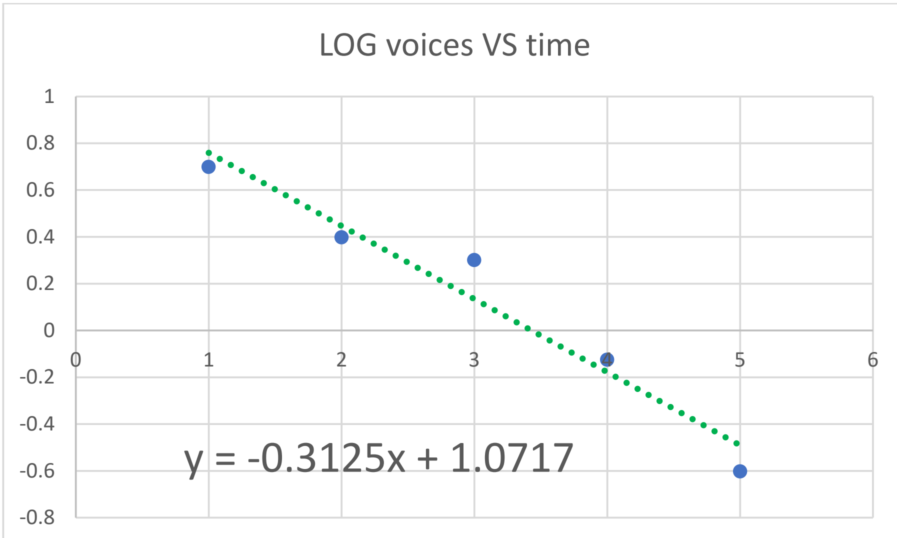


So if this line was fitting the data points nicely we would have found a power law. We would take the slope (in this case -1.6791) and that would be our n . but the line doesn't go through (or at least close by) to the points, so we DIDN'T FIND A POWER LAW ☹

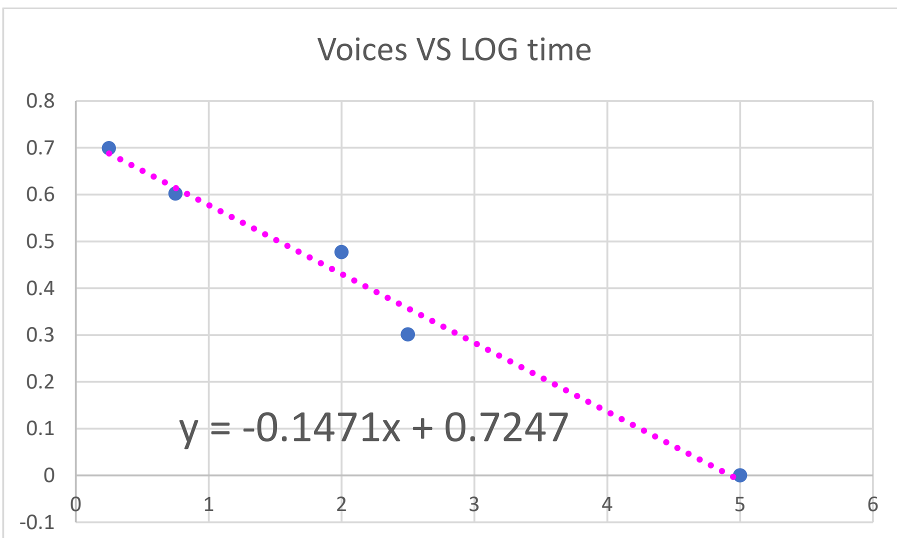
OK. Don't give up yet!

So next we will check to see if maybe we found an EXPONENTIAL law. So this time we will do LOG of one axis and leave the other axis as is.

So first let's do the LOG of the vertical axis VS the original horizonal axis



Now let's do the opposite: the original vertical axis VS the LOG of the horizonal axis



ALRIGHT! You see that the last one is actually pretty good! The two points in the middle are a little off the line, but they are pretty close to the line, and also they "cancel" each other in opposite directions. WE FOUND AN EXPONENTIAL LAW! 😊

OK so now I'm doing something a little silly which is using the GREEN (LOG voices VS Time) because I don't want to confuse us and it fits exactly with Raskolnikov's explanation:

So let's refresh our memory with what he said:

Say for an exponential law

$$y = ae^{bx}$$

taking the log of both sides gives

$$\log(y) = bx + \log(a)$$

Which means that there will be a linear relationship between x

and $\log(y)$

OK, so we do this in the reverse order. We start with the bottom line and work our way upwards. We have just found a linear relationship between the horizontal axis (time) and the “LOG of the vertical axis” (“ LOG voices “).

So now we try to do this:

$$\log(y) = bx + \log(a)$$

Or in our example:

$$\log(voices) = b * time \ + \ \log(a)$$

So Excel told us what the line equation was, we are interested in the GREEN line here:

$$y = -0.3125x + 1.0717$$

So here you see that b plays the part of the slope of the line. A line equation is always: “how much we go up” EQUALS “slope” times “how much we go the right PLUS “where we intersect the vertical axis. I hope you remember this from school, otherwise invent examples for yourself like y=x (a diagonal line of 45° that cuts in ZERO because it’s actually y=1*x+0) and another example y=2x (a steeper diagonal line because for each step to the right (x) we go up two steps (y). This line is really y=2*x+0). And then make yourself an example like y=x+1 (a diagonal line of 45° that cuts the vertical axis at height 1, which means a little higher than the origin). And after a few examples like these you will be convinced that b plays the part of the slope of the line.

And then we go to the last step (in Raskolnikov's explanation it's the first line) :

$$y = ae^{bx}$$

So instead of b we plug in our slope -0.3125

$$y = ae^{-0.3125x}$$

AND THIS IS OUR EXPONENTIAL LAW OF WHEN PORNSTARS CHANGE SEXUAL POSITIONS! 😊

I guess the a changes from pornstar to pornstar, but if we stick to the same pornstar (or once we established what is the a for the pornstar that interests us), then from that moment on we can know how much he enjoys in each moment (within a "cycle" like "part 3" in our example).

Let's plug in a few of our data points into the formula we have just found, and see what happens:

Our first point: $x = 1$ and $y = 5$

So let's plug these numbers in the equation:

$$y = ae^{-0.3125x}$$

We get:

$$5 = ae^{-0.3125*1}$$

Which is:

$$5 = a * 0.7316156289$$

Which means:

$$a = 6.834189706$$

OK. Our second point: $x = 2$ and $y = 2.5$

So let's plug these numbers in the equation:

$$y = ae^{-0.3125x}$$

We get:

$$2.5 = ae^{-0.3125*2}$$

Which is:

$$2.5 = a * 0.5352614285$$

Which means:

$$a = 4.670614894$$

Is this similar to the a we calculated a moment ago? So-so. But remember we chose the GREEN line to make our example easier.

OK. Our third point: $x = 3$ and $y = 2$

So let's plug these numbers in the equation:

$$y = ae^{-0.3125x}$$

We get:

$$2 = ae^{-0.3125*3}$$

Which is:

$$2 = a * 0.3916056267$$

Which means:

$$a = 5.107178916$$

OK this value is between those two a 's that we've found, so that's encouraging 😊

OK. Our fourth point: $x = 4$ and $y = 0.75$

So let's plug these numbers in the equation:

$$y = ae^{-0.3125x}$$

We get:

$$0.75 = ae^{-0.3125*4}$$

Which is:

$$0.75 = a * 0.2865047969$$

Which means:

$$a = 2.617757218$$

This a is far away from the rest ☹

OK. Our fourth point: $x = 5$ and $y = 0.25$

So let's plug these numbers in the equation:

$$y = ae^{-0.3125x}$$

We get:

$$0.25 = ae^{-0.3125*5}$$

Which is:

$$0.25 = a * 0.2096113872$$

Which means:

$$a = 1.192683295$$

I hope I'm not doing something wrong, I attribute this quite different a 's to the fact that we chose the GREEN line (to make it more similar to Raskolnikov's example.

Let's test if this gives a reasonable result if we had another point (a sixth point).

So let's do an average of all the different a 's that we've got: 4.084484806.

So for our purpose here $a = 4$

Now let's say we could measure another data point, the sixth data point:

$$y = ae^{-0.3125x}$$

But we now know a so we write:

$$y = 4e^{-0.3125x}$$

And we know the x of this point, it's the time 6 so we plug this in as well:

$$y = 4e^{-0.3125*6}$$

Ok <drumroll please…> let's calculate and see if we get a reasonable y (it should be less than a quarter because the fifth point was a quarter and the pornstar's voices are going down all the time)

$$y = 4e^{-0.3125*6}$$

$$y = 4 * 0.1533549668$$

$$y = 0.6134198674$$

So annoying! AAARRRGGGHHH!!! OK to be honest I've had it up to here with this chapter, so I'm sure Raskolnikov's equations are correct, so either I made a mistake along the way, or (which I hope is the case) I over simplified by choosing the GREEN line to make it easier for us. But I hope by now you realize how important LOG is, not just because it's historically important for other calculations, but because it's just as fundamental and "natural" as any other function that we've talked about so far.

OK I'm writing this the following day – so today we'll cheat! 😊

Let's use WolframAlpha website to check if our points match any regularity:

https://www.wolframalpha.com/examples/mathematics/statistics/regression-analysis/

LOG

we write in WolframAlpha this:

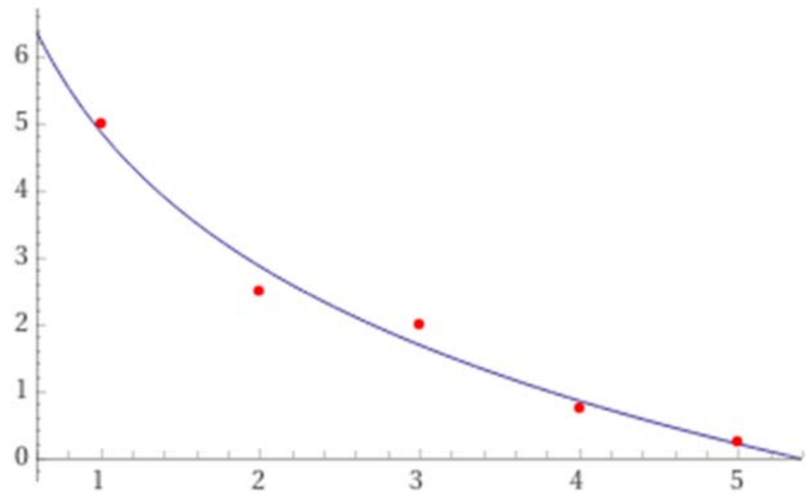
log fit { {1,5} , {2,2.5} , {3,2} , {4,0.75} , {5, 0.25} }

and we get this:

Least-squares best fit:

$$-2.89792 \log(0.185973\, x)$$

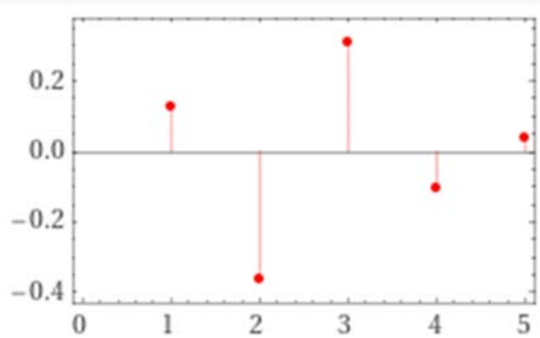
Plot of the least-squares fit:



Fit diagnostics:

AIC	BIC	R^2	adjusted R^2
5.92638	4.75469	0.992803	0.988004

Plot of the residuals:



So we will try this equation with the “sixth point” and see if it’s indeed less than a quarter:

$$y = -2.89792 \log(0.185973x)$$

So we plug in x=6 and watch what happens <drum roll please>

$$y = -2.89792 \log(0.185973 * 6)$$

$$y = -0.1379443167$$

OK so this is not so far from a quarter. WolframAlpha doesn't know that we can't go below ZERO, because in real life there is no such thing as a negative voice.

EXPONENTIAL

we write in WolframAlpha this:

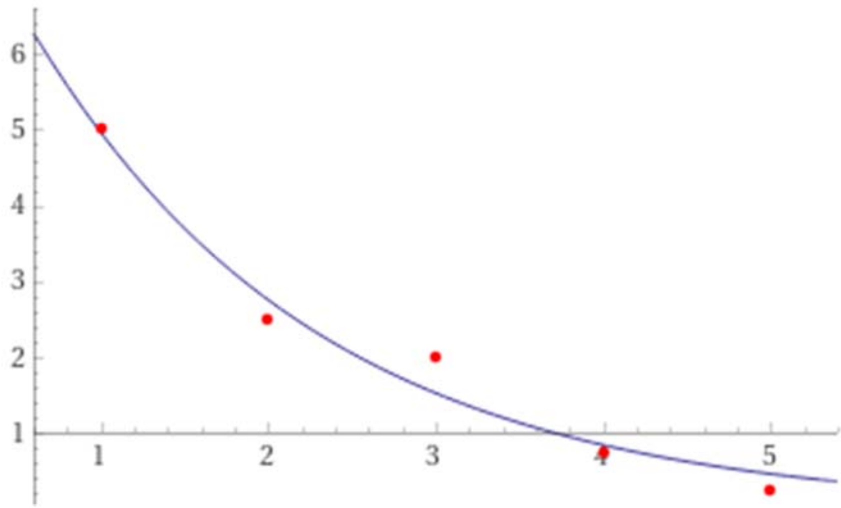
exp fit { {1,5} , {2,2.5} , {3,2} , {4,0.75} , {5, 0.25} }

and we get this:

Least-squares best fit:

$8.90539\, e^{-0.585589\, x}$

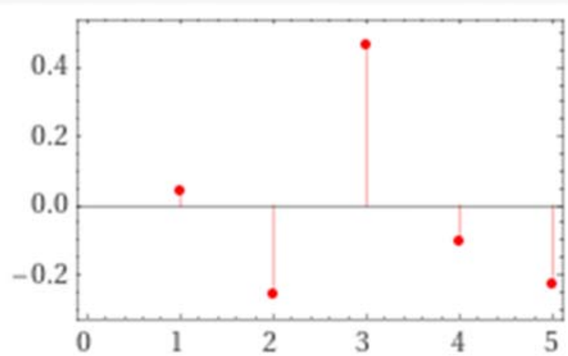
Plot of the least-squares fit:



Fit diagnostics:

AIC	BIC	R^2	adjusted R^2
7.39668	6.22499	0.990342	0.983903

Plot of the residuals:



So we will try this equation with the “sixth point” and see if it’s indeed less than a quarter:

$$y = 8.90539e^{-0.585589x}$$

So we plug in x=6 and watch what happens <drum roll please>

$$y = 8.90539e^{-0.585589*6}$$

$$y = 0.2653044383$$

Yay! 😊 this is almost exactly what we expected!!!

So honestly I don't know which one of WolframAlpha's to choose:

The R^2 is closer to one in the LOG fit. This means it fits the existing points better.

But the next point (6th point) is predicted better in the EXP fit.

It's much closer to a quarter (the difference is about 0.01) than both my calculation (which was 0.36 too high) and WolframAlpha's LOG calculation (which was about 0.38 too low).

So I leave this to you, and I hope I helped a little!

Subchapter 2.06 – Implicit differentiation as swingers party with tall and rich men and their wives

OK so now we are in part 6 of the series of videos by 3Blue1Brown:

Implicit differentiation, what's going on here? | Chapter 6, Essence of calculus

https://www.youtube.com/watch?v=qb40J4N1fa4

So like in the previous sub-chapter, I can't come up with an easier more intuitive way to explain the subject, so I'll just try to motivate the use of such functions and graphs and relate it to our stories from love and sex.

OK. So when we read in Wikipedia about implicit function

https://en.wikipedia.org/wiki/Implicit_function

The examples are very mathematical, except this one which is more "human"; don't worry we will explain what the economics terms are all about in just a moment:

in an **indifference curve**

[a graph representing different quantities of two goods, points between which a consumer is indifferent]

the derivative is the **marginal rate of substitution**

[how much more of y one must receive in order to be indifferent to a loss of one unit of x.]

OK. Now to see what it means, I suggest you watch this nice video from Khan Academy:

Indifference curves and marginal rate of substitution

https://www.khanacademy.org/economics-finance-domain/microeconomics/choices-opp-cost-tutorial/utility-maximization-with-indifference-curves/v/indifference-curves-and-marginal-rate-of-substitution

To put it in simply, it's TRADE-OFF

https://en.wikipedia.org/wiki/Trade-off

the more you get from one thing, the less you get of the other thing.

This is so prevalent in our life, every time you are deciding between two possibilities that you can take some of this and some of that.

Let's explain with an example from love and sex:

Let's say you are a man looking for a one-night stand.

So according to this article by Lindsay Dodgson from Insider:

A study of 68,000 people determined what men and women look for most in a casual partner, and it's not intelligence or kindness

https://www.insider.com/what-men-and-women-want-casual-partners-2019-11

the most important qualities in the woman would be:

an attractive body (70% said this is very important)

an attractive face (68.6% said this is very important)

But girls who are BOTH sexy and beautiful get chosen very early on, and they already have a boyfriend or a husband (or they are out of your league if they are free).

So in real life a guy would have to choose some trade-off:

A girl who has a pretty body but an ugly face (butterface)

OR

A girl who has an ugly body but a pretty face

OR

Some mixture of an OK body and an OK face

If you prefer to do the same with a woman that's looking for a SHORT-term relationship with a man, then the research says that:

90% of women wanted a casual partner to be taller than them

I searched in Google Scholar for all the papers by Virginia J. Vitzthum the lead researcher, but I couldn't find this specific research.

But I think we all know what the other major factor that women look for: STATUS (which usually is a proxy for money).

To show you this isn't just my opinion here is the headline of another article about LONG-term relationships:

also by Lindsay Dodgson from Insider

A study of 68,000 people has determined what women really look for in a partner, and it's not money or a muscular body

https://www.insider.com/what-women-really-look-for-in-a-partner-study-research-2019-7

notice the headline says it's NOT MONEY in long term relationships (personally I think women are just lying their asses off when they say it's not money in the long term as well), but anyway regardless of my personal opinion, it goes to show you that the consensus (general opinion) is that 1st or 2nd thing that women desire most in a one night stand is for the guy to be rich and/or famous.

So if we do the equivalent trade-off for a woman choosing a man it would be like:

But guys who are BOTH tall and rich get chosen very early on, and they already have a girlfriend or a wife (or they are out of your league if they are free).

So in real life a woman would have to choose some trade-off:

A guy with lots of height (tall) but not much money (not rich)

OR

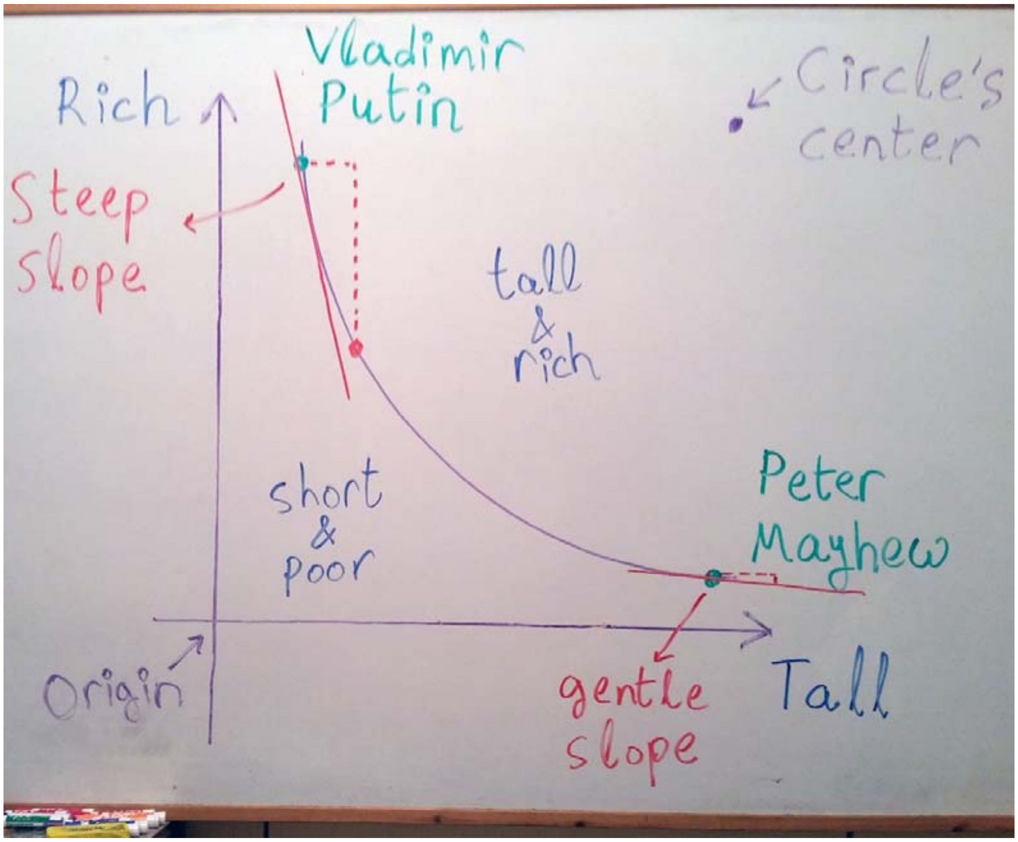
A guy who doesn't have much height (not tall) but has lots of money (rich)

OR

Some mixture of an OK height and an OK wealth.

OK so now that you see that men are superficial (at least when it comes to casual relationship) but so are women , let's see what the graph looks like:

Picture 1 - indifference curve of: rich VS tall



I hope you can see the **purple** curve from top left to bottom right.

This purple curve is part of a circle, and on the top right you can see the circle's center (a purple dot).

The horizontal axis is how tall the man is. The vertical axis is how rich the man is.

OK. So the important thing to understand is that each point (man) on the purple curve (the indifference curve) has the same worth for the woman. For example on the top left we see Vladimir Putin who is the richest man in the world (in secret bank accounts etc, he is the strongest man in the world, in a huge country where corruption rules). But physically Putin is short, his height is about 1.65 meters. On the opposite edge of the curve we have Peter Mayhew (the actor who portrayed Chewbacca in the films of Star Wars).He is poor (not rich) but he is very tall – his height is 2.21 meters. So for a woman they all have the same worth. In fact every man on the curve has the same worth for a woman, so she is indifferent between these man. That's why the purple curve is called an indifference curve.

Above and to the right of the curve, we have all the men who are "worth" more to the woman, because each of them has a "sum" of $rich + tall$ which is higher than any man on the curve.

Below and to the left of the curve, we have all the men who are "worth" less to the woman, because each man there has a "sum" of $rich + tall$ that is lower than any man on the curve.

For example the basketball player that we talked about who slept with 20,000 women, he is not as rich as Putin of course, but he is fairly wealthy. And he is not as tall as Peter Mayhew (Chewbacca) but he is fairly tall. So the SUM of the worth he has for a woman is more than each individual man on the purple indifference curve. So for a woman he is worth more than Putin, and he is worth more than Chewbacca's actor.

What happens if a woman sees Putin (the richest man) and let's say for this woman it's critical that the man will be a little higher?

Then over a very short distance towards TALL (going to the right when she chooses her man) she goes by Putin and Bill Gates and Jeff Bezos and so on. So she "pays" a lot in the RICH department, for a little improvement in the TALL department.

So at the "Putin" point, for every step to the right ("run"), she falls a lot down (anti-"rise") so remember the slope is rise over run (which means y divided by x) so in this point the slope is negative and STEEP.

(So remember the slope is the rate of change. So it's the change in y which is NEGATIVE which means the woman is GIVING or LOSING dollars in the man, and she is willing to do in order to RECEIVE or WIN centimeters in the man.

The way we set up our axis, the more we have of something, the more we advance in the POSITIVE direction of that quality (the quality can be money or height), so if the woman is getting LESS height (in her man) than this is a movement in the NEGATIVE direction of that axis.)

As compared to at the "Chewbacca" point, where for the same size of step to the right ("run"), she falls down very little (very little anti-"rise") so since the slope is rise over run (which means y divided by x) so in this point the slope is negative and GENTLE.

OK so let's read again what Wikipedia wrote, and this time we will explain using our example:

in an **<u>indifference curve</u>** (the **purple** curve of all the man that have the same "worth" as Putin and Chewbacca. Now the late Peter Mayhew is sadly no longer with us, and Vladimir

Putin is sadly no longer in the line of health. But imagine if when they were both young there was a swingers party and they went there with their wives, and also other people who are along the same **purple** curve. So every woman who's husband is on the **purple** curve doesn't mind switching her husband with and other woman who's husband is on the **purple** curve).

[a graph representing different quantities of two goods (two qualities of men), points between which a consumer (the woman who is choosing the man) is indifferent]

the derivative is the **marginal rate of substitution** (marginal meaning here: for every extra additional unit that the woman gets of something (something like the man's height). Substitution is trade-off: she is giving up some of a man's wealth and in return she is gaining more of a man's height).

[how much more of x (height) one (the woman) must receive in order to be indifferent to a loss of one unit of y (wealth) .]

Please note:

Here we look from the perspective of "Putin's wife": you already have a lot of money, and you will gladly give away a lot of it for a little more height.

the original phrasing in Wikipedia is like looking from the perspective of "Chewbacca"'s wife: you already have a lot of height, and you will gladly give a lot of it for a little more wealth.

But it's the same curve, and the same explanation, so I switched the x and y this time, to make it similar to our example.

So now we feel the slope intuitively which means qualitatively. But what do we do when we want to find the **purple** curve exactly which means quantitatively?

Then we notice that it is a part of a circle (notice the circle's center point in the top right of the picture).

So the equation of a circle is written like this

https://en.wikipedia.org/wiki/Circle#Equations

$$x^2 + y^2 = r^2$$

The x and y tell us at what point we right now, and the r is the radius (the distance from that point to the center of the circle). The "squared" is because it's actually our old friend the Pythagorean theorem

https://en.wikipedia.org/wiki/Pythagorean_theorem

$$a^2 + b^2 = c^2$$

OK. So we have the **purple** curve (which is the lower left part of a circle).

But now we want the SLOPE , the tangent line to the circle at some point.

Usually when we want a slope we have y equals something with x and numbers.

But here we want the slope of this thing:

$$x^2 + y^2 = r^2$$

So what we do is we take the derivative of it AS IS. And only afterwards we will extract what we want.

$$2x + 2y * y' = 0$$

the "x squared" became 2x, the "y squared" is multiplied by the internal derivative (because y itself depends on x, and we did derivative of everything with respect to x, in other words, how does each thing changes when we change x a little bit).

Okay. So now we can divide the whole equation by 2.

$$x + y * y' = 0$$

Now we move the x to the other side of the equation by doing minus x on both sides:

$$y * y' = -x$$

and lastly we move the y to the other side of the equation by doing divide by y to both sides:

$$y' = -\frac{x}{y}$$

OK so we got the derivative fairly easily. This method of derivative of everything first, and only extracting what you want afterwards is called:

Implicit differentiation

Now imagine on the other hand, if we wanted to find the slope as we usually did before (with "explicit" differentiation), so I'm showing you now what NOT to do:

We started with the **purple** curve

$$x^2 + y^2 = r^2$$

And we would then have to extract y, so we do minus "x squared" from both sides:

$$y^2 = r^2 - x^2$$

And now we want to get rid of the square on the y, so we take a square root from both sides:

$$y = \sqrt{r^2 - x^2}$$

And now we need to do a derivative of this which is a lot harder!

Sometimes (in other examples) it's so hard that we can't do it at all, and that's why we need

Implicit differentiation

OK. In minute 12:33 of the video, 3Blue1Brown tells us how to find the derivative of $\ln x$

So first of all what is $\ln x$?

It is our familiar LOG (from previous subchapter – remember with the changing sex positions?) but this time it's not in the base of 10, but instead in the base of the very special number e. So since this number e is very special, instead of saying:

"LOG base e" of something, and write like so:

$$\log_e somthing$$

We simply invented another word for "LOG base e" and this word is "LN" (but in lowercase letters). So we are saying: "Natural Log" of something, and write like so:

$$\ln something$$

You might think it's idiotic why don't we just say "Lan"? And indeed in Israel we do.

BUT in the rest of the world it's more complicated, and the best way is to say: "natural log". (by the way there is also the calling it "log" way, and the calling it "ellen" way like L N which is what 3Blue1Brown does as you've noticed).

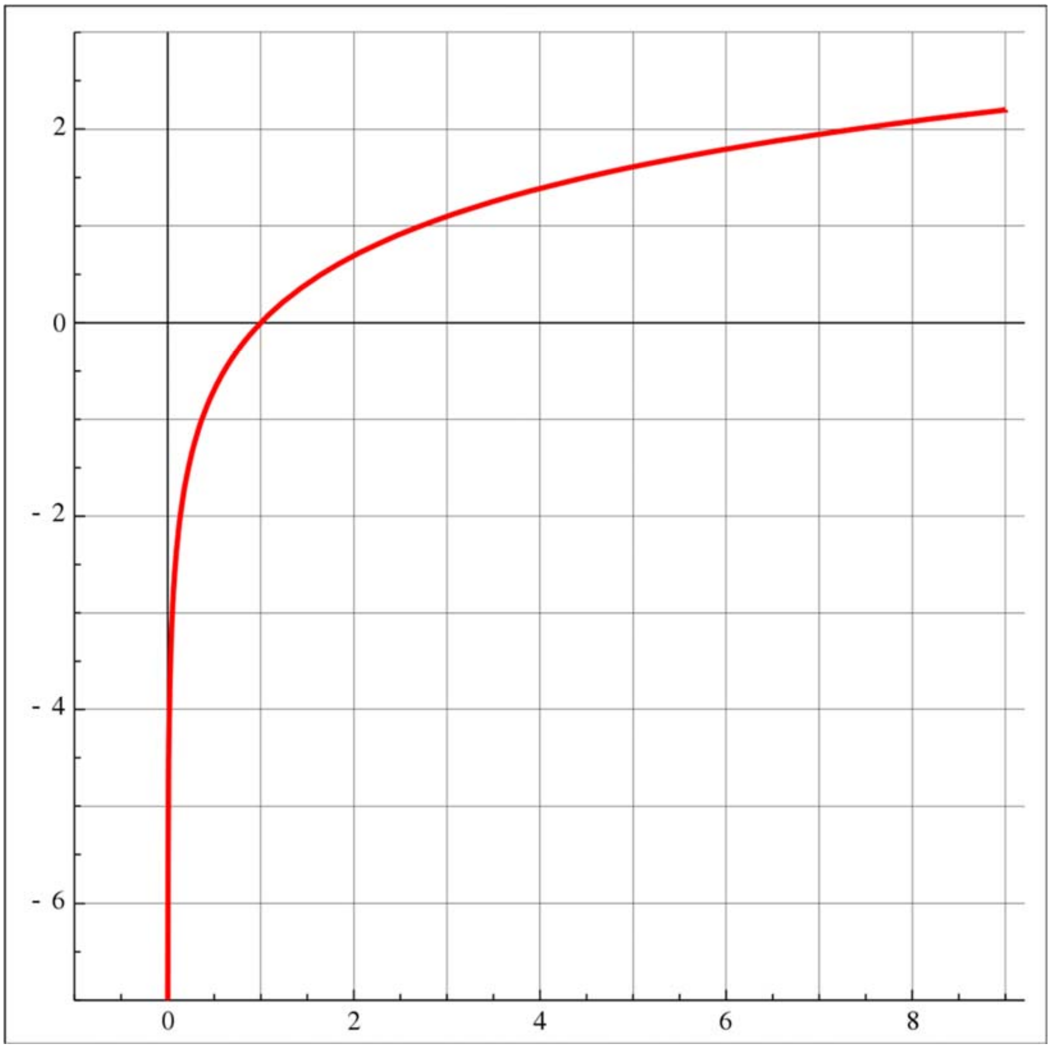
How do YOU pronounce "ln x"?

MathAdam

https://www.youtube.com/watch?v=4ry06_g6wYE

Here is a picture of $\ln x$ from Wikipedia

Thank you very much to Elmextube for the picture!



So we see that when x is ONE, the graph height is ZERO. Why is that?

First let's write what we found:

$$\ln 1 = 0$$

Another way to write this is:

$$\log_e 1 = 0$$

Which means:

$$e^0 = 1$$

So it’s not surprising at all, because ANYTHING to the power of ZERO , equals ONE.

To the right we see the graph going up slowly towards infinity (this will happen when we will reach infinity to the right). Which we talked about when we described LOG.

To the left we see the graph going down slowly towards minus infinity (this will happen when we reach zero to the left). I know this doesn’t look slowly, but Elmextube from Wikipedia explains that it’s slower than “any power law of x”. to be honest I’m not sure what that means, but I’m too lazy to try to figure it out now.

For our purpose here we just need to understand how it works:

So we see that when x is HUGE, the graph height is BIG. Why is that?

First let’s write what we found:

$$\ln HUGE = BIG$$

Another way to write this is:

$$\log_e HUGE = BIG$$

Which means:

$$e^{BIG} = HUGE$$

So it’s not surprising at all, because ANYTHING bigger than ONE , when it’s raised to a BIG power, gives a HUGE result.

So that’s why to the right side the graph goes up slowly but surely to infinity.

What about the part between ONE and ZERO?

So we see that when x is FRACTION, the graph height is NEGATIVE. Why is that?

First let’s write what we found:

$$\ln FRACTION = NEGATIVE$$

Another way to write this is:

$$\log_e FRACTION = NEGATIVE$$

Which means:

$$e^{NEGATIVE} = FRACTION$$

So it's not surprising at all, raising any NUMBER to a NEGATIVE power, means ONE OVER THAT NUMBER. Since e is bigger than ONE, then $\frac{1}{e}$ is smaller than ONE.

OK now let's look for an example for $\ln x$ from love and sex.

At first I wanted to do this graph with what the "trade" that you have in bed, like we see in the movie Pulp Fiction in the bargaining (negotiation) between Butch and his girlfriend Fabienne:

FABIENNE: Butch? Will you give me oral pleasure?

[Butch kisses her on the mouth.]

BUTCH: Will you kiss it?

[She nods her head: "yes."]

FABIENNE: But you first.

So I guess there is a "trade" like this between many couples in bed, also between acts that are not symmetric, like she will allow him to penetrate her ass (anal sex) which he enjoys very much and she suffers from, and in return he needs to do something that she enjoys very much and he suffers from like licking her pussy for a long time.

The horizontal axis meaning is "who is doing to who":

At exactly 1 they are licking each other mutually like 69.

At 2 the man is licking her twice as much as she licks him.

At ½ the man is licking her half as much as she licks him.

The horizontal axis is "pampering the woman".

Starting from ONE going to the right, the woman abuses the man more and more.

Starting from ONE going to the left, the man abuses the woman more and more.

The vertical axis is the "enjoyment of the woman".

Starting from ZERO height going up, the woman is enjoying more and more.

Starting from ZERO height going down, the woman is suffering more and more.

So the slope of the graph is horniness (sexual arousal)

$$horniness = \frac{enjoyment}{pampering}$$

So for example to the right you see that when the man licks a woman's pussy, she reaches her first orgasm very fast, like in a few minutes, and then it's harder for her to reach the second orgasm, it's harder for her to concentrate, and the third one is even harder to reach and so on.

So a HUGE pampering of the woman by the man would give BIG enjoyment. Because she gets less and less horny.

On the other hand, I'm reminding you from Konrad Lorenz

An ancient Austrian peasant joke describes exactly what happens so: ' today I will pleasure my dog : At first I will beat it with all my might, and afterwards I will stop. '

So in the part of the graph between $x = 0$ and $x = 1$ we know the woman is suffering and yet her horniness is great. Why is that? It's exactly because of the idea in what Konrad Lorenz said.

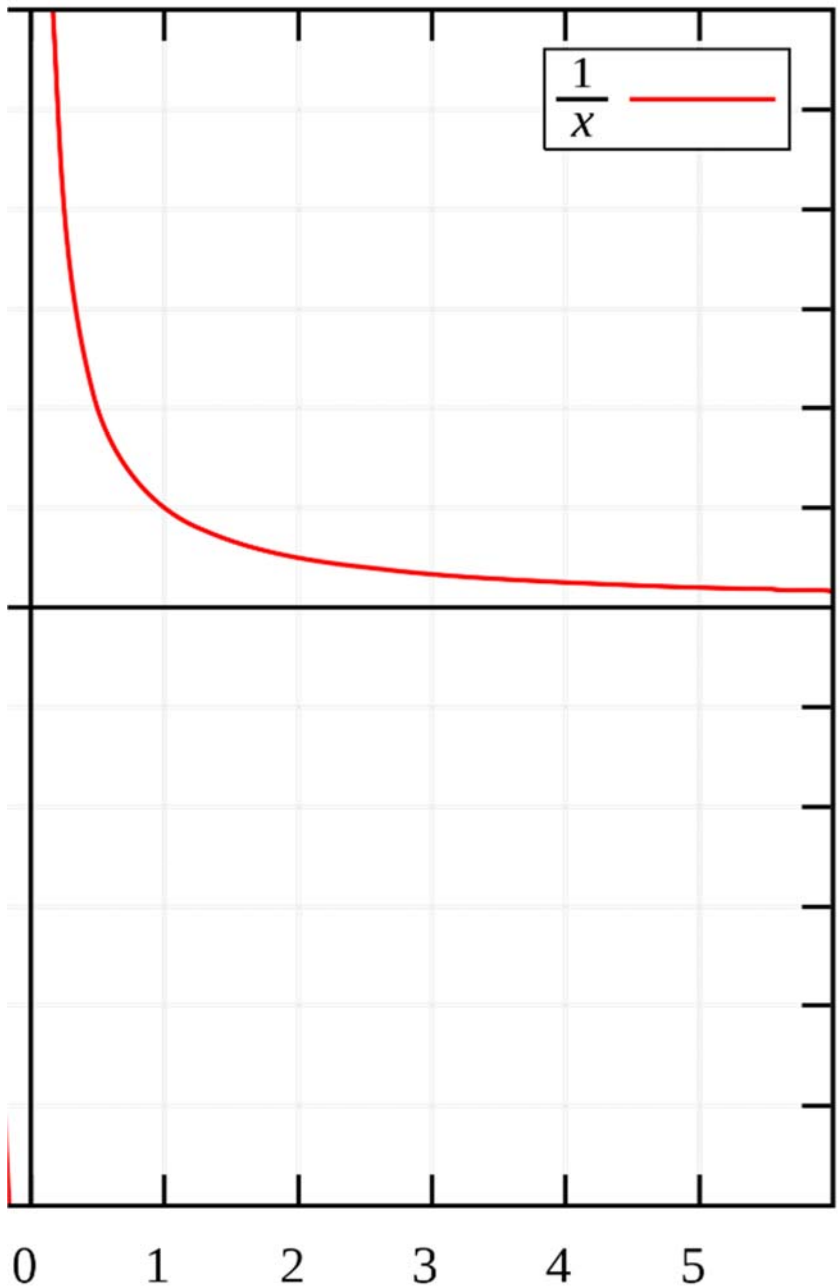
So for example let's say the woman sucks the man's cock, and the man forces her head with his hand and goes deep until she gags and has tears, and then for a moment takes the cock out of her mouth and gives her a moment to breath. This will get the woman very horny although she suffers, because the "rise over run" is very great at that moment: she went from suffering a lot, to no suffering, and this change is done over a short time (very little pampering) so the slope which is her horniness is great.

So let's summarize the woman's horniness: If a man that she desires fucks her roughly, she gets very horny. If he is fucking her normally she has normal mediocre horniness. If a man pampers her more and more, her enjoyment grows but less and less fast, because her horniness decays.

So what graph do we know that near $x = 0$ has very great values, and then it loses intensity up to a normal value at $x = 1$ and from there on to the right it decays almost to ZERO?

If you guessed $y = \frac{1}{x}$ you are correct!

Thank you very much to Ktims from Wikipedia (Multiplicative inverse)



So the horizontal axis is still pampering of the woman but the vertical axis now is HORNINESS (sexual arousal) of the woman.

So we see now visually the horniness of the woman getting lower the more the man is pampering her.

So you see the derivative of $\ln x$ is simply $\frac{1}{x}$

Interestingly, we could describe the same graphs by looking at the man!

(NOTE: we are talking about an average man, not especially sadistic or masochistic.)

In the enjoyment graph we could make the horizontal axis the EFFORT put in by the man, it's very easy for him to treat the woman like a slave, it's harder for him to treat her equally, it's a lot harder for him to treat her like a queen.

In the enjoyment graph we can make the vertical axis the REVERSED enjoyment of the man. An average man enjoys most the rough things, enjoys mediocrely the regular sex, and enjoys less and less if he has to pamper the woman like going down on her for a long time.

In the horniness graph we could be even more naturally measure the vertical axis as the man's horniness based on "the more the woman suffers the more it's arousing for the man".

In the book "The Dark Side of Man" by Michael Ghiglieri he explains that the average man (not some sadistic freak) finds the sight of a suffering woman's face to be sexually arousing. (provided that she is young and attractive). Unfortunately I no longer have this terrific book at home, and I can't find it on PDF to search the study for you, but researchers found that ordinary man are turned on by fertile women in pain. Much of our ancestors did not meet during a romantic date but instead during a rape in the middle of a raid by the neighboring tribe or nation, so you see why a soldier who gets off on raping defenseless women would promote his genes and they spread in the population.

I wanted to show you that the average man gets most turned on by the things that cause the woman the most suffering (of course within limits of not hurting the woman and with mutual consent). But the study that I found was so prude that it didn't even mention anal sex, acts like cumming on her face, etc. How can so many man desire such things in porn and not transfer them into bed with their wife?

https://www.forbes.com/sites/zhanavrangalova/2017/10/01/the-10-most-appealing-sexual-acts-to-us-adults/?sh=6f2fe671255d

The 10 Most Appealing Sexual Acts To U.S. Adults

by Zhana Vrangalova

This article describes this study:

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0181198

Sexual diversity in the United States: Results from a nationally representative probability sample of adult women and men

by Debby Herbenick, Jessamyn Bowling, Tsung-Chieh (Jane) Fu, Brian Dodge , Lucia Guerra-Reyes, Stephanie Sanders

So I will give you the proof from prostitutes, where man pay so we are sure they want a specific act that they paid for, and we know how much they want it based on the price:

Prostitutes have just such a menu with a price list. The price of each item (sex act) will be a function of two things: supply and demand. In other words, how easy it is for the prostitute to supply this (for example anal is painful so it costs more than vaginal sex). And demand means how much the clients want this thing. If something is in great demand then the prostitute can charge more for this thing.

Unfortunately in Israel prostitution is no longer legal. Because of a stupid law which went into effect (came into force) on July 10th 2020. The law says the consumer (the "john", the client) of prostitution should pay a fine. I'm sorry that the link is in Hebrew:

https://he.wikipedia.org/wiki/%D7%97%D7%95%D7%A7_%D7%90%D7%99%D7%A1%D7%95%D7%A8_%D7%A6%D7%A8%D7%99%D7%9B%D7%AA_%D7%96%D7%A0%D7%95%D7%AA

This is amazingly stupid and unfair both to the clients and to the prostitutes, and I can write a whole book of how dumb it is.

HAVE FUN WITH SHARON

https://web.archive.org/web/20190309085929/http://web.2allsex.com/Sites9/sexwithsharon/

meeting up to 40 minutes,

price 400 or 600 NIS, details on the spot.

(400 NIS equals 123 U.S. Dollars)

(600 NIS equals 184 U.S. Dollars)

additional 200 NIS to lengthen the meeting to be one hour.

(200 NIS equals 61 U.S. Dollars)

Facesitting (she sits on face)

Pee (she on you)

Silicone doll (I don't know what this means, I guess an actual sex doll and Sharon is watching or helping?)

Two guys can come to me together,

Price: each pays on himself time is shared.

I can come to your place only in Tel Aviv.

costumes (no additional charge)

Here comes a great variety of cosplay, like French maid, police officer, etc.

Also many "props", like sex toys like anal bids, butt-plug, strap-on, whip, hand-cuffs.

Since no additional charge is written, I guess instead of fucking with your dick you can fuck Sharon with a toy or whip her gently etc, and she doesn't mind.

http://www.wikizona.org/view.php?id=79

400 NIS per hour, cum in mouth, 600 shekels for anal sex.

(400 NIS equals 123 U.S. Dollars)

(600 NIS equals 184 U.S. Dollars)

this website has some feedbacks some good some bad.

https://web.archive.org/web/20161124024710/http://www.sexadir.co.il/place.asp?AdvertiseID=6768

a very big "johns" (prostitutes' clients) forum which had discussions with recommendations.

Sharon in action (unfortunately the videos themselves are not available anymore)

http://www.pornstar.co.il/category.aspx?category=173

And a sex slave girl named Shachar

Shachar Sub BDSM (bdsm)

http://www.wikizona.org/view.php?id=174

Price: 1500 NIS

(462 U.S. Dollars)

Remark: 1500 NIS, but she does everything and really enjoys it.

Here is the advertisement in the same forum “sex adir” (“marvelous sex” in Hebrew)

obedient/slave-girl

whatever you want I'm at your service

for those who are well off (wealthy) and in the know (connoisseur) only

a possible location + at your home/hotel

real photos

https://web.archive.org/web/20080404000235/http://www.sexadir.co.il/place.asp?CategoryID=25&AdvertiseID=2125

Also I remember for sure that Shachar used to charge about 700 NIS for an hour of that includes only regular sex (215 U.S. Dollars) , and about 900 NIS (277 U.S. Dollars) for an hour that includes also anal sex. And the 1500 NIS (462 U.S. Dollars) would make it include everything.

So this also goes to prove that man were willing to pay a lot more for the kinky stuff. Personally I never visited Sharon (unfortunately), but I did visit Shachar once for the whole package plus (I also paid more for another girl friend of hers Kim to join us), so it cost 1500 + 600 NIS but it was one of the most amazing things ever. I remember on the way back from Tel Aviv calling on the phone to my friend Rosner and telling him that if God Forbid a truck would hit me, of course I wouldn't want that to happen, but still I would die a happy man! 😊

Subchapter 2.07 – Limits epsilon and delta as LGBT couples, and L'Hôpital's rule as containment

We are now in chapter 7 of the series by 3Blue1Brown

Limits, L'Hôpital's rule, and epsilon delta definitions | Chapter 7, Essence of calculus

https://www.youtube.com/watch?v=kfF40MiS7zA

3Blue1Brown says at the beginning that limit means to approach.

So what do we have in sex and love that approaches something but never reaches there? Gay people! (for example a gay man tries to be like a woman but never gets there etc).

So one thing that we will check is who they are ATTRACTED TO:

So it turns out there is a scale for how gay someone is, this is the Kinsey scale:

https://en.wikipedia.org/wiki/Kinsey_scale

After answering some questions, you get your grade:

from 0 meaning exclusively heterosexual, to 6 meaning exclusively homosexual.

You can see people take the test here:

People Take The Kinsey Test

by BuzzFeed UK

https://www.youtube.com/watch?v=Cf-7wXqA7-Q

So for simplicity I will call it here

$$gayfeel$$

Like “how gay does someone feel” in terms of how attracted he is to same-sex partners.

For example if we say

$$gayfeel = 6$$

That person is totally gay.

On the other hand if we say

$$gayfeel = 0$$

That person is totally straight.

Another thing that we will use is who is ATTRACTED TO THEM:

So it turns out there is a scale for how masculine or feminine someone is, this is the Bem test:

Bem Sex-Role Inventory

https://en.wikipedia.org/wiki/Bem_Sex-Role_Inventory

You can see these videos on Youtube:

The Bem Sex Role Inventory

by Marcus Weaver-Hightower

https://www.youtube.com/watch?v=pKE3WuAUNCY

In the version that we will use you get three scores in this test:

from 1 to 7 how masculine you are

from 1 to 7 how feminine you are

from 1 to 7 how androgynous you are

So first of all we want to make it similar to the Kinsey Test from ZERO to SIX, so we will subtract one from each of the three scores.

from 0 to 6 how masculine you are

from 0 to 6 how feminine you are

from 0 to 6 how androgynous you are

let's talk about a MAN (for simplicity).

So we want to make a "how GAY you behave / look to others" test here.

we can take his "how masculine" score and flip it (doing 6 minus his "how masculine" score) So this is his ANTI-masculine score.

And this ANTI-masculine score we average together with his “how feminine” score:

$$gaylook = \frac{(6 - masculine) + feminine}{2}$$

So if a guy got 6 (maximum) in his masculine and 0 (minimum) in his feminine. So his ANTI-masculine will be ZERO, and we average this with his 0 feminine, so he’s doesn’t look gay:

$$gaylook = \frac{(6 - 6) + 0}{2} = \frac{0}{2} = 0$$

On the other hand if another guy got 0 (minimum) in his masculine and 6 (maximum) in his feminine. So his ANTI-masculine will be SIX, and we average this with his SIX feminine, so he looks totally gay:

$$gaylook = \frac{(6 - 0) + 6}{2} = \frac{12}{2} = 6$$

I’m sorry I ignore the androgynous, I’m trying to keep this example simple.

OK so now let’s assume that a gay person is happy if his “how gay you feel” matches his “how gay you look”.

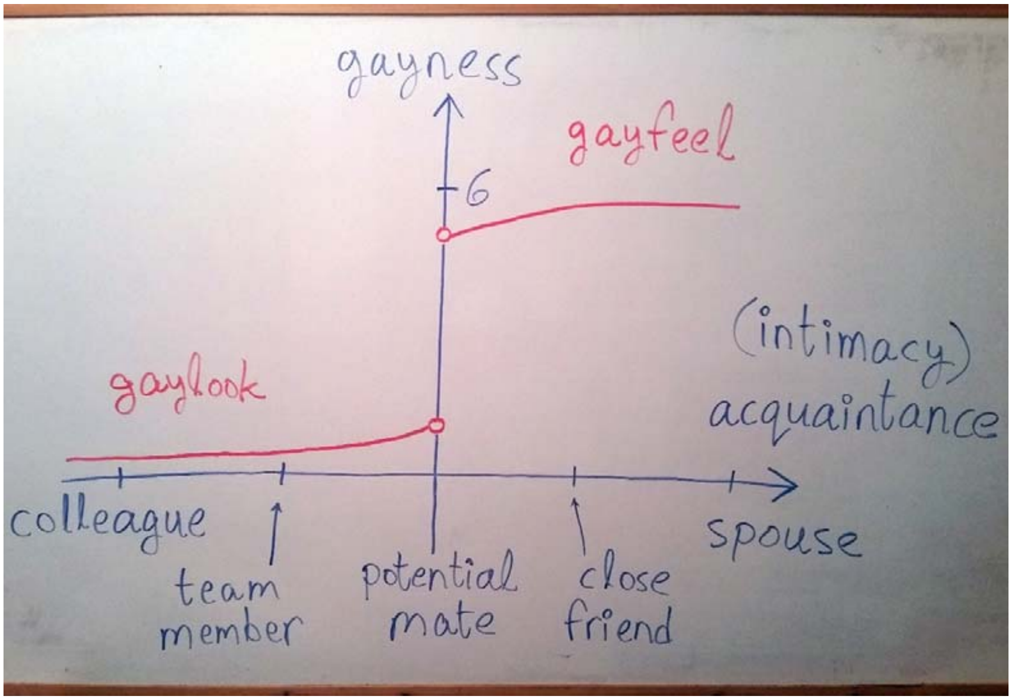
Think about it, if he’s 100% gay and also acts 100% gay, then he will attract the kind of people that are interested in the same thing that he is interested.

On the other hand, if he is 100% gay (gay in my example is wanting to be the woman), but he acts like a macho man, then he will have a hard time to find someone who will treat him like a woman which is what he wants. So he would be unhappy.

OK. So one the one side we have $gayfeel$ and on the other side $gaylook$

Now we check if “what he feels” (his internal dreams and fantasies – like he wants to be a woman) connects with “what he looks like” (how he comes across to the other –does he look like a woman to the other).

Picture 1: Critical time at beginning of relationship



“You never get a second chance to make a good first impression”

So there’s the beginning of the first date and we talked about how critical it is.

OK so if the hollow red points merge to be the same point, then we have a connection and we can say what the “gayness” value at that point. Otherwise, there is one “gayness” value of “how he looks” when the other person approaches to be a potential mate, and there’s another value of “how he feels” looking back in retrospect if he was in the right set of mind for the date to succeed.

In this picture we see that the red hollow points do not connect at all, so the gayness function is not continuous at that point.

But what if they look very close? How do we know if the two hollow red points are close enough to merge with each other so that they are one and the same point?

Please note: in this example the horizontal axis is the acquaintance level (or intimacy level). If you have trouble with the concept of intimacy (that is if you are a man 😉) think of it like a time line, and for each stage of the relationship there are specific DO ’s and DON’T ’s to that moment in time. Like if a girl would seriously talk about marrying you at the 1st minute after she met you, then it would seem like this is too fast. On the other hand if you have a few dates with a girl and you still haven’t kissed, it would seem like this is too slow.

OK. So we take a small intimacy environment around the that critical time at beginning of relationship. (in this example that's the moment ZERO (the vertical axis), and the "environment" means include the time a little before that and the time a little after that)

OK. What is the height that will make the date work perfectly? Let's say the

$$ideal\ intimacy$$

level on a date is "your trips abroad and your hobbies",

and you can go a little less intimate than this with "what music and films you like"

or you can go a little more intimate with "where you're from and what's your ambitions"

but that's it.

So that's our small ε .

This letter is called "epsilon" and it means "a tiny distance". So we check this narrow width

from ε to the left of that point which is

$$ideal\ intimacy - \varepsilon$$

To ε to the right of point which is

$$ideal\ intimacy + \varepsilon$$

https://en.wikipedia.org/wiki/(%CE%B5,_%CE%B4)-definition_of_limit

And what we try to find is what is the height distance between his $gaylook$ and his $gayfeel$ only in this narrow width.

It's like we are only looking at the first date (narrow time slice) and we see how close are his internal image and his external image. If they are too far the date will not be successful and they will not turn to be a couple get marry etc.

So how do we know if his internal (from the left-hand side) and external (from the right-hand side) "gayness" values are close enough?

We mark a horizontal line in the middle height between them, and say that we allow for the "gayness" to be only a small distance above it and below it.

This small distance is called "delta" δ

And it means "a small height difference"

So we have some $"ideal\ gayness"$ if they absolutely match.

And we take a small value above this

$$ideal\ gayness + \delta$$

And we take a small value below this

$$ideal\ gayness - \delta$$

So now let’s draw this example where they are so close that we suspect they are actually one point, and then the function is continuous. Let’s sketch this new situation:

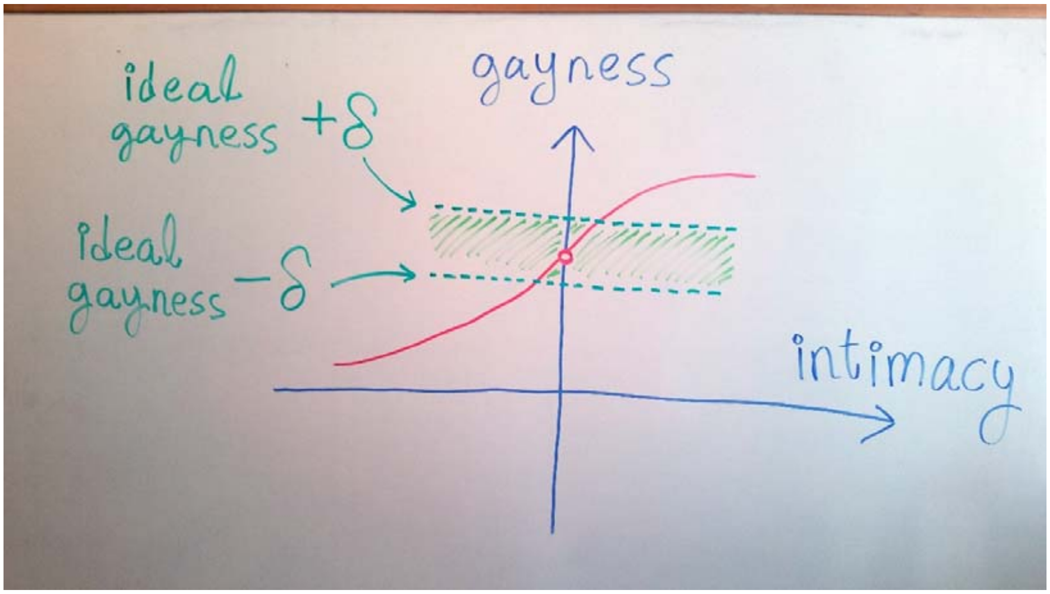
Now we “zoom in” to check if the two red hollow points merged into one point.

So the whole thing is like a question and an answer, or someone challenges us and we need to succeed in that challenge he gives us.

CHALLENGE: can you make the gayness THIS close to the ideal gayness?

(as close as this small δ from above and from below)

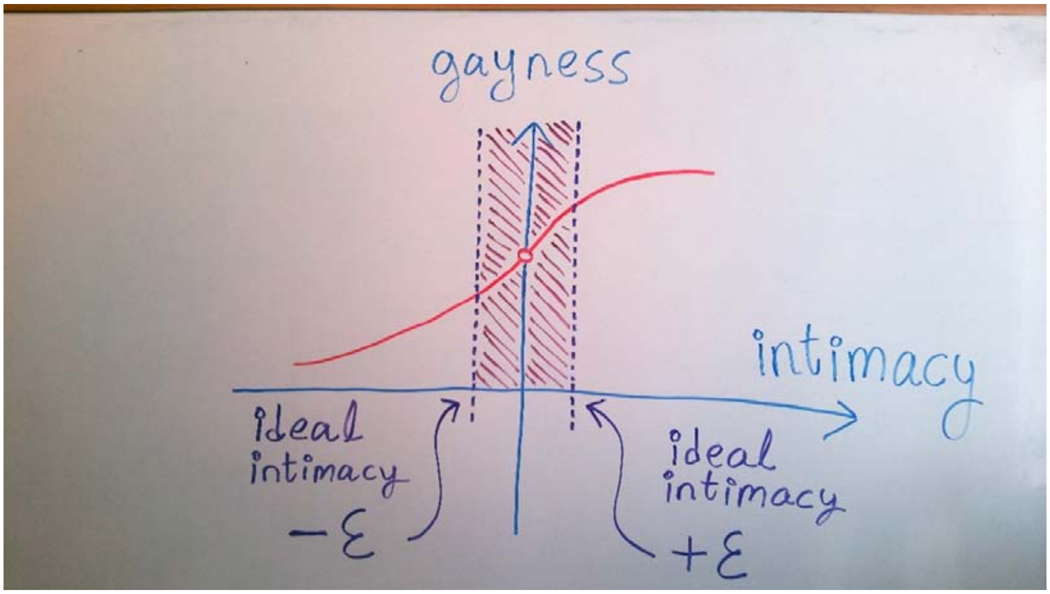
In other words: can you force the points to remain inside the green band?



RESPONSE: yes I can, by looking at a very short time period THAT close to the ideal intimacy moment

(as close as that tiny ε from the left and from the right)

In other words: yes I can by looking only at what happens inside the narrow purple band.



And then in the next round, he challenges us by a closer (in other words: smaller) δ

And our response is answering by choosing a tinier ε

And this challenge-response rounds can go on and on to infinitely miniscule sizes.

So IF for ANY δ that the enemy will ask us, we can answer successfully with SOME tiny enough ε , THEN that means that there is a there is a LIMIT at that point.

Or in our story language:

Let's say after already becoming a couple they think back and analyze what happened when they first dated, and our guy (which is described by the graph) is the angel who says it was just perfect, he had the ideal GAYNESS in the critical moment of the ideal INTIMACY; and the other guy is the devilish bitch who says no at first it looked like the curves didn't match: you projected one thing while you were another thing inside.

so IF for ANY "demand of being closer to the ideal GAYNESS", our guy is able to successfully answer by showing that there was a very brief time (intimacy) period before and after the ideal INTIMACY moment, when that demand was fulfilled (our guy was as close to the ideal GAYNESS as much as the bitch has just demanded), THEN that means that our guy did indeed approach the ideal GAYNESS at that the moment of the ideal INTIMACY.

I hope you understood what this epsilon-delta definition of limit means. If not read here:

https://en.wikipedia.org/wiki/(%CE%B5,_%CE%B4)-definition_of_limit#Informal_statement

OK. Now in order to get ready to L'Hôpital's rule

https://en.wikipedia.org/wiki/L%27H%C3%B4pital%27s_rule

which talks about dividing two functions (how many times one can get inside the other), we need to understand what that means in our metaphor.

Actually L'Hôpital's rule talks about a situation where we CAN'T divide the two functions because it's like dividing by ZERO which is forbidden; But let's understand first the simpler scenario of what happens where we CAN divide the two functions.

Let's say our gay couple are the two functions.

Now as you probably know there is a term in psychology that's called: CONTAINMENT.

https://en.wikipedia.org/wiki/Wilfred_Bion

this is one of the rare cases where the Hebrew version of Wikipedia does a better job than the English version of Wikipedia (in something that has nothing to do with Israel or Jews). So allow me to translate the explanation from the Hebrew version:

https://he.wikipedia.org/wiki/%D7%94%D7%9B%D7%9C%D7%94_(%D7%A4%D7%A1%D7%99%D7%9B%D7%95%D7%9C%D7%95%D7%92%D7%99%D7%94)

Containment (in English: containing) is a concept in the field of psychology that describes an ability to accept emotions and difficulties of the individual or of the other as they are, without pushing/shoving them or denying them or projecting them on the other person in an unadapted/unsuited way.

Containment is linked to the ability to give emotions and hard situations an interpertation or observation that enables to accept them and assimilate them.

The concept of containment was developed in the 50's and 60's of the 20th century by the psychoanalyst Wilfred Bion, in the context of the concept of projective identification of

Melanie Klein from whom he learned psychoanalysis. the concept of containment of Bion refers to the ability of the mother to contain feelings and threatening situations of the baby without projecting them back onto the baby. for instance, the mother's ability to understand anxiety of the baby that cries and screams and to approach and hug and comfort him, instead of interpreting the screams as expressing threatening feelings that might even be linked to the mother's inner world (such as: "the baby hates me") and as a result to freeze or to get distanced from him because of the difficulty with coping with these feelings.

In the context of psychotherapy, Bion describes the therapist as a "container" ("tank") for the patient, whose job is to contain his difficult emotions, by which he is thratened and find it difficult to process them himself. the containemnt is done by accepting these emotions, delaying them within him and turning them less threateneing, and finally returning them to the patient through an theraputic intervention like interpertation in a way that he can feel them, accept them and not be threatened by them. In so doing, according to Bion, the thrapist can develop the ability of self containment - learning to gradually observe such difficult emotions and contain them within himself.

Side by side with using this concept in context of parentship and psychotherapy, the concept of containment might be used in any relatoionship between people (such as friendship, working relationship (industrial relations)) in terms of the ability of the individual to accept difficult emotions of the other, understand and respond accordingly, in a manner that neither rejects these emotions nor projects them onto the other.

OK. So far Hebrew Wikipedia. If this psychology mambo jumbo is too abstract, let me put it in simpler terms. I once had a girlfriend named Karoliese and she explained to me the question she would ask herself before she would get married: “Can I put up with this shit?”. Yes not very romantic, but you get the idea. So to contain someone is to put up with his shit.

OK. So going back to our example, this time around armed with the term CONTAINMENT.

So dividing two functions is figuring out “how many times” the first function that’s up in the numerator (above the fraction line) can contain the second function that’s down in the denominator (below the fraction line). This “how many times” is a third function that’s the quotient (the result of the division operation).

So let’s suppose our guy is the first function (that is divided) up in the numerator, and the bitchy partner is the second function (by which we divide) down in the denominator.

So dividing the two is figuring out “how much” the first function can CONTAIN the second function. For example after how many tantrum episodes by the bitch, would the rational partner break and say “I can’t take it anymore”. So that “how much” is a third function that we will call “CHEMISTRY” (because I’m tired of calling everything “love”).

So let's write this as an equation:

I'm taking the terms "MASC" for a "masculine gay man" and "FEM" for a "feminine gay man" from this article in the Washington Post, I hope it's the correct term - imagine someone like Marlon Brando who you're willing to bet that he's straight macho man and he's actually homosexual, and on the other hand imagine David Bowie or someone else whose whole appearance shouts "I'm gay".

How I finally learned to stop favoring 'masculine' gay men

By Jack Rushall

https://www.washingtonpost.com/news/soloish/wp/2016/07/07/how-i-finally-learned-to-stop-favoring-masculine-gay-men/

Ok. So our equation is:

$$chemistry = \frac{masc}{fem}$$

Okay so if there is a great CHEMISTRY, that means the MASC can CONTAIN a lot of times the FEM's tantrums etc.

OK. So since these are functions, if their graphs are "smooth" and continuous, we can find out their derivative. In other words if these gay people are normal people (and not psychos who "jump" from state to state in a moment with no apparent reason), then we can usually predict them and see "where it's going" or "what's their leaning". In terms of a graph this is the slope at that moment. That means if they continue the way they are now:

is the $masc$ going up ("man up") and the fem going down ("calm down"), so that now the $chemistry$ is no going up ("flare up")?

So we need to know where each of them is "going" if we want to predict the CHEMISTRY. But what happens if we can't tell? Let's say that both of them are going to ZERO. That means that the $masc$ gets weaker and weaker so it's harder for him to CONTAIN the other, but at the same time the fem gets weaker and weaker too, so he becomes easier to CONTAIN.

Which if these two TRENDs will win?

$$(chemistry)' = \frac{masc \to 0}{fem \to 0} = ?$$

What L'Hôpital's rule is actually tells us is that the key word is TREND. We should look how fast (what slope) each of them is changing. The “trend” of each one (in other words: the slope of each function) is competing with the other one. That’s exactly what the derivative tells us, the rate of change. So L'Hôpital's rule tells us to calculate the derivative by simply comparing the derivative of which function wins:

$$(chemistry)' = \frac{(masc)'}{(fem)'}$$

And if that still comes out as “something that races to ZERO” divided by “another something that races to ZERO” then do L'Hôpital’s rule again, and find the rate of change of the rate of change of each of them (second derivative) and so on.

Subchapter 2.08 – Integration and the fundamental theorem of calculus as investment love and turn-on OR attention submissiveness and arousal

OK we are in the 8th video by 3Blue1Brown (in this series)

Integration and the fundamental theorem of calculus | Chapter 8, Essence of calculus

https://www.youtube.com/watch?v=rfG8ce4nNh0

By the way this is how this book actually started – that's the first idea I came up with!

PLEASE NOTE:

3Blue1Brown uses the usual position→speed→acceleration which is a lot easier to explain, but I wanted to make things special and more exciting for you! I'm the good guy! 😊

Okay 3Blue1Brown is using the very standard way of explaining, which is also the historical way because Newton invented calculus to calculate how the planets move. So we can do this, or we can do something more interesting which is explaining through love and sex.

We'll use two separate examples, one related to love and one related to sex.

Instead of using distance, and distance's derivative speed, and speed's derivative acceleration,

We will use in our "love model": spend (of time and money and attention), and spend's derivative which is love, and love's derivative which is "turn-on".

And we will use in our "sex model": attitude, and attitude's derivative which is submissiveness, and submissiveness' derivative which is arousal.

I promise it will become more clear once I will explain it with the aid of illustrations (graphs).

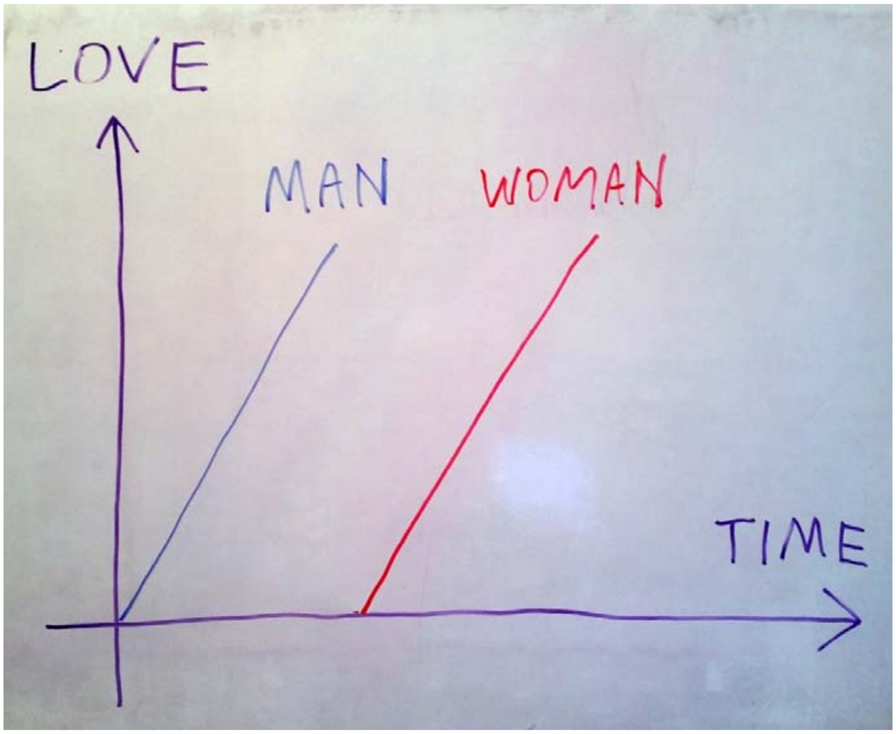
I will draw for you approximate graphs on the whiteboard by hand, because the accuracy here is not important, I just want you to understand the ideas. Later on we can always make things more rigorous but now we want to get the hang of it.

I remember with my mythological ex-girlfriend, we were invited once to the home of her best friend and her (the best friend's) boyfriend. So we were sitting in that other couple's yard and they were nice people. Towards the end of our visit, we were alone just the guys (me and the boyfriend of my ex's best friend) and he told me: "you love her too much".

I answered that I know I spoil her, but I'm sure I have bad traits which I'm unaware of and they surely upset her, so at least in all the things that I am aware of and that I am in control of, I want her to have all the best that I can give.

If you are naïve like me (I'm not naïve in general, just in love), you might think it's absurd to say "you love her too much", I mean how can the best thing in the world be bad? Well it turns out that guy was right. Thinking back, basically that is why I lost my mythological ex-girlfriend. So now we will break down how the woman's mind works and by the way we will understand calculus.

Picture 1 – the woman follows the man

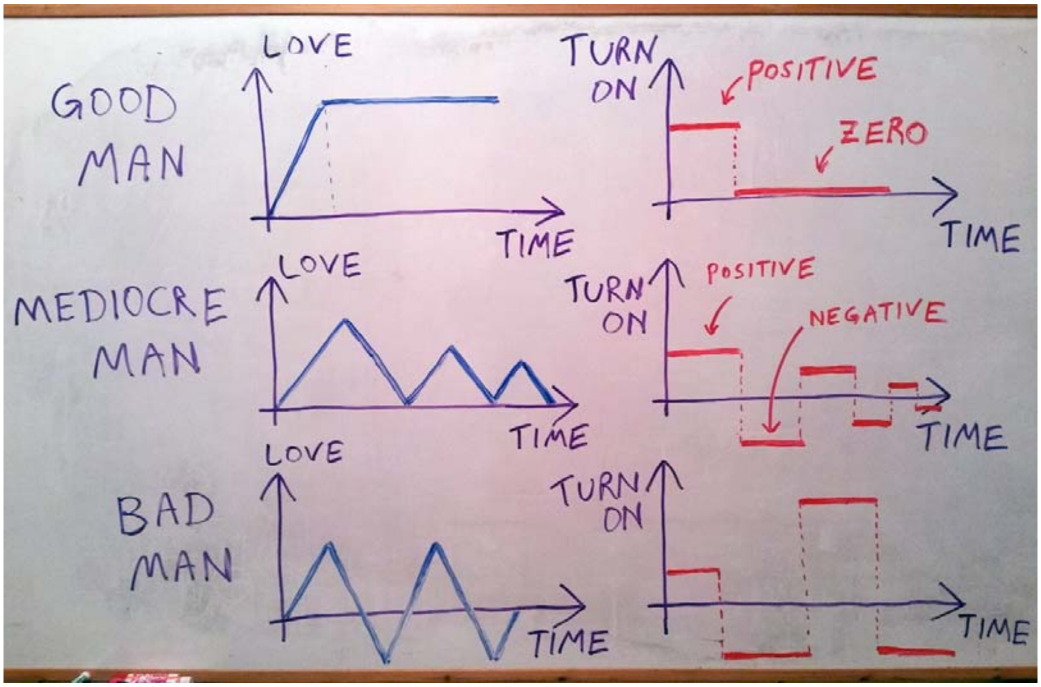


What we see in the picture is that the man falls in love first, and also the man tells the woman he loves her first. The woman takes more time, but she reaches the same level of love later on.

OK now the main idea which can be put in Verdi's words: La donna è mobile – or in English – Woman is fickle (by the way, in the opera it is the song of the bad guy, and the good woman sacrifices herself for him. But the title of the song is very appropriate to real life as will be explained shortly).

What do I mean that the woman is fickle? It's like in electromagnetism – the CHANGE (not the level) in the electrical field (the love of the man) creates a magnetic field (the love of the woman). The woman loves the "falling in love" which is the CHANGE (growth) in love. That is why any swindler/con man/liar/cheat/scoundrel who plays it "cool" wins her over. Now I will explain with graphs.

Picture 2 – the man's love towards the woman and his love's derivative (this derivative equals the turn-on of the man, and it equals to the love of the woman toward the man) .



OK, I hope you can see it, this picture is like a table of graphs. There are 3 lines (good man, mediocre man, bad man) and 2 columns (love versus time, turn-on versus time).

So in each line we have the original function (man's LOVE vs TIME) on the left in blue, and we have the derivative of that function (TURN-ON vs TIME) on the right.

OK let's start on the 1st line which is the good man.

In the upper left, we see the good man's love towards the woman grows quickly to the maximum which is high and stays fixed there.

Now look at the derivative of this graph, which is the turn-on on the top right. The woman checks the rate of change (which is positive as long as the man's love grows), but then the rate of change becomes ZERO (when the love is fixed which means unchanging). The woman doesn't care that the good man's love function is steady on the maximum and she gets a lot of love from him. She just sees the derivative (she gets used to and bored from this constant love) and she sees ZERO.

By the way my mythological ex-girlfriend once told me (when we were a few months together) that every time I tell her she's beautiful (which she was!) she hears "looking nice". ☹

OK now we are on the 2nd line, the mediocre man.

On the middle left, we see the mediocre man's love towards the woman, grows more slowly to a lower maximum and then fades to zero. Then again we he sees he's losing her he gives some effort (not as hard as the initial courtship) and then again fades to zero love. Etc.

Now look at the derivative of this graph, which is the turn-on on the middle right. The woman checks the rate of change (which is positive each time that the mediocre man gives some effort, and negative each time he takes her for granted). But the woman doesn't care about the negative parts (on the contrary, it gives her an achievement feeling when she does get him), and on the other hand she is excited about every positive section (not in the original love function on the left, but in the derivative function on the right). So you see we get an absurd conclusion where the woman will love the man who loves her mediocrely compared to the good man who loves her constantly! ☹

OK now we are on the 3rd line, the bad man.

On the bottom left, we see the bad man's love towards the woman, it doesn't get as high as the good man, and even not as high as the mediocre man, and then it plunges to ZERO and then even further down to the negative (negative love means he hates her at that point). But watch what happens now, the bad man comes to his senses and it grows: his hate first turns to indifference (ZERO) and then to the same height he was before (not very high), but it's a long climb in the upper direction (he starts very negative and grows to positive so high in absolute terms, but very high in reference to the bottom of hate).

Now look at the derivative of this graph, which is the turn-on on the bottom right. Again, the woman checks the rate of change (which is positive each time that the bad man stops hating her and then loves her a little, and negative each time he ignores her and then hate her). But the woman doesn't care about the negative parts (on the contrary, she is more grateful for the "flip" upwards comes)

By the way I looked up a quote from Konrad Lorenz which I read as a kid in " Civilized Man's Eight Deadly Sins". It goes like this (I will translate from Hebrew which is clearer and then give you the English version which is less clear) :

An ancient Austrian peasant joke describes exactly what happens so: ' today I will pleasure my dog : At first I will beat it with all my might, and afterwards I will stop. '

If you want here it is in the "softened" English version (Perhaps they didn't like the fact the Konrad Lorenz was in the Nazi Party, and maybe they didn't like the cruelty to animals as well) :

' The old joke about the man who persistently hit himself on the head with a hammer because it felt so good when he stopped, here hits the nail on its head '.

OK so anyway you can see that the woman likes to be treated as the dog in the proverb. I'm not saying this happily, I'm very sad about it, both because that's why I always found it very hard to find a girl who would like to be my girlfriend, and because if women stopped doing that then the bad people would go extinct. But the actual number of women who are attracted to bad people who are bad to them, leaves no room for doubt, this is sad but true.

OK now back to the graph:

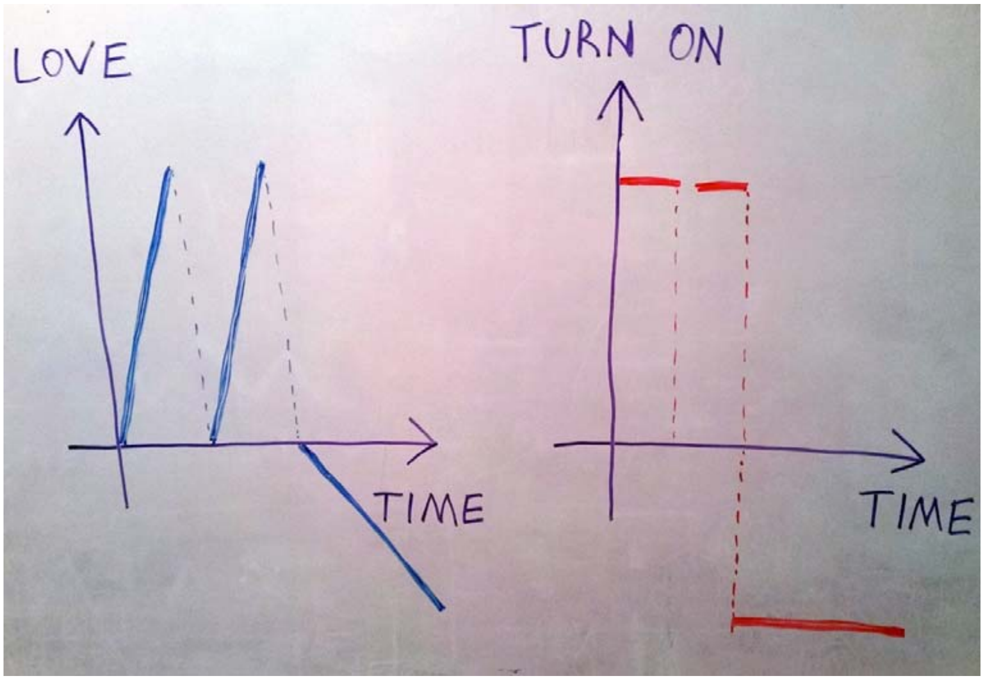
On the other hand the woman is excited about the length of every positive section (not in the original love function on the left, but in the derivative function on the right). So you see we get a very absurd conclusion where the woman will love the man who loves-hates her badly even more then the mediocre man who loves-ignores her! ☹

OK now we will figure out something even more amazing/depressing:

Why do so many women fall for swindler/con man/liar/cheat/scoundrel?

With our new tools or the love function and the derivative function (which is the man's turn-on function, and the woman's love function), it's easy to see how it happens:

Picture 3 – swindler



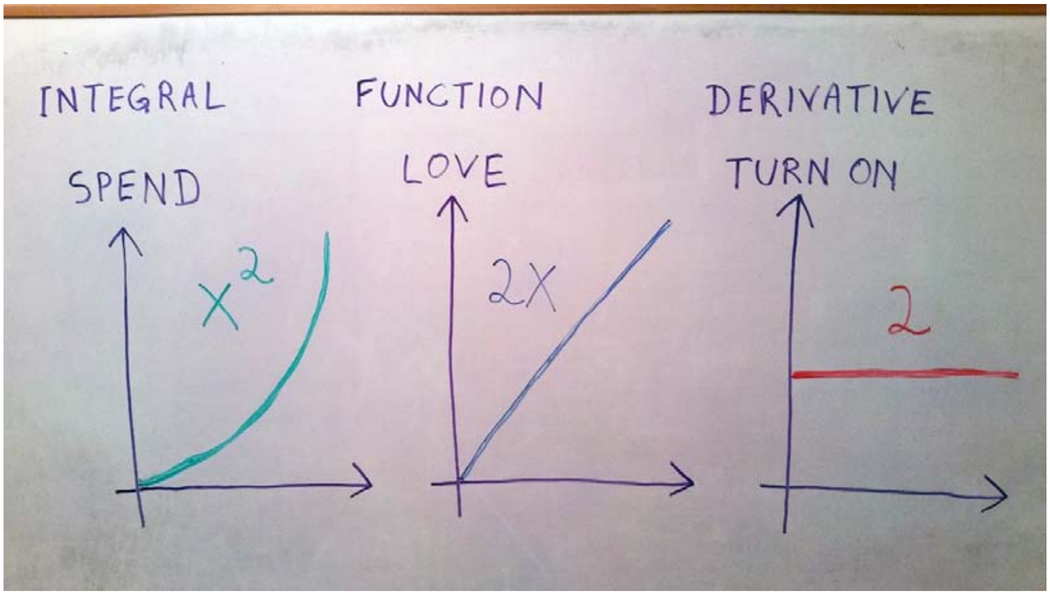
As we can see on the left graph in blue, the swindler's fake "love" jumps up very fast, and this sudden rise gives on the right graph very high derivative. That's why women love swindlers. The "fall" after each rise is the period during which the swindler deliberately vanishes from the woman's life. For example he can say he's on very important business trip, or he's a secret agent, etc.

On the right graph we can see that the short and intense periods of (false) wooing translate in the derivative to very high and very short "burst" plateaus. After establishing huge trust and love in the woman this way, the swindler cashes in on all these feelings of the woman, by taking advantage of her sexually and/or financially and/or abandoning her to raise his kids by herself while he repeats the process with his next victim.

OK so far we talked about DERIVATIVE (momentary rate of change).

Now let's just mention the inverse which is the INTEGRAL (sum of all these momentary changes).

Picture 4 – the function (Love), the derivative of love (turn on), and the integral of love (spend).



Moving to the right (in this picture) is done by the operation of derivative: the derivative of spend is love; and the derivative of love is turn on.

Moving to the left (in this picture) is done by the operation of integral: the integral of turn on is love; and the integral of love is spend.

Here I wanted to make things simpler so I referred as function to the middle one, and if we go from the middle to the right it's done by deriving, and if we go from the middle to the left it's done by integrating.

The usual example for the rate of change: the derivative of position is speed; the derivative of speed is acceleration.

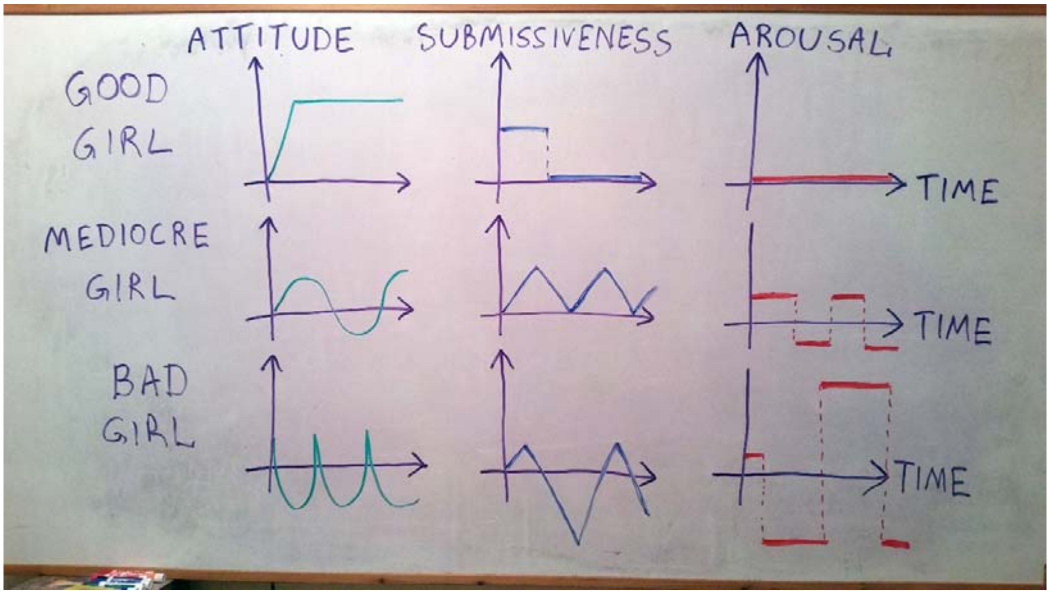
The usual example for the sum of the small changes: the integral of the acceleration is speed; the integral of the speed is the position.

The numerical examples in the picture: 2 and $2x$ and x^2 are just to give us a ballpark feeling.

By the way the sad conclusion of our discussion here is that it's most effective for the woman to have something like "alternating current" (AC) instead of "direct current" (DC). So the most effective relationship for a woman would be with several male partners in different phases. Something like Pulsed DC.

OK so far we talked about the "love model" – how to win over the woman. I promised you also a "sex model". Here is the "sex model" – how to win over the man.

Picture 5 – Sex model



Let's first explain our model with words:

The man is looking for change (variation) in sex. A change in sex is being kinky, which means change in dominance/submissiveness. The girl being at one moment a goddess on a pedestal in the next moment a dirty humiliated whore which he controls.

OK, again I hope you can see it, this picture is like a table of graphs as we've seen before. There are 3 lines (good girl, mediocre girl, bad girl) and 3 columns (attitude (of the girl towards the guy) versus time, submissiveness (of the girl towards the guy) versus time, arousal (of the guy from the girl's behavior) versus time).

If the change in this dominance/submissiveness is great then the arousal is great. So in our model the original function is submissiveness and the DERIVATIVE of the function is arousal.

What is the INTEGRAL of the function? We need something that when it changes back and forth it makes the girl dominant/submissive. I think this is attitude (or attention/giving). A bitchy or flirtatious girl is very volatile, one moment she's nice, the next she's cruel, so these changes establish her control which we will see as dominance (or negative submissiveness).

OK. Now back to the picture:

So in each line we have the original function (girl's SUBMISSIVENESS vs TIME) on the middle in blue, and we have the derivative of that function (guy's AROUSAL vs TIME) on the right in red, and we have the integral of the function (girl's ATTITUDE vs TIME) on the left in green.

OK let's start on the 1st line which is the good girl.

On the top left (in green), we see the good girl in the beginning gives the guy more and more attention and kindness (what we call here good attitude), until she reaches her maximum of giving and she stays at that constant maximum.

On the top middle (in blue), we see that the guy interprets the good girl in bed as submissiveness which he likes at the beginning. But once the good girl reached her maximum of attitude the guy doesn't have anything to "submit" so he feels ZERO submissiveness from her.

On the top right (in red), we see how much aroused is the guy from the good girl's behavior, which is not at all. At first she is submissive in a uniform way, and then she's neither submissive nor dominant, in a constant way, so she's constant almost the entire time, so he doesn't feel this arousing saint/whore "flips" which excite him.

OK now let's look at the 2nd line which is the mediocre girl.

On the middle row on the left (in green) we see her attitude goes up and down in a wavy form.

On the middle row on the center (in blue) we see that this unstable behavior is interpreted in guy's mind as repeating "conquests" of the girl each time she "gives in".

On the middle row on the right (in red) we see how this translates to ups and downs from positive to negative. Let's assume he's prepared to suffer through the negatives (like when she "forces" him to give her oral sex) in order to reach the positives (like when he "forces" her to give him oral sex).

so absurdly he's more excited with the mediocre girl in bed, then with the good girl who gives him everything! ☹

OK finally we are on the 3rd line which is the bad girl.

On the bottom left (in green) we see that the bad girl treats the guy badly most of the time, with "peaks" every once in a while.

On the bottom middle (in blue) we see that the guy interprets this as being very dominant and very submissive in alternating fashion. Why? In absolute terms he doesn't get much from the cruel girl: let's say if the bad girl once in a millennium gives him a blowjob, the mediocre girl would let him cum in her mouth, and the good girl would also let him cum on her face and swallow. But he feels greater "conquest" in "submitting" the bad girl every once in a very long time to raise above all her negativity (dominance) and become slightly positive (submissive). ☹

On the bottom right (in red) we see that the long "ascending" from her great dominance over him to being slightly submissive towards him (which can be in a rare "treat" of letting him be on top – which the mediocre girl would give him at least half the time, and the good girl would give him whenever he wants), looks for the guy like a great change in her, so he is aroused to have any kind of sex with his queen, and if she's allowing herself to be slightly submissive he's very aroused. ☹

Subchapter 2.09 – What does area have to do with slope? As “I Put A Spell On You” and natural porn star quality

/////// BEGIN of short musical rant ///////

I googled the name of the song and it brought up Annie Lennox?!? This is why you can’t trust Google (in retrospect this is from the success of the movie “Fifty Shades of Grey” which brings me to the question why did this boring movie succeed so much? There are things so much more interesting in porn!) so anyways I spent the last hour listening to many other versions:

https://en.wikipedia.org/wiki/I_Put_a_Spell_on_You#Covers_and_samples

And the best version by far is still by Nina Simone!

From the first few seconds of the slow haunting and seductive violins with which this version opens it tells all the other versions: “Kids, go play outside, Momma is about to do her black magic now…”, then Nina Simone starts to sing and the charm flows from the speakers. No need for gimmicks of any kind. Then the strings give way to the horns with an uncompromising fast "double-tonguing" saxophone which symbolizes I guess either the man or the magic spell itself, anyway it tries to compete with her, but Nina Simone being the musical voodoo queen that she was end up with everything under her control.

I Put A Spell On You

Nina Simone

https://www.youtube.com/watch?v=2UppUCB5V-w

/////// END of short musical rant ///////

OK. We got to part 9 in 3Blue1Brown’s series

What does area have to do with slope? | Chapter 9, Essence of calculus

https://www.youtube.com/watch?v=FnJqaIESC2s

OK so he tries to find the average height of the sine curve (between 0 ° and 180 °)

So where did the name of this subchapter come from? Because literally this is what our story will be. When I googled for a story for this subchapter I found this interesting article:

Romance Rides on Brainwaves

New research finds a matchmaker in our brain.

By R. Douglas Fields Ph.D.

https://www.psychologytoday.com/us/blog/the-new-brain/202001/romance-rides-brainwaves

which explains this research paper:

Don't you want me, baby? Cardiac and electrocortical concomitants of romantic interest and rejection

by

F.M. van der Veena, A. Burdzinaa , S.J.E. Langeslagb

Biological Psychology

Volume 146, September 2019, 107707

https://doi.org/10.1016/j.biopsycho.2019.05.007

Which says is that there is a specific area in our brain which lights up in a specific way when we are romantically interested in someone. It's like a romance-o-meter inside our brain.

BUT

Now I'm telling you that I think that like many things in nature we can operate this in reverse and make someone fall in love with us! An example to such reversal of cause and effect is the "God helmet":

https://en.wikipedia.org/wiki/God_helmet

which triggers the "God spot" that each of us have in our brain

https://en.wikipedia.org/wiki/Neuroscience_of_religion

the same area in the brain that lights up when someone experiences genuine spiritual religious experience, can be lit up artificially and produce a similar experience (like some presence is with you in the same room, you are guarded by an angel etc).

But because most of the public is religious and also religions have massive money and power, Wikipedia is very amorphic about this, because the religious people don't like the idea that they are worshipping a bug (or a feature?) inside our brain.

Okay so maybe you are one of these religious people so another example of reversal of cause and effect is needed:

Misattribution of arousal

https://en.wikipedia.org/wiki/Misattribution_of_arousal

Here the idea is that when we fall in love we get excited, but this can work in reverse too: For example if a girl meets a guy on a high and narrow bridge (she is excited because the situation is dangerous) her brain later interprets this as if she was excited about the guy, and she falls in love with the guy. That's why it's recommended to go for a first date to an amusement park (Luna Park) because the physically exciting rides will convince your date partner that he or she is falling in love with you.

OK now lets say we a girl and we want this guy to fall in love with us.

So admittedly this requires some preparation and money, and might be cheating but remember what John Lyly taught us: All Is Fair in Love and War.

First thing's first: where is this "anterior cingulate cortex"?

https://en.wikipedia.org/wiki/Anterior_cingulate_cortex

We see in Wikipedia that it's in the area of the guy's higher forehead (a few centimeters above his eyebrows). Of course we can't put an electrode into his brain. So what can we do? If we could put a transmitter that will transmit the correct signal in the correct time, and place it on the guy's forehead we're in business. How do we get there? Luckily there is a bug in the human male system that any straight guy if you tell him that you got two tickets to the sports game of his favorite team (when they're playing in town) and you have no one to go with, and you wonder if he'll go be interested go with you as friends, that's an offer a can't refuse – HE WILL COME. At least that's what they show in the American movies. To find out which team he's a fan off is not very hard just keep your eyes peeled for a sticker/shirt/key-chain etc, or eavesdrop when the guys talk sports which is easy because they usually argue in a loud voice about these things.

So we got him to be close to you for like an hour or so (I'm not a fan of sports myself so I don't know exactly). How do you get to his forehead? Here we have a shopping list that we need to buy and then carefully prepare beforehand.

First you need to buy matching hats (like pink or red for you and blue or black for him) like if it's hot where you live then something like caps:

https://www.amazon.com/Ny-Yankees-Cap/s?k=Ny+Yankees+Cap

and if it's hot where you live then something like a wool hat

https://www.amazon.com/New-York-Yankees-Knit-Hat/s?k=New+York+Yankees+Knit+Hat

And at the game itself you need to insist that you both put THESE caps because you have a superstitious all your life that it brings luck to your favorite team (yes we need a small white lie here) and he mustn't take it off the whole game because it's really important to you. Since he's in your debt for the ticket HE WILL WEAR IT.

OK now of course his cap is where the magic happens. Since people get sweaty during sports these hats have a layer like lining to absorb the sweat, so this is where we hide the electronic device that will generate the required waveform for the guy's brain.

Where does the device gets the power? We don't want it to have a battery, because we want to keep things as small and light-weighted and unnoticeable as possible, so device needs to be "passive", like the electronic smart card you put in the car and opens the boom barrier or many other examples

Radio-frequency identification (RFID)

https://en.wikipedia.org/wiki/Radio-frequency_identification

like for example the electronic toll collection device in California

https://en.wikipedia.org/wiki/FasTrak

or another example the "chip" which is the size of a grain of rice that is inserted under every dog's skin to identify him, this microchip (integrated circuit) is exactly such a RFID device.

https://en.wikipedia.org/wiki/Microchip_implant_(animal)

By the way I'm sure in the future they will implant such things into humans, I personally think this is a step in a terrible direction, see here how the FDA already approved this:

https://en.wikipedia.org/wiki/Radio-frequency_identification#Human_implantation

OK so this solves the power to the device issue, you will have in your purse (a girl always has some bag or purse or something) a matching transmitter device to the receiver & transmitter (this is called "transponder") in the guy's hat. Your transmitter needs to give the power to his device, so it needs batteries. But since it's in your purse it can be as big as we need.

OK another thing your device needs to transmit to the guy's device is what kind of waveform we want the small device (the guy's device) to transmit to the guy's brain.

OK so I have a confession to make: To my great shame, I don't know ANYTHING about electronics! so from here on I am guessing what can be done in principle.

As you know there are tiny gadgets that read brainwaves

Electroencephalography

Dry EEG electrodes

https://en.wikipedia.org/wiki/Electroencephalography#Dry_EEG_electrodes

Which are very small

https://en.wikipedia.org/wiki/Neurowear

https://www.amazon.co.uk/Macrotellect-EEG-Headset-Brainlink-V2-0/dp/B07F5M12MS

https://www.amazon.com/neurosync-brain-computer-interface-others/dp/b0143q5m22

Wikipedia says:

In 2015, Mind Solutions Inc released the smallest consumer BCI (brain–computer interface) to date, the NeuroSync. This device functions as a dry sensor at a size no larger than a Bluetooth ear piece.

So we just need the opposite device, something that TAKES electricity and GIVES brainwaves.

I'm sure it's just a matter of which frequency and modulation and waveform and other things that if I knew something about electronics I could tell you how it actually can be done. Basically if you've ever studied high school physics, if you move electricity through a conductor (the brain runs electricity inside its nerves) the change in electricity makes a magnetic field (which we pick up using these small devices of electroencephalography that I told you about). And if you remember the physics lessons, you can do the same in reverse, when the magnetic field changes outside of an electric conductor (using a small inductor very close to the skull),

https://en.wikipedia.org/wiki/Inductor

this change causes electric current to run through the electric conductor (we make electricity run inside the nerves)

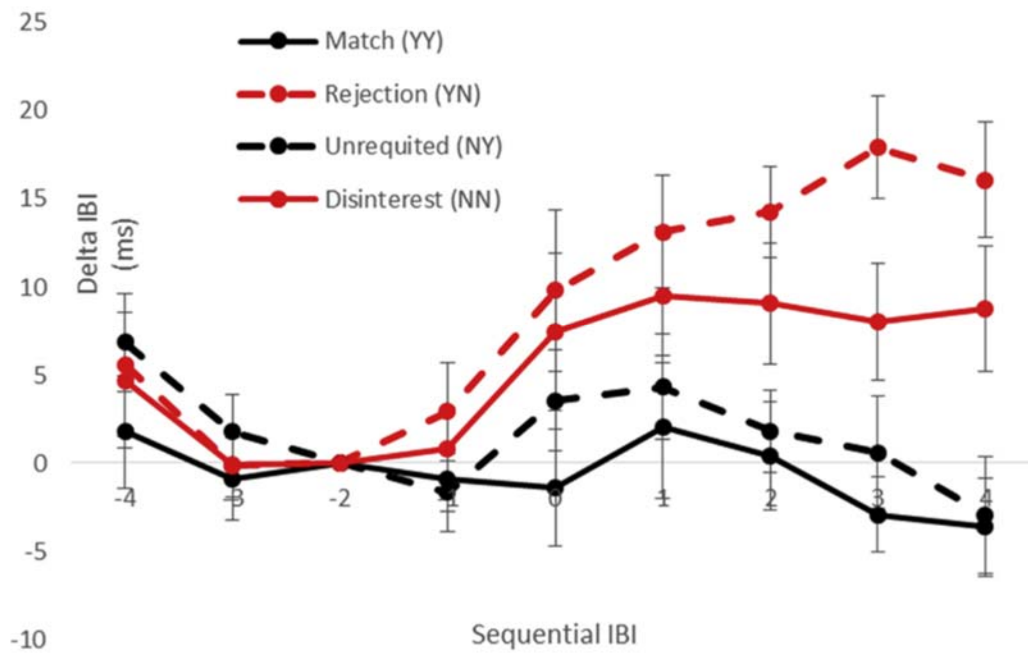
https://en.wikipedia.org/wiki/Neural_oscillation

How do we know we affect exactly the nerves that we want? Because this specific circuit is already ready to pass electricity in the first second he looks at us, so it's just a matter of how much current will pass there: a lot means he will think we're hot; a little means he will think we're not.

OK so in the scientific paper that we are talking about you can see that the "match" always has the strongest signal:

OK so here I have another confession to make: I switched the graphs by mistake:

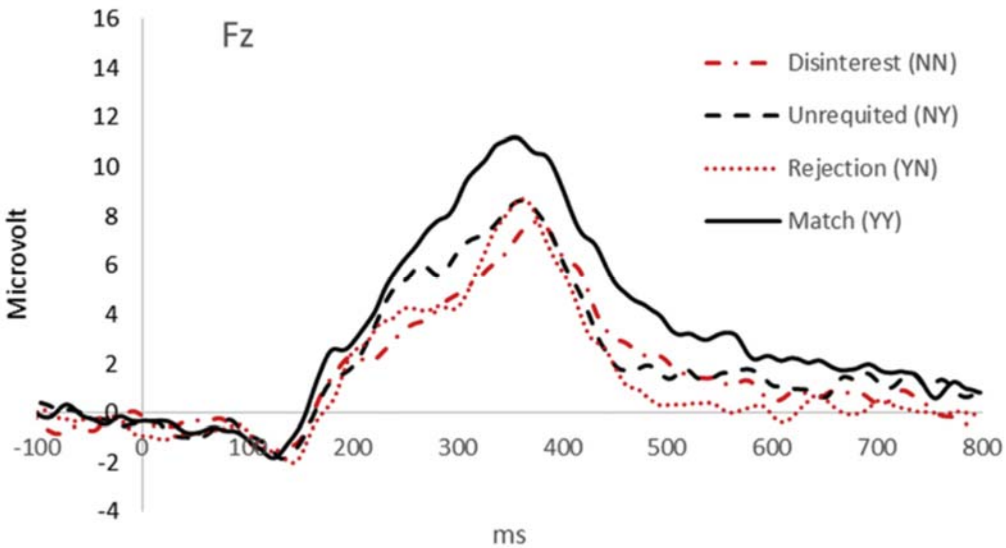
I saw this graph of the heart:



And I thought it looked somewhat like SINE wave and I mistakenly thought it refers to the brain activity.

But it turns out now that I looked again, that this nice SINE-like waves are describing the HEART and not the brain.

This is the graph of the BRAIN, and it doesn't look like SINE:



But I am too lazy now to come up with a totally different story ☹ so:

(1) Don't ever to try to mess up with someone's heart electricity because you will probably shut down their natural pace maker mechanism and they will die!

(2) Since we only need the "hill" part anyway in this scenario from the BRAIN graph – remember SINE from ZERO to 180 degrees is one hill – we'll just ignore the fact that the HEART graph fits better, and make do with the BRAIN graph and assume that a round hill that the SINE produces is good enough.

(3) The good part is that in the heart graph the MATCH was the lowest (the heart slows like the proverbial missed a beat when we see our love interest. While in the brain graph on the other hand, the MATCH is the highest strongest signal and this is good for us because we can make a signal higher (transmit with more power) so we mask whatever original signal the body made (like we do in Electronic Warfare for communications that we jam), but we don't know how to lower a signal that the body is already producing.

OK so the last thing we need in our scheme is the trigger device, which can't be in our purse, it needs to be in our hands, because when the guy looks at us we immediately needs to activate the trigger so he gets the right "vibe" about us. What can we control discretely with our hands?

First of all if we are wearing pants than this doesn't have to be our hand, we can wire the toes of our feet inside our shoes that when we make a movement we don't usually do (like for example the upward extension of our big toe will close a circuit that will wirelessly order our purse to activate the guy's hat.

But I think that today everybody have their mobile phone in their hands the whole time, especially if you are in a sports game you have an excuse you need to be ready to take a photo at any moment. So maybe it's simpler to do this with an app on our mobile phone that will be connected to the unit in our purse. Again it takes some work but what wouldn't we do for love?

OK. So after all this preparation we come to the question that 3Blue1Brown is asking us: What is the average value in the first half of the SINE wave?

In our case I simplify the BRAIN graph, let's say we start at height 0 and then go up to 11

And finally go back to 0, and all this is measured in microvolts.

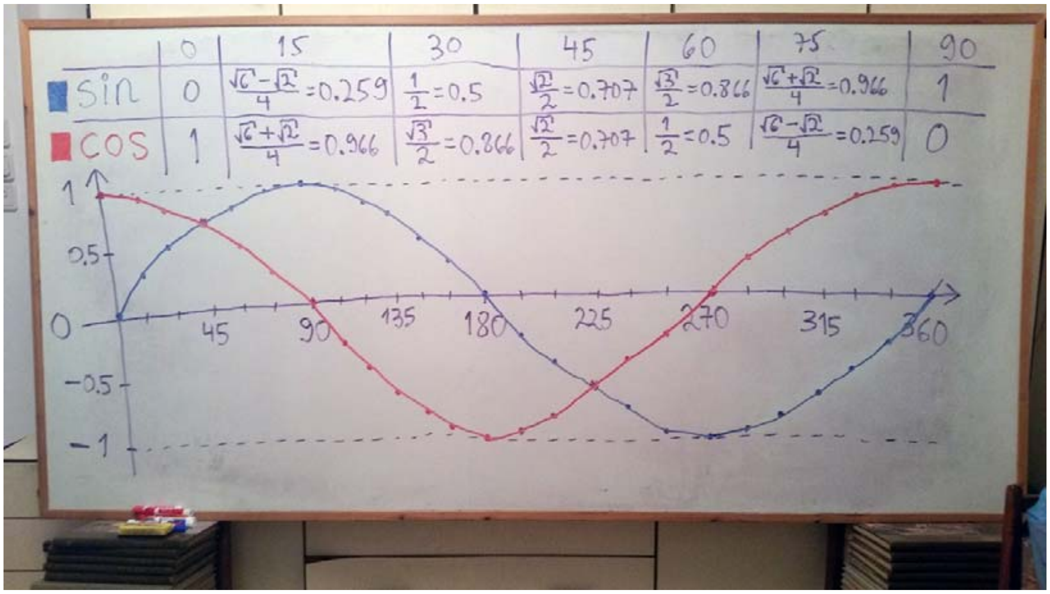
And it starts from time 150 and finishes at about time 550 and all this is measured in milliseconds.

By the way if you ask yourself what is the DERIVATIVE of the electric field we got, it's the magnetic field that produced it. Because a change in one of them creates the other. We mentioned this also as the inspiration for the changing swindler that turns-on the girls because of the quick CHANGE in his "love" (like the magnetic field CHANGE quickly and so creates the electric field and vice versa).

OK. So I my plan was to motivate you with this story which I think I did because who wouldn't be interested in a real life love potion? That's what people look for the most along history. Yes, together with the elixir of life to live forever and also the philosopher's stone to be rich – but what they want to DO with all that time and money is be with the babe that they love and make her love them back.

OK so we got the motivation to look into the first half cycle of the SINE function. But now I feel like if I would just describe the changing electricity and magnetism etc, it doesn't mean anything to our intuition. In fact my favorite lecturer from MIT OpenCourseWare videos – Prof. Walter Lewin – once said in a lecture about electricity and magnetism that these things are NOT intuitive even to him, so don't feel bad this stuff isn't intuitive to anyone! 😊

So I think it's fair enough if we use for the interpretation the SINE and COSINE the same metaphor that we already used in subchapter 2.03 (with The Big Bang Theory) with picture 8, where we used the scenario of horniness. To make a long story short they are chasing each other with a constant gap between them (they are the same graph with a phase shift of $90°$).



///////// BEGIN text from subchapter 2.03 ////////////////

Scenario 1 – mental "horniness":

OK so first I suggest we will interpret the picture as mental horniness level (sexual arousal).

How do the man gets turned on? He gets an erection from visual stimulation from some stimulus. Maybe it's the woman bending over, or her scent or something. The man knows (feels physically) he was aroused consciously when he feels his dick hard. So he is now aware of his physical horniness and this causes his mental horniness to rise. So let's just follow the blue line from the beginning (left). He was neutral towards sex which is 0 (height) at time $0°$ (left most) and now he's getting more and more horny until we reach the maximum of $+1$ at time $90°$.

(Now for the moment ignore what happens to the woman from time at time $0°$ to time $90°$. We will get back to this time and explain in the next cycle).

OK so what happens between $90°$ and $180°$?

There's a mutual feedback between the woman not yet in the mood (neutral meaning 0) , and the man who was super in the mood 1 , but now gets cold signs from the woman.

For example when she is reluctant she is tickled by his touch (when she is aroused the same area of the body interprets the sensation as pleasurable and sensual not tickling).

So the man cools down to 0 , and the woman is verging on annoyed at -1 .

$$\vdots$$

OK so we finished the first whole cycle from $0°$ to $360°$

So now we are at the second cycle, the graph visually looks the same, you just add to each point in time the first cycle which we just finished meaning $+360°$

OK so what happens between $360°$ and $450°$? (this is what I owe you from before by the way)

Let's say they are both in bed and the woman is hot at maximum but then she sees that the man's dick is only half erect and that gets her down to neutral level 0 .

But on the other hand the man still excited from what she encouraged him before gets over this time span a full hard on and he's fully horny in the level of $+1$.

///////// END text from subchapter 2.03 ///////////////

OK so now with this more familiar and human and intuitive story let's try to translate 3Blue1Brown's visual explanations to our verbal explanations.

So each man has in his pants a built-in horniness gauge like a horny-meter which is of course his dick. So imagine if we tied the man in one fixed place, and taped a marker pen (felt-tip pen) to his dick, and we had a paper rolling from the right side of the man to the other, then we could use the man himself to get the graph of the SINE,

like these demonstrations of a sand pendulum:

Sand Pendulum at the Exploratorium

Physicsfun

https://www.facebook.com/watch/?extid=SEO----&v=595259780837973

Sand Pendulum - Simple and Complex Harmonic Motion

Pete von Werder

https://www.youtube.com/watch?v=Bud1uvDMOzU

So if we would consider

the man's dick when it's soft (not erect) and pointing 45 ° towards his feet and this would be our value of MINUS ONE,

and the man's dick when it's hard (semi-erect) and pointing 0 ° that is perpendicular to the man's body and this would be our value of ZERO,

and the man's dick when it's hard (fully erect) and pointing 45 ° towards his head and this would be our value of PLUS ONE,

then we could use the man himself as horniness gauge.

For the woman she doesn't get hard (the clit does get more blood but we can't see) and she gets wet inside her pussy which we also can't see (theoretically we could measure the conductivity when she's wet). So anyway we would just refer to the horniness value theoretically, as if we could stop the action every minute and ask them how horny they are right now: from the lowest -1 which means frigid, through 0 which means neutral, all the way up to the highest $+1$ which means hot as a fire.

So what would be the average of the MAN (who is the SINE in this example) in all the time that takes him to get from ZERO to PLUS ONE and back to ZERO ?

Why is this useful?

Perhaps the wants the man who is best in bed NATURALLY, and she comes to the conclusion that if the man is in his NATURAL peak then he performs like the SINE wave, and if he performs better this means he is cheating with VIAGRA, and if the man is performing worst than the SINE then it means he as some erectile dysfunction.

By the way I once read an article with male porn star Kyle Stone who complained that Viagra almost put him out of the porn business, because suddenly every guy could do ARTIFICIALLY what only he (and very few others) could do NATURALLY

https://www.theage.com.au/entertainment/viagra-ruining-industry-porn-stars-20020705-gdud6f.html

So let's say we are in a special situation where we can't get Viagra or anything like it

https://en.wikipedia.org/wiki/PDE5_inhibitor

Let’s say we are producing a porn movie in space and each kilogram that we launch is very expensive or the sponsor the film is an organic products company and wants everything natural, or maybe like the actress Renee said in the interview with Kyle Stone:

"You always know who is on Viagra because it makes them red in the face and in the chest, which is really ugly," she said.

Now comparing the graphs themselves is complicated because it’s a curvy shape with many many values. On the other hand comparing the average is very easy it’s just one value. So in conclusion, we want to find the average horniness of the MAN in the first half of the cycle (the hard-on part of the fucking) – how close is he to this natural porn star quality?

Let’s say the guy maintained his erection for half an hour, which is 30 minutes.

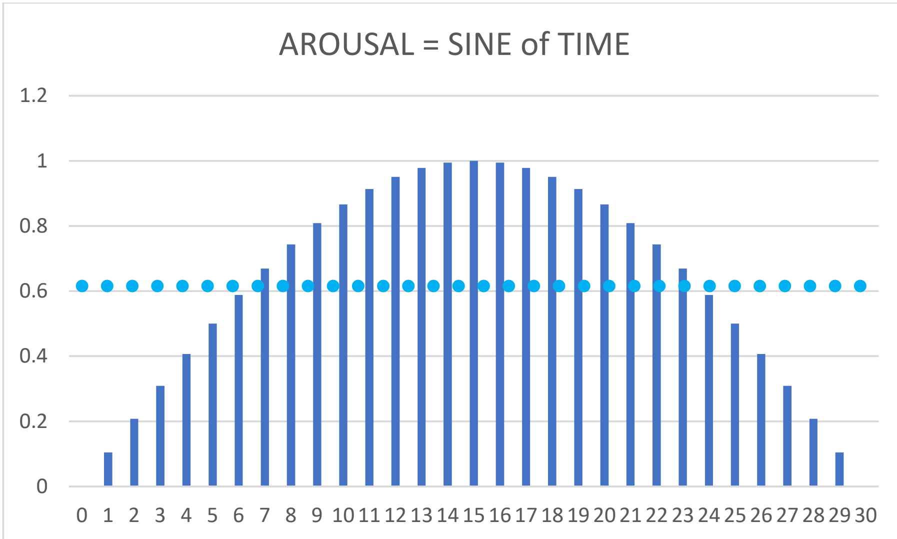
So we could measure him every 1 minute.

You can do this yourself in Excel: in A1 you write TIME, and below this in A2 you write 0, and below this in A3 you write “=A2+1” (but without the quotes signs). And then stand on the lower right corner of the A3 rectangle, press the mouse button (the regular left mouse button) until the mouse becomes a small cross, and then DRAG downwards until you reach A32. This way Excel will fill automatically 1,2,3,… all the way up to 30.

Now in B1 write AROUSAL. And in B2 write “=SIN(RADIANS(A2*180/30))” (but without the quotes signs). And drag the corner of B2 downwards in the same way that we did before, until you reach B32.

Go to the middle of the A1 (not the corner this time) and hold down your mouse button (left mouse) and DRAG downwards and a little to the right until all the cells we used are highlighted.

Now go to the menu and choose INSERT. And in the CHARTS section click on the big button “recommended chart”. And in the window that opens choose “clustered columns”:



So in the picture you can see the columns, and imagine they are each touching each other (I don't know Excel that well 😊).

Also you can click on the graph you just made, and then click on the PLUS symbol + and from the options you can choose trendline, so you have the average like I did. Now you can click on the trendline and RIGHT CLICK and choose format trendline and you can make it more fancy like I did in the panel that opens on the right side of the screen (click the bucket symbol for all the "cosmetics" such as width and color of the line.

OK. What do we see? The dotted turquoise line is about 0.6

(in units of erection per each moment)

That means if we look for the NATURAL PORN STAR QUALITY, we are looking for a guy with this number. Above this he's not natural, below this and he's too impotent.

OK so we know this thanks to Excel. But what if we want to do this ourselves?

So 3Blue1Brown tells us the secret: Don't think about his horniness in each moment (the height of each column), instead think about his horniness TIMES time, in each moment (the area of each column).

To understand what this is we need to think what function has the horniness as it's DERIVATIVE (rate of change).

Man's horniness changes as ???

As they say in French:

Cherchez la femme ('look for the woman')

https://en.wikipedia.org/wiki/Cherchez_la_femme

I know we talked about the woman as the DERIVATIVE of the man, back in subchapter 2.03 she was the DERIVATIVE of the SINE which is the COSINE which is the red graph here (COS).

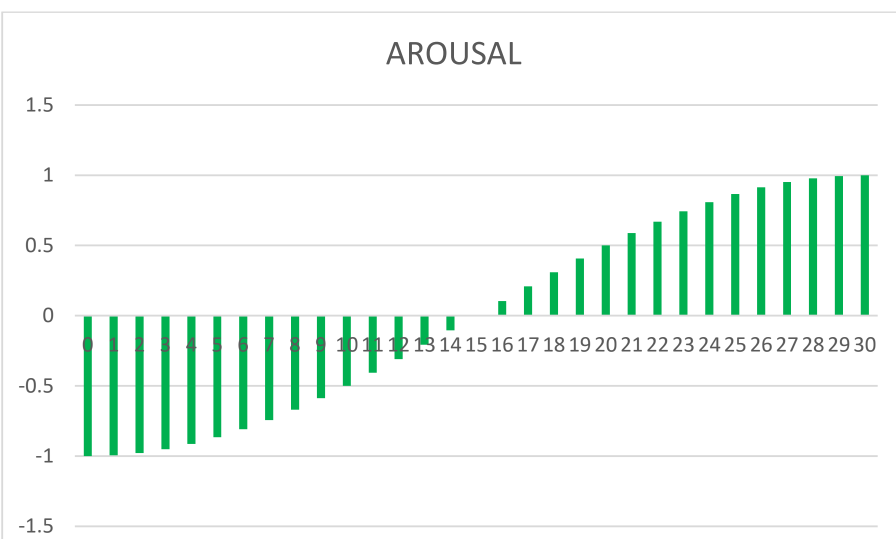
BUT

The woman's horniness and actions are not just the RESULT of the man's horniness and actions, they are also the CAUSE of the man's horniness and actions.

In other words the woman (not AS IS but with some "twist") is the ANTI-DERIVATIVE of the man. In other words the DERIVATIVE of the "woman with twist" is the man.

What is that twist? In our case it's a MINUS, this means we FLIP the COSINE like a mirror in the UP-DOWN direction:

=(-1)*COS(RADIANS(A2*180/30))



This is the graph of MINUS COSINE. Which means the opposite of the woman's horniness and actions.

What does this mean in real life? What "mirrors" the WOMAN's horniness?

This thing is strong when the woman's horniness is weak.

This thing is weak when the woman's horniness is strong.

I would say it's her Prude

https://en.wikipedia.org/wiki/Prude

Cambridge dictionary:

a person who is easily shocked by rude things, especially those of a sexual type

Merriam-Webster dictionary:

a person who is excessively or priggishly attentive to propriety or decorum especially : a woman who shows or affects extreme modesty

Collins dictionary:

If you call someone a prude, you mean that they are too easily shocked by things relating to sex.

So the green graph is the PRUDE graph of the WOMAN.

So we understand that there is a battle inside the woman between the "angel" which represents are morals and upbringing and the "devil" which represents her desire and horniness. So the green graph is the prudish "angel".

How does this affect the MAN?

The CHANGE in the PRUDE excites the man. The man finds it very sexy that the good girl BECOMES a bad girl. Even if the change is slight. For example on the beach no one gets an erection when he sees all these beautiful girls in tiny bikini swimsuit. Because there is no CHANGE there. The woman started off in a certain PRUDE value and ends up with exactly the same PRUDE value.

But if in bed or in another context where showing more skin means she is more sexually available a guy sees the same amount of bare skin this is a lot more arousing for him because here this means that before she took of her clothes she was more PRUDE and now that she took her clothes off she is less PRUDE. This CHANGE if measured from moment to moment (like the moment when her ass is revealed mmm) this is the DERIVATIVE of PRUDE.

At the beginning the PRUDE green graph is in -1 which means she is not prude at all.

Think of the beautiful Kelly Stafford who is mentally like a female version of Rocco Siffredi (the best male porn star ever in my opinion):

https://es.wikipedia.org/wiki/Kelly_Stafford

https://it.wikipedia.org/wiki/Kelly_Stafford

https://fr.wikipedia.org/wiki/Kelly_Stafford

The man sees the woman acting like a slut and dropping her PRUDE act, like maybe she talked dirty to him, or started moaning or acted slutty, and it's very arousing for him so in the next "turn/station" (it takes time for each partner to react) he gets to his most aroused and he is in PLUS ONE .

But while Kelly has the mentality of Rocco which means "no limits", a regular woman has a battle going on inside her: "oh I'm such a slut, it's not moral, it's not respectable" etc.

So the regular woman horniness is going down (RED graph from subchapter 2.03) and the PRUDE graph of the regular woman is going up (GREEN graph) to ZERO.

How does this affect the MAN?

He is now very horny but he sees that the woman is starting to hold back,

And she stops being responsive and fun.

Then later she might even say something like "slow down" or pushes him back a little, which has a chilling effect so his horniness is getting down to ZERO has her PRUDE gets up to $+1$.

So let's summarize: the woman's PRUDE changes from -1 to $+1$ and this changes dictated the horniness of the man.

the ANTI-DERIVATIVE at the end, MINUS the ANTI-DERIVATIVE in the beginning, gives us how much surface is below the function.

What is the meaning of the surface? It's not the horniness which is the height of each column; and it's not the time which is the width of each column. It's the product of what happens when we combine horniness and time, so I would say it's all the ACTIONS that the man do.

Like if the man is horny for a moment he would thrust his pelvis into against her pelvis, or squeeze her tits and so on. So each small SEXUAL ACTION like this is the area of a column. A rectangle.

Like a public display of affection but without the public part 😊

https://en.wikipedia.org/wiki/Public_display_of_affection

and all these areas of all the rectangles together are the area below the graph of the man, which is the whole total of the small SEXUAL ACTIONS during that time.

What does the "fundamental theorem of calculus" tell us?

https://en.wikipedia.org/wiki/Fundamental_theorem_of_calculus#Formal_statements

$$\int_a^b f(t)dt = F(b) - F(a)$$

THE LEFT SIDE tells us that:

If we have a function MAN'S HORNINESS which we call $f(t)$

And we want to SUM UP (the $\int$ is an elongated S from the latin word "summa" which means the English word "sum") all the area that is below the graph of our function between the points a and b ,

THE RIGHT SIDE tells us that:

Then all we need to do is take $F(t)$ (which the ANTI-DERIVATIVE to our function), which in our case is the PRUDE and calculate only in these two points. And the difference between them is the answer!

In our case the total area (the sum of all the man's sexual actions) is the difference between how PRUDE the woman is in the end of this time which is VERY PRUDE $+1$, and how PRUDE the woman is in the beginning of this time which is VERY NOT PRUDE -1 .

So this difference is $+1-(-1)=2$.

That's because in each time the CHANGE of PRUDE dictates how horny the man will be in that moment. And given time (going from height of the columns = "man's horniness" to height TIMES time = man's sexual actions) we get the all the rectangles (area of columns) together which is the total of what the man does = all his sexual actions.

But we didn't care about his actions, we wanted to know what goes on in his mind (or his dick which when aroused it's the same thing), so we have AREA and we want HEIGHT. So we need to divide by the WIDTH. What is the width? It's the total time. Since we are talking about the time from $0°$ to $180°$ but remember we are calculating in RADIANS so that means 0 to π . So the total time that we are talking about in this subchapter is $\pi-0$ which means of course π .

So to summarize:

We want to divide the difference in PRUDE value at the end points 2

By the total time between the end points which is π

So the answer is $\frac{2}{\pi}$

This is the average SLOPE of the PRUDE between the start time and the end time. SLOPE is the DERIVATIVE. The derivative of the PRUDE is the HORNINESS of the man. So we have here the average HORNINESS of the man, which we calculated without Excel all by ourselves! 😊

Which is about **⅔** which makes sense because we saw that the average of the man's horniness (The dotted turquoise "trendline" remember?) was about 0.6

Subchapter 2.10 – Higher order derivatives as Sex in Space and the Battle of the Sexes

OK. We are now in the 10th video by 3Blue1Brown:

Higher order derivatives | Chapter 10, Essence of calculus

https://www.youtube.com/watch?v=BLkz5LGWihw

First of all the reason we are talking about sex in space

https://en.wikipedia.org/wiki/Sex_in_space

is because I think it's very cool. Why hasn't this been done yet already?

The closest thing so far was this:

Short of actual space, the adult entertainment production company Private Media Group has filmed a movie called The Uranus Experiment: Part Two where an actual zero-gravity intercourse scene was accomplished with a reduced-gravity aircraft. The filming process was particularly difficult from a technical and logistical standpoint. Budget constraints allowed for only one 20-second shot, featuring the actors Sylvia Saint and Nick Lang.[21] Berth Milton, Jr, president and CEO of Private Media Group, says "You would not want to be afraid of flying, that's for sure!"[22]

And I've watched some of it now and I think that scene is on minute 28:30 when the actor tries to cum in the mouth of the actress (Sylvia Saint) and the sperm just flies in all different directions 😊

https://xhamster.com/videos/the-uranus-experiment-2-7320860

But why do we talk about sex in space?

Because I will talk to you about the movement of the man's pelvis when thrusting his dick into and out of the woman's pussy, and what slows down this movement is the mass of the man. Now on Earth we talk about mass and think about weight. But in space we don't have weight, but we still have mass. So in space the concept of mass as INERTIA (the body wants to keep what it's doing, if it's moving then keep moving in the same direction, if it's stopped then remain stopped) is much more clear to understand. So when we will later say that what the woman seeks is a fit man (like not fat) and his pelvis thrusts prove it to her by causing vibrations (as will be explained very soon), then we can understand the whole mass better if we think about it in space. A fat man can't change his direction fast in space either, not because he is heavy (there's no weight without gravity) but because he has a lot of mass so he has a lot of INERTIA.

By the way I downloaded the Sex in Space episode from The Universe series, which Wikipedia shows a screenshot from. So if I'll get some more insights I will add them here later.

JERK is the DERIVATIVE of acceleration:

If something moves (for example a car) it changes position.

the RATE OF CHANGE of the position is the velocity.

the RATE OF CHANGE of the velocity is the acceleration.

the RATE OF CHANGE of the acceleration is JERK (or jolt)

Above this it continues but I can't think of useful examples, even if I don't limit myself to love and sex, so I'll just do what humans do when they don't understand something, they concentrate on what it's called.

So the next three "RATE OF CHANGE"s are inspired by the advertising mascots of Kellogg's Rice Krispies:

Snap, Crackle, and Pop.

https://en.wikipedia.org/wiki/Fourth,_fifth,_and_sixth_derivatives_of_position

the RATE OF CHANGE of the JERK is the snap or jounce

the RATE OF CHANGE of the snap is the crackle

the RATE OF CHANGE of the crackle the is pop

We will talk about JERK which is the 3rd DERIVATIVE of position.

https://en.wikipedia.org/wiki/Jerk_(physics)#Physiological_effects_and_human_perception

Human body position is controlled by balancing the forces of antagonistic muscles. In balancing a given force, such as holding up a weight, the postcentral gyrus establishes a control loop to achieve the desired equilibrium. If the force changes too quickly, the muscles cannot relax or tense fast enough and overshoot in either direction, causing a temporary loss of control.

...

Excessive jerk may also result in an uncomfortable ride, even at levels that do not cause injury. Engineers expend considerable design effort minimizing "jerky motion" on elevators, trams, and other conveyances.

For example, consider the effects of acceleration and jerk when riding in a car:

Skilled and experienced drivers can accelerate smoothly, but beginners often provide a jerky ride. When changing gears in a car with a foot-operated clutch, the accelerating force is limited by engine power, but an inexperienced driver can cause severe jerk because of intermittent force closure over the clutch. ...

Where do we see this in sex? We can't see this when a guy fucks a girl with his dick, because then the inertia of his whole pelvis and torso is keeping his acceleration down (the force from his butt muscles

https://en.wikipedia.org/wiki/Gluteal_muscles

pushes his pelvis forward but since force equals mass TIMES acceleration, then acceleration equals force divided by mass. and here we divide by a lot of mass, the mass of the torso (trunk) which is most of his body.

On the other hand, we see in porn (I'm sorry I never got a chance to try this in real life) that when they want the girl to cum (or squirt) the guy is simulating just dick with two fingers and penetrating the girl repeatedly with his hand like this, using the muscle of his arm - the muscle we show when someone tells us to "make a muscle"

https://en.wikipedia.org/wiki/Biceps

So now the part that's moving (his forearm from his elbow to his fingers) has little mass, and he can get high acceleration. but the important part is that since accelerates forward, and then decelerates forwards (inwards into the girl's pussy), and then momentarily stops, and then accelerates backwards (outwards from the girl's pussy) and then decelerates backwards and momentarily stops and so on,

there is a change in acceleration which means JERK.

so the JERK is the RATE OF CHANGE of the acceleration. and as we understood from the examples with the car and the elevator this gives her a sense of loosing control, so the girl loses control over her bladder and squirts which triggers an orgasm.

Another interesting thing about JERK can be learned from Wikipedia in French:

https://fr.wikipedia.org/wiki/%C3%80-coup

Importance in the mechanisms

Relationship between acceleration and compression of a cylinder rod: isolation of the moving part (top) and isolation of the piston (bottom).

When you push on a rod to compress it, the deformation progresses in the form of a compression wave.

To create an acceleration, you have to make an effort, according to the fundamental principle of dynamics . From the application of this force and the notion of inertia , an elastic deformation results . If the acceleration changes rapidly, then the strain also changes rapidly; this causes oscillations in the system, and therefore vibrations.

Examples

More concretely, let us take the example of a mobile of mass m pushed by a jack on a horizontal plane. The movement is done without friction, the mass of the cylinder rod is negligible. We place ourselves in a phase of uniform acceleration, a is therefore constant. If we isolate the mobile (at the top in the figure opposite), we see that it must be pushed with a force

$F = ma$.

If we isolate the piston, we see that it undergoes the thrust of the fluid (oil or air depending on the type of cylinder), being F, and the action of the mobile, -F. The rod is therefore in elastic compression, it undergoes a deformation which is proportional to the acceleration.

If the acceleration changes slowly (the jerk value is small), then the length of the rod gradually varies. But if the acceleration varies rapidly, the change in length propagates in the form of a compression wave . The parts are adapted to new stresses in the form of damped oscillations . It creates jerks, vibrations.

The greater the acceleration, the greater the thrust force, and the greater the elastic deformation of the system.

Let us now place ourselves on the side of the solid pushed by the jack. Let us take a formed solid (see figure opposite):

of a parallelepipedic block denoted 1, of mass m_1 ;

a sphere denoted 2, of mass m_2 ;

the sphere being connected to the block by a rod of negligible mass.

To accelerate this system with respect to the ground, it is necessary to provide a force F equal to

$$F = (m_1 + m_2) a .$$

The system then deforms elastically. This is easily understood by placing oneself in the frame of reference linked to the system {1; 2} (figures on the right):

the part 1 undergoes an inertia force F_{i1} opposite to F, it is therefore in compression;

the part 2 is subjected to an inertia force F_{i2} opposite to F, the rod is therefore in bending .

If the acceleration varies slowly - therefore if the jerk value is low - then part 1 will deform slowly, and the bending of the rod connecting 2 to 1 will evolve slowly. But if the acceleration varies suddenly - so if the jerk is important - then the sudden compression or relaxation of block 1 will propagate in the form of a compression wave, and the rod between 2 and 1 will undergo a boost.

Conclusion

A large jerk value means that the acceleration changes sharply, so the force changes sharply. One can then no longer consider that the deformation of the system is homogeneous. So there are vibrations that propagate in the system. These vibrations can create degradation, as well as noise.

OK. I'm sorry it's long but it's all relevant. What do we learn that is relevant to sex?

That when we the JERK (the RATE OF CHANGE of the DERIVATIVE) is big then we have vibrations.

The first association is a vibrator, and indeed you see that every gadget that causes the woman to cum (reach orgasm) is focused on the vibrations, and not for example friction of the pussy like we might have thought intuitively from thinking how the dick goes in and out.

This means that in order to reach an orgasm, the things that is important for the woman is the vigorous thrusting of the man's pelvis. If the impact from his dick changes the acceleration of her pussy walls (which also reach her clit) then the RATE OF CHANGE of the acceleration of her private parts is big that is the JERK is big, and then there is vibration which causes her to cum. and that's what the vibrator successfully imitates.

interestingly the device that Wikipedia describes with a little mass on top of a little rod (which has negligible mass) which is attached to a big mass that moves forwards and backwards, sounds exactly like the famous sex toy Sybian

https://en.wikipedia.org/wiki/Sybian

especially with the “egg” configuration:

https://sybian.com/product/g-egg/

the sybian is pressed against the woman's pussy all the time, so here it's not like the thrusting of the man's pelvis or fingers, but it uses the same mechanism of vibrations. in fact it's a lot more efficient in terms of making the vibrations because it moves something very small (tiny mass) back and forth with great force (electric engine) and very short distance span, so the changes in acceleration are maximized.

When we see a sybian without the woman sitting on it, we can see that the vibrations also get in sync and out of sync with the whole device (resonance) and probably that what happens in the correct shaking frequencies when the woman sits on top (but in other frequencies now because the woman is added mass).

French Wikipedia also warns us that with a lot of JERK there will be a lot of noise, and indeed a sybian when the woman operating it in high speeds sounds like an airplane taking off.

I even speculate that the real reason that many women enjoy very much being spanked from time to time while being fucked (by a man) is that the slap on their behind shakes the whole area and causes some of the vibrations (by an elastic deformation of the ass cheek and then a compression wave that moves through all that soft region). When the vibrations reach the pussy area it helps them to get aroused and then to cum. So the enjoyment is not from the pain or humiliation but actually from the vibration.

I've seen now that at least one company of sex toys have a mobile app where you can see the graph of the action:

Hismith Premium Sex Machine Pro Traveler 2.0

Brand: SINLOLI

https://www.amazon.com/Hismith-Premium-Traveler-Wireless-Powerful/dp/B08NJL7FXY/ref=zg_bs_1243836011_47?_encoding=UTF8&psc=1&refRID=H8E10PT8ZD2Y4BF4Q60H

Hismith Premium Sex Machine

https://www.amazon.com/Hismith-Premium-Machine-Intellgent-Controlled/dp/B083VX56MY/ref=zg_bs_1243836011_4?_encoding=UTF8&psc=1&refRID=H8E10PT8ZD2Y4BF4Q60H

you can see the app with the graphs here in Google Play store:

https://play.google.com/store/apps/details?id=com.hismith.hismithapp&hl=en&gl=US

So maybe in the future smarter consumers will demand to know what exactly is the JERK in each stage, and how the JERK changes, and so in the next edition of this book I will be able to tell you about the DERIVATIVE of JERK a.k.a the RATE OF CHANGE of JERK, a.k.a. SNAP ?

OK. So far in this book we did psychology – analyzing one person each time.

Now what we'll try to do is sociology – analyzing a lot of people together.

in Sociology there is structure

(examples are the ancient, the feudal, and the capitalist social order)

https://en.wikipedia.org/wiki/Social_order

in Sociology there is also CHANGE

(examples are global demographic shifts and

gendered patterns of work and care)

https://en.wikipedia.org/wiki/Social_change

the RATE OF CHANGE will be of interest to us because this is the DERIVATIVE.

the RATE OF CHANGE of the RATE OF CHANGE will be the DERIVATIVE of the DERIVATIVE. we call that the 2nd DERIVATIVE.

and so on.

OK so to get intuition we will first plot graphs for higher derivatives: 2nd , 3rd, 4th

of simple functions and try to see if they remind us of anything in sociology.

We want to end up with the simplest functions like x^2 and x^3

So first of all we need to find out using Wolfram|Alpha what are the ANTI-DERIVATIVE (which we call INTEGRAL)of them.

We type:

antiderivative of x^2

(and hit <ENTER>)

And Wolfram|Alpha gives us this:

$$\int x^2\,dx = \frac{x^3}{3} + constant$$

We don't care about the constant.

So Wolfram|Alpha tells us , that the DERIVATIVE of $\frac{x^3}{3}$ is x^2

OK let's do the same again. Now we type:

antiderivative of x^3/3

(and hit <ENTER>)

And Wolfram|Alpha gives us this:

$$\int \frac{x^3}{3}\,dx = \frac{x^4}{12} + constant$$

We don't care about the constant.

So Wolfram|Alpha tells us , that the DERIVATIVE of $\frac{x^4}{12}$ is $\frac{x^3}{3}$

OK let's do the same again. Now we type:

antiderivative of x^4/12

(and hit <ENTER>)

And Wolfram|Alpha gives us this:

$$\int \frac{x^4}{12}\, dx = \frac{x^5}{60} + constant$$

We don’t care about the constant.

So Wolfram|Alpha tells us , that the DERIVATIVE of $\frac{x^5}{60}$ is $\frac{x^4}{12}$

OK that’s enough ANTI-DERIVATIVES for us, although we could go on forever.

Let’s do DERIVATIVES now:

We type:

derivative of x^2

(and hit <ENTER>)

And Wolfram|Alpha gives us this:

$$\frac{d}{dx}(x^2) = 2x$$

So Wolfram|Alpha tells us , that the DERIVATIVE of x^2 is $2x$

OK let’s do the same again. Now we type:

derivative of x^2

(and hit <ENTER>)

And Wolfram|Alpha gives us this:

$$\frac{d}{dx}(2x) = 2$$

So Wolfram|Alpha tells us , that the DERIVATIVE of $y = 2x$ is $y = 2$

And we know that the DERIVATIVE of any constant is ZERO (including ZERO itself which is also a constant), so from now on it would just be ZERO ZERO ZERO …

$$\frac{d}{dx}(2) = 0$$

And so on.

OK so much for x^2 "family". now I'll do quickly the same thing from the x^3 "family".

$$\int x^3\,dx = \frac{x^4}{4} + constant$$

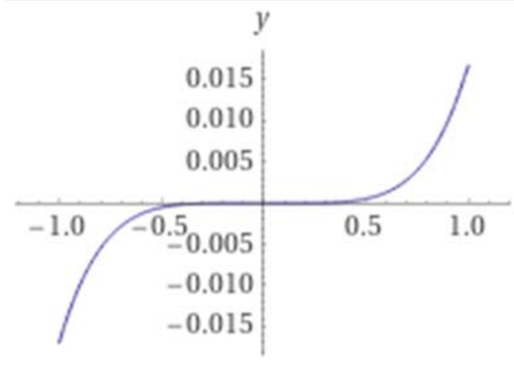
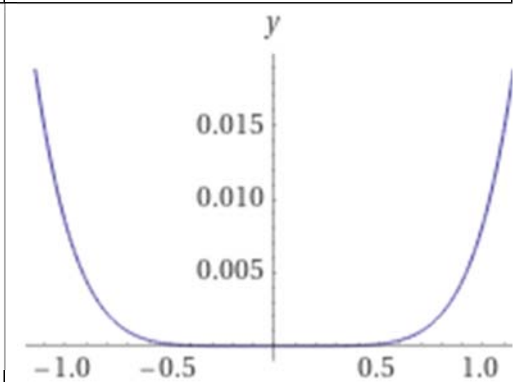
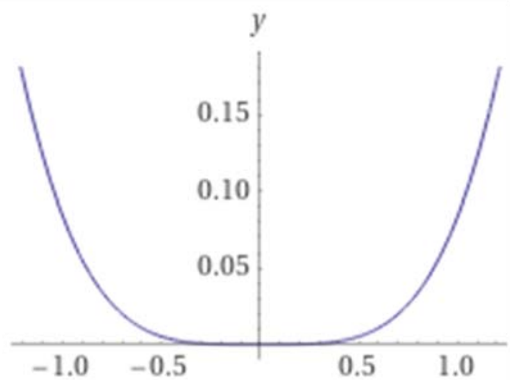
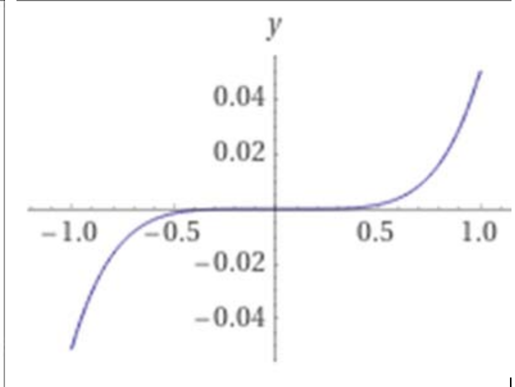
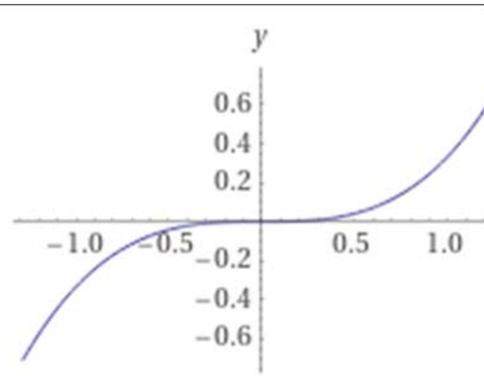
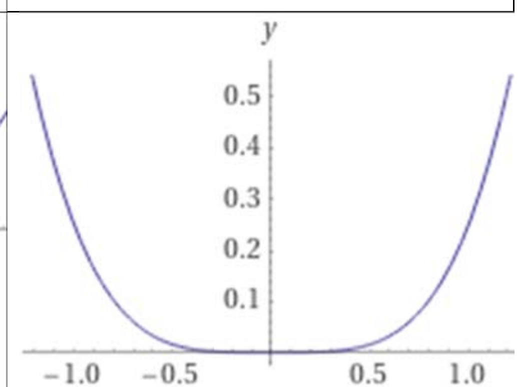
$$\int \frac{x^4}{4}dx = \frac{x^5}{20} + constant$$

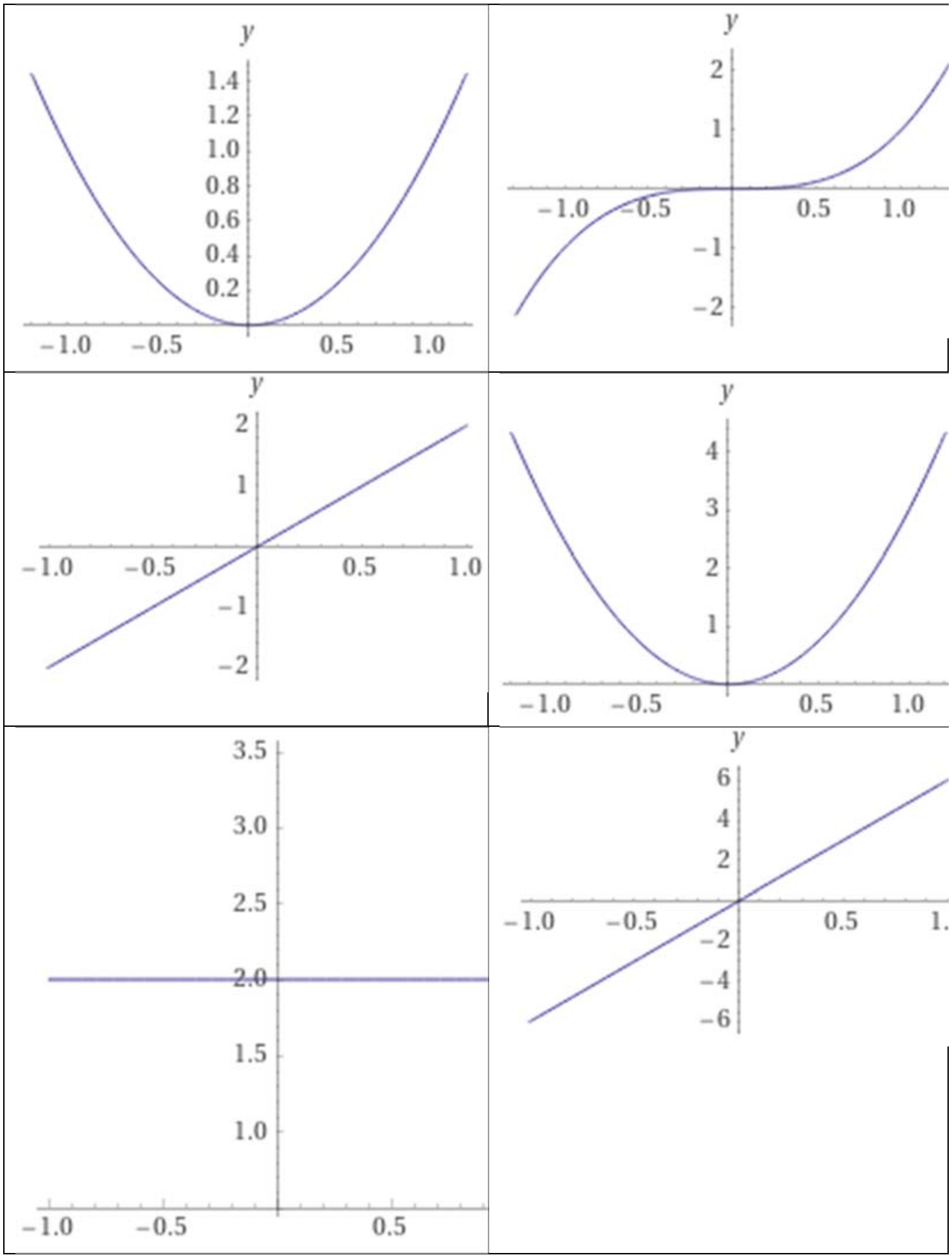
$$\int \frac{x^5}{20}dx = \frac{x^6}{120} + constant$$

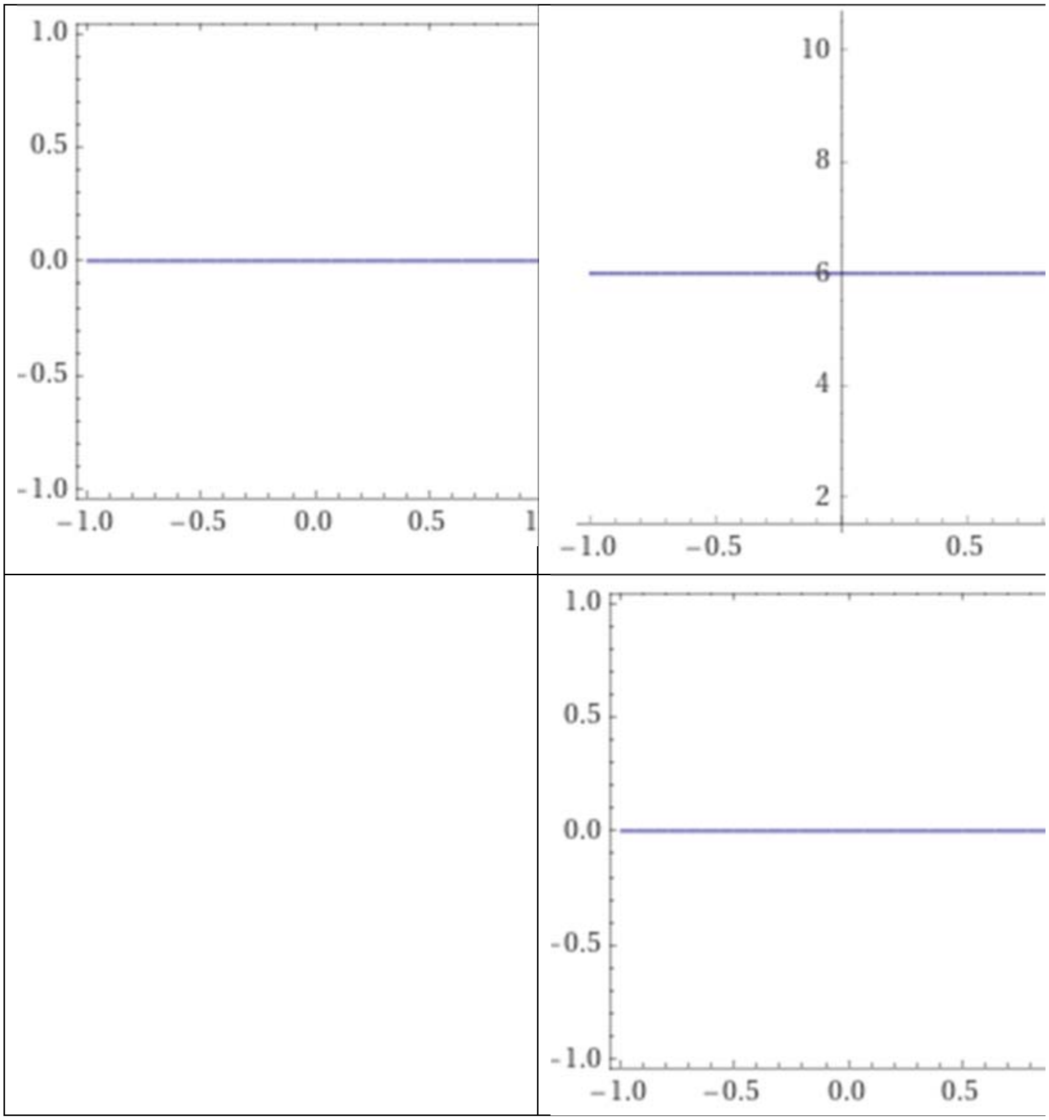
And the derivatives of x^3 are:

$3x^2$ and then $6x$ and then 6 and then 0 and then 0 …

Now let’s make a table with the graphs of these functions so we can compare visually:

x^2 function Its anti derivatives, the function AS IS, and then its derivatives	x^3 function Its anti derivatives, the function AS IS, and then its derivatives
	
	
	


y
1.4
1.2
1.0
0.8
0.6
0.4
0.2
−1.0 −0.5 0.5 1.0
y
2
1
−1.0 −0.5 0.5 1.0
−1
−2
y
2
1
−1.0 −0.5 0.5 1.0
−1
−2
y
4
3
2
1
−1.0 −0.5 0.5 1.0
3.5
3.0
2.5
2.0
1.5
1.0
−1.0 −0.5 0.5
y
6
4
2
−1.0 −0.5 0.5
−2
−4
−6



OK. So I think you can agree with me that the association from the moment it becomes a flat line is death and from this there is no return. like we see in the movies when someone dies and the electronic monitor shows no heartbeat and instead of a beep beep beep it's just beeeeeeeeeeeep ☹ And we see that the x^2 dies more quickly than the x^3.

IN GENERAL THEY ARE DOING THE SAME THING BUT ONE STEP AFTER EACH OTHER.

So we will only look at the x^2 for simplicity.

So before that we have stagnation on a certain constant level. This is one step before dying. This may be like the society we see in the wonderful movie Idiocracy (2006), where they don't think about how to solve their big problems, they just want to get money and sex and to popular. Does this sound familiar?

OK so the straight line in y=2x shows us constant positive growth to one side, and constant negative growth to the other side. What does this remind us of? Of a situation of WIN-LOSE when one gets the good and the other gets the bad. This could be the rich and the poor. This could be the men and the women.

From there on there are ONLY TWO BEHAVIORS :

The “Bowl”: WIN-WIN situation. Equality between the classes or between the sexes.

The “Snake”: WIN-LOSE situation. Inequality between the classes or between the sexes.

So if we do a DERIVATIVE we move from one behavior to the other. With every DERIVATIVE that we do (as we go down in the table) both the bowl and the snake are more “rounded” and “soft”. I couldn’t show this in the drawings because of the scale, but think how slowly x^2 is climbing (the slope of the walls of the bowl is gentler) as it grows to infinity, as compared to how fast x^4 is climbing (the slope of the walls of the bowl is steeper) as it grows to infinity. And of course x^6 is even faster and steeper and so on.

The same happens with the snake. The more DERIVATIVEs we do (as we go down the table) the gentler the slope and the slower it goes to plus infinity above and minus infinity below.

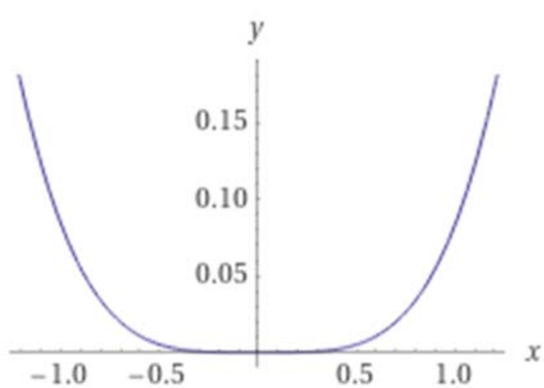
So I think our story will be that as time goes by the EQUALITY between the genders is going between two BEHAVIORS :

The “Bowl”: when the men and the women are considered equal in importance

The “Snake”: when one sex is considered more important then the other.

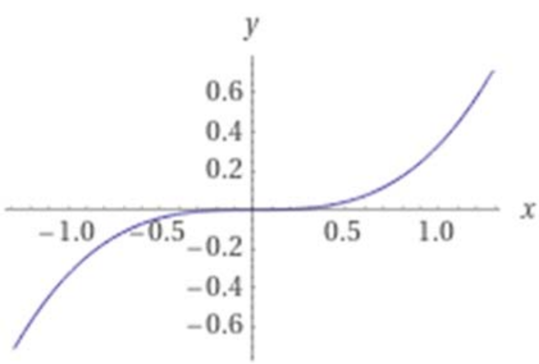
So let’s look at the DERIVATIVEs as a timeline:

$$y = something * x^4$$



In the beginning like 100,000 years ago, we were hunters (men) and gatherers (women) they are very equal, most of the energy (calories) came from the WOMAN's like if she collected berries etc, and on the other hand the MEN are important also because they bring the protein (meat of animals). Such small tribes to this day in the Amazon for example are very equal and decide things by convincing and talks. So this is BOWL shape which means WIN-WIN.

$$y = something * x^3$$

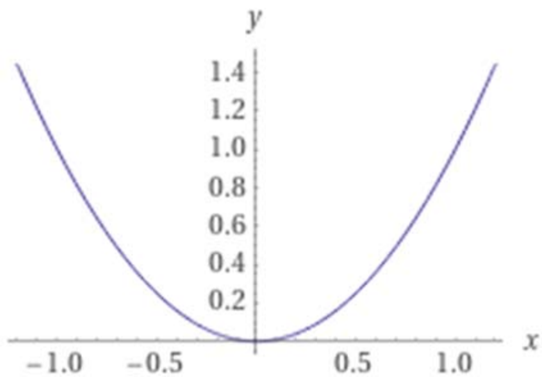


Then like 10,000 years ago we became farmers and the man was stronger so his strength was needed to work the plough (plow).

https://en.wikipedia.org/wiki/Plough

This gave a lot of advantage to the MEN and so the WOMEN were considered property of the MEN worst then slaves. So this is SNAKE shape which means WIN-LOSE. The men win the women lose.

$$y = something * x^2$$

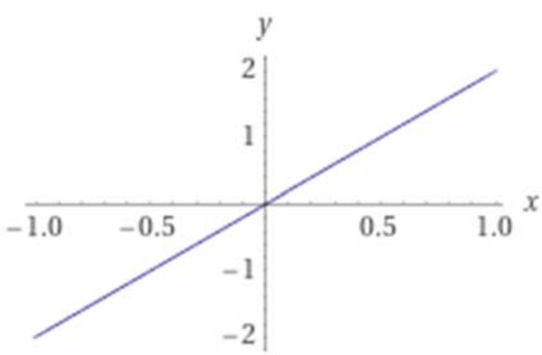


Then like 100 years ago the activist women Suffragettes (like the mother in Mary Poppins) managed to get women the right to vote.

https://en.wikipedia.org/wiki/Suffragette

So along with them women could study and work outside of the house and live along if they want and they weren't treated like animals like religions do (because religions fix things like in the bible which when the world was ruled by MEN alone). So now women are equal again so this is BOWL shape which means WIN-WIN.

$$y = something * x^1$$



Then like 10 years ago the feminist women has gone too far, and now the situation is reversed. Men are discriminated against in courts when there is a divorce, and the "good" plan for the woman is to get a man and then dump him with no reason (or some little reason) and only "milk" his money and make it hard for him to see the kids and poison the kids against him, and in generally take half his money for herself and then more for the kids, and it doesn’t matter if he has very little money and she has a lot of money, the law is arranged against the MEN. So the WOMEN treat the MEN like slaves now.

There is a book I haven't read by Prof. Dr. Hugo de Garis

“MASCULISM”

“Men’s Rebellion Against Being Manslaves to Women

An e-Textbook of 370+ Masculist Flyers

for Men’s Studies Courses”

https://profhugodegaris.wordpress.com/masculism-mens-rebellion-against-being-manslaves-to-women-a-textbook-of-300-masculist-flyers-for-mens-studies-courses/

https://profhugodegaris.wordpress.com

I read the beginning (I didn't look into his claims against Jewish bankers which i guess is anti semitic, but i just read the short perface.

And it sounds very reasonable to me! He talks about divorce, abortion, living off the man's money, taking the kids, all the things that scare me (and I guess many others).

[By the way: when it comes to what will happen I think he is totally wrong, he says that MEN will unite and won’t give WOMEN their sperm, even if I ignore advances in genetics that will make sperm redundant (and later the uterus redundant), so even if we ignore this, MEN (and people in general) have no way to unite, let’s say all of them unite except one single man, then this single man can fertilize all the women on earth and be a huge evolutionary success which is very tempting. (even just fucking the beautiful women is tempting). So he ignores what happens in reality. This book is about love and sex, so I can’t tell you much about the fight against AI which is the subject that is most important to me, but I’ll tell you this: Prof. Hugo de Garis does the same thing with AI! he understands the problem of what’s now brilliantly, and then tries to foresee what the future will be and gets it totally wrong (he underestimate the selfishness and stupidity of people) : he thinks that the AI supporters will fight the AI opposers, while in reality the AI supporters are huge governments so they control all the weapons and what’s more important the best AI, so they will wipe out everybody else easily, no war needed. It’s like when the Nazis exterminated the Jews we don’t call this war between them we call this genocide of one side by the other. And soon after that the AI will wipe out them (what’s left from humanity).]

There is also another book which I haven't read:

Men on Strike: Why Men Are Boycotting Marriage, Fatherhood, and the American Dream - and Why It Matters

by Helen Smith PhD.

https://www.amazon.com/Men-Strike-Boycotting-Marriage-Fatherhood/dp/1594037620

Again, I only read the book's description but it makes a lot of sense to me: the whole system TODAY is rigged AGAINST the MEN.

Then the backlash goes to crazy directions of almost hating women, which I don't agree with at all:

https://en.wikipedia.org/wiki/Masculism

https://en.wikipedia.org/wiki/Men_Going_Their_Own_Way

But at the core there is something right! WOMEN are in the last few years abusing the MEN in some specific fields: like the court of law in divorce.

BUT

Do WOMEN control the MEN in every field? No. It's still the situation that the MEN control the WOMEN in most fields. Like business, or politics or military and so on. So the MEN still hold most of the top positions: in the most rich people in the world, how many WOMEN are there?

So I would say in total today MEN rule more but not EXPONENTIALLY more than WOMEN, today MEN in total are just LINEARILY better off than WOMEN.

Jeff Bezos (CEO of Amazon) and MacKenzie Scott divorced and their net worth ratio is ~ 3.3

193.4 billion USD / 59.1 billion USD

and from this List of most expensive divorces:

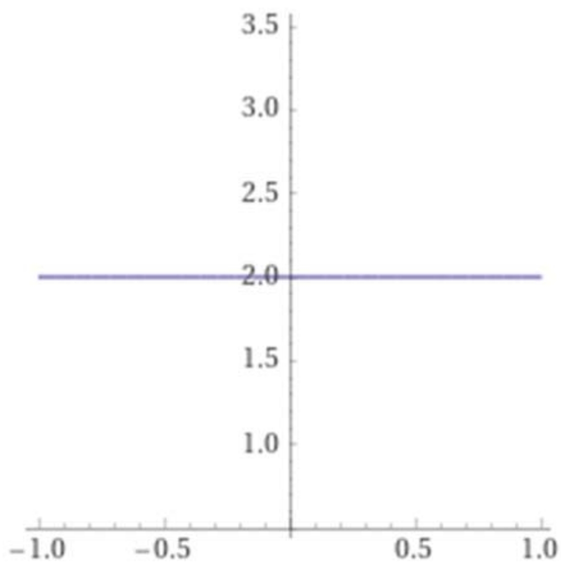
https://en.wikipedia.org/wiki/List_of_most_expensive_divorces

We see that only in recent years women get BILLIONS, before it was in MILLIONS.

So to summarize today the situation is still better for MEN but they are linearly better (not exponentially better). So today we have a slanted line.

OK now we are getting to what will happen, so I'm trying to predict the future:

$$y = something * x^0$$



Things will balance out eventually but not a good way: many people will not be married, and will not live together, it will be like the breaking of the family unit altogether.

Together with this many people will be very poor either because the AI took their jobs are climate wars or some new disease or lack of food, food prices will be very high etc.

So I don't know if you've watched this series from HULU called Harlots. The opening titles go like this:

1763. London is booming. And one in five women makes a living selling sex.

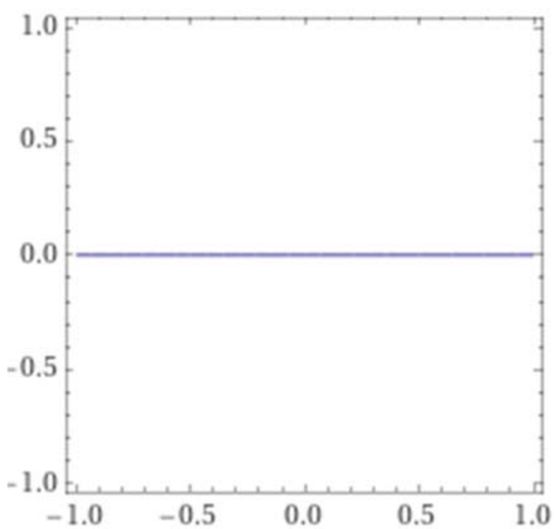
So I think something like this will happen, if it's not already starting to happen with all the "webcam" girls. People will not stop fucking and having babies, but they will stop making well organized families, and like the terrible concept of "UBER" fucks up taxi drivers that you can count on and leave them jobless, and everybody in every field will not have one steady day job, instead each person will have to scrape a living from many different odd jobs he is not qualified in, so will many women from the poor masses be forced to sell their body.

So I think daily life BOTH for MEN and WOMEN will be comprised from many small interactions, and in this sense everybody will have to "sell their ass" so it will be more equal. There will be no court that could force the MEN to be slaves for WOMEN, but in a way everybody will be slaves.

This is the straight horizontal line which is LOSE LOSE.

From this situation the planning and attention span to big problems will be very limited, if you are trying to survive all the time, like in an urban jungle, you can't make important science and so on, so all of society's achievements will soon drop to ZERO.

$$y = ZERO$$



This is a straight horizontal line but on ZERO and this is also LOSE LOSE.

So now you understand how the each stage is the RATE OF CHANGE of the next one.

Let's check if this is indeed true:

The horizontal middle (ZERO) in all our scenarios is in the vertical middle (ZERO) except in the Y=constant case, but there the constant is a lot smaller than infinity, so we'll treat it relatively like it's also in the vertical middle (ZERO).

So after concluding that our middle is always more or less the same (ZERO), let's check what happens when we go to the right and to the left.

The horizontal axis is the GENDER, so on the left we have very feminine WOMEN and on the right we have very masculine MEN, and in the middle people who are in between.

So let's track an average MAN (halfway to the right) and an average WOMAN (halfway to the left) through the ages (DERIVATIVES).

Remember in the film Star Wars: Episode I - The Phantom Menace, Yoda says: Everything! Fear is the path to the dark side. Fear leads to anger. Anger leads to hate. Hate leads to suffering. I sense much fear in you.

?

So we need to have some chain of sociological states that lead to each other in this way, but instead of one person through his life, we will do it with one person through the ages, like in the openings of the wonderful Once Upon a Time... Man series, in the beautiful opening, there is the same man and he changes from a prehistoric man, to an ancient Egyptian. To ancient Roman, and so on.

So what sequence of situations do we have here?

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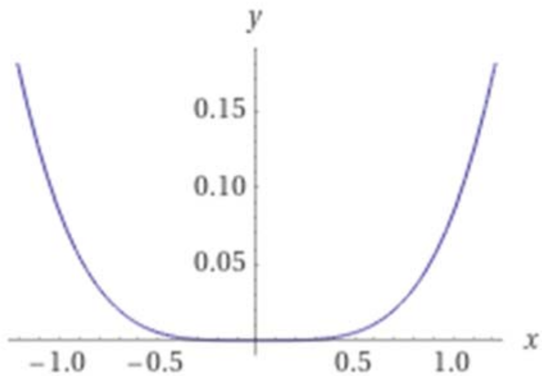
<td>

$$y = something * x^4$$



</td>
<td>MAN Hunter,
WOMAN gatherer.

Nature</td>
</tr>
<tr>
<td colspan="2">$DERIVATIVE\ meaning: Domestication$</td>
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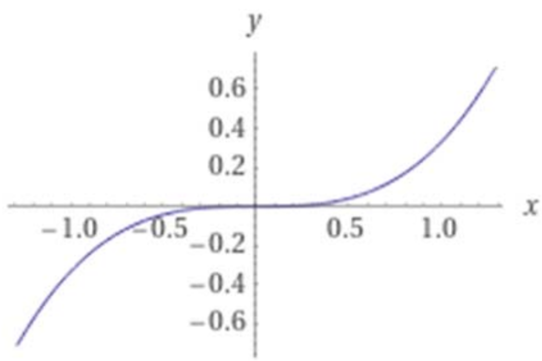
<tr>
<td>

$$y = something * x^3$$



</td>
<td>Wikipedia "Gender roles in agriculture":
MAN participated in "field" tasks (animal care, plowing, harvesting crops, using farm machinery, etc.),
WOMAN participated primarily in "farmhouse" tasks (preparing and preserving food and feed-stuffs, and maintaining the farm compound).

Agriculture farmers</td>
</tr>
<tr>
<td colspan="2">$DERIVATIVE\ meaning: Industrialization$</td>
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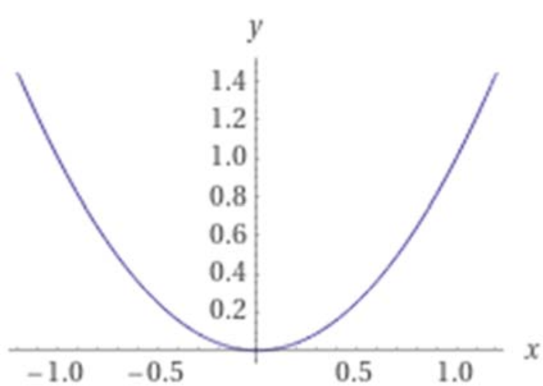
<tr>
<td>

$$y = something * x^2$$



</td>
<td>MAN: blue collar heavy industry
WOMAN: pink collar services</td>
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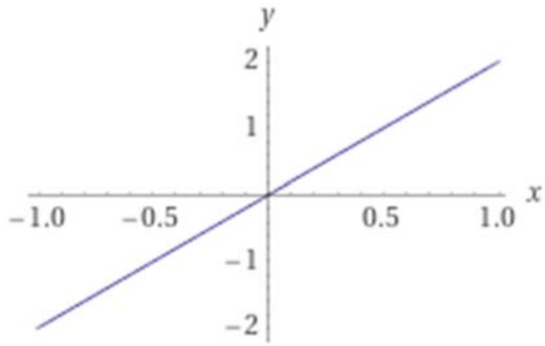
<table>
<tr><td colspan="2">$DERIVATIVE\ meaning: Information$</td></tr>
<tr><td>$$y = something * x^1$$</td><td>MAN: white collar clerk
WOMAN: white collar clerk

Office day jobs
Based more on information and knowledge</td></tr>
<tr><td colspan="2">$DERIVATIVE\ meaning: Fragmantation$</td></tr>
</table>

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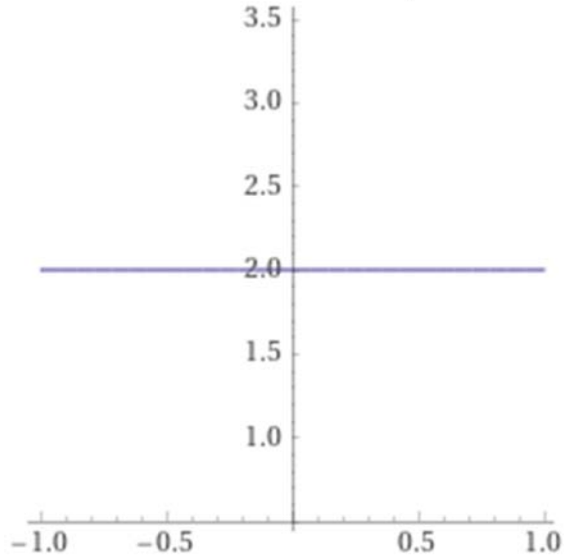
<td>

$$y = something * x^0$$



</td>
<td>

MAN: freelance partial jobs
WOMAN: freelance partial jobs

More and more specialized and abstract far from nature

</td>
</tr>
<tr>
<td colspan="2">

$DERIVATIVE\ meaning: Computerization$

</td>
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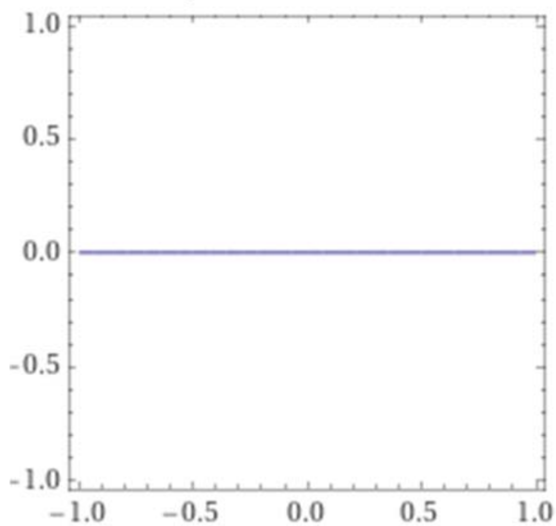
<tr>
<td>

$$y = ZERO$$



</td>
<td>

MAN: useless
WOMAN: useless

Replaced by Artificial Intelligence

</td>
</tr>
</table>

So if Master Yoda would describe the whole process it would be something like:

Domestication → Industrialization → Information → Fragmentation → Computerization

What is the common thread to all these?

I would say it's AUTOMATION. Treating things like a machine and taking out the human soul.

So in our new metaphor each time we do DERIVATIVE we see this as AUTOMATION of that part of society.

For example:

The hunter man became the more mechanized cowboy.

The gatherer woman became the more mechanized jam cooker.

So we see how this process weakened the woman a lot relatively to the man.

For example:

The farmer man became a more mechanized factory worker (like in Charlie Chaplin's movie).

The chicken feeding woman became a school teacher (school is mechanizing education).

We can see how this brought back the woman so she's equal to the man.

In each of the next stages the process repeats: both the man and the woman work in something more removed from nature, see less the end product, take less pride what they created because deep down they know they are charlatans who create artificial bullshit, and so on.

So in each step they are becoming more like cogs in the machine until finally they are replaced by machines altogether.

In each step they need to work less hard, they are more safe, and they are more specialized. But human beings are NOT MEANT TO BE idle safe and specialized! We are meant to SURVIVE IN ADVENTURES AND EXPLORE A MILLION THINGS! Can you see why everybody is so miserable?

If our forefathers would have heard about contracts to make a child together, or women who marry themselves and have a baby from a sperm donation, and I guess soon everybody will be cloning themselves and genetically upgrading themselves, they would be appalled!

So I'm sorry that this subchapter was depressing, but if we don't face reality and think about the problems there is no chance that we will ever change them!

Subchapter 2.11 – Taylor series as the couple's success and happiness

OK we are now in part 11 of 3Blue1Brown series

Taylor series | Chapter 11, Essence of calculus

https://www.youtube.com/watch?v=3d6DsjIBzJ4

first of all please watch this video by the BBC with American musician Wendy Carlos:

Wendy Carlos demonstrates her Moog Synthesizer in 1970

https://www.youtube.com/watch?v=4SBDH5uhs4Q

Wendy is a brilliant pioneer of electronic music, she helped to develop the first commercial synthesizer - Moog, and she wrote the music in the films: A Clockwork Orange (1971) , The Shining (1980) , and Tron (1982). She also made synthesizers popular with "Switched-On Bach" her album where she played the music of Johann Sebastian Bach on the synth, an cool combination of old and new.

Wendy is a transgender woman, and I think that's part of her ability to first marry these two different worlds of science and art, technology and music, and so on.

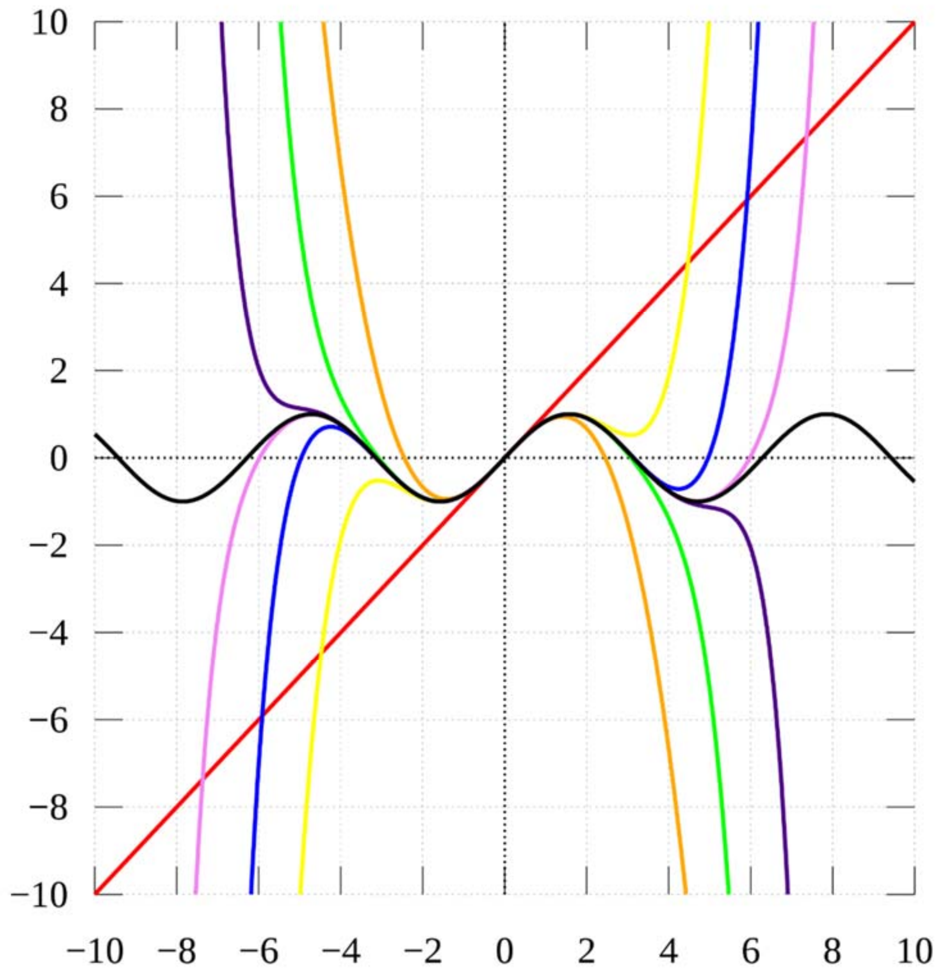
So anyways you really should watch (and listen!) to the video in the link because she explains beautifully in a few minutes the idea behind a synthesizer.

A synthesizer takes simple wave forms, like SINE that we know for example, and others, and puts them on top of each other (adds) or removes them from each other (subtract) to make a result wave which is more interesting and realistic (sounds like a musical instrument).

OK. So a Taylor series does exactly that but for functions. We take simple functions and put them together to simulate more and more closely some complicated function.

https://en.wikipedia.org/wiki/Taylor_series

See this illustration from Wikipedia – thank you very much to IkamusumeFan !



So here we are trying to simulate (get closer to) the SINE (the black wiggly wave), using the colorful simpler functions.

Don't get confused: in music SINE is the basic simple building block.

In math the simple building block is the POWER.

$$y = something * x^{some\ power}$$

Which we've met in the previous subchapter.

So in the above picture the RED diagonal line is

$$y = \ something * x^1$$

And the ORANGE "snake" is almost (ignore the fact that it's flipped horizontally like in a mirror)

$$y = \ something * x^3$$

And the **YELLOW** more winding (twisting) “snake” has inside it

$$y \ \approx \ something * x^5$$

Why is the **YELLOW** “snake” more winding (twisting) ?

Please notice that we said “has x^5 inside it” and not “is x^5”. That’s because the **YELLOW** snake is built from more then one POWER. How do we know? Because it’s not a pure “bowl” or “snake” – it’s more wiggly than either of them. So it’s some combination of lines and bowls and snakes (these three kinds are the most basic building blocks) put together.

We call this a POLYNOMIAL

https://en.wikipedia.org/wiki/Polynomial

POLYNOMIAL looks like this: X to the power of something PLUS X to the power of something else and so on.

What does this mean to us in our story language?

It means nature (evolution) is not an engineer, and it doesn’t rebuild the next model from scratch, it just adds on top of what is already there. So our brain has inside it all our evolution:

Triune brain model by Paul D. MacLean

https://en.wikipedia.org/wiki/Triune_brain

- At first we whisper poetry in our loved one’s ear and this stimulates her neo-cortex which is the outmost and newest (in evolutionary terms) layer of her brain, which is used for speech and logic and higher thinking.

- And when we’re in love we act like primal mammals that were that developed the limbic system which is strong emotions, no longer words but mushy stuff: smoochie-smoochie lovey-dovey kissy-wissy. We go back to being babies breastfed by our mother (mammals). This a deeper older layer of our brain.

- And at the most basic level we enter the deepest core the reptilian brain which deals with survival and instinct. At this level we want our sex hard and almost violent.

That’s why for example no woman really likes to dominate man in bed.

Note: i’m not talking about “switch” which likes to be the queen and then the whore in bed and this intensifies are “falling” into the whore state and hence her excitement of her being submissive in bed.

No, I’m talking about how no woman enjoys being really dominant in bed. Anytime you see a woman dominating in bed it’s one of these situations:

(1) She is very ugly or fat and that’s her only way to get men at all.
(2) She actually hates man (e.g.: been molested as a kid) and it’s not sex it’s “revenge”
(3) She asked by the man to do it (because it arouses many men).
(4) She is paid to do it (again by the man).
(5) She is not really a woman “brain-wise” (male brain born in a feminine body).

Take the most hardcore dominatrix and chances are that to the man she really chooses, during sex she will submit to him, like we’ve talked about with Kelly Stafford and Rocco Siffredi. She might toy with beta males for making a living or amuse herself, but when she really wants sex she wants an alpha male to toy with her.

This is not because the woman is educated in a certain way. It’s HARDWIRED into the woman to be submissive in sex towards the man. Being the physically weaker gender, being raped during wars through the ages, women who liked that reproduced better (or even simply survived more). Maybe it goes further to our ancestors, because in many species in nature the male forces the female, like in the reptiles which we just talked about. And to some degree this runs in the genes to later creatures, like when the lion has sex with the lioness, he doesn’t whisper poetry in her ear – he bites her nape.

So how does this relate to the different POWERS?

Each of them can be seen as a layer in our brain, or a building block in our thinking.

Remember in the previous subchapter we talked about how at first the MAN and WOMAN are equal but different (hunter gatherer) and then unequal (farmer and housewife) and then equal again (factory worker and teacher) and then moderately unequal (lawyer and clerk) and then equal again but NOT IN A GOOD WAY (freelancer and freelancer)?

the “NOT IN A GOOD WAY” part is because the WOMAN doesn’t like being the same as the MAN.

The WOMAN wants to earn more and she says she wants to earn the same as the MAN, but when this does happen and she earns even a little more than him she is not attracted to him anymore. I’m not making this up, this is backed up by scientific research:

The Happiness Penalty for Breadwinning Moms

by Wendy Wang from the Institute for Family Studies

https://ifstudies.org/blog/the-happiness-penalty-for-breadwinning-moms

Researchers get tangled in sociological and psychological explanations of why is that the WOMAN is unhappy because they try to be politically correct, if you just try to be correct and look at biology you see that the explanation is in the BIOLOGY level: the WOMAN wants the MAN to lead. She is genetically hard wired for the MAN to lead (the family bread winning in this case). That’s why she is unhappy.

Modern life also put the WOMAN in other unnatural situations, like not being able to be with the kids, having to postpone childbearing because it will hold back her career. If people were less concerned with politically correctness, they would be a lot happier.

So back to our topic at hand:

Let’s say we have a SINE function like in the picture.

In our story language this would be the situation our couple the MAN and WOMAN.

The more we go to the right side, we are talking about the MAN.

The more we go to the left side, we are talking about the WOMAN.

So the first approximation to their situation is the **RED** line.

Let’s say they both work as programmers, but she wasn’t put in a team manager position because she had to leave early to take care of the kids. So they are moderately unequal.

Then in addition to that (or on top of that) we have the second approximation which refines the previous one to be closer to SINE. That’s the **ORANGE** snake.

It’s horizontally flipped that means the INPUT (the x) is in MINUS. So instead of x we put MINUS x.

So let’s say this would be the WOMAN interpersonal skills. While the MAN might be insensitive to nuances, like he treats his coworkers like objects and giving orders, the WOMAN understands their feelings and can motivate them better thanks to her emotional intelligence. Also she is better at multitasking and tend to cooperation more, so to make a long story short once she does get to be a manager she will be a better manager than him.

So that gives the WOMAN upwards and the MAN downwards the more masculine he is and the more feminine she is.

Then we have the **YELLOW** snake which is more winding (twisting). What might that be?

It has a “bump” on both sides, so it’s a quality in them that at first looks like an advantage for the WOMAN and a disadvantage for the MAN, but the more their gender roles kick in, the more it becomes a disadvantage for the WOMAN and an advantage for the MAN.

Let’s say for example it’s the military service.

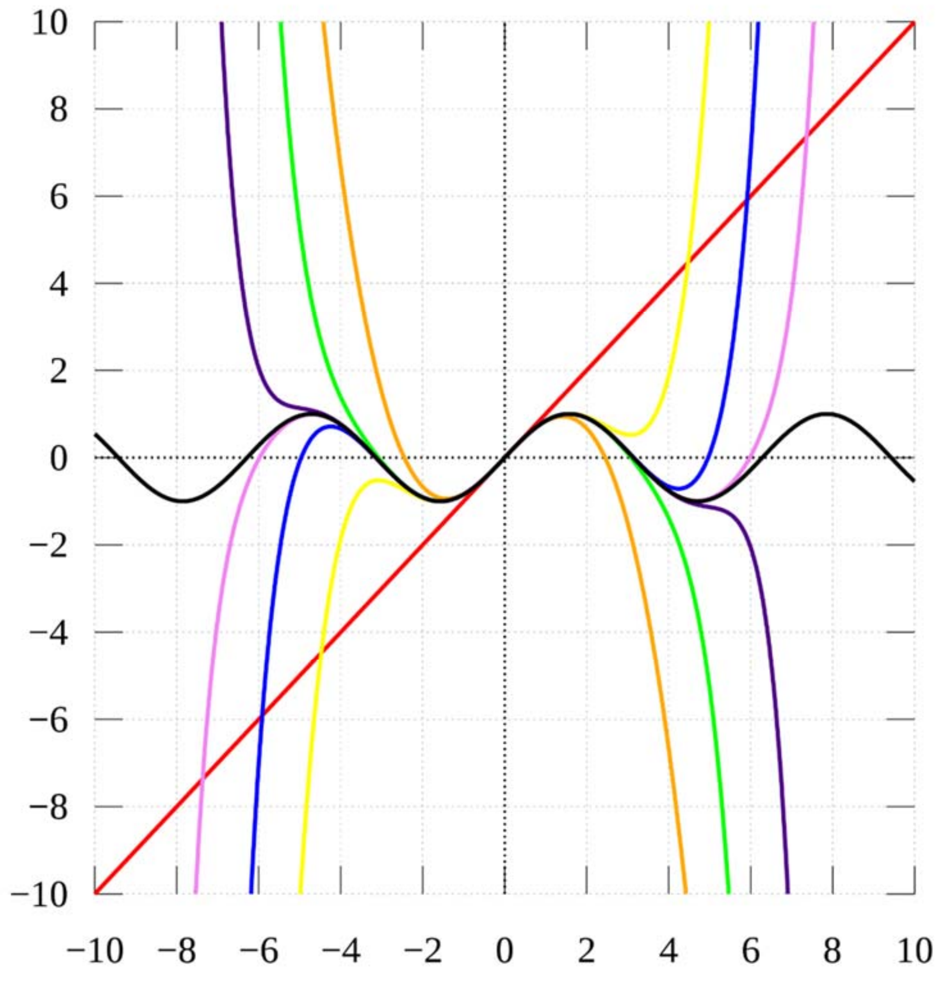
MAN undergo longer military service in Israel, (for example when I was a soldier I served 3 years and girls served 2 years) so the WOMAN has a head start to go to university etc., but since the MAN’s military service is usually more significant than the WOMAN’s, this later gives the MAN managerial skills (from being commanding officer for example) or resilience from being trained as fighters and so on.

Then we have the **LIGHT GREEN** snake which is the other way around, starts off as bad for the WOMAN and good for the MAN, but eventually is good for the WOMAN and bad for the MAN. What could this be?

This could be the one sidedness of MAN as opposed to WOMAN. The woman is forced to juggle around work family friends etc. (mainly because the man can focus only on one thing at the time). But on the other hand if this one thing of the man fails, he is devastated because that was his only thing.

Assuming our vertical axis is success or happiness, think of how a MAN who “put all his eggs in one basket” let’s say invested all his time and effort in his “start-up” company, and since 9/10 of “start-up” company failed, his statistically failed. How does he feel now? On the other hand, the woman is a lot better at covering all her bases, not being extreme in any of them, so she can take comfort in her connection with the kids, and her supportive friends, etc.

OK so I’m copying thie picture again – thank you very much again IkamusumeFan!



So notice how we approximate the SINE using many POLYNOMIALs

Or in our story we approximate the couple's success using the DERIVATIVES which are all kinds of sociological changes that mankind has gone through along the ages.

The multifaceted diversified resourcefulness of the WOMAN gatherer

Vs.

The "tunnel vision" of the MAN hunter (male manager who hunts a project goal).

The community social skills of the farmers' wives and cooperation

Vs.

The hierarchical issuing orders to subordinates that the fighting men got in the wars between landowners under the local feudal lord or king (before agriculture there weren't any kings or empires because you couldn't store food. That started with cultivating grains like wheat rice and maze).

And so on.

So now when we read in Wikipedia

https://en.wikipedia.org/wiki/Taylor_series#Approximation_error_and_convergence

$$\sin(x) = x^1 - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \cdots$$

Then I hope you recognize our all our old friends:

x^1 is the RED line

x^3 is the ORANGE snake (flipped because of the MINUS)

x^5 is the YELLOW winding (twisting) snake

and so on.

In minute 8:30 in the video, 3Blue1Brown explains why we have all these factorials (exclamation mark symbols).

Let's remind ourselves. For example "five factorial":

$$5! = 1 * 2 * 3 * 4 * 5 = 120$$

So if we take the DERIVATIVE of something that has x^5 we would get 5 TIMES something with x^4.

if we then take the DERIVATIVE of that something that has x^4 we would get 4 TIMES something with x^3.

if we then take the DERIVATIVE of that something that has x^3 we would get 3 TIMES something with x^2.

if we then take the DERIVATIVE of that something that has x^2 we would get 2 TIMES something with x^1.

So you see now why when we do the DERIVATIVE operation again and again we get things with factorials.

This is like saying that when we get to more and more “primitive” ways of thinking, although we they are more natural to us we have all the “politically correct” to get out of the way. If you move from the neon lights of the city where you work as a parasitic bureaucrat, and you are disgusted by it.

If you want to produce something useful and work with your hands physically like opening in your basement a workshop for carpentry or metalworking, you will have to encounter some resistance from your family and friends (society). That’s because for them you are going backwards in the “evolution” of mankind. You are going against the social trend towards symbolic INFORMATION.

If you would want to move to a country-side village to live by the sweat of your brow raising organic food from the soil, you will have to tackle that resistance from before TIMES more resistance (because for them you are going TWO steps down the “evolution” ladder). Now you are going against INFORMATION TIMES INDUSTRIALIZATION.

If you will want to move to live with a primal tribe in the forest.

participant observation in cultural anthropology, now you want to learn as much as possible from the medicinal herbs knowledge of the shaman ("witch doctor") of the tribes in the Amazon, which can know of a leaf that can prove to cure cancer for example.

By the way one such cultural anthropologist was Margaret Mead who influenced the 1960s sexual revolution, with her reports about sex in the south pacific islands

https://en.wikipedia.org/wiki/Margaret_Mead

now you will encounter resistance of INFORMATION TIMES INDUSTRIALIZATION TIMES DOMESTICATION because it’s another stage of humanity that you’re going to (now you want to be a hunter gatherer).

So in a Taylor series we always see the factorials get bigger and bigger down at the denominator with every term that joins the series.

In minute 9:09 in the video, 3Blue1Brown tells us that every new term that we add does not affect the previous terms. Why is that? Suppose we have the above Taylor series:

$$\sin(x) \approx x^1 - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}$$

Let’s look at Wolfram Alpha what is the first DERIVATIVE, second DERIVATIVE …

When we type

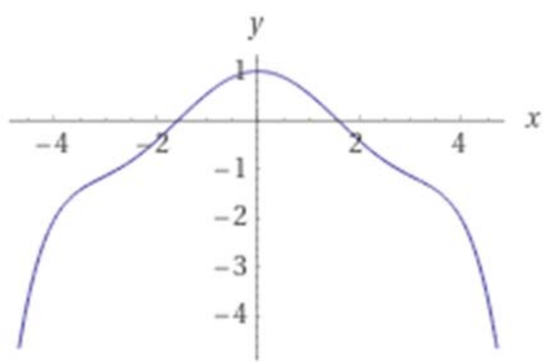
first derivative (x^1 - x^3 / 3! + x^5/5! - x^7/7!)

and press <ENTER>

we get:

$$\frac{d}{dx}\left(x^1 - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}\right) =$$

$$+1 - \frac{x^2}{2} + \frac{x^4}{24} - \frac{x^6}{720}$$



So in the point where x=0 the bottom line becomes

$$+1 - \frac{0}{2} + \frac{0}{24} - \frac{0}{720}$$

So you see that the x^1 that we had in the original became ONE.

Anyway you see that in the point x=0 the bottom line will become

$$+1 - 0 + 0 - 0$$

Which is of course ONE.

You also see in the small graph of the 1st DERIVATIVE that when x=ZERO then y=ONE.

OK let's do a second DERIVATIVE of the original expression (which is just like doing a DERIVATIVE of the DERIVATIVE of the original expression) :

When we type

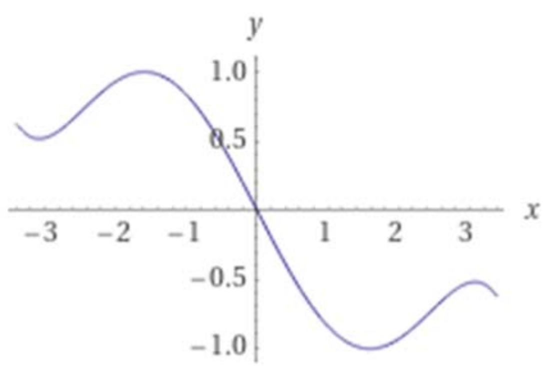
second derivative (x^1 - x^3 / 3! + x^5/5! - x^7/7!)

and press <ENTER>

we get:

$$\frac{d^2}{dx^2}\left(x^1 - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}\right) =$$

$$-x + \frac{x^3}{6} - \frac{x^5}{120}$$



So you see that the MINUS x^2 / 2 that we had in the previous time became MINUS x.

Anyway you see that in the point x=0 the bottom line will become

$$-0 + 0 - 0$$

Which is of course ZERO.

You also see in the small graph of the 2nd DERIVATIVE that when x=ZERO then y=ZERO.

OK let's do a third DERIVATIVE of the original expression (which is just like doing a DERIVATIVE of the DERIVATIVE of the DERIVATIVE the original expression) :

When we type

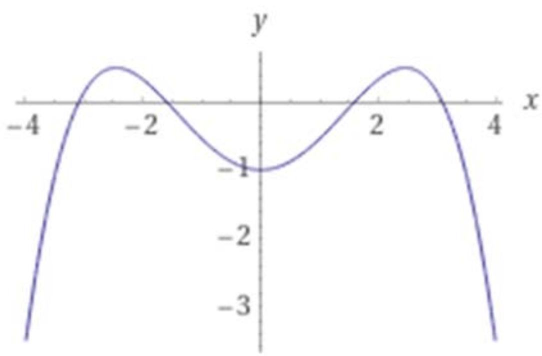
third derivative (x^1 - x^3 / 3! + x^5/5! - x^7/7!)

and press <ENTER>

we get:

$$\frac{d^3}{dx^3}\left(x^1 - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}\right) =$$

$$-1 + \frac{x^2}{2} - \frac{x^4}{24}$$



So you see that the MINUS x that we had in the previous time became MINUS ONE.

Anyway you see that in the point x=0 the bottom line will become

$$-1 + 0 - 0$$

Which is of course MINUS ONE.

You also see in the small graph of the 3rd DERIVATIVE that when x=ZERO then y=MINUS ONE.

OK let's do a fourth DERIVATIVE of the original expression (which is just like doing a DERIVATIVE of the DERIVATIVE of the DERIVATIVE of the DERIVATIVE of the original expression) :

When we type

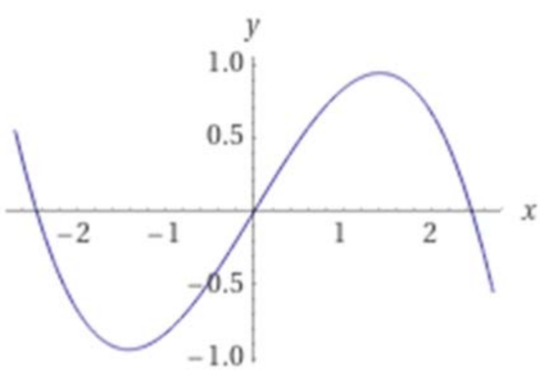
third derivative (x^1 - x^3 / 3! + x^5/5! - x^7/7!)

and press <ENTER>

we get:

$$\frac{d^4}{dx^4}\left(x^1 - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}\right) =$$

$$x - \frac{x^3}{6}$$



So you see that the x^2 / 2 that we had in the previous time became x.

Anyway you see that in the point x=0 the bottom line will become

$$0 - 0$$

Which is of course ZERO.

You also see in the small graph of the 4th DERIVATIVE that when x=ZERO then y=ZERO.

So the conclusion we need to understand is that each time we do a DERIVATIVE of what we had, each and every term in the expression is moving one step to the LEFT side:

The term that was on the most left side is the only one which has a CHANCE of not being ZERO.

If this term contains x then in the point x=0 it is ZERO.

If this term does not contain x then it has some value (for example: ONE, MINUS ONE).

But the main point to understand is that ALL THE OTHER TERMS CONTAIN X SO THEY BECOME ZERO AT THE POINT X=ZERO

So now we understand what 3Blue1Brown says in minute 9:40

“each DERIVATIVE of a POLYNOMIAL at x=ZERO is controlled by one and only one of the coefficients [that something that multiplies x]”

So far we talked all the time about approximating the function $\sin x$

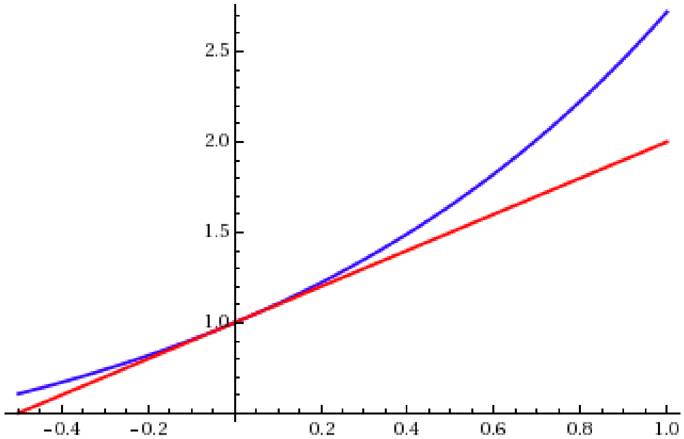
In minute 13:35 3Blue1Brown gives the example of e^x

So first of all you can see a few pictures here in Wikipedia:

Taylor's theorem

https://en.wikipedia.org/wiki/Taylor%27s_theorem

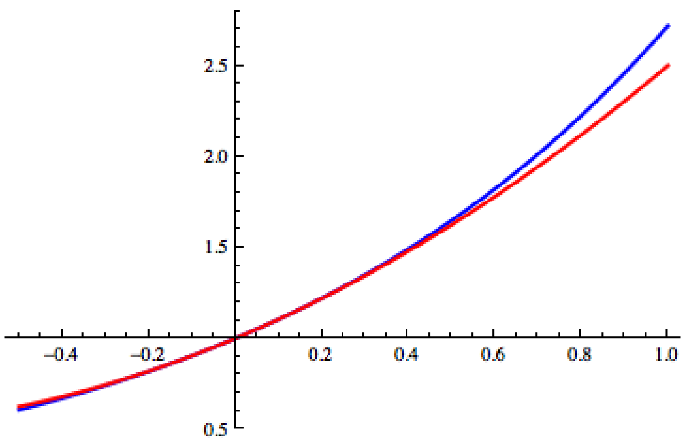
here is the approximation with x up to the first power



$y = e^x$ is in **blue**, and the approximation $y = 1 + x$ is in **red**,

(thank you very much to Slawekb)

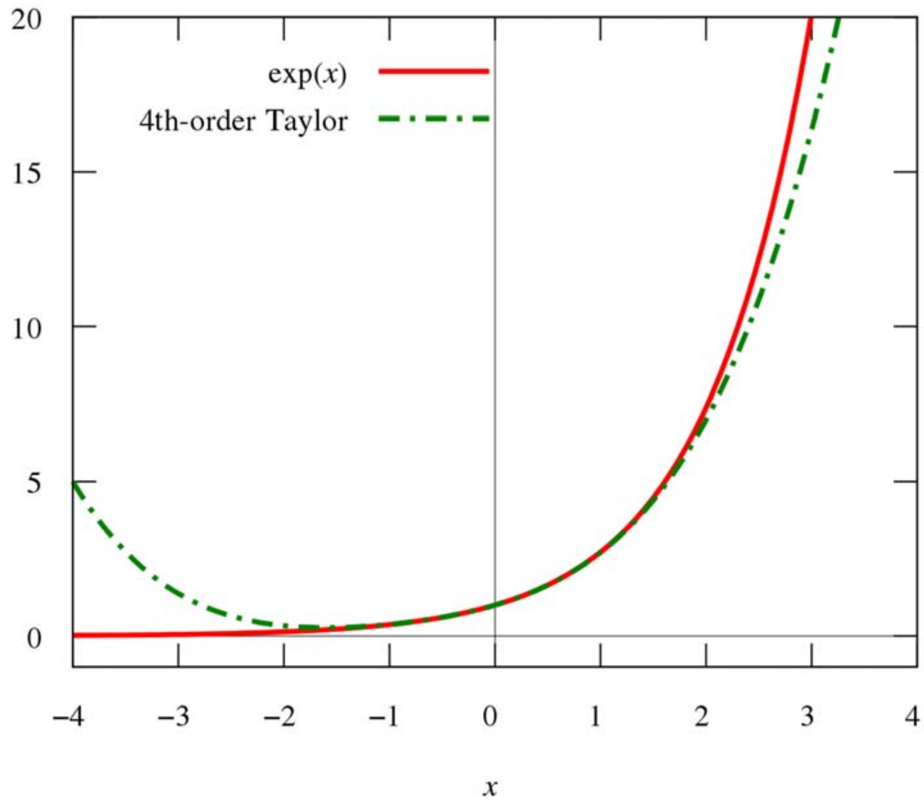
Now here it is with x up to the second power - Note how the approximation is better:



$y = e^x$ in **blue**, and approximation $y = 1 + x + \frac{x^2}{2}$ in **red**,

(thank you very much to Creidieki)

And here it is with x up to the fourth power – even better approximation!



this time $y = e^x$ is in **red**, and the approximation

$y = 1 + x + \frac{x^2}{2} + \frac{x^3}{6} + \frac{x^4}{24}$ is in dashed **green**.

So what grows exponentially? I would say the appeal of sex robots a.k.a. sexbots

https://en.wikipedia.org/wiki/Sex_robot

I think like there is Moore's law that computers double their power every two years,

I think we can make a law about sexbots doubling their appeal every e years. (about every 2.7 years)

This is a law that I have just made up, it's not real.

BUT there are a few separate trends that support such an idea:

First of all. Sex robots are getting more attractive and pleasant to be with – better AI hardware (so it grows with the real Moore's law) and improvements in the software (which is developed for other social uses too, like "chat-bots" that are in people's phones such as Apple's Siri and Amazon's Alexa

https://en.wikipedia.org/wiki/Virtual_assistant

About the physical side, there are advances in robotics and material science so they can get more realistic and even surpass the sex appeal of a real woman, or at least the average woman that the average man is able to have sex with.

Second of all, there is more open mindedness to sex with robots, probably because of the series Westworld (I've only watched the first episode, it's about an amusement park for adults where they can talk with totally human looking robots, have sex with the robots, and even act violently towards the robots ☹).

https://en.wikipedia.org/wiki/Westworld_(TV_series)

As humans (especially women) go through all sorts of surgery like silicone implants in the breasts and so on (which I personally find disgusting ☹ but here also I guess I'm the exception because a lot of female porn stars do this), it makes sense that people lose their touch with what's real and even prefer the fake imitation.

Sex with a robot? 1 in 4 men would consider it

by Yael Bame

https://today.yougov.com/topics/relationships/articles-reports/2017/10/02/1-4-men-would-consider-having-sex-robot

In 2020, both men and women are more likely to consider having sex with a robot

by Hoang Nguyen from YouGovAmerica

https://today.yougov.com/topics/science/articles-reports/2020/03/19/2020-both-men-and-women-are-more-likely-consider-h

So there are these and other trends like for example that people don't see it as so bad to cheat on their spouse with a robot, and the trend of not having to buy a sex robot because there are (already today) brothels which offer sex robots for rent

Sex doll brothels are now a thing. What will happen to real-life sex workers?

by Elisabeth J. Dickson from Vox

https://www.vox.com/the-goods/2018/11/26/18113019/sex-doll-brothels-legal-sex-work

and as we talked about in the book there is the option to 3D print which is becoming available

And add to this the growing power of virtual reality, so that removes the demand for perfection in the details of the doll because they can be refined in the virtual world that you see in your headset (or whatever technology will become available in the future like

The Display of the Future Might Be in Your Contact Lens

by Julian Chokkattu from WIRED

https://www.wired.com/story/mojo-vision-smart-contact-lens/

And to this the fact that some people CAN'T fulfill their sexual desires with a prostitute for example pedophiles, I'm not justifying their fantasies, I'm just saying ignoring reality never helped anybody. Some people say it might help them not to hurt children. I really don't know.

So all in all with all these trends put together, it sounds reasonable that the number of people having sex with robots will grow exponentially like

$$y = e^x$$

So how can we interpret the DERIVATIVE in each stage?

Our function is how many people are having sex with robots each year.

So I claim that it's like "the chicken and the egg" positive feedback loop between the technological advancements in the sex robots (the supply) and the desire of MEN to pay for sex with the sex robots (the demand).

The more money is poured in, the better the product/service, and then people are willing to pay more money for the product/service.

So all the trends that we talked about can be divided into two groups: trends that enlarge the SUPPLY such as research in robotics, and trends that enlarge the demand such as TV shows that display this stuff.

So the DERIVATIVE in our example might represent alternately a growth from the SUPPLY in one year and a growth from the DEMAND in another year.

So how did we reach this approximation? We are looking at the point $x = 0$

So we see that the original graph intersects the vertical axis at $y = 1$

Because the original function is $y = e^x$

and when x=ZERO then function=ONE $e^0 = 1$

you can think of it as the developer of the first sex robot test driving it 😊

so our approximation starts with:

$$y = 1$$

Now we the approximation to have the following property (this time in the 1st DERIVATIVE):

the DERIVATIVE (slope) of the original function

needs to be EQUAL to

the DERIVATIVE (slope) of the function's approximation

what is the DERIVATIVE of the function $y = e^x$?

This is the only function in the world which no matter how much you DERIVE it, the result is the same original function. The DERIVATIVE of e^x is e^x .

So we need the next term in the approximation to be 1 after we DERIVE it one time (one time because it's now the first DERIVATIVE).

What something becomes ONE when you derive it once? x

so our approximation so far looks like this:

$$y = 1 + x$$

Now we the approximation to have the following property (this time in the 2^{nd} DERIVATIVE):

the DERIVATIVE (slope) of the original function

needs to be EQUAL to

the DERIVATIVE (slope) of the function's approximation

what is the DERIVATIVE of the function $y = e^x$?

This is the only function in the world which no matter how much you DERIVE it, the result is the same original function. The DERIVATIVE of e^x is e^x .

So we need the next term in the approximation to be 1 after we DERIVE it two times (two times because it's now the second DERIVATIVE).

What something becomes ONE when you derive it twice? $\frac{x^2}{2}$

(the first DERIVATIVE of this is ½ * 2x which is x , and the DERIVATIVE of that x is 1)

so our approximation so far looks like this:

$$y = 1 + x + \frac{x^2}{2}$$

And the more we continue this process, the better approximation we will get to the original function – in this case e^x.

What does this Taylor series means in our story language?

The first term is how it starts.

The second term is how it changes.

The third term is how the change changes.

The fourth term is how the change of the change changes.

So what could be the story behind this?

The first term is the developer who loves his creation like Pygmalion

https://en.wikipedia.org/wiki/Pygmalion_(mythology)

The second term is how this number (ONE person) changes? It changes by him telling two or three friends. So they try out the sex robot as well. They also give him feedback advices, and most importantly some of them give the developer money to make one for them too!

So the RATE OF CHANGE of the original number of users is e

But this RATE OF CHANGE doesn't stay constant,

Because the original function doesn't just grows fast, it is growing more and more rapidly.

So the third term is that with that extra money the developer can save in costs (economies of scale) and he can make the next model will look less like a cheap blowup doll and more like a high end poseable mannequin and more interactive with more sensors (touch, temperature, vibration, moisture, and so on).

https://store.arduino.cc/new-home/components-sensors

So let's say these improvements has made the sex robot THAT much more attractive, and for our story let's suppose that THAT is not just two or three TIMES more attractive than what it was, but exactly e TIMES.

So the RATE OF CHANGE of the RATE OF CHANGE is e TIMES e

Or in other words e^2

and so on.

In each x (year) our function e^x (the appeal of the sex robots which we measure in how many MEN use it) gets bigger faster and faster (we multiply the previous number of MEN by e).

Last word about this issue:

I don't think it's a good thing that people will have sex with AI sex robots, I'm just telling you what's going to happen. You can see why this is bad here:

Campaign Against Sex Robots

https://campaignagainstsexrobots.org/

OK so in minute 18:29 in the video, 3Blue1Brown shows we can use this to find the value of e without a calculator:

$$e^x = 1 + \frac{x^1}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \cdots$$

All we need to do is plug in x=1

$$e^1 = 1 + \frac{1^1}{1!} + \frac{1^2}{2!} + \frac{1^3}{3!} + \frac{1^4}{4!} + \cdots$$

So just from these first four terms we get

$$e^1 \approx 1 + 1 + \frac{1}{2} + \frac{1}{6} + \frac{1}{24}$$

So we write them all with the lowest common denominator

$$e^1 \approx \frac{24}{24} + \frac{24}{24} + \frac{12}{24} + \frac{4}{24} + \frac{1}{24}$$

So we can add everything together and get

$$e^1 \approx \frac{65}{24}$$

So now we need to do long division:

$$\begin{array}{rl}
2.7 & \\
\hline
65. & \big| \; 24 \\
-\;48. & \\
\hline
17.0 &
\end{array}$$

So I'm too lazy to continue, but you get the idea, we get fairly close to e using the first four terms, and the more terms we will use the closer we can get to e .

Appendix I – Unused ideas: Boolean Algebra as OKCupid's pervy questions, Induction as "a woman is never satisfied", Recursion as Casanova algorithm

In the beginning when I was naïve about how much time it takes to write this kind of book, I wanted to cover a wider scope, including other branches of mathematics.

So here are two unused ideas and a "lead" to a third idea.

The first idea is about

mathematical induction

https://en.wikipedia.org/wiki/Mathematical_induction

Theorem (addressed to a girl):

IF your first boyfriend was normal

and in spite of this you were not happy with him,

THEN you will never be happy with any boyfriend.

Proof using induction:

Base $n = 1$

With the first boyfriend you were not happy – given.

Induction step:

IF with $n = k$ you are not happy

(for example if with your third boyfriend you are not happy)

THEN with $n = k + 1$ you are not happy

(then also with the fourth boyfriend you are not happy).

There are 3 possible options:

$k + 1$ is better than k → not happy because you hope $k + 2$ will be even better.

$k + 1$ is the same as k → not happy the same as you were not happy before.

$k + 1$ is worse than k → not happy even more than before.

The second idea is about

Recursion

https://en.wikipedia.org/wiki/Recursion

Lemma ("helping theorem") :

A girl will never match you up with a girl that is prettier than her.

Proof of Lemma:

The prettier girl doesn't need this. Any guy that the less pretty can get, the prettier girl can get herself.

Algorithm for sleeping with all the girls:

Let's say there's a guy who doesn't look for a girlfriend but he is a mythological lover in bed. So any girl will arrange a meeting for him with her less pretty girl friends. And they will do the same for their less pretty girl friends. And so on and so on.

Stop step:

Does the girl have no more girl friends who are less pretty than she is?

If there are no more – then go back to the girl friend who sent you here.

Recursion step:

Make love with this girl and after that ask her if she mind referring you to her girl friends.

Okay the third was about "Boolean algebra" but it's just a beginning of an idea:

https://en.wikipedia.org/wiki/Boolean_algebra

So I guess it was teaching the idea of logic AND , OR , NOT , and so on, using all the weird questions that the matchmaking website OKCupid asks you (like: do you enjoy cutting your partner during sex).

So they have these insights that I guess they get with machines that process big data, like: if you have mentioned avocado in your profile, then you are looking for true love. Or another one: if you mentioned beer and steak in your profile, then you are just looking for sex.

So I guess what I meant that we build together with the woman reader a questionnaire to see if the man in front of us is right for us. I guess it was something in this spirit.

Here is the link I copied for myself:

List of OkCupid Answers

From CWCki the encyclopedia about Chris Chan the author of Sonichu.

https://sonichu.com/cwcki/List_of_OkCupid_Answers

thanks Chris!

Appendix II – The killer app for 3d printing – Personalized 3d sex dolls

Later note: I just saw that people already thought about this here:

Make a sex robot AT HOME: 'Hyper realistic' 3D printed cyborgs to hit the market

THE world's first sex robot 3D printed at the touch of a button will herald the "evolution of our society" – and it's coming soon, Daily Star Online can exclusively reveal.

By Joshua Nevett

https://www.dailystar.co.uk/news/latest-news/sex-robots-3d-printed-cost-16999491

This chapter doesn't really belong to this book, but I don't have any better place to put this idea, so there.

While I was taking a bath I read the beginning of this book:

Fabricated: The New World of 3D Printing

by Hod Lipson and Melba Kurman

The authors say that the 3D printing technology did not find its "killer application" yet.

https://en.wikipedia.org/wiki/Killer_application

(like personal computers got into every home because of video games for example).

Then I remembered Peter Sunde (one of the founders of The Pirate Bay – which was the biggest file sharing website at the time), where he said that something like 90% of the volume of traffic is porn. So this was about pirated porn, but I think it shows the level of interest in this content in general.

The "vision" I had was that we can take this huge human need, and combine it with the customizability and discretion of building things by yourself in your private home using your 3D printer.

On the one hand, sex dolls look and (according to documentaries) feel very human, but they are not personalized:

https://en.wikipedia.org/wiki/Sex_doll

On the other hand toys get more personalized but they are just separate body parts:

The company "Fleshlight"

https://en.wikipedia.org/wiki/Fleshlight

They have a product line that makes plastic (or silicone or whatever it's made of) masturbation sleeves molded after the exact shape of the pussies and assholes of famous female pornographic actresses, and they have another line for assholes of I guess gay male pornographic actors, and also they have a function of build your own.

They also have yet another line for dildos in the shape of the dicks of famous male pornographic actors.

But as you understand this kind of technology has a few drawbacks:

(1) It's not a complete sex doll of your fantasy subject, it's just one body part.
(2) It's not any girl you want, only selected porn stars.
(3) It's hard to get it discretely you get a package and neighbors might notice.

All these problems can be fixed using the technology of a 3D printer, combined with a few "assisting" technologies, such as a module that can paint on the 3D model the texture or pattern that the program makes.

Let's imagine a few possible scenarios with the basic idea:

You are living away from your wife or girlfriend, let's say you are a soldier or studying abroad or something.

Then you ask your sweetheart to scan her body with an "assisting" technology, which she can do herself in the privacy of her house, by taking photos of her naked body from the front from the side from the back etc. Then a special software transforms these 2D photos into a 3D model.

Your sweetheart sends you the 3D model file (can be an encrypted e-mail for example). Then you use your private 3D printer (or at least the private time you get on a shared 3D printer), to print a sex doll of your loved one.

Then the software guides the "assisting" technology to draw and paint the image of your sweetheart on the generic sex doll so now it's the most intimate and arousing sex doll. Then after you finish and clean the doll you can shred the doll (like today we shred paper) and the same raw material can be used all over again to make something else.

Or think about all these millions of people just watching porn and masturbating with their hand or a toy in front of a screen, now they can upgrade this enjoyable activity to a whole new level.

So the process can be something like printing pipes from hard plastic which are the skeleton and the user will screw them (yes I mean screw not fuck yet! 😊)

https://en.wikipedia.org/wiki/Screw

to each other, and then the 3D printer will produce the soft parts that you can wrap like a sleeve over that, probably from silicone, and then the machine will print "skin" that you can wrap over that which will probably be PVC, and finally the machine will paint the head like facial features and the user screws the head last.

And not to raise suspicion about the amount of raw material these can be packaged and delivered as water tanks or bottles (in the case of silicone) and so on.

Another software module can for example calculate a 3D model from simple pictures, like if a guy fantasizes about his coworker and she's already taken (or not into him from some reason or another), then he can take the video from the company's last recreational day when they went to the beach for example, and the software will analyze from several shots from different directions how to build a model of that woman.

https://en.wikipedia.org/wiki/2D_to_3D_conversion

https://en.wikipedia.org/wiki/3D_reconstruction_from_multiple_images

Also inside the "skeleton" tubes you can put a hand warmer

https://en.wikipedia.org/wiki/Hand_warmer

And in the right parts you can use lube so it's has the right feel to it, etc.

So for example many women provide sex services in the form of personalized webcam talks, and selling personal items like panties they wore etc. So think about it now they can also sell their model, and the guys at home can dress it and play with it etc.

This could also boost virtual reality headsets and the woman on the other side can have the complementary computer controlled 3d camera, so you have almost the real experience even though she is a porn star in another country and you could never meet in real life.

Also I though about prosthetics for couples for example where the man has a small penis and the woman fantasizes about a well-endowed porn star, so they can take the measurements of the husband and subtract from the porn star 3D model, and create a space in the dildo for the husband's cock, so that it's like he fucks his wife but with a huge cock like she wants.

Here is the description of 3D printed model of a dildo from The Pirate Bay, that pretty much says all there is to say about it:

The 3D dildo (6.83 MegaBytes)

Under the category: Other > Physibles

uploaded on: September 13th 2013 by mindcrasher

The 3Dildo - Our first realistic dildo allows people to scale and print a dildo in the exact size they desire. Some people believe this is the reason that 3D printers will become popular. I agree. People with these devices will want to print all sorts of things and they will certainly want to avoid buying them in a store. Note, these photos show the dildo as it will print, with external support. You can easily remove the support and have just the dildo itself.