Mastering SEQUENCE

Excel's most amazing function with more than 200 examples

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Dedicated to

My beloved daughters

Noga

&

Gili

Who have patiently borne with me

In the last year

About the Author

Meni Porat has been working in the software industry for more than 20 years. He has played central roles in numerous projects as a systems analyst and project manager. He worked for various financial institutions: banks, credit card companies and insurance companies. Currently, he is a self-employed consultant and Excel & VBA instructor. The author is also very active on social media channels, especially Facebook and LinkedIn. On the latter, he has published during the last year more than 150 posts and articles which have been read by more than 400,000 people. During that period he also featured in four YouTube international webinars on Excel. As a tribute to his contributions to the international Excel community, the author has been awarded with the Most Valuable Professional (MVP) by Microsoft.

About the Reviewer

Cristiano Galvao is a Microsoft MVP from Brazil with over 2 decades of working experience with Microsoft Excel. He has been a guest speaker on the major Excel conferences abroad, and is the organizer of the Excel Weekend, the most important Excel conference in South America. Cristiano is the technical reviewer of many Excel books translated to Portuguese, including authors such as Bill Jelen, John Walkenbach, Paul McFedries, Ron Person, Joseph Schmuller, and more.

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I would like to express my gratitude to my daughters for their support and understanding while their father was seized in a fit of writing momentum, leaving them only a small amount of patience and leisure.

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I wish to express my obligation to BPB Publications for their unstinted aid. I am indebted to the publisher who saw the potential in the book's subject, took the risk and made this book come true. The long enterprise has reached its successful goal.

Finally, a special thanks to many of my Linkedin friends who read my numerous posts and responded enthusiastically. Their feedback greatly motivated me.

Preface

Excel is a ubiquitous sophisticated software. With the introduction of the new Dynamic Array Functions (DAF) in Excel 365, using Excel has become much simpler and extremely fast.

This book presents the crème de la crème of these new functions: SEQUENCE. This function is explained thoroughly in more than 200 examples accompanied by almost 300 pictures.

The book is designed to provide the most comprehensive guide to that function. You will be able to find examples of how to implement SEQUNECE (usually with collaboration with other functions) in almost any field imaginable: from text and numbers to finance and mathematics.

The vast number of practical examples is intended to guide the reader on how to implement this function cleverly in building solutions to challenges in Excel.

Throughout the book, the reader will encounter well-designed answers to problems in various levels of complexity. It is not necessary to the read the book's chapters sequentially. Just pick randomly the chapters that interest you or those that are most relevant to your problems.

With this book, you will gain the knowledge and skills to become a proficient and efficient problem solver in Excel. We do believe that you will find this book informative, useful, and inspiring.

Chapter 1: A Short Introduction to Dynamic Array Functions in Excel 365 – Explains the new features in Excel 365. This is nothing short of a revolution in Excel: instead of a formula that returns a single-cell result, we now have an array of results in multiple cells. This introductory chapter illustrates the use of these functions in 30 examples. Some of the DAF were published only a few months ago.

Chapter 2: SEQUENCE in Text Operations – Every analyst (data/business/financial…) needs some very common text manipulation in order to clean his/her data and prepare it for analysis. This chapter supplies more than 60 examples of how to do it.

Chapter 3: Using SEQUENCE with Numbers – Easy-to-apply methods for creating a sequence of numbers (ascending or descending, positive or negative), duplicating a number (or a sequence of numbers), extracting numbers from a mixed string, etc. are showcased in this chapter.

Chapter 4: SEQUENCE in Arrays – As the name implies, Dynamic Array Functions are meant to deal with arrays of data, both in input and output. This chapter will show you several ways to build dynamic arrays, flip them vertically and horizontally, transpose arrays, fetch multiple results for a search value and more.

Chapter 5: SEQUENCE in Date and Time Operations - Dates and times calculations are very common in Excel. The SEQUENCE function will show you neat tricks to generate sequence of dates, create various dynamic monthly and yearly calendars, generate automatic schedules, produce lists of dates (for example: last day of each month of the year), calculate net workdays in a given period (with/without holidays) and many more.

Chapter 6: Financial Operations with SEQUENCE – This chapter will be of great interest for readers whose expertise is in finance: accountants, economists, financial analysts, CFOs etc. The chapter supplies a new approach to old solutions for financial functions: PMT, DB, NPV, PDURATION, RATE, IRR etc.

Chapter 7: SEQUENCE - The Ancilla of Math – Whether you are a mathematics teacher or not, here, you will find some fresh ideas of how to harness new approaches (sometimes with dynamic Excel charts to better illustrate the concept) to mathematical challenges in algebra, trigonometry and the number theory.

Chapter 8: SEQUENCE and Other Animals – Last but not least, this chapter is dedicated to some more complex examples. It demonstrates the powerful symbiosis and cooperation of SEQUENCE and other advanced functions. Several examples with the new versatile LAMBDA function are also given.

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A Short Introduction to Dynamic Array Functions in Excel 365

Introduction

The latest version of Excel (Excel 365) is nothing short of a revolution. The new formula engine of Excel allows you to reference an array in one formula and get multiple results. This was not the case until a few years ago. However, the most revolutionary aspect of this new version is that Microsoft has added some new functions, which operate on arrays and enhance their flexibility and ease of use.

This chapter will briefly introduce some of these powerful functions and demonstrate their utility and efficiency.

This introduction demonstrates only a small fraction of these functions' power. Also, only in few cases will we exemplify the combination of two or more of these functions. Such co-operation of two or more DAF can have endless applications for problems in Excel that could not have been solved earlier with formulae.

Structure

This chapter will discuss the functions in the bulleted list below. Each function will be briefly explained and elucidated in a picture/pictures which will show the function in action.

In this chapter, we will discuss the following topics:

- Introducing Dynamic Array Functions
- Examples of the new DAF
    - UNIQUE - returns a list of unique values in a range.
    - FILTER - selects data according to condition/s.
    - SORT - sorts a range, ascending/descending.
    - SORTBY - sorts a range by another range/array.
    - RANDARRAY - generates a bounded array of random numbers.
    - SEQUENCE - generates a sequence of numbers/characters.
    - TEXTSPLIT - splits text across columns/rows by a specified delimiter.
    - TOCOL - converts a horizontal/bi-dimensional array to a vertical one.
    - TOROW - converts a vertical/bi-dimensional array to a horizontal one.
    - VSTACK - stacks one or more arrays vertically, upon the other.
    - HSTACK - stacks one or more arrays horizontally, one after the other.
    - EXPAND - expands/pads an array by specified dimensions.
    - ARRAYTOTEXT - converts an array/range to a single-cell text string.
    - TEXTBEFORE - returns the text before a delimiter/substring.
    - TEXTAFTER - returns the text after a delimiter/substring.
    - CHOOSECOLS - returns data by specified column number/s.
    - CHOOSEROWS - returns data by specified row number/s.
    - WRAPROWS - wraps a row/column after a specified number.
    - WRAPCOLS - wraps a row/column after a specified number.
    - XLOOKUP - searches a range/array and returns first found item.
    - XMATCH - searches an item in a range/array and returns its position.
    - TAKE - returns part of an array according to rows/columns specified.
    - DROP - drops rows and/or columns from an array.
    - VALUETOTEXT - converts non-text to text, text left intact or wrapped in quotes.

Objectives

After reading this chapter, you will be able to understand the difference between single-cell and multiple-cell functions in Excel. You will also realize the quantum leap of the new **Dynamic Array Functions** (**DAF**). This chapter will make it easier for you to comprehend the versatility and flexibility of the new generation functions, and implement these functions in your daily work.

Introducing Dynamic Array functions

This chapter exemplifies all the **Dynamic Array Functions** (**DAF**) introduced by Microsoft until the date of writing this chapter (December 2022). Some of these functions might be available only in the Beta version, which gives you the advantage of getting acquainted with them in advance.

These functions are very versatile and powerful. They can accomplish many new features that were not available in previous versions of Excel.

However, this chapter does not include the new **`LET`** and **`LAMBDA`** functions. Nor does it contain the LAMBDA **`helper`** functions that do not operate alone and serve as ancillary functions to LAMBDA. For example: **`MAP`**, **`MAKEARRAY`**, **`DROP`**, **`SCAN`**, **`REDUCE`**, **`BYCOL`**, and **`BYROW`**.

Although these non-DAF functions are not presented in the current chapter, some of them will be demonstrated in the next chapters, where we will expose the **`SEQUENCE`** Function in action.

The DAF list, however, is up to date and includes all the *independent* functions published till the date of writing this chapter.

Examples of the new DAF

We will now discuss the examples of the new DAF functions in detail:

UNIQUE function

The **UNIQUE** function extracts unique values from a list/array as illustrated in the following figure:

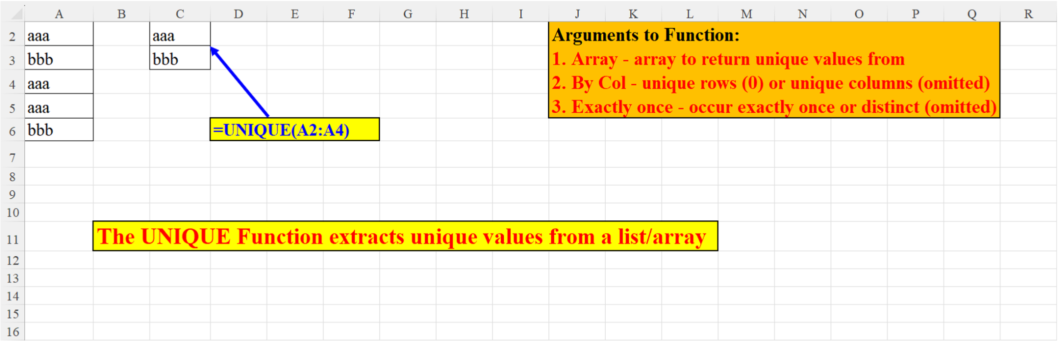


Figure 1.1: The UNIQUE function: A simple Example

FILTER function

The **FILTER** function retrieves from an array only records that match a condition/conditions as illustrated in the following figure:

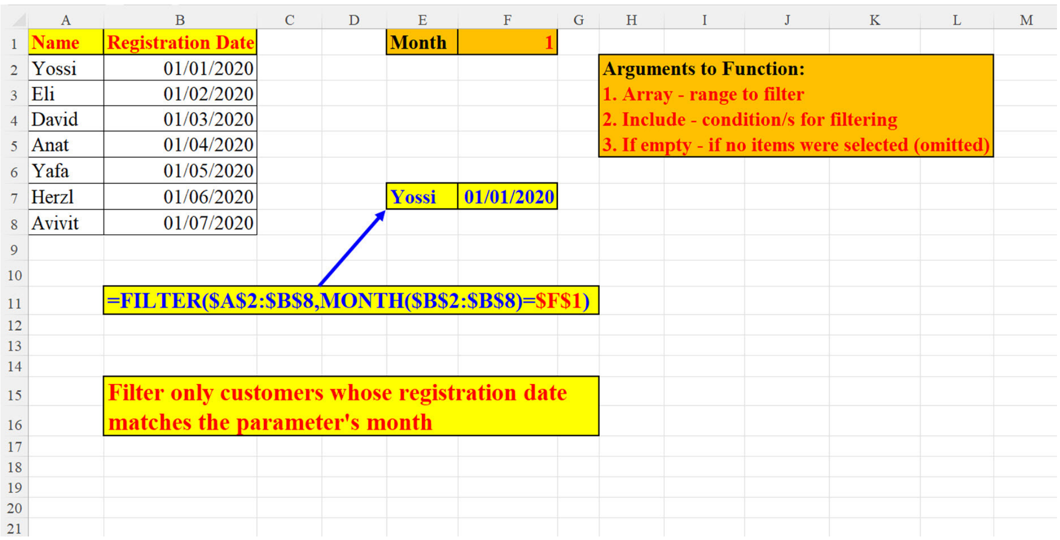


Figure 1.2: The FILTER function - filter only those who registered in January

SORT function

The **SORT** function sorts an array according to parameters. If the parameters are omitted (as in our example), the sort is being executed with the default parameters. In our example, the sort is in ascending order (the default):

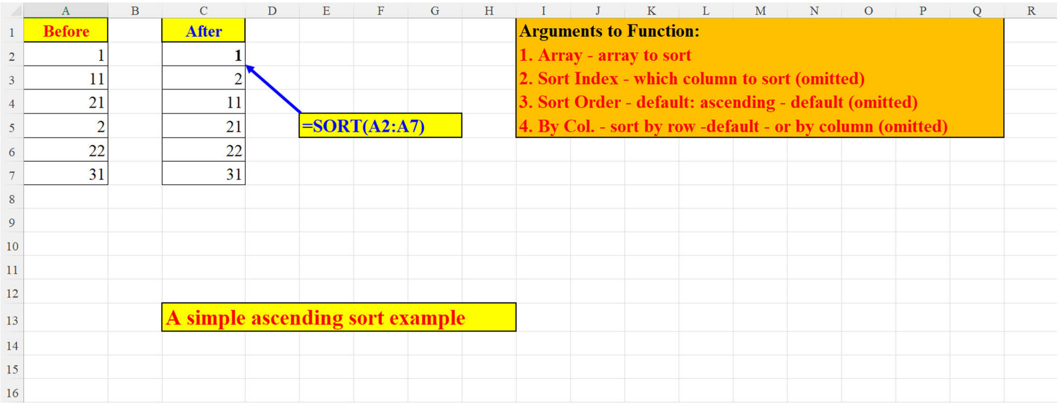


Figure 1.3: *The SORT function (example 1): ascending SORT*

In the following example, we are sorting in descending order (the third parameter is -1):

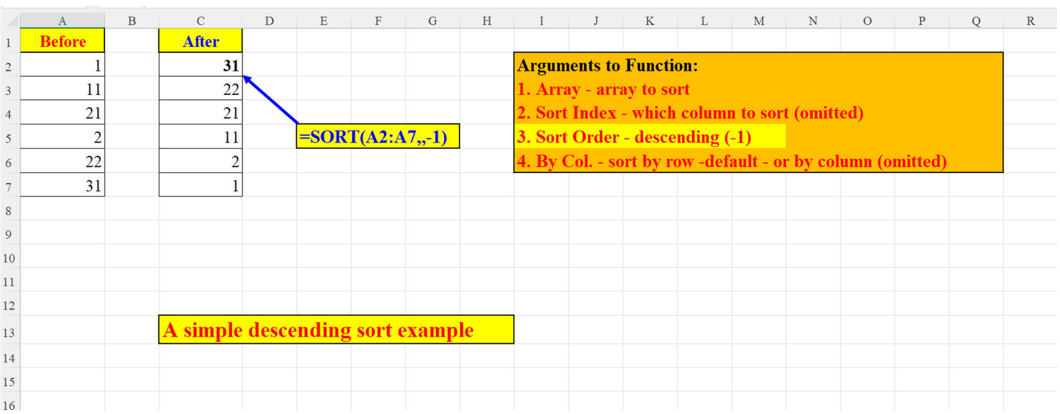


Figure 1.4: *The SORT function (example 2): descending SORT*

SORTBY function

The **SORTBY** function sorts by an array. In our example, the months of the dates array (B2:B8):

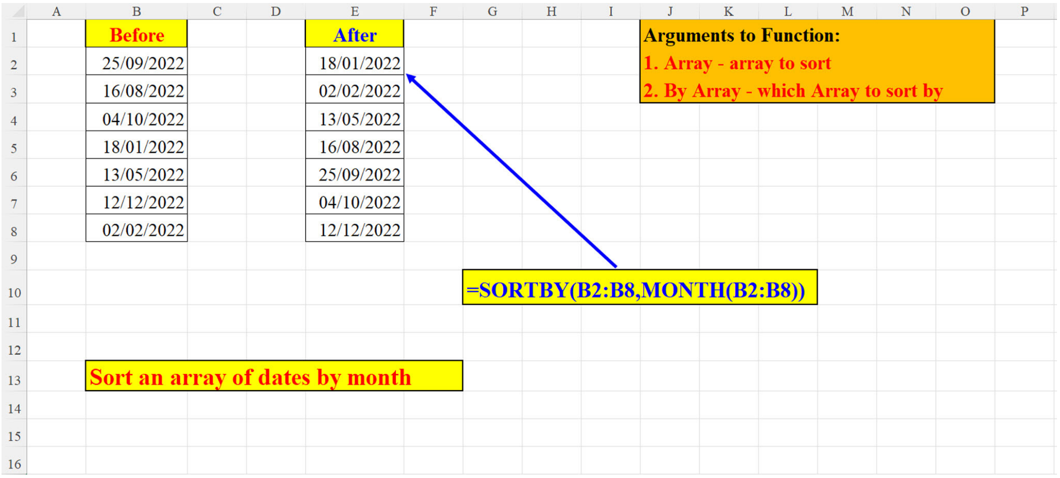


***Figure 1.5**: The SORTBY function: SORT dates by month*

RANDARRAY function

The **RANDARRAY** function generates a random array. In our example, it creates ten random integer numbers between 1 and 100:

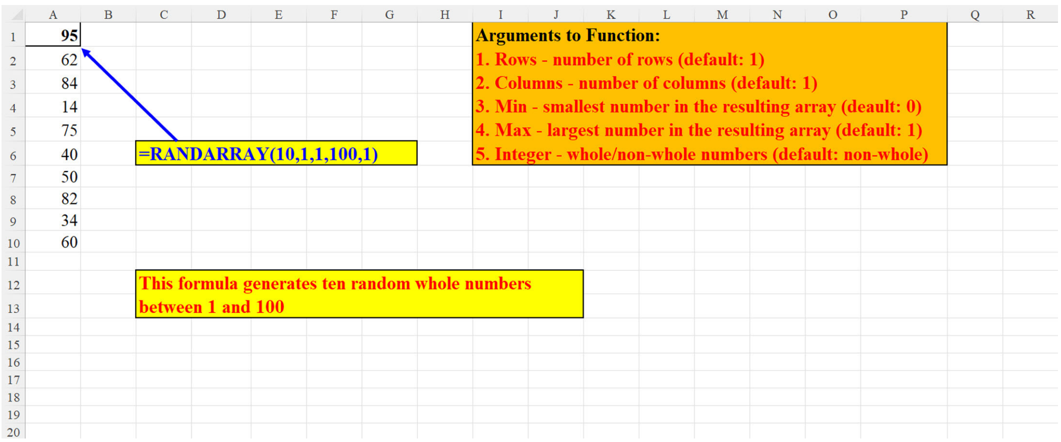


***Figure 1.6**: The RANDARRAY function: generate random numbers*

SEQUENCE function

We will learn the **SEQUENCE** function inside out, so here is a simple example of creating a sequence of 12 descending numbers:

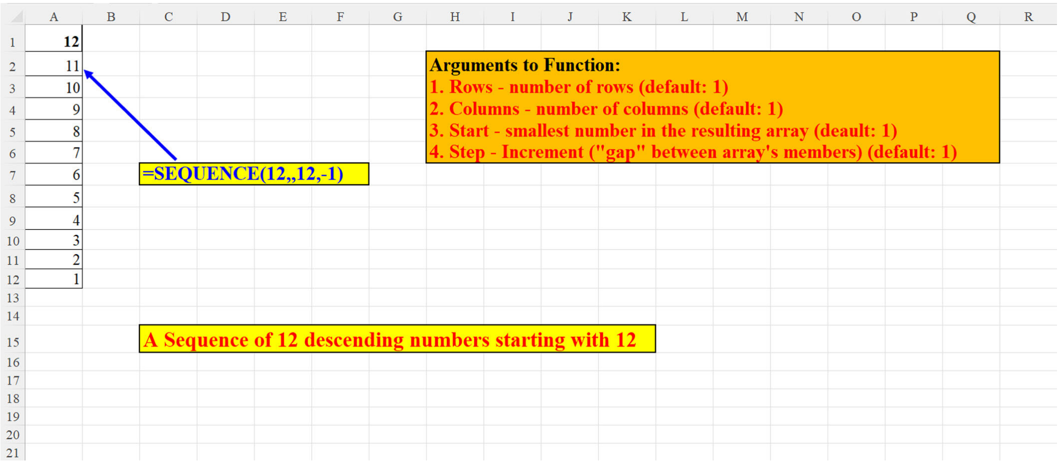


Figure 1.7*: The SEQUENCE function: create a sequence of numbers*

TEXTSPLIT function

The **TEXTSPLIT** function splits a cell's value by a delimiter.

In the following example, we use an array constant (in curly braces) to define more than one delimiter.

Please note, that although this function is considered a DAF it can operate properly only on single cells:

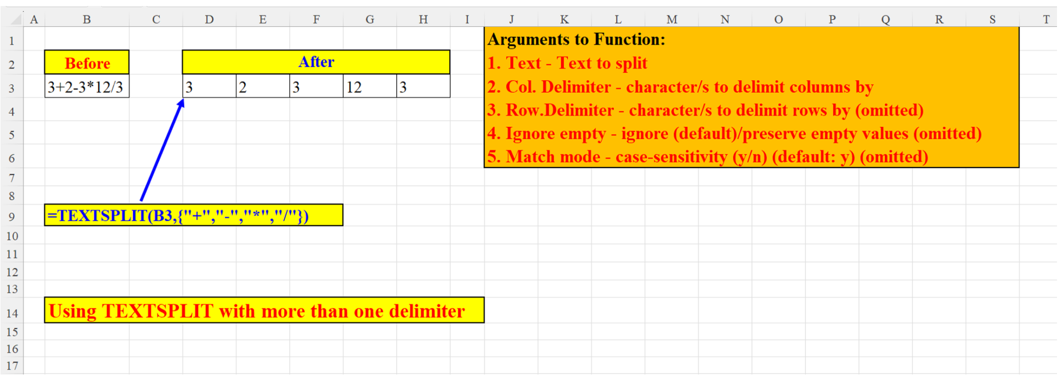


Figure 1.8*: The TEXTSPLIT function: Split a cell's text into several cells*

TOCOL function

Example 1:

A simple example of the **TOCOL** function in which we transpose the original array from horizontal to vertical:

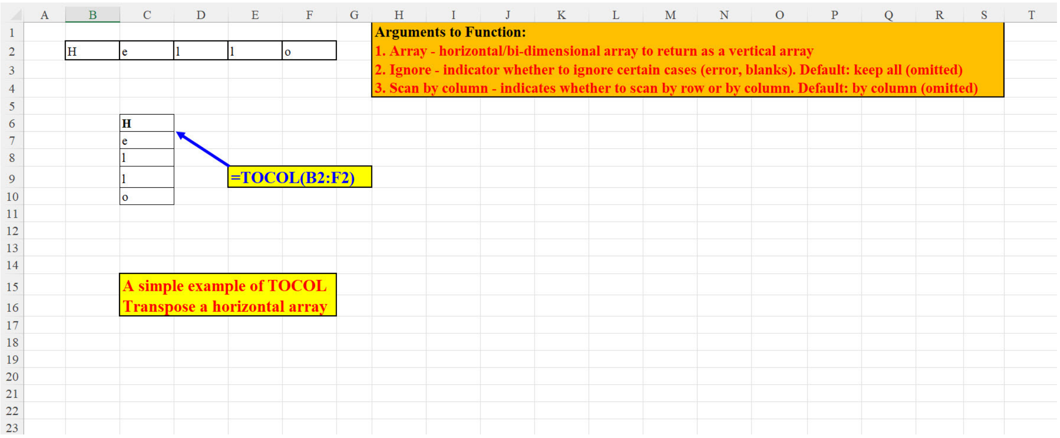


***Figure 1.9**: TOCOL: A very simple Example*

Example 2:

In this example, we use a "trick": the inner IF statement returns an invalid value ("NA"), and since TOCOL's second argument = 2 tells Excel to ignore errors, the resulting array (Col.E) displays matching rows only:

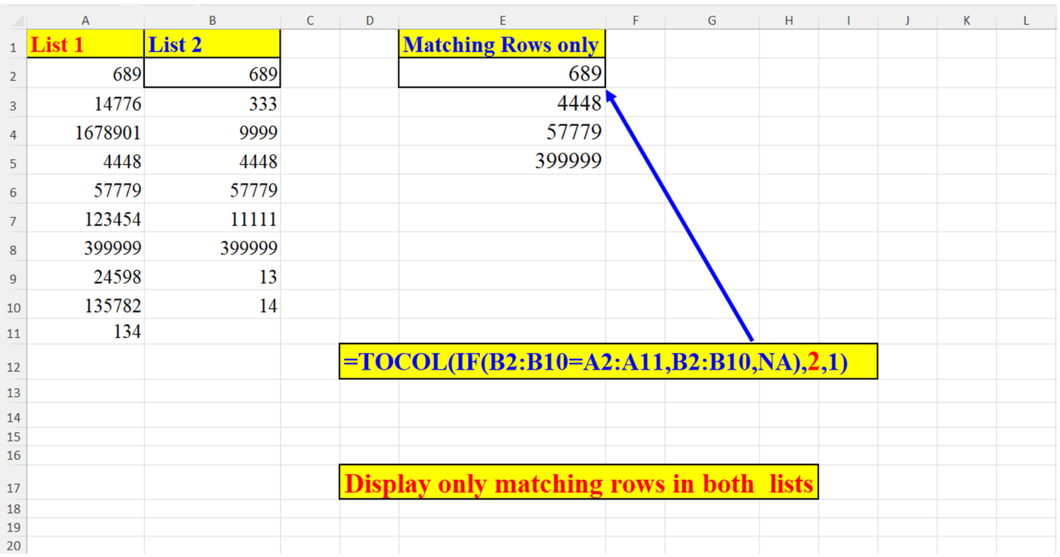


***Figure 1.10**: TOCOL: A more "sophisticated" Example*

TOROW function

A simple example of the **TOROW** function in which we transpose the original array from vertical to horizontal is illustrated in the following figure:

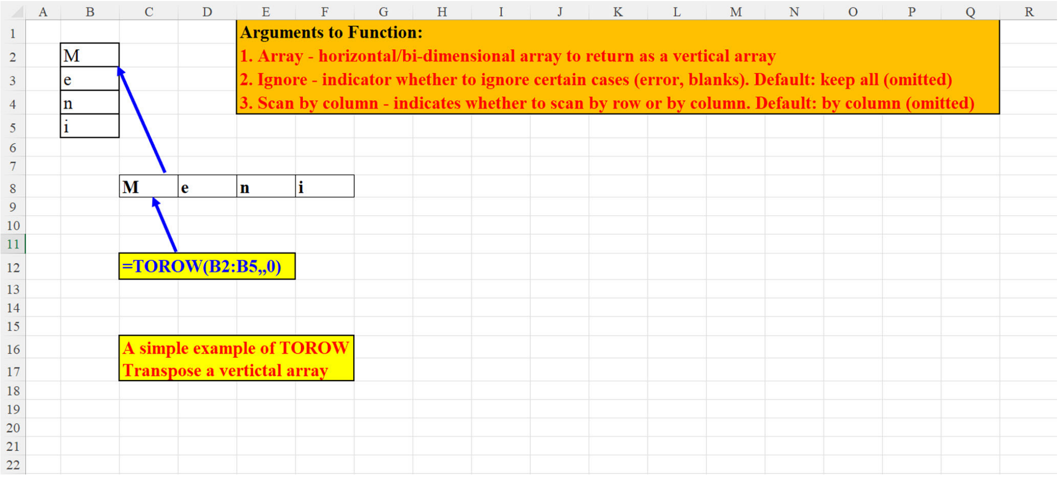


Figure 1.11: *TOROW: A very simple example*

VSTACK function

In the following example, we *stack* two arrays one on top of the other to create one vertical array:

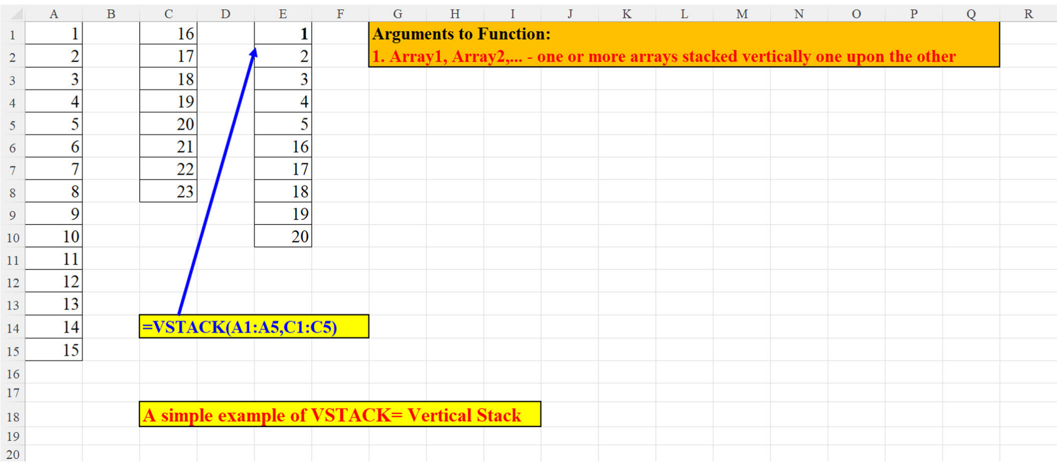


Figure 1.12: *VSTACK: A very simple example*

VSTACK versus TOCOL

The following image demonstrates the differences between **TOCOL** (on the left-hand side) and **VSTACK** (on the right-hand side).

TOCOL creates the stack horizontally, from left to right. However, **VSTACK** *stacks* the first column on top of the second one:

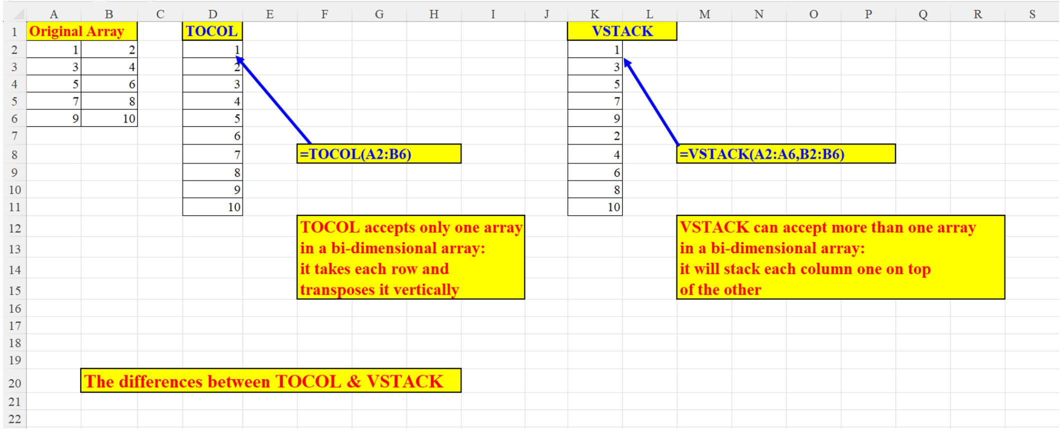


Figure 1.13: The differences between TOCOL and VSTACK

HSTACK function

The **HSTACK** function *stacks* horizontally, as can be seen in the following figure. We *slice* two rows and combine them to one long array, arranged horizontally:

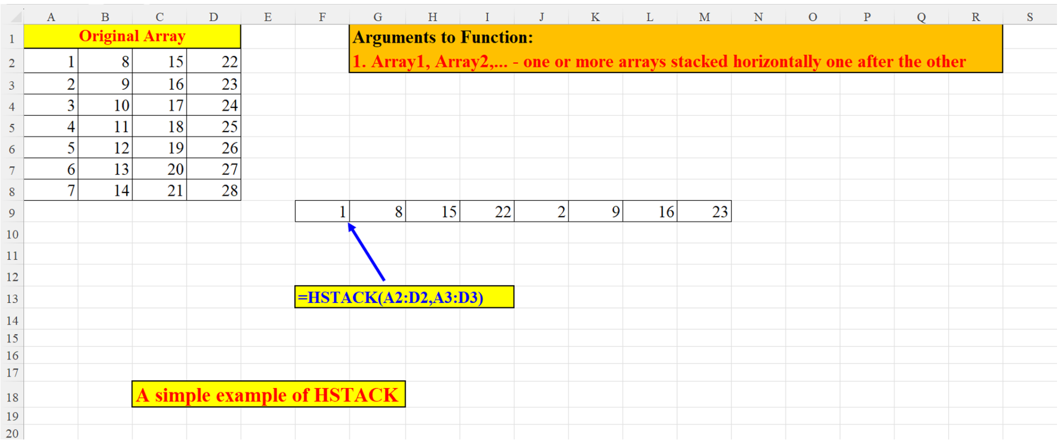


Figure 1.14: HSTACK: a very simple example

EXPAND function

This example utilizes the new Data Types feature of Excel 365 (Data*Data Types*Geography):

Figure 1.15: *EXPAND example*

ARRAYTOTEXT function

Some examples of the **ARRAYTOTEXT** function, from top to bottom: converting an array of numbers to text in a single cell (two examples), converting an array of characters to a single cell (two examples) and showing the similarities between this function and the **TEXTJOIN** Function.

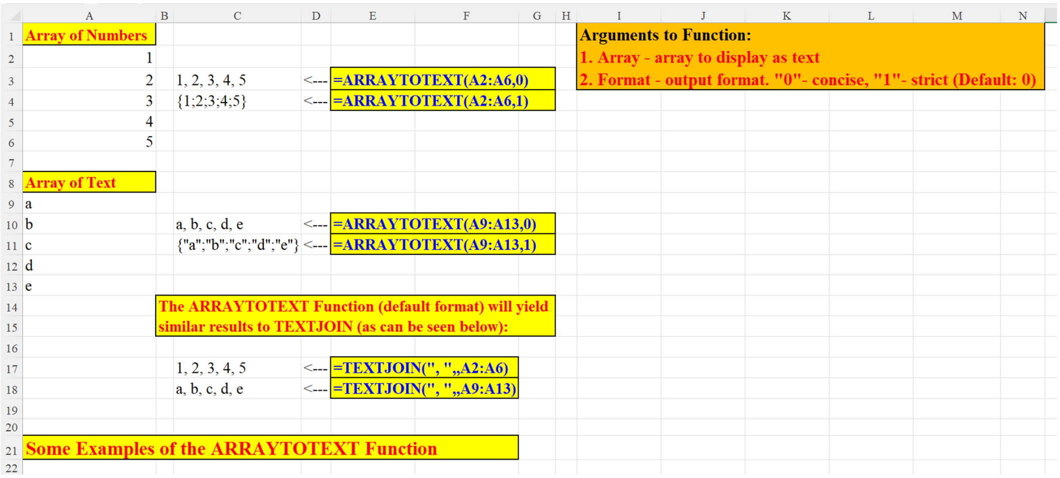


Figure 1.16: *ARRAYTOTEXT example*

TEXTBEFORE function

The **`TEXTBEFORE`** function can extract text from an array / range preceding a delimiter:

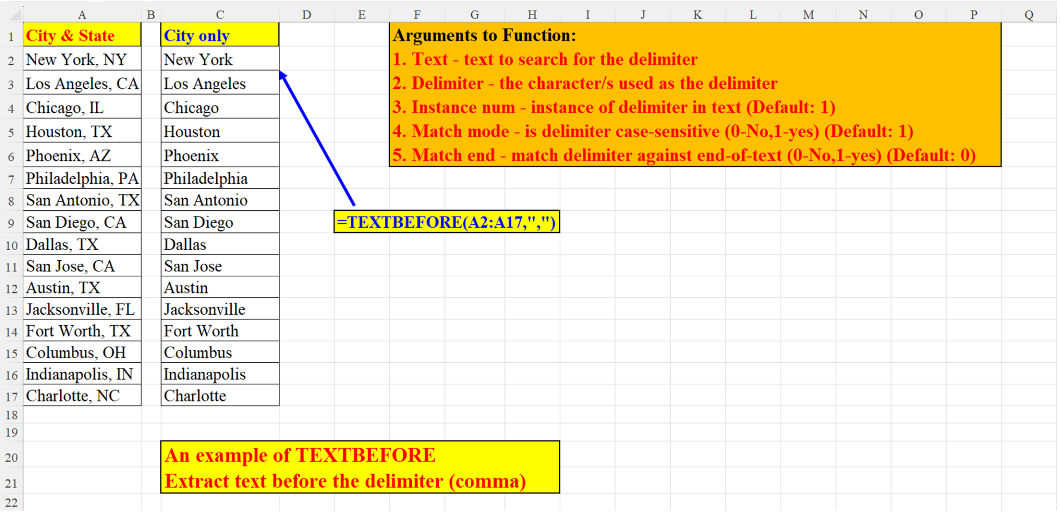


***Figure 1.17**: TEXTBEFORE example*

TEXTAFTER function

Here, two examples are being demonstrated.

Example 1:

The first is a simple one, where the instance number = -1, which means: finding the last occurrence of the delimiter and fetching the text immediately following it. This is illustrated in the following figure:

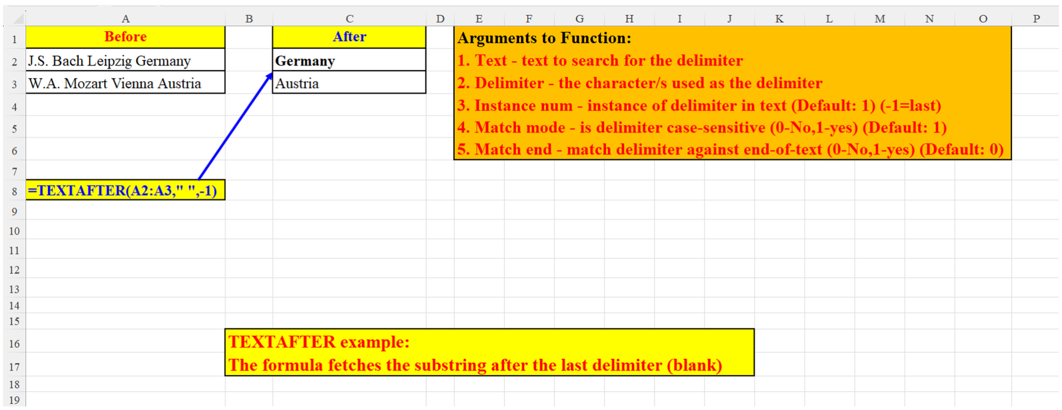


***Figure 1.18**: TEXTAFTER – a simple example*

Example 2:

The second example illustrates a very interesting feature of this function:

Even though the delimiter is defined as a single blank character (" "), the function returns the text after more than one blank.

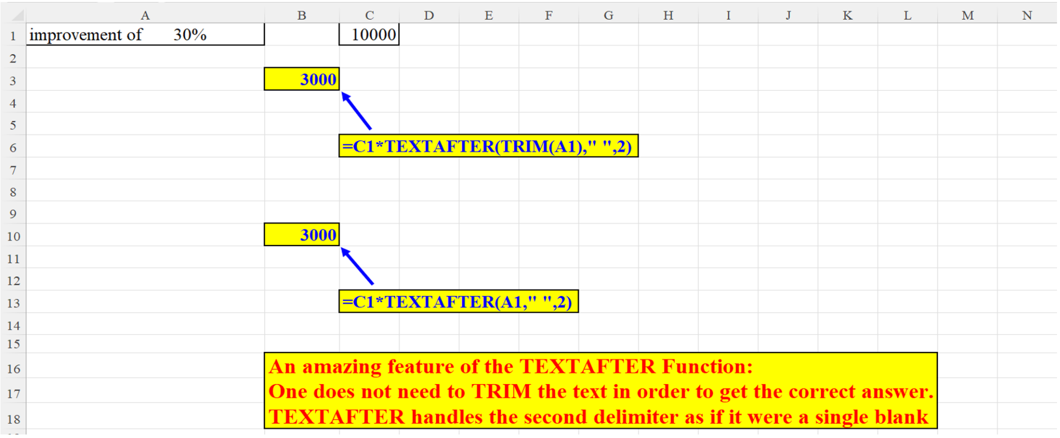


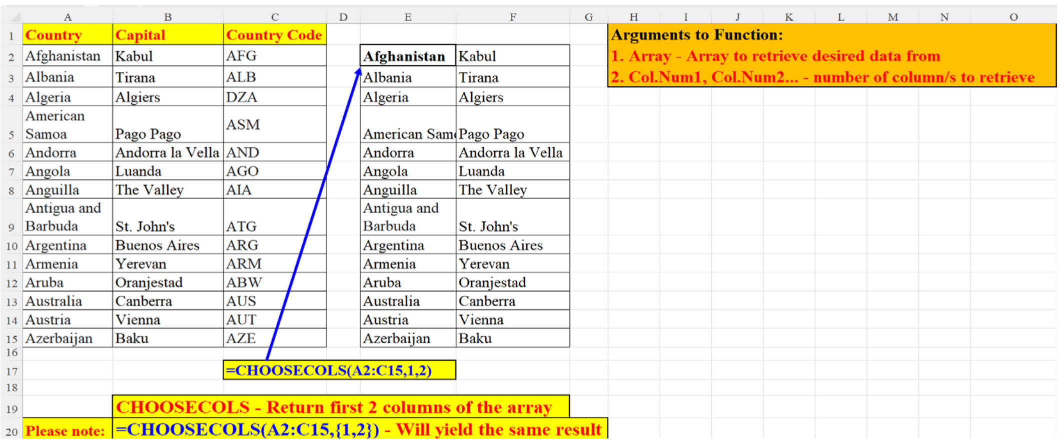
Figure 1.19: *TEXTAFTER – An amazing feature*

CHOOSECOLS function

The **`CHOOSECOLS`** function allows us to select only certain columns of a multi-column array.

Please note that:

- The second argument can be written either as a list of numbers, that is, 1,2 or as an array constant: {1,2}
- Specifying -1 as the second argument will fetch the last column only:



Country	Capital	Country Code			
Afghanistan	Kabul	AFG		Afghanistan	Kabul
Albania	Tirana	ALB		Albania	Tirana
Algeria	Algiers	DZA		Algeria	Algiers
American Samoa	Pago Pago	ASM		American Samo	Pago Pago
Andorra	Andorra la Vella	AND		Andorra	Andorra la Vella
Angola	Luanda	AGO		Angola	Luanda
Anguilla	The Valley	AIA		Anguilla	The Valley
Antigua and Barbuda	St. John's	ATG		Antigua and Barbuda	St. John's
Argentina	Buenos Aires	ARG		Argentina	Buenos Aires
Armenia	Yerevan	ARM		Armenia	Yerevan
Aruba	Oranjestad	ABW		Aruba	Oranjestad
Australia	Canberra	AUS		Australia	Canberra
Austria	Vienna	AUT		Austria	Vienna
Azerbaijan	Baku	AZE		Azerbaijan	Baku

Figure 1.20: *CHOOSECOLS example*

CHOOSEROWS function

The **CHOOSECOLS** function allows us to select only certain rows of a multi-row array.

Please note that:

- The second argument can be written either as a list of numbers, that is, 1,6 or as an array constant: {1,6}
- Specifying -1 as the second argument will fetch the last row only:

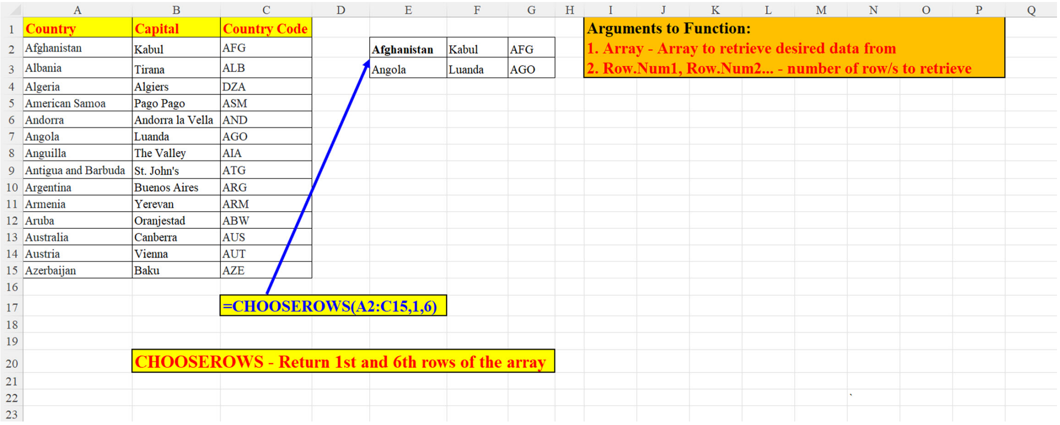


***Figure 1.21**: CHOOSEROWS example*

WRAPROWS function

The **WRAPROWS** function *wraps* a vertical array by rows. In the following example, we *wrap* two consecutive rows of the original (one-dimensional) array into a two-column array:

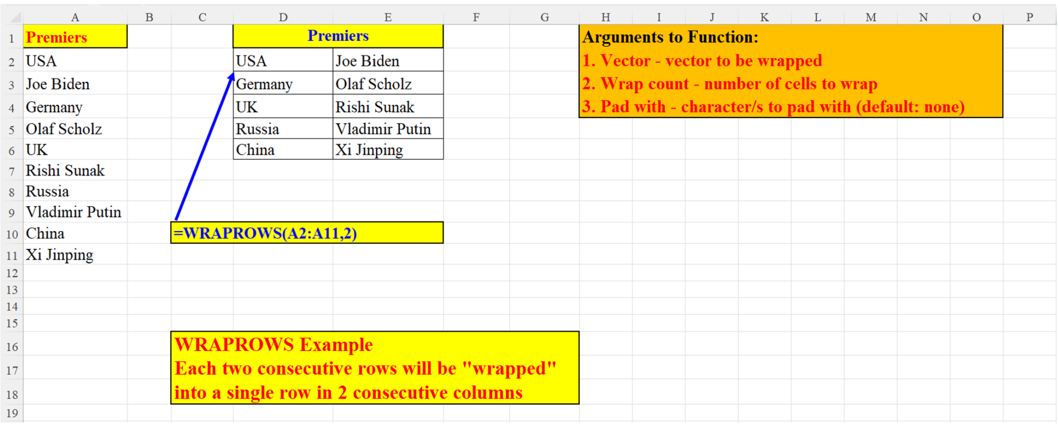


***Figure 1.22**: WRAPROWS example*

WRAPCOLS function

In the **WRAPCOLS** function example, each two consecutive rows of the original (one-dimensional) array are being *wrapped* into a two-row array as illustrated in the following figure:

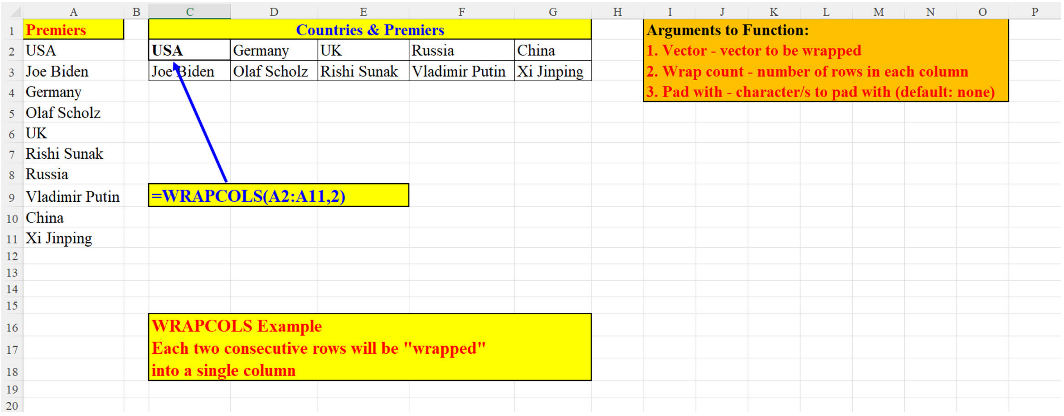


***Figure 1.23**: WRAPCOLS example*

XLOOKUP function

The **XLOOKUP** function is the more advanced and flexible version of the good old **VLOOKUP** function.

Example 1:

In our example, Argument no. 5 is -1 means: Exact match. If the Lookup Value is not found, the next smaller item is returned.

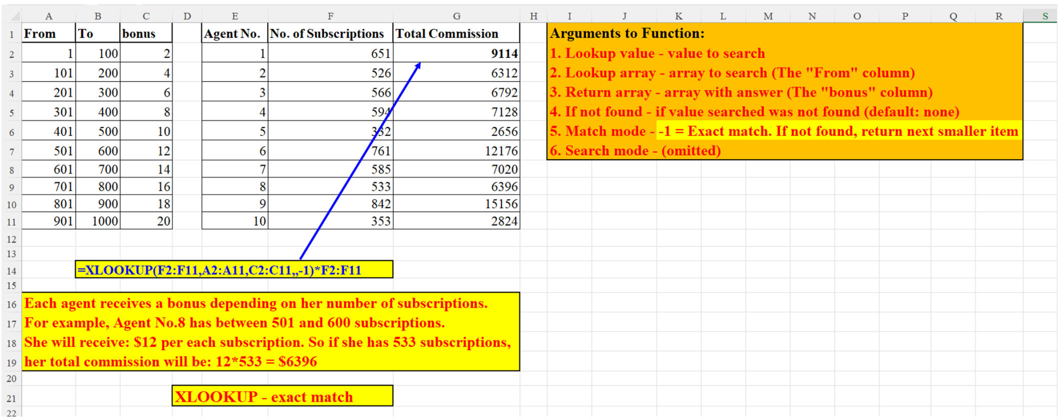


***Figure 1.24**: XLOOKUP example 1 – exact match returns the next smaller value*

Example 2:

Another example with **XLOOKUP**. Here, Argument no.5 is 2 which means: wildcard match as shown in the following figure:

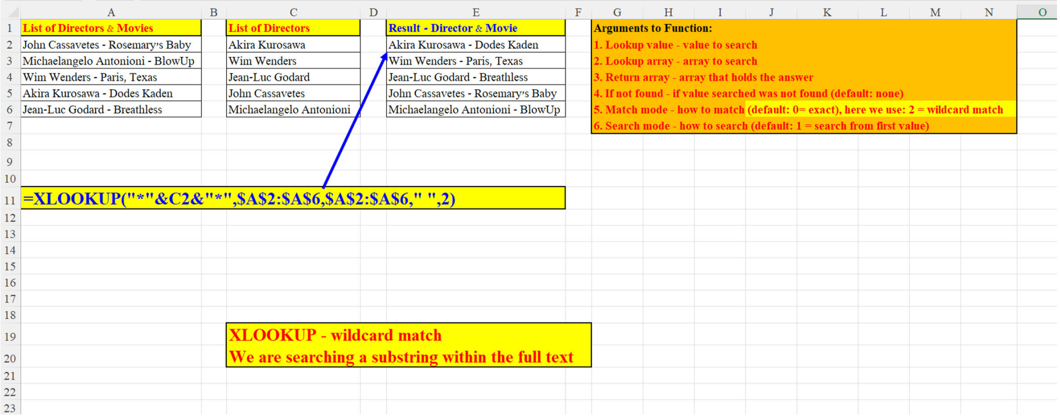


Figure 1.25: XLOOKUP example 2 – wildcard match

Example 3:

Third example of XLOOKUP. Here Argument no.5 is 2 which means: exact match. If not found, as in our case, the next larger item is returned as shown in the following figure:

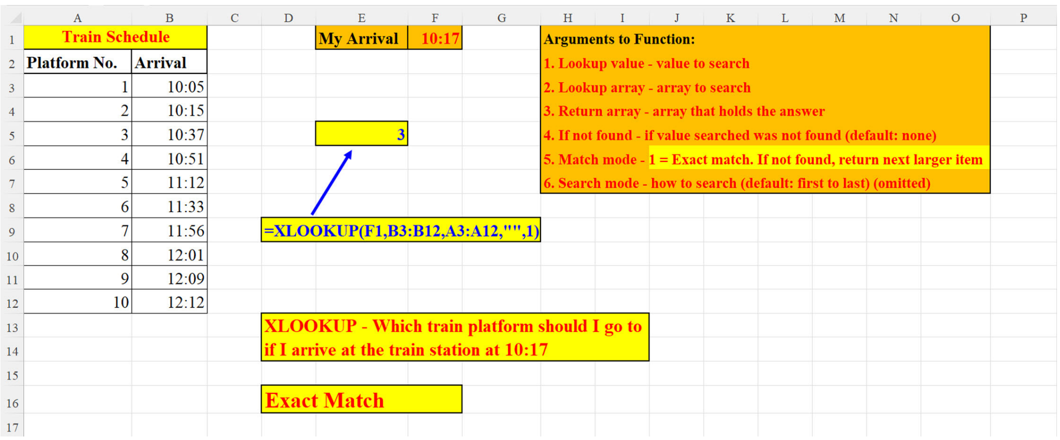


Figure 1.26: XLOOKUP example 3 – exact match returns the next larger item

XMATCH function

XMATCH is a more advanced version of the veteran **MATCH** function. When searching for an exact match, (as in our example) the looked-up column does not need to be sorted (as in **MATCH**). See the following screenshot:

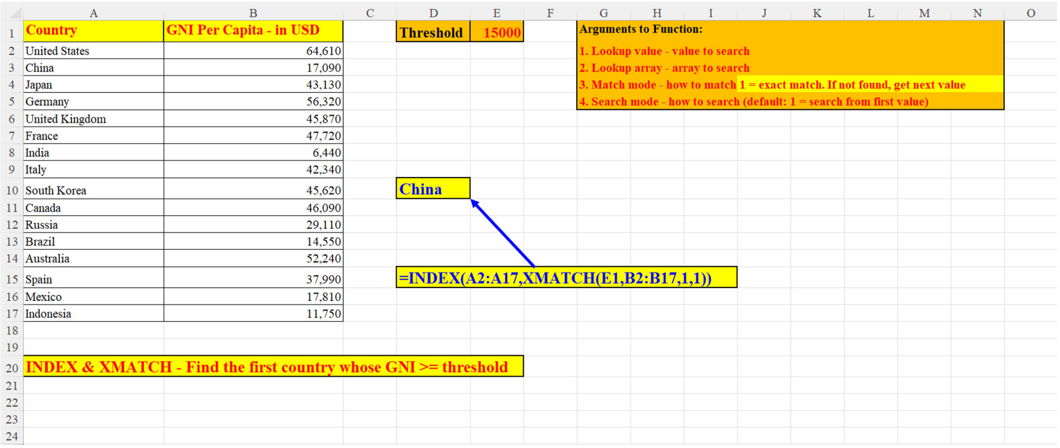


***Figure 1.27**: XMATCH combined with INDEX: find 1st country whose GNI>=15,000*

TAKE function

The **TAKE** function *carves* a sub-array from the original array. Here, the result is a 3*3 array:

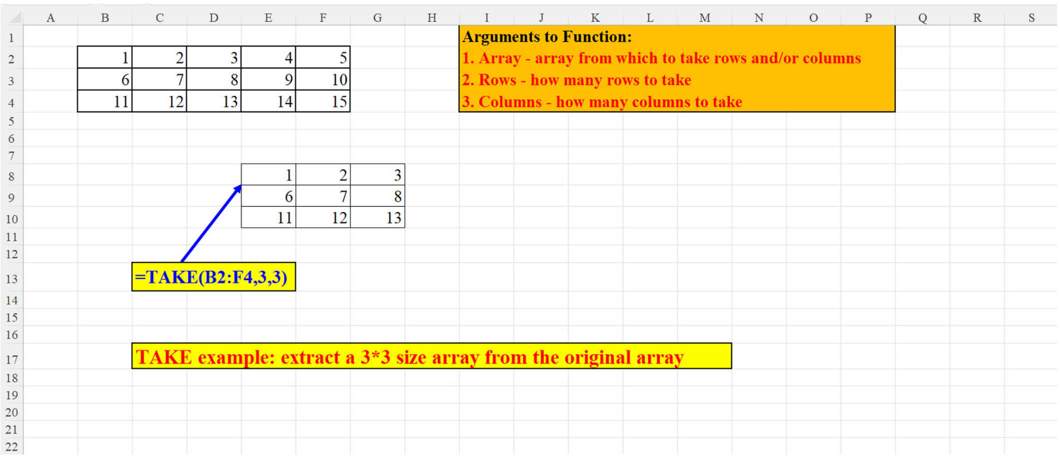


***Figure 1.28**: TAKE example: create a two-dimensional "sub-array"*

DROP function

The **DROP** function omits rows and/or columns from an array to create a smaller array.

The second argument is negative, which tells Excel to drop rows from the array's end:

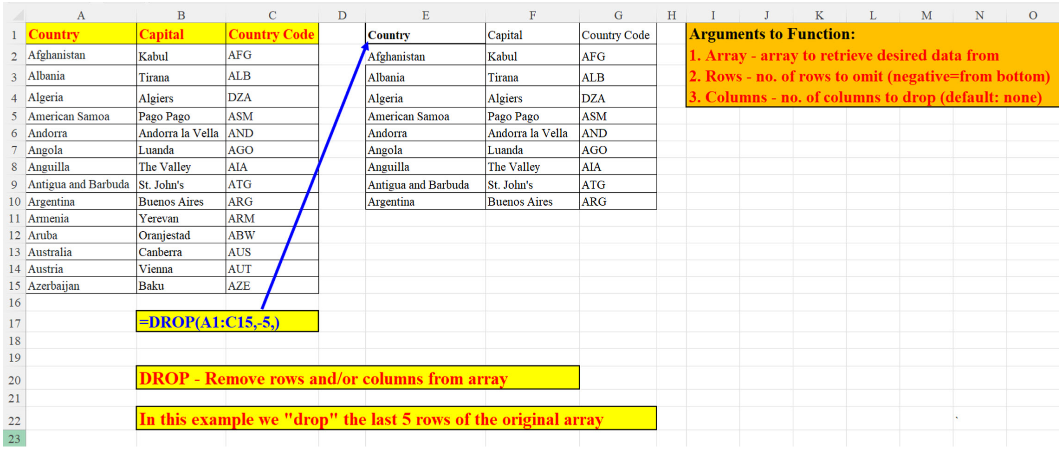


Figure 1.29: DROP example

VALUETOTEXT function

The **VALUETOTEXT** function converts non-text to text. Since the second argument is omitted, the text is unaltered (that is, not put in quotes):

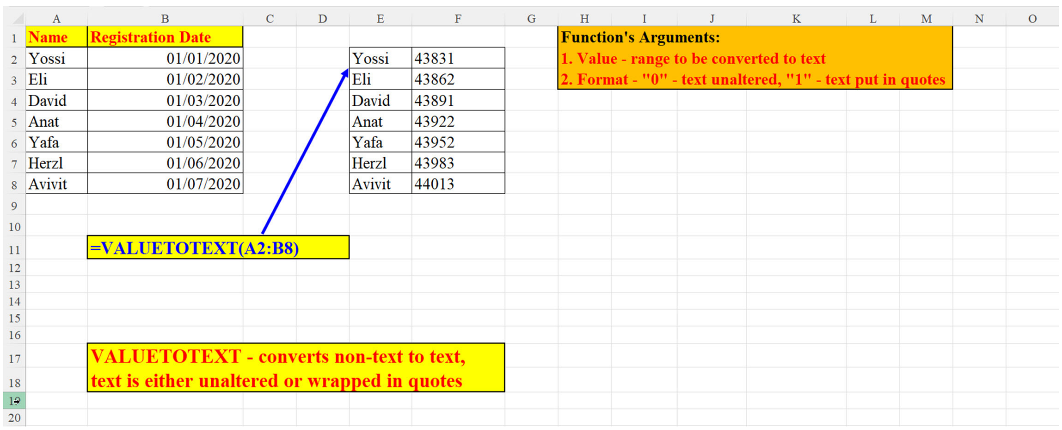


Figure 1.30: VALUETOTEXT example

Conclusion

In this chapter, we became acquainted with a new type of functions in Excel. No more functions that operate on a single cell or yield a result in a single cell. These functions are the Dynamic Array Functions which operate on an array or produce an array, either from a single cell or from an array. Some of these new functions can operate simultaneously on rows as well as on columns.

The next chapter, *SEQUENCE* and *TEXT* operations is going to delve into the intricate features of SEQUENCE in abundant cases and examples, which show its amazing potence and suppleness when slicing and dicing text.

Points to Remember

- The above DAF can be organized into the following categories: Transpose: **`TOROW`**, **`TOCOL`**
- Compact and rearrange: **`HSTACK`**, **`VSTACK`**, **`CHOOSEROWS`**, **`CHOOSECOLS`**, **`WRAPROWS`**, **`WRAPCOLS`**, **`TAKE`**, **`EXPAND`**, **`DROP`**, **`UNIQUE`**, **`SORT`**, **`SORTBY`**
- Search and Select: **`XLOOKUP`**, **`XMATCH`**, **`FILTER`**
- Slice and cleave: **`TEXTSPLIT`**, **`TEXTBEFORE`**, **`TEXTAFTER`**
- Manipulate data: **`VALUETOTEXT`**, **`ARRAYTOTEXT`**
- Randomize data: **`RANDARRAY`**
- Create series: **`SEQUENCE`**
- Please be advised that these categories are given only for the sake of simplicity. As you practice them, you will surely find new ways to implement and apply them, often in concert with other DAF to enhance the power and robustness of your formulae and achieve neat results which were not possible in the past.

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CHAPTER 2
SEQUENCE in Text Operations

Introduction

This chapter will thoroughly discuss how useful the SEQUENCE function is in text operations. After *Chapter 1, Introduction to Dynamic Array Functions in Excel 365*, the introductory chapter, we are going to dive in this chapter and the next ones to understand the various areas of Excel in which **`SEQUENCE`** can be helpful, useful, and efficient.

This chapter, as the title hints, will exemplify the use of **`SEQUENCE`** with other Excel functions to execute solutions to variegated tasks. Some examples are going to use the new functions discussed in the previous chapter (and also the **`LET`** function, which was only mentioned).

Structure

The chapter covers the following topics:

- Examples of SEQUENCE with text
    - Finding the names of the 10 highest-paid employees
    - How many words are there in the cell (version 1)
    - How many words are there in the cell (version 2)

- How many times does a string appear in the cell (method 1 of 5)
- How many times does a string appear in the cell (method 2 of 5)
- How many times does a string appear in the cell (method 3 of 5)
- How many times does a string appear in the cell (method 4 of 5)
- How many times does a string appear in the cell (method 5 of 5)
- Extract all characters - Horizontally
- Extract all characters – Vertically
- All uppercase English in one column
- All uppercase English in one cell
- Duplicate a sequence of characters
- Duplicate a cell by a duplication factor (method1)
- Duplicate a cell by a duplication factor (method2)
- Creating English uppercase letters without knowing how many letters there are
- Transpose without TRANSPOSE
- Extract only first three letter of weekday names
- Extract only digits from a string (method 1 of 3)
- Extract only digits from a string (method 2 of 3)
- Extract only digits from a string (method 3 of 3)
- Extract only unique Alphabetic characters from a string
- Split numbers and Text
- Remove unwanted Characters from string (2 named ranges as parameters)
- Remove unwanted characters from string (Formula)
- How many times does a string appear in a range
- Is it a Palindrome?
- Add vendor to list (the table)
- Add vendor to list (the formula)
- Remove all digits from the string
- Move first name from end of cell to the beginning
- Reverse String (Method 1)

- Reverse String (Method 2)
- From Vertical to Horizontal
- How many words are there in the cell without the separator (SEQUENCE)
- How many words are there in the cell without the separator (TEXTSPLIT)
- "Off with their heads"
- Extract only digits and add a separator
- How many lower-case letters are there in the cell (Method 1)
- How many lower-case letters are there in the cell (Method 2)
- All Greek letters in one formula
- Find last word in cell (Method 1 of 3)
- Find last word in cell (Method 2 of 3)
- Find last word in cell (Method 3 of 3)
- Number of characters in cell (without the separator)
- Number of non-empty cells in a column
- Strip leading and trailing digits (Method 1 of 2)
- Strip leading and trailing digits (Method 2 of 2)
- Increasing Text from End to Start
- Increasing Text from Start to End
- Hebrew Gematria (Formula)
- Hebrew Gematria (Gtable – Translation table)
- Extract only Country Names
- How many occurrences of a String starting from a certain Position
- Remove Diacritics from Hebrew words
- Is it a Palindrome (Arabic)
- Convert Hebrew Letters into English Letters
- Fetch description of Nth item of a non-sorted Key
- Extract Letters only from a chosen Language (Formula)
- Extract Letters only from a chosen Language (Validation List)
- Gematria in English (Method 1)

- Gematria in English (Method 2)
- How many active months?
- VLOOKUP&SEQUENCE – fetch more than one column
- Find Unicode value for any character in the string, no matter which language

Objectives

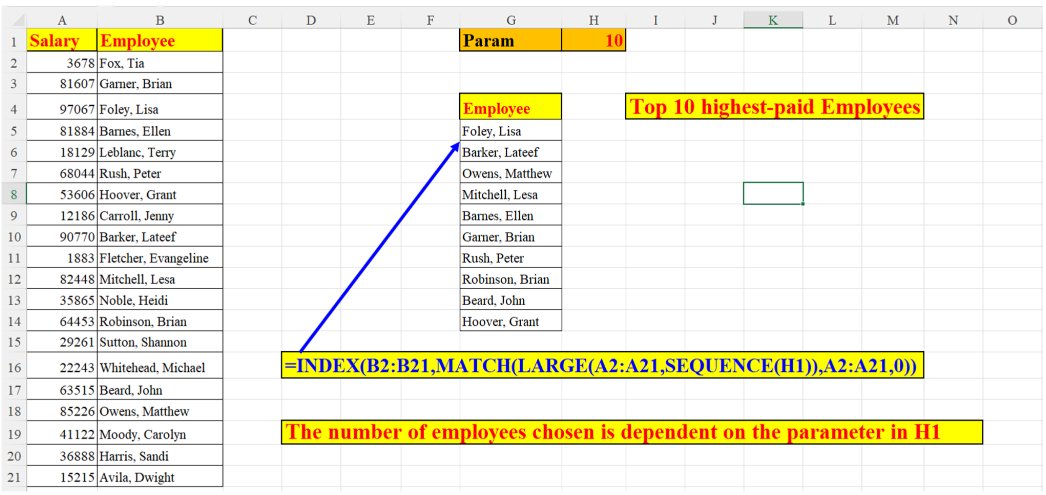
The objective of this chapter is to familiarize the reader with the variety of features, challenges, and flexibility by which the `SEQUENCE` function can be implemented when dealing with textual challenges in Excel.

Examples of SEQUENCE with text

In this section, we will look at various examples of SEQUENCE with text:

Finding the names of the 10 highest-paid employees

This formula displays the 10 highest-paid employees in the list. The parameter in cell H1 enables us to choose any number we desire, be it smaller or larger than 10 as shown in the following figure:



	A	B	G	H
1	Salary	Employee	Param	10
2	3678	Fox, Tia		
3	81607	Garner, Brian		
4	97067	Foley, Lisa	Employee	
5	81884	Barnes, Ellen	Foley, Lisa	
6	18129	Leblanc, Terry	Barker, Lateef	
7	68044	Rush, Peter	Owens, Matthew	
8	53606	Hoover, Grant	Mitchell, Lesa	
9	12186	Carroll, Jenny	Barnes, Ellen	
10	90770	Barker, Lateef	Garner, Brian	
11	1883	Fletcher, Evangeline	Rush, Peter	
12	82448	Mitchell, Lesa	Robinson, Brian	
13	35865	Noble, Heidi	Beard, John	
14	64453	Robinson, Brian	Hoover, Grant	
15	29261	Sutton, Shannon		
16	22243	Whitehead, Michael		
17	63515	Beard, John		
18	85226	Owens, Matthew		
19	41122	Moody, Carolyn		
20	36888	Harris, Sandi		
21	15215	Avila, Dwight		

Figure 2.1: Names of the top 10 highest-paid employees

How many words are there in the cell (version 1)

This is the first solution version for this challenge:

The words are separated by a delimiter (in our example, a space (" ")). In such a case, the formula trims excessive spaces between words, giving us the correct result as shown in the following screenshot:

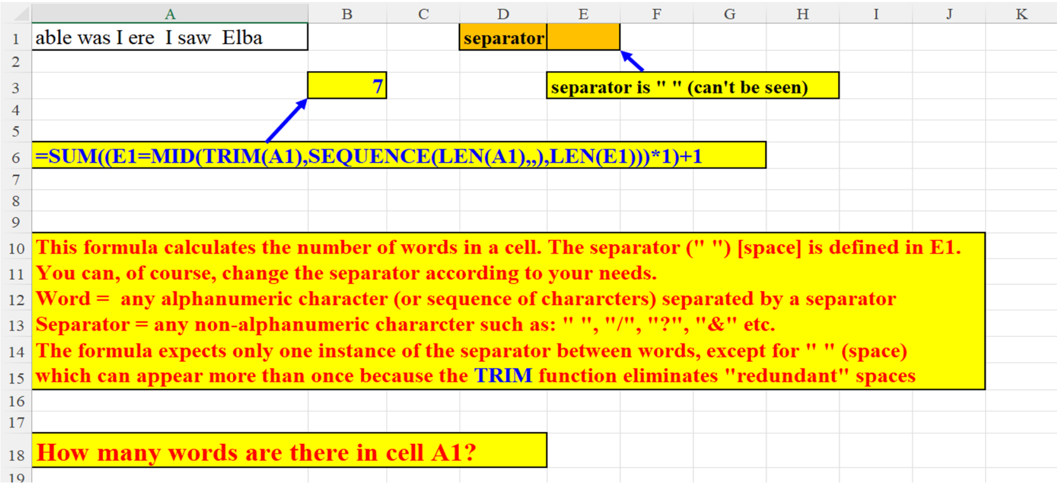


Figure 2.2: *How many words are there in the cell (version 1)*

How many words are there in the cell (version 2)

A shorter alternative to the previous example, using the more advanced function: `TEXTSPLIT` as shown in the following screenshot (released lately and is explained in *Chapter 1, Introduction to Dynamic Array Functions in Excel 365*):

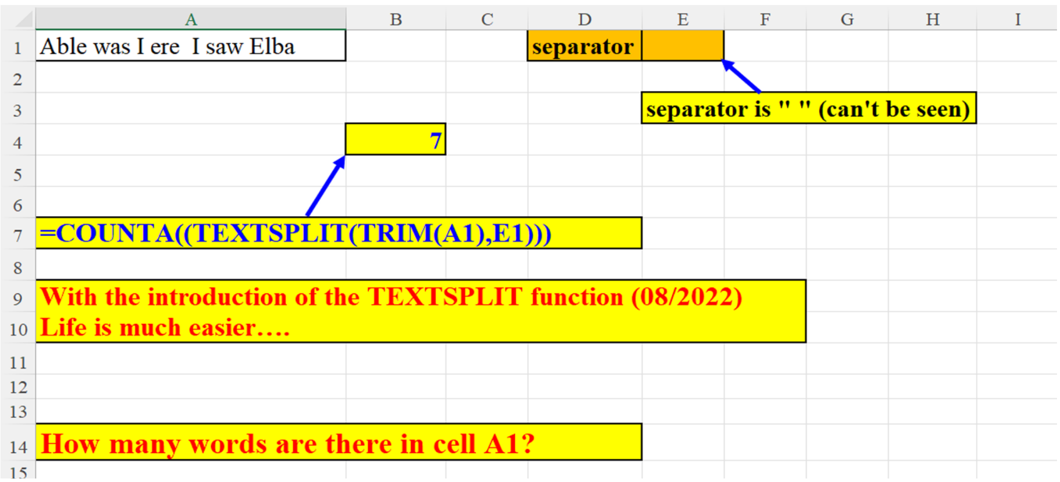


Figure 2.3: *How many words are there in the cell (version 2)*

How many times does a string appear in the cell

Method 1 of 5

Method 1 (of 5): We want to know how many times the string defined in D2 (parameter) appears in cell A2. If we want a case-sensitive search, we should change `SEARCH` to `FIND` as shown in the following screenshot:

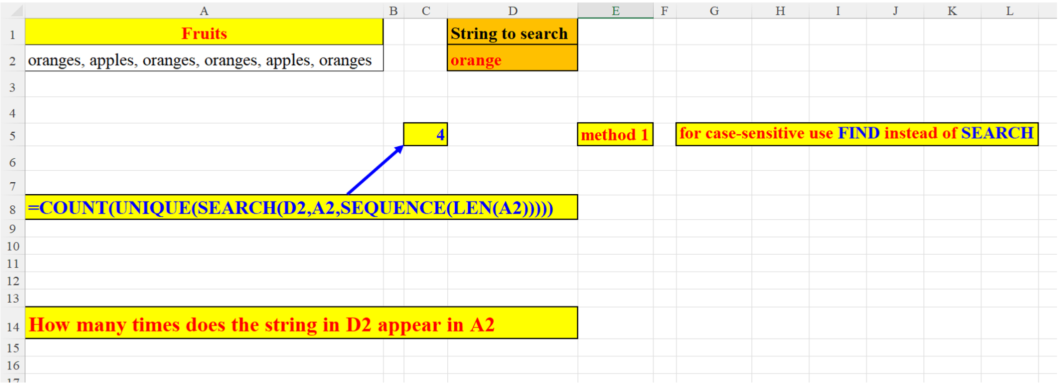


***Figure 2.4**: How many times does a string appear in the cell (method 1)*

Method 2 of 5

Method 2 (of 5): using `SUM`:

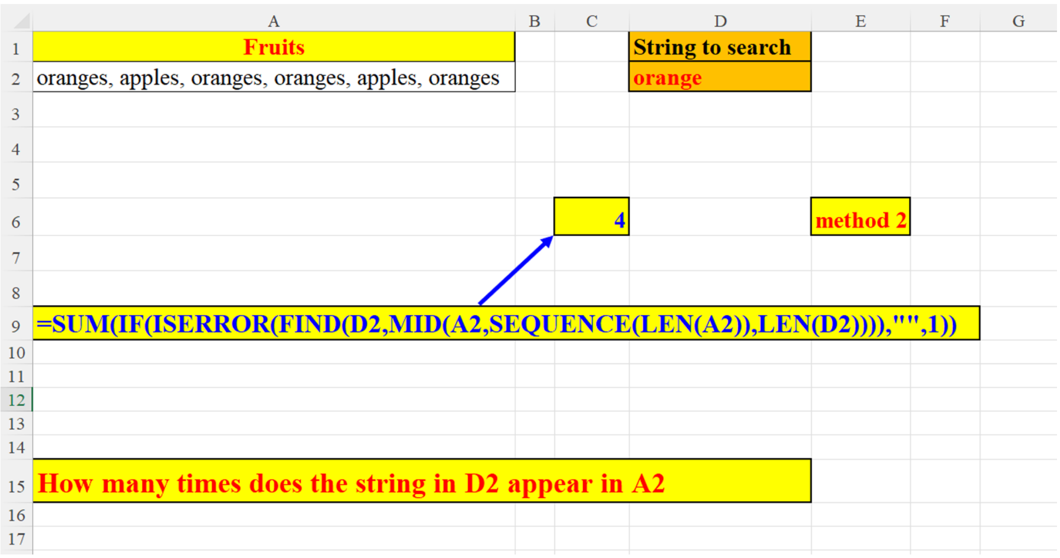


***Figure 2.5**: How many times does a string appear in the cell (method 2)*

Method 3 of 5

Method 3 (of 5): using **EXACT**:

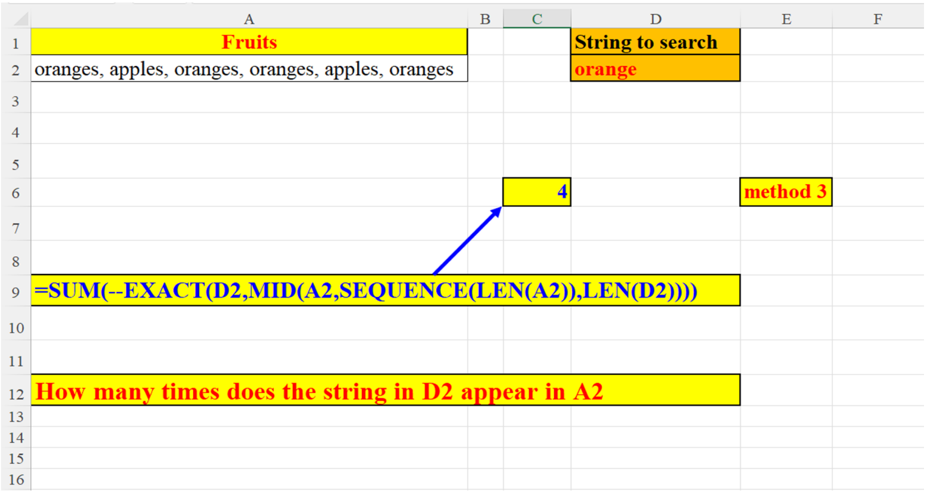


Figure 2.6: *How many times does a string appear in the cell (method 3)*

Method 4 of 5

Method 4 (of 5): The N function converts **FALSE** / **TRUE** to **0/1**:

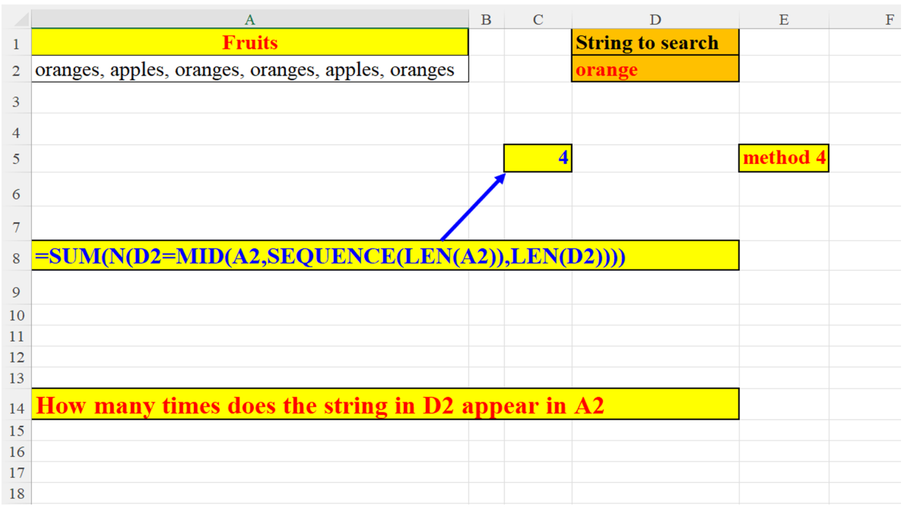


Figure 2.7: *How many times does a string appear in the cell (method 4)*

Method 5 of 5

Method 5 (of 5): Using **`UNIQUE`**:

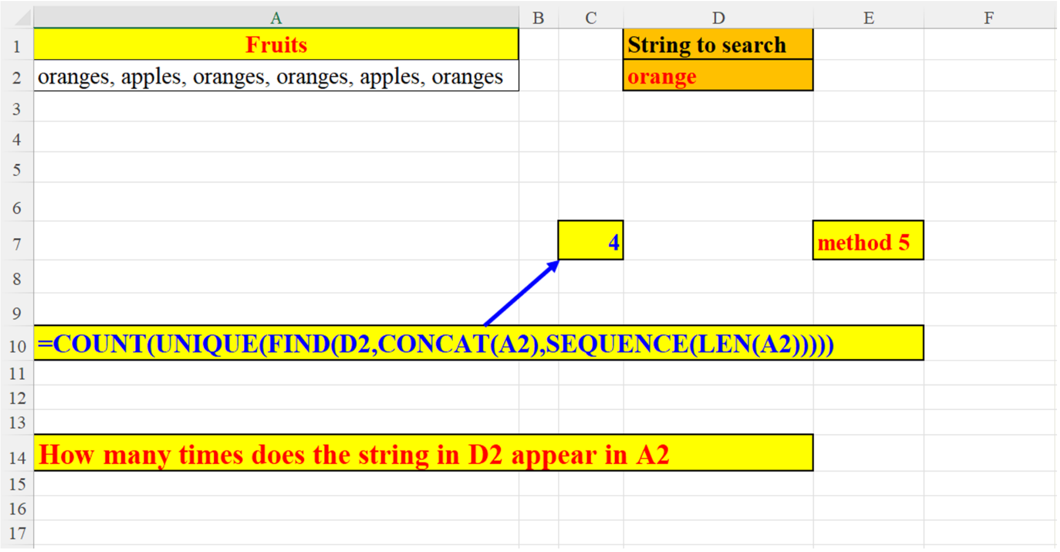


***Figure 2.8**: How many times does a string appear in the cell (method 5)*

Extract all characters - Horizontally

Split each character of the original string into a separate cell (horizontally):

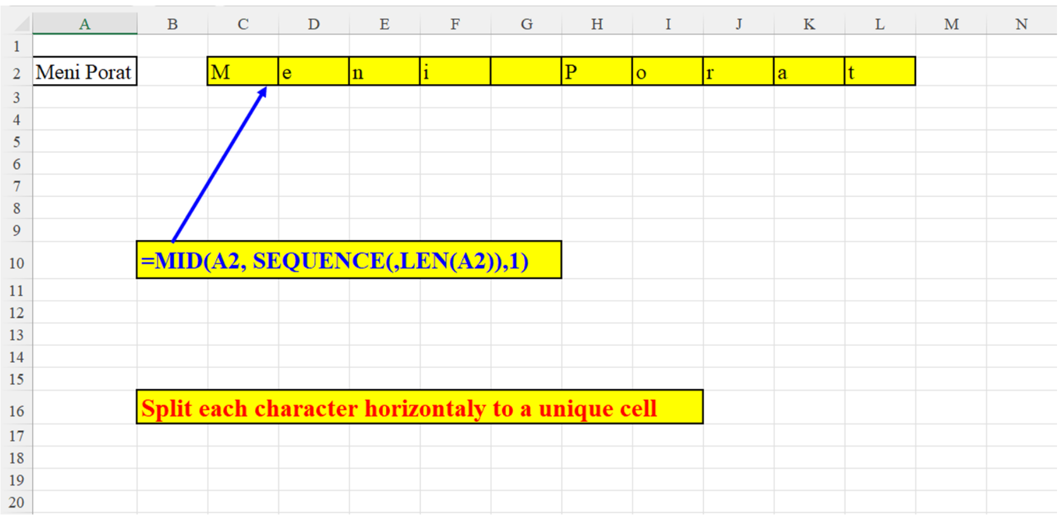


***Figure 2.9**: Extract all characters – Horizontally*

Extract all characters – Vertically

Split each character of the original string into a separate cell (vertically) as shown in the following screenshot:

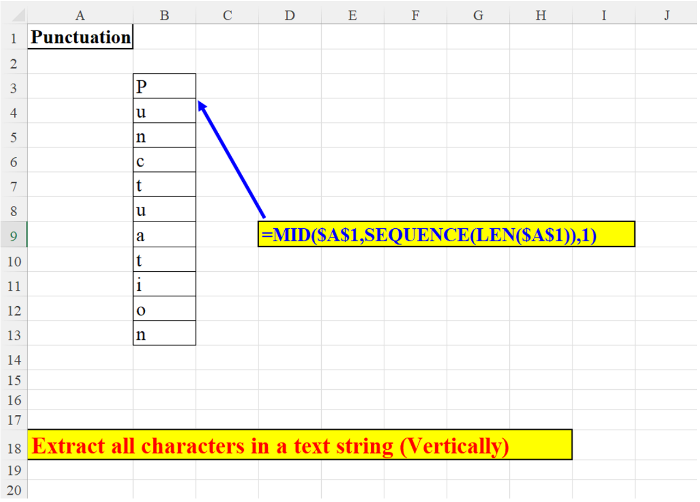


***Figure 2.10**: Extract all characters – Vertically*

All uppercase English in one column

Generating the whole English alphabet (Uppercase Letters) with one simple formula in a range is shown in the following figure:

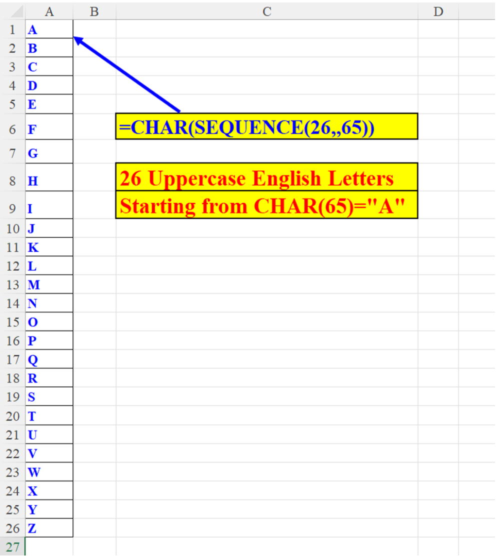


***Figure 2.11**: All uppercase English Letters in one Column*

All uppercase English in one cell

Generating the whole English alphabet (Uppercase letters) with one simple formula in one cell can be seen in the following screenshot:

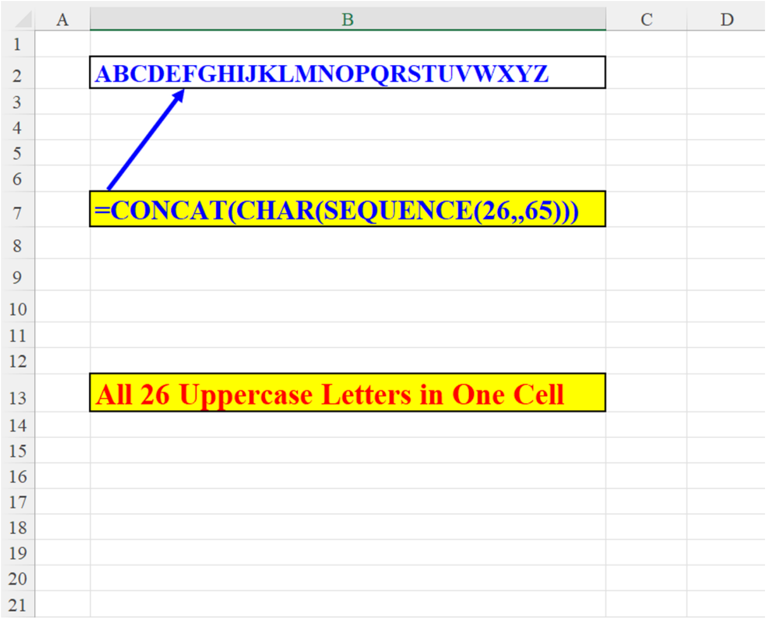


Figure 2.12*: All uppercase English letters in one cell*

Duplicate a sequence of characters

The following technique is very useful when you want to duplicate a sequence of characters. You need to supply three parameters:

- which characters to start with (cell: G2)
- the total number of characters in the array (in cell: I2)
- by what factor to duplicate each letter (how many times should each character appear) (in cell: M2):

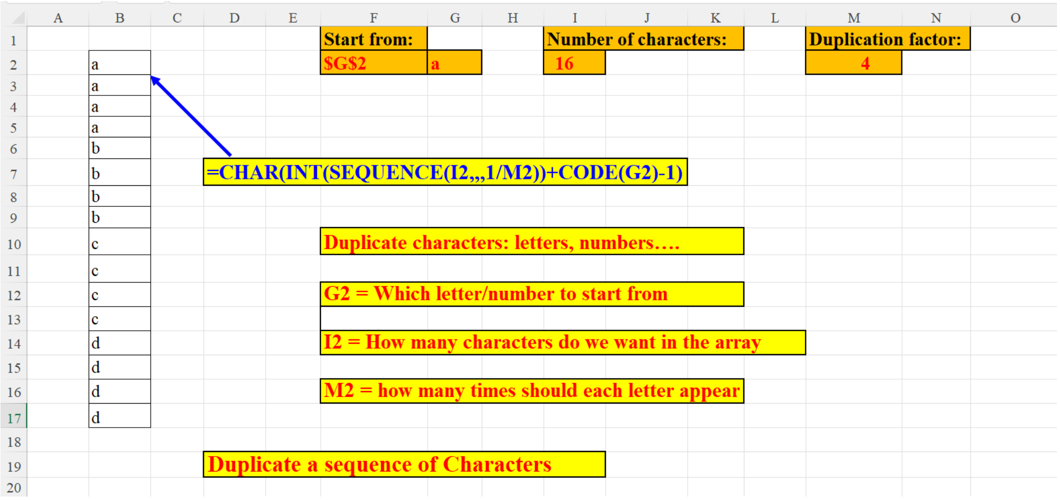


Figure 2.13: *Duplicate a sequence of characters*

Duplicate a cell by a duplication factor

Method 1

The duplication factor (in cell: I2) specifies how many times the string in cell A2 should be duplicated.

Method 1 of 2 is illustrated in the following figure:

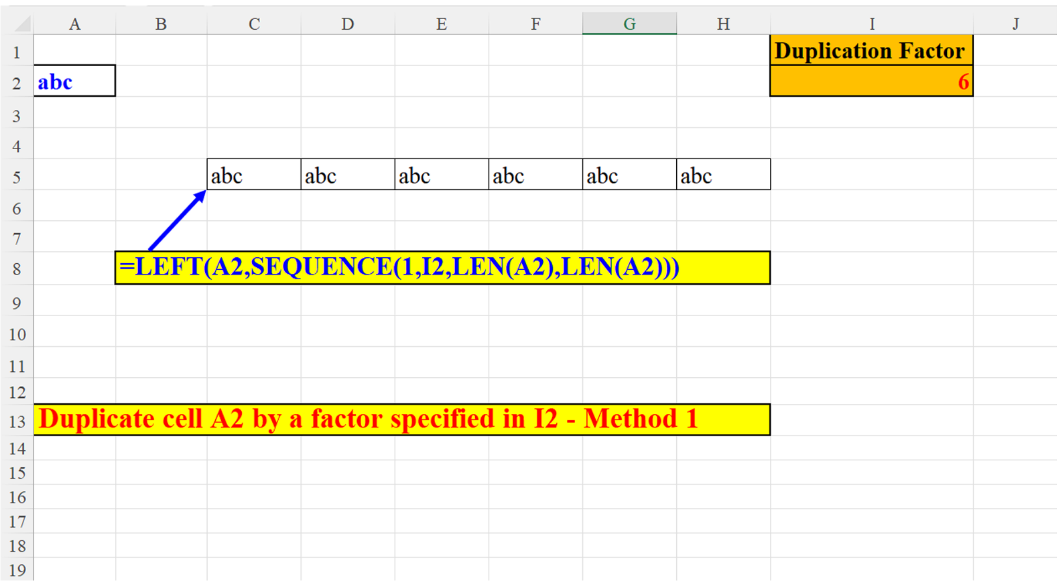


Figure 2.14: *Duplicate a cell by a duplication factor (method1)*

Method 2

The duplication factor (in cell: I2) specifies how many times the string in cell A2 should be duplicated.

Method 2 of 2 is illustrated in the following figure:

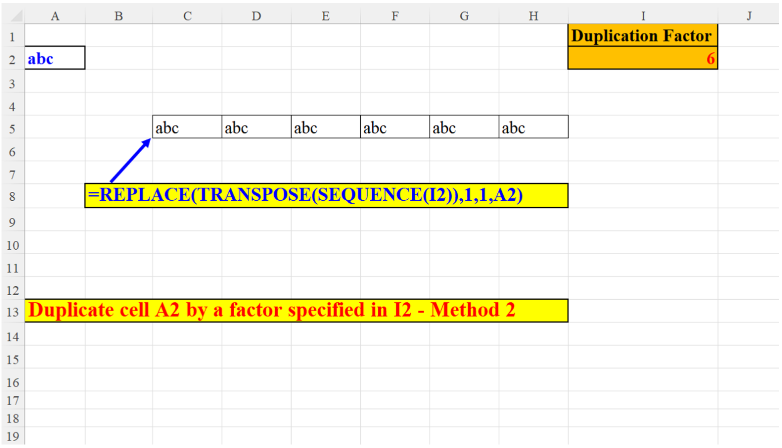


***Figure 2.15**: Duplicate a cell by a duplication factor (method2)*

Creating English uppercase letters without knowing how many letters there are

The trick here is to find the number of letters by subtracting the ASCII value of the first letter (“A”) from that of the last letter (“Z”) as shown in the following figure:

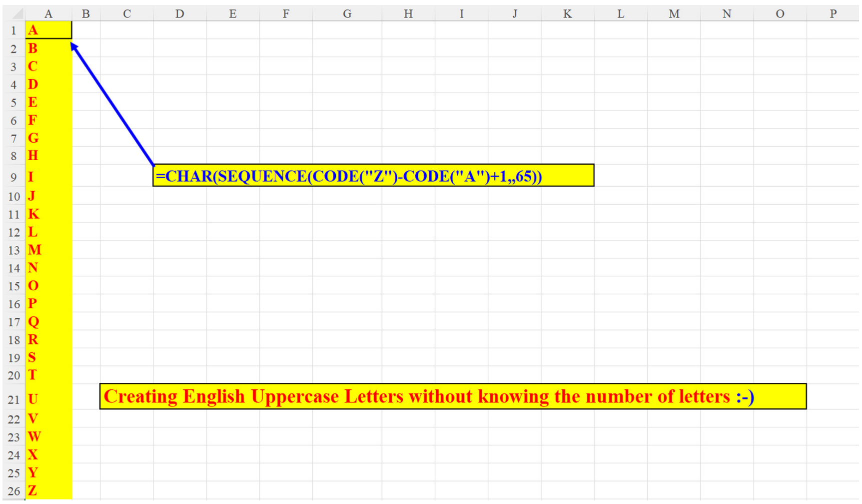


***Figure 2.16**: Creating the English uppercase letters without knowing the number of the Alphabet letters*

Transpose without TRANSPOSE

Converting a vertical list into a horizontal list without using the **TRANSPOSE** function can be done as seen in the following screenshot:

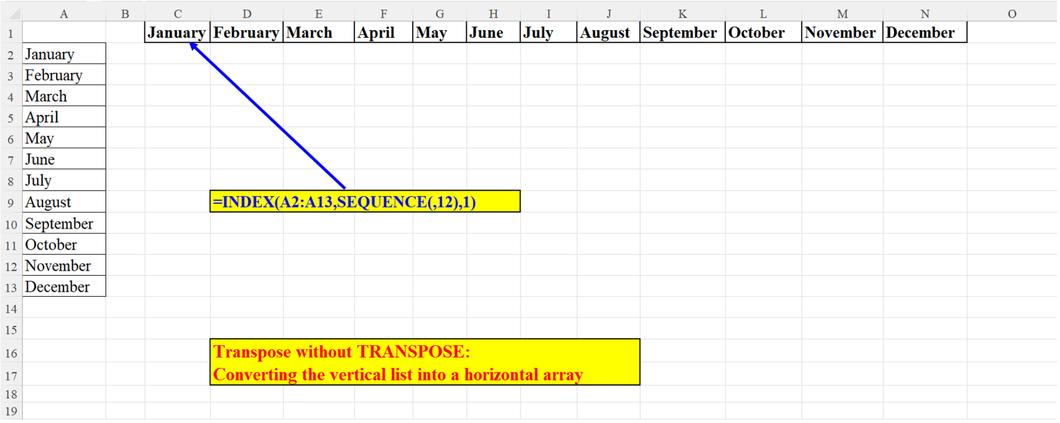


Figure 2.17: Transpose without TRANSPOSE

Extract only first three letter of weekday names

Two methods to extract only the first three letters of the weekday names – with and without **SEQUENCE**:

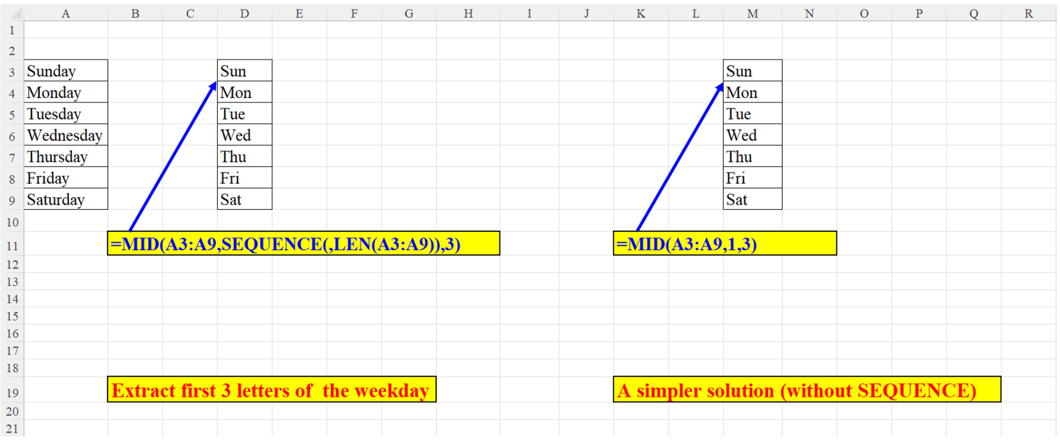


Figure 2.18: Extract first three letters of the weekday names (with & without SEQUENCE)

Extract only digits from a string

Method 1 of 3

This is the first of three methods which demonstrate how to extract only digits from a cell.

An additional method will be demonstrated in *Chapter 8, SEQUENCE and other animals*.

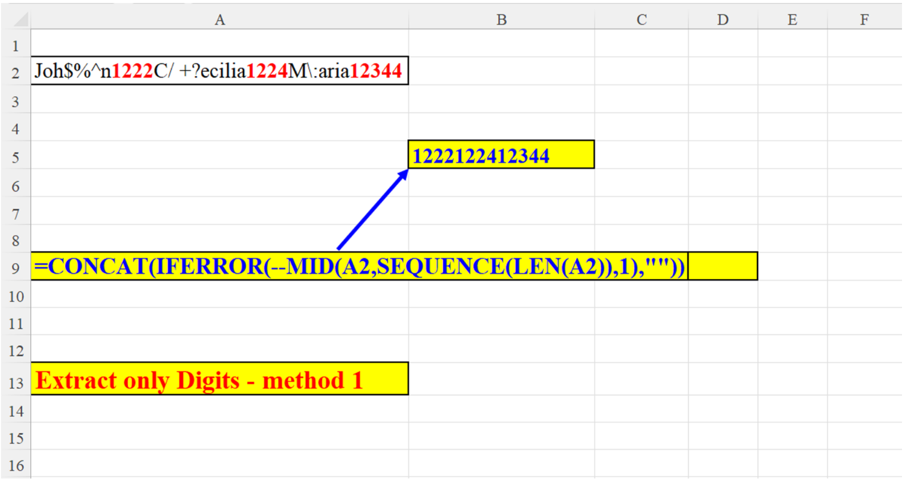


Figure 2.19: *Extracting only digits from a string (method 1 of 3)*

Method 2 of 3

Extracting only digits from a cell (Method 2) is shown in the following screenshot:

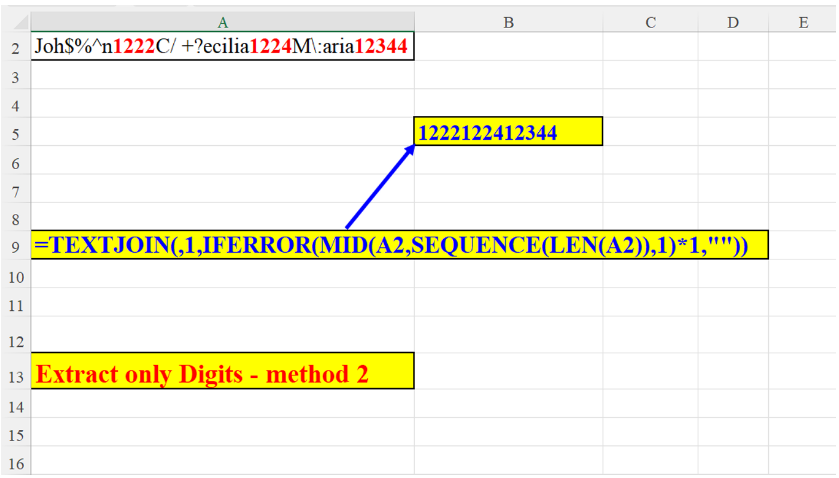


Figure 2.20*: Extracting only digits from a string (method 2 of 3)*

Method 3 of 3

Extracting only digits from a cell (Method 3) is shown in the following screenshot:

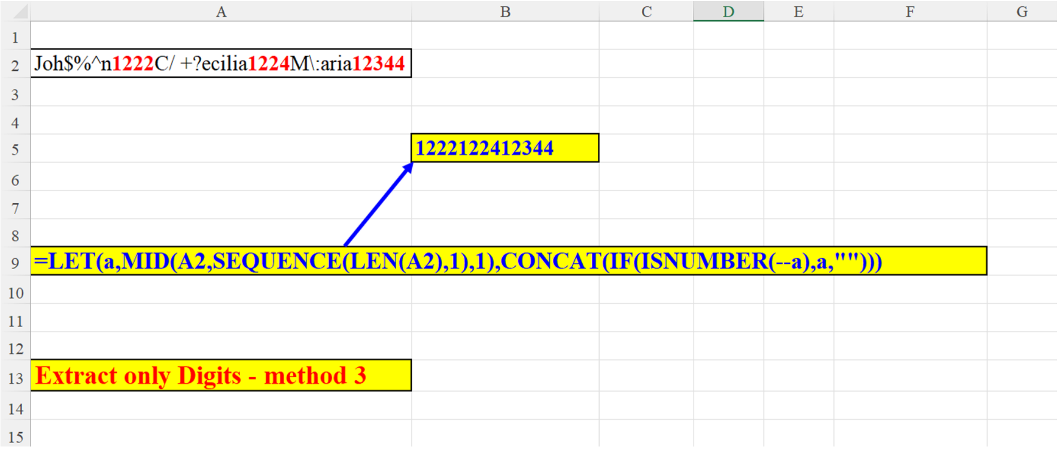


***Figure 2.21**: Extracting only digits from a string (method 3 of 3)*

Extract only unique Alphabetic characters from a string

Extracting only one occurrence of each letter in cell B4 is shown in the following screenshot:

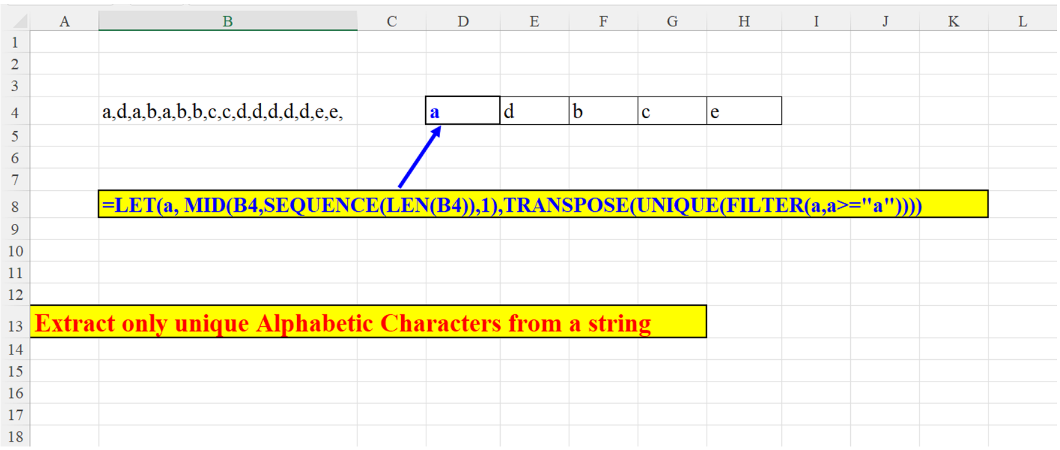


***Figure 2.22**: Extract only unique alphabetic characters from a string*

Split numbers and text

The two formulae combine two new functions (**`TEXTBEFORE`** and **`TEXTAFTER`**, explained in *Chapter 1, Introduction to Dynamic Array Functions in Excel 365*) with **`SEQUENCE`** in order to separate international country codes from the country names as is shown in the following screenshot:

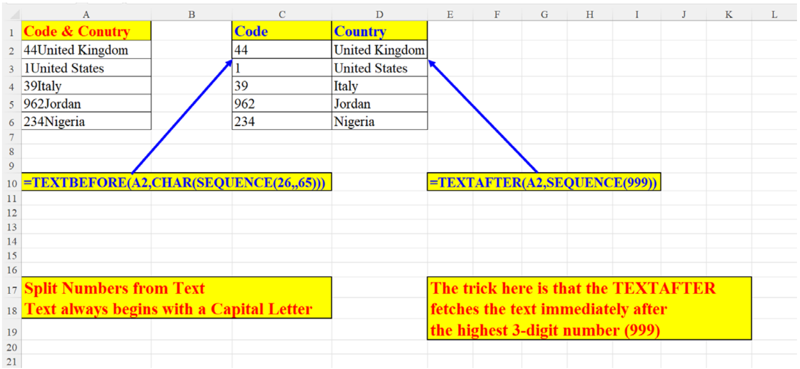


Figure 2.23: *Split numbers from text*

Remove unwanted characters from string (2 named ranges as parameters)

In order to remove unwanted characters, the parameters shown here are the Switches (indicating which subset should be kept, for example: digits, lowercase letters, uppercase letters, and so on) and the ASCII values associated with these switches. These parameters make the solution flexible, as we can always choose which characters to remove (that is, non-printable characters) and which to keep. The following figure displays the parameters (switches and values) defined in the Name manager. These parameters will be used in the formula shown in the next section (see *Figure 2.25*).

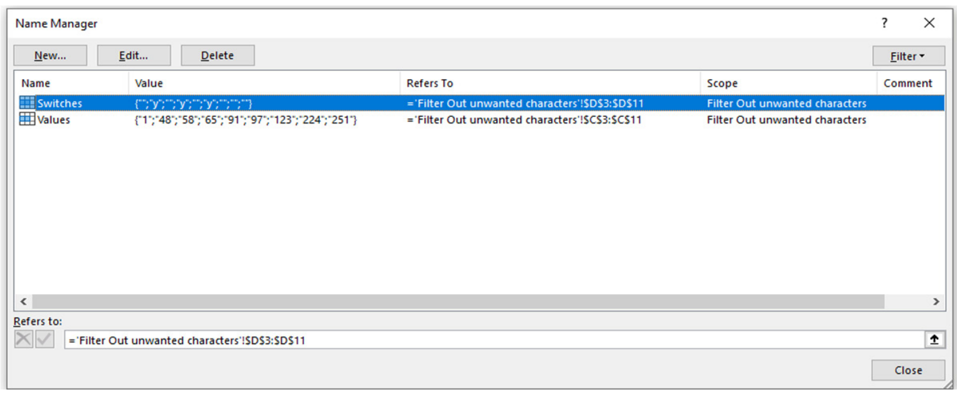


Figure 2.24*: Remove unwanted characters (the Parameters pane)*

Remove unwanted characters from string (Formula)

In this example, we want to keep in each cell of the Before range (A27:A33) only: digits, upper case English characters and lower-case English characters.

The results in the After range (B27:B33) show the *clean* data as can be seen in the following screenshot:

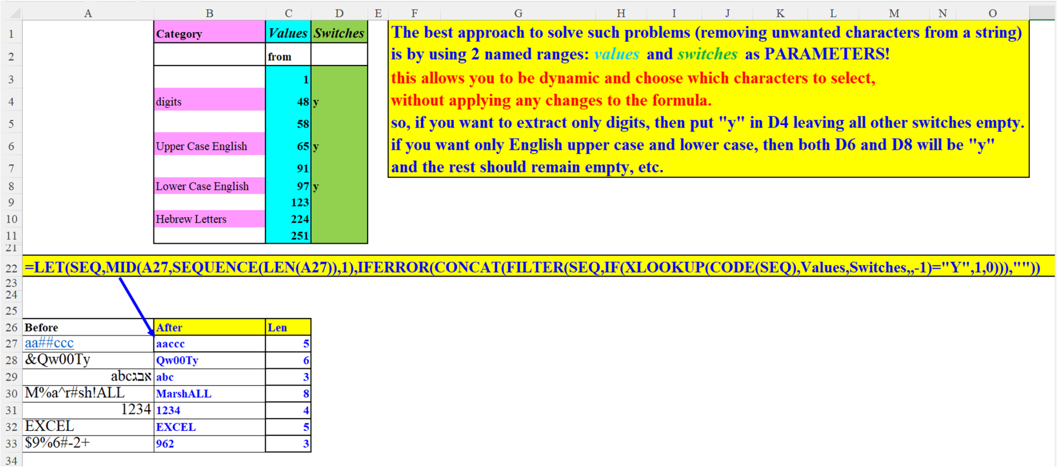


Figure 2.25: *Remove unwanted characters (the Formula)*

How many times does a string appear in a range

We want to find out the number of times the string defined as a parameter (cell: I1) appears in the searched range (Cell A2:A5) as shown in the following figure:

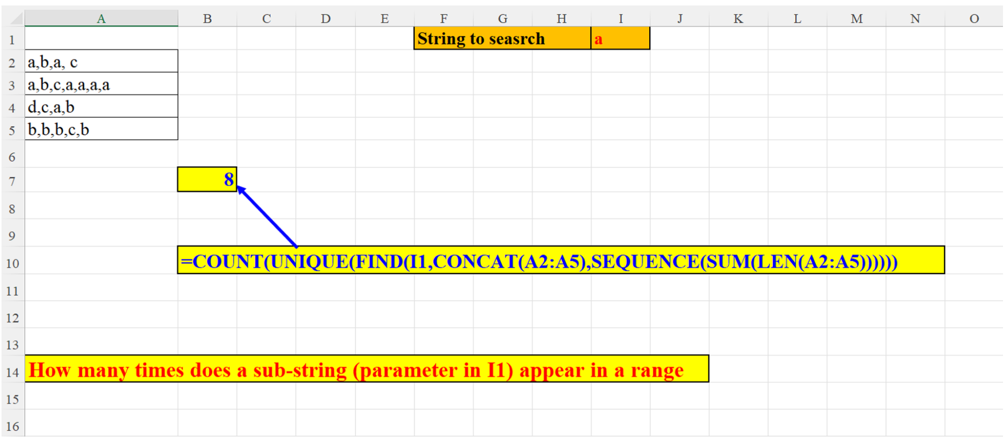


Figure 2.26: *How many times does a string appear in a range*

Is it a Palindrome?

A palindrome is a word, phrase or sentence that can be read exactly the same from beginning to end as well as from end to beginning. This example demonstrates the famous saying attributed to Napoleon Bonaparte, after returning from exile in the island of Elba: *Able was I ere I saw Elba* as shown in the following screenshot:

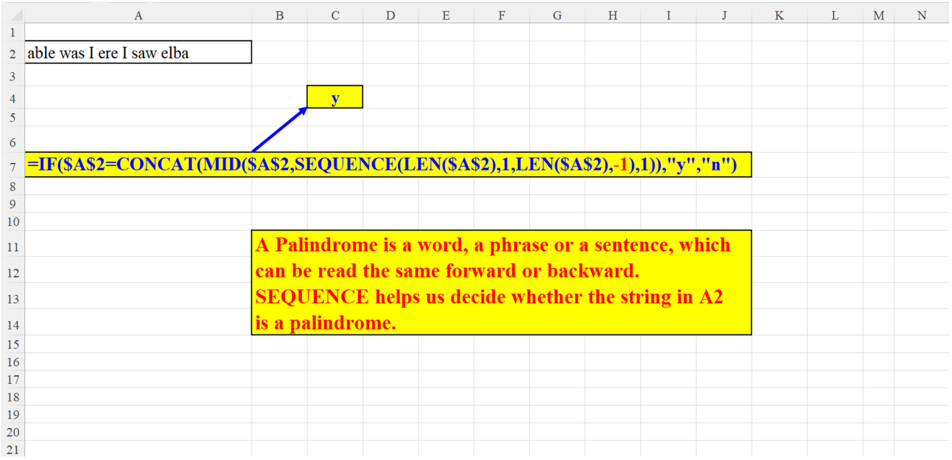


***Figure 2.27**: Is it a Palindrome?*

Add vendor to list (the table)

If you add a new name into the **Desc.** Column (column A), and that name appears on the vendors table (defined in this figure as TVEN, column D), then by moving to the **Vendor** column (column B), that name is automatically added to the list of valid vendors in column B as shown in the following screenshot:

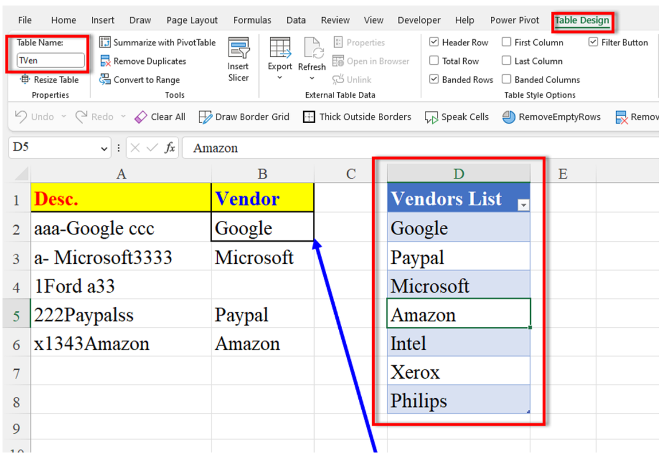


***Figure 2.28**: Add vendor to list (dynamic table)*

Add vendor to list (the formula)

If you add a new name into the **Desc.** Column (column A), and that name appears on the vendors table (defined in the previous figure as TVEN column D), then by moving to the **Vendor** column (column B), that name is automatically added to the list of valid vendors in column B as shown in the following screenshot:

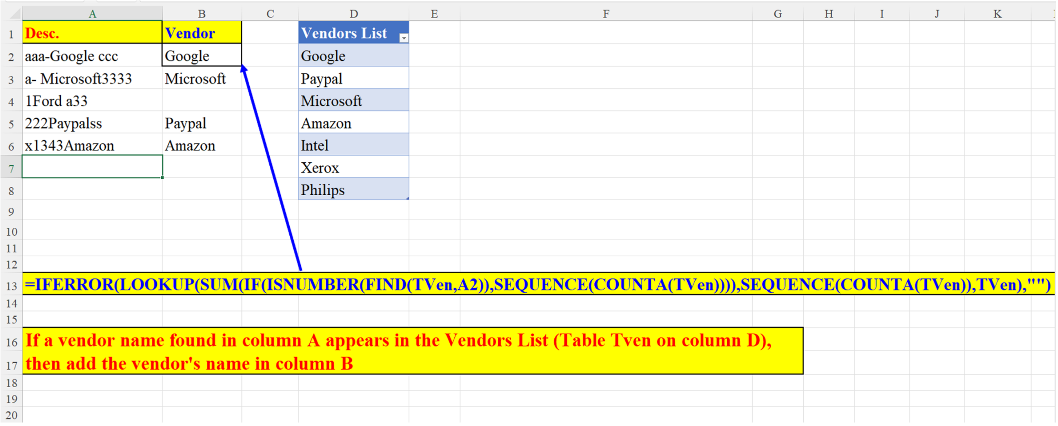


***Figure 2.29**: Add vendor to list (the formula)*

Remove all digits from the string

How to remove only the digits from a cell leaving all other characters intact can be seen illustrated in the following figure:

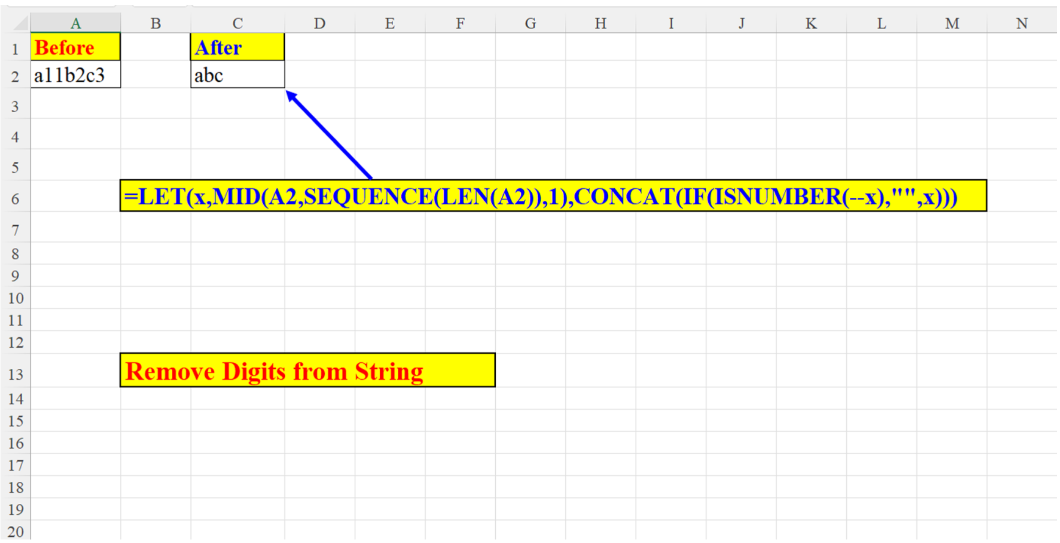


***Figure 2.30**: Remove all the digits from the string (cell A2)*

Move first name from end of cell to the beginning

What happens if we receive a file of names where the first name appears at the end, and we want to move it to the beginning?

Here is a solution:

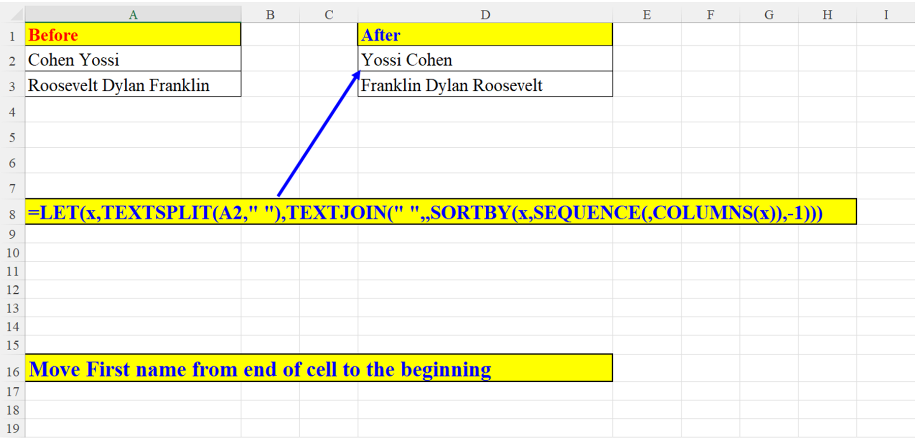


Figure 2.31: Move first name from the end to the beginning

Reverse String

Method 1

Reverse a string (method 1 of 2) – Using **`TEXTJOIN`** with **`SEQUENCE`**:

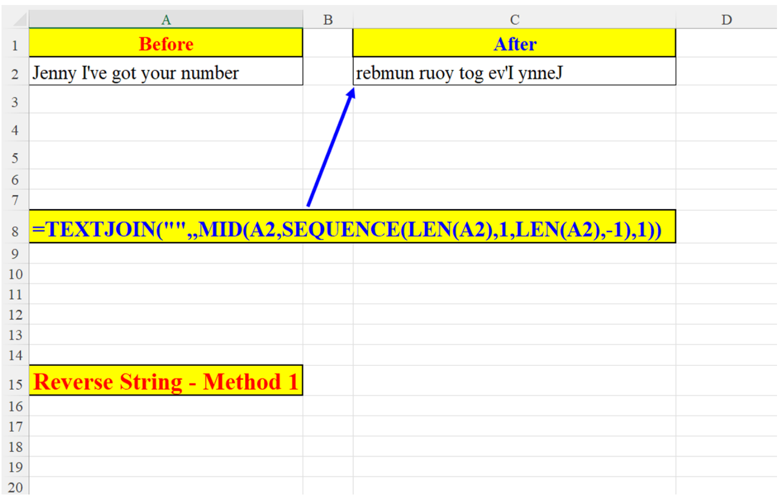


Figure 2.32: Reverse string (Method 1)

Method 2

Reverse a string (method 2 of 2) – Using **`CONCAT`** with **`SEQUENCE`** as shown in the following figure:

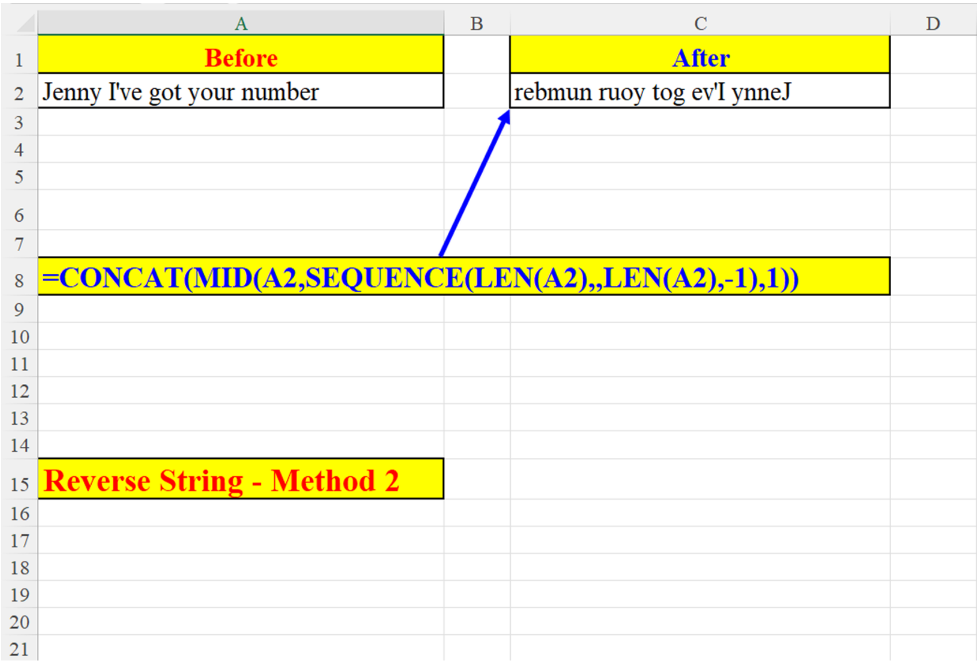


Figure 2.33: *Reverse string (Method 2)*

Sort Text in alphabetical order

The string in cell A2, which contains only lowercase letters, is sorted in alphabetical order. The "a" defined by the LET function replaces the reference to cell A2:

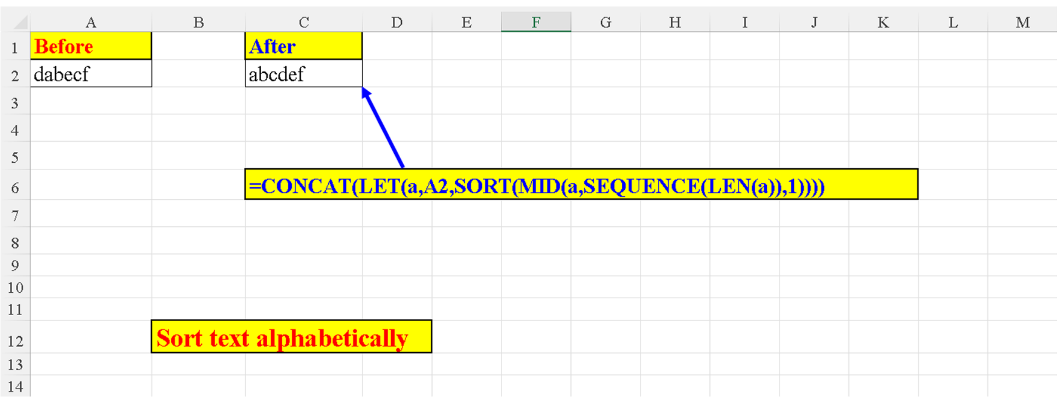


Figure 2.34: *Sort text in alphabetical order*

How many words are there in the cell without the separator (SEQUENCE)

In this example, we count the number of *words* in the cell. A word, for that matter, is any combination of characters which is different from the separator. The separator is defined in cell E1 as shown in the following screenshot:

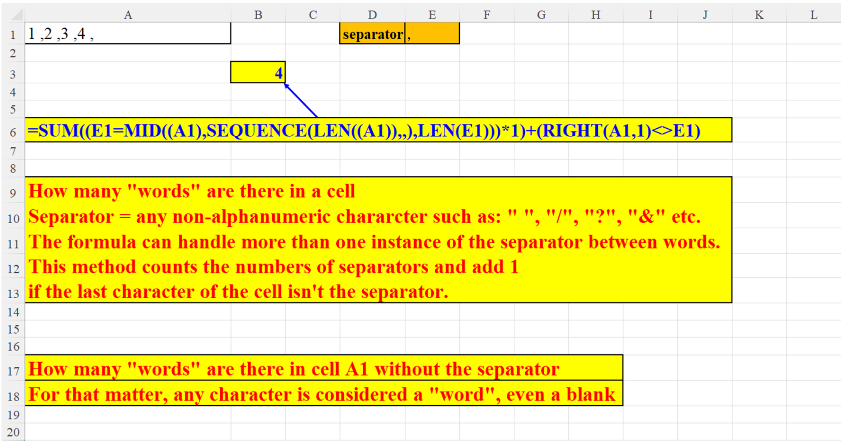


Figure 2.35*: How many words are there in the cell A2 without the separator? (SEQUENCE function)*

How many words are there in the cell without the separator (TEXTSPLIT)

A shorter alternative to the previous example, using the more advanced function: `TEXTSPLIT` (which is explained in *Chapter 1, Introduction to Dynamic Array Functions in Excel 365*):

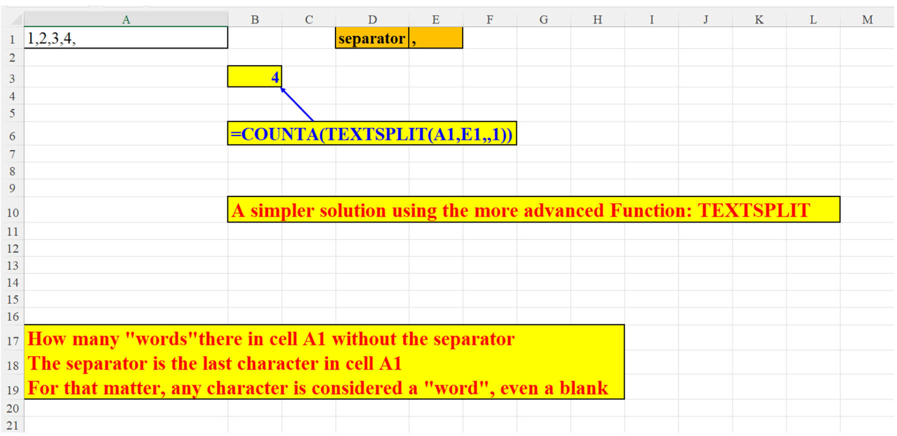


Figure 2.36*: How many words are there in cell A2 without the separator? (TEXTSPLIT function)*

Off with their heads

In this example, we *chop off* one character from the original string (defined in Cell F1) as shown in the following figure:

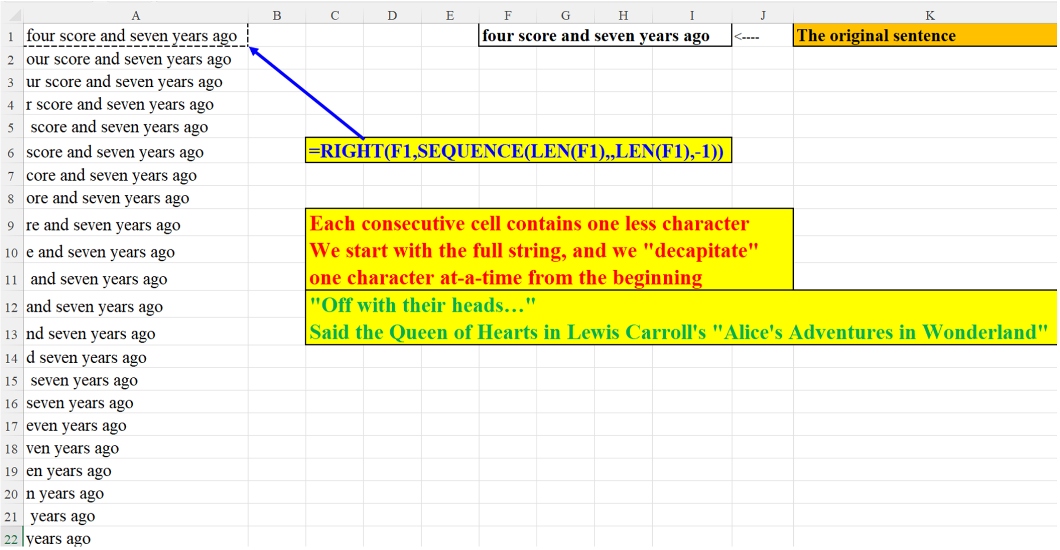


Figure 2.37: "off with their heads" – chopping one character at a time from the "head" of the string

Extract only digits and add a separator

Removing all non-numeric characters from cell A3. Each group of consecutive digits is then separated by the separator defined in cell F2:

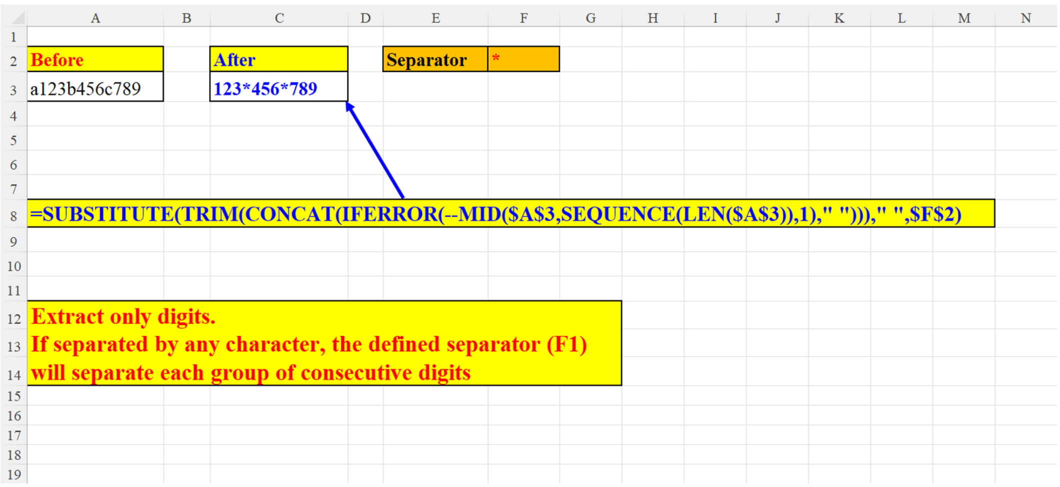


Figure 2.38: *Extract only digits and add a separator (defined in cell F2)*

How many lower-case letters are there in the cell

Method 1

Counting the number of lower-case letters in each cell (A2:A4) - Method 1:

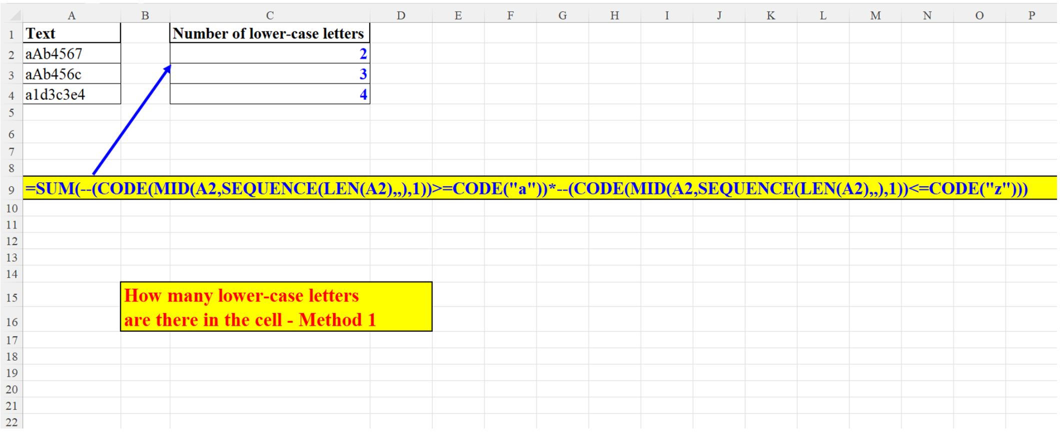


***Figure 2.39**: How many lower-case letters are there in the cell (Method 1)*

Method 2

Counting the number of lower-case letters in each cell (A2:A4) – Method 2.

This formula uses the more advanced function LET (mentioned in *Chapter 1, Introduction to Dynamic Array Functions in Excel 365*):

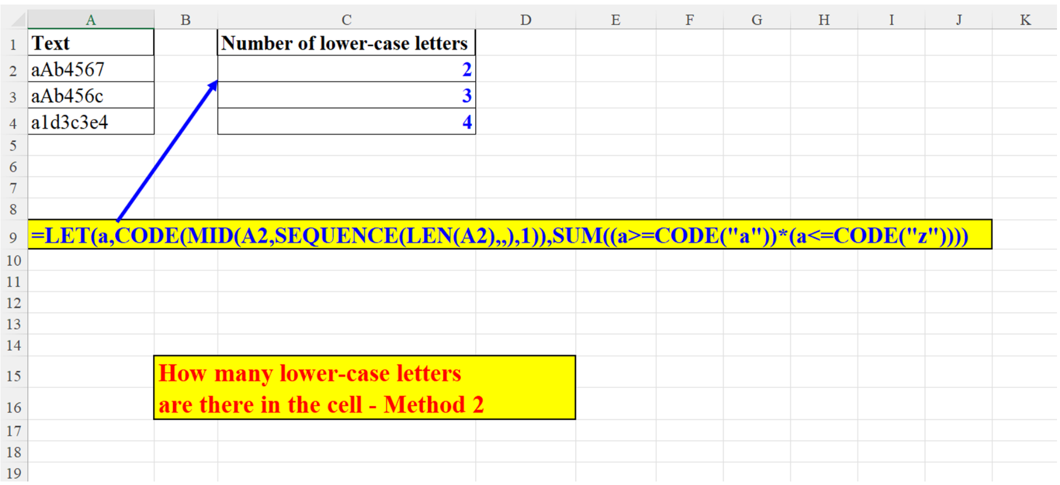


***Figure 2.40:** How many lower-case letters are there in the cell (Method2)*

All Greek letters in one formula

Generating the list of all the Greek letters. The Greek characters are not a part of the standard ASCII character set; therefore, we used the **UNICHAR** function (that uses the more comprehensive **UNICODE** character set) instead of the **CHAR** function as illustrated in the following screenshot:

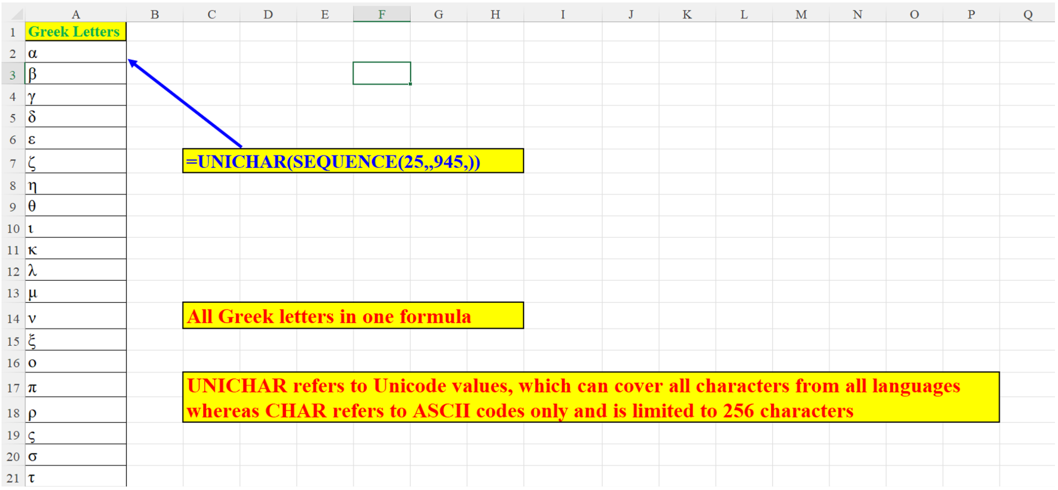


***Figure 2.41**: All Greek letters in one formula*

Find last word in cell

Method 1 of 3

Finding the last word in cell A1 (Using **LOOKUP** and **SEQUENCE**) – Method 1:

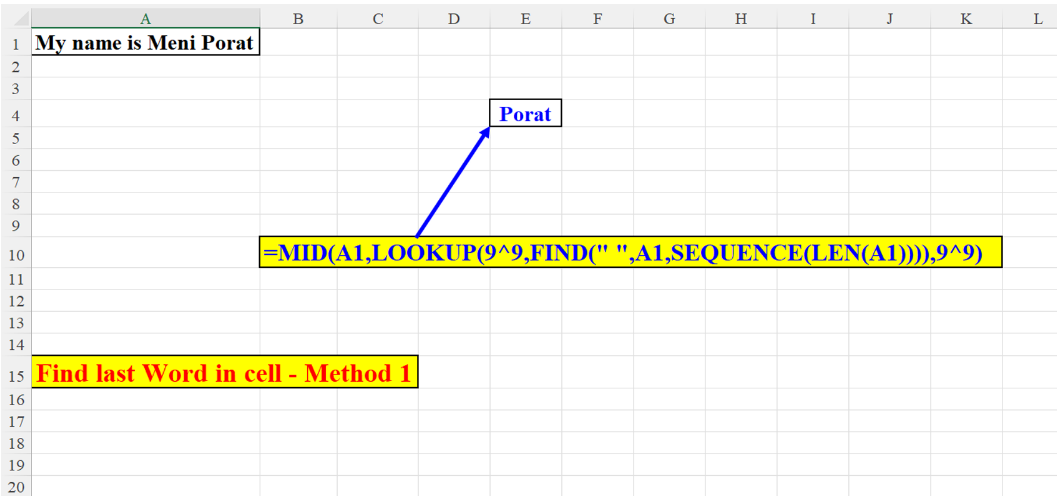


***Figure 2.42**: Find last word in cell using SEQUENCE (Method 1 of 3)*

Method 2 of 3

Finding the last word in cell A1 (Using **`MAX`**, **`FIND`** and **`SEQUENCE`**) – Method 2:

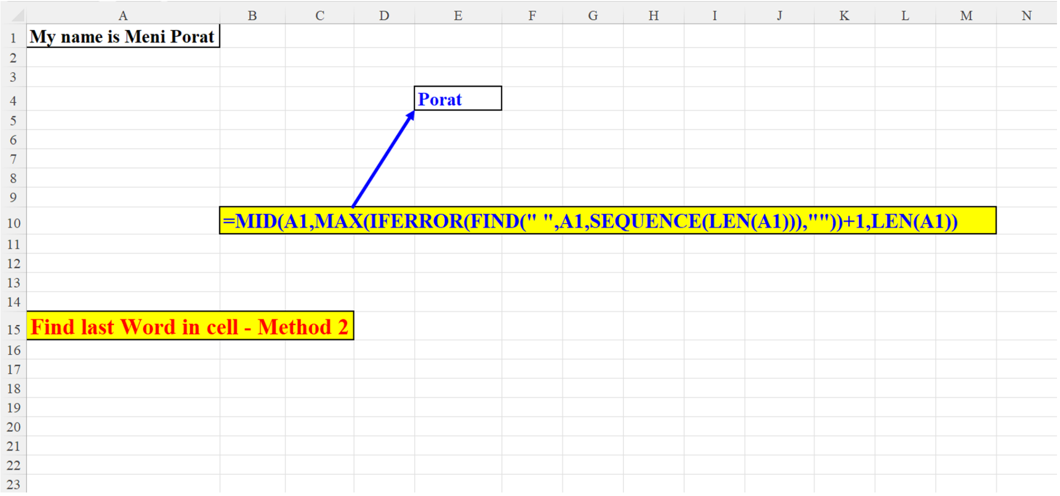


Figure 2.43: *Find last word in cell using SEQUENCE (Method 2 of 3)*

Method 3 of 3

A shorter alternative to the previous examples (*Figures 2.42* and *Figure 2.43*), using the more advanced function: **`TEXTAFTER`** (which was explained in *Chapter 1, Introduction to Dynamic Array Functions in Excel 365*):

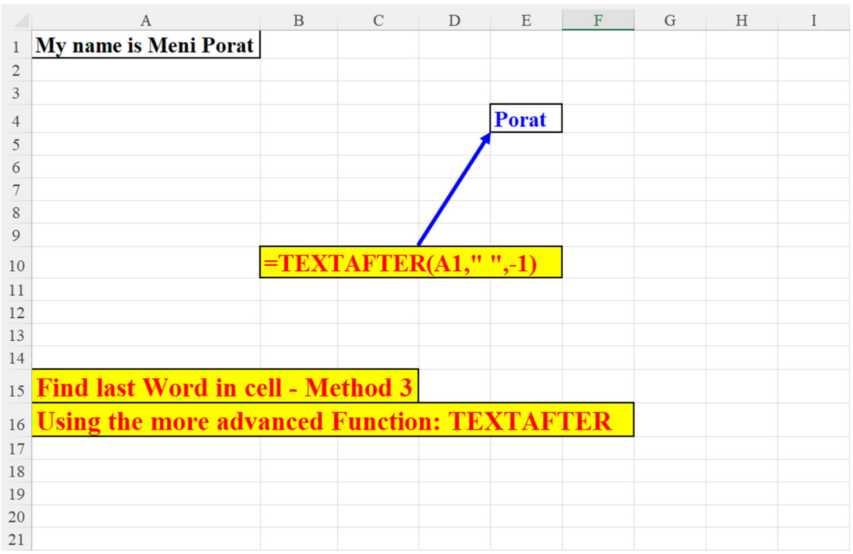


Figure 2.44: *Find last word in cell – using TEXTAFTER (Method 3 of 3)*

Number of characters in cell (without the separator)

In our example, the separator defined in the parameter is " " (blank). The formula "trims" any additional blanks between the words (as, for example, between "saw" and "Elba" where there are two blank characters).

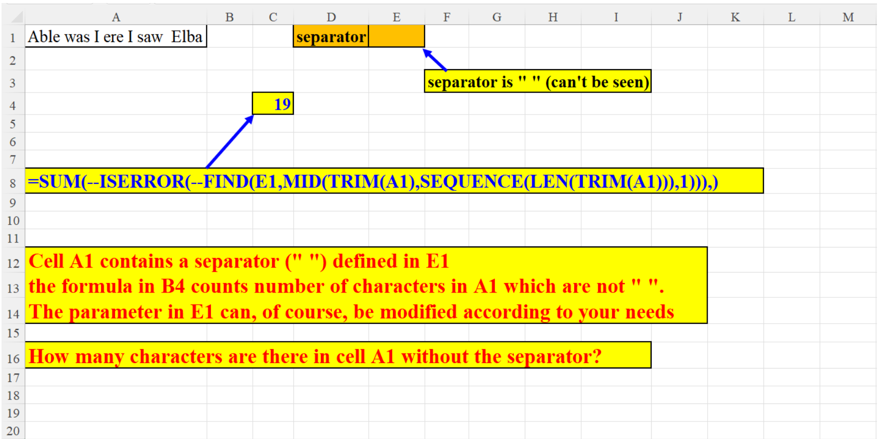


Figure 2.45: *Number of characters in cell without the separator*

Number of non-empty cells in a column

Finding the number of non-empty cells in the entire column is shown in the following figure:

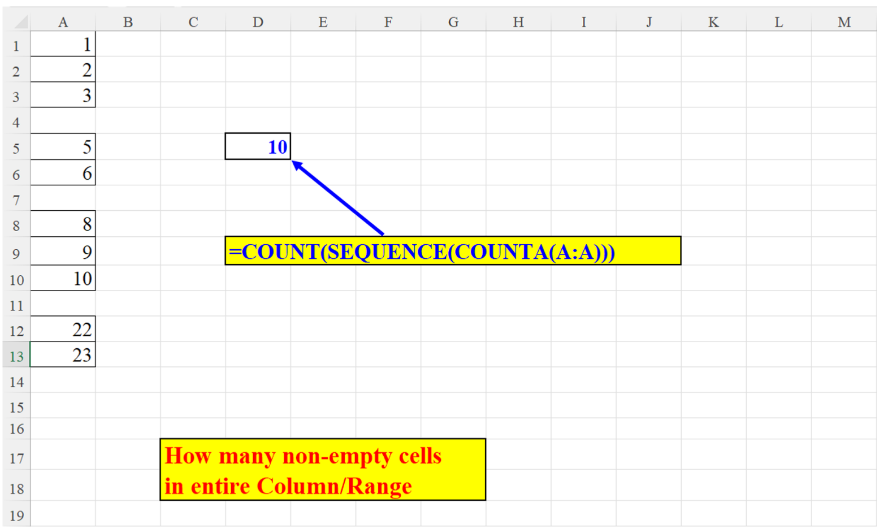


Figure 2.46: *Number of non-empty cells in column A*

Strip leading and trailing digits

Method 1 of 2

Removing leading and trailing digits using **`LET`**, **`SEQUENCE`** and **`CONCAT`** (method 1):

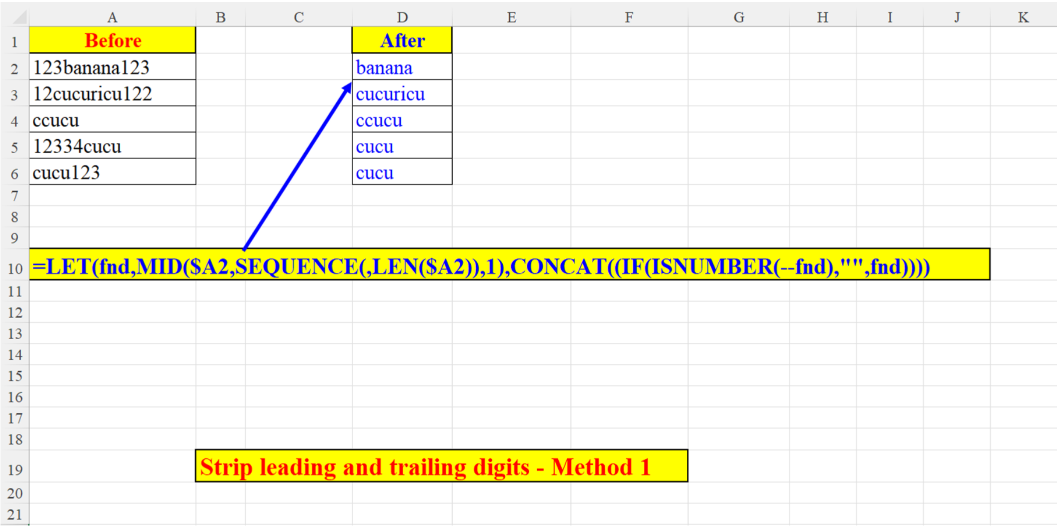


***Figure 2.47**: Strip leading and trailing digits (Method 1)*

Method 2 of 2

Removing leading and trailing digits using **`LET`**, **`SEQUENCE`** and **`TEXTJOIN`** (method 2):

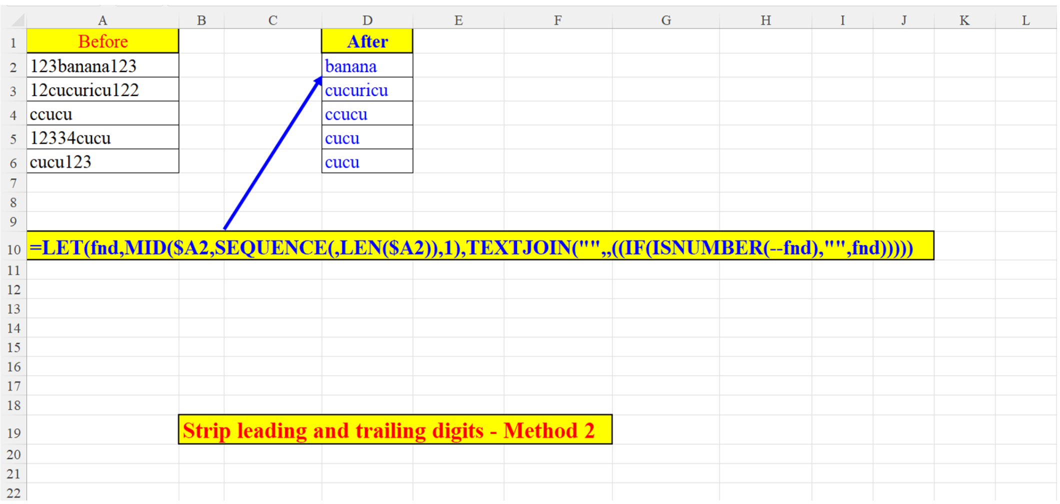


***Figure 2.48:** Strip leading and trailing digits (Method 2)*

Increasing Text from end to start

We start from the last character of the sentence (in cell D1) and each consecutive cell contains one more character, till we reach the full-blown sentence:

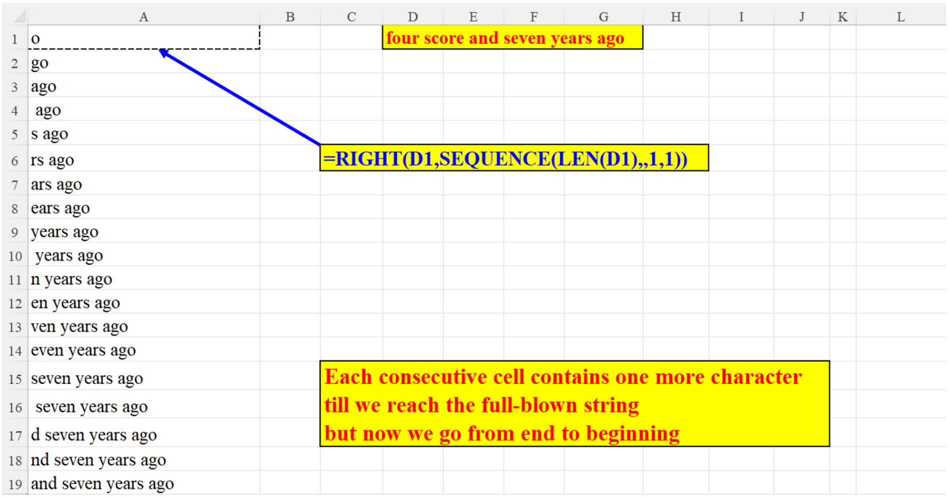


***Figure 2.49**: "Increasing" text from End to Start*

Increasing Text from start to end

We start from the first character of the sentence (in cell D1) and each consecutive cell contains one more character, till we reach the full-blown sentence as shown in the following screenshot:

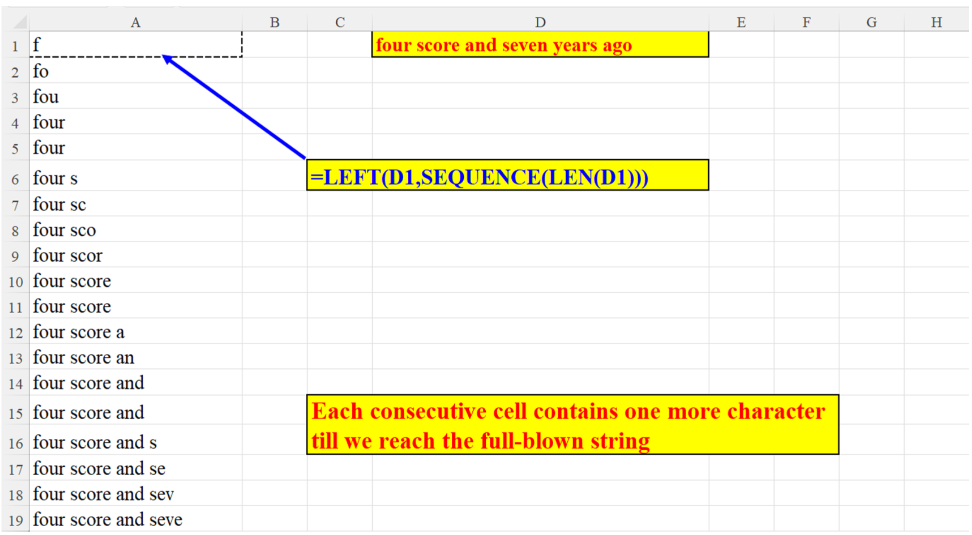


***Figure 2.50**: "Increasing" text from Start to End*

Hebrew Gematria (Formula)

Gematria is the practice of assigning numerical values to Alphabet letters and summing up these values (for a word, phrase, or sentence). Gtable (A6:E33 as shown in *figure 2.52)* is an Excel table where for each Hebrew letter a numeric value is given as shown in the following screenshot:

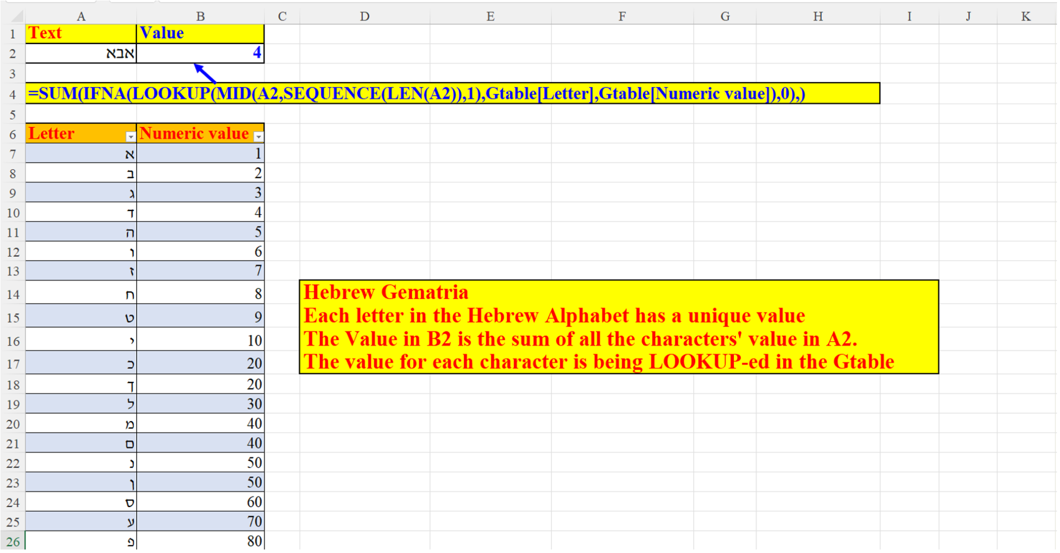


***Figure 2.51**: Hebrew Gematria (Formula)*

Hebrew Gematria (Gtable – Translation table)

This is the translation table used in the solution displayed in the previous section: **Hebrew Gematria (Formula)** as shown in the following screenshot:

Letter	Numeric value
א	1
ב	2
ג	3
ד	4
ה	5
ו	6
ז	7
ח	8
ט	9
י	10
כ	20
ך	20
ל	30
מ	40
ם	40
נ	50
ן	50
ס	60
ע	70
פ	80
ף	80
צ	90
ץ	90
ק	100
ר	200
ש	300
ת	400

***Figure 2.52**: Hebrew Gematria (Gtable – Translation table)*

Extract only Country Names

This is how to extract only the country names from a long string:

The inner function (**`TEXTSPLIT`**) splits the text by any digit (0-9) which removes all the digits. Then, the outer function (**`FILTER`**) filters out every comma (","), because its length is 1:

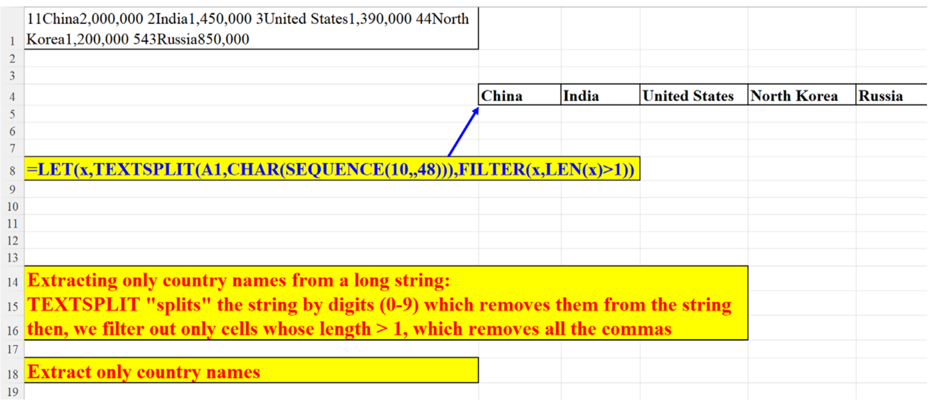


***Figure 2.53**: Extract only country names*

How many occurrences of a String starting from a certain position

We are looking for the number of times the parameter string (defined in cell: D2) appears in cell A2, but we start at the position specified in the "starting from" parameter (cell: F2) as shown in the following screenshot:

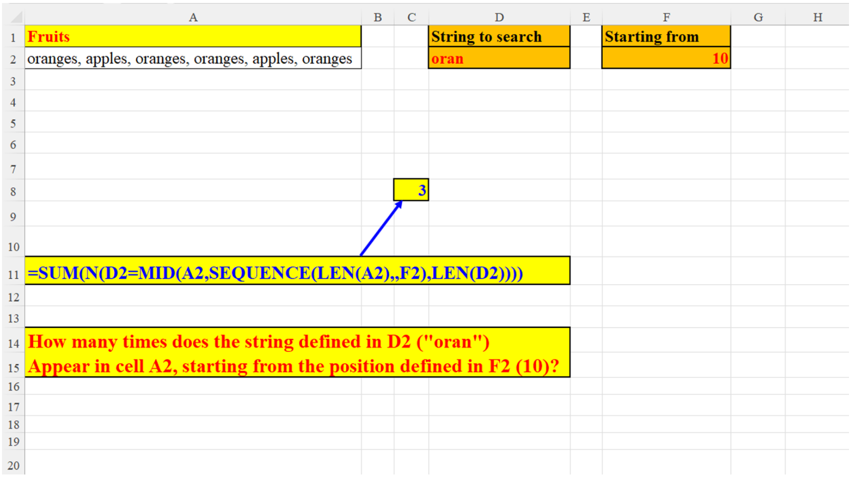


***Figure 2.54**: How many times does the search string appear, starting from a certain position*

Remove Diacritics from Hebrew words

The Hebrew languages has Diacritics, and special symbols that help pronounce the syllables correctly (since there are no vowels in Hebrew).

Sometimes, we want to remove these Diacritics as they usually do not appear in books, articles, internet sites, and so on. This is illustrated in the following figure:

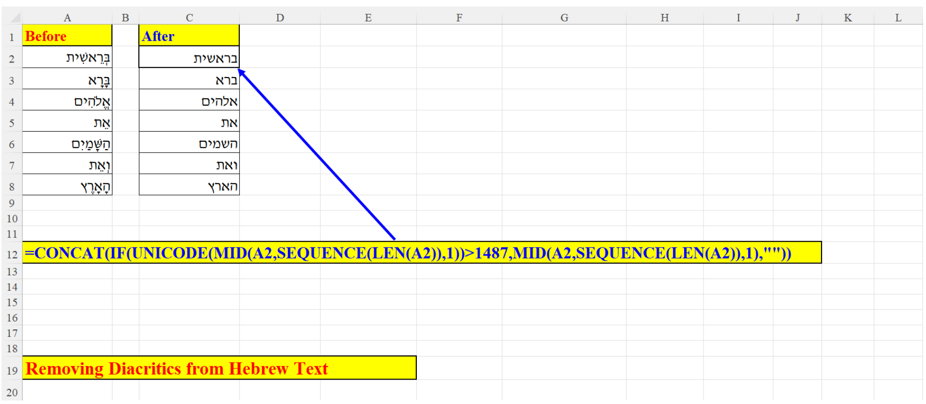


***Figure 2.55**: Remove Diacritics from Hebrew Words*

Is it a Palindrome (Arabic)

A palindrome is a word, phrase or sentence that can be read exactly the same from beginning to end as well as from end to beginning.

Here we check three Arabic words to find out whether they are palindromes or not.

Another example of a Palindrome checking can be found above, in the section: *Is it a Palindrome?* (*Figure 2.27*)

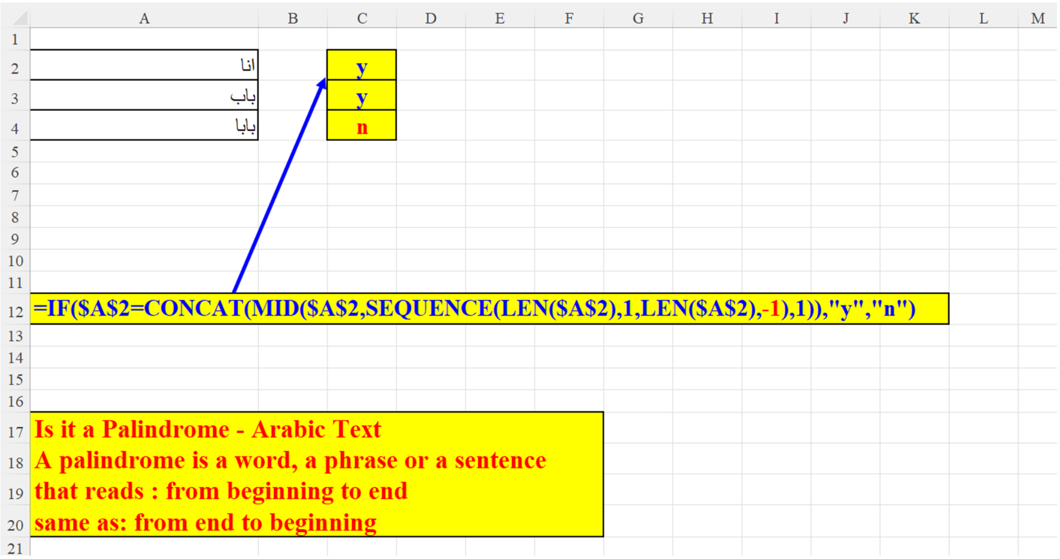


***Figure 2.56**: Is it a Palindrome (Arabic)*

Convert Hebrew letters into English letters

This formula helps solve an issue that is very common for bilingual keyboards users. If, for example, you type both in Hebrew and English, sometimes you unitentionally forget to switch to English while typing in Hebrew. The result is *gibberish* (as can be seen in cells A1 and C1). So, instead of erasing the contents of the entire cell, use the formula to convert "gibberish" into English as shown in the following screenshot:

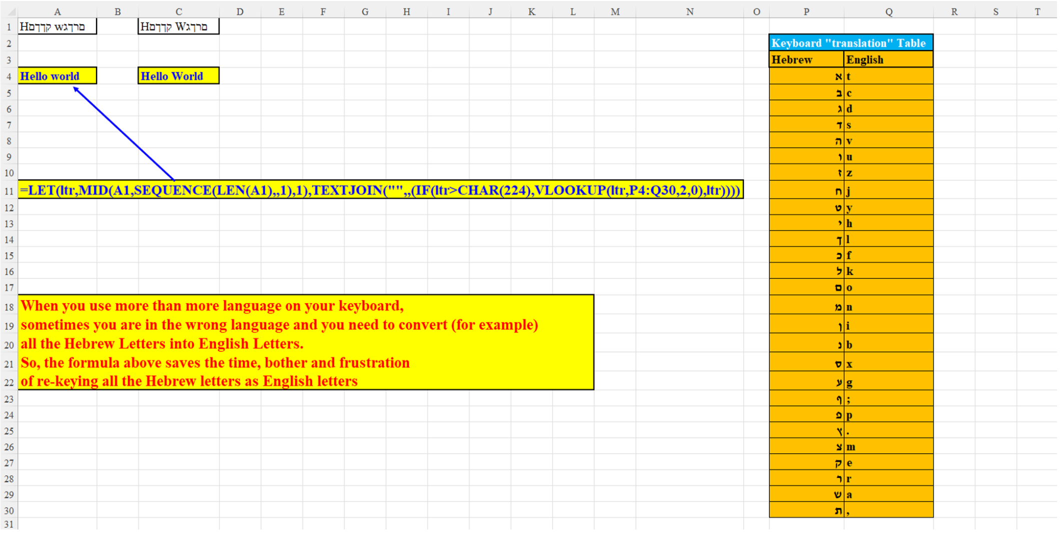


Figure 2.57: *Convert Hebrew Letters into English Letters*

Fetch description of Nth item of a non-sorted Key

We want to find the Nth (in our case: 5th, defined as a parameter in cell: E2) for Cat. No. 2 (defined as a parameter in cell: D2) as shown in the following screenshot:

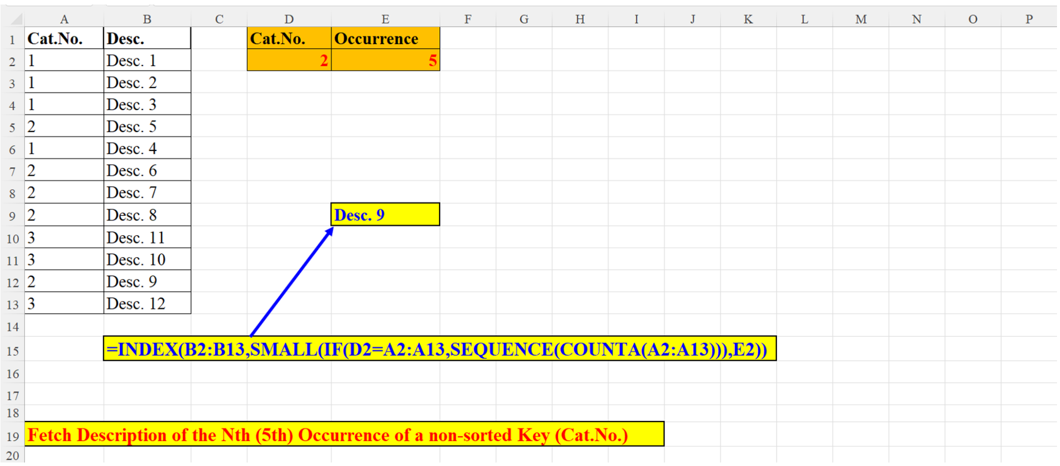


Figure 2.58: *Fetch Description of the Nth (5th) occurrence of a non-sorted Key (Column A: Cat.No.)*

Extract letters only from a chosen language (Formula)

The formula in the following figure extract only letters of the language chosen in cell J2 (which is a validation list, as can be seen in the next section:

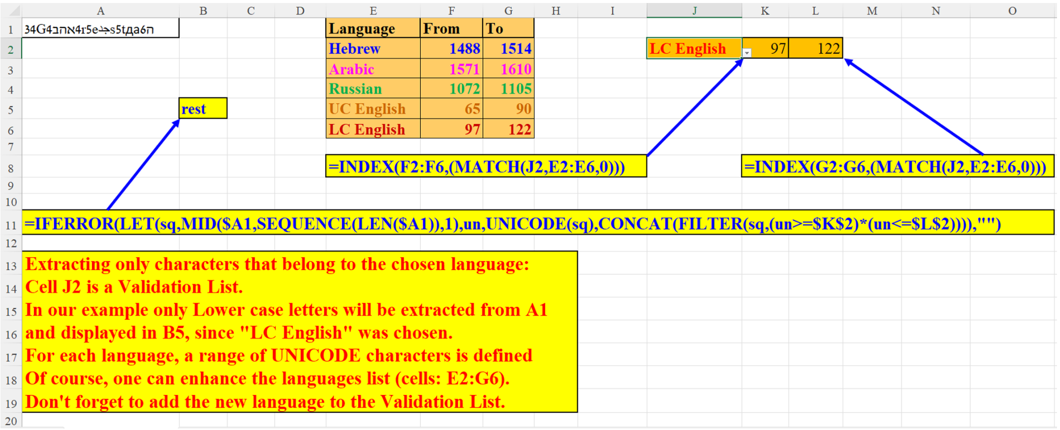


Figure 2.59: Extract only letters from the Language chosen in J2 (Validation List)

Extract letters only from a chosen language (Validation list)

Here is the Validation list in cell J2 that selects the language whose letters should be extracted from cell A1 (see previous section, *Extract letters only from a chosen language (Formula)*):

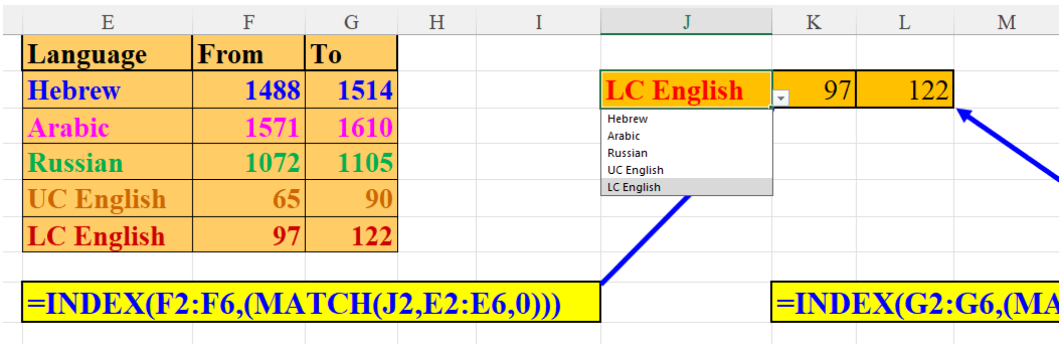


Figure 2.60: The Validation List (Cell: J2) contains all the Languages on the list (E1:G6)

Gematria in English

Method 1

Gematria (as explained above, in the section, *Hebrew Gematria (Formula)*, see *Figure 2.51*) is the practice of assigning numerical values to Alphabet letters and summing up these values (for a word, phrase or sentence). The dataset (K1:L27) is an Excel table where for each English letter a numeric value is given.

Method 1: using **`SUM`** and **`LOOKUP`**:

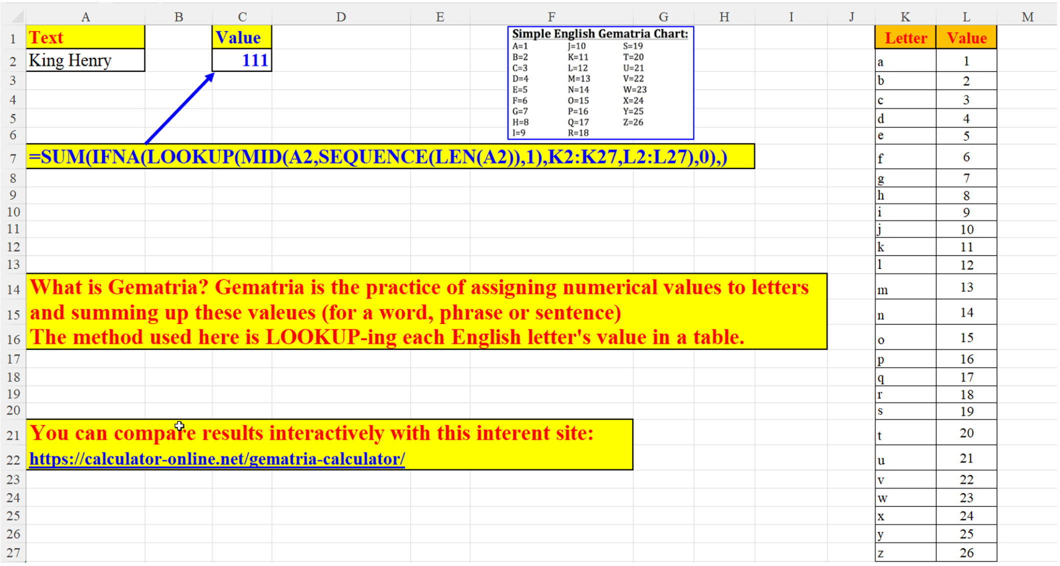


***Figure 2.61**: Gematria in English – Method 1*

Method 2

Gematria (as explained above, in the section *Hebrew Gematria (Formula)*) is the practice of assigning numerical values to alphabet letters and summing up these values (for a word, phrase or sentence).

Method 2: We do not need a table, as in the previous solution. We subtract 96 from each ASCII value (since a = 97, b = 98, c = 99 etc.). In case there are both upper-case and lower-case letters, we convert them all to lower-case since their values are the same. The formula ignores any characters that do not belong to the English alphabet as shown in the following figure:

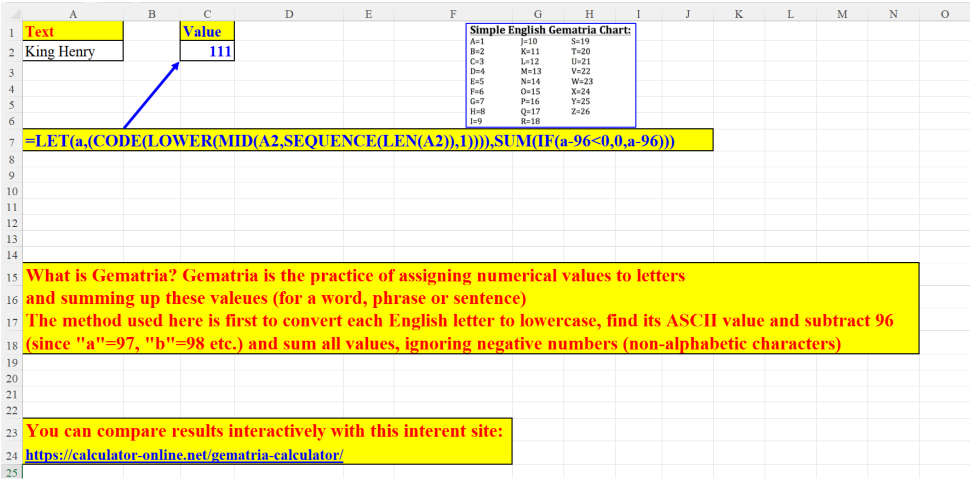


***Figure 2.62**: Gematria in English – Method 2*

How many Words are there in a Range?

This example is similar to the one demonstrated in Section: How many words are there in the cell (version 2), *Figure 2.3*. Both examples use the **`TEXTSPLIT`** function (explained in *Chapter 1, Introduction to Dynamic Array Functions in Excel 365*). Cells A1:A3 hold several words separated by space/s. The **`TRIM`** function removes spaces from the beginning and end of each cell. In addition, it leaves only one space between words. Then the **`TEXTJOIN`** function combines all the words in the range where a delimiter (space) is inserted between every text item. The **`TEXTSPLIT`** splits the string by that same delimiter into distinct cells. Finally, the **`COUNTA`** function counts the number of cells created by **`TEXTSPLIT`**:

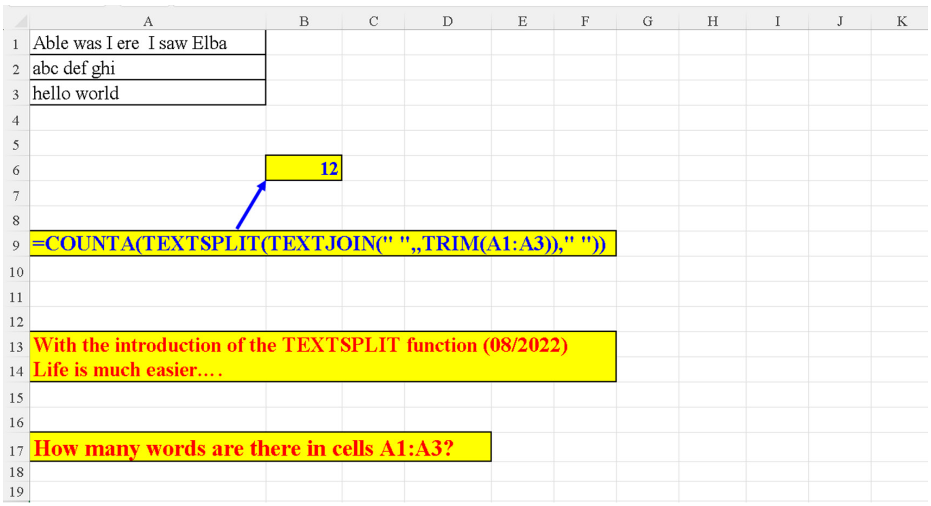


***Figure 2.63**: How many words are there in a range*

Extract only non-digits from String

The string in cell A2 contains both digits and non-digits. We want to remove all the digits from the string. We split the string into its components and build it back (without the digits) by concatenating each and every character of the original string that is not a digit. The **`LET`** function is used to avoid repetition of that part of the formula which splits the string **`MID($A2,SEQUENCE(LEN($A2)),1)`** as shown in the following screenshot:

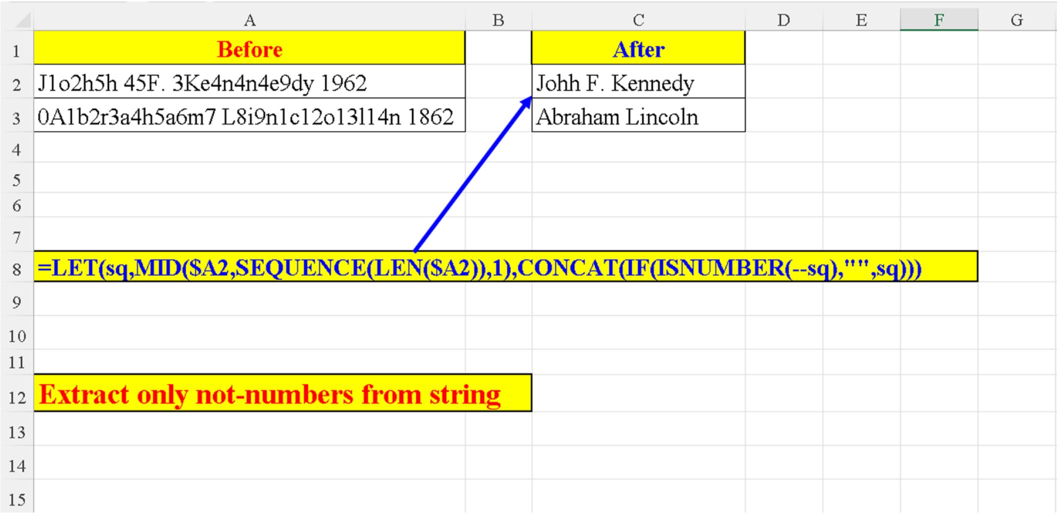


***Figure 2.64**: Extract only non-digits from string*

Find Unicode value for any character in the string, no matter which language

The **`UNICODE`** combined with **`SEQUENCE`** brings each character's **`UNICODE`** value. It does not matter if we have text from more than one language:

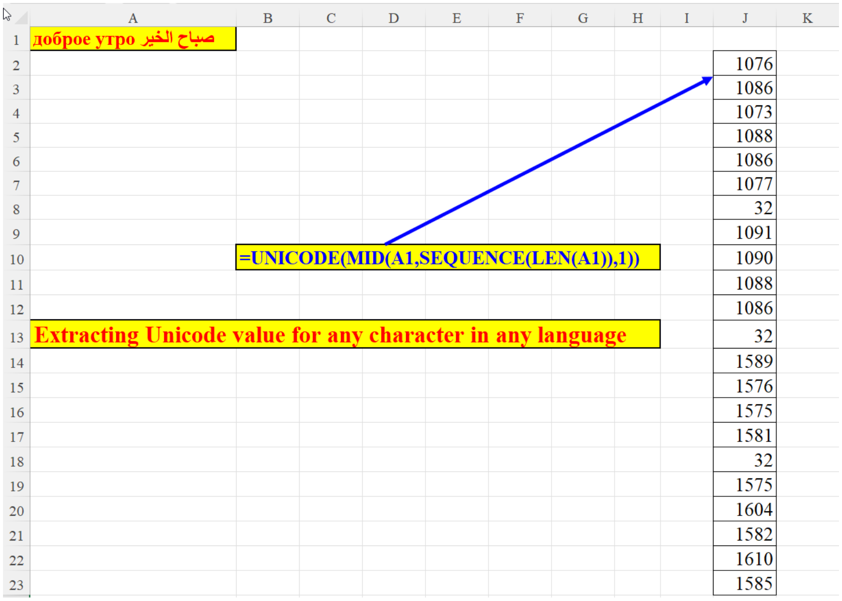


***Figure 2.65**: Find Unicode value for any character*

Conclusion

This chapter illustrated more than 60 cases of SEQUENCE usage with textual operations.

The next chapter will discuss the utilization of SEQUENCE when dealing with numbers.

Points to remember

- SEQUENCE can handle text from any direction (from beginning to end or: from end to beginning).
- SEQUENCE can easily split any text, in any language.
- SEQUENCE can easily extract parts of text: only letters, only digits, only special characters, and so on.
- SEQUENCE can effortlessly “translate” text.
- SEQUENCE can duplicate strings.
- SEQUENCE can generate series of strings, for example: The Alphabet of languages.
- SEQUENCE is capable of transposing text: vertical to horizontal and vice versa.
- SEQUENCE can assist us with removing unnecessary characters from text.

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CHAPTER 3
Using SEQUENCE with Numbers

Introduction

This chapter will demonstrate how to employ the **`SEQUENCE`** function when dealing with numbers. In a spreadsheet, numbers are the *bread and butter* of Excel. The **`SEQUENCE`** function has many tricks "up her sleeve" to handle sundry cases where manipulation with numbers is needed. Sometimes, as we will see in several instances, the data is inexistent, and the **`SEQUENCE`** function has to generate data out of nothing.

Structure

In this chapter, we will discuss the following topics:

- Examples of **`SEQUENCE`** with numbers
    - Five methods to generate 12 positive integers
    - Five methods to generate 12 negative integers
    - Descending **`SEQUENCE`** – Two methods
    - Duplicate cell horizontally
    - Duplicate cell vertically
    - Duplicate numbers

- Creating a vertical **SEQUENCE** of numbers – 2 methods
- Find missing numbers in a list
- Reverse a number
- Reverse a horizontal ascending array
- Reverse a horizontal descending array
- **SEQUENCE** of odd and even numbers
- Sum all digits in a cell which has only digits
- Sum all digits in a cell which has digits and text
- Sum every Nth row
- Sum the largest N numbers
- Sum the smallest N numbers
- Two tricks with **SEQUENCE** (ROW())
- SUM (**SEQUENCE** (virtual array))
- Alternate 1s and 0s
- Dynamic **SEQUENCE**
- Two methods to extract a number from string's end
- Two methods to extract a number from string's start
- Find N largest numbers (Asc.)
- Find N largest numbers (Desc.)
- How many columns in a sheet
- How many digits
- Reverse numbers horizontally by a parameter
- Reverse order of **SEQUENCE** of numbers
- Subject with the highest score
- **SEQUENCE** based on number of unique values
- Dynamic frequency based on dynamic bins
- **SEQUENCE** column
- Building a chessboard in three steps
- Creating N-digit number with the same digit repeated N times

Objectives

After reading this chapter, you will be able to perform many Excel tasks, like handling numbers, generating an array, reversing an array's order, summing part of an array, and so on. Applying the methods exemplified and explained in this chapter will save you a lot of time and effort. The **`SEQUENCE`** function is extremely useful with handling numbers in myriad situations in Excel. Understanding and practicing this chapter's examples will immensely improve your level of aptitude in Excel.

Examples of SEQUENCE with numbers

We will now discuss in detail the examples of applying the **`SEQUENCE`** function in numerical operations. Please be aware of the fact that we are not going to deliberate upon mathematical issues, but only on numbers as integers. The integration of **`SEQUENCE`** with mathematics will be explained in *Chapter 7, SEQUENCE - The Ancilla of Math.*

Five methods to generate 12 positive integers

The following five examples exhibit five methods of creating a vertical array of 12 numbers, using only the first argument of the function: **`ROWS`**. The number of desired rows (12) is contrived by five different methods: explicit number, Excel generated number (The **`ROWS()`** function), the number of the year's months from a fictitious date and a range of column names which yields the desired number.

Method 1

This is the simplest way to generate the first twelve natural numbers with **`SEQUENCE`**:

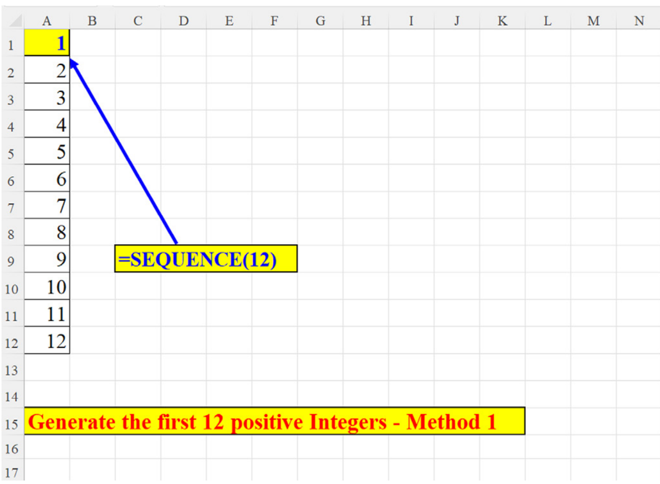


***Figure 3.1**: Generate 12 positive integers - Method 1*

Method 2

Another variation with **`SEQUENCE`** is using the **`ROW`** function. This function returns the (row) number of a reference:

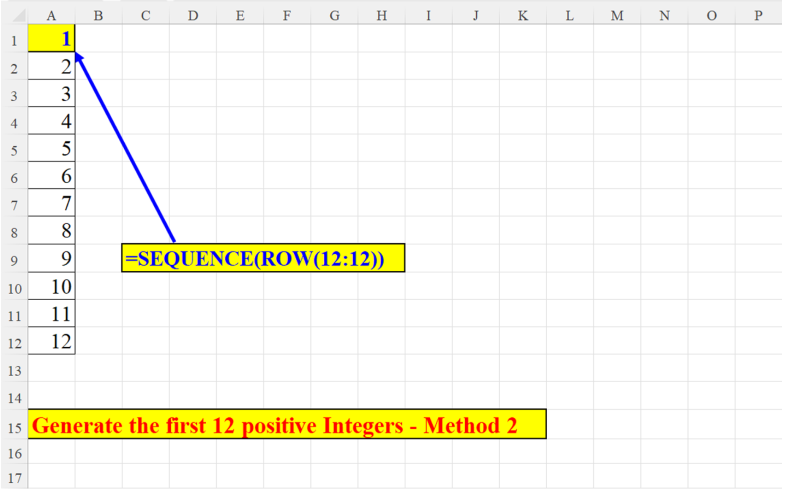


***Figure 3.2**: Generate 12 positive integers - Method 2*

Method 3

The **`SEQUENCE`** function combined with **`ROWS`**. The **`ROWS`** function returns the count of rows of the reference. The reference can be a range of cells (that is, A1:A12) or a range of numbers (as in our example):

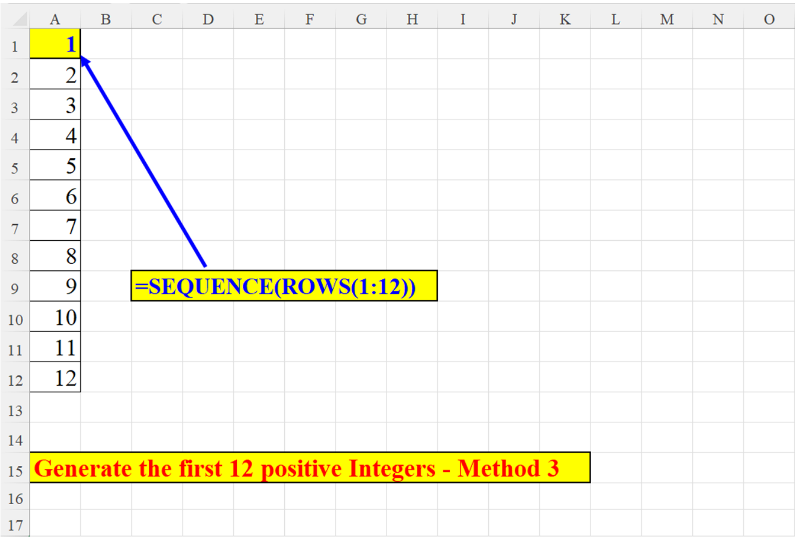


***Figure 3.3**: Generate 12 positive integers - Method 3*

Method 4

Here, we use the number of months in a year to produce the first twelve integers. The expression: **`DATE(1,1,)`** creates the date: 31/12/1900 and the **`MONTH`** function that wraps it, yields the month number of this date: 12 as shown in the following figure:

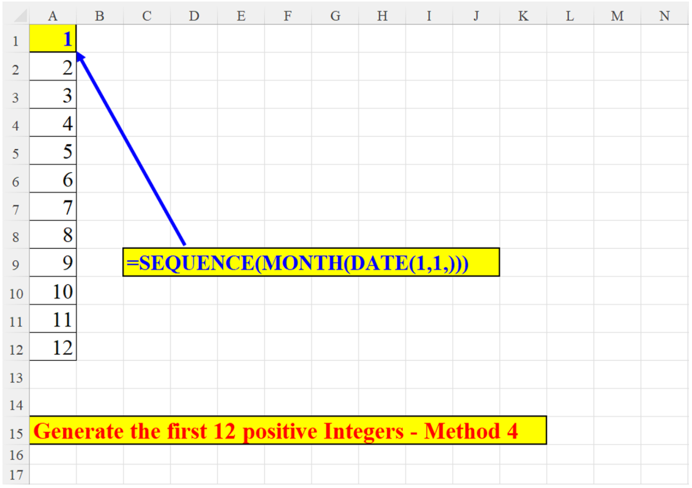


***Figure 3.4**: Generate 12 positive integers - Method 4*

Method 5

The **`COLUMNS`** function returns the number of columns in a reference. In our example, the range of columns A:L has twelve columns:

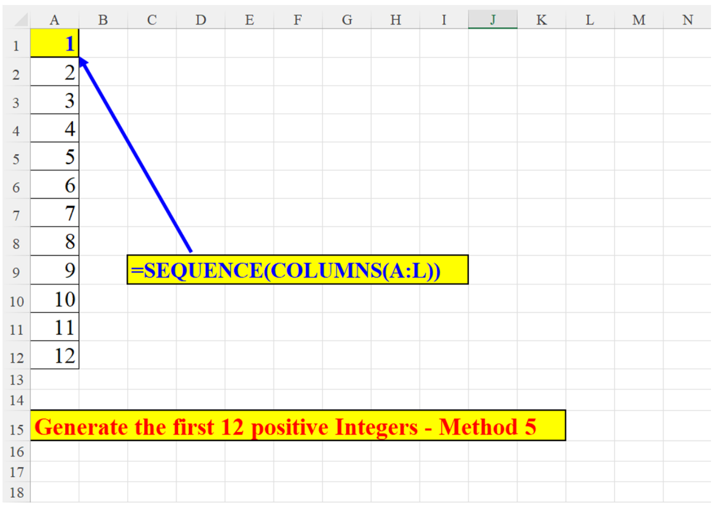


***Figure 3.5**: Generate 12 positive integers - Method 5*

Five methods to generate 12 negative integers

In this section, we will look at five techniques to create a **SEQUENCE** of 12 negative numbers. Some of them use the same techniques used above to initiate positive numbers, but the result is multiplied by -1. Other techniques use more than one argument of the **SEQUENCE** function, where the Starting number and Increment are both negative. The last example illustrates a lesser-known *trick* in Excel: instead of beginning the formula with the obvious equal sign (=) which precedes any formula, we establish the negative numbers with the minus sign (-) without specifying the =.

Method 1

Generating 10 consecutive negative integers. The third argument (-1) tells the function which number to start with. The fourth argument (-1) tells that the increment is negative as shown in the following figure:

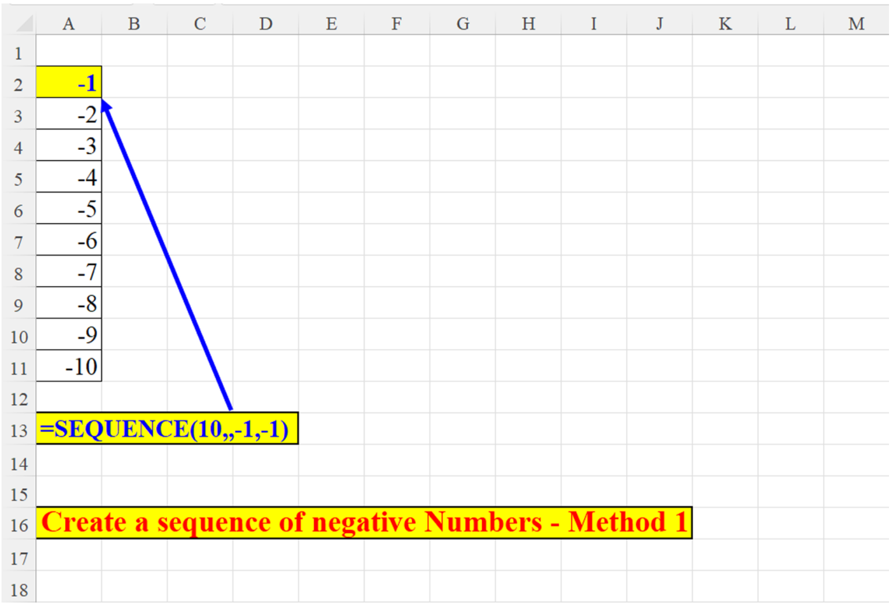


***Figure 3.6**: Negative SEQUENCE – Method 1*

Method 2

Multiplication of a positive array by (-1) turns the entire array into a negative one:

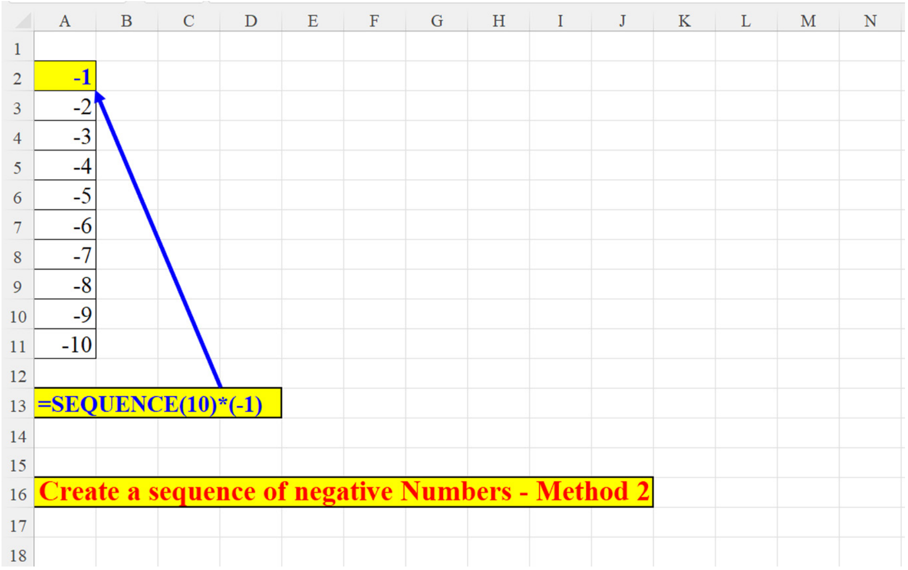


Figure 3.7*: Negative SEQUENCE – Method 2*

Method 3

In the following figure we create a horizontal array, and then transpose it vertically:

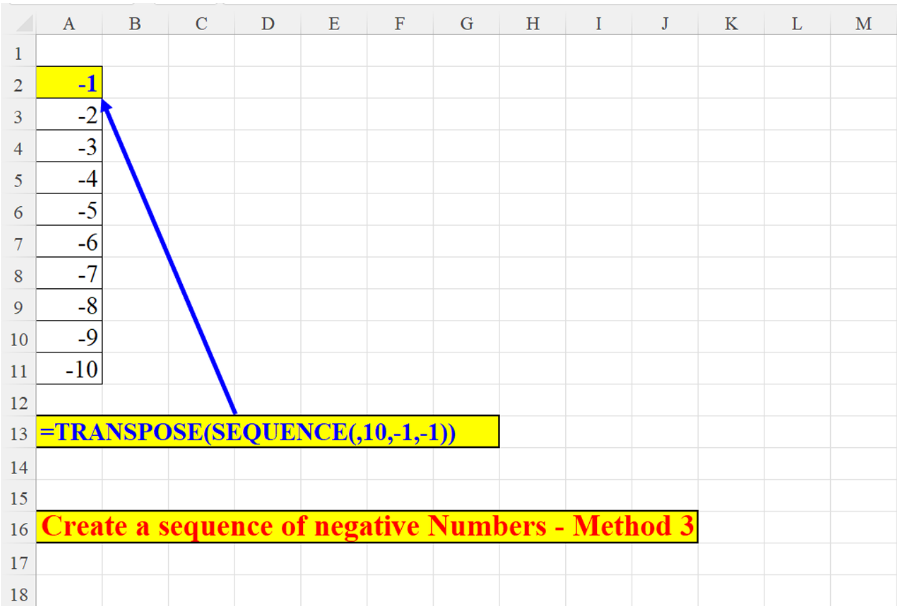


Figure 3.8*: Negative SEQUENCE – Method 3*

Method 4

This picture is similar to *Figure 3.3*. The only difference is that we multiply the result by (-1) for a negative array:

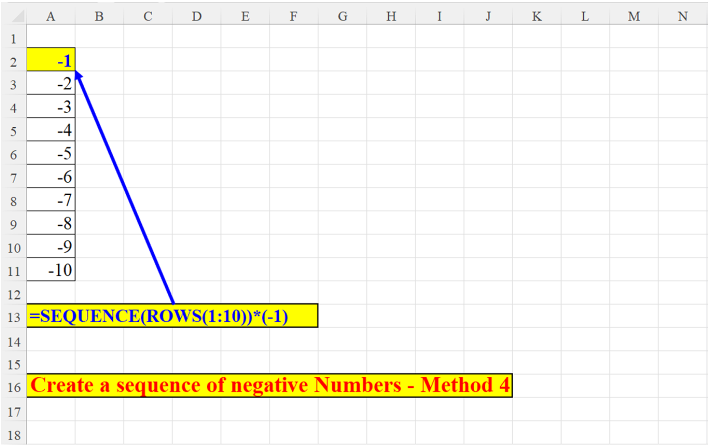


Figure 3.9: *Negative SEQUENCE – Method 4*

Method 5

The minus sign (-) following the equals sign (=) which starts every formula in Excel, not only causes the array to be negative: it also makes the (=) superfluous. We could have written the formula without it as shown in the following screenshot:

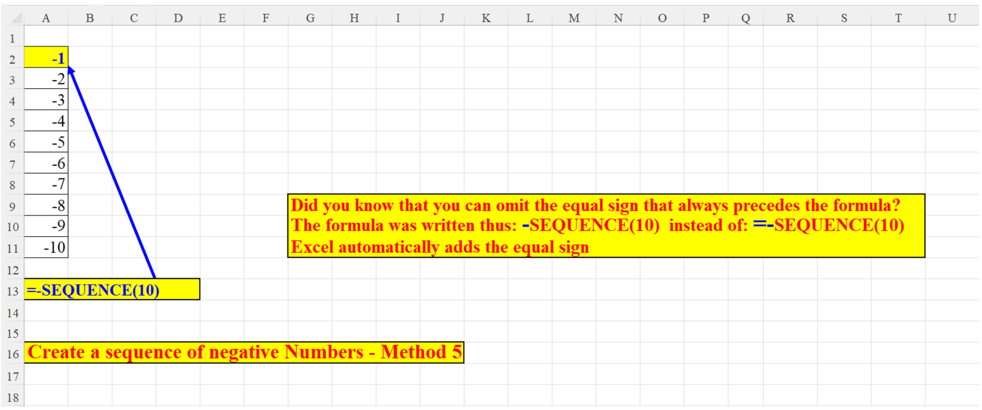


Figure 3.10: *Negative SEQUENCE – Method 5*

Descending SEQUENCE – Two methods

Using a parameter, we demonstrate two procedures to initiate an array of descending numbers. The parameter specifies the size of the array as well as the number with which to begin the array. The second procedure combines the **SORT** function with the **SEQUENCE**: we need to sort the array in descending order such that its elements are arranged from largest to smallest.

Method 1

The parameter (in cell **G1**) tells the **SEQUENCE** function both the size of the array and its starting number. Since the last argument is (-1) this is a descending sequence:

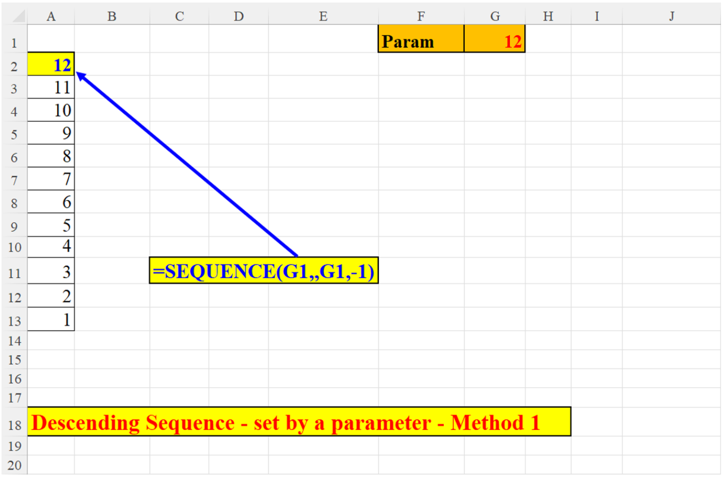


***Figure 3.11**: Descending SEQUENCE – Method 1*

Method 2

Wrapping the **SORT** function around the **SEQUENCE** function: **SEQUENCE** returns an ascending 12-member array which is then converted to a descending array by the **SORT** function:

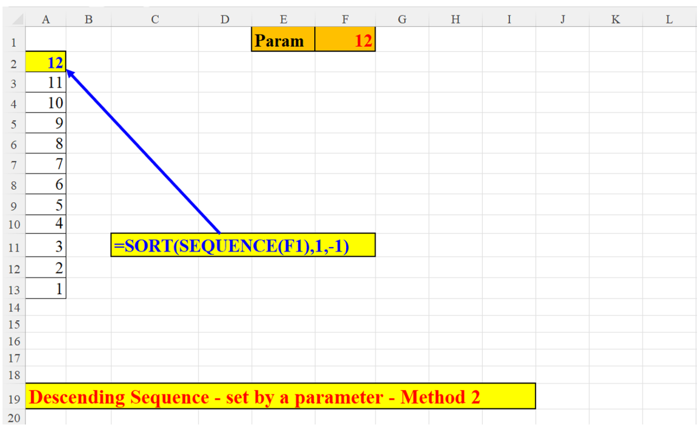


***Figure 3.12**: Descending SEQUENCE – Method 2*

Duplicate cell horizontally

The value in cell A2 is duplicated 10 times (the duplication factor is defined as a parameter in cell M2). The value in A2 is pointed by the **INDIRECT** of the value defined in cell L2. The **INDIRECT** function *translates* the text (in cell L2) into a valid Excel reference. The **TEXT** part of the formula generates 10 empty horizontal cells which are concatenated to the value in A2 to create a textual array. Multiplying this array by 1 converts the text array into a numeric one as shown in the following figure:

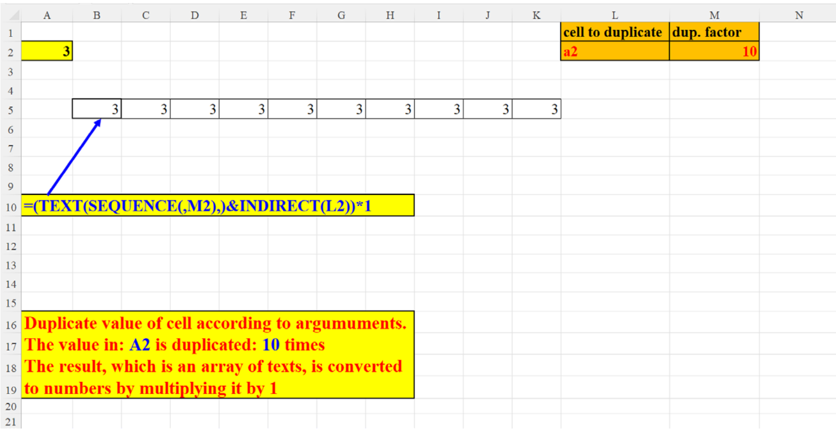


Figure 3.13*: Duplicate Cell Horizontally*

Duplicate cell vertically

The techniques used here are similar to the ones used in the previous section, only the **SEQUENCE** here returns a vertical array and not a horizontal one. The double-minus (**--**) at the beginning of the formula transforms the textual array into a numeric array as shown in the following figure:

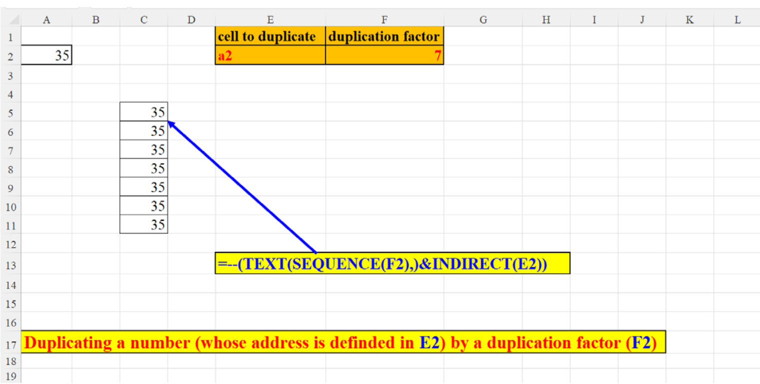


Figure 3.14*: Duplicate Cell vertically*

Duplicate numbers

The Duplication factor in cell O2 determines the number of occurrences for each number. Since the last argument of the **`SEQUENCE`** ("increment") is a fraction, the **`INT`** function turns the first 6 items into the number: 1, the next 6 items into: 2, and so on as shown in the following figure:

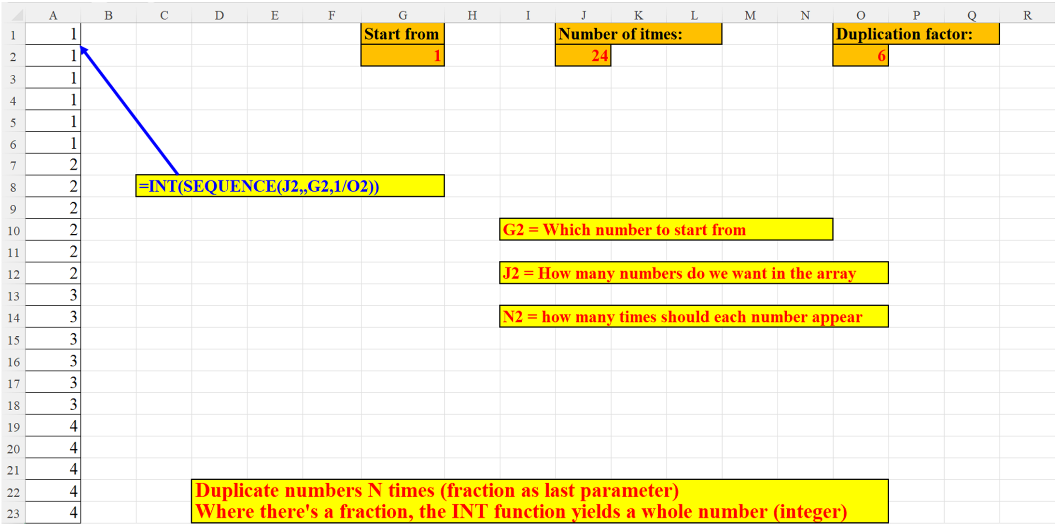


***Figure 3.15**: Duplicate numbers*

Creating a vertical SEQUENCE of numbers – Two methods

The following two pictures demonstrate how to generate a vertical **`SEQUENCE`** of numbers using an old method **`ROW()`** and our acquaintance **`SEQUENCE`**. The advantage of **`SEQUENCE`** over the old method is not so obvious in the first picture, though it is quite clear in the second one, with the parameter. The old method becomes much less intuitive when using a parameter (always better than *hard-coded* values within the formula). It is noteworthy to mention that the **`ROW`** function will not create the integer **`SEQUENCE`** 1-6 if moved to a different starting row, since **`ROW()`** always points to the row number in which it is defined:

Method 1: Creating a sequence of numbers **without** a parameter

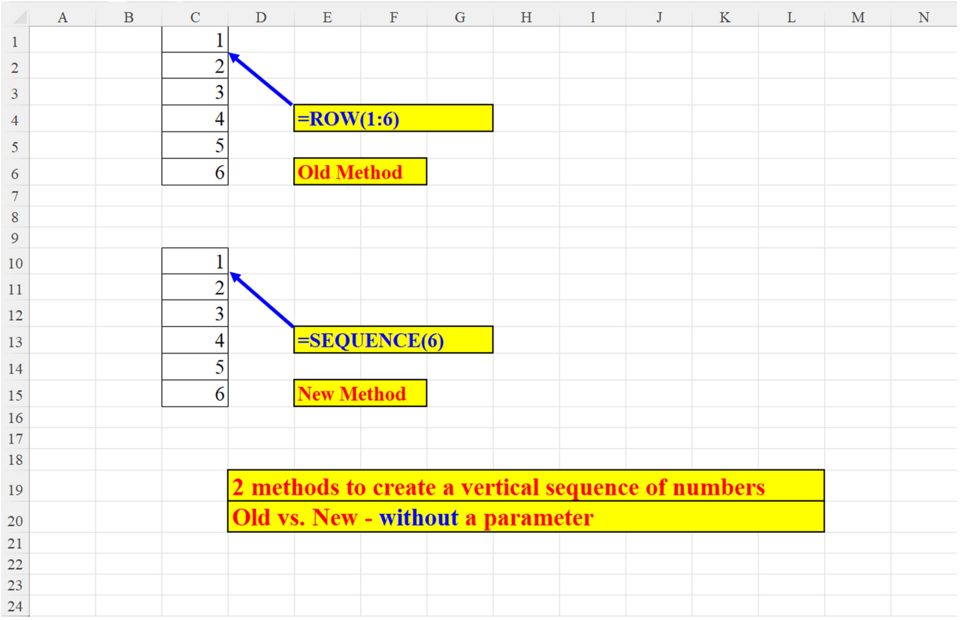


Figure 3.16*: Two methods to create a vertical SEQUENCE of numbers (**without** a parameter)*

Method 2: Creating a sequence of numbers **with** a parameter

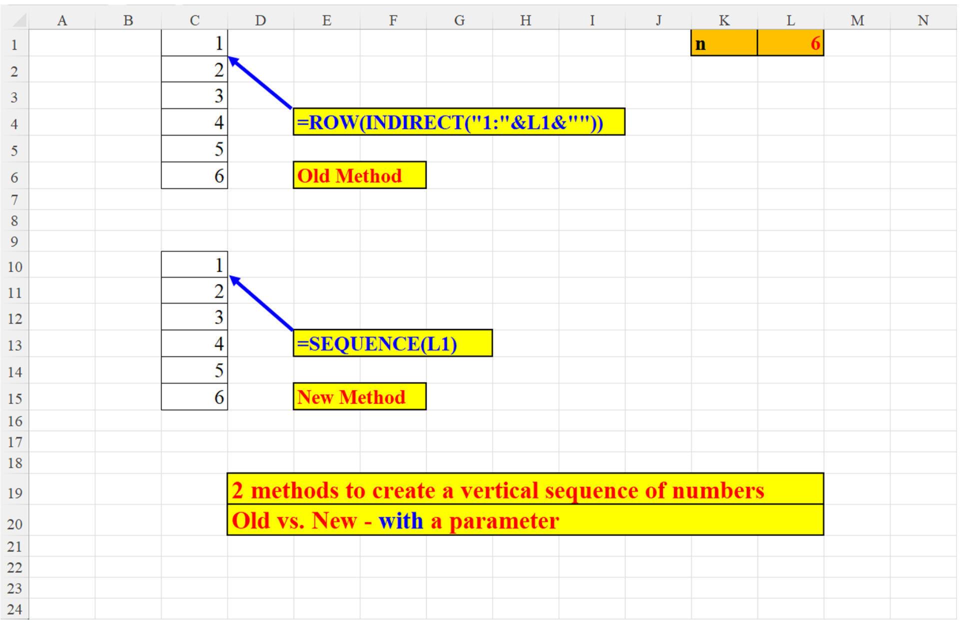


Figure 3.17*: Two methods to create a vertical SEQUENCE of numbers (**with** a parameter)*

Find missing numbers in a list

Suppose you have an unordered, incomplete list of numbers, and you want to know which numbers are missing from the list. The new **Dynamic Array Function** (**DAF**), **TOCOL**, (explained in *Chapter 1, A short introduction to Dynamic Array Functions in Excel 365),* together with **SEQUENCE**, generates the list of missing numbers. The formula does not need to know in advance what is the largest number in the original list as shown in the following screenshot:

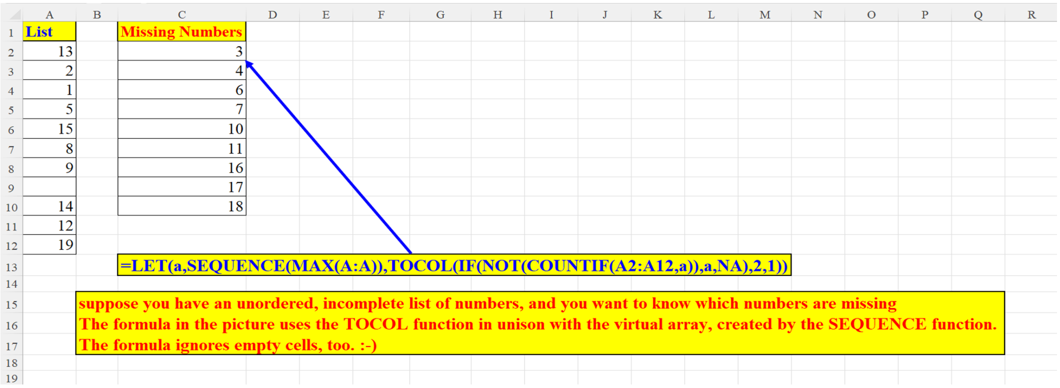


***Figure 3.18**: Find the missing numbers in a list*

Reverse a Number

The following example displays a simple procedure to reverse a number. The last argument of the **SEQUENCE** function is negative: (-1) which tells Excel to create a reverse (decending) **SEQUENCE** , and then the MID function splits the *reversed* **SEQUENCE** into N consecutive horizontal cells (where N is the length of the original number).

Even though all the numbers are left-aligned (as if they were text), they are numbers, nevertheless:

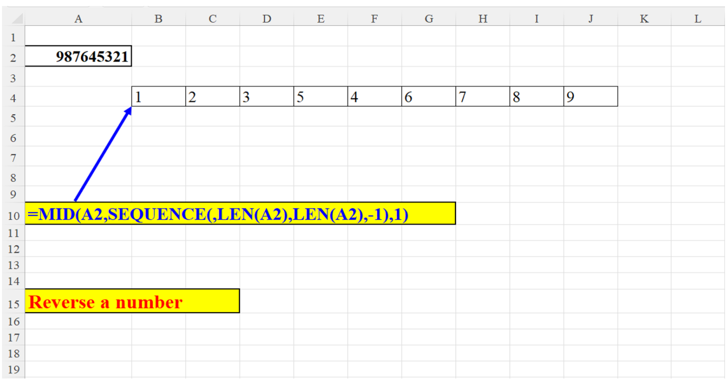


***Figure 3.19**: Reverse a number*

Reverse a horizontal ascending array

In cells A2:J2 we have an array of 10 consecutive numbers. We do not know in advance whether it is an ascending (first item=1) or descending (first item>1) array.

Since we skipped the first argument (there are no rows in the array), the array's size is decided by the second argument (COUNT(2:2)) which returns the number of non-empty cells in row number 2. The array's starting number is established by the third argument (identical to the second) and the last argument determines whether the resulting array is going to be ascending or descending as shown in the following screenshot. Another very interesting feature of this formula is the fact that if we move the array in row 2, the formula "adapts itself" automatically to the array's new starting location:

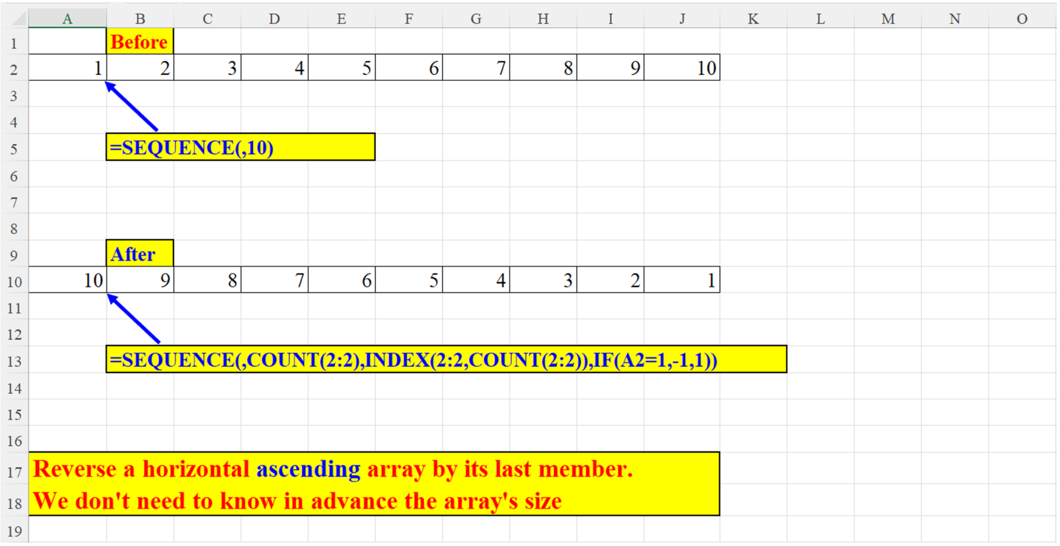


***Figure 3.20**: Reverse horizontal ascending array*

Reverse a horizontal descending array

This example utilizes the same technique as in the previous section. The formula reverses a descending array into an ascending one as shown in the following screenshot:

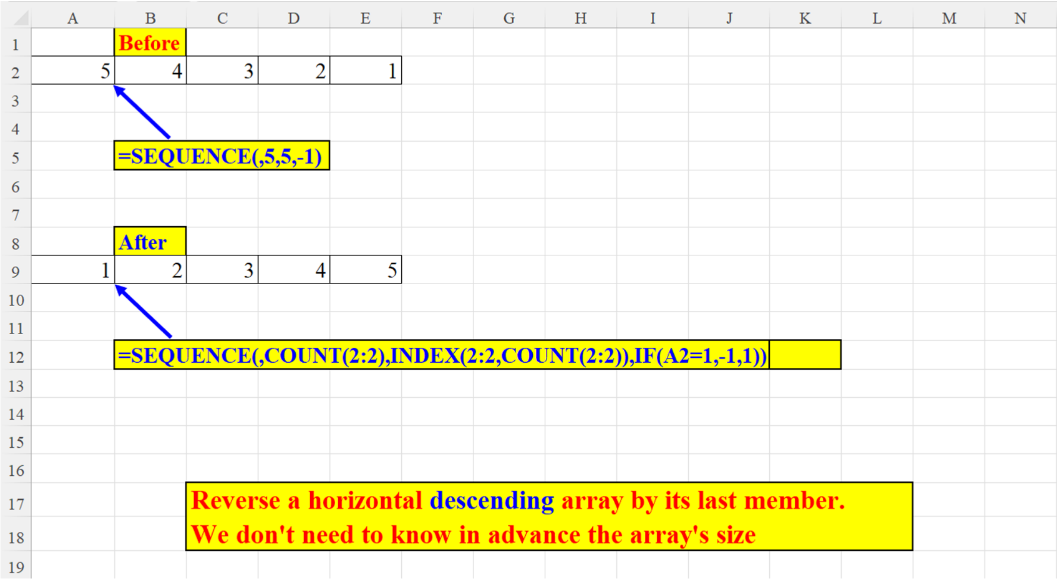


***Figure 3.21**: Reverse horizontal descending array*

SEQUENCE of odd and even numbers

The only difference between the two formulae is the third argument: 1 for odd numbers, and 2 for even numbers as shown in the following screenshot:

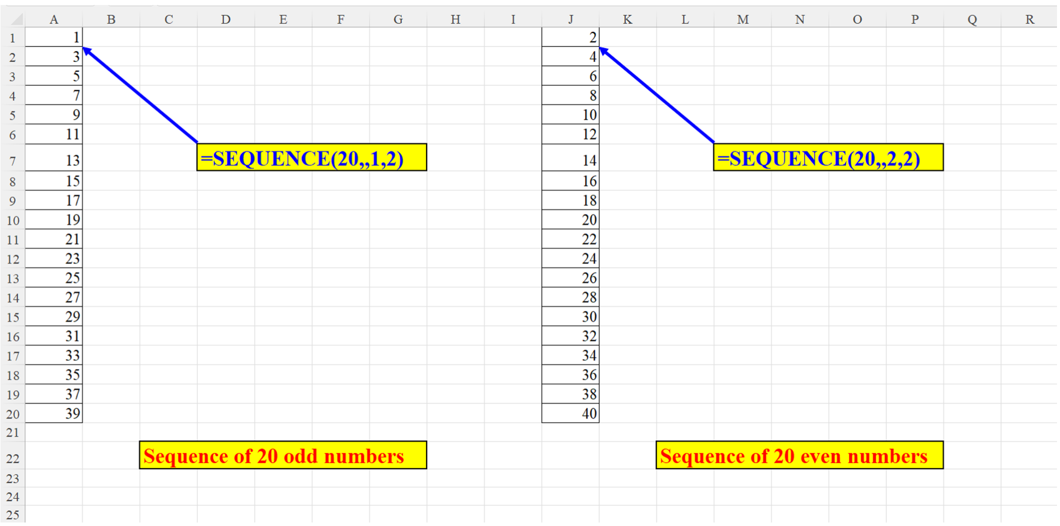


***Figure 3.22**: SEQUENCE of odd and even numbers*

Sum all digits in a cell which has only digits

The inner part of the formula *splits* the number into separate digits, which are then SUMmed by the outer function as shown in the following screenshot:

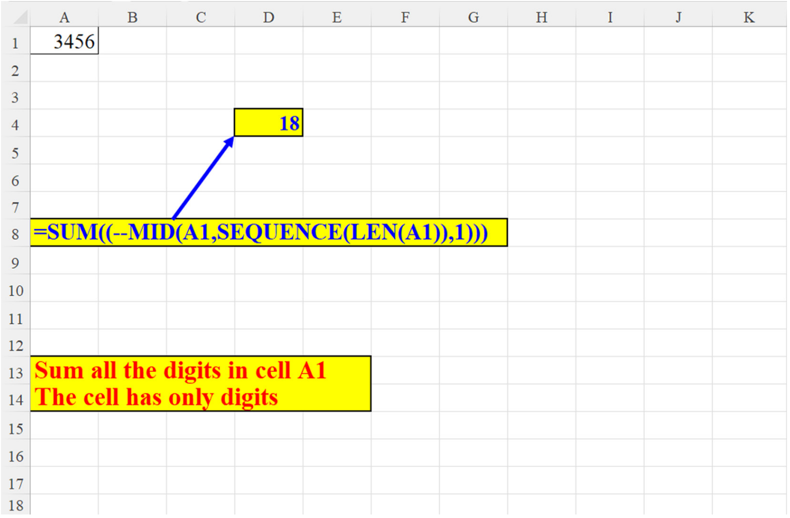


***Figure 3.23**: SUM all digits in a cell containing only digits*

Sum all digits in a cell which has digits and text

The inner part of the formula *splits* the number into separate digits and ignores non-digit characters, which are then SUMmed by the outer function as shown in the following screenshot:

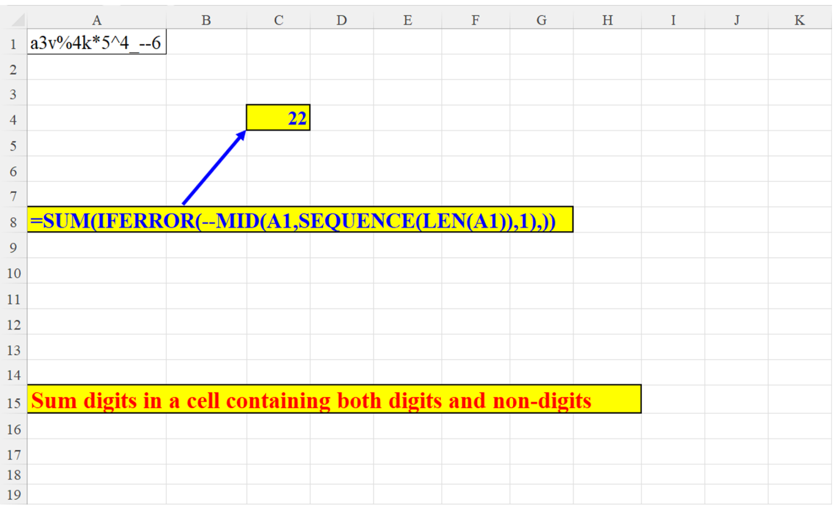


***Figure 3.24**: SUM all digits in a cell containing digits and text*

Sum every Nth row

The formula first locates all the numbers in the dataset whose location is divisible by 3 (3^{rd},6^{th},9^{th}) [numbers divisible by 3 have no remainder]. These numbers are then SUMmed up by the **SUMPRODUCT** function as shown in the following screenshot:

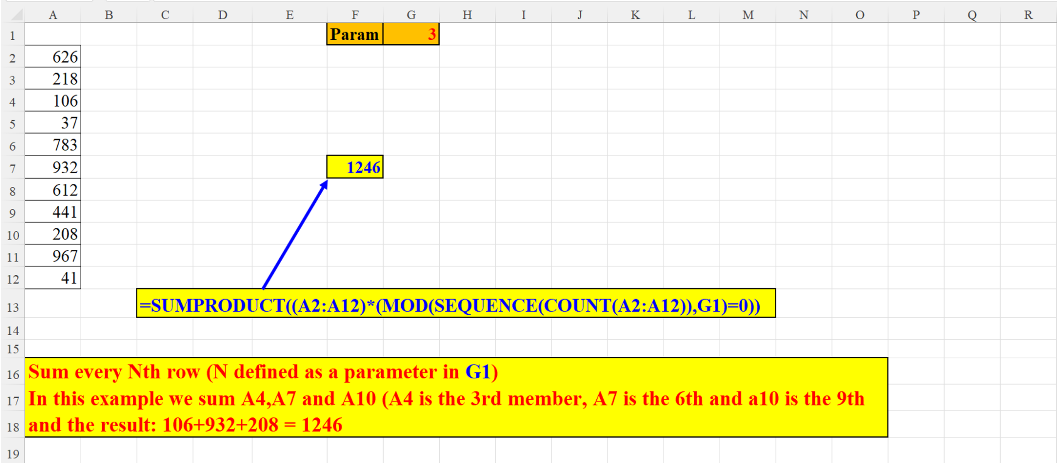


***Figure 3.25**: SUM every Nth row*

Sum the largest N numbers

The **LARGE** function returns the N(3) largest numbers, which are then SUMmed by the **SUMPRODUCT** function as shown in the following screenshot:

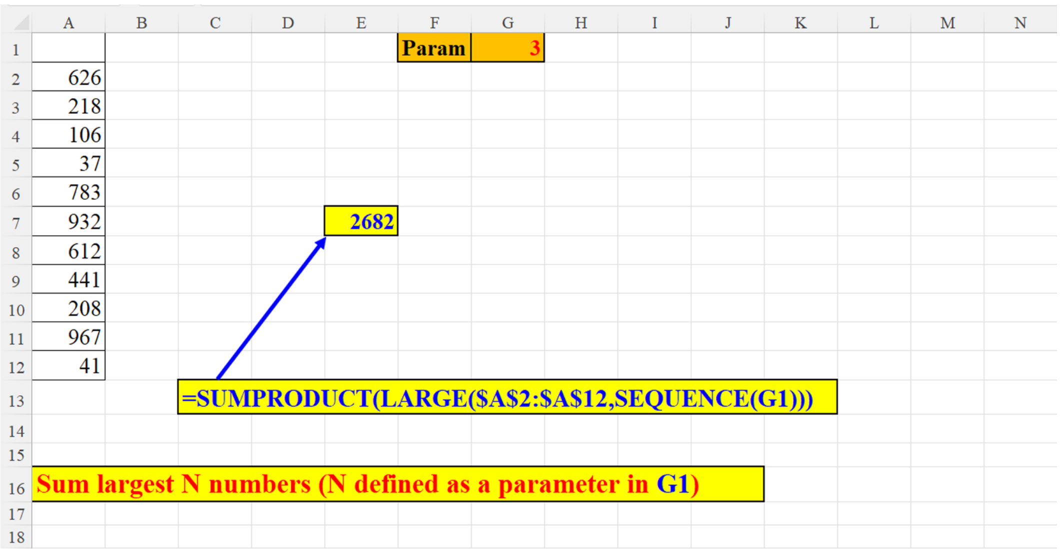


***Figure 3.26**: SUM largest N numbers*

Sum the smallest N numbers

This example is similar to the previous one, but here the **`SMALL`** function returns the three smallest numbers as shown in the following screenshot:

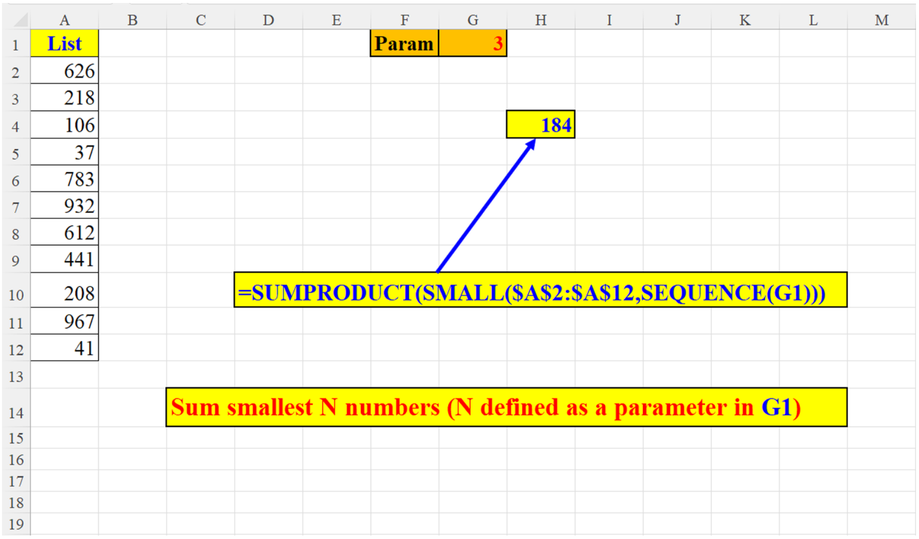


***Figure 3.27**: SUM smallest N numbers*

Two tricks with SEQUENCE (ROW())

This is really interesting: the row on which you type this formula: **`SEQUENCE(ROW())`**, is the number of members in the array. As can be seen in *Figure 3.28*, if you type the formula on row no. 5, the formula creates the **`SEQUENCE`** : 1,2,3,4,5. If you type the formula on row no. 8, the array: 1,2,….8 is generated.

Create a SEQUENCE of n Rows starting from Row(n)

If we type the formula: **=SEQUENCE(ROW())** in any row, the formula generates a sequence of n integers, where n is equal to the row number. You do not need to specify the array's size.

For example, if we type the formula in row 5, we get a sequence of the first 5 natural numbers. If the formula is written in row 8, it yields a sequence of the first 8 natural numbers.

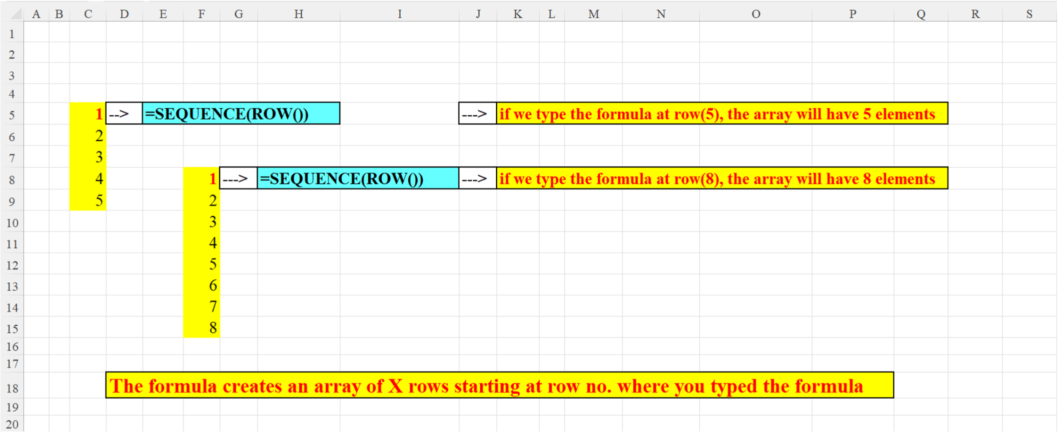


Figure 3.28: *Create a SEQUENCE of n Rows starting from Row(n)*

SUM a virtual array created by SEQUENCE (ROW())

Let us take the example in the previous subsection one step further. Now we want to SUM the array that the **`SEQUENCE(ROW())`** formula generated when typed on certain row. The result will be the sum of the array without a "physical" array! The array that is SUMmed is virtual: It exists only in Excel's memory, it does not "reveal" itself on the spreadsheet!

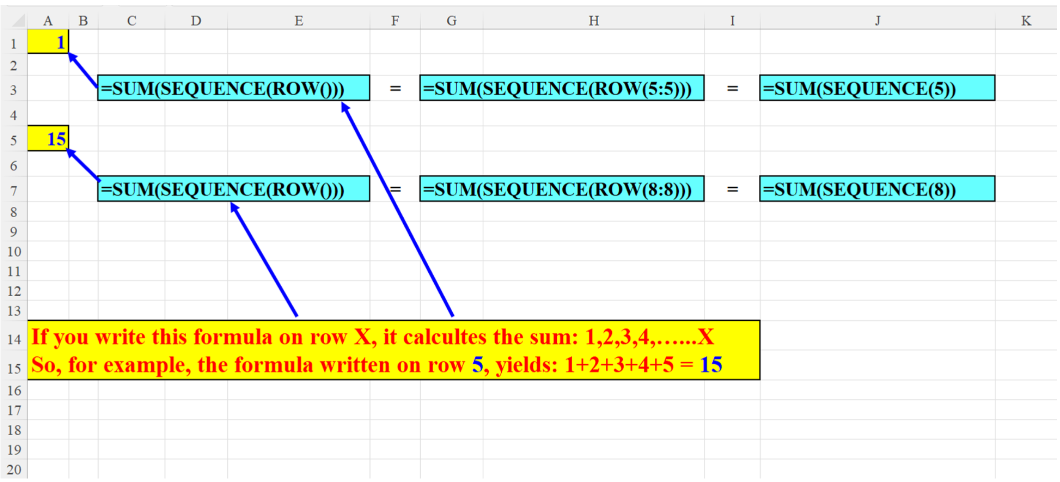


Figure 3.29: *SUM a Virtual Array created by SEQUENCE (ROW())*

SUM SEQUENCE (virtual array)

Another interesting demonstration of the unique feature of **`SEQUENCE`** manifested in the previous subsection: A *real* array is engendered by the **`SEQUENCE`** function however it becomes *virtual* if we wrap it with the **SUM** function as shown in the following screenshot:

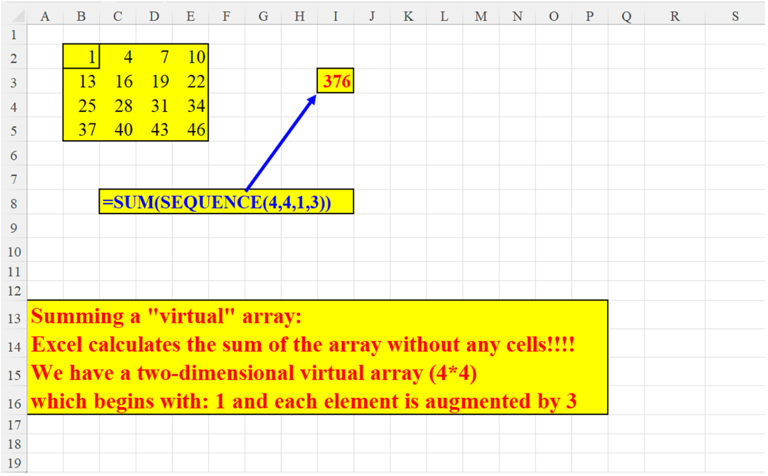


Figure 3.30: *SUM&SEQUENCE (virtual array)*

Alternate 1s and 0s

In cell B2 we have five zeroes (00000) preceded by five ones (11111). We engender an array of 1's and 0's, where the **TEXTJOIN** function joins the first five digits of cell B2 with the last five digits as shown in the following screenshot:

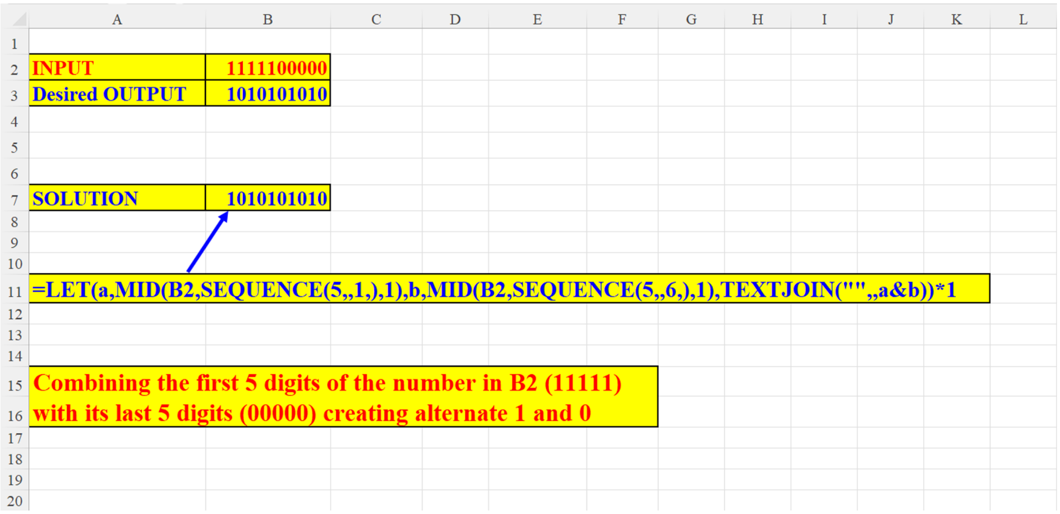


Figure 3.31: *Alternate 1s and 0s*

Dynamic SEQUENCE

Three parameters shape this array: the first (in cell G1) sets the number of items, the second (in cell J1) sets the starting number and the third (in cell M1) assigns the increment as shown in the following screenshot:

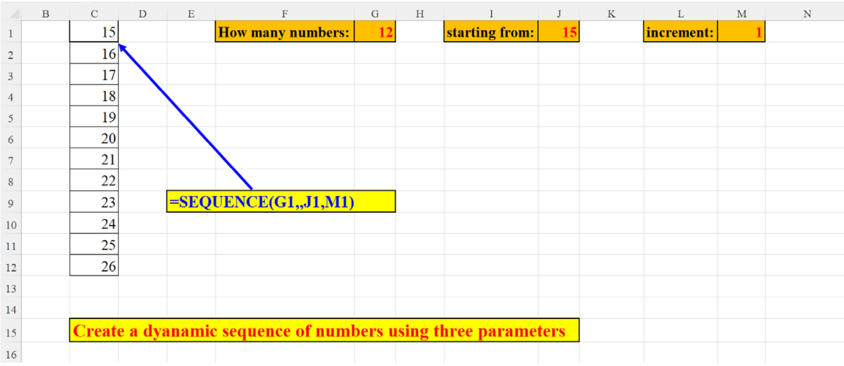


***Figure 3.32**: Dynamic SEQUENCE*

Two methods to extract a number from the string's end

This section will demonstrate two methods of extracting a number that appears at the end of a string, and preceded by non-digits.

Method 1

The formula finds the cell's first integer location (in our case, the 4th character) and then extracts all the digits from that location to the end of the string. The assumption here is that all the cell's digits appear at the cell's end:

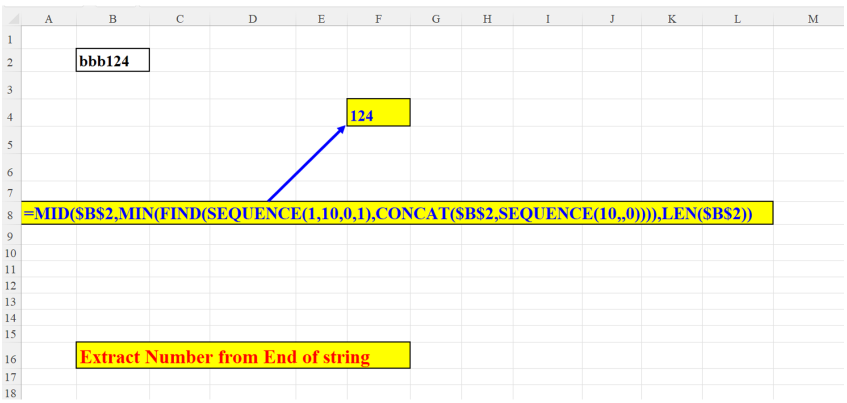


***Figure 3.33**: Extract a number from the string's end – Method 1*

Method 2

This screenshot exemplifies the use of two new DAF function, **`TEXTAFTER`** and **`VSTACK`**, (explained in *Chapter 1, A short introduction to Dynamic Array Functions in Excel 365*). The **`VSTACK`** function *piles up* all non-numeric characters (preceding 0, CHAR(48) and succeeding 9, CHAR(57)). Then the **`TEXTAFTER`** function returns the text after the last occurrence of the non-digits (the third argument to the function is: -1):

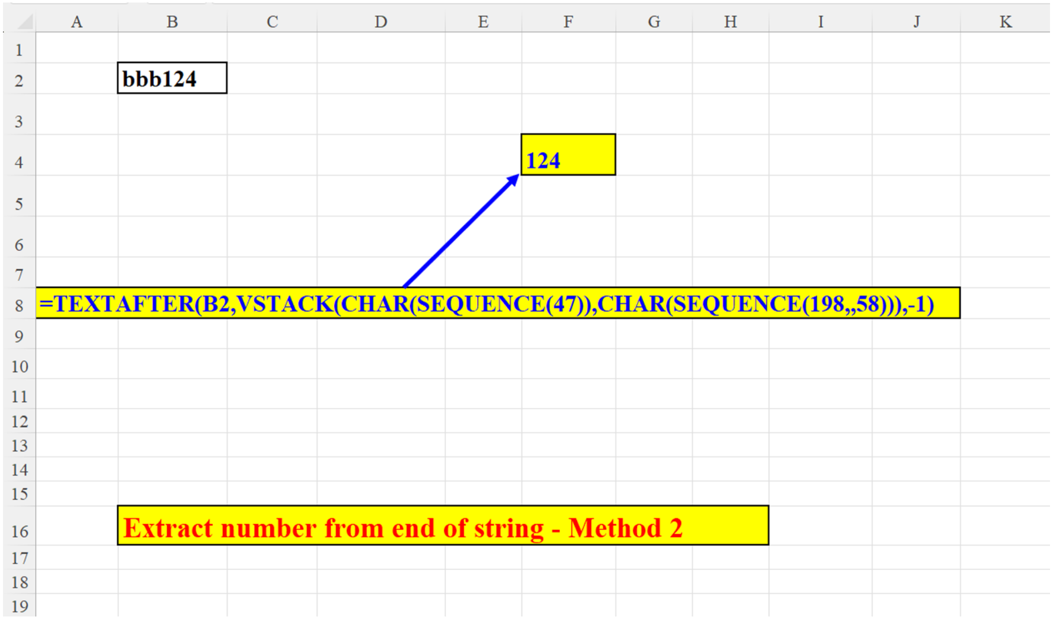


***Figure 3.34**: Extract a number from the string's end – Method 2*

Two methods to extract a number from the string's start

This section will demonstrate two methods of extracting a number that appears at the beginning of a string before any non-numeric characters.

Method 1

The **`MATCH`** function retrieves the location of the first non-digit character (in our case: 4). Then the **`LEFT`** function extracts 4-1 = 3 characters from the string's start as shown in the following screenshot:

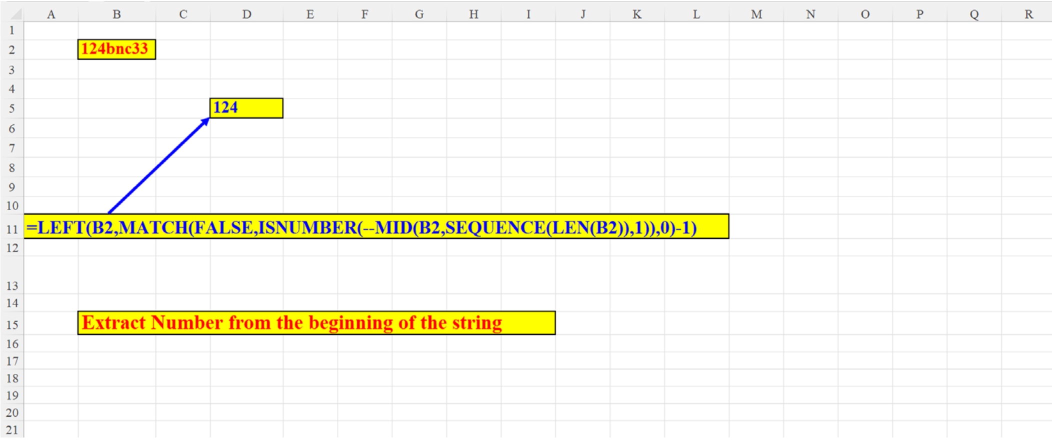


Figure 3.35*: Extract a number from the string's start – Method 1*

Method 2

The technique used here is similar to the one used in the previous section, method 2. But instead of using the **`TEXTAFTER`** function, we use the **`TEXTBEFORE`** (this function is explained in: *Chapter 1, A short introduction to Dynamic Array Functions in Excel 365*). The third argument to the function is omitted, since we use the default: instance number=1 as shown in the following screenshot:

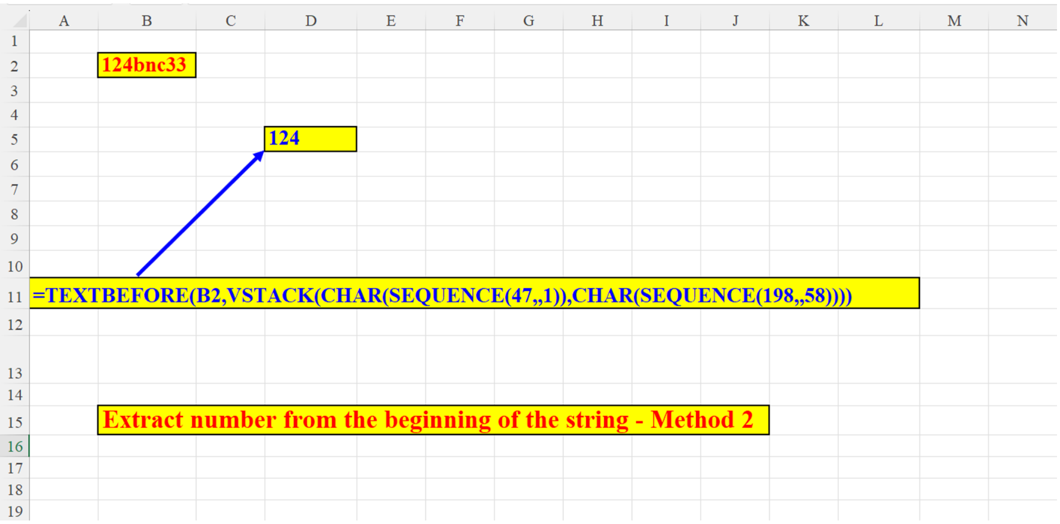


Figure 3.36*: Extract a number from the string's start – Method 2*

Find N largest numbers (Ascending)

The **LARGE** function extracts the 3 (parameter in cell G1) largest numbers from the dataset in Column B. Since the last parameter of **SEQUENCE** is -1, the result shown in ascending order (from small to large) is illustrated in the following screenshot:

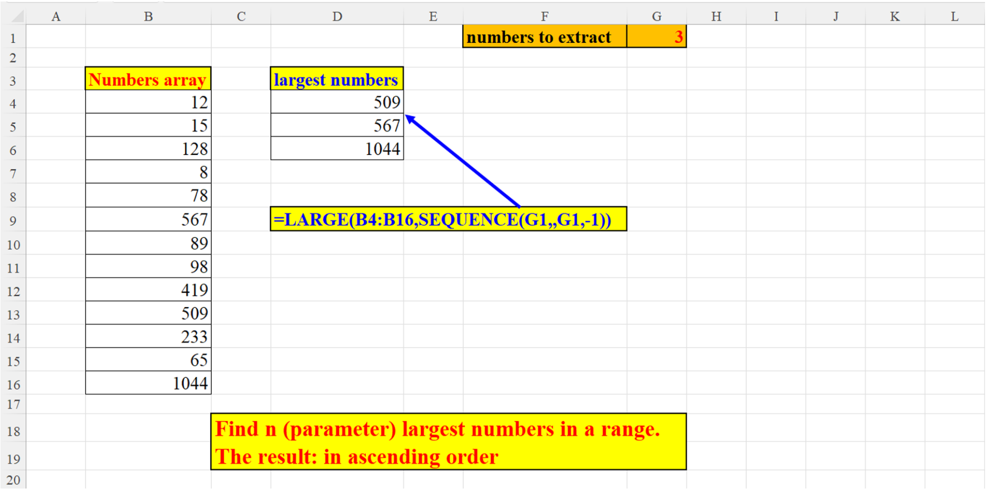


***Figure 3.37**: Find N largest Numbers(Asc.)*

Find N largest numbers (Descending)

The **LARGE** function extracts the 3 (parameter in cell G1) largest numbers from the dataset in Column B. Since the last parameter of **SEQUENCE** is 1, the result is shown in descending order (from large to small) as shown in the following screenshot:

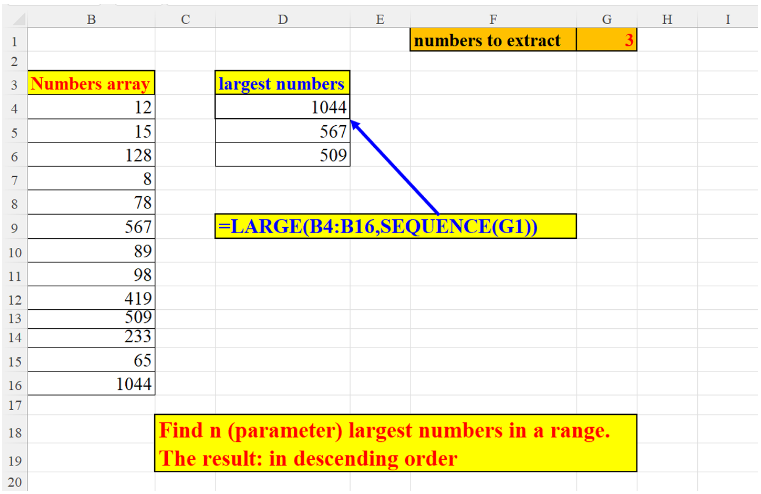


***Figure 3.38**: Find N largest Numbers(Desc.)*

How many columns in a sheet

This formula is quite complicated and deserves an explanation:

First, the MID function with the SEQUENCE function yields the 3-character array, "X";"F";"D" since the string length in A2 is 3, and 3-len(A2)= 0. When concatenated with A2, we get the string in cell A2. Then, the **`CODE`** function *translates* each letter of the array into its ASCII code: X=88, F=70, D=68. Further, we subtract 64 from each of these values since the ASCII codes for uppercase English letters starts with A=65. So, the result is this numeric array: {24; 6; 4}.

Finally, we multiply each number of the array by: 26^2, 26^1 and 26^0 and sum the result:

$24*26^2 + 6*26^1 + 4*26^0 = 16224 + 156 + 4 = 16384$.

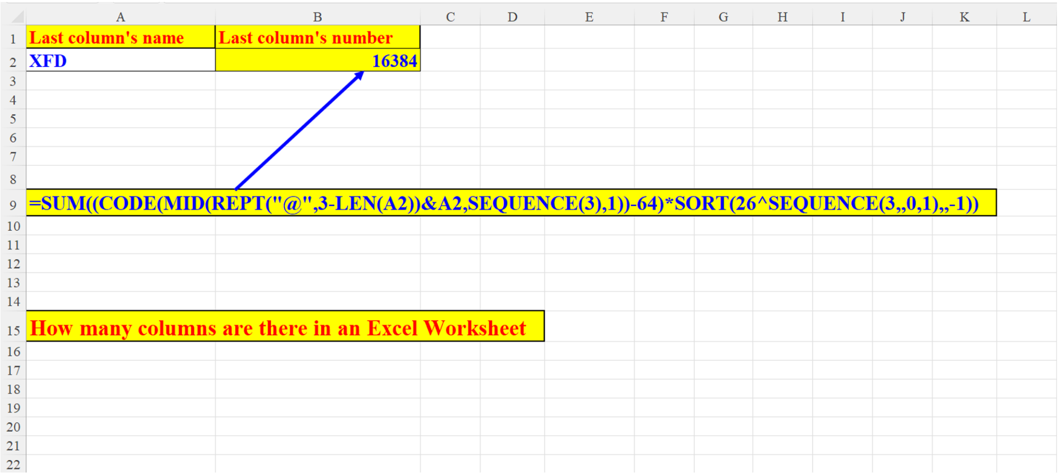


***Figure 3.39**: How many columns in a sheet*

How many digits

The **`MID`** function in unison with the **`SEQUENCE`** function extracts only digits from the string in cell A2. Then, these digits are concatenated into a single number, and finally the `LEN` function returns this number's length as shown in the following screenshot:

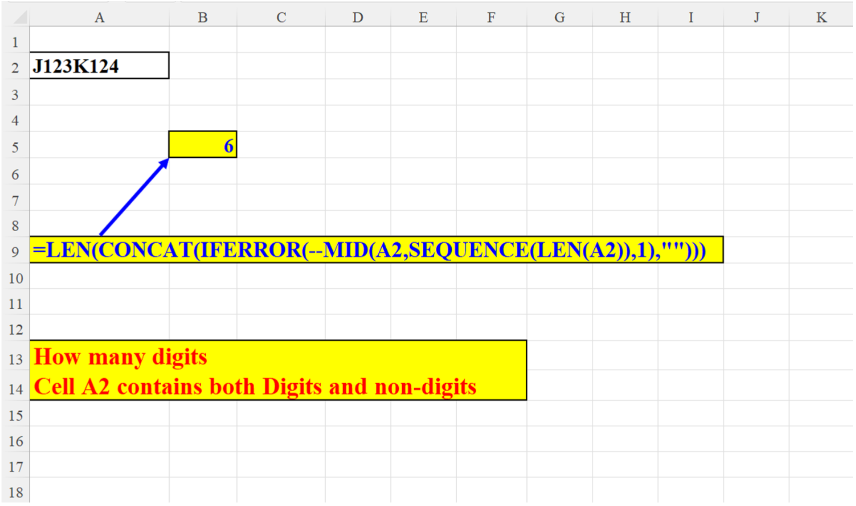


Figure 3.40: *How many digits*

Reverse numbers horizontally by a parameter

The formula suggested here is a simpler procedure to reverse a number (compare subsections *Descending Sequence - method 1, Figure 3.11*) and *Descending Sequence - method 2, Figure 3.12*). A parameter (in cell K1) sets the array's size, both the original one (in A2) and the reversed one (in A10) as shown in the following screenshot:

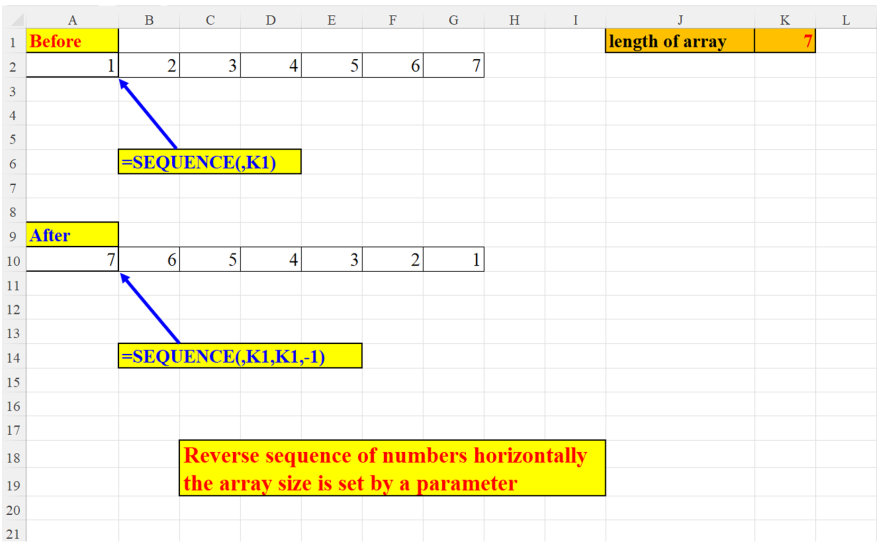


Figure 3.41: *Reverse numbers horizontally by a parameter*

Reverse order of a SEQUENCE of numbers

A dynamic table in column A (*Tnum*) is a table of natural numbers (integers greater than 0), ordered consecutively in ascending order. The array contrived in column C reverses the order of the original table. Since we are dealing with a dynamic table, adding new numbers to the table will automatically update the array in column C as shown in the following screenshot:

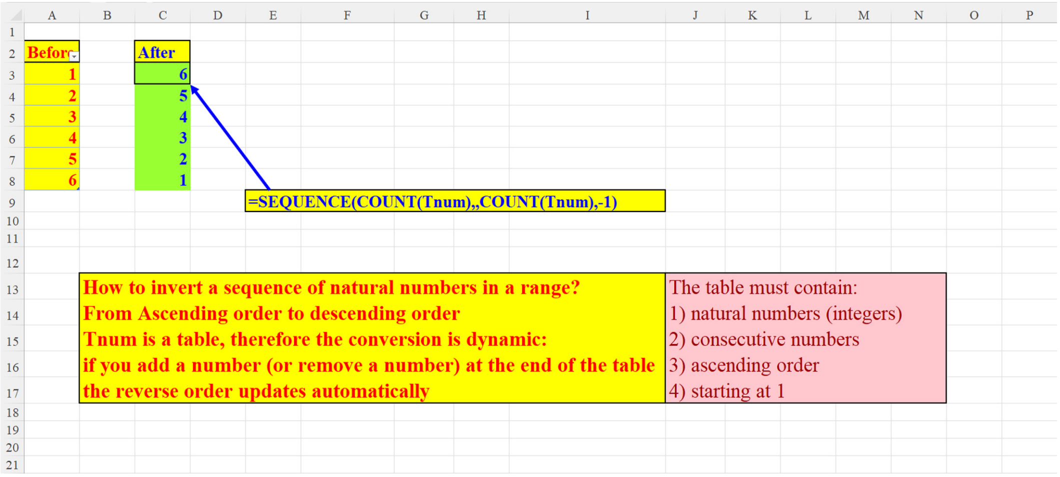
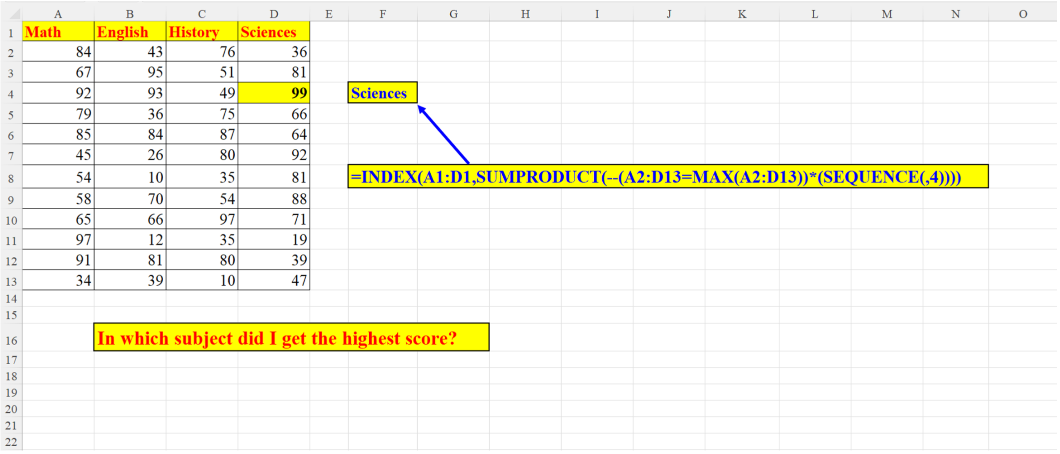


***Figure 3.42**: Reverse order of a SEQUENCE of numbers*

Subject with the highest score

This is basically an **`INDEX-MATCH`** formula, where the *traditional* **`MATCH`** is replaced by the **`SUMPRODUCT`** function: the search for the largest number in the range A2:D13 generates an bi-dimensional (4*12) array in which only one value is **`TRUE (1)`**. This array is multiplied by the one-dimensional array created by the **`SEQUENCE`** function (4 elements, since we have 4 columns). The result of this multiplication is the column where we have the highest score: the 4th column, which is the Sciences subject as shown in the following screenshot:

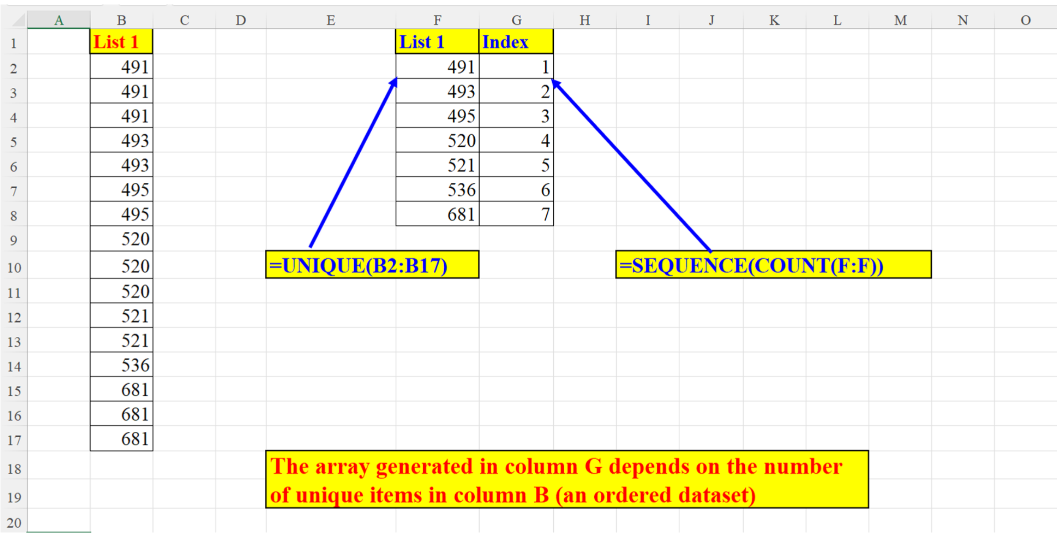


Math	English	History	Sciences
84	43	76	36
67	95	51	81
92	93	49	99
79	36	75	66
85	84	87	64
45	26	80	92
54	10	35	81
58	70	54	88
65	66	97	71
97	12	35	19
91	81	80	39
34	39	10	47

***Figure 3.43**: Subject with the highest score*

SEQUENCE based on number of unique values

For each unique item in list 1 (sorted in ascending order, column B) we add an index number (column G). There are seven items in unique List1 (column F), so the array produced by the **`SEQUENCE`** function has seven index numbers as shown in the following screenshot:



List 1
491
491
491
493
493
495
495
520
520
520
521
521
536
681
681
681

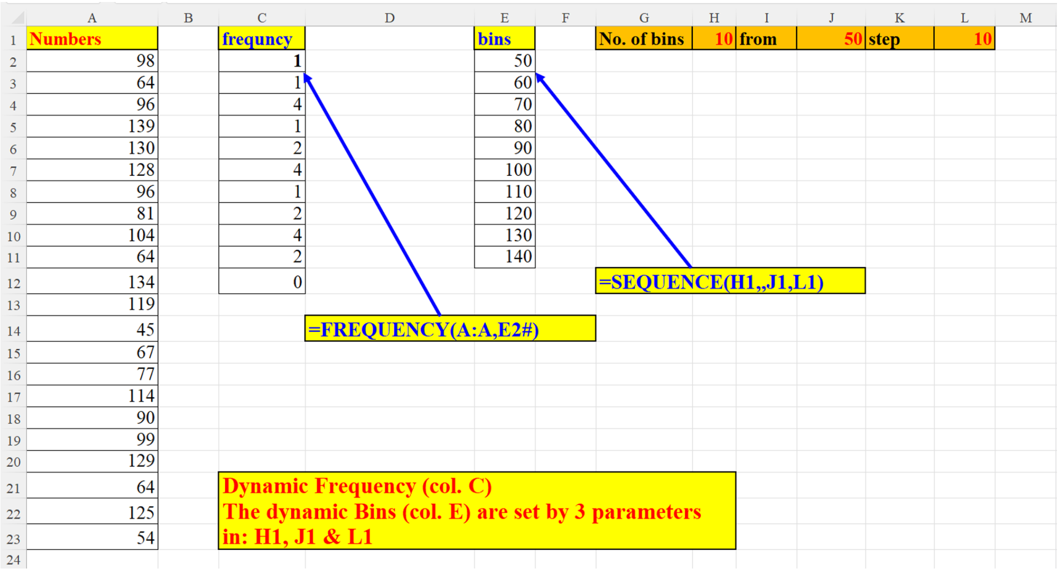
List 1	Index
491	1
493	2
495	3
520	4
521	5
536	6
681	7

***Figure 3.44**: SEQUENCE based on number of unique values*

Dynamic frequency based on dynamic bins

The **FREQUENCY** function in Excel is used to sum vertically the number of items for each bin in the bins array (Column E). The bins array is built dynamically according to three parameters in: H1, J1, L1 which are, respectively, the number of bins (10), the start of the array (50) and the step/increment for item in the array. The **FREQUENCY** function (in Column C) counts all the items for each bin. For example, in the first bin (50) there is only one number (45) which is less than or equal to 50. In the 100th bin we have 4 numbers: 96, 96, 98, 99, and so on.

Please pay attention to the notation of the second argument of the **FREQUENCY** function. The # in the E2# denotes the Spilled Range Operator. E2# is the array created by the **SEQUENCE** function as shown in the following screenshot:



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Numbers		frequncy		bins		No. of bins	10	from	50	step	10	
2	98		1		50								
3	64		1		60								
4	96		4		70								
5	139		1		80								
6	130		2		90								
7	128		4		100								
8	96		1		110								
9	81		2		120								
10	104		4		130								
11	64		2		140								
12	134		0										
13	119												
14	45												
15	67												
16	77												
17	114												
18	90												
19	99												
20	129												
21	64												
22	125												
23	54												
24													

***Figure 3.45**: Dynamic frequency based on dynamic bins*

SEQUENCE column

Both formulae (in A1 and in A10) yield the same result: the number 10 is *spilled* all over row 1 and row 10. The size of the upper and lower arrays is the same: all columns of the worksheet as shown in the following figure:

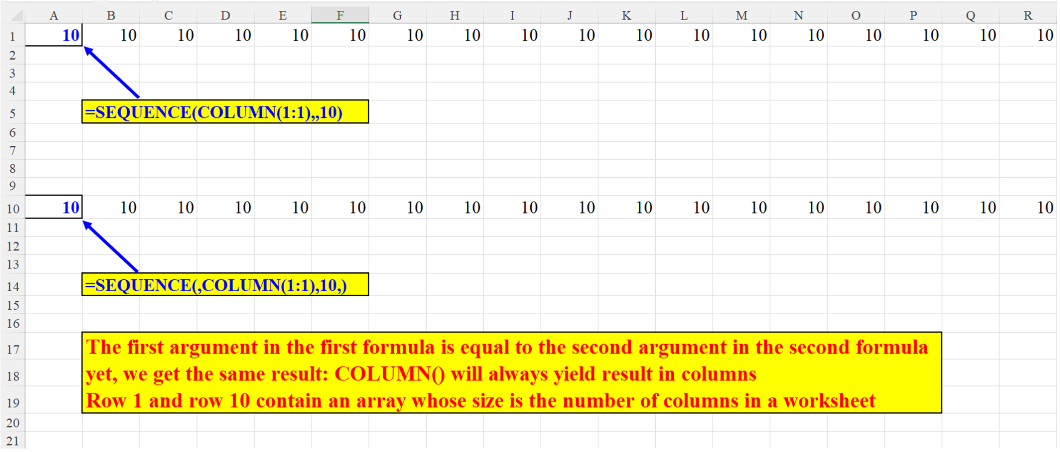


***Figure 3.46:** SEQUENCE column*

SEQUENCE and COLUMNS

The result of: **`COLUMNS(1:1)`** is the number of the worksheet's columns (=16384). When *wrapping* this number with the **`SEQUENCE`** function, we obtain a vertical array of 16384 rows as shown in the following screenshot:

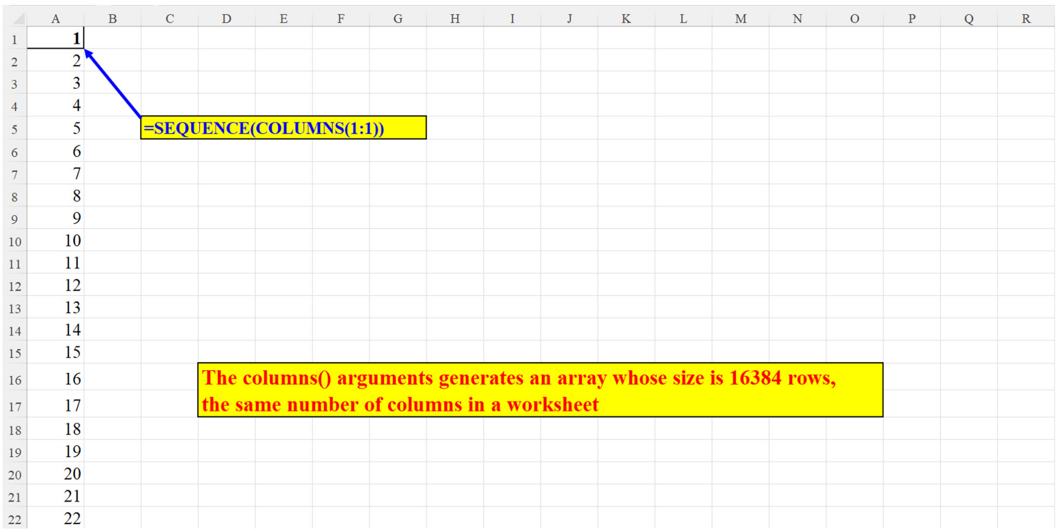


***Figure 3.47**: SEQUENCE and COLUMNS*

Building a chessboard in three steps

This section is going to explain (in three steps) how to build a chessboard in Excel.

Chessboard - Step 1

Step 1: The formula

`=IF(ISODD(COLUMN()),BITAND(SEQUENCE(8),1),--NOT(BITAND(SEQUENCE(8),1)))` creates a bi-dimensional array (8*8). It is written in Cell A1 and then dragged down to cell A8.

This formula generates alternate 1's and 0's so that next to each cell containing 1, there are only cells containing 0 (left, right, beneath and above). In odd Column numbers (A,C,E,G) the function **`BITAND(SEQUENCE(8),1)`** produces alternate 1's and 0's starting with 1: {1;0;1;0;1;0;1;0}. For each odd number in the array defined in the function's first argument: **`SEQUENCE(8)`**, the function generates 1 and for each even number in that array the function begets 0. That is how a **`SEQUENCE`** of 8 alternate 1's and 0's is created.

However, in even Column numbers (B,D,F,H) the function **`NOT(BITAND(SEQUENCE(8),1))`** produces the opposite array: {0;1;0;1;0;1;0;1}. Here the process is reversed with the **`NOT`** operator: for each 1 on an odd column number, a 0 is generated whereas for each 0 on such column number, a 1 is engendered.

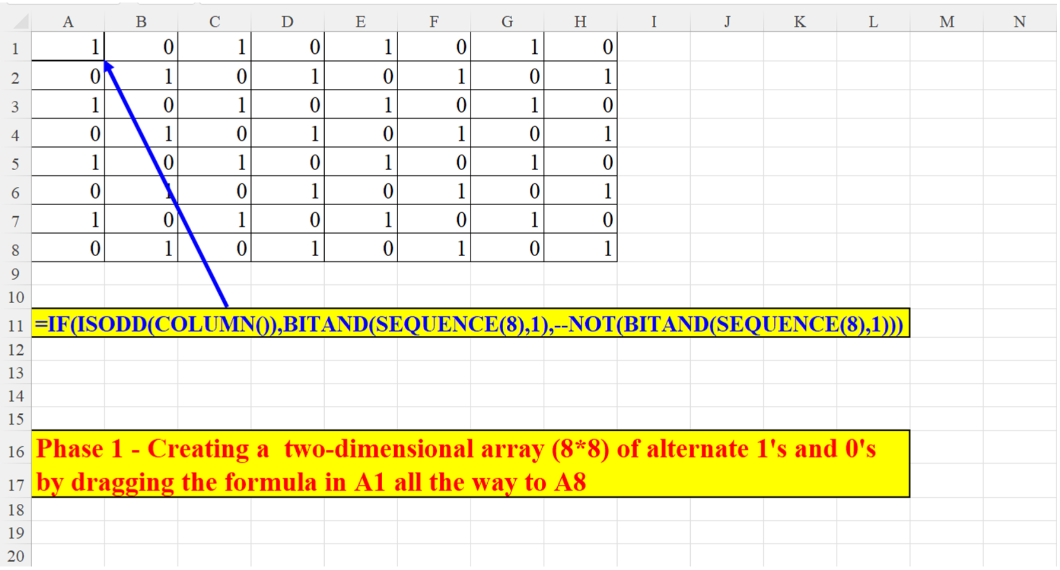


***Figure 3.48**: Chessboard - Step 1*

Chessboard - Step 2

Step 2: We resize the array originated in *Step 1* to create 64 square cells: the height of each cell is equal to its width as shown in the following screenshot:

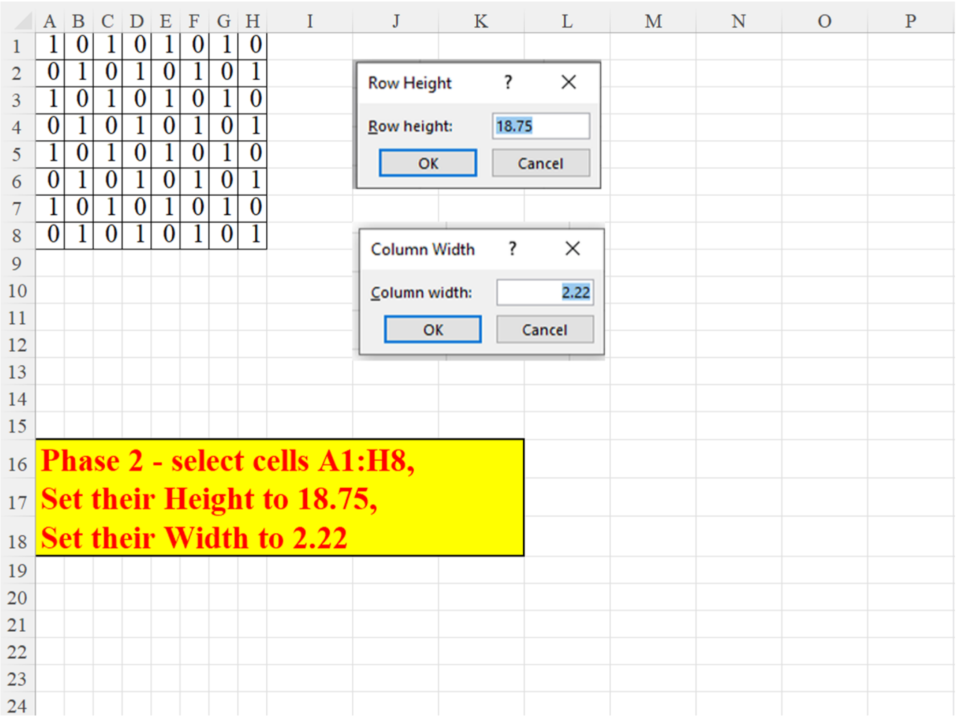


Figure 3.49: *Chessboard - step 2*

Chessboard - Step 3

Step 3: First, we employ the Conditional Formatting feature in order to *paint* black each cell containing 1. Then, to *clean* the contents of all the cells, we use the following trick with format cells: in custom number formatting we define the type: ;;; (three semicolons). This will hide the contents of all the chessboard's cells.

Now we have a chessboard in cells A1:H8 as shown in the following screenshot:

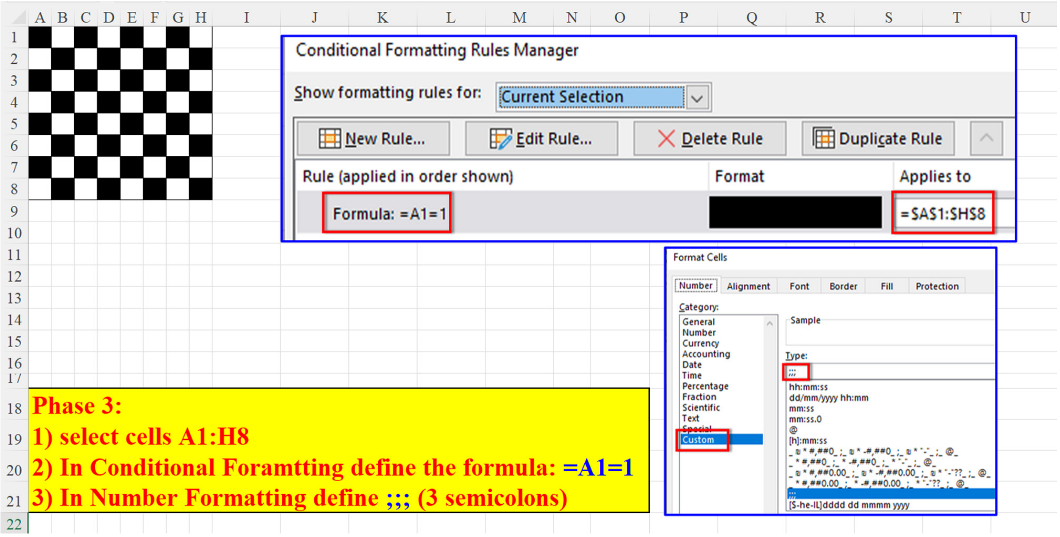


Figure 3.50: *Chessboard - step 3*

Creating N-digit number with the same digit repeated N times

The **SEQUENCE** function creates an array of 5 times the digit 5. The **CONCAT** function then combines all these 5 digits together and creates a 5-digit number as shown in the following screenshot:

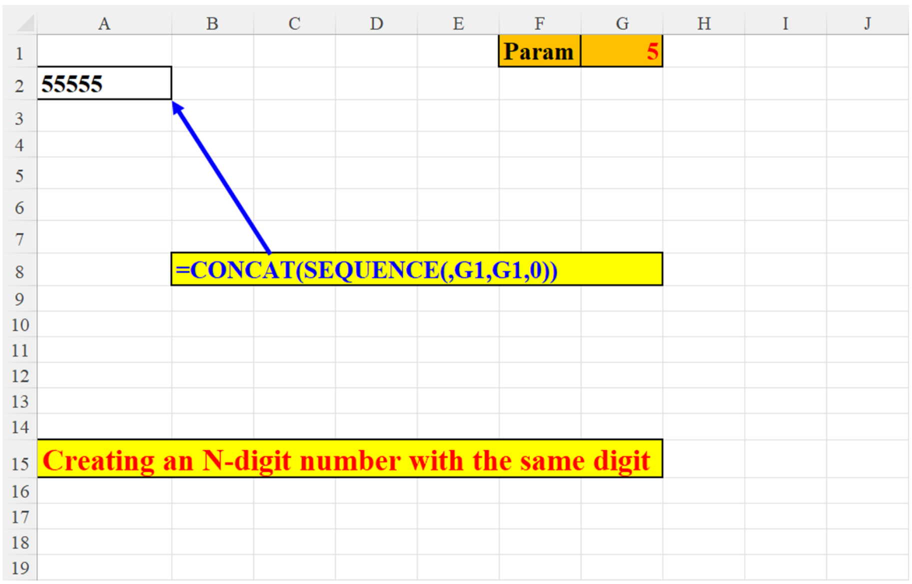


Figure 3.51: *Creating N-digit number with the same digit repeated N times*

Conclusion

This chapter exemplified and demonstrated many use-cases where the **`SEQUENCE`** is applied in numeric operations or in generating numbers. One very interesting feature that we encountered in this chapter is the fact that this function can generate results even with a *virtual* array.

The next chapter will discuss the employment of **`SEQUENCE`** with arrays.

Points to remember

- SEQUENCE is very useful in creating ascending or descending arrays of numbers, starting from any number with any increment (either positive or negative). If the increment is 0 (as, for example, in sub-section *Extract a number from the string's start – Method 2*) the same digit/number is generated in the array.
- SEQUENCE can easily be applied to extract numbers or digits from a string.
- SEQUENCE combined with SUMPRODUCT, helps summing certain *chunks* of data, such as part of a list of numbers (for example: *SUM every Nth row*, *SUM the largest N numbers*, *SUM the smallest N numbers*)
- SEQUENCE combined with SUMPRODUCT, can imitate the MATCH function (for example: section *SUM SEQUNECE (virtual array)*)
- SEQUENCE can generate an array of alternate 0's and 1's (for example: section *Alternate 1s and 0s*)

CHAPTER 4
SEQUENCE in Arrays

Introduction

As we already know, the SEQUENCE is one of the new Dynamic Array Functions of Excel 365. So, what would be more appropriate than demonstrating its seamless conjunction with arrays? An Excel array is a set of similar and related items arranged contiguously. Each item in the array can be accessed directly, by an index. That is why the SEQUENCE function is, so to speak, built-in to the very concept of arrays. Not only can it create an array, but it can also easily create a subset of an array which can hold one or more items.

In this chapter, we will display and explain the advantages of using the SEQUENCE function when arrays are the focus. The SEQUENCE function helps us generate arrays: unidimensional as well as bidimensional, dynamic arrays, flipped arrays (upside-down or "mirror"), etc.

Structure

In this chapter, we will discuss the following topics:

- Examples of SEQUENCE with arrays
    - Creating an array of identical numbers - Two methods
    - Creating an array of ascending numbers - Three methods

- From one cell to a vertical array
- How many active months
- Build a dynamic array - horizontal or vertical
- Flip columns horizontally
- Flip vertical array (with and without SEQUENCE)
- Flip part of vertical array using a parameter
- Create a two-dimensional array using 4 parameters
- Flexible LARGE
- MMULT with static ranges and with dynamic Arrays
- Four useful tricks with VLOOKUP
- From vertical to horizontal – Two Methods
- Four two-dimensional arrays generated by two parameters
- Select columns by parameters
- Transpose a vertical array without knowing its size beforehand
- Fetching multiple results for a search value
- Vertical to horizontal without TRANSPOSE

Objectives

Upon concluding this chapter, you should be able to implement the **`SEQUENCE`** function when operating on arrays of data, either numeric or non-numeric. **`SEQUENCE`** is a good companion to many other useful functions. Applying it to those functions will enhance your versatility in Excel.

Examples of SEQUENCE with arrays

As the chapter's name implies, we are going to exhibit the **`SEQUENCE`** function when employing array operations.

We will manifest some of the advantages of using **`SEQUENCE`** with arrays. For example, creating an array of identical numbers, creating an array of descending numbers, flipping/creating vertical arrays from horizontal arrays and vice versa, several methods for fetching specific data items from a **`VLOOKUP`** table, selecting specific columns from a data set, fetching multiple results for a search value and more.

Creating an array of identical numbers - Two methods

We demonstrate here two methods to create an array of identical numbers. It is worth noting that using a parameter is always a preferred procedure. If you want to change the array's size, you will not have to *tamper with* the formula itself. Another point to be stressed is that in the second formula, we can omit the third argument (starting number), but we should explicitly indicate the fourth argument (step/increment) as 0, otherwise, the formula will use the default value (1) and the array created will not consist of identical members as shown in the following screenshot:

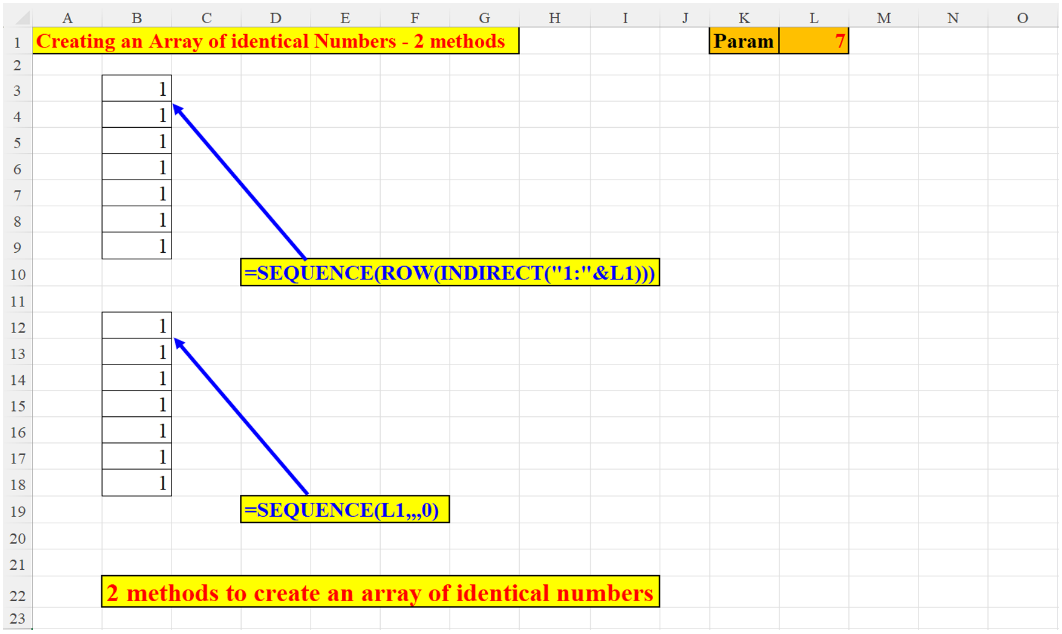


Figure 4.1: *Creating an Array of identical Numbers - Two Methods*

Creating an array of ascending numbers – three methods

As we all know, there is (almost) always more than one way to solve a problem in Excel. *Figure 4.2* exhibits three solutions for creating an array of ascending values:

- First, we have the older method before the Dynamic Array Functions. Here, we use the **`ROW`** function combined with **`INDIRECT`**. Although **`INDIRECT`** is a *volatile* function (which means that it recalculates every time a change is made to the workbook), the impact of a very small number of *volatile* functions is negligible.

- Secondly, we have a mixture of the **`ROWS`** function with the **`INDIRECT`**, wrapped with our function. The **`ROWS`** function returns the number of elements in the array (ROWS(1:7), which is 7. This number (7) is the argument to the **`SEQUENCE`** function which then generates a one-dimensional array of seven natural numbers, from 1 to 7.
- However, the shortest, most obvious solution is on the bottom left: **`SEQUENCE`** with only one argument, the parameter in L1 as shown in the following screenshot:

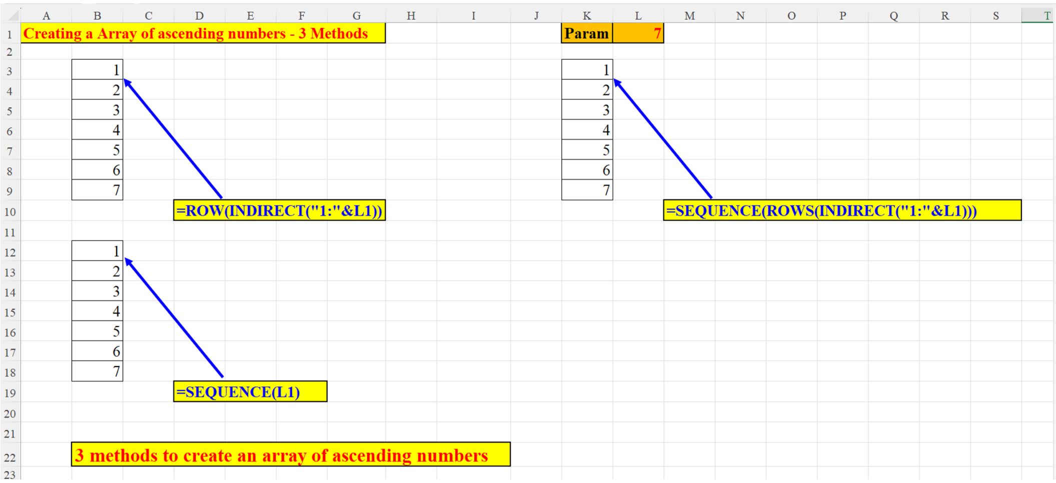


***Figure 4.2**: Creating an array of ascending numbers - 3 methods*

From one cell to a vertical array

Here is an example of how to split a string into its components. We use a text function (**`MID`**) that separates the name to the characters composing it. The **`SEQUENCE`** function creates a vertical array of the components of the name in A1. The length of the array is, of course, identical to the original string's length as shown in the following screenshot:

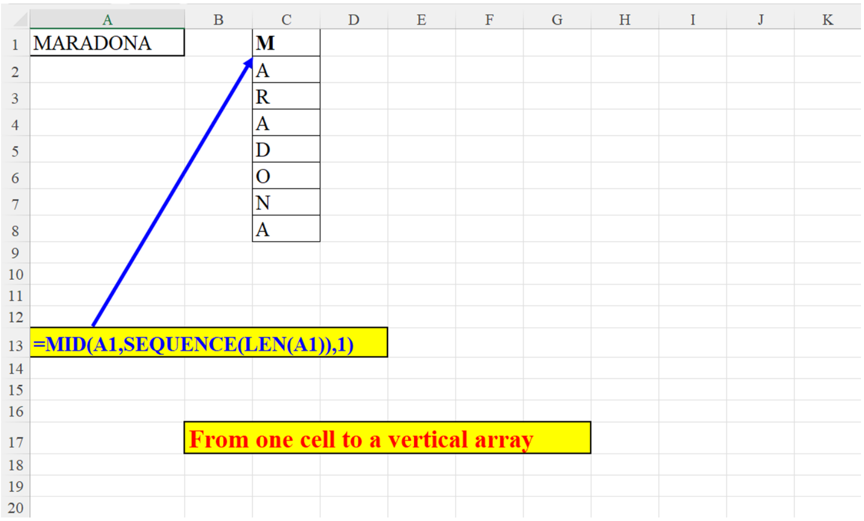


***Figure 4.3**: From one cell to a vertical array*

How many active months

The challenge is this: We have a string of 12 pairs of numbers, each pair representing a month: the first – January, the second – February etc. If the pair's numeric value is greater than 0, it means that in the corresponding month some transactions were made, and we must count this month as a profitable month. The formula:

```
=SUM(IF(MID(A1,SEQUENCE(,12,1,2),2)*1>0,1,0))
```

sums all these pairs to find out how many lucrative months we had in that year:

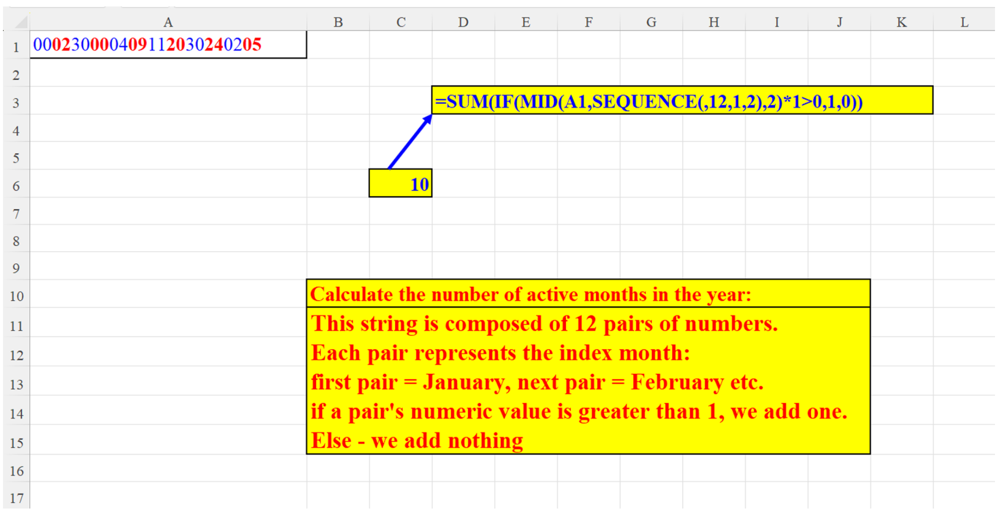


***Figure 4.4**: How many active months*

Build a dynamic array - horizontal or vertical

The formula in the following figure implements four elements:

- Whether we want a horizontal or vertical array. If cell B1 is "R", then we want a vertical array (by Row), otherwise – we want a horizontal array.
- Cell D1 stores the array's size: how many rows (if it is a vertical array) or columns (if it is a horizontal array).
- Cell F1 sets the starting value.
- Cell H1 determines the step/increment. It is 1 by default, so we can omit it if we want an increment of 1 between the array's members:

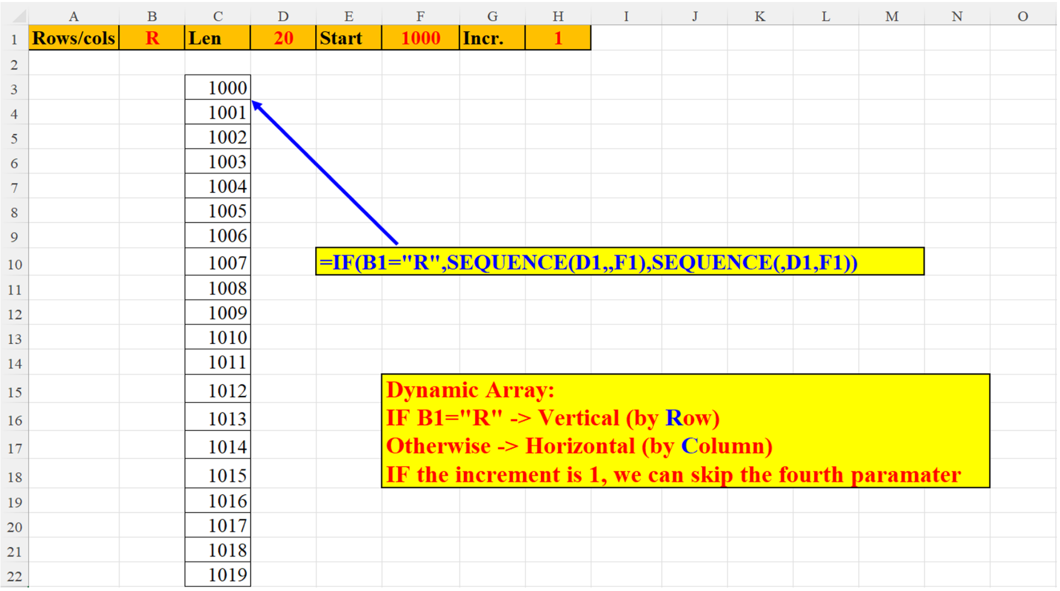


***Figure 4.5**: Build a dynamic array - Horizontal or Vertical*

Flip columns horizontally

This section will display two methods to flip columns horizontally: the first one uses a dynamic range (a parameter) whereas the second one uses *hard coded* references. Both examples use advanced DAF, as explained in *Chapter 1, Introduction to Dynamic Array Functions in Excel 365*.

Method 1

The parameter (in K1) specifies the range to be flipped where we are using **`INDIRECT`**. This function *translates* the text in K1 into a valid reference in Excel. As explained above, it is not recommended to use many instances of the **`INDIRECT`** function in the worksheet (see the section: *Creating an array of ascending numbers - three methods*) , but here we use it only once to establish the size of the array to flip. The **SORTBY** function sorts the columns to flip (determined by the **SEQUENCE**) in descending order (its last argument is: -1) and the result: a *mirrored* array is shown in the following screenshot:

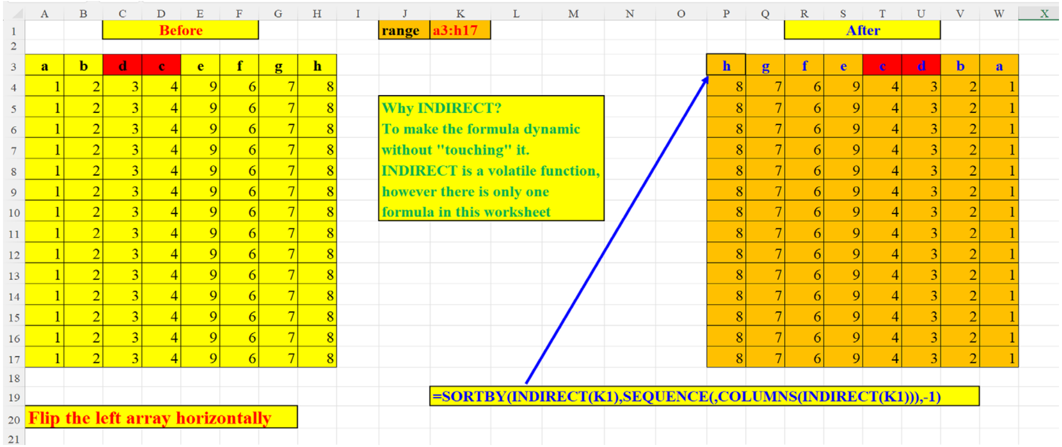


Figure 4.6: *Flip Columns horizontally – Method 1*

Method 2

Using the new DAF function **CHOOSECOLS** with our **SEQUENCE**, yields the desired *mirror* array. The **COLUMNS** function (appearing twice within the **SEQUENCE** function) returns both the number of columns to flip (3) and the column to start with. As in the previous example, the last argument to the **CHOOSECOLS** is negative to indicate the reverse order of columns in the resulting array. This is shown in the following screenshot:

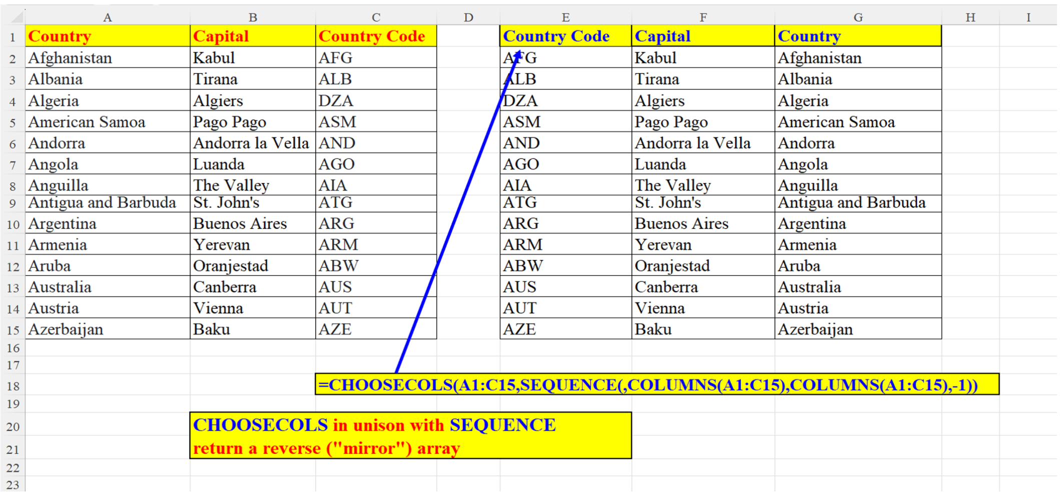


Figure 4.7: *Flip columns horizontally – Method 2*

Flip vertical array (with and without SEQUENCE)

The following figure shows two methods of flipping a vertical array *upside down*. On the right-hand side, we have a solution that uses the **`OFFSET`** function in tandem with the **`COUNTA`** function. This, of course, is not a dynamic solution. We need to drag the formula all the way down to row 13, the last row of the array. The solution suggested on the left-hand side is, of course, a dynamic solution that turns the array topsy-turvy in one go:

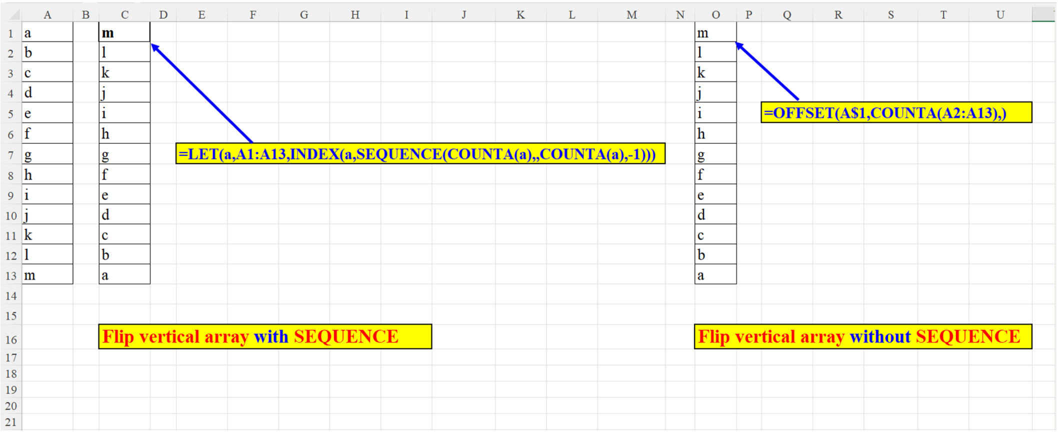


Figure 4.8: *Flip vertical array (with and without SEQUENCE)*

Flip part of vertical array using a parameter

The parameter (in I1) enables us to choose only part of the array to be flipped without *hard-coding* the range within the formula. This example is similar to the previous one, however the preceding figure (*Figure 4.8*) suggests flipping the whole array. The current example flips only a part of the array. This is done with the **`INDIRECT`** function. By using the **`LET`** function (which enables us to define variables of the formula) we can significantly shorten the original formula as shown in the following screenshot:

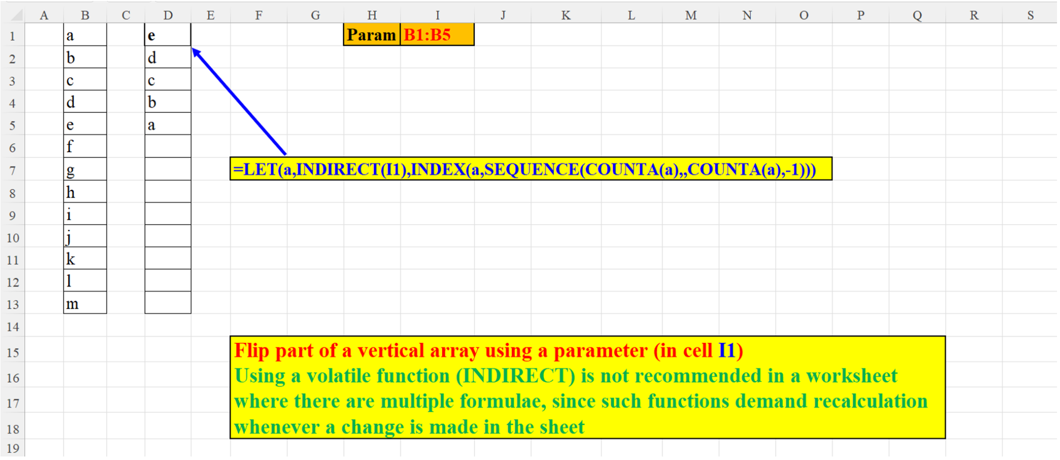


***Figure 4.9**: Flip part of vertical array using a Parameter*

Create a two-dimensional array using four parameters

The following screenshot demonstrates creating a two-dimensional array. The number of rows is set dynamically: we divide the total number of items in the array (parameter in cell I1) by the desired number of columns (parameter in cell R1). The starting number is defined in cell L1, and the solution is flexible enough to allow us an array with increments greater than 1 or even smaller than 1 (a descending array). The increment is defined in cell O1:

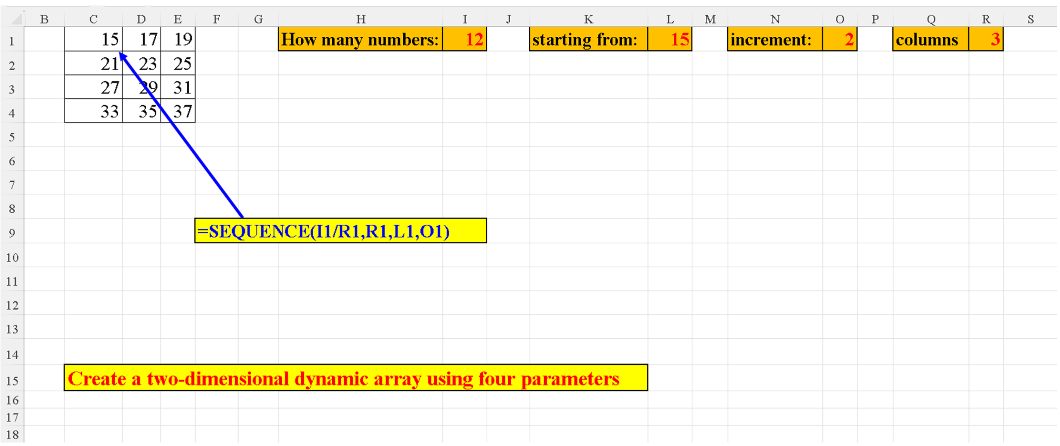


***Figure 4.10**: Create a two-dimensional array using four parameters*

Flexible LARGE

The parameter in H1 defines the number of agents to display. This number is in fact the second argument of the **LARGE** function. It lets us create a dynamic header of the report (in cell D2) as shown in the following screenshot:

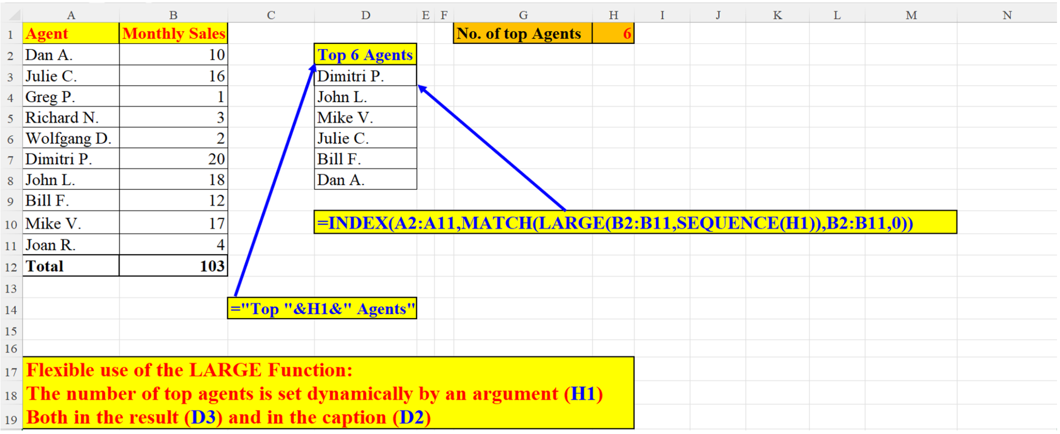


***Figure 4.11**: Flexible LARGE*

MMULT with static ranges and with dynamic Arrays

The **MMULT** function returns the result of multiplication of two arrays. On the left-hand side formula, we use multiplication of ranges whereas on the right-hand side formula we multiply arrays. In the right-hand side formula, we need to specify explicitly all four arguments of the second **SEQUENCE** function: we need to know not only the size of the rectangular array (3 rows by three columns) but also its starting number (9) and its step/increment (-1) as shown in the following screenshot:

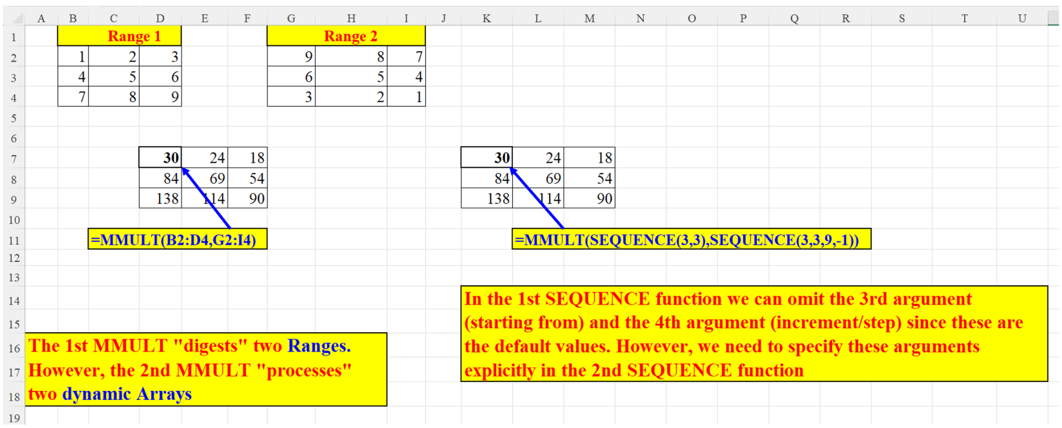


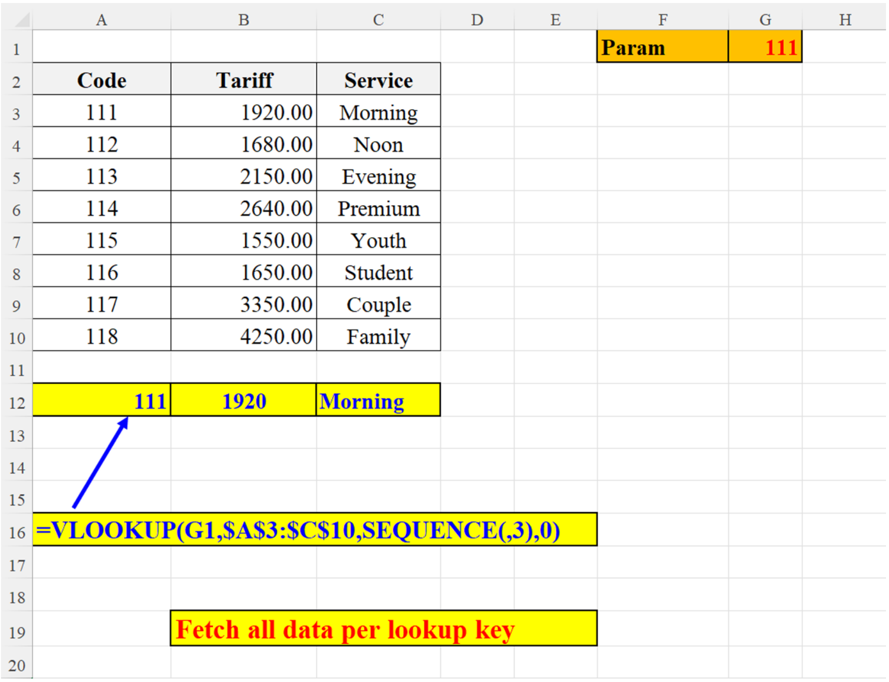
***Figure 4.12**: MMULT with static ranges and with dynamic arrays*

Four useful tricks with VLOOKUP

When used with **`VLOOKUP`**, **`SEQUENCE`** can return multiple results in various forms. In the next four examples we present four such cases: fetching all columns for the search key, fetching all columns in reverse order, fetching data from the last two (out of the three) columns and finally, fetching data from the first and last (third) columns.

VLOOKUP - Fetch all columns of an item searched

The following figure demonstrates how to fetch all columns of a searched item. The second argument to the **`SEQUENCE`** function specifies the number of columns to be returned by the **`VLOOKUP`** function for the item specified in cell G1:

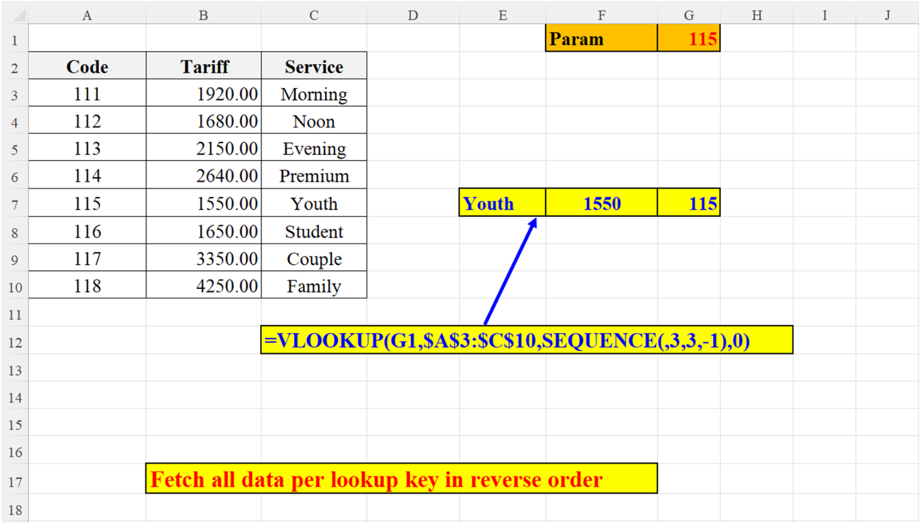


Code	Tariff	Service
111	1920.00	Morning
112	1680.00	Noon
113	2150.00	Evening
114	2640.00	Premium
115	1550.00	Youth
116	1650.00	Student
117	3350.00	Couple
118	4250.00	Family
111	1920	Morning

***Figure 4.13**: VLOOKUP - Fetch all columns of item searched*

VLOOKUP - Fetch all data per lookup key in reverse order

In the following example, **`SEQUENCE`** *tells* **`VLOOKUP`** to return backwards the data found for the search key (parameter in cell G1): fetch three columns (second argument) starting from the third column (third argument) in reverse order (fourth argument):

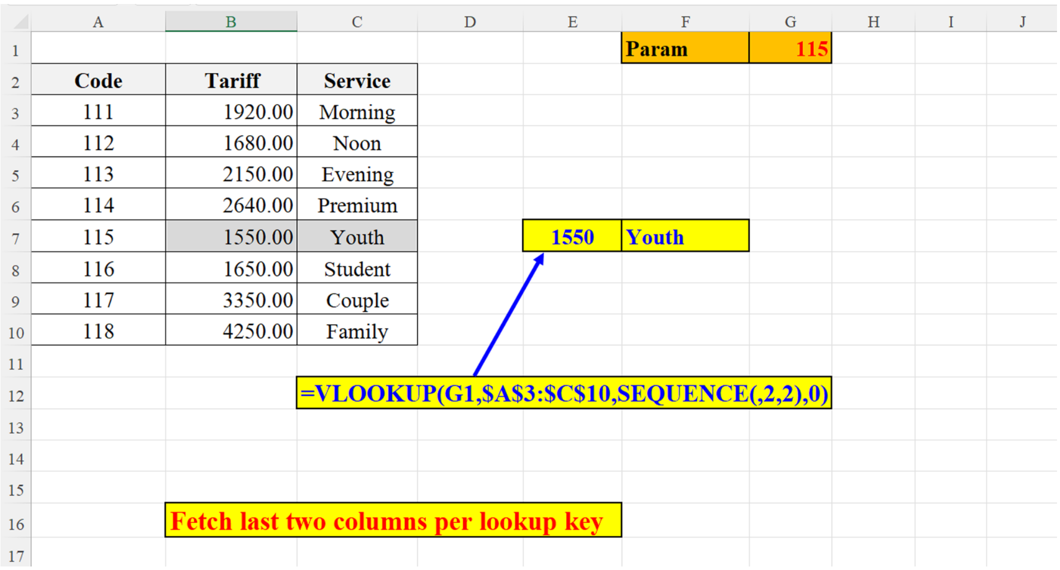


Code	Tariff	Service
111	1920.00	Morning
112	1680.00	Noon
113	2150.00	Evening
114	2640.00	Premium
115	1550.00	Youth
116	1650.00	Student
117	3350.00	Couple
118	4250.00	Family

Figure 4.14: *VLOLKUP - Fetch all data per lookup key in reverse order*

VLOOKUP - Fetch last two columns for a search key

The following screenshot illustrates how to fetch the last two columns for the key defined in cell G1: start from the second column (SEQUENCE's argument number 2) and get two columns (argument number 3):



Code	Tariff	Service
111	1920.00	Morning
112	1680.00	Noon
113	2150.00	Evening
114	2640.00	Premium
115	1550.00	Youth
116	1650.00	Student
117	3350.00	Couple
118	4250.00	Family

Figure 4.15: *VLOOKUP - Fetch last two columns for a search key*

VLOOKUP - Fetch the first and third data items per lookup key

The following screenshot depicts a case where we fetch only the first and third columns of the data items for the key in cell G1. **VLOOKUP**'s second argument (table array defined in the **SEQUENCE** function) returns two columns, starting with the first table's array column and skipping the second column (**SEQUENCE**'s last argument is: 2, which means: *Step 2* columns):

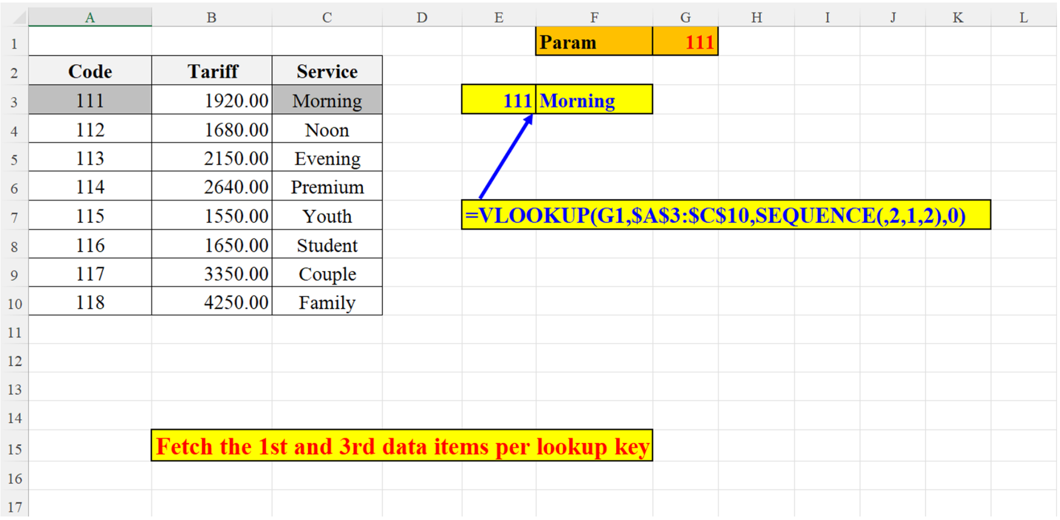


***Figure 4.16**: VLOOKUP - Fetch the first and third data items per lookup key*

From vertical to horizontal – Two Methods

The challenge here is to convert data in one column (where there are gaps between the contiguous *chunks* of data) into a two-column array (in the first example) or three-column array (in the second example).

Method 1

The first method first filters all the data (non-empty) cells, while the **SEQUENCE** function sets an array of three rows and two columns, to host the data filtered: 6 data rows divided into two columns, as shown in the following screenshot. The

LET function allows you to assign a name to a variable. In our example, the r is a substitute (shorthand) to the expression B2:B9 (in our case, the range: B2:B9):

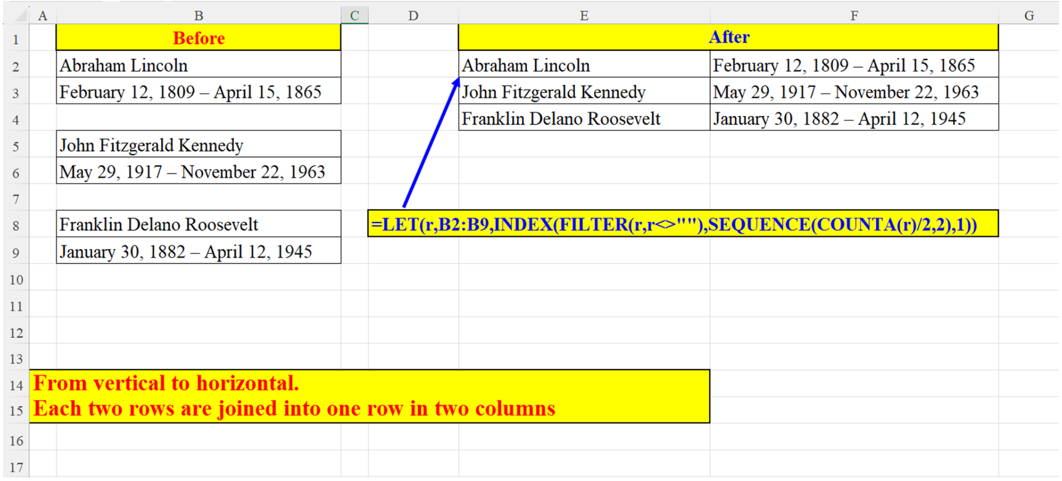


Figure 4.17: From vertical to horizontal - Method 1

Method 2

The second method splits the data in column A (rows 2-17) into a two-dimensional 4*4 array. This array is then *cleaned* of its 4th rows (which are empty) and the resulting array consists of 4 names in three columns. Again, we use here (as in our previous sub-section) the **LET** function to define a "shorthand" for a lengthy expression: **INDEX(A:A,SEQUENCE(16/4,4,2))**.

The **SEQUENCE** function defines a bi-dimensional array: 4 rows (there are 16 rows in the range (2:17) for each person, and we want to *transpose* each such 4 rows into 4 columns. Since the **INDEX** function returns 0 for an empty cell (each fourth row becomes the fourth column), we then remove these zeroes with the **IF** function. The result (on the right-hand side of the picture) displays three data items per person in each row:

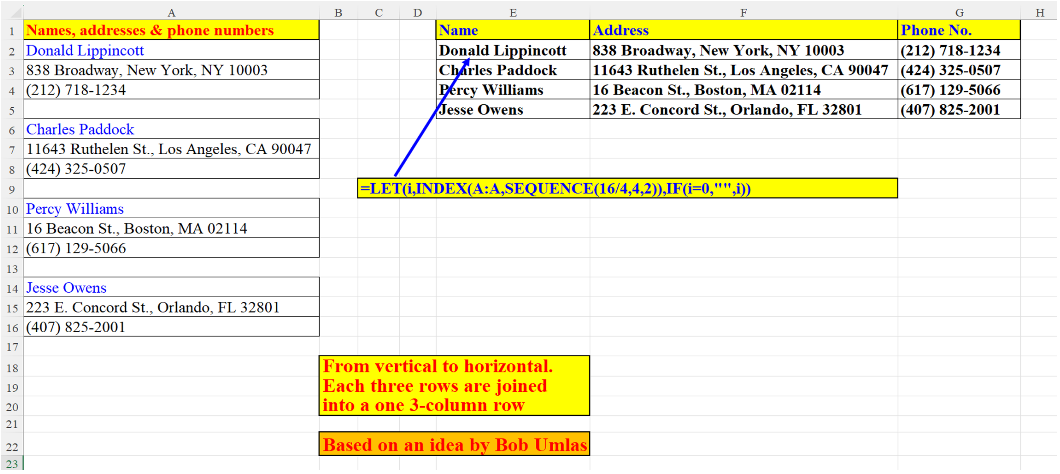


Figure 4.18: *From vertical to horizontal - Method 2*

Four two-dimensional arrays generated by two parameters

The two parameters in L1 and L2, enable us to generate four different kinds of arrays.

The two arrays on the left-hand side consist of a 2-row by 6-column array and a 6-row by 2-column array. The two arrays on the right-hand side are in fact the swapping of each dimension of their respective array on the left: the array in P2:Q8 manifests the shift from 2 rows by 6 columns into 6 rows by two columns, and the array in P11:U12 shows the shift from 6 rows by two columns into 6 columns by two rows.

You need to pay heed to the special notation of a spilled array in the formula in P2 and P11: the # sign following the cells address (B2), denotes a spilled array which starts at B2 as shown in the following screenshot:

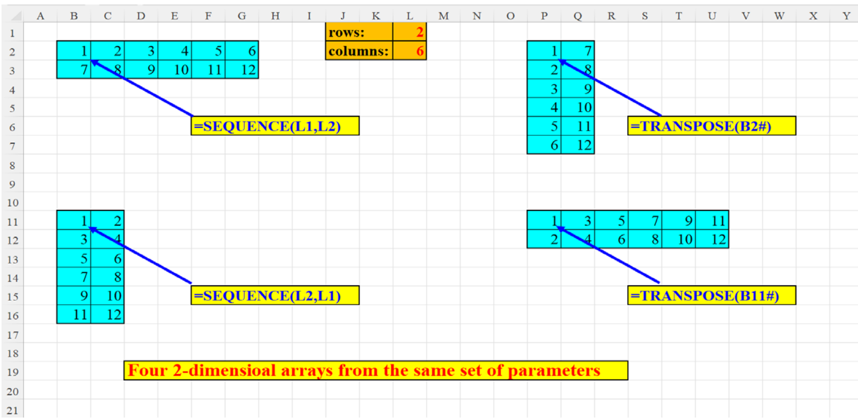
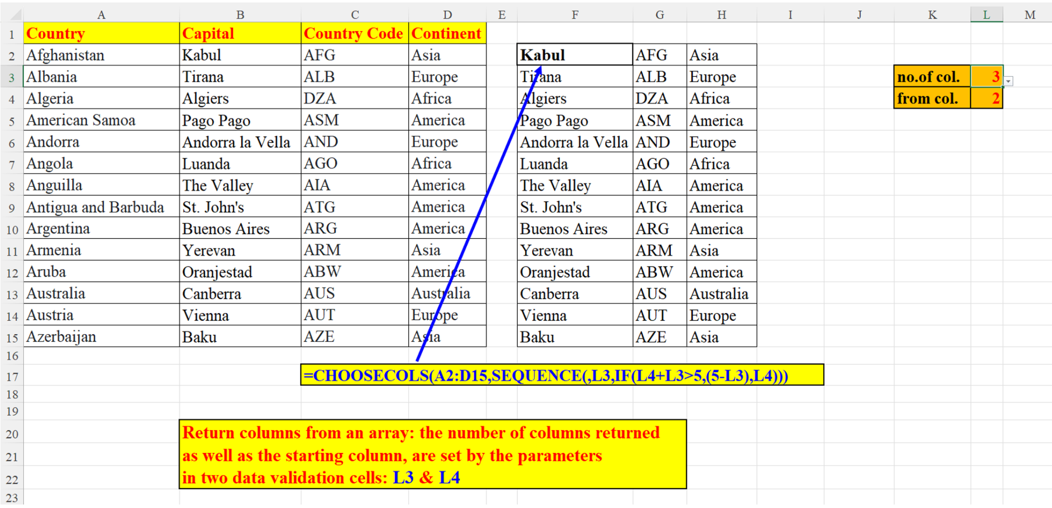


Figure 4.19: *Four two-dimensional arrays generated by two parameters*

Select columns by parameters

The **CHOOSECOLS** function (mentioned and explained in *Chapter 1, Introduction to Dynamic Array Functions in Excel 365*) enables us to choose certain columns from an array. In this case, we want to select the last two columns (third and fourth) of the original array. The parameters in L3 and L4 (which are data validation lists whose values are 1-4) determine respectively the numbers of columns to display and the starting column number. The **IF** function within the **SEQUENCE** verifies that no error is produced when selecting incompatible values from the parameters as shown in the following screenshot:



	A	B	C	D	E	F	G	H	K	L
1	Country	Capital	Country Code	Continent						
2	Afghanistan	Kabul	AFG	Asia		Kabul	AFG	Asia		
3	Albania	Tirana	ALB	Europe		Tirana	ALB	Europe	no.of col.	3
4	Algeria	Algiers	DZA	Africa		Algiers	DZA	Africa	from col.	2
5	American Samoa	Pago Pago	ASM	America		Pago Pago	ASM	America		
6	Andorra	Andorra la Vella	AND	Europe		Andorra la Vella	AND	Europe		
7	Angola	Luanda	AGO	Africa		Luanda	AGO	Africa		
8	Anguilla	The Valley	AIA	America		The Valley	AIA	America		
9	Antigua and Barbuda	St. John's	ATG	America		St. John's	ATG	America		
10	Argentina	Buenos Aires	ARG	America		Buenos Aires	ARG	America		
11	Armenia	Yerevan	ARM	Asia		Yerevan	ARM	Asia		
12	Aruba	Oranjestad	ABW	America		Oranjestad	ABW	America		
13	Australia	Canberra	AUS	Australia		Canberra	AUS	Australia		
14	Austria	Vienna	AUT	Europe		Vienna	AUT	Europe		
15	Azerbaijan	Baku	AZE	Asia		Baku	AZE	Asia		

=CHOOSECOLS(A2:D15,SEQUENCE(,L3,IF(L4+L3>5,(5-L3),L4)))

Return columns from an array: the number of columns returned as well as the starting column, are set by the parameters in two data validation cells: L3 & L4

***Figure 4.20**: Select columns by parameters*

Transpose a vertical array without knowing its size beforehand

If we do not know in advance the size of the source array, but know where it starts, then the **COUNTA** function (the second argument: number of columns which should be equal to the number of rows in the original array) will help up set up the size of the output array as shown in the following screenshot:

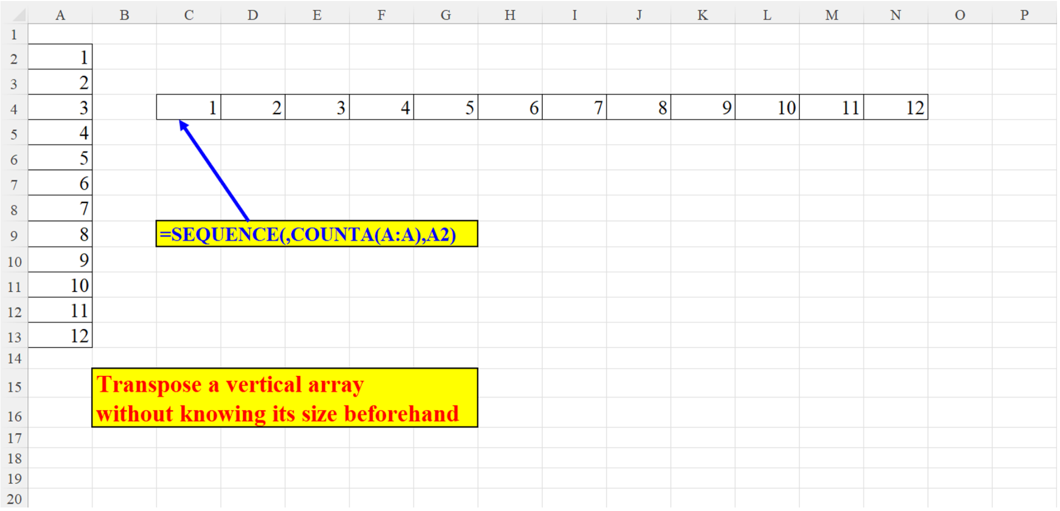


***Figure 4.21**: Transpose a vertical array without knowing its size beforehand*

Fetching multiple results for a search value

How do we fetch multiple results for a certain agent who has multiple records in the input array?

First, we create a unique list of agents (in cells J2:J7). Then, we can select the agent from the drop-down list of the data validation of cell F2. The **`INDEX`** conjoined with the **`SEQUENCE`** delivers some empty non-valid values which are eliminated from the list with the assistance of the **`TOCOL`** function as shown in the following screenshot:

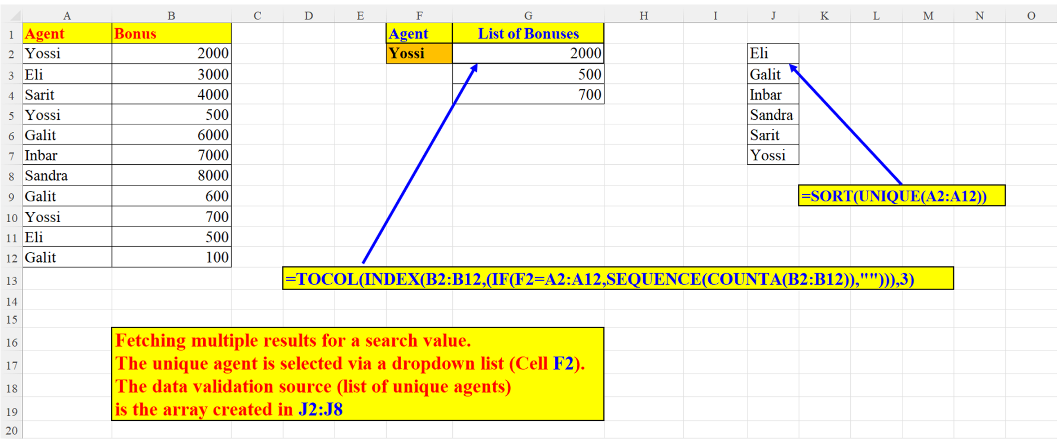


***Figure** 4.22: Fetching multiple results for a search value*

Vertical to horizontal without TRANSPOSE

The vertical array of months (A2:A13) is converted into a horizontal array. The **`SEQUENCE`** function yields a 12-item horizontal array which is *populated* by the **`INDEX`** function as shown in the following screenshot:

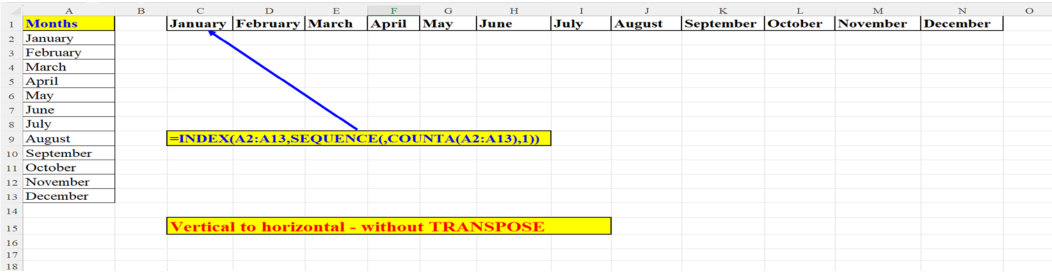


Figure ***4.23:*** *Vertical to horizontal without TRANSPOSE*

Conclusion

In this chapter we referred to cases where the **`SEQUENCE`** can be easily used when dealing with arrays. Since **`SEQUENCE`** is a Dynamic Array Function (see explanation in *Chapter 1*, *Introduction to Dynamic Array Functions in Excel 365*) it is clear that this chapter perfectly illustrates its role as an array formula.

The next chapter will explain in detail the **`SEQUENCE`** function in the context of dates and times.

Points to remember

- SEQUENCE adapts itself flawlessly to working with arrays.
- SEQUENCE can build arrays on the fly, either horizontally or vertically.
- SEQUENCE easily generates one- or bi-dimensional arrays.
- SEQUENCE can return multiple results in various forms if you use it with VLOOKUP.

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https://discord.bpbonline.com

CHAPTER 5
SEQUENCE in Date and Time Operations

Introduction

Excel is indispensable when dealing with time operations. It helps us calculate periods of time (seconds, minutes, hours, days, weeks, months and years). We use time in calendars, for scheduling, measuring duration of an activity, calculations involving timespan and of course in myriad of other cases and scenarios. This chapter will focus on all these features. It is my opinion that when it comes to dealing with dates and times in Excel, there is no function as advantageous as **`SEQUENCE`**. Multiple examples in this chapter will exemplify **`SEQUENCE`**'s versatility and its ease of use in this context. We will demonstrate (among other things) not only how to calculate durations of time, set schedules, and so on, but also how to build dynamic and flexible monthly and yearly calendars.

Structure

In this chapter, we will discuss the following topics:

- Examples of **`SEQUENCE`** with date and time
    - 12 months with each month's first day
    - The year's months with the last day of each month - three methods
    - N consecutive dates starting from today (two methods)

- Display month names without a specific date
- 2 Methods to display the weekday names
- Adding minutes to time
- Adding seconds to time
- `SEQUENCE` of days in a given month
- A `SEQUENCE` of dates (between start and end dates)
- Extract only time – four traditional methods
- Extract only time – a new method
- Presence in class by month
- How many Mondays are there in a given month
- How many Saturdays between two dates
- Display only dates of Wednesdays in 2020
- How many Wednesdays are there in 2020
- `SEQUENCE` of the month's last date for each month (two methods)
- A horizontal `SEQUENCE` of descending dates: first of each month
- A substitute for NETWORKDAYS.INTL (for a certain month)
- A substitute to the NETWORKDAYS.INTL (any period)
- A substitute to NETWORKDAYS.INTL - with/without weekends
- How many working days are there in each month of a given period
- How many eligibilities days
- The doctor's schedule (2 versions)
- The doctor's schedule (version 1)
- The doctor's schedule (version 2)
- Monthly calendar – classic vs. non-classic
- Monthly calendar in 20 languages
- Two methods for creating a list of the month's days
- Yearly calendar – good vs. bad
- Dynamic yearly calendar – in one formula
- Dynamic yearly calendar – Conditional Formatting
- Dynamic yearly calendar - by month
- Dynamic yearly calendar - by week
- Yearly horizontal calendar with highlighted weekday (two examples)

- Yearly horizontal calendar
- Yearly vertical calendar with highlighted weekday (two examples)
- Conditional Formatting – each weekday is formatted differently

Objectives

If you read this chapter thoroughly and exercise the examples given in it, you will be able to implement the **`SEQUENCE`** function in a huge range of related situations and problems.

Examples of SEQUENCE with date and time

The **`SEQUENCE`** function can be of great assistance when applied to date and time. We are going to exhibit its abilities in this territory, from the tiniest (second) to the immense (year).

12 months with each month's first day

This simple formula displays the dates of the first of each month for the year 2021. Of course, the Year argument is superfluous, but did you know that if you omit it, you will get the list of months for the year 1900? (which in Excel is Year 0). This is illustrated in the following screenshot:

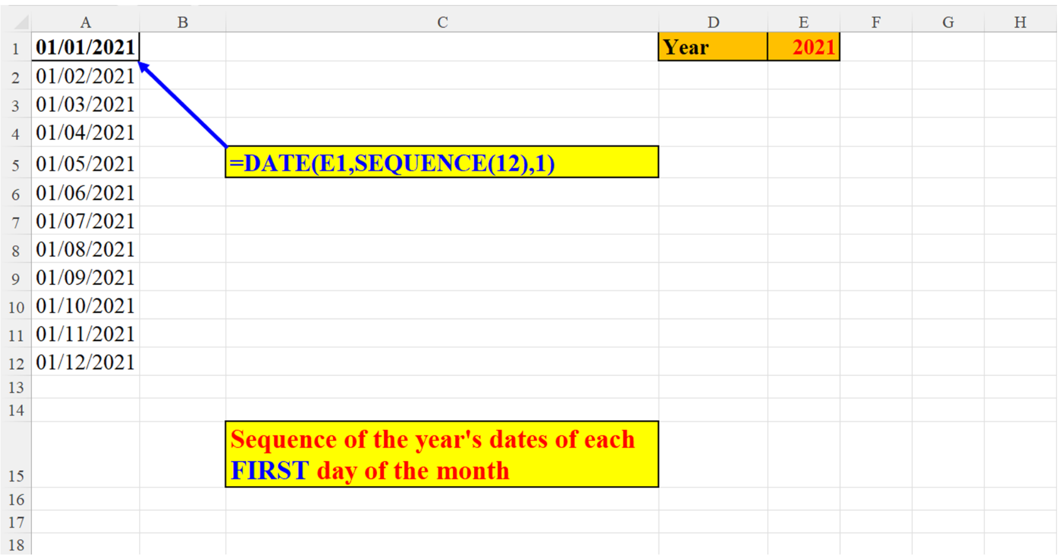


***Figure 5.1**: Sequence of the year's 12 months: each with the month's first day*

The year's months with the last day of each month - three methods

There are three methods mentioned in this section that will show you how to create an array of the year's months, with each month's last day. In this section, we will learn how tio display the last date of each month of the year.

Method 1

The first method uses a trick by which you do not need to specify the last argument of the **DATE** function (that is, the DAY): If the month's number is current+1 (for example, 2 for January 3 for February, and so on) then the formula automatically generates the last day of the month. You can omit the DAY argument as shown in the following screenshot:

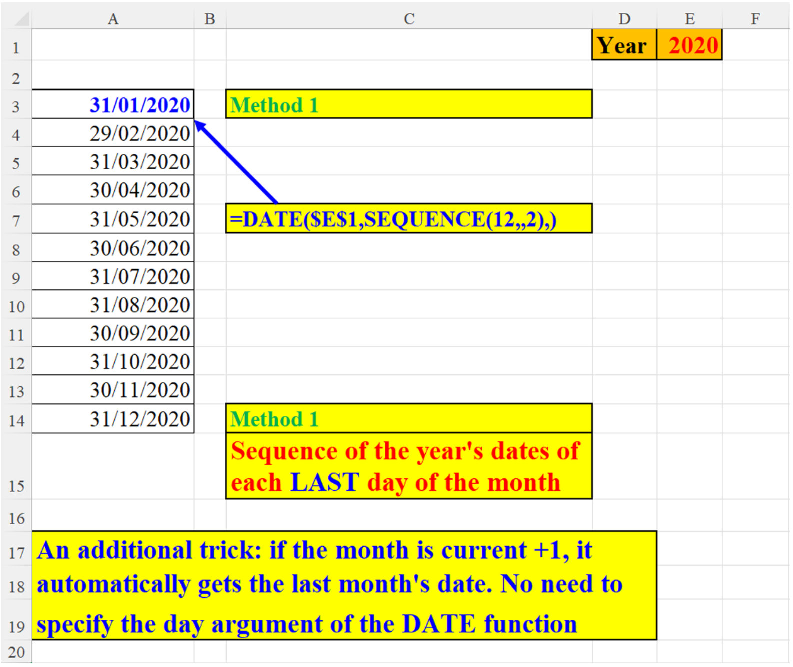


Figure 5.2: *Display the last date of each month of the year – method 1*

Method 2

The second method uses the following trick: the **SEQUENCE(12,0)** generates the array: 0,1,2….11. So, the dates array created by the **DATE** function is the following: 01/12/2019, 01/01/2020, ….01/11/2020. Now, adding 1 month (last argument of the **EOMONTH** function) creates the desired array as shown in the following screenshot:

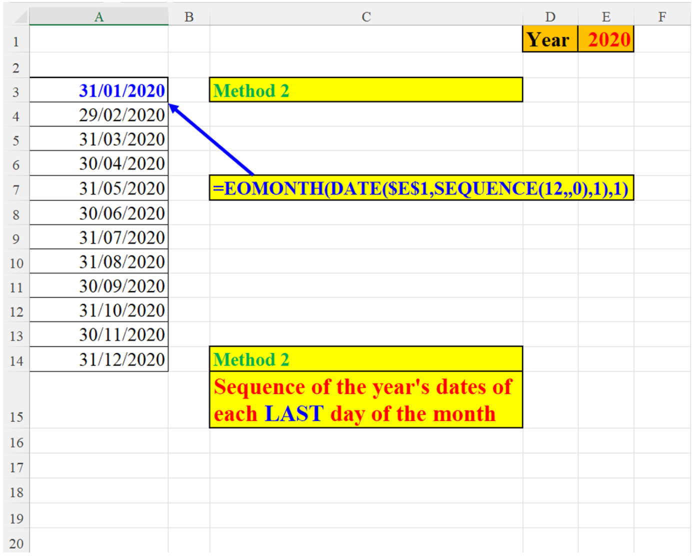


Figure 5.3: Display the last date of each month of the year – method 2

Method 3

This method is a little simpler than the previous one, yet it uses the same functions to generate the sought-after result. Here, the **`DATE`** function yields the first dates of each month in 2020. The second argument of the **`EOMONTH (0)`**, *converts* the date into the month's last date as shown in the following screenshot:

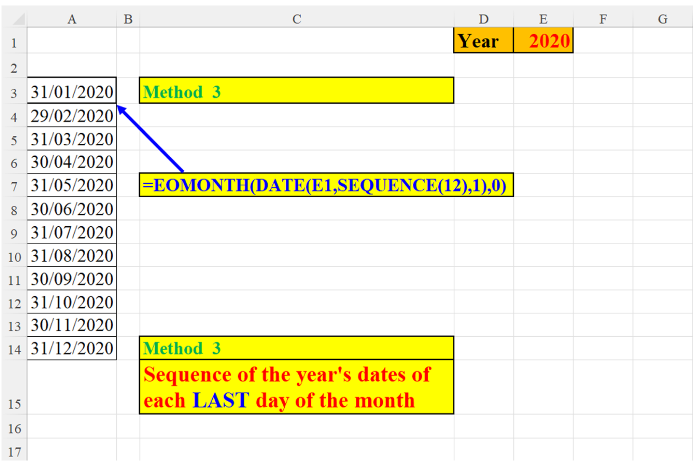


Figure 5.4: Display the last date of each month of the year – method 3

N consecutive dates starting from today (two methods)

Method 1

`SEQUENCE`'s first parameter is the number of days (taken from the parameter in cell **G1**). **`SEQUENCE`**'s last parameter (value to start with) is today.

One can, of course, start with any date. In such a case, we would add the starting date as an additional parameter as shown in the following screenshot:

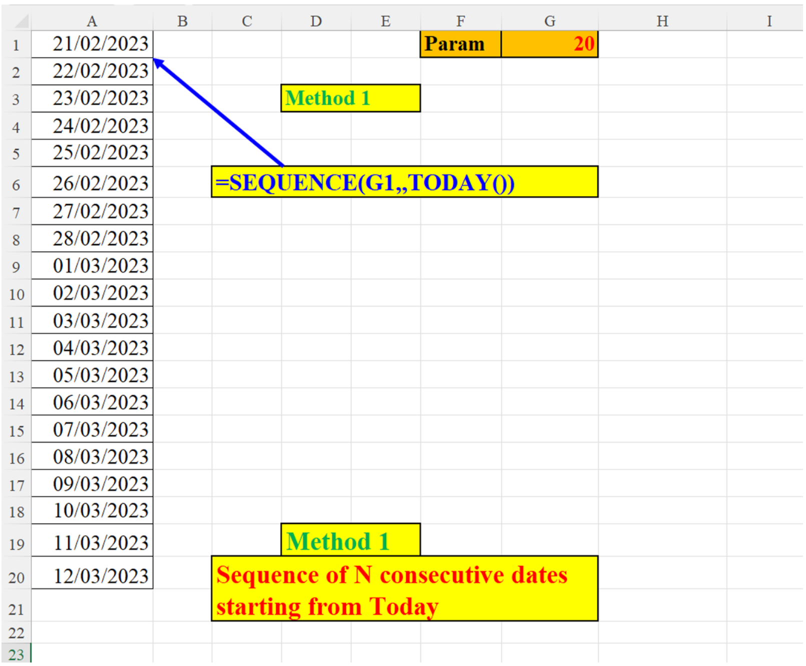


***Figure 5.5**: N consecutive dates starting from today – method 1*

Method 2

In this example, the starting date (Today) is not an argument to the **SEQUENCE** function. It is the *starting point* from which we add the **SEQUENCE** of days, according to the parameter in G1 as shown in the following screenshot:

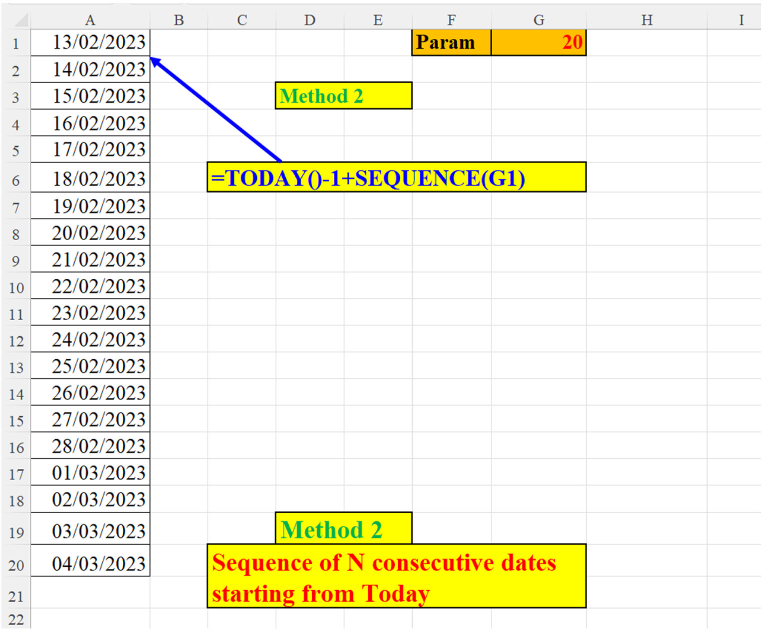


***Figure 5.6**: N consecutive dates starting from today – method 2*

Display month names without a specific date

The formula in *Figure 5.7* does not need a date to display the months names, nor does it need any other function. The **DATE** function uses the same trick as in *Figure 5.2*: if the month is current+1, it automatically generates the month's last date (so we do not need the **DAY** argument of the **DATE** function). Moreover, we can omit **DATE**'s first argument (**YEAR**) and excel interprets the missing argument as 0: year 0 in Excel in 1900, so we have created a *legal* date that Excel can *understand*. The **DATE** function then generates a sequence of numbers which are the cumulative days for each month from the beginning of the year. If you wonder why **b1** is the prefix of the **TEXT**'s second argument: Since my Windows default language is not English, if I omitted the **b1** and specified only **mmmm**, Excel would display the result in my native language. To have the month names in

English this is the shortest method. Of course, if your Windows' default language is English, then the **`b1`** prefix is redundant as shown in the following screenshot:

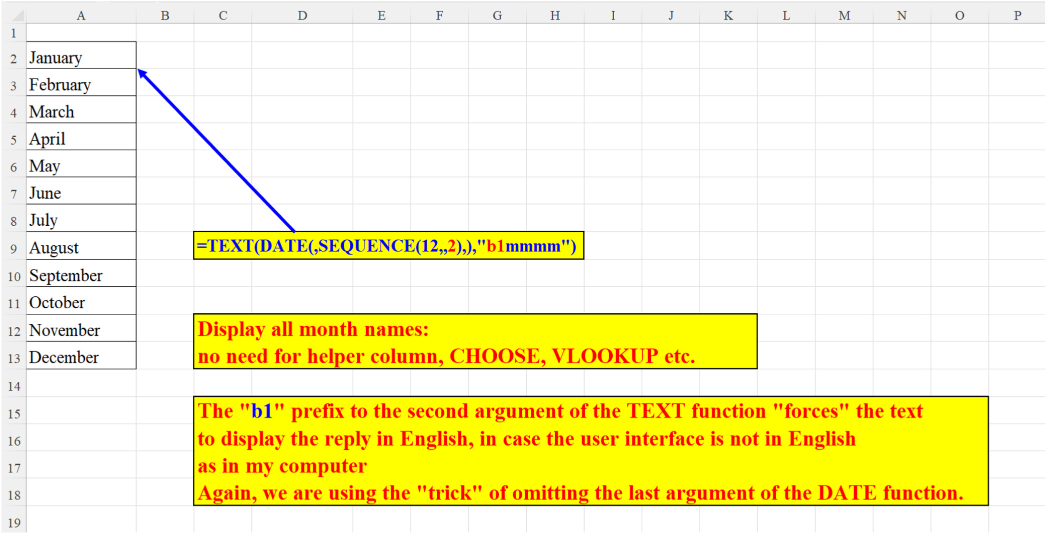


Figure 5.7: *Display month names without a specified date*

Two methods to display the weekday names

The **`TEXT`** function transforms an array of seven numbers into weekday names. Please refer to the previous section, *Display month names without a specific date* for an explanation of the **`b1`** prefix of **`TEXT`**'s second argument as shown in the following screenshot:

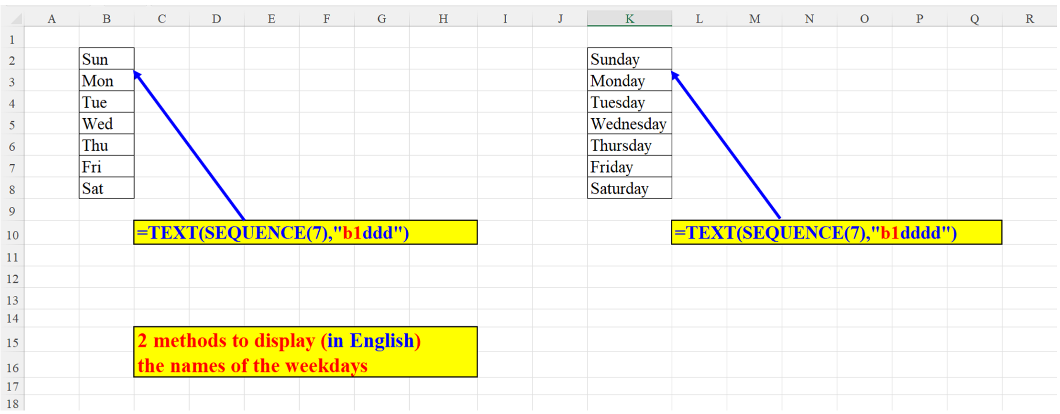


Figure 5.8: *Two methods to display the weekday names*

Adding minutes to time

The formula builds a dynamic array of time gaps within an hour. The time gap is given as a parameter in cell H1. The parameter for the starting hour is defined in cell E1. The size of the array is determined by the gap size. For example, if it is 4, then there are: 60/4 = 15 gaps as shown in the following screenshot:

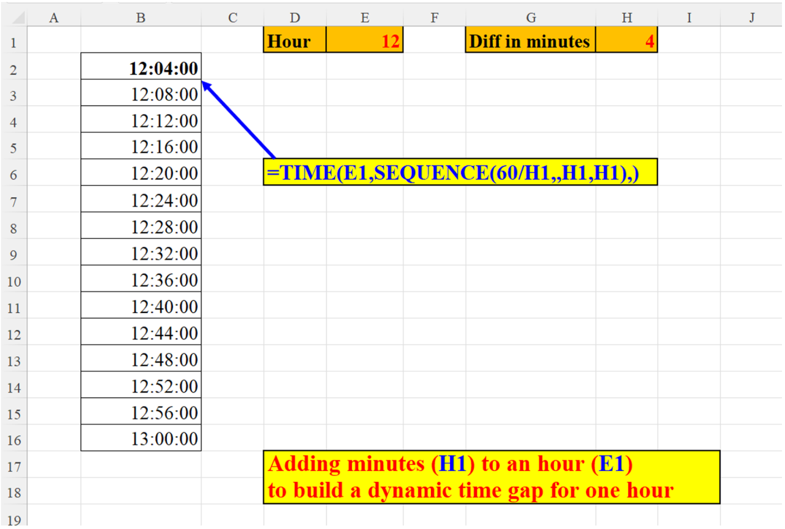


***Figure 5.9**: Adding minutes to time*

Adding seconds to time

In the following example we will create a time gap in seconds. The gap size is given as a parameter in cell H1. The parameter for the starting hour is defined in cell E1, and the size of the array is set in cell K1 as shown in the following screenshot:

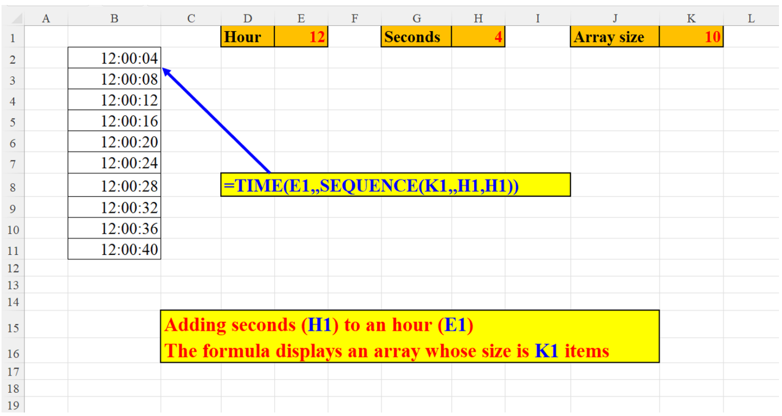


***Figure 5.10**: Adding seconds to time*

Sequence of days in a given month

In this section, we will learn how to create the array of days in a given month (cell I2) and year (cell I1). Here, we will again use the *trick* of omitting the **DAY** argument from the **DATE** function (see preceding section: *Display month names without a specific date*) as shown in the following screenshot:

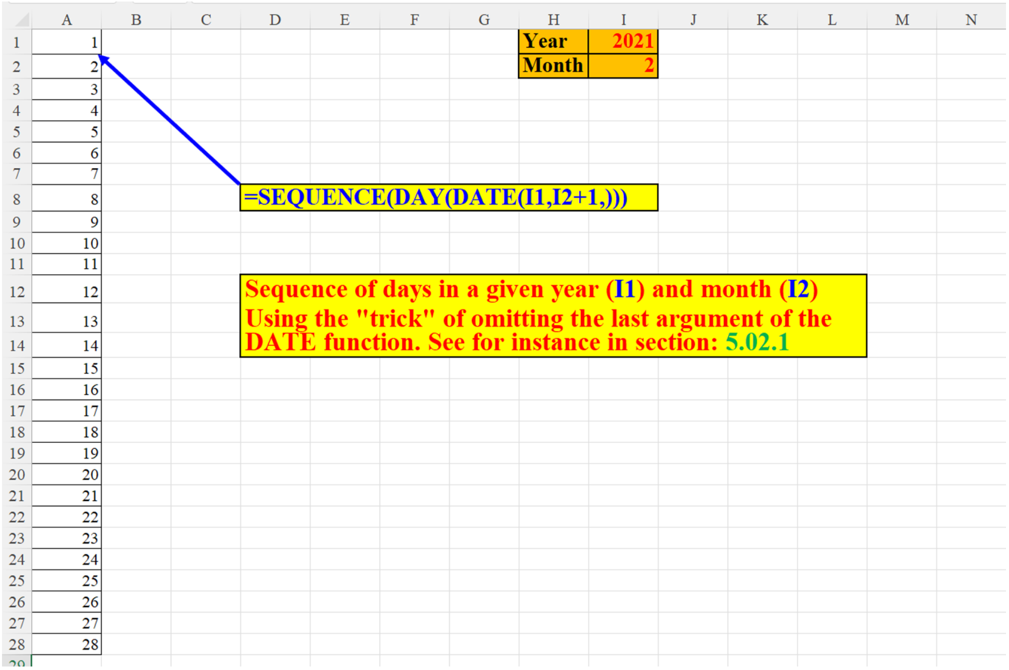


***Figure 5.11**: SEQUENCE of days in a given month*

A SEQUENCE of dates (between start and end dates)

In this section we will generate an array of dates where only the start date (cell C1) and the end date (cell C2) are known. The sequence is not limited to the scope of only one month. It can span over more than one month as shown in the following screenshot:

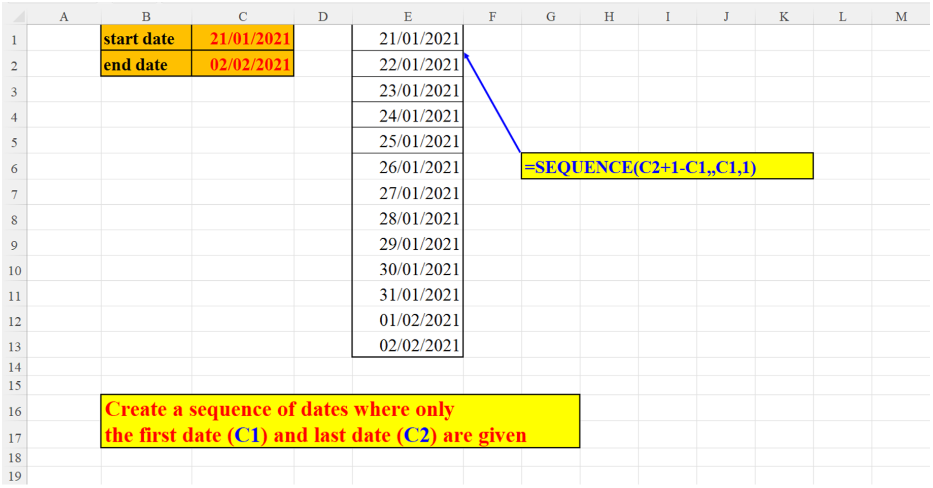


Figure 5.12: *A Sequence of dates (between start and end date)*

Extract only time –four traditional methods

Here are four traditional procedures to extract only the time from cells holding both dates and times:

- The first one (in cell C2) is using Excel's **`TIME`** function.
- The second one (cell C7) extracts the time (which is a fraction) by using the **`MOD`** function.
- The third method subtracts the **`INT`** (integer), which is the date portion of cell A12.
- And the fourth one uses the **`TRUNC`** function (which removes the fractional part of the number in C17, so that after the subtraction we are left with the fraction

All four methods are shown in the following screenshot:

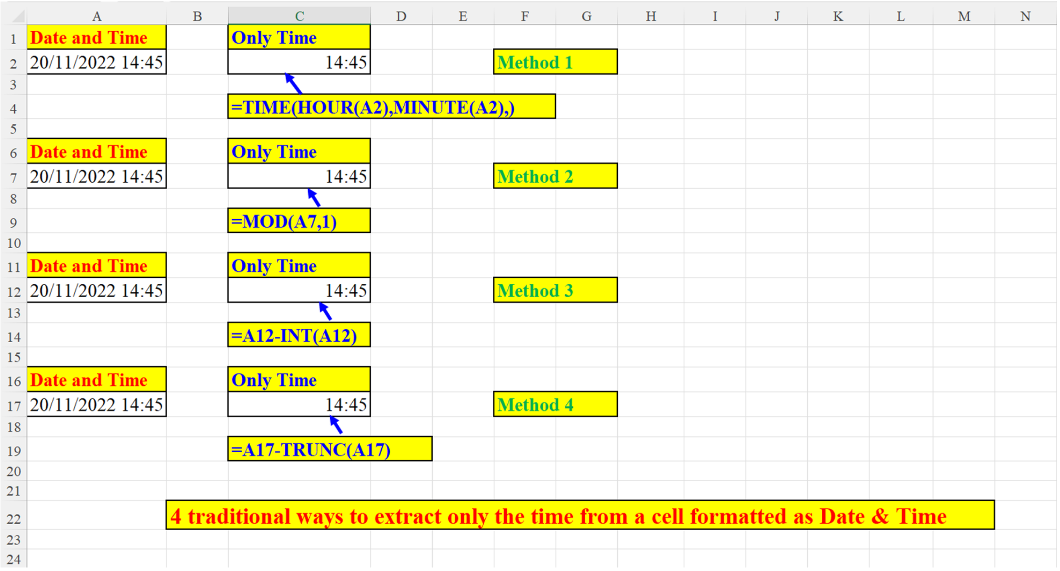


Figure 5.13: *Extract only time – four traditional methods*

Extract only time – a new method

In addition to the four known techniques to draw out the time part of a Date and Time cell, here is another method using **`SEQUENCE`**. First, it locates the **`"."`** (the separator denoting the decimal place). Then, it retrieves the decimal part and converts it from a string to a number. Since the cell holding the result is formatted as "**`hh:mm`**" the result appears as an hour as shown in the following screenshot:

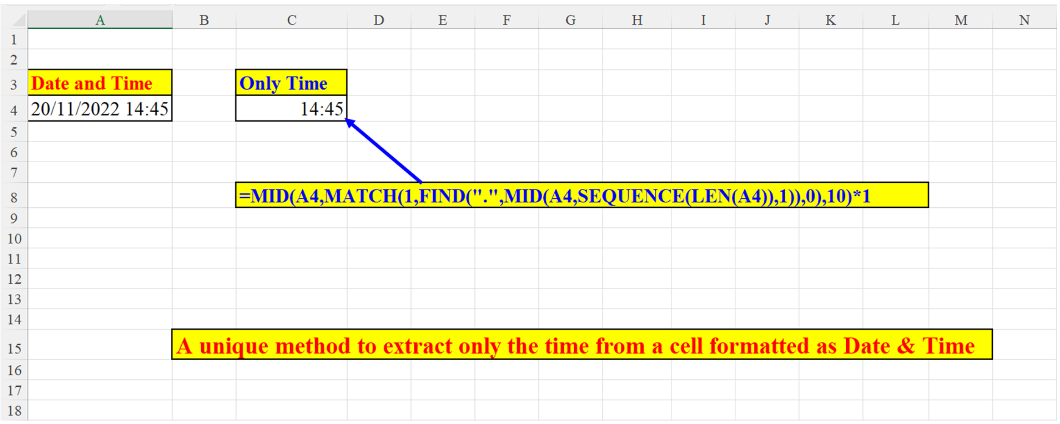
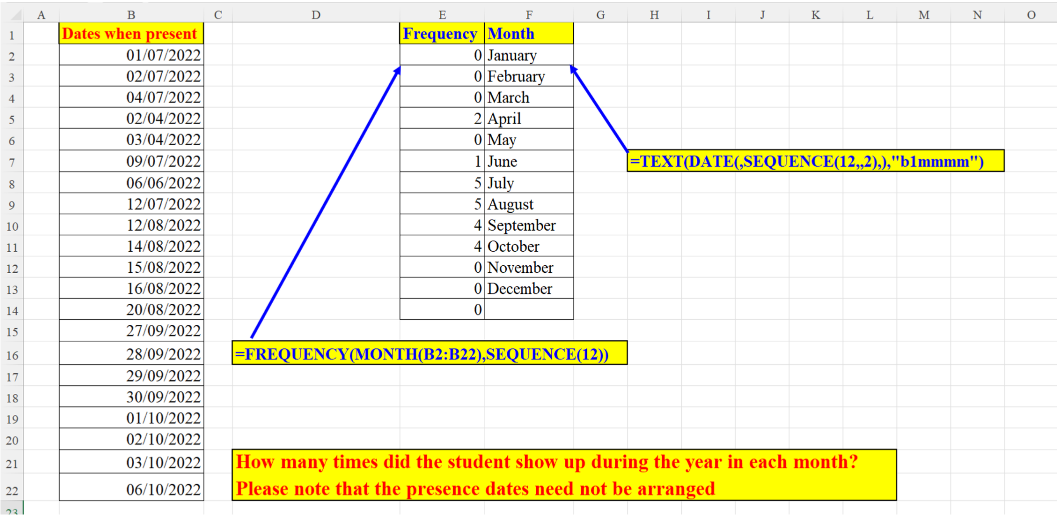


Figure 5.14: *Extract only time – a new method*

Presence in class by month

The following figure exemplifies the use of the **`FREQUENCY`** function concomitantly with our **`SEQUENCE`**. It shows the number of times the student showed up during the Academic year, month by month. Please note that the list of dates need not be sorted, as it is done automatically by the **`FREQUENCY`** function as shown in the following screenshot:



	B	E	F
1	Dates when present	Frequency	Month
2	01/07/2022	0	January
3	02/07/2022	0	February
4	04/07/2022	0	March
5	02/04/2022	2	April
6	03/04/2022	0	May
7	09/07/2022	1	June
8	06/06/2022	5	July
9	12/07/2022	5	August
10	12/08/2022	4	September
11	14/08/2022	4	October
12	15/08/2022	0	November
13	16/08/2022	0	December
14	20/08/2022	0	
15	27/09/2022		
16	28/09/2022		
17	29/09/2022		
18	30/09/2022		
19	01/10/2022		
20	02/10/2022		
21	03/10/2022		
22	06/10/2022		

Figure 5.15: Presence in class by month

How many Mondays are there in a given month

In this section, we will learn to calculate the number of Mondays in a given month.

The formula receives two arguments:

- The desired month
- The wanted weekday

How many Mondays (parameter in cell B2) were there in January 2022 (cell A2). You are free to choose any month or weekday, according to your needs as shown in the following screenshot:

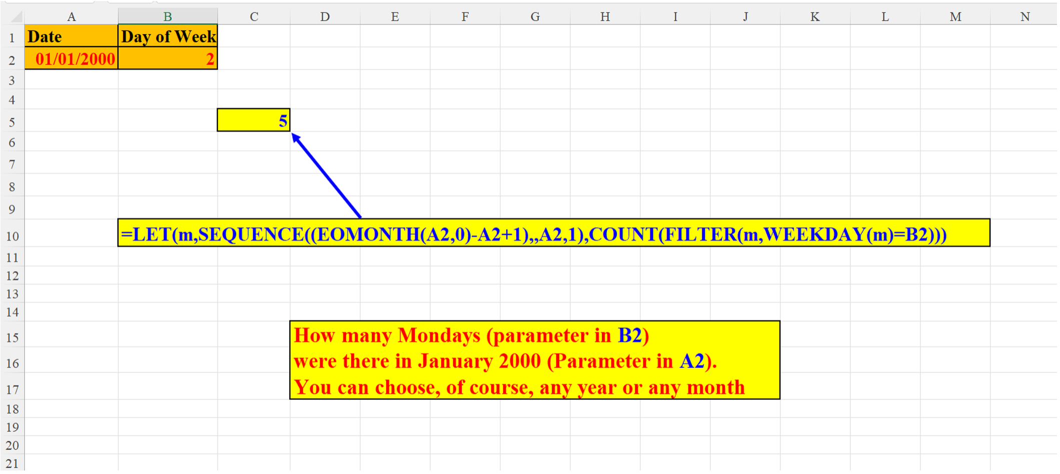


***Figure 5.16**: How many Mondays are there in a given month*

How many Saturdays between two dates?

In this section we will read about two methods that will help us find how many Saturdays there are between two days:

Method 1

This example illustrates Saturday (weekday is a parameter defined in cell G2). The parameters for the start date and the end date are in cells E2 and F2, respectively. These, of course, can be modified for any other period or any other weekday. Besides, the **`SUM`** function used in this example can be perfectly replaced by the **`SUMPRODUCT`** function:

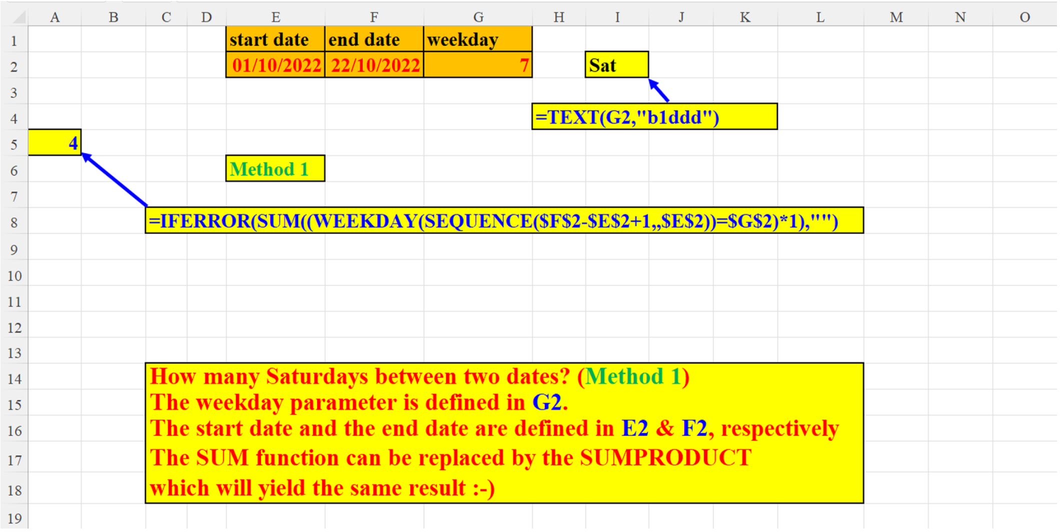


Figure 5.17: How many Saturdays in a given period – method 1

Method 2

Another procedure to achieve the same goal: find how many Saturdays there are in a certain period of dates.

The method exhibited here is quite similar to the one described in the preceding section: *How many Mondays are there in a given month* as shown in the following screenshot:

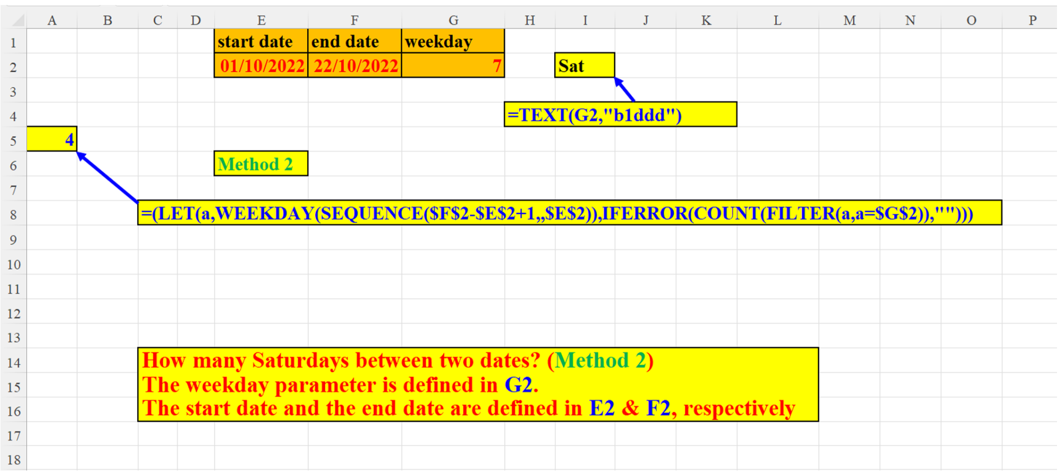


Figure 5.18: How many Saturdays in a given period – method 2

Display only dates of Wednesdays in 2020

In this example we want to find out all the dates of Wednesdays in the year 2020. The first part of the formula determines whether the parameter year (in cell G2) is a leap year. The second parameter filters out all the Wednesdays (parameter in cell H2) as shown in the following screenshot:

(Calendar image by: **www.blank-calendar.com**):

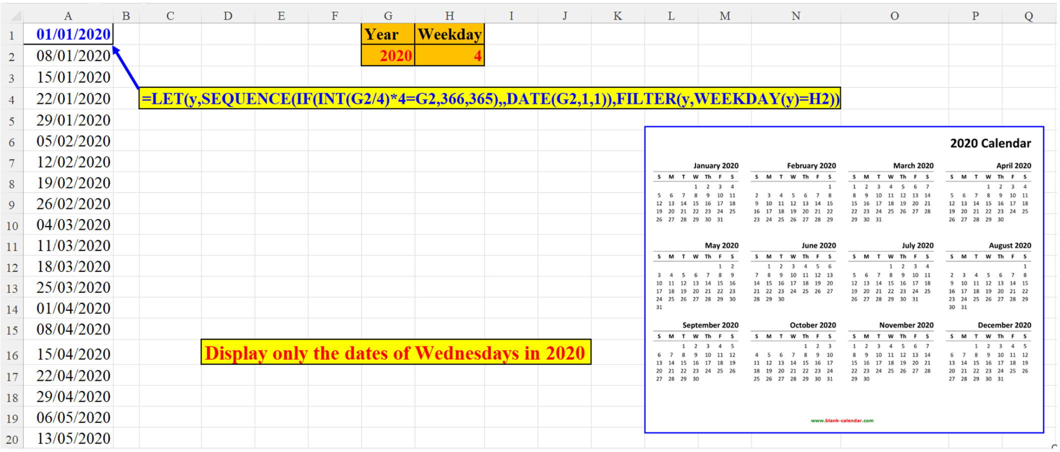


Figure 5.19: Display only dates of Wednesdays in 2020

How many Wednesdays are there in 2020?

In this section we will find the number of Wednesdays (parameter in cell H2) in the year 2020 (parameter in cell G2). The procedure to determine whether this is a leap year is slightly different from the one used in the previous section: *Display only dates of Wednesday in 2020* as shown in the following screenshot:

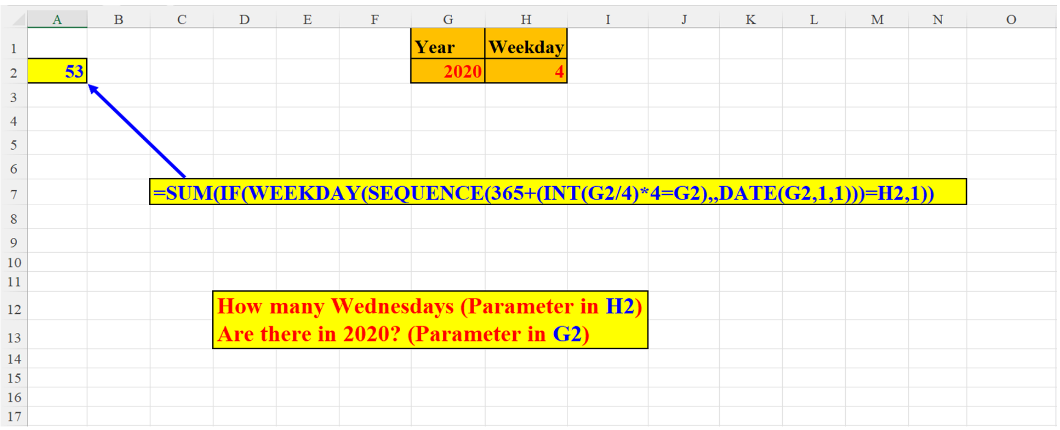


Figure 5.20: How many Wednesdays are there in 2020

Sequence of the month's last date for each month (two methods)

Method 1

The formula in this example uses the same trick as already shown in the preceding section: *The year's months with the last day of each month - three methods (method 1)*, if the month argument to the **DATE** function is current+1, then we can skip the **Day** argument, because the **DATE** function calculates the last day of the current month. **SEQUENCE**'s last argument is 0, so we start with the second month (2+0). Since the **Day** argument is missing, we get the date of January's last day as shown in the following screenshot:

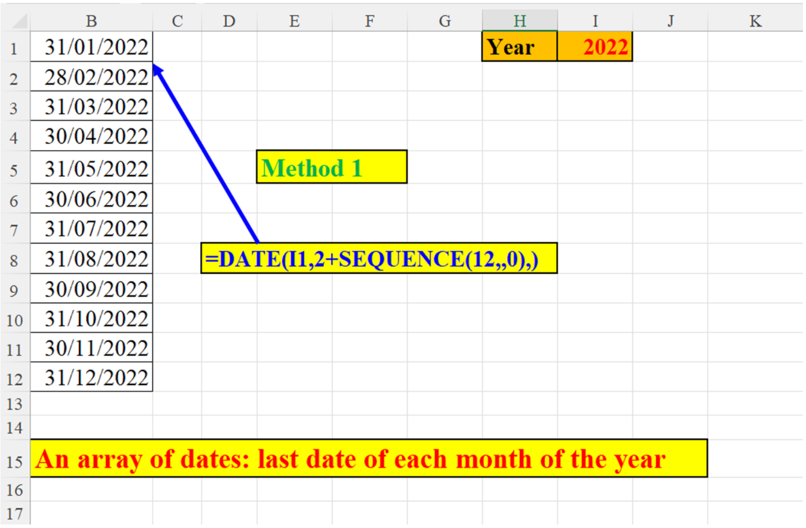


Figure 5.21: *Sequence of the month's last date for each month (method 1)*

Method 2

A similar approach to the one demonstrated in the previous subsection (as can be seen in *Figure 5.21*), but here, **SEQUENCE**'s last argument is not 0 but 1 (not explicitly specified) as shown in the following screenshot:

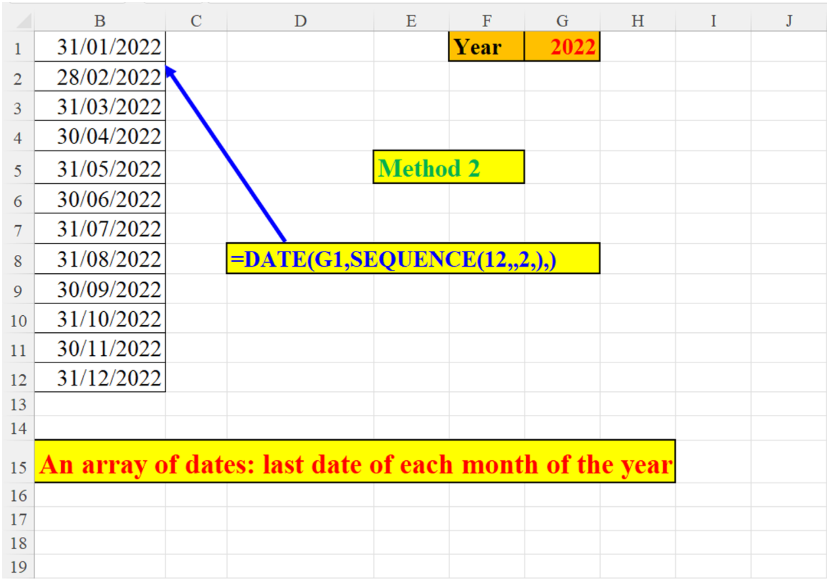


Figure 5.22*: Sequence of the month's last date for each month (method 2)*

A horizontal SEQUENCE of descending dates - First of each month

In this section, we will discuss the sequence of descending dates starting from 01/06/2020 (parameter defined in cell H2). The size of the sequence (six consecutive months) is set in cell I2. The minus sign preceding the **SEQUENCE** function *forces* the formula to generate a sequence of numbers in descending order starting with 0. Then, the **EDATE** adds this sequence to the starting date thus creating a sequence of dates in descending order.

To create a vertical sequence, all you have to do is switch places between **SEQUENCE**'s first two arguments:

`SEQUENCE(,$I$2,0)` instead of **`SEQUENCE($I$2,,0)`**

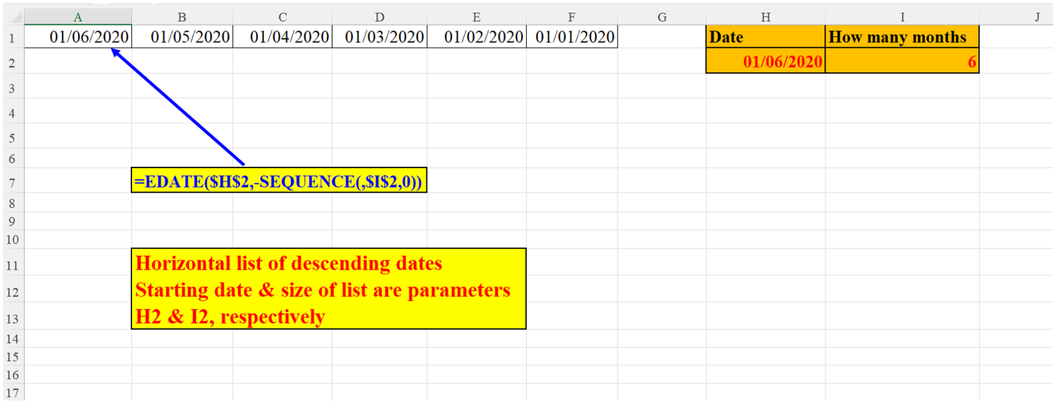


Figure 5.23*: Sequence of descending dates: 1st of each month*

A substitute for NETWORKDAYS.INTL (for a certain month)

The following formula is my *replacement* for Excel's built-in **`NETWORKDAYS.INTL`** function. As the name suggests, it calculates the number of working days in a given period, excluding any combination of weekends (specified in cells D2:D3) and holidays (specified in cells J2:J10) [you can add as many holidays as you need in column J]. This function is very flexible: it can exclude either only the weekends or only the holidays, both or none. My solution takes the original idea one step further: it lists all the net working days for the specified month.

To make the formula shorter, we defined a Named Range MonCal as can be seen in *Figure 5.25*. The formula within that Named Range takes the month (parameter in cell G2) and generates the dates of all the month's days. This is a relatively simple formula. The main formula, however, is quite complicated and an explanation is due. It has three steps:

Step 1: Filter only dates which do not fall on the weekend days: neither on Friday (cell D6) nor on Saturday (cell D3).

Step 2: *Stacking* the filtered dates from *Step 1* with the list of holidays dates.

Step 3: Now that we have the holidays twice (one in MonCal and one from *Step 2*), the **`UNIQUE`** function removes those duplicate values to give us the desired result: list of days that are neither weekends nor holidays. The third argument of the **`UNIQUE`** function is: 1, which tells the function to return rows that occur exactly once in the array.

To visualize the result, we have added the month's calendar (in the middle of the following figure):

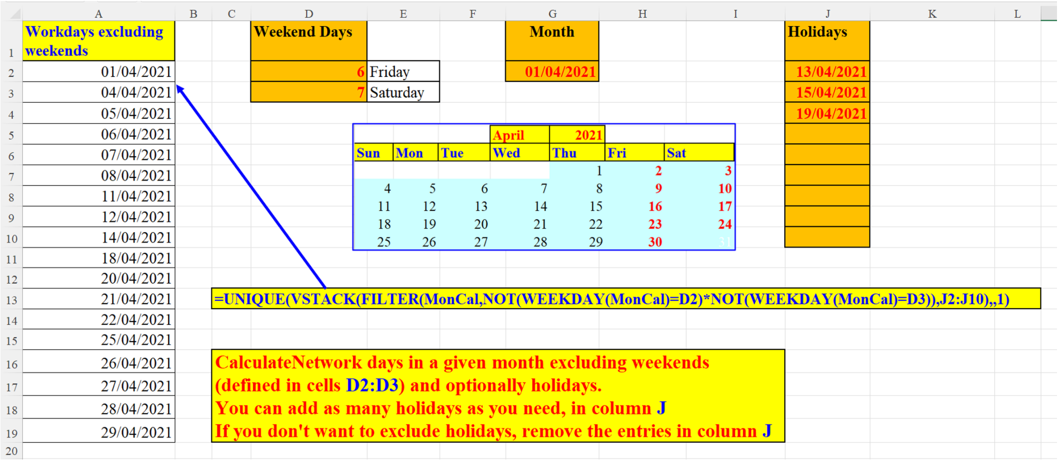


Figure 5.24: *Instead of NETWORKDAYS.INTL (for a certain month)*

The MonCal Named Range

The formula within the MonCal Named Range takes the month (parameter in cell G2) and generates the dates of all the month's days:

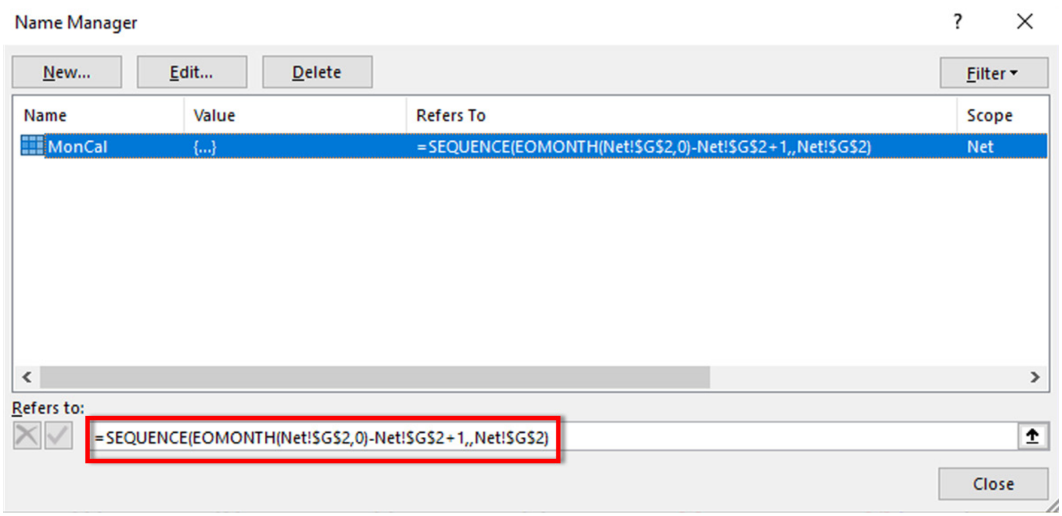


Figure 5.25: *The MonCal Named Range "begets" the array of the month's dates*

A substitute for the NETWORKDAYS.INTL (any period)

This is another version of the **`NETWORKDAYS.INTL`**, however here we have some differences when compared to the previous section:

Instead of an array of net working days, here, we calculate the number of net working days (the same as Excel's **`NETWORKDAYS.INTL`**).

The holidays parameter (column O) can be ignored altogether if cell J2 is set to 0 or left blank.

This formula can calculate any range of days, not necessarily one whole month.

The **`SUM`** function uses the name **`wk`** (defined by the **`LET`** function to shorten the formula), to extract only dates which do not fall on either Friday (cell G2) or Saturday (cell G3). Of course, you can define any weekend days. If you do not want to exclude any weekend days, just leave these cells empty (or with 0) as shown in the following screenshot:

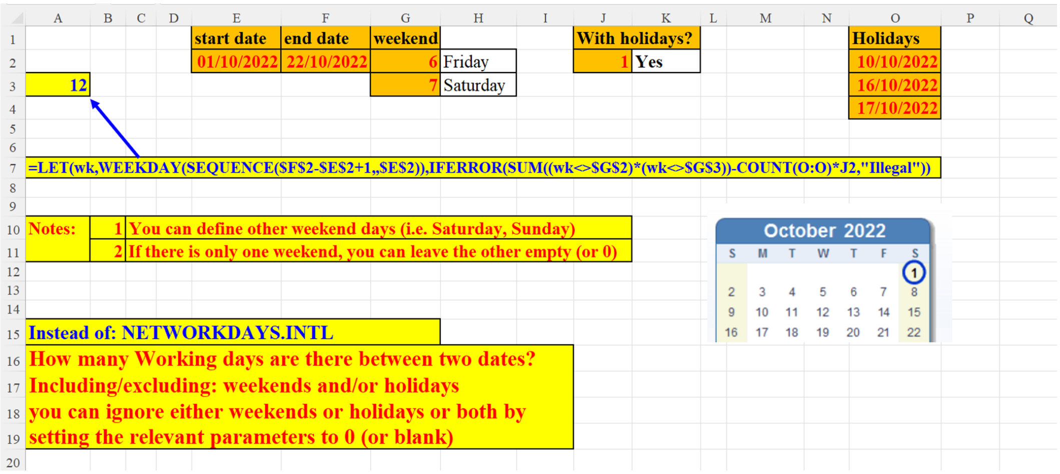


Figure 5.26: *Instead of NETWORKDAYS.INTL (any period)*

A substitute for NETWORKDAYS.INTL - with/without weekends

The last version of **`NETWORKDAYS.INTL`**'s replacement can exclude only weekends. These are defined in cells E2 and E3 and can be replaced or ignored completely, according to your needs. Here again, we employ a Named Range to keep the formula terse. As in the previous section, A substitute for **`NETWORKDAYS.INTL`** (for a certain month), the formula in it calculates the entire monthly calendar. As opposed to the two previous versions, this formula displays both the array of working days for the chosen month (parameter in cell G2) along with the number of total working days as shown in the following screenshot:

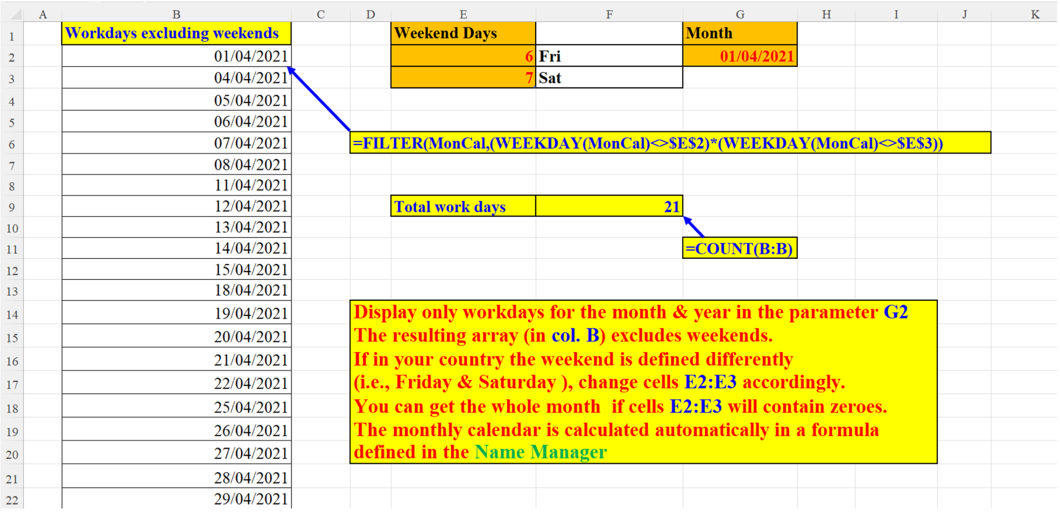


Figure 5.27: *Instead of NETWORKDAYS.INTL (with/without weekends)*

The Definition of MonCal

The formula within the MonCal Named Range takes the month (parameter in cell G2) and generates the dates of all the month's days as shown in the following screenshot:

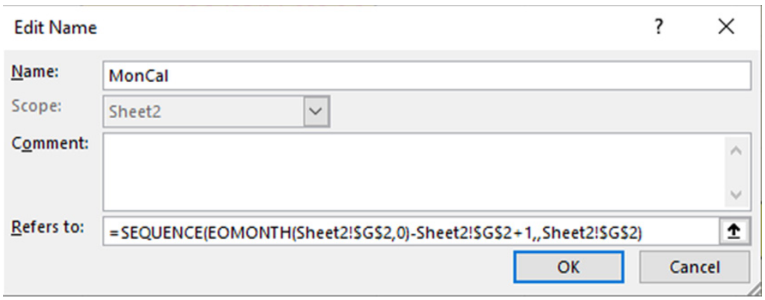


Figure 5.28: *Definition of MonCal*

How many working days are there in each month of a given period?

This formula *imitates* the `NETWORKDAYS.INTL` function. It calculates the net workdays for each month in the month's parameter (cells: M1:M4) for the period stated in cells E2:F2. The weekend days parameter (cells G2:G3) can be modified, according to your country's weekends. If you do not want to exclude any weekend days, just leave those cells empty (or with 0) as shown in the following screenshot:

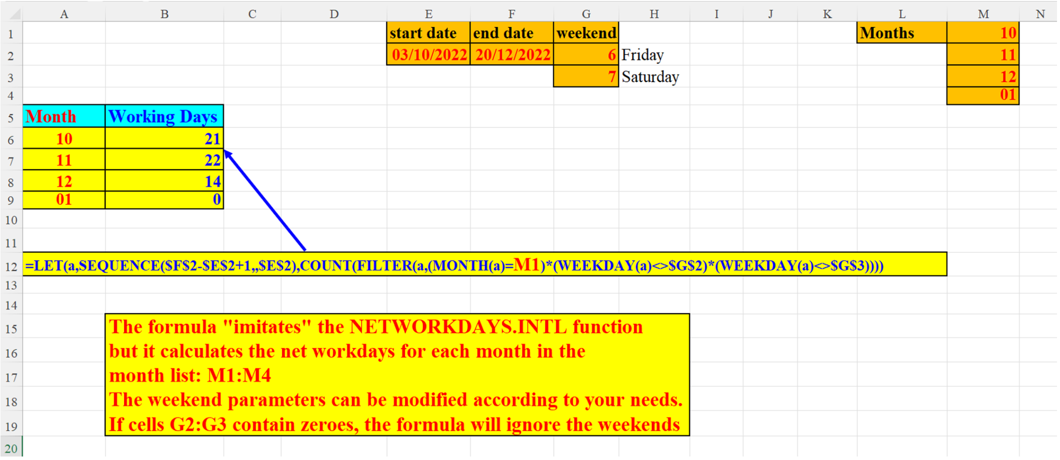


Figure 5.29: *How many working days are there in each month of a given period*

How many eligibility days?

This example demonstrates an imaginary social security office. Its customers are supposed to report every month on certain weekdays for them to be eligible for social security monthly allowances. The reporting period is from 01/08/2021 (cell B1) to 31/08/2021 (cell E1). In cells A4:A8 we have a list of customers. As stated above, each customer has certain days in a week in which he/she must report at the agency (cells B4:B8).

For example, Bridget has to report on Sundays and Mondays (1,2) whereas Catherine is supposed to show up at the agency every Sunday, Monday, Wednesday and Thursday (1,2,4,5) during the month.

In cells C4:C8 we calculate for each attendee the number of times they must report during the reporting period. So, for example, since August 2021 has five Sundays and five Mondays, Bridget must report 10 times in that month. Jessica, on the other hand, is required to arrive at the agency every day of the week, so she must show up 31 times in that month. A calendar of August 2021 is added (on the right-hand side of the figure) to assist in checking the accuracy of the solution as shown in the following screenshot:

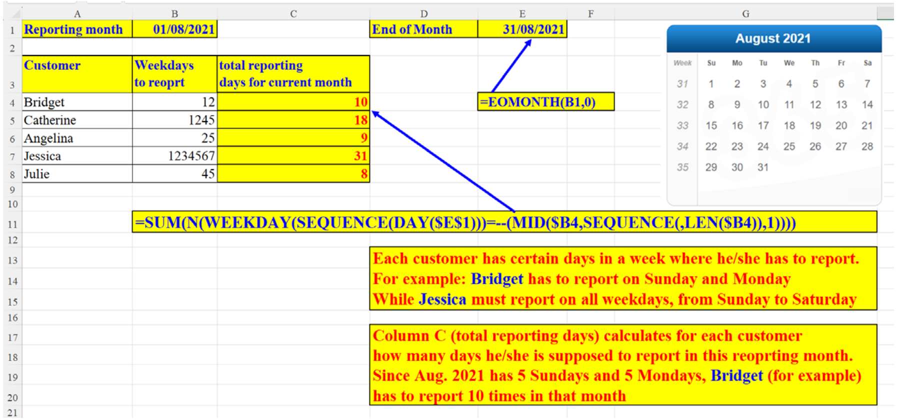


Figure 5.30: *How many eligibility days*

The doctor's schedule (two versions)

The following two examples exhibit two settings of a schedule for a doctor's clinic. Viewing these two alternatives, each physician is free to choose their preferred timetable.

The doctor's schedule (version 1)

This is the first version of the doctor's schedule. We have two parameters: the opening hours of the clinic (cells J1:K1) and the time allotted per patient (cell E1). The formula builds the timetable accordingly (in Column A) as shown in the following screenshot:

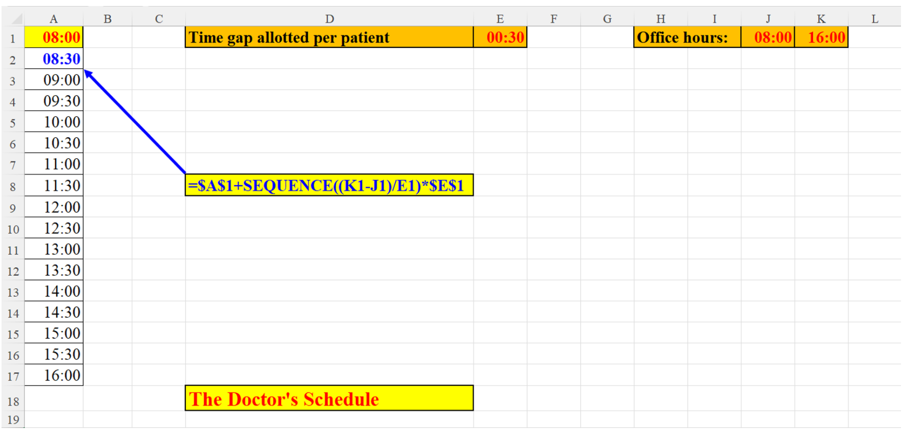


Figure 5.31: *The doctor's schedule (version 1)*

The doctor's schedule (version 2)

This is the second version of the doctor’s schedule. Instead of defining the opening and closing hours, we offer a slightly different approach: We set the number of daily open hours (in cell D1), the time allotted per patient (in cell F1) and the opening hour of the clinic (in cell H1):

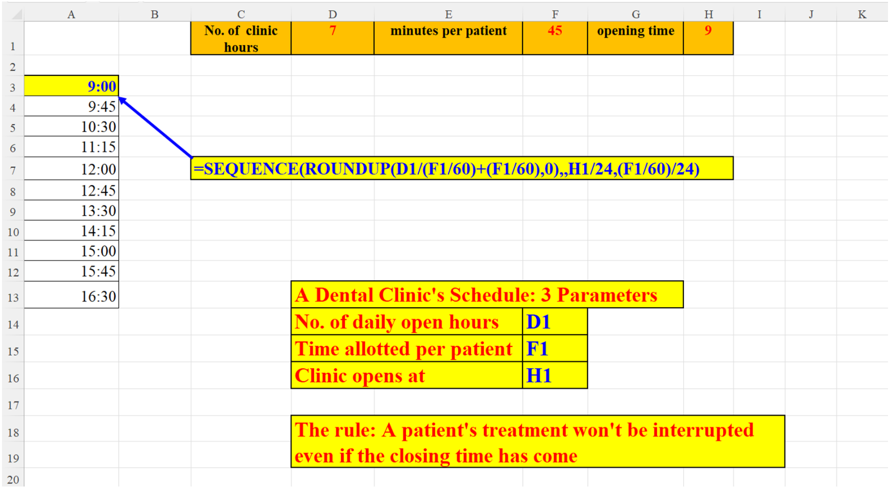


Figure 5.32: *The doctor’s schedule (version 2)*

Monthly calendar – classic versus non-classic

Two monthly calendars: One - classic (Where the week starts on Sunday) and the second – Non-classic (where the week starts on the weekday of the month’s first day). Both methods use the same formula, without any modification.

Monthly calendar - classic

This subsection illustrates the *Classic* monthly calendar: it starts on Sunday. The year (2017 parameter in cell E1) and the month (April chosen via data validation in cell E2) were selected for this illustration because April 2017 was a rare month: It had 6 weeks. Since this is a *classic* monthly calendar, the parameter in cell E3 is 1.

The calendar, as mentioned above, has only one formula (can be seen in cell A20). The other two formulae are set to create the weekday names (cells A11:G11) and generate the month name (cell D10).

The *trick* behind this calendar, along with the formula, is its Conditional Formatting technique, as can be seen in *Figure 5.34*.

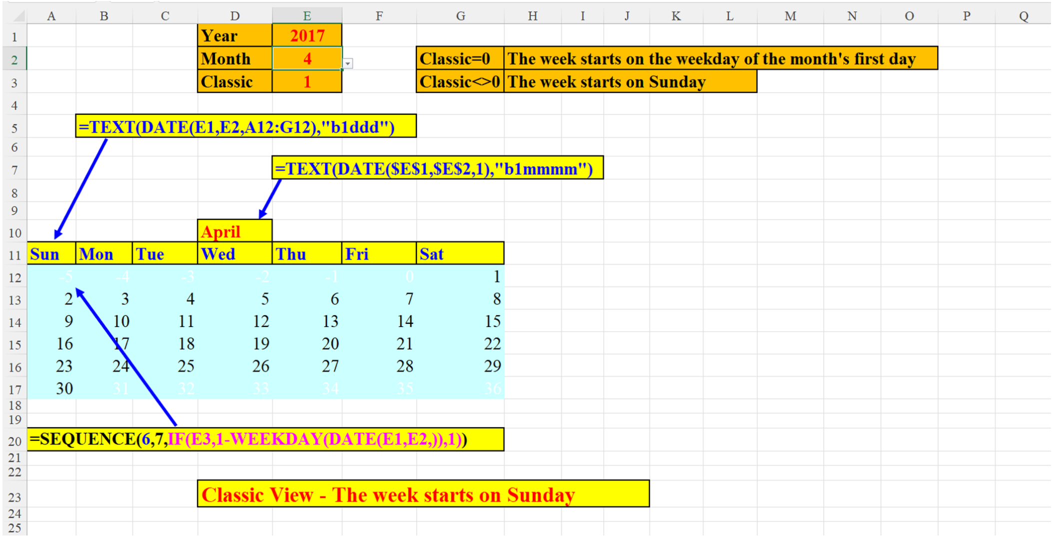


Figure 5.33: *Monthly calendar – classic*

The technique used in the following figure is the *trick* behind this calendar. Along with the formula, this Conditional Formatting technique, can be seen in *Figure 5.34*. The entire range of the calendar (cells A12:G17) has a light background color. The cells in row 12 preceding the 1st of April (in cell G12) contain numbers less than 1 and we want to hide them. The same applies to the cells succeeding the last month's day, April 30th (in cell A17): all these cells hold values greater than 30, so we want to hide them too. So, for the first case we have rule no.1: **`=A12<1`** and for second one we have rule no.2: **`=A12>DAY(DATE($E$1,$E$2+1,))`**. These rules are formatted with a transparent font, so they are invisible:

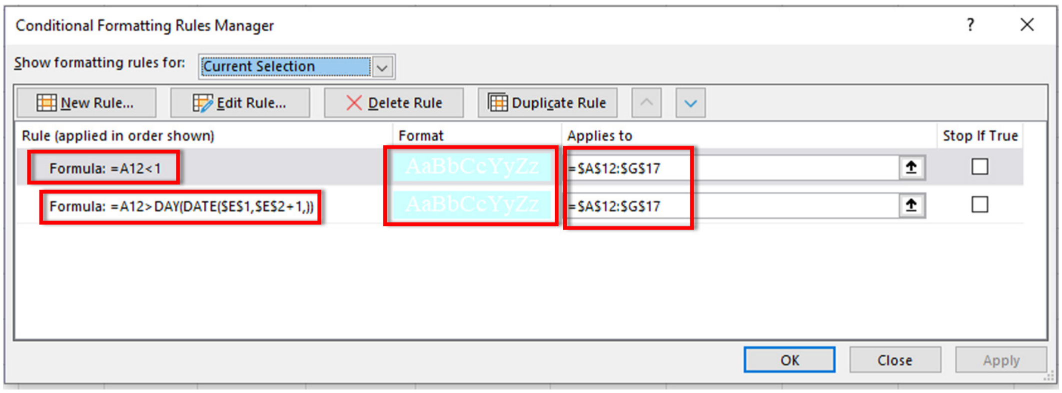


Figure 5.34: *Monthly Calendar – Classic – Conditional Formatting*

Monthly calendar – non-classic

The non-classic calendar is identical in all details but one to the classic calendar, the difference in the value defined in cell E3. Now, the parameter is *non-classic* which means: the week starts on the weekday of the month's first day.

This slight change has an impact in two places:

- The weekdays (cells A11:G11) begin on Saturday and not on Sunday.
- The calendar adapts itself automatically to the new situation: the calendar now has only five rows, and not six rows as in the *classic* calendar. (However, we already know that actually six rows are displayed. Thanks to the Conditional Formatting mechanism, the superfluous cells are hidden because their font is transparent) as shown in the following screenshot:

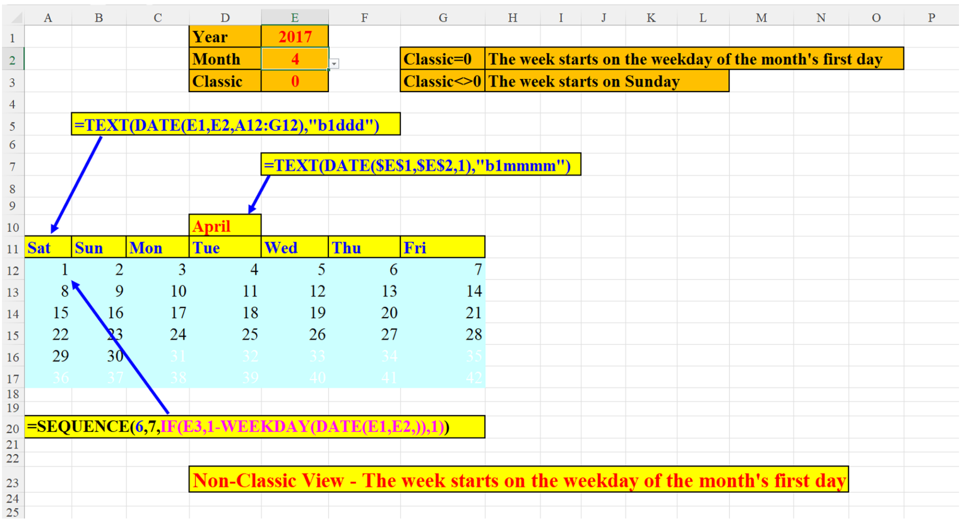


Figure 5.35: Monthly calendar – non-classic

Monthly calendar in 20 languages

In this section, we will learn how to display 20 calendars in 20 different languages.

First, there are three parameters:

- the year (in cell E1),
- the month (in cell E2) (a drop-down list whose values are defined in cells R2:R13), (see *Figure 5.37*), and
- the language (in cell E3) (a drop-down list whose values are taken from cells M2:M22, (see *Figure 5.38*).

Then, we have three formulae:

- which sets the weekdays names (cells A11:G11) according to the language chosen in cell E3. It searches the table defined in columns M:O by the language name and fetches the day format (from Column O) to be implemented in the weekday names.
- which sets the month name (cell D9) according to the language chosen in cell E3. It searches the table defined in columns M:P by the language name and fetches the day format for that language (from Column P) to be implemented in the month name.
- which populates the calendar array (cells A11:G15). In this example, we will use the *non-classic* monthly calendar:

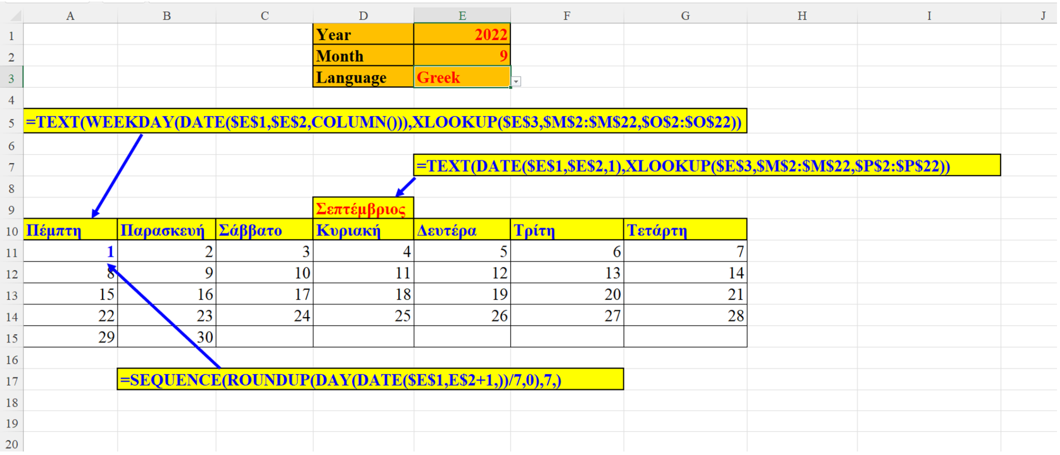


Figure 5.36: *Monthly calendar in 20 languages*

Monthly calendar in 20 languages – list of languages and formats

The dataset introduced in the following screenshot represents the table used in the previous screenshot to fetch the language (defined in cell E3) by the **XLOOKUP** function. The language (in our case: Greek) is searched in cells M2:M22. **XLOOKUP** returns the month format (cells P2:P22) for the month name in Greek (cell D9) and for the weekday names (cells O2:O22) which will be displayed in cells A10:G10.

The formula to fetch the month name in Greek can be seen in cell E7, and the formula to return the Greek weekday names is displayed in cell A5 (See *Figure 5.36*).

	M	N	O	P
1	Language	Short Day Format	Long Day Format	Month Name Format
2	Italian	[$-it-IT]ddd	[$-it-IT]dddd	[$-it-IT]mmmm
3	Arabic	[$-ar-EG]ddd	[$-ar-EG]dddd	[$-ar-EG]mmmm
4	Hebrew	[$-he-IL]ddd	[$-he-IL]dddd	[$-he-IL]mmmm
5	English (Br.)	[$-en-BR]ddd	[$-en-BR]dddd	[$-en-BR]mmmm
6	English (US)	[$-en-US]ddd	[$-en-US]dddd	[$-en-US]mmmm
7	German	[$-de-DE]ddd	[$-de-DE]dddd	[$-de-DE]mmmm
8	French	[$-fr-FR]ddd	[$-fr-FR]dddd	[$-fr-FR]mmmm
9	Greek	[$-el-GR]ddd	[$-el-GR]dddd	[$-el-GR]mmmm
10	Chinese	[$-zh-CN]ddd	[$-zh-CN]dddd	[$-zh-CN]mmmm
11	Japanese	[$-ja-JP]ddd	[$-ja-JP]dddd	[$-ja-JP]mmmm
12	Hungarian	[$-hu-HU]ddd	[$-hu-HU]dddd	[$-hu-HU]mmmm
13	Spanish	[$-es-ES]ddd	[$-es-ES]dddd	[$-es-ES]mmmm
14	Portuguese	[$-pt-PT]ddd	[$-pt-PT]dddd	[$-pt-PT]mmmm
15	Russian	[$-ru-RU]ddd	[$-ru-RU]dddd	[$-ru-RU]mmmm
16	Czech	[$-cs-CZ]ddd	[$-cs-CZ]dddd	[$-cs-CZ]mmmm
17	Dutch	[$-nl-NL]ddd	[$-nl-NL]dddd	[$-nl-NL]mmmm
18	Turkish	[$-tr-TR]ddd	[$-tr-TR]dddd	[$-tr-TR]mmmm
19	Bulgarian	[$-bg-BG]ddd	[$-bg-BG]dddd	[$-bg-BG]mmmm
20	Danish	[$-da-DK]ddd	[$-da-DK]dddd	[$-da-DK]mmmm
21	Hindi	[$-hi-IN]ddd	[$-hi-IN]dddd	[$-hi-IN]mmmm
22	Polish	[$-pl-PL]ddd	[$-pl-PL]dddd	[$-pl-PL]mmmm
23				

Figure 5.37: *List of languages and their corresponding day- and month- formats*

Monthly calendar in 20 languages – list of month numbers

This is the list of months used in the data validation of the preceding section: *Monthly calendar in 20 languages* (See *Figure 5.36*, cell E2).

	R
1	Months
2	1
3	2
4	3
5	4
6	5
7	6
8	7
9	8
10	9
11	10
12	11
13	12
14	

Figure 5.38: *List of the month numbers (drop-down list to choose the month from)*

Two methods for creating a list of the month's days

In this section, we will discuss two methods for creating a list of the month's days.

You should avoid the first one, which will yield wrong results (see *Figure 5.39*). It is better to use the second, dynamic one (see *Figure 5.40*). It assures us that we always get the correct number of days for the chosen month (February).

Monthly calendar – a bad attitude

This is an example of how not to create a dynamic monthly calendar: not all months have 31 days as can be seen in the following screenshot:

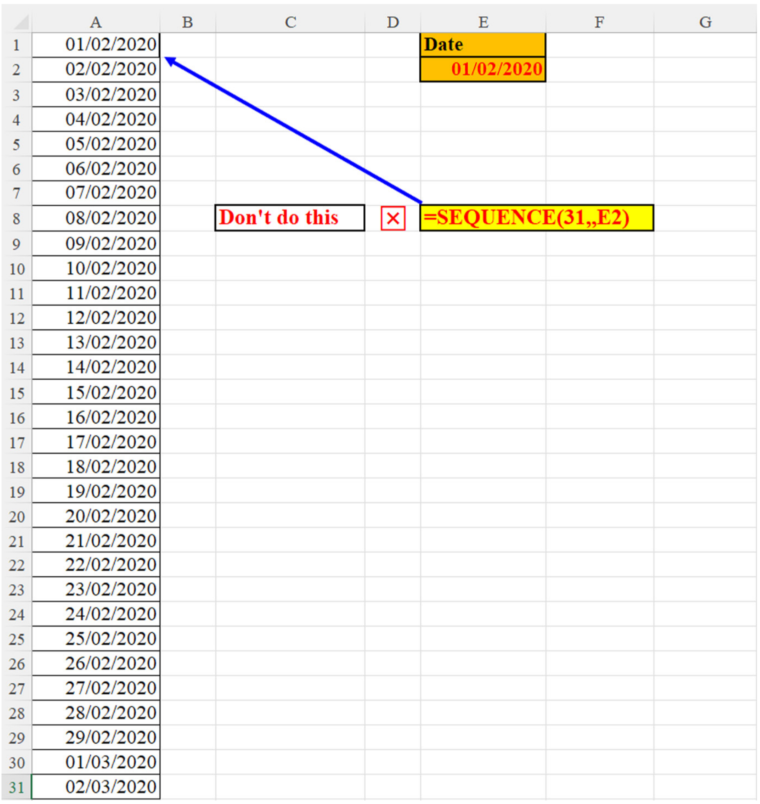


Figure 5.39: *Monthly calendar – a bad attitude*

Monthly calendar – a good attitude

This is a better approach to build a dynamic monthly calendar. The number of days in a given year and month can easily be found by using the **EOMONTH** function which returns the desired month's last date. From that result, we extract the number of days, which is the first argument to the **SEQUENCE** function.

This way we can be sure that we have the correct number of days in the chosen month's calendar:

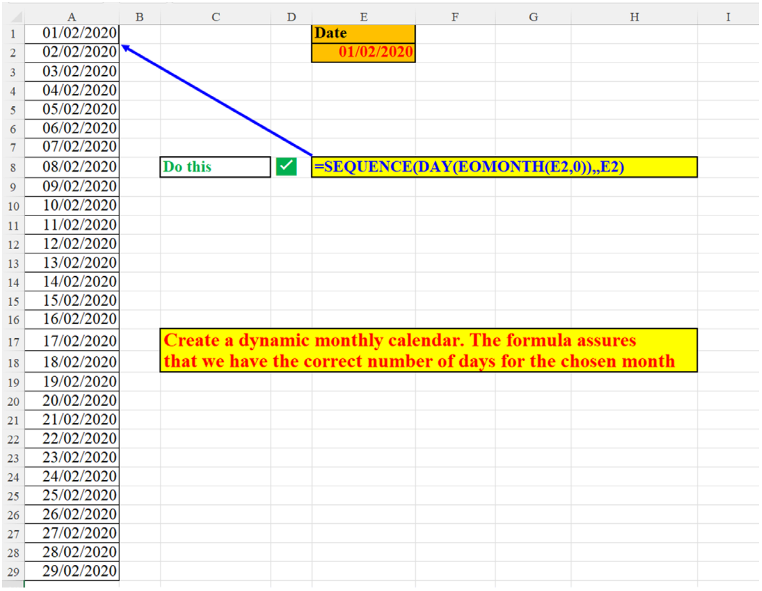


Figure 5.40: *Monthly Calendar – a better attitude*

Yearly calendar – good versus bad

Here again, we can see two attitudes to displaying the entire year's days. This time, the first one is better because it considers the fact that the chosen year (in cell E2) might be a leap year, a year in which there are 366 days and not 365:

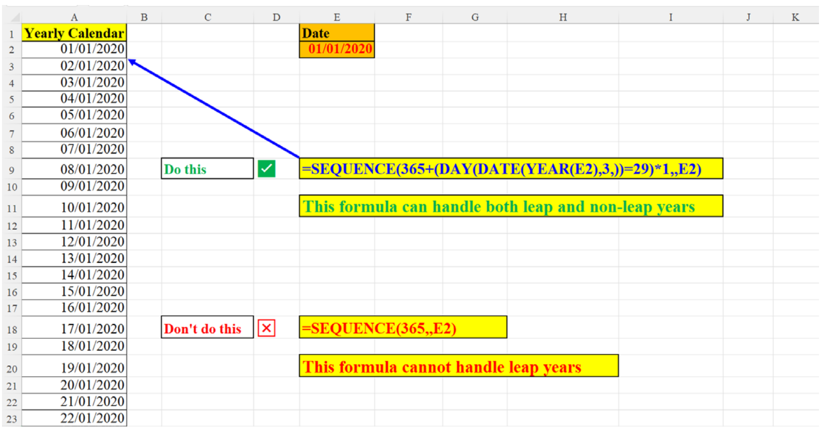
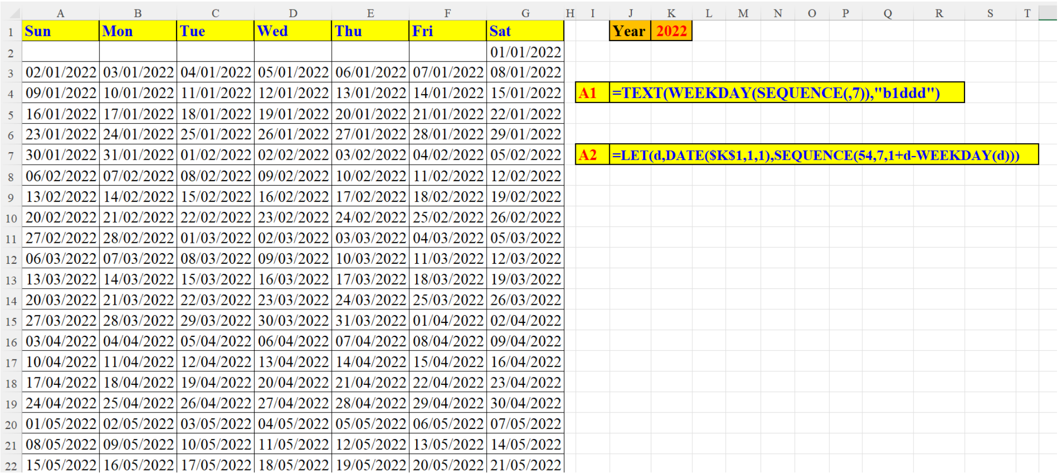


Figure 5.41: *Yearly calendar – good versus bad*

Dynamic yearly calendar – in one formula

This yearly calendar is dynamic. It uses the "classic" method (see preceding section: *Monthly calendar – classic versus non-classic, Figure 5.33*). It accepts only one parameter (the year, in cell K1) and builds dynamically both the weekday names (in cells A1:G1) and the calendar itself (cells A2:G55) as shown in the following screenshot:



	A	B	C	D	E	F	G
1	Sun	Mon	Tue	Wed	Thu	Fri	Sat
2							01/01/2022
3	02/01/2022	03/01/2022	04/01/2022	05/01/2022	06/01/2022	07/01/2022	08/01/2022
4	09/01/2022	10/01/2022	11/01/2022	12/01/2022	13/01/2022	14/01/2022	15/01/2022
5	16/01/2022	17/01/2022	18/01/2022	19/01/2022	20/01/2022	21/01/2022	22/01/2022
6	23/01/2022	24/01/2022	25/01/2022	26/01/2022	27/01/2022	28/01/2022	29/01/2022
7	30/01/2022	31/01/2022	01/02/2022	02/02/2022	03/02/2022	04/02/2022	05/02/2022
8	06/02/2022	07/02/2022	08/02/2022	09/02/2022	10/02/2022	11/02/2022	12/02/2022
9	13/02/2022	14/02/2022	15/02/2022	16/02/2022	17/02/2022	18/02/2022	19/02/2022
10	20/02/2022	21/02/2022	22/02/2022	23/02/2022	24/02/2022	25/02/2022	26/02/2022
11	27/02/2022	28/02/2022	01/03/2022	02/03/2022	03/03/2022	04/03/2022	05/03/2022
12	06/03/2022	07/03/2022	08/03/2022	09/03/2022	10/03/2022	11/03/2022	12/03/2022
13	13/03/2022	14/03/2022	15/03/2022	16/03/2022	17/03/2022	18/03/2022	19/03/2022
14	20/03/2022	21/03/2022	22/03/2022	23/03/2022	24/03/2022	25/03/2022	26/03/2022
15	27/03/2022	28/03/2022	29/03/2022	30/03/2022	31/03/2022	01/04/2022	02/04/2022
16	03/04/2022	04/04/2022	05/04/2022	06/04/2022	07/04/2022	08/04/2022	09/04/2022
17	10/04/2022	11/04/2022	12/04/2022	13/04/2022	14/04/2022	15/04/2022	16/04/2022
18	17/04/2022	18/04/2022	19/04/2022	20/04/2022	21/04/2022	22/04/2022	23/04/2022
19	24/04/2022	25/04/2022	26/04/2022	27/04/2022	28/04/2022	29/04/2022	30/04/2022
20	01/05/2022	02/05/2022	03/05/2022	04/05/2022	05/05/2022	06/05/2022	07/05/2022
21	08/05/2022	09/05/2022	10/05/2022	11/05/2022	12/05/2022	13/05/2022	14/05/2022
22	15/05/2022	16/05/2022	17/05/2022	18/05/2022	19/05/2022	20/05/2022	21/05/2022

Figure 5.42: *Dynamic yearly calendar - in one formula*

Dynamic yearly calendar – Conditional Formatting

Similar to the Monthly *classic* calendar, this solution also uses Conditional Formatting with two rules (see *Figure 5.43*).

The first caters for cases where the year does not start on a Sunday.

The second takes care of instances where the year does not end on a Saturday.

As can be seen in *Figure 5.43*, these two rules use white (transparent) font color in such cases:

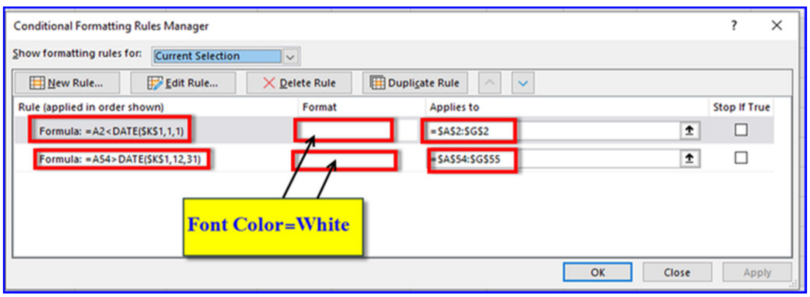


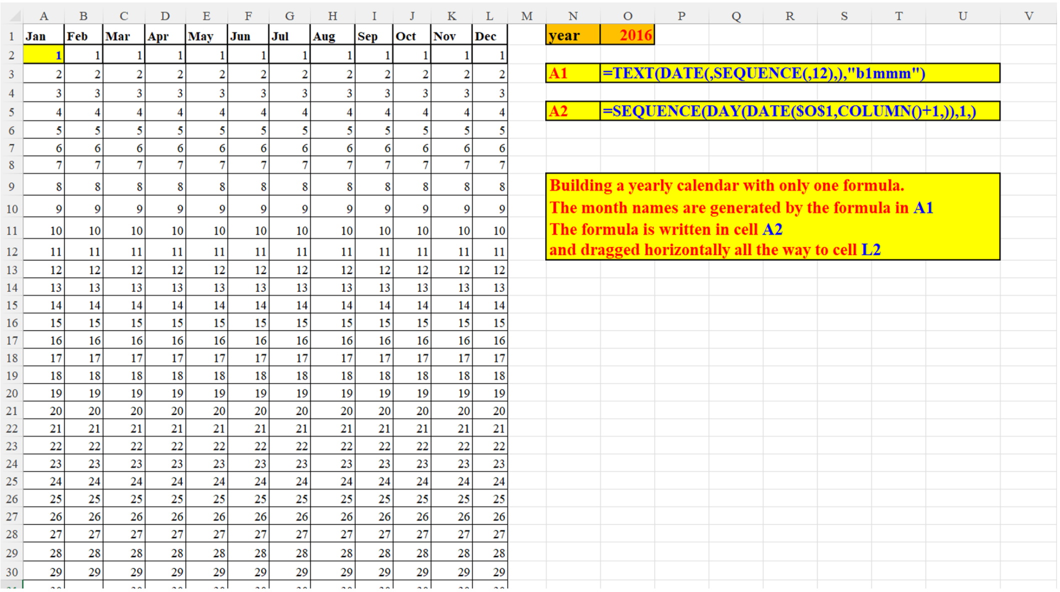
Figure 5.43: *Dynamic yearly Calendar – Conditional Formatting*

Dynamic yearly calendar - by month

The formula that builds the yearly calendar takes only one parameter: year (in cell O1).

The formula in cell A1 (shown in cell O3) propagates the month names in the 12 cells: A1:L1.

We build the dynamic calendar by writing the formula in cell A2 (displayed in cell O5) and then dragging it horizontally all the way to cell L2 as shown in the following screenshot:



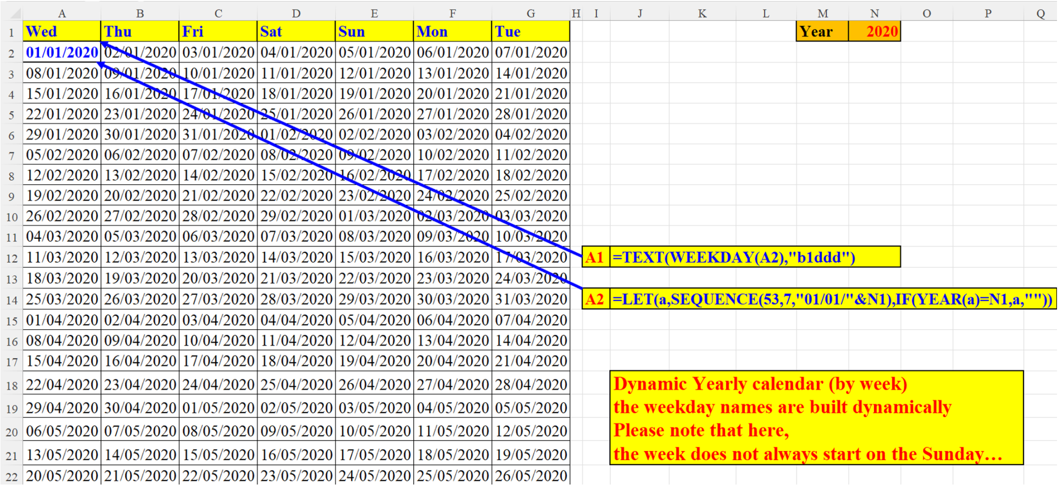
	A	B	C	D	E	F	G	H	I	J	K	L
1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2	1	1	1	1	1	1	1	1	1	1	1	1
3	2	2	2	2	2	2	2	2	2	2	2	2
4	3	3	3	3	3	3	3	3	3	3	3	3
5	4	4	4	4	4	4	4	4	4	4	4	4
6	5	5	5	5	5	5	5	5	5	5	5	5
7	6	6	6	6	6	6	6	6	6	6	6	6
8	7	7	7	7	7	7	7	7	7	7	7	7
9	8	8	8	8	8	8	8	8	8	8	8	8
10	9	9	9	9	9	9	9	9	9	9	9	9
11	10	10	10	10	10	10	10	10	10	10	10	10
12	11	11	11	11	11	11	11	11	11	11	11	11
13	12	12	12	12	12	12	12	12	12	12	12	12
14	13	13	13	13	13	13	13	13	13	13	13	13
15	14	14	14	14	14	14	14	14	14	14	14	14
16	15	15	15	15	15	15	15	15	15	15	15	15
17	16	16	16	16	16	16	16	16	16	16	16	16
18	17	17	17	17	17	17	17	17	17	17	17	17
19	18	18	18	18	18	18	18	18	18	18	18	18
20	19	19	19	19	19	19	19	19	19	19	19	19
21	20	20	20	20	20	20	20	20	20	20	20	20
22	21	21	21	21	21	21	21	21	21	21	21	21
23	22	22	22	22	22	22	22	22	22	22	22	22
24	23	23	23	23	23	23	23	23	23	23	23	23
25	24	24	24	24	24	24	24	24	24	24	24	24
26	25	25	25	25	25	25	25	25	25	25	25	25
27	26	26	26	26	26	26	26	26	26	26	26	26
28	27	27	27	27	27	27	27	27	27	27	27	27
29	28	28	28	28	28	28	28	28	28	28	28	28
30	29	29	29	29	29	29	29	29	29	29	29	29

Figure 5.44: *Dynamic yearly calendar – by month*

Dynamic yearly calendar - by week

This yearly calendar is arranged by week. In each column (weekday) only the dates that fall on that weekday are displayed. The year's parameter is defined in cell N1.

The formula creating the calendar is defined in cell A2. The *trick* here is that the formula in cell A1 (which generates the weekday names) can be activated only after the formula in cell A2 has been *launched*. Please note that this is a *non-classic* calendar, which means that the week does not always start on Sunday (please see preceding section: *Monthly calendar – classic versus non-classic, Figure 5.35*) as shown in the following screenshot:



Wed	Thu	Fri	Sat	Sun	Mon	Tue
01/01/2020	02/01/2020	03/01/2020	04/01/2020	05/01/2020	06/01/2020	07/01/2020
08/01/2020	09/01/2020	10/01/2020	11/01/2020	12/01/2020	13/01/2020	14/01/2020
15/01/2020	16/01/2020	17/01/2020	18/01/2020	19/01/2020	20/01/2020	21/01/2020
22/01/2020	23/01/2020	24/01/2020	25/01/2020	26/01/2020	27/01/2020	28/01/2020
29/01/2020	30/01/2020	31/01/2020	01/02/2020	02/02/2020	03/02/2020	04/02/2020
05/02/2020	06/02/2020	07/02/2020	08/02/2020	09/02/2020	10/02/2020	11/02/2020
12/02/2020	13/02/2020	14/02/2020	15/02/2020	16/02/2020	17/02/2020	18/02/2020
19/02/2020	20/02/2020	21/02/2020	22/02/2020	23/02/2020	24/02/2020	25/02/2020
26/02/2020	27/02/2020	28/02/2020	29/02/2020	01/03/2020	02/03/2020	03/03/2020
04/03/2020	05/03/2020	06/03/2020	07/03/2020	08/03/2020	09/03/2020	10/03/2020
11/03/2020	12/03/2020	13/03/2020	14/03/2020	15/03/2020	16/03/2020	17/03/2020
18/03/2020	19/03/2020	20/03/2020	21/03/2020	22/03/2020	23/03/2020	24/03/2020
25/03/2020	26/03/2020	27/03/2020	28/03/2020	29/03/2020	30/03/2020	31/03/2020
01/04/2020	02/04/2020	03/04/2020	04/04/2020	05/04/2020	06/04/2020	07/04/2020
08/04/2020	09/04/2020	10/04/2020	11/04/2020	12/04/2020	13/04/2020	14/04/2020
15/04/2020	16/04/2020	17/04/2020	18/04/2020	19/04/2020	20/04/2020	21/04/2020
22/04/2020	23/04/2020	24/04/2020	25/04/2020	26/04/2020	27/04/2020	28/04/2020
29/04/2020	30/04/2020	01/05/2020	02/05/2020	03/05/2020	04/05/2020	05/05/2020
06/05/2020	07/05/2020	08/05/2020	09/05/2020	10/05/2020	11/05/2020	12/05/2020
13/05/2020	14/05/2020	15/05/2020	16/05/2020	17/05/2020	18/05/2020	19/05/2020
20/05/2020	21/05/2020	22/05/2020	23/05/2020	24/05/2020	25/05/2020	26/05/2020

Figure 5.45: *Dynamic yearly calendar – by week*

Yearly Horizontal calendar with highlighted weekday (two examples)

This is a horizontal calendar in only one formula, but with two Conditional Formatting rules. The first rule refers to the calendar itself (cells B4:AF15, see *Figure 5.48*) and *controls* the color of all the calendar's cells whose dates fall on the same day as the weekday specified in the parameter Weekday (cell L1).

The second Conditional Formatting rule is *responsible* to display (in column AH) the name of the weekday chosen in L1 and *colored* by the first rule. The color, as can be seen in the following two figures (*Figure* 5.46 and *Figure* 5.47) are the same, both for the highlighted dates in the calendar and the weekday name displayed in column AH. Another *trick* shown here is that each weekday name is displayed in a different cell: Sunday – in cell AH4, Monday – in cell H5…. and Saturday – in cell AH10.

The formula (in cell B4) creates a horizontal calendar, in which each month of the year parameter (in cell I1) *stretches* to the right according to the month's size (number of days). It is copied (without any alterations) to cells B5:B15.

The months names (in column A) are generated in a manner similar to the one shown in *Figure 5.7*: *Display month names without a specified date*

Yearly horizontal calendar

Example 1 (weekday chosen: Sunday)

In the following screenshot only Sundays (cell L1 is equal to 1) in the year 2022 are *painted*. The calendar is horizontal: Month names in A4:A15 and the dates in B4:AF15:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1								year	2022	Weekday		1					Horizontal Calendar in one Formula																	
2																	The formula for each month is determined automatically																	
3																																		
4	Jan	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		Sunday
5	Feb	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28					
6	Mar	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
7	Apr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
8	May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
9	Jun	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
10	Jul	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
11	Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
12	Sep	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
13	Oct	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
14	Nov	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
15	Dec	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
16																																		
17			B4	`=SEQUENCE(,DATE($I$1,ROW()-2,)-DATE($I$1,ROW()-3,))`																														
18																																		

Figure 5.46: *Yearly horizontal calendar – example 1*

Example 2 (weekday chosen: Saturday)

In the following screenshot only Saturdays (cell L1 is equal to 7) in the year 2022 are *painted*. The calendar is horizontal: Month names in A4:A15 and the dates in B4:AF15:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1								year	2022	Weekday		7					Horizontal Calendar in one Formula																	
2																	The formula for each month is determined automatically																	
3																																		
4	Jan	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
5	Feb	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28					
6	Mar	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
7	Apr	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
8	May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
9	Jun	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
10	Jul	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		Saturday
11	Aug	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
12	Sep	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
13	Oct	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
14	Nov	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
15	Dec	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31		
16																																		
17			B4	`=SEQUENCE(,DATE($I$1,ROW()-2,)-DATE($I$1,ROW()-3,))`																														
18																																		

Figure 5.47: *Yearly horizontal calendar – example 2*

Yearly horizontal calendar - Conditional Formatting - calendar

The following figure depicts the Conditional Formatting pane which exhibits the rules "behind" the weekday names, in *Figure 5.46* and *Figure 5.47*. These rules apply to the calendar (cells B4:AF15).

Each cell in the dataset of yearly weekdays (B4:AF15) is checked to see if it matches the weekday in the parameter (cell L1): Sunday – in *Figure 5.46* and Saturday - in *Figure 5.47*. If it does match, then that cell is *painted* accordingly by the colors defined in the format: magenta – for Sunday (marked with label 1, as shown in *Figure 5.48*), orange – for Monday (marked with label 2, as shown in *Figure 5.48*), red – for Tuesday (marked with label 3, as shown in *Figure 5.48*), and so on:

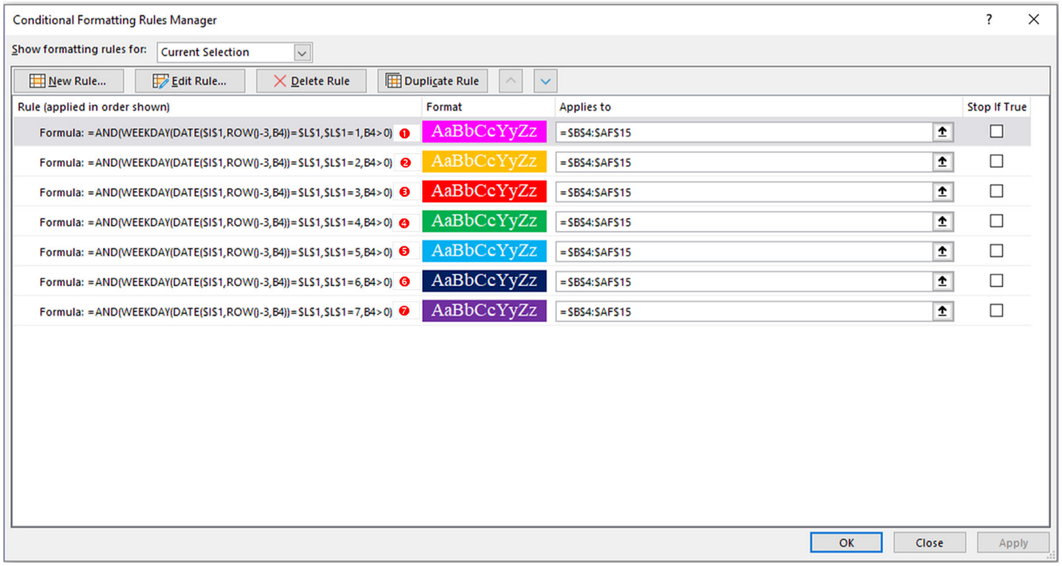


Figure 5.48: *Yearly horizontal calendar – Conditional Formatting – calendar*

Yearly horizontal calendar - Conditional Formatting - weekday names

The following figure depicts the Conditional Formatting pane which exhibits the rules *behind* the weekday names, in *Figure 5.46* and *Figure 5.47*. These rules apply to cells (AH4:AH10).

For each weekday chosen in L1, the corresponding weekday name is displayed in cells: AH4:AH10 and is *painted* accordingly by the colors defined in the format:

magenta – for Sunday (marked with label 1, as shown in *figure 5.49*), orange – for Monday (marked with label 2, as shown in *figure 5.49*), red – for Tuesday (marked with label 3, as shown in *Figure 5.49*), and so on. If cell L1 contains 1 (Sunday) then cell AH4 is selected and painted in magenta (marked with label 1, as shown in *Figure 5.49*); if cell L1 contains 2 (Monday) then cell AH5 is selected and painted in orange (marked with label 2, as shown in *Figure 5.49*), and so on. Cells (AN4:AN10) which cannot be seen on *Figure 5.46* and *Figure 5.47* contain the weekday names: Sunday to Saturday.

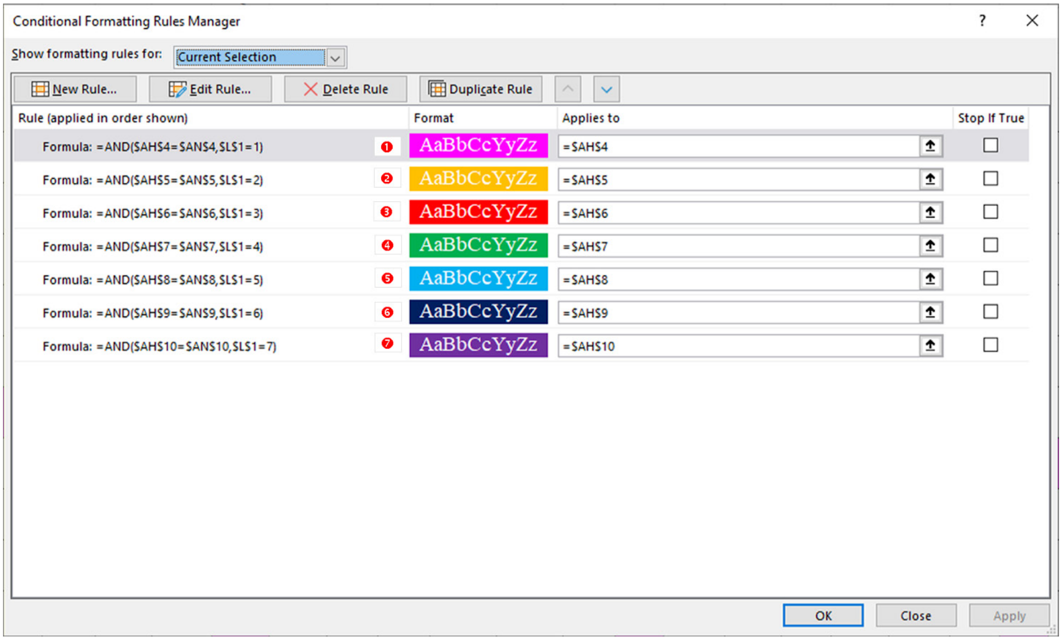


Figure 5.49: *Yearly horizontal calendar – Conditional Formatting – weekday names*

Yearly vertical calendar with highlighted weekday (2 examples)

The vertical calendar in this section is similar to the one in the previous section: Yearly horizontal calendar with highlighted weekday (two examples) (*Figure 5.46*).

The only significant difference is in the layout (vertical vs. horizontal) and, of course, in the formula. Here too, the formula is copied (vertically) from A4 to L4. Also, here we have two Conditional Formatting rules, one for the calendar (see *Figure 5.52*) and the second for the weekday names (see *Figure 5.53*).

Yearly vertical calendar – example 1

The calendar in the following screenshot is similar to the one in *Figure 5.46* but here it is vertical: Month names are in cells A3:L3. Only Sundays are painted since the weekday parameter (cell J1) is equal to 1:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1							year	2022	Weekday	1				
2														
3	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Sunday
4	1	1	1	1	1	1	1	1	1	1	1	1		
5	2	2	2	2	2	2	2	2	2	2	2	2		
6	3	3	3	3	3	3	3	3	3	3	3	3		
7	4	4	4	4	4	4	4	4	4	4	4	4		
8	5	5	5	5	5	5	5	5	5	5	5	5		
9	6	6	6	6	6	6	6	6	6	6	6	6		
10	7	7	7	7	7	7	7	7	7	7	7	7		
11	8	8	8	8	8	8	8	8	8	8	8	8		
12	9	9	9	9	9	9	9	9	9	9	9	9		
13	10	10	10	10	10	10	10	10	10	10	10	10		
14	11	11	11	11	11	11	11	11	11	11	11	11		=SEQUENCE(DAY(DATE($H$1,COLUMN()+1,)),1,)
15	12	12	12	12	12	12	12	12	12	12	12	12		
16	13	13	13	13	13	13	13	13	13	13	13	13		
17	14	14	14	14	14	14	14	14	14	14	14	14		
18	15	15	15	15	15	15	15	15	15	15	15	15		Vertical Yearly Calendar
19	16	16	16	16	16	16	16	16	16	16	16	16		
20	17	17	17	17	17	17	17	17	17	17	17	17		
21	18	18	18	18	18	18	18	18	18	18	18	18		
22	19	19	19	19	19	19	19	19	19	19	19	19		
23	20	20	20	20	20	20	20	20	20	20	20	20		

Figure 5.50: *Yearly vertical calendar – example 1*

Yearly vertical calendar – example 2

The calendar in the following screenshot is similar to the one in *Figure 5.47* but here it is vertical: Month names are in cells A3:L3. Only Saturdays are painted since the weekday parameter (cell J1) is equal to 7:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1							year	2022	Weekday	7				
2														
3	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
4	1	1	1	1	1	1	1	1	1	1	1	1		
5	2	2	2	2	2	2	2	2	2	2	2	2		
6	3	3	3	3	3	3	3	3	3	3	3	3		
7	4	4	4	4	4	4	4	4	4	4	4	4		
8	5	5	5	5	5	5	5	5	5	5	5	5		
9	6	6	6	6	6	6	6	6	6	6	6	6		Saturday
10	7	7	7	7	7	7	7	7	7	7	7	7		
11	8	8	8	8	8	8	8	8	8	8	8	8		
12	9	9	9	9	9	9	9	9	9	9	9	9		
13	10	10	10	10	10	10	10	10	10	10	10	10		
14	11	11	11	11	11	11	11	11	11	11	11	11		=SEQUENCE(DAY(DATE($H$1,COLUMN()+1,)),1,)
15	12	12	12	12	12	12	12	12	12	12	12	12		
16	13	13	13	13	13	13	13	13	13	13	13	13		
17	14	14	14	14	14	14	14	14	14	14	14	14		
18	15	15	15	15	15	15	15	15	15	15	15	15		Vertical Yearly Calendar
19	16	16	16	16	16	16	16	16	16	16	16	16		
20	17	17	17	17	17	17	17	17	17	17	17	17		
21	18	18	18	18	18	18	18	18	18	18	18	18		
22	19	19	19	19	19	19	19	19	19	19	19	19		
23	20	20	20	20	20	20	20	20	20	20	20	20		

Figure 5.51: *Yearly vertical calendar – example 2*

Yearly vertical calendar – Conditional Formatting - calendar

The following figure depicts the Conditional Formatting pane which exhibits the rules “behind” *Figure 5.50* and *Figure 5.51*. These rules apply to the vertical calendar (cells A4:L34)

Each cell in the dataset of yearly weekdays (A4:L34) is checked to see if it matches the weekday in the parameter (cell J1): Sunday – in *Figure 5.50* and Saturday - in *Figure 5.51*. If it does match, then that cell is “painted” accordingly by the colors defined in the format: magenta – for Sunday (marked with label 1, as shown in *figure 5.52*), orange – for Monday (marked with label 2, as shown in *figure 5.52*), red – for Tuesday etc.

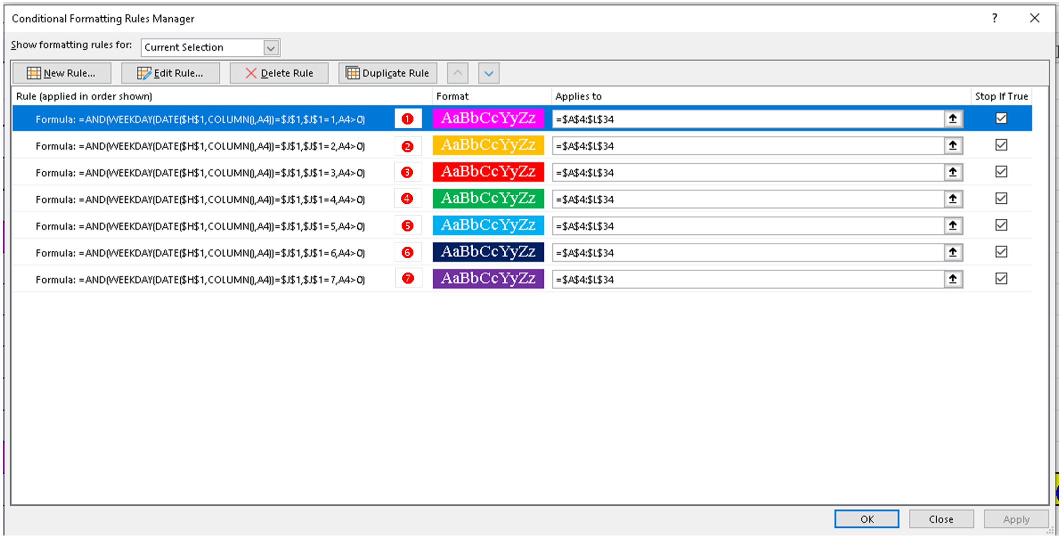


Figure 5.52: *Yearly vertical calendar – Conditional Formatting – calendar*

Yearly vertical calendar – Conditional Formatting – weekday names

The following screenshot (*Figure 5.53*) depicts the Conditional Formatting pane which exhibits the rules “behind” the weekday names, in *Figure 5.50* and *Figure 5.51* (cells N3 and N9, respectively). These rules apply to the weekday names (cells N3:N9)

For each weekday chosen in J1, the corresponding weekday name is displayed in cells N3:N9 and is painted accordingly with the same color of that weekday in the calendar (cells A4:L34): magenta – for Sunday (marked with label 1, as shown in *figure 5.53*), orange – for Monday (marked with label 2, as shown in *figure 5.53*), red – for Tuesday etc.

Cells (AC2:AC8) which cannot be seen on *Figure 5.50* and *Figure 5.51* contain the weekday names: Sunday to Saturday.

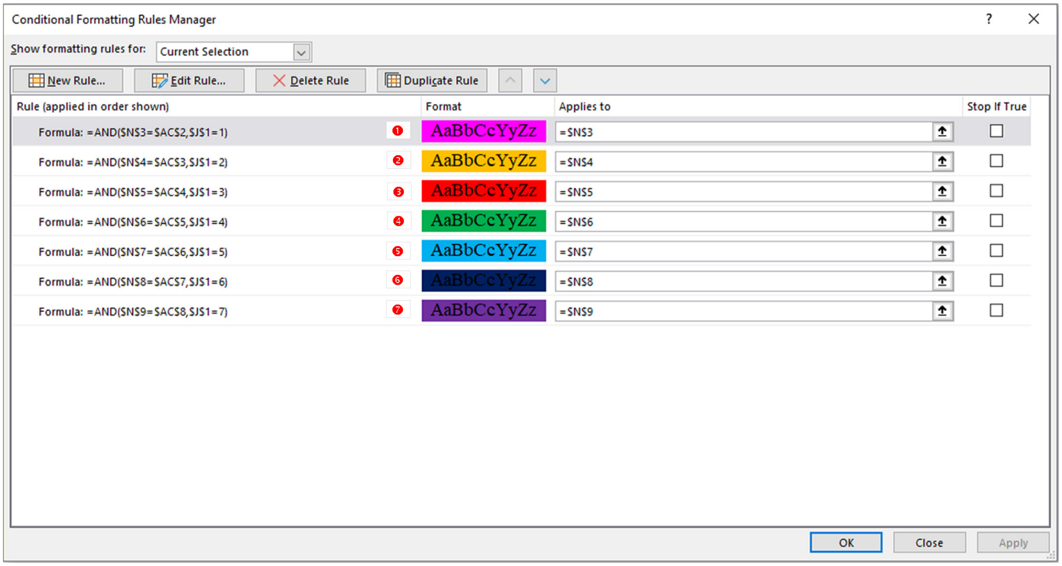


Figure 5.53: *Yearly vertical calendar – Conditional Formatting – weekday names*

Yearly calendar: one formula with Conditional Formatting

This is the last yearly calendar with one formula. Here we have only one Conditional Formatting rule, but since we have only the YEAR parameter (in cell H1) and no weekday to select, the calendar is formatted with each weekday having its own color (the color legend is displayed in cells N2:O8).

NOTE: If you feel that the calendar is too cluttered, you can change the Conditional Formatting rule (for example, to ignore Fridays and Saturdays).

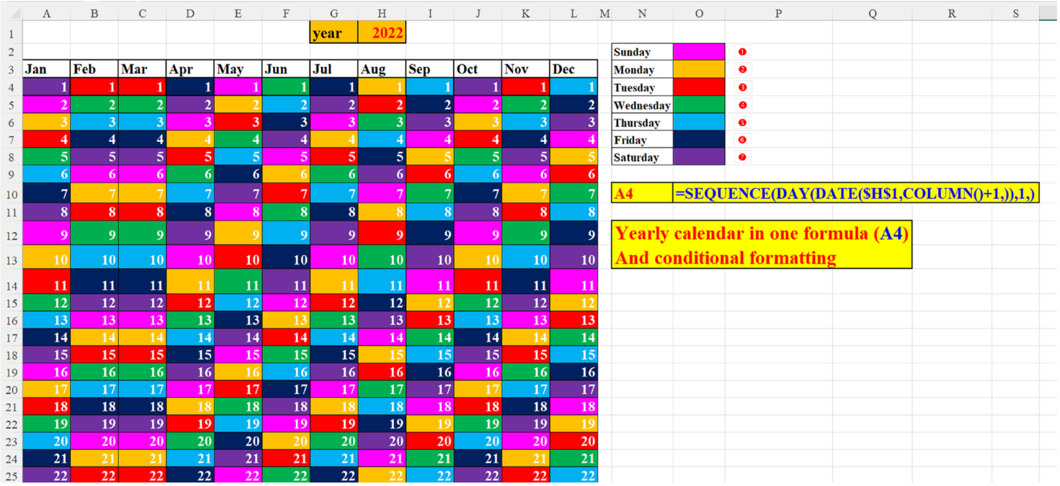


Figure 5.54: *Yearly Calendar – One formula with Conditional Formatting*

Conditional Formatting – each weekday is formatted differently

The following screenshot depicts the Conditional Formatting rules for *Figure 5.54*. Each cell in the calendar (A4:L34) has a different color: Sunday is painted in magenta (as represented by label 1 in *Figure 5.55*), Monday is painted in orange (as represented by label 2 in *Figure 5.55*), Tuesday is painted in red (as represented by label 3 in *Figure 5.55*). These, of course, correspond to the colors associated with the weekday names in the previous figure: *Figure 5.54*: Yearly Calendar - One formula with Conditional Formatting (cells N2:P8).

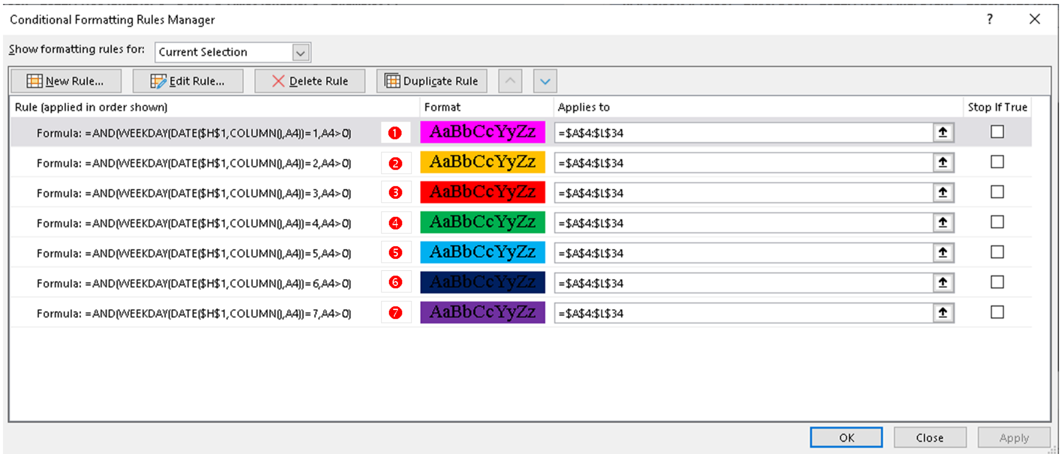


Figure 5.55: *Conditional Formatting – each weekday is formatted differently*

Conclusion

In this chapter, we have showcased **`SEQUENCE`** in more than 30 examples. This function has been used in various instances, on any scale of time: from second, minute, hour to week, month, and yearly operations. **`SEQUENCE`** is indispensable in this context. We demonstrated how to calculate time gaps (seconds, minutes, and so on), how to set timetables, how to compute net working days in a period of time with/without weekends and/or holidays, how to create a dynamic sequence of dates, how to build classic and non-classic monthly calendars, how to construct vertical and horizontal yearly calendars with/without formatting the weekdays, how to assemble presence tables, how to find out the number of a certain weekday in a particular period of time, and how to display your monthly calendar in other languages and many more.

In the next chapter, we will discuss some very interesting solutions related to financial challenges. We will see how the **`SEQUENCE`** function is requisite in shortening the process of solving fiscal problems.

Points to remember

- **`SEQUENCE`** is ideal when constructing calendars, either monthly or yearly. Clever use of Conditional Formatting makes your calendar both flexible and outstanding.

- By using **`SEQUENCE`**, you can easily set up a perfect substitution for the NETWORKDAYS.INTL both in scope and in flexibility.

- **`SEQUENCE`** easily generates the list of the first or last day of the months of a given year.

- **`SEQUENCE`** is phenomenal in setting timetables based on fixed gaps of time.

CHAPTER 6

Financial Operations with SEQUENCE

Introduction

This chapter manifests the use of **`SEQUENCE`** in core financial functions. The implementation of this function in traditional fiscal functions is nothing short of a revolution. Now, one can quickly review several solutions at once. No need to code many formulae to view multiple results. Some finely chosen examples of business-oriented functions illustrate the advantages of using **`SEQUENCE`** in functions that hitherto were implemented without arrays, neither as input nor as output. These functions are the standard financial functions of Excel, used throughout the world of finance, especially in loans and investments.

Structure

In this chapter, we will discuss the following topics:

- Examples of **`SEQUENCE`** with financial functions
    - Loan return by payments per period
    - PMT - Periodic payment of a loan – traditional method
    - Periodic payment of a loan – a more flexible method
    - The Depreciation function in Excel – DB

- ○ Equally divide a sum of money over a period of time
- ○ One formula: How varying loan amounts impact the loan's installments
- ○ NPV – No need for a Data table
- ○ PDURATION - Multiple results
- ○ The RATE function – multiple results
- ○ RRI - calculate the average annual interest rate of an investment
- ○ SEQUENCE and SUM

Objectives

The goal of this chapter is to give you, the reader of this book, some ideas on how to use "traditional" financial functions in a manner that will save you time as well as display several optional solutions simultaneously. This will make it easier for you to determine which is the scenario that best suits your needs, instead of wasting time running multiple simulations with a single argument and solution.

Examples of SEQUENCE with financial functions

The following sections manifest the use of **`SEQUENCE`** in core financial functions.

Loan return by payments per period

We need to return a loan, but cannot decide how to *spread* the installments over a period of time. The number of payments per period is defined in cell E1. The larger this number, the smaller the number of periods. In principle, it does not really matter whether the period is a month, a quarter, or a year. We just want to know the total amount of periods given the number of installments (defined in A4:A8) and the parameter in E1.

So, for example, if we are supposed to return 18 installments (cell A4) where, in each period we return six installments, then the total period to return that loan would be three periods (result in G4). If we have only nine installments, (cell A6) then we need two periods (G6), to return six payments in in the first period and three payments in the second period. This is illustrated in the following figure:

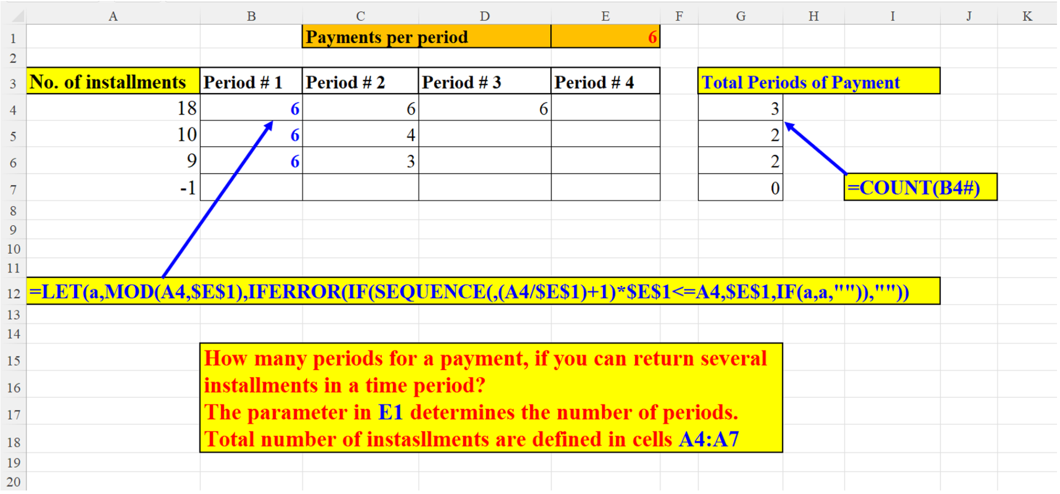


***Figure 6.1**: Loan Return by payments per period*

PMT - Periodic payment of a loan – traditional method

When returning a loan, we want to know the amount of money we are supposed to pay on each installment, whether we return the money monthly, quarterly, or yearly. So far, we could calculate the PMT (periodic payment for constant payments and constant interest rate) for only one amount or only one interest rate, as explained in the example.

In the following example, we will demonstrate the monthly payment due for a fixed loan amount (PV in cell H2) and a fixed interest rate (4.40% = cell F2 + cell I2) for a period of 12 months (nper=number of periods, in cell G2). Since this is the traditional method, we get only result (in cell A2). To make the calculation more flexible, we added 2 spin buttons, one for the initial rate (in cell D2) and the second for the incremental rate (in cell K2). Cells E2 and J2, respectively, are helper cells, since the spin buttons can handle only integers, not fractions. F2 is the initial rate (4%). We divide cell E2 by 100 and cell I2 is the incremental rate (0.4%). We divide cell J2 by

1000. The first argument to the formula (B2) is the monthly rate (=4.40%/12) since we return the loan monthly as shown in the following screenshot:

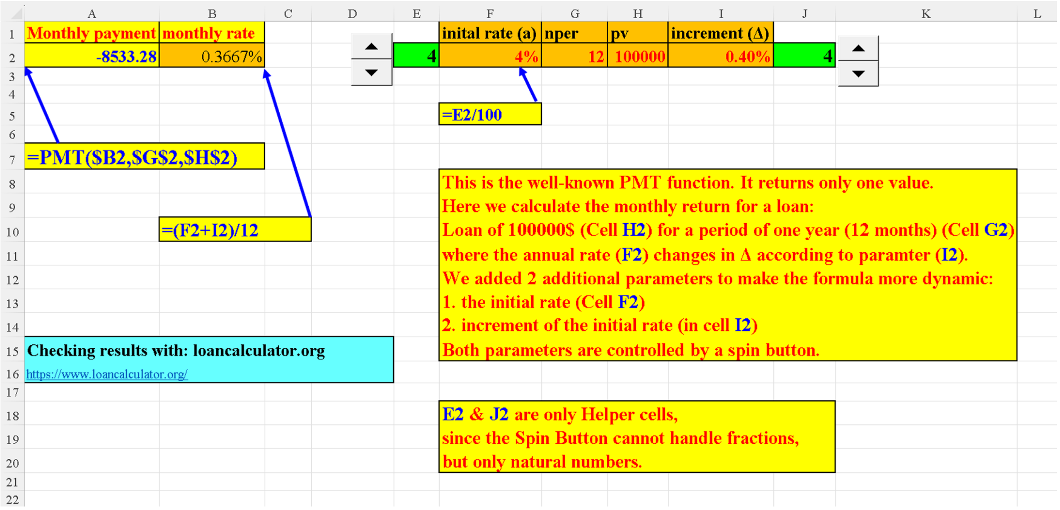


Figure 6.2: *Monthly payment of a loan – "traditional" method*

Now we can compare our calculation to the result in **www.loancalculator.org**. As can be clearly seen, our result in *Figure 6.2* and the site's result (in *Figure 6.3*) are identical:

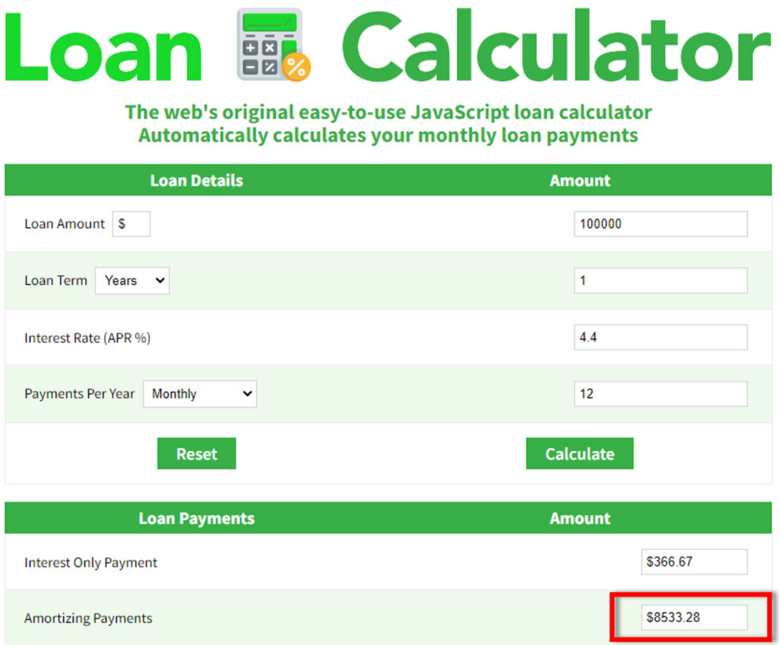


Figure 6.3: *Monthly payment of a loan – comparing the result with Loan Calculator site*

In the following figure, we can see that the **Spin** button for the initial rate is linked to cell E2. Since, as stated previously, the **Spin** button cannot display fractions, the desired interest rate (4%) is achieved in cell F2 by dividing E2 by 100 as shown in the following screenshot:

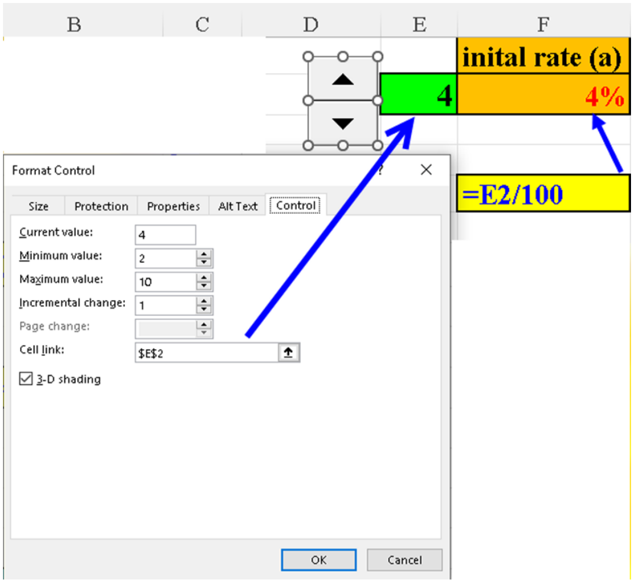


***Figure 6.4**: Monthly payment of a loan – Spin Button – Initial Rate*

The following figure shows the **Spin** Button for the incremental rate. It is linked to cell J2. Since, as stated previously, the **Spin** button cannot display fractions, the desired incremental rate (0.4%) is achieved in cell I2 by dividing J2 by 1000 as shown in the following screenshot:

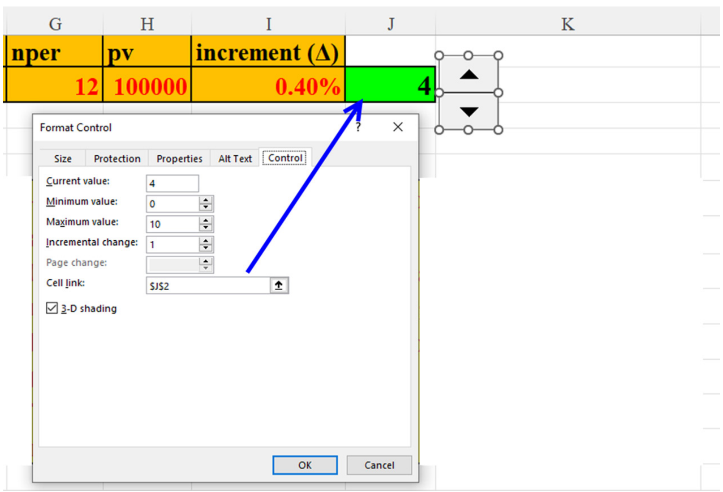


***Figure 6.5**: Monthly payment of a loan – Spin Button – Incremental Rate*

Periodic payment of a loan – a more flexible method

As we have seen in the previous section, the traditional PMT function returns only one value. However, if we want to examine the PMT [=periodic payment] for several interest rates, we hereby suggest a more flexible method. The idea is that you can play with one or more arguments of this function, for example, the interest rate. Instead of feeding the formula with only one value, we can provide it with an array of value thanks to the **`SEQUENCE`** function. As can be seen in *Figure 6.6*, we have an array of 12 monthly interest rates (cells B2:B13), starting from 4% (parameter in F2) growing by the increment defined in I2. The **`SEQUENCE`** function within the PMT formula: **`SEQUENCE(F5,F2,I2)/12`** - creates the array shown in B2:B13 and enables us to generate a simulation of 12 monthly payments (as can be seen in the result's array, cells A2:A13) for 12 different monthly rates, as opposed to just one payment in Section, *Periodic payment of a loan – traditional method* above.

The same method of **`Spin`** buttons is used here, exactly as in our previous example (see *Figure 6.4* and *Figure 6.5*), so there is no need to display them again.

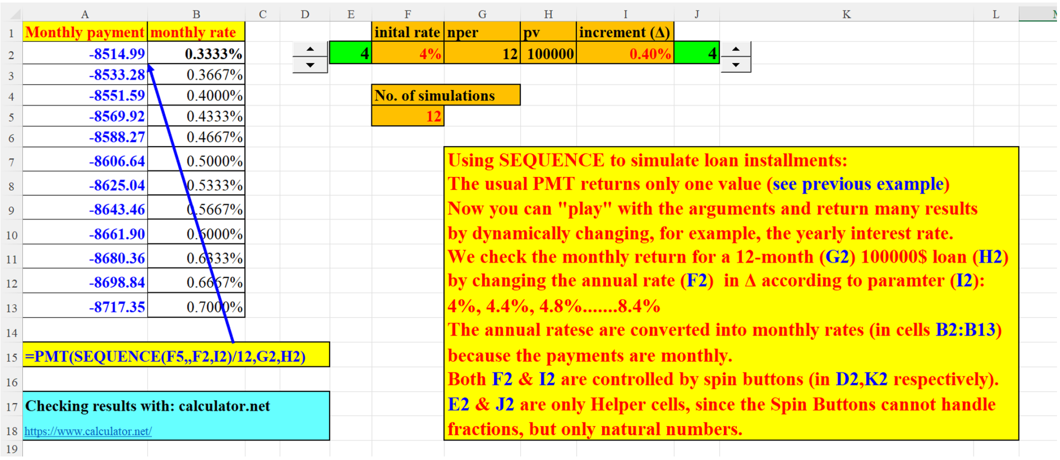


Figure 6.6*: Periodic payment of a loan – a more flexible method*

On comparing our calculation to the result in **www.loancalculator.org**. we can clearly see that the result (in *Figure 6.6*) (cell A2) and the site's result (in *Figure 6.7*) are identical:

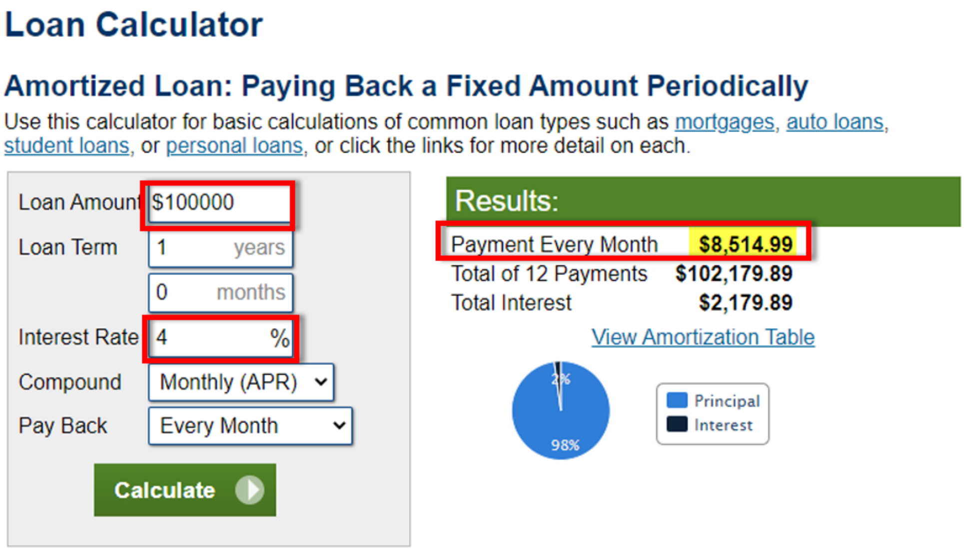


Figure 6.7: *Periodic payment of a loan – compare result in cell A2 (Figure 6.6) with Loan Calculator site*

Comparing our calculation to the result in **www.loancalculator.org**. As can be clearly seen, our result (in *Figure 6.6*) above (in cell A3) and the site's result (in *Figure 6.8*) are identical:

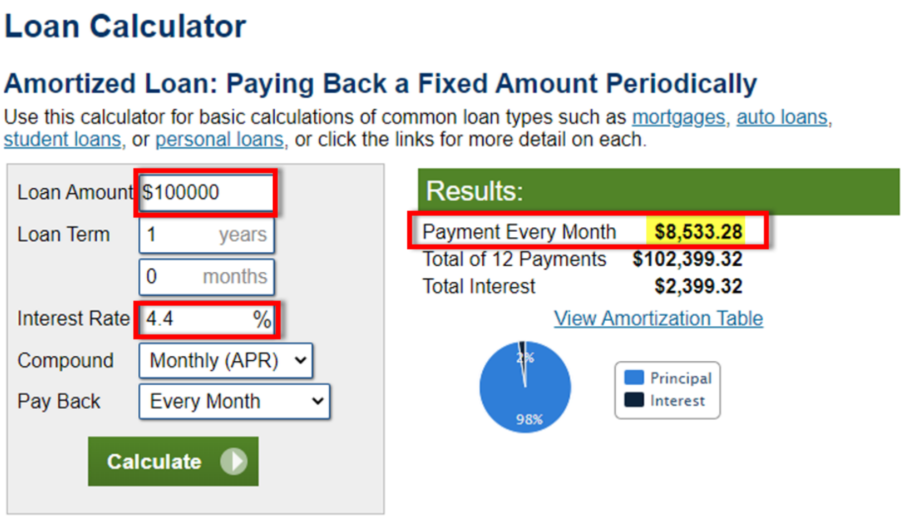


Figure 6.8: *Periodic payment of a loan – compare result in cell A3 (Figure 6.6) with Loan Calculator site*

The following figure (*Figure 6.9*) shows the same result as in cell A13 (*Figure 6.6*). It is displayed to compare our results with the site's results:

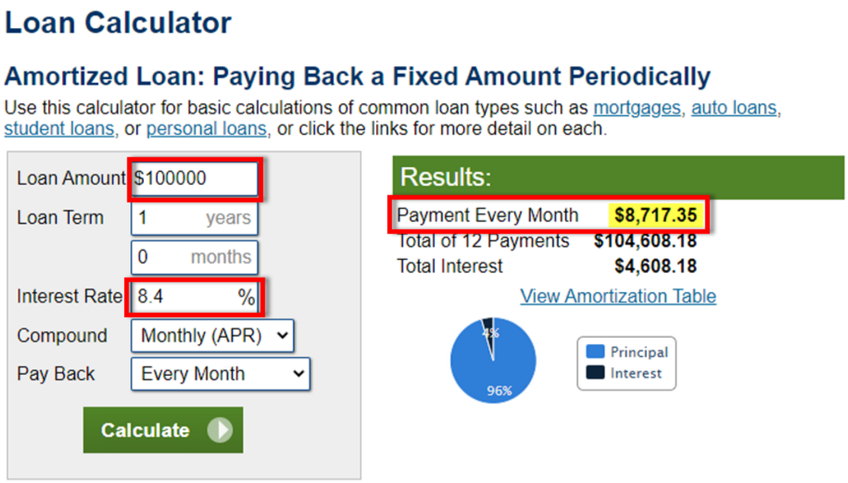


***Figure 6.9**: Periodic payment of a loan – compare result in cell A13 (Figure 6.6) with Loan Calculator site*

The Depreciation function in Excel – DB

Depreciation (do not mix it with deprecation) is the inevitable process by which an asset gradually reduces its value as time goes by. The original method requires a formula for each period (as can be seen in the upper part of *Figure 6.10*).

We propose a simpler solution where one formula (in cell C9) replaces five formulae. If the depreciation period is longer, then of course the advantage of this technique is even more conspicuous as shown in the following screenshot:

	A	B	C	D	E	F	G	H
1	**Initial Cost**	200,000						
2	**Salvage value**	25,000						
3	**Life (depreciation period)**	5	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	
4	**Period**	1,2,3,4,5	1	2	3	4	5	
5								
6		**Depreciation amount**	$ 68,000.00	$ 44,880.00	$ 29,620.80	$ 19,549.73	$ 12,902.82	
7		**calculated per year**	=DB(B1,B2,B3,C4)	=DB(B1,B2,B3,D4)	=DB(B1,B2,B3,E4)	=DB(B1,B2,B3,F4)	=DB(B1,B2,B3,G4)	
8								
9		**Depreciation amount**	$ 68,000.00	**Year 1**				
10		**calculated at once**	$ 44,880.00	**Year 2**				
11		**in one formula**	$ 29,620.80	**Year 3**				
12		**for all 5 years**	$ 19,549.73	**Year 4**				
13			$ 12,902.82	**Year 5**				
14								
15				**=DB(B1,B2,B3,SEQUENCE(5))**				
16								
17			**Calculating the declining-balance depreciation of an asset**					
18			**The depreciation (DB) calculated separately per each year (5 formulae C6:G6)**					
19			**can be achieved with only one formula instead of 5 (cell C9)**					
20								
21								
22								

***Figure 6.10**: The Depreciation function – one formula instead of five*

Equally divide a sum of money over a period of time

The following figure indicates a simple procedure to equally divide a certain amount of money (defined in C2) into a defined number of months (in cell B2) starting from a certain date (visible in cell A2). The period's dates are constructed dynamically in row 1 (cells D1:O1) and the amounts per month are displayed in row 2 (cells D2:O2). The number of months defined in cell B2 cannot exceed 12:

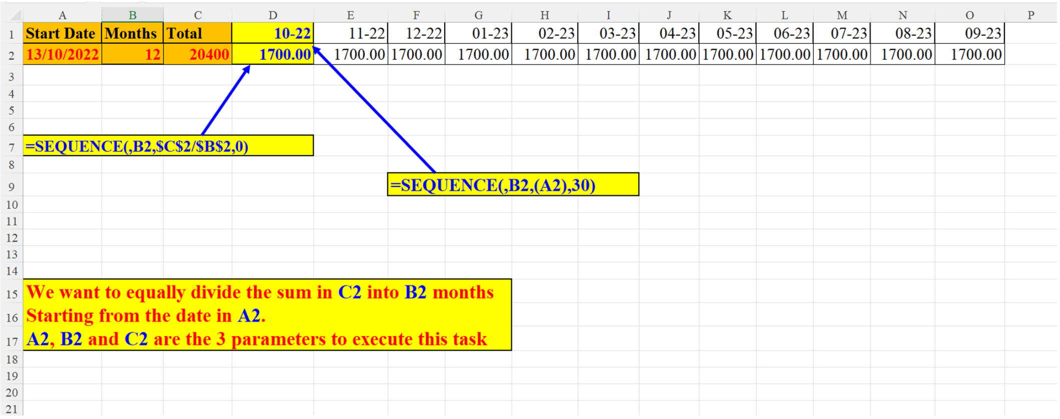


***Figure 6.11**: Equally divide a sum of money over a given period of time*

One formula - How varying loan amounts impact the loan's installments

The traditional PMT function can handle only one amount at a time. But what if we would like to simulate more than one loan **Present value** (**PV**)?

Well, **`SEQUENCE`** comes to the rescue again:

We simulate two payment frequencies:

- Quarterly (in *Figure 6.12*) and
- Monthly (in *Figure 6.15*)

This is controlled by the parameter in cell E2 (Data Validation drop-down list with 2 values: 4 – quarterly, 12 – monthly).

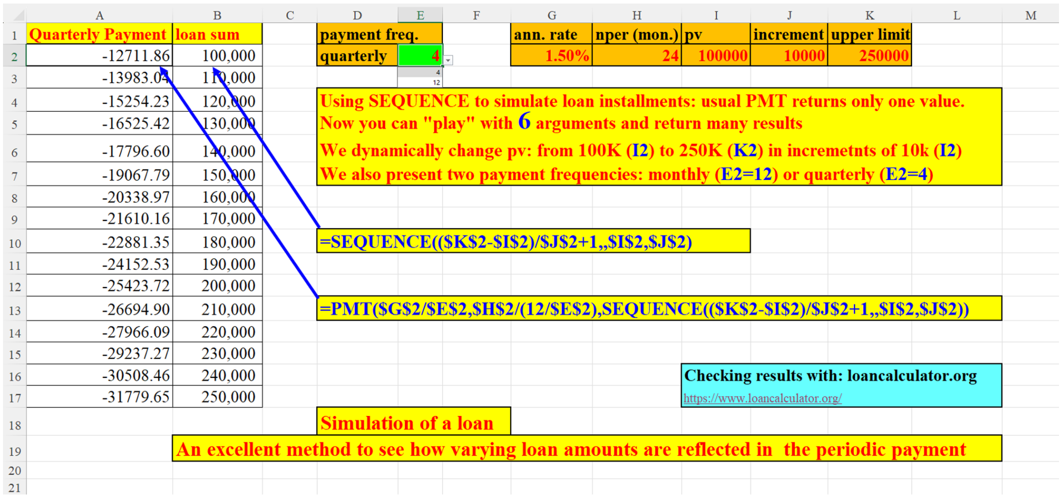
Figure 6.12 makes this evident. We have six arguments for this PMT simulation:

1. Payment Frequency (cell **E2**) = quarterly
2. Annual rate (in cell **G2**) = 1.50%

3. Number of payments (in cell **H2**) = 24
4. Loan amount (in cell **I2**) = 100,000
5. Increment (in cell **J2**) = 10,000
6. Upper limit (in cell **K2**) = 250,000

The last two arguments are *dedicated* for the dynamic solution: in the *traditional* method, we needed only the first four arguments. The new arguments (number 5 and 6) are arguments to the **`SEQUENCE`** function (as can be seen in cell D10): we start with the loan amount (I2) with increments of (J2) for a number of instances calculated in the expression: **`($K$2-$I$2)/$J$2+1`** So, in column B (cells B2:B17) we can see the sequence of loan amounts, which correspond to the (quarterly) payments in column A (cells A2:A17).

With only one formula we clearly see how varying loan amounts are reflected in the periodic payments as shown in the following screenshot:



Quarterly Payment	loan sum
-12711.86	100,000
-13983.04	110,000
-15254.23	120,000
-16525.42	130,000
-17796.60	140,000
-19067.79	150,000
-20338.97	160,000
-21610.16	170,000
-22881.35	180,000
-24152.53	190,000
-25423.72	200,000
-26694.90	210,000
-27966.09	220,000
-29237.27	230,000
-30508.46	240,000
-31779.65	250,000

payment freq.	
quarterly	4

ann. rate	nper (mon.)	pv	increment	upper limit
1.50%	24	100000	10000	250000

Figure 6.12: *Multiple loan amounts (PV) – quarterly payment frequency*

Checking the formula's accuracy for a $100,000 loan (payment= quarterly, annual rate=1.5%, number of payments=24). The result in *Figure 6.12* (cell A2) is identical to the result in the following screenshot (*Figure 6.13*). The picture is from the Loan Calculator site:

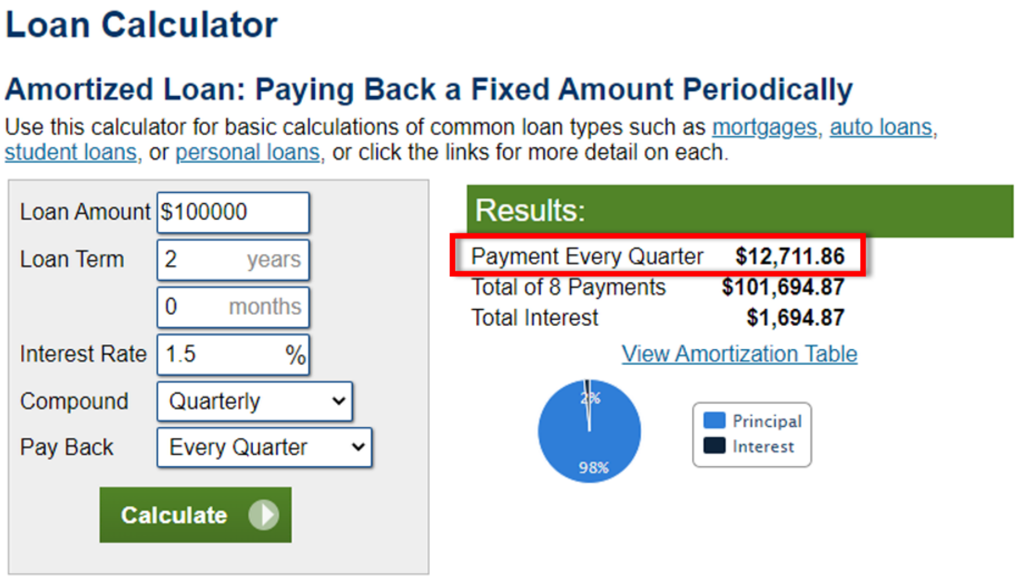


Figure 6.13*: Multiple loan amounts (PV) – quarterly payment for a 100,000$ loan*

Checking the formula's accuracy for a $250,000 loan (payment= quarterly, annual rate=1.5%, number of payments=24). The result in *Figure 6.12* (cell A17) is identical to the result in the following screenshot (*Figure 6.14*). The picture is from the Loan Calculator site:

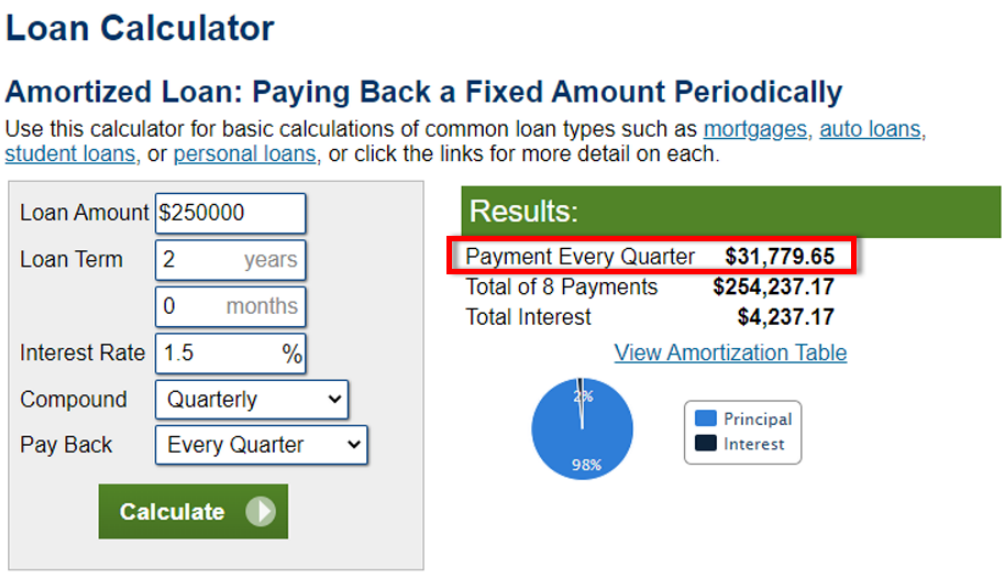


Figure 6.14*: Multiple loan amounts (PV) – quarterly payment for a 250,000$ loan*

The following screenshot is the counterpart of *Figure 6.12*. It shows the same loan simulation, but here, the pay back is monthly, not quarterly:

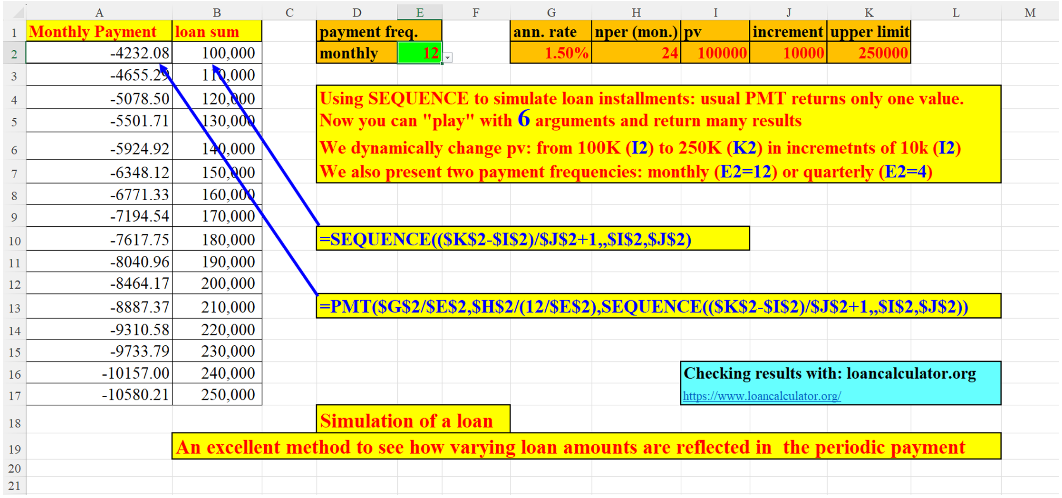


***Figure 6.15**: Multiple loan amounts (PV) – monthly payment frequency*

Checking the formula's accuracy (*Figure 6.15*) for a $100,000 loan (payment= monthly, annual rate=1.5%, number of payments=24). The result in *Figure 6.15* (cell A2) is identical to the result in the following screenshot (*Figure 6.16*). The picture is from the Loan Calculator site:

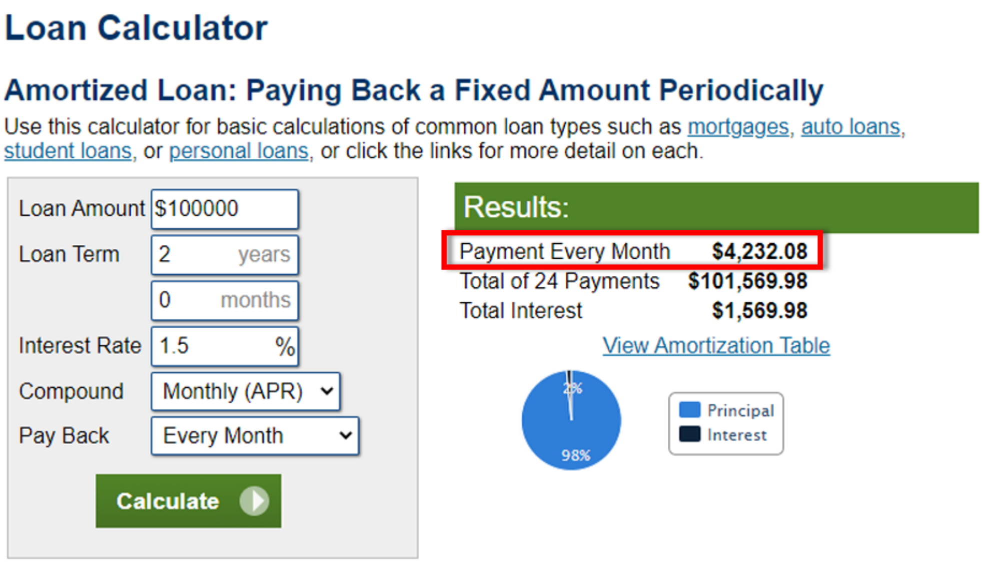


***Figure 6.16**: Multiple loan amounts (PV) – monthly payment for a 100,000$ loan*

Checking the formula's accuracy (*Figure 6.15*) for a $100,000 loan (payment= monthly, annual rate=1.5%, number of payments=24). The result in *Figure 6.15* (cell A17) is identical to the result in the following screenshot (*Figure 6.17*). The picture is from the Loan Calculator site :

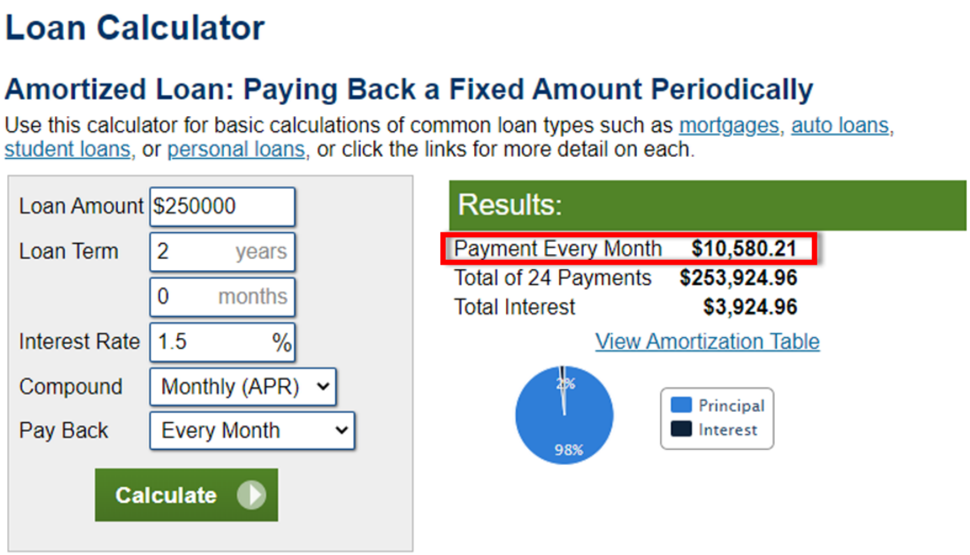


Figure 6.17: *Multiple loan amounts (PV) – monthly payment for a 250,000$ loan*

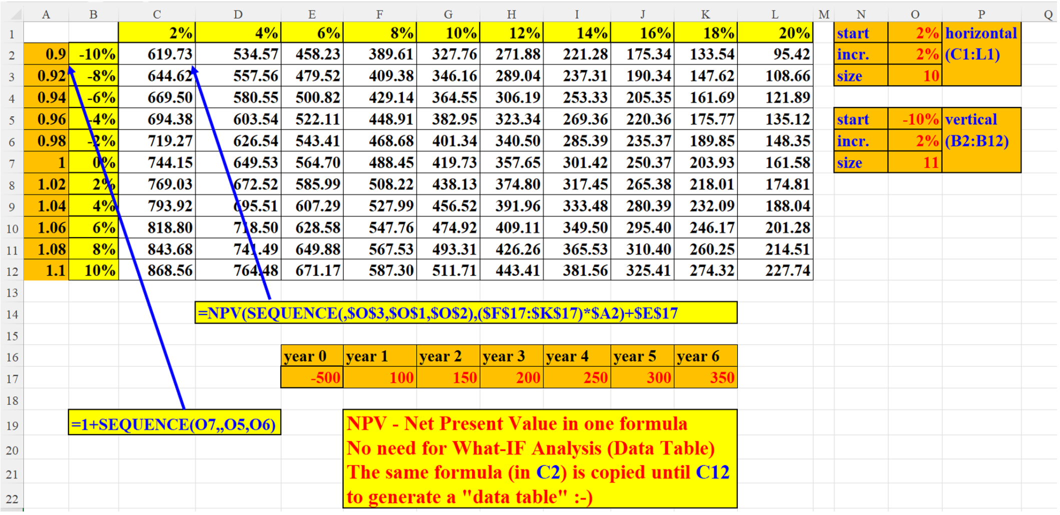
NPV – No need for a data table

This section explains how the data table in Excel's Data Tab menu (**`Data*Forecast*What-If Analysis*Data table`**) becomes redundant if we use the **`SEQUENCE`** function.

The following is a sensitivity analysis of **Net Present Value** (**NPV**):

- We have a two-dimensional array: the vertical (cells B2:B12) analyses the cash flow from: 10% to: +10% (in increments of 2%) [see cells N5:O7] whereas the horizontal array (cells C1:L1) examines the cost of capital from: 2% to: 20% (in increments of 2%) [see cells N1:O3]
- The investment (-500) can be seen in E17. We are analyzing the cash flow for years 1-6 (cells F17:K17).
- As can be seen in the formula written in cell C2, the NPV is calculated for the cash flow array (C2:C12, corresponding to B2:B2). The formula in cell C2 is then dragged to the right all the way to the last horizontal array item: C2:L2.

So here you have it, one formula instead of the *old-fashioned* data table:



	A	B	C	D	E	F	G	H	I	J	K	L
1			2%	4%	6%	8%	10%	12%	14%	16%	18%	20%
2	0.9	-10%	619.73	534.57	458.23	389.61	327.76	271.88	221.28	175.34	133.54	95.42
3	0.92	-8%	644.62	557.56	479.52	409.38	346.16	289.04	237.31	190.34	147.62	108.66
4	0.94	-6%	669.50	580.55	500.82	429.14	364.55	306.19	253.33	205.35	161.69	121.89
5	0.96	-4%	694.38	603.54	522.11	448.91	382.95	323.34	269.36	220.36	175.77	135.12
6	0.98	-2%	719.27	626.54	543.41	468.68	401.34	340.50	285.39	235.37	189.85	148.35
7	1	0%	744.15	649.53	564.70	488.45	419.73	357.65	301.42	250.37	203.93	161.58
8	1.02	2%	769.03	672.52	585.99	508.22	438.13	374.80	317.45	265.38	218.01	174.81
9	1.04	4%	793.92	695.51	607.29	527.99	456.52	391.96	333.48	280.39	232.09	188.04
10	1.06	6%	818.80	718.50	628.58	547.76	474.92	409.11	349.50	295.40	246.17	201.28
11	1.08	8%	843.68	741.49	649.88	567.53	493.31	426.26	365.53	310.40	260.25	214.51
12	1.1	10%	868.56	764.48	671.17	587.30	511.71	443.41	381.56	325.41	274.32	227.74

	N	O	P
1	start	2%	horizontal
2	incr.	2%	(C1:L1)
3	size	10	
5	start	-10%	vertical
6	incr.	2%	(B2:B12)
7	size	11	

=NPV(SEQUENCE(,$O$3,$O$1,$O$2),($F$17:$K$17)*$A2)+$E$17

	E	F	G	H	I	J	K
16	year 0	year 1	year 2	year 3	year 4	year 5	year 6
17	-500	100	150	200	250	300	350

=1+SEQUENCE(O7,,O5,O6)

NPV - Net Present Value in one formula
No need for What-IF Analysis (Data Table)
The same formula (in C2) is copied until C12
to generate a "data table" :-)

***Figure 6.18**: NPV – instead of a Data Table*

PDURATION - Multiple results

The classic **PDURATION** function calculates the number of periods (in years or in months) until a certain investment amount (in our example: cell B1 = $8000) reaches the desired **Future value** (**FV**), in our case: $16,000 (in cell B2).

The classic solution is shown in cell D18. The **PDURATION** function takes three arguments: Monthly Rate (cell B20), PV and FV (B1 and B2, respectively, as explained previously).

However, replacing the first argument with an array (cells D5:D13), yields an array of results, as can be seen in cells A5:A13. The array size is set in cell A3. To make the solution even more flexible, we have added 2 spin buttons: one for the annual rate (in cell H1, linked to G1) and one for the increments (Δ in cell H2, linked to G2). Thus, we can control both the initial annual rate and the size of the increments, as shown in the following screenshot:

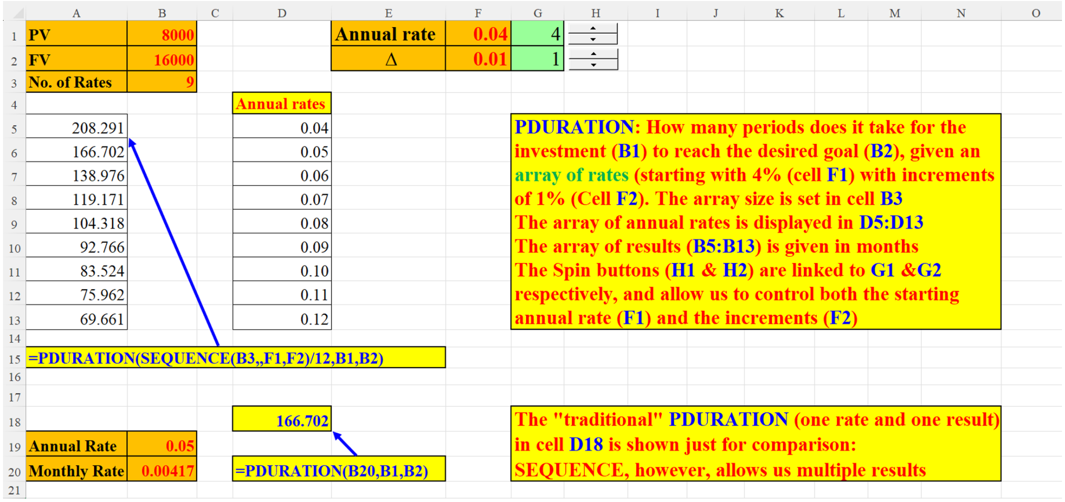


Figure 6.19: *The PDURATION function – "classic" vs. "revolutionary"*

The **Spin button** for the annual rate is defined in cell H1. It is linked to cell G1. Since the rates are expressed in percentage, the value in G1 is divided by 100 as shown in the following screenshot:

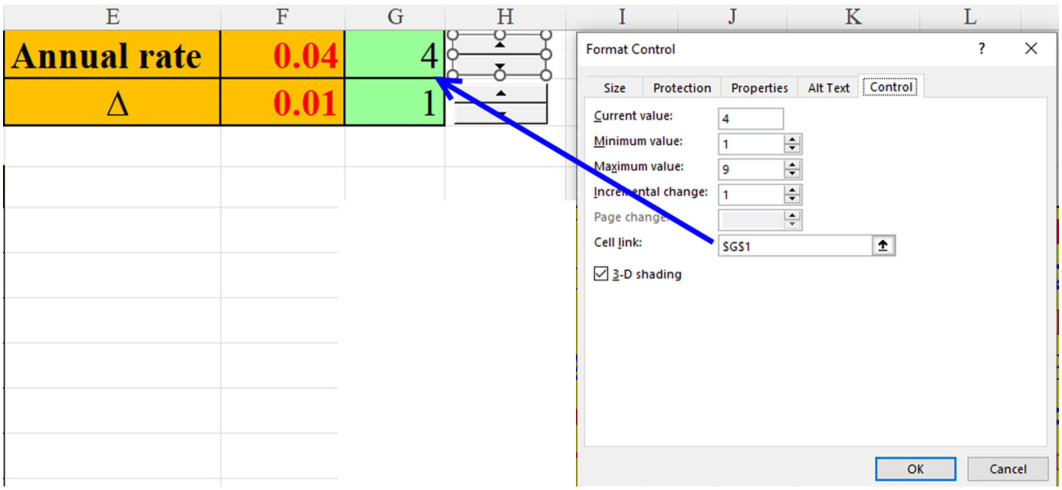


Figure 6.20: *The* ***PDURATION*** *function – Spin Button – Annual Rate*

The **Spin button** for the interest rate increments is defined in cell H2. It is linked to cell G2. Since the rates are expressed in percents, the value in G2 is divided by 100 as shown in the following screenshot:

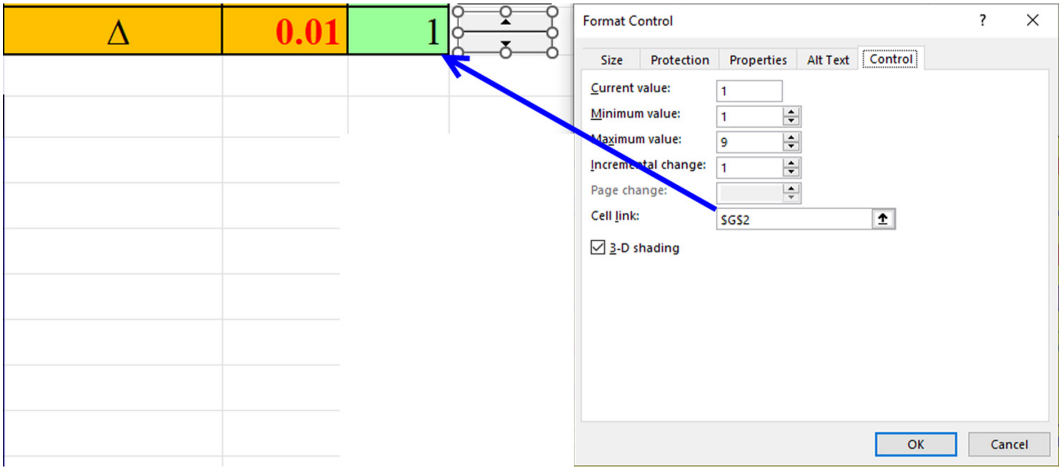


Figure 6.21*: The PDURATION function – Spin Button – Increment (Δ)*

The RATE function – multiple results

The **RATE** function usually returns only one value. It takes three arguments:

- Loan period (cell D1, in *Figure 6.22*)
- Monthly payment (cell D2, in *Figure 6.22*)
- Loan amount (cell D3, in *Figure 6.22*)

However, by replacing the last argument with an array of 11 members (parameter in cell G1), as shown in cells D7:D17, we can examine the impact of 11 different loan amounts on the monthly rate, (cells A7:A17) where both the loan period and the monthly payment are immutable.

The multiple results option in the **RATE** function is possible, of course, thanks to the **SEQUENCE** function as shown in the following screenshot:

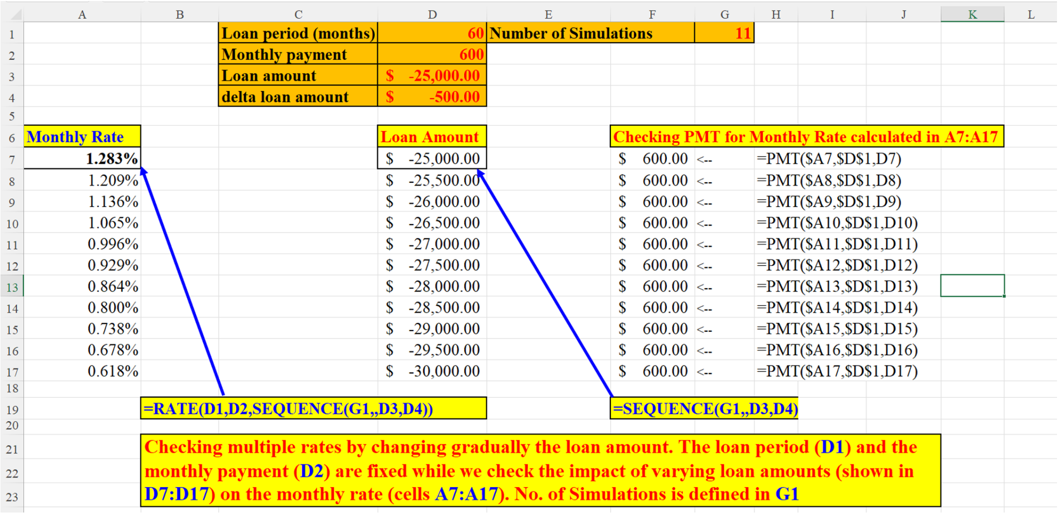


***Figure 6.22**: The RATE function – multiple results*

RRI - calculate the average annual interest rate of an investment

The RRI financial function calculates the average annual interest rate for a period.

It takes the following arguments:

The number of years invested (nper), the starting amount (PV), and the ending amount (FV).

This function usually returns only one value. However, by replacing the first argument with an array (created by the **SEQUENCE** function), we can simulate multiple interest rates for multiple periods. In our example, we simulate 10 different periods, from one year to 10 years. The interest rates, as can be seen in cells A1:A10 change accordingly.

The **PDURATION** function (explained previously, **PDURATION** – multiple results) implemented here in cells: H10:H19, is an excellent tool to verify the results of the **RRI** function as shown in the following screenshot. If we calculate the **PDURATION**, where its first argument is the rate (in cell A1=30%), the PV is 10000 (I2+J2) and FV is 13000 (I3+J3) – the result is: 1 (one year). This means that the **RRI** for one year, when the PV is: 10000 and FV is: 13000, will be 30%. The fact that these two functions are *interchangeable* makes it possible to check the result of the **RRI** with the **PDURATION** function, and vice versa:

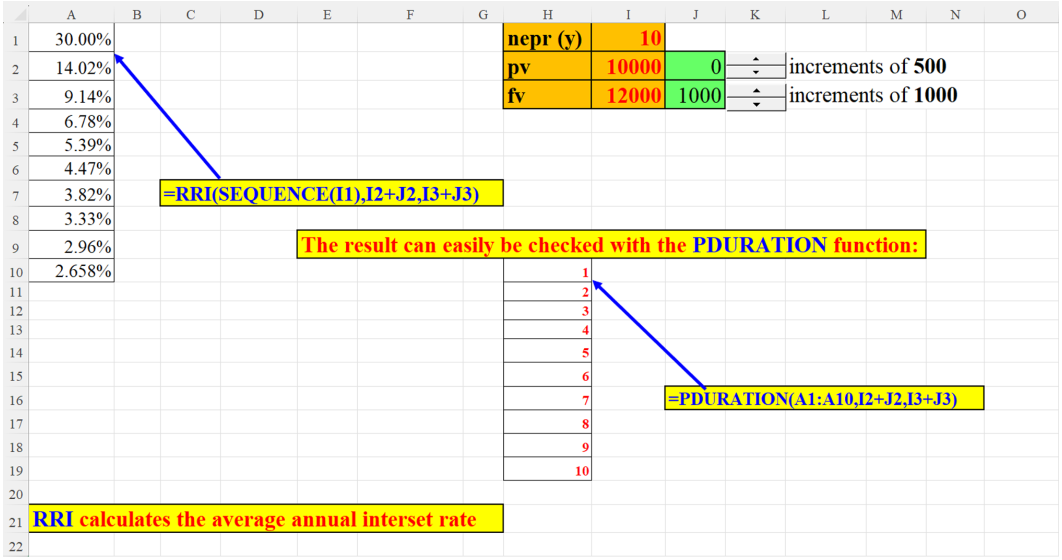


Figure 6.23: Adding multiple average annual interest rates instead of just one

The **Spin button** for incrementing the **Present Value** (**PV**) is defined in cell K2. It is linked to cell J2, and serves to enhance the PV in increments of 500: 500,1000,1500 etc. Its minimum value is: 0 and its maximum value is: 9500.

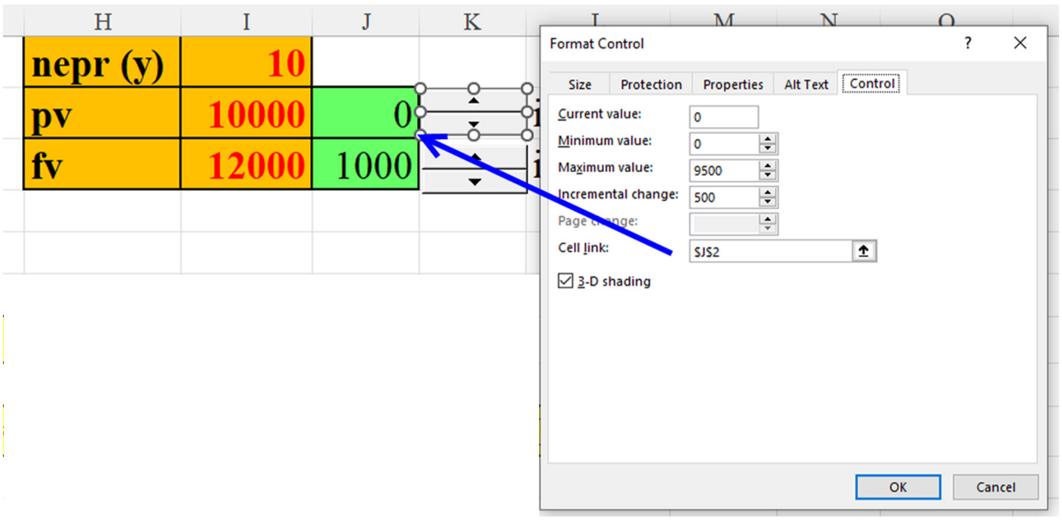


Figure 6.24: Adding multiple average annual interest rates spin button - PV

The **Spin button** for incrementing the **Future Value** (**FV**) is defined in cell K3. It is linked to cell J3, and serves to enhance the PV in increments of 1000: 1000,2000,3000 etc. Its minimum value is: 0 and its maximum value is: 30000:

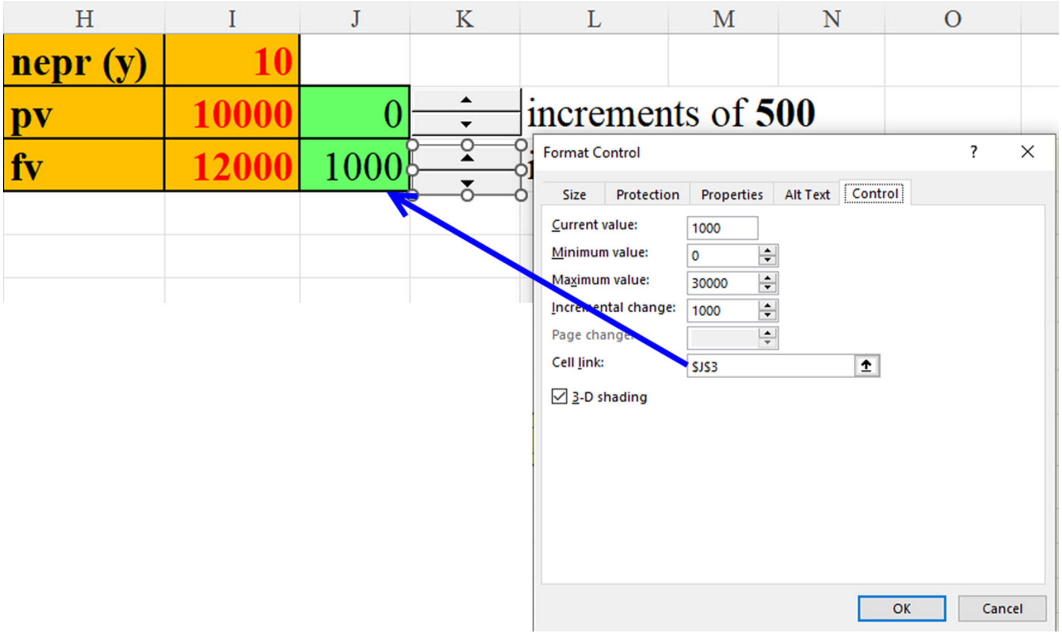


***Figure 6.25**: Adding multiple average annual interest rates spin button - FV*

SEQUENCE and SUM

In this section, we will learn how to sum only transactions from a certain part of the year.

The following figure demonstrates a method by which you can sum transactions which belong to a certain part of the year, for example: April-September, June-October, February-August, and so on.

The trick is to use the months to sum as an array: the number of elements to sum is determined by the expression: K2-K1+1 and the starting month is set by the `From Month` parameter (cell K1):

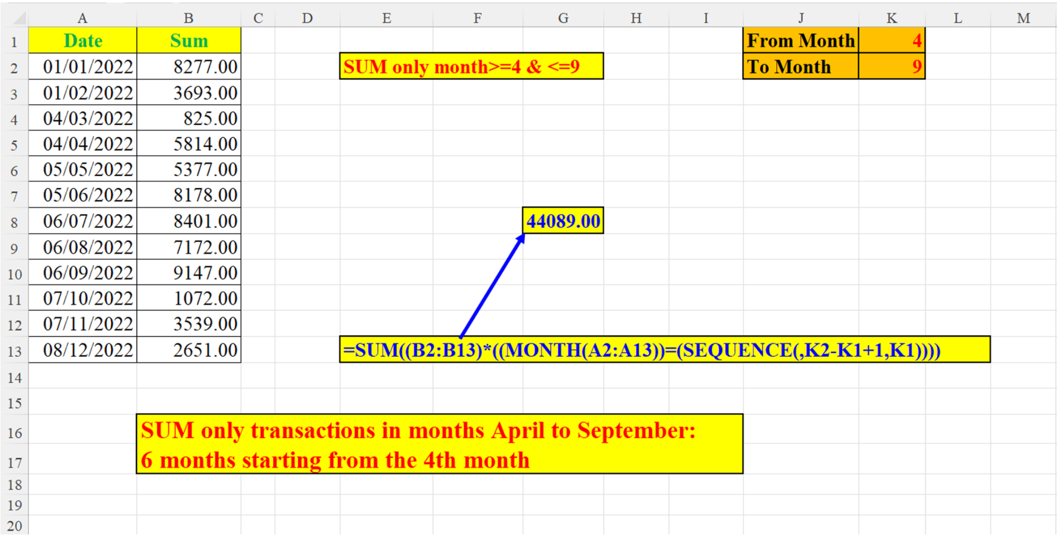


Figure 6.26: Sum only transactions from a defined sequence of months

Conclusion

Most financial functions in Excel accept only single-value arguments and return single-value results. In this chapter, we have shown how to convert such traditional functions into multiple-result functions, thanks to the **`SEQUENCE`** function. Moreover, in cases where we could achieve an array of results (for example, in the **`NPV`** function, by using a Data table, a built-in function in Excel), we showed that this unwieldy method can be easily replaced by the **`SEQUENCE`** function.

In the next chapter, we will discuss some interesting implementations of **`SEQUENCE`** in mathematics: algebra, geometry, trigonometry and more.

Points to remember

- SEQUENCE is extremely practical when you weigh several options, in loans or investments, looking for the optimal interest rate, loan period, periodic payment amount and so on.
- Designing your arguments cleverly can be immensely helpful when setting the increments (Δ) for a certain argument. For example, if you want to see the impact of every fraction of an annual interest rate (0.2%, 0.25%, 0.3%) set the increments accordingly.
- Using **Spin** buttons makes the process much faster and easier. The **Spin** buttons add an additional level of flexibility.

CHAPTER 7
SEQUENCE - The Ancilla of Math

Introduction

Every software is built upon binary logic, that is, numbers containing only 0s and 1s. In this sense, Excel is no exception. However, since Excel is basically a calculatory software, it also has many mathematical functions. The examples in this chapter are going to demonstrate its outstanding capabilities, both in calculations and in its graphical user interface: a visual display of the mathematical computation. This chapter mentions about two dozen examples showcasing the integration of `SEQUENCE` with mathematical functions. The illustrations cover some areas such as: algebra (fractions, sums, powers), probability, trigonometry, bit operations and more.

Structure

In this chapter, we will discuss the following topics:

- Examples of SEQUENCE in math operations
  - A number to the power of
  - Two methods to create a sequence of square roots
  - Two methods to generate a sequence of fractions
  - Creating a sequence of alternate 1's and 0's

- Dynamic quadratic equation
- SUM - a virtual Array
- How many candles
- Raising the number 2 to the power of 10 using bit operation
- Simplest OR
- Dynamic Sine with 2 Spin Buttons
- Exponential Growth example
- Dynamic multiplication table
- BIN2DEC – MMULT and SEQUENCE
- BIN2DEC - SUM (or SUMPRODUCT) with SEQUENCE
- Filling the missing values in a geometric series
- Trigonometry with SEQUENCE
- An array of duplicate numbers generated by bit operations
- Using MMULT and SEQUENCE to track wins, losses, and ties in each quarter
- Digital root
- First N odd numbers squared (A simple solution)
- First N odd numbers squared (A complex solution)
- Find first divisor of a number (divisor found)
- Find first divisor of a number (divisor not found)

Objectives

The objective of this chapter is to show you how advantageous the use of **`SEQUENCE`** is when dealing with mathematical operations. Since **`SEQUENCE`** is an array function, it can speed up your calculations by executing several solutions concurrently. Learning these techniques will undoubtedly save you a lot of time, effort, and frustration.

Examples of SEQUENCE in math operations

The ensuing examples demonstrate the implementation of **`SEQUENCE`** in math.

A number to the power of

The **`POWER`** function in Excel yields only one solution. However, by using the **`SEQUENCE`** function cleverly, we can achieve multiple solution with only one formula. In the example below we use two spin buttons to make the array solution even more flexible. We can control both the numbers to be raised to the desired exponent (in cell J1) and the exponent (in cell M1) as shown in the following screenshot:

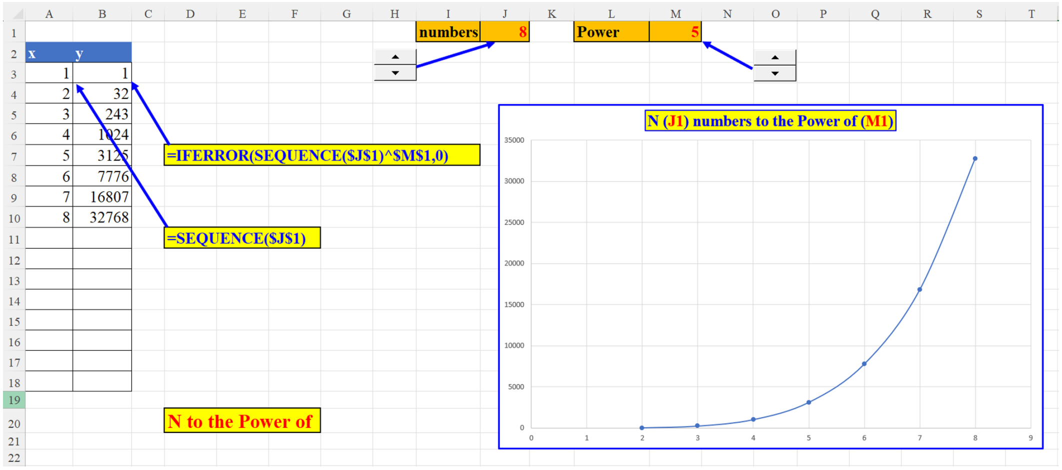


***Figure 7.1**: A number to the power of*

The **Spin** button linked to cell J1 controls the numbers presented in column A as shown in the following screenshot:

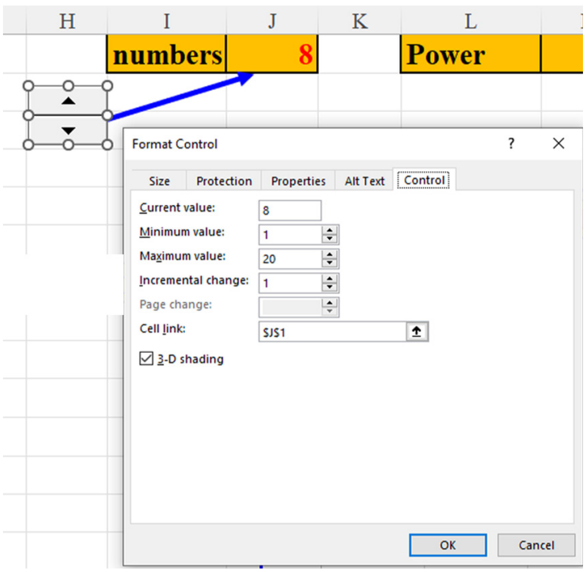


***Figure 7.2**: The Number Spin button*

The **Spin** button linked to cell M1 controls the power by which the numbers in column A are raised.

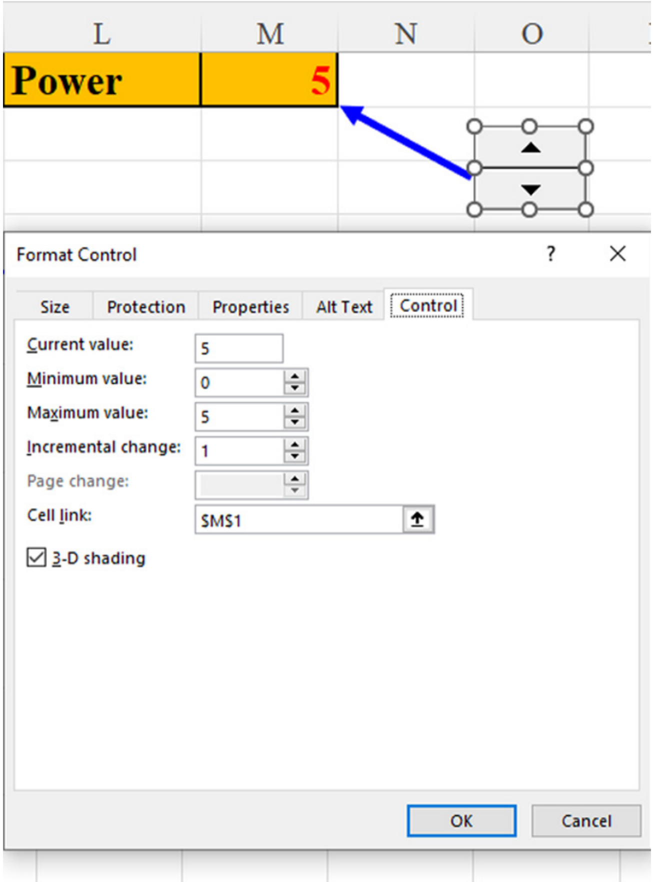


***Figure 7.3**: The Power Spin button*

Two methods to create a sequence of square roots

The method on the left-hand side of *Figure 7.4* uses array constants. This is a static array, that is, whenever you want to increase or decrease the array's size, you need to tamper with the formula. On the right-hand side of the following figure, we have a dynamic array created, with the **SEQUENCE** function. If we want to change the array's size, all we have to do is change the parameter (in L1). We do not touch the formula as shown in the following figure:

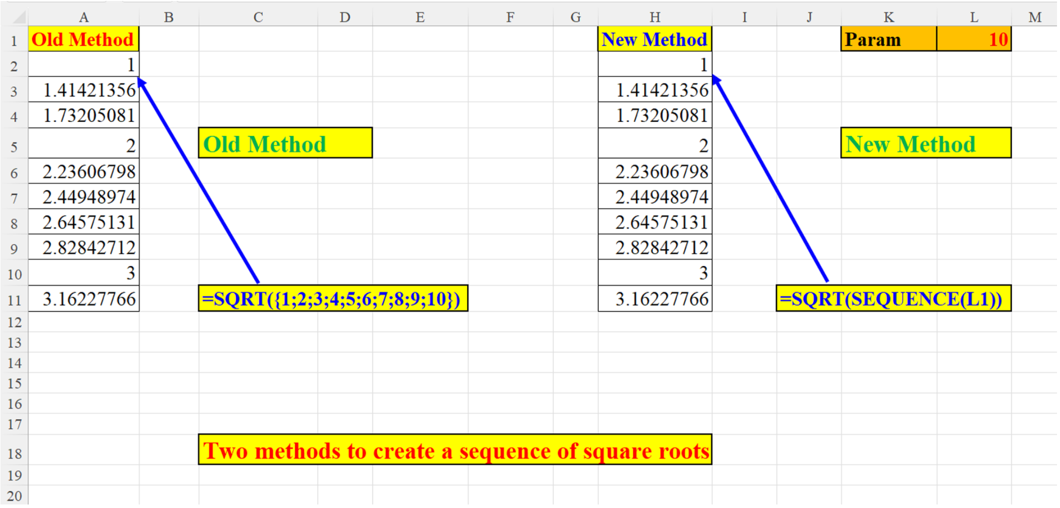


Figure 7.4: Two methods to create a sequence of square roots

Two methods to generate a sequence of fractions

To create an array of n fractions we need to know its size (*n* is 9, defined in cell E1), and the fraction itself (0.1, defined in cell E2). The first method (on the left-hand side) saves us the bother of defining the first member of the array as shown in the following screenshot:

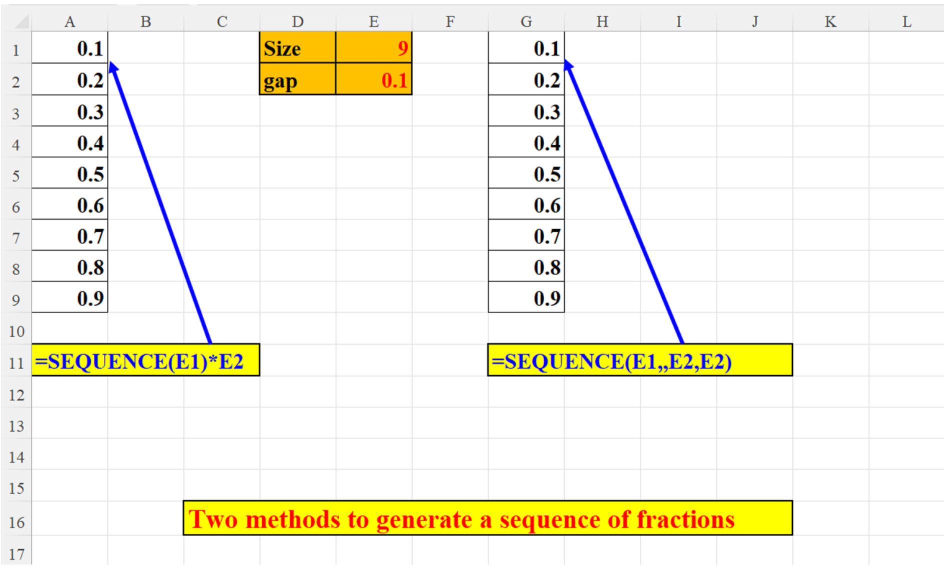


Figure 7.5: Two methods to create a sequence of fractions

Creating a sequence of alternate 1's and 0's

In this section, we will use the **BITAND** function to generate a series of alternate 1's and 0's. To spawn the opposite series, we use the **NOT** operator as shown in the following screenshot:

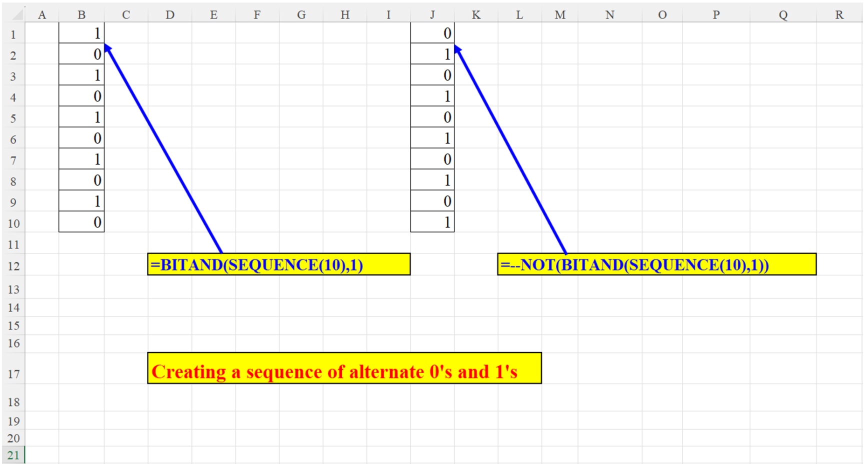


***Figure 7.6**: Creating a sequence of alternate 1's and 0's*

Dynamic quadratic equation

Here is a demonstration of the $Y{=}X^2$ equation, a quadratic equation. Each value in column A (x) is raised to the power of 2 in column B (y). The size of the array is determined by a **Spin** button attached to cell P1 (in our case: 5, so the x axis goes from -5 to 5), as can be seen in the **SEQUENCE** function. We use a helper cell (J1) because a spin button cannot handle negative numbers as shown in the following screenshot:

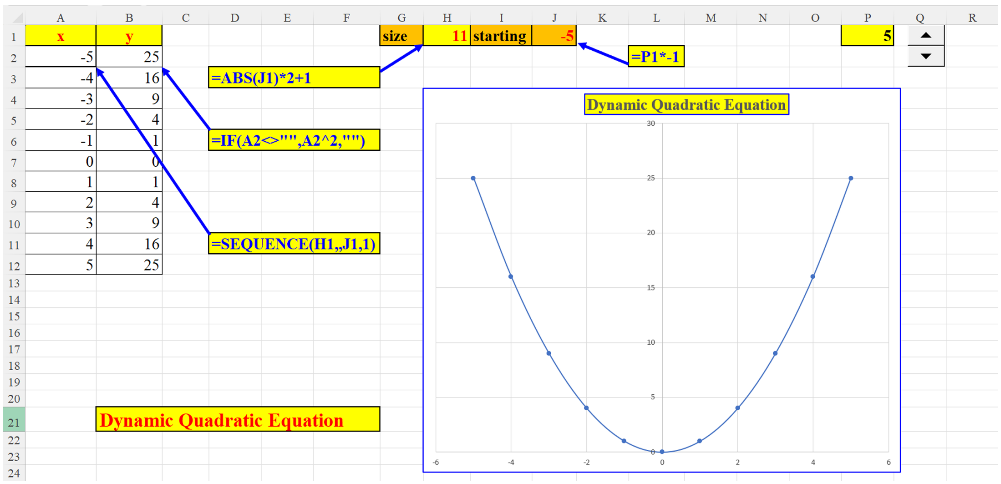


***Figure 7.7**: Dynamic quadratic equation*

The **Spin** button linked to cell P1 determines the two extremes of the array in column A. For example, if P1 is 5 (as in our example), then the array's range is from -5 to +5:

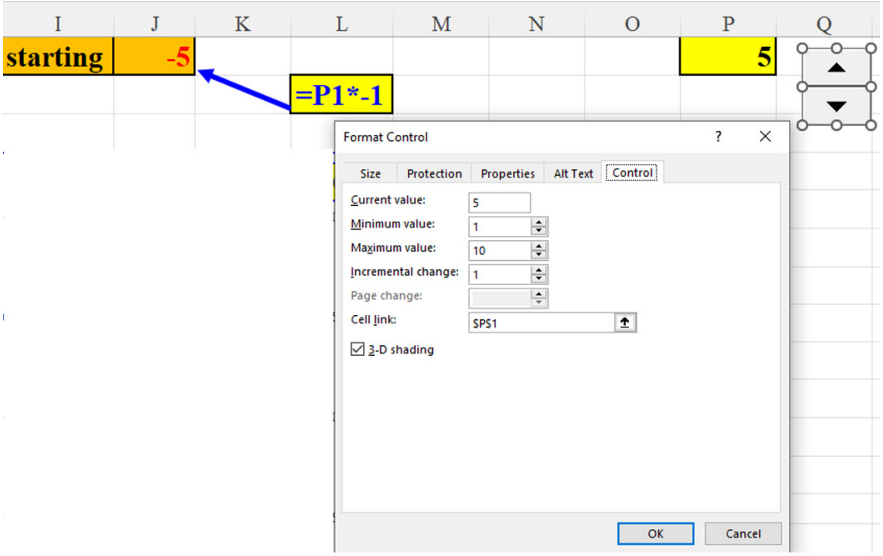


Figure 7.8: Dynamic quadratic equation – Spin button

SUM - a virtual Array

The upper-part function is a demonstration of a bi-dimensional array: 4 rows by 4 columns, which starts with one and is augmented by 3. The sum function on the right then sums this array. The notation C2# is a spill range reference that refers to the entire array and not to cell C2 alone. The formula in the lower part attains the same result with a *virtual* array, that is, the array created (which is exactly the same as the previous one) exists in Excel's memory, but cannot be seen on the spreadsheet itself as shown in the following screenshot:

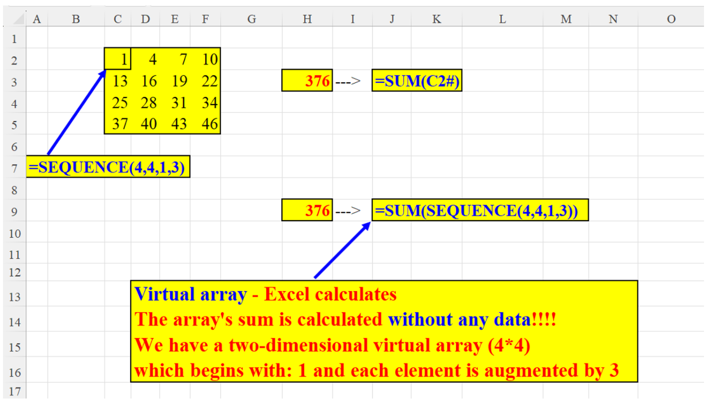


Figure 7.9: SUM a virtual array

How many candles

In the Jewish Feast of lights (which lasts eight days), we light a Hanukkiah (a nine-branched candelabrum). We start by lighting two candles on the first day and ending with nine candles in the eighth and last day of the holiday. But what if we want to add a candelabrum on each day till the last, that is, the eighth day? We will have 8 candelabras. How can we calculate the total candles needed for all the candelabras during the whole feast?

	A	B	C	D	E	F	G
1	Day	Candles needed for 1 candelabra	Candles needed for N candelabras				
2	1	2	2				
3	2	3	6				
4	3	4	12		240		
5	4	5	20				
6	5	6	30				
7	6	7	42				
8	7	8	56		=SUM((SEQUENCE(8)+1)*(SEQUENCE(8)))		
9	8	9	72				
10			240				

13 The Jewish Feast of Lights (Hanukkah) lasts 8 days.
14 On the 1st day you light 2 candles,
15 on the 2nd - three, on the 3rd - four etc.
16 The question:
17 how many candles do we need, if:
18 On the first day you light only one Hanukkiah (9-candle candelabra),
19 on the 2nd - 2 candelabras, on the 3rd - 3 candelabras…?

Figure 7.10*: How many candles*

Raising the number 2 to the power of 10 using bit operation

The **BITLSHIFT** function is a bit operation which shifts to the left bit at a time. Each such shift multiplies the result by 2. Using the **SEQUENCE** function, we can dynamically create a geometric series whose size is set by the parameter in cell H1 as shown in the following screenshot:

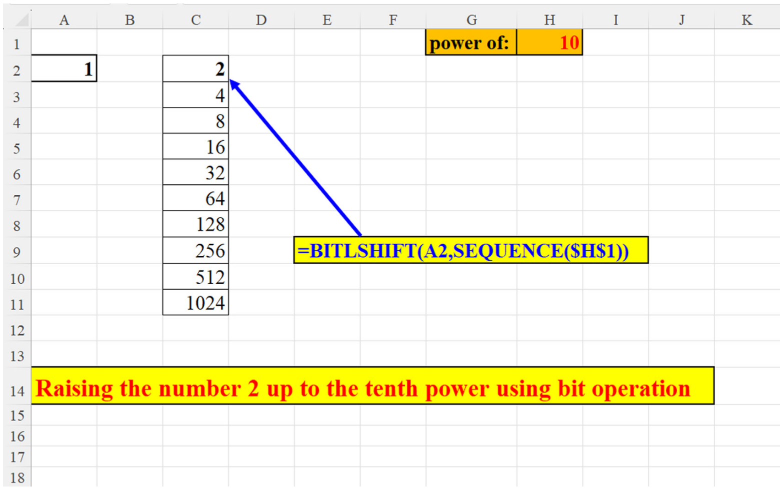


Figure 7.11: *Raising the number 2 to the tenth power using bit operation*

Simplest OR

The fastest, simplest method to check whether the value defined in cell A1 is an integer between 1 and 10 as shown in the following screenshot:

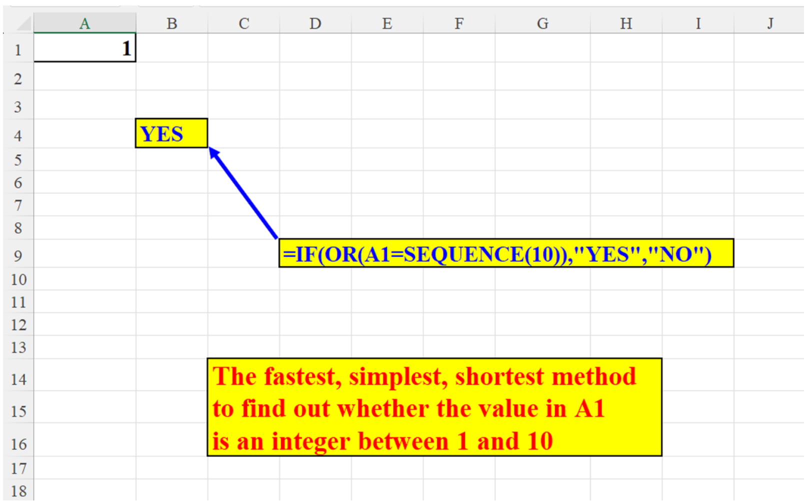


Figure 7.12: *Simplest OR*

Dynamic Sine with two Spin buttons

The following figure displays the use of **SEQUENCE** to create a dynamic sine chart. On the left-hand side we have a table of *x*-*y* values, created dynamically with two spin buttons. The *x*-axis values are expressed in fractions of Radians (=PI() = 180), generated by the first spin button in cell I2 and set by cell G2 (the amplitude). The distance of the chart is indicated by the second **Spin** button in cell N2:

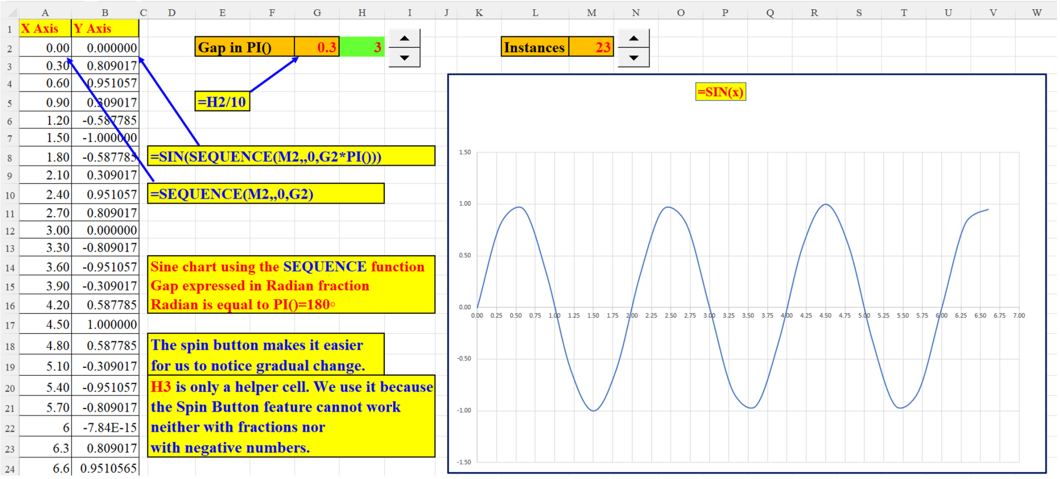


Figure 7.13: *Dynamic SINE with two Spin buttons*

The **Spin** button in cell I2 sets the amplitude of the chart. Since **Spin** buttons cannot take fractions, we divide the value in H2 (the cell linked to the **Spin** button) by 10, to produce a fraction (in G2) as shown in the following screenshot:

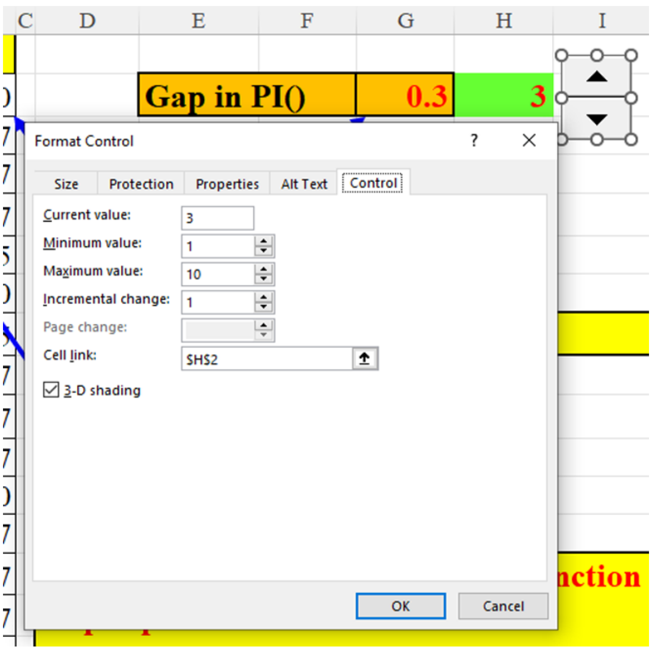


Figure 7.14: *Dynamic SINE – Spin Button 1 – Gap in PI()*

The **Spin** button in I2 determines the number of the chart's instances (*x*-axis values) as shown in the following screenshot:

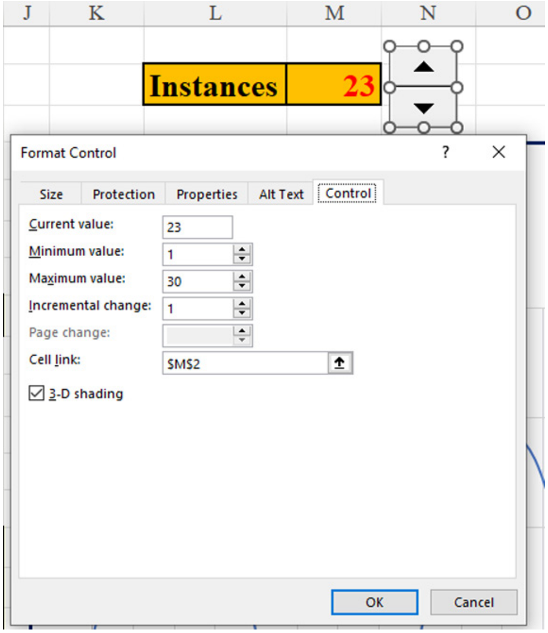
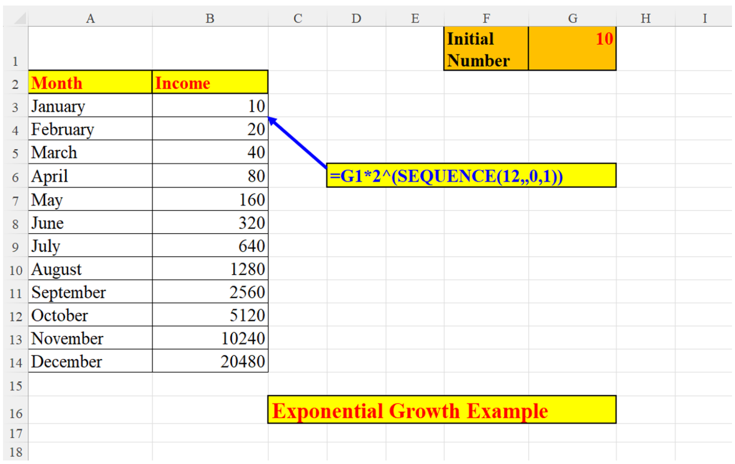


Figure 7.15: *Dynamic SINE – Spin Button 2 – number of instances*

Exponential Growth example

Figure 7.16 displays an array of numbers raised to the power of 2 over a period of 12 months; each value in the array is twice as large as its predecessor. The initial number is a parameter (in cell G1) as shown in the following screenshot:



	A	B	C	D	E	F	G	H	I
1						Initial Number	10		
2	Month	Income							
3	January	10							
4	February	20							
5	March	40							
6	April	80		=G1*2^(SEQUENCE(12,,0,1))					
7	May	160							
8	June	320							
9	July	640							
10	August	1280							
11	September	2560							
12	October	5120							
13	November	10240							
14	December	20480							
15									
16			Exponential Growth Example						
17									
18									

Figure 7.16: *Exponential growth example*

Dynamic multiplication table

The dynamic multiplication table shown below is controlled by two parameters which decide its horizontal (cell Q1) and vertical size (cell Q2):

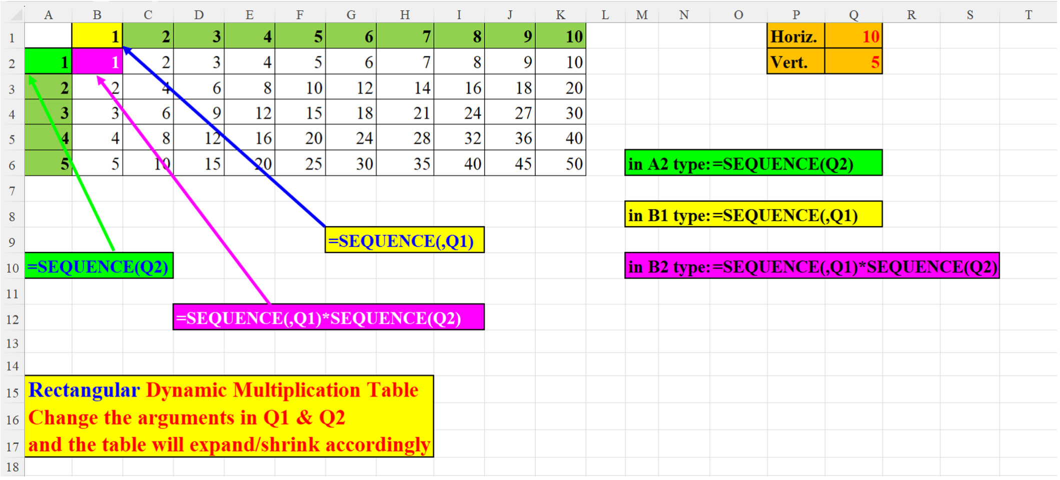


***Figure 7.17**: Dynamic multiplication table*

BIN2DEC – MMULT and SEQUENCE

The following figure demonstrates a method of converting a binary number (in A1) into a decimal number. The formula makes use of the `MMULT` function. This function returns the matrix product of two arrays: the array of the input's digits and the array of the descending numbers: 7,6….1, raised to the power of 2 as shown in the following screenshot:

The first array (of the input digits) returned by: *MID(A1,SEQUENCE(,LEN(A1)),1)*1* is: *{1,1,1,1,1,1,1,1}*

The second one is the array of two raised to the power of the following numbers: 7,6,5,4,3,2,1,0. These digits represent the location of the digits within the original string, from left to right. We start from 7 (not from 8) because the value of number in the n-th place, is: `2^(n-1)`.

So, the array generated by `(2^(LEN(A1)-SEQUENCE(LEN(A1))))` is: `{128;64;32;16;8;4;2;1}`

The multiplication of the horizontal array by the vertical array yields the desired result 255 as shown in the following screenshot:

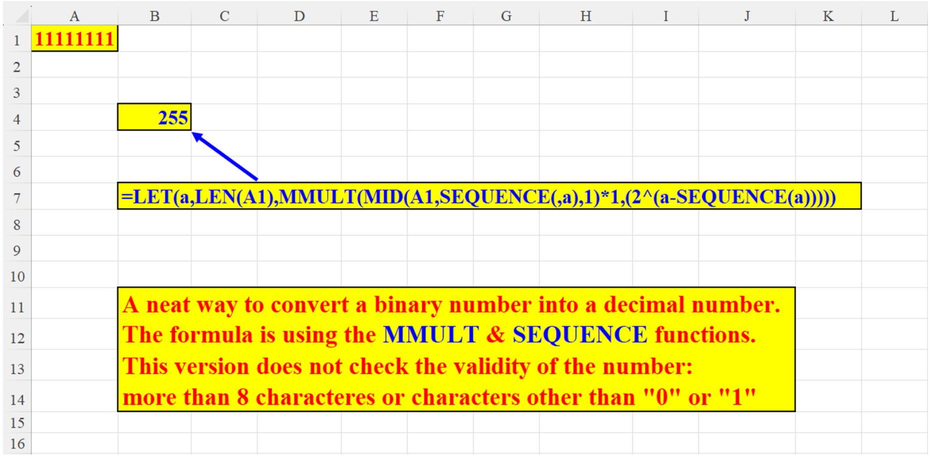


Figure 7.18: BIN2DEC – MMULT and SEQUENCE

BIN2DEC - SUM (or SUMPRODUCT) with SEQUENCE

This solution is similar to the previous one, but here we will take advantage of the **SUM** or **SUMPRODUCT** function instead of the **MMULT** function as shown in the following screenshot.

This solution is identical to the previous one (*Figure 7.18*). The only difference is that here we use **SUMPRODUCT** instead of **MMULT**:

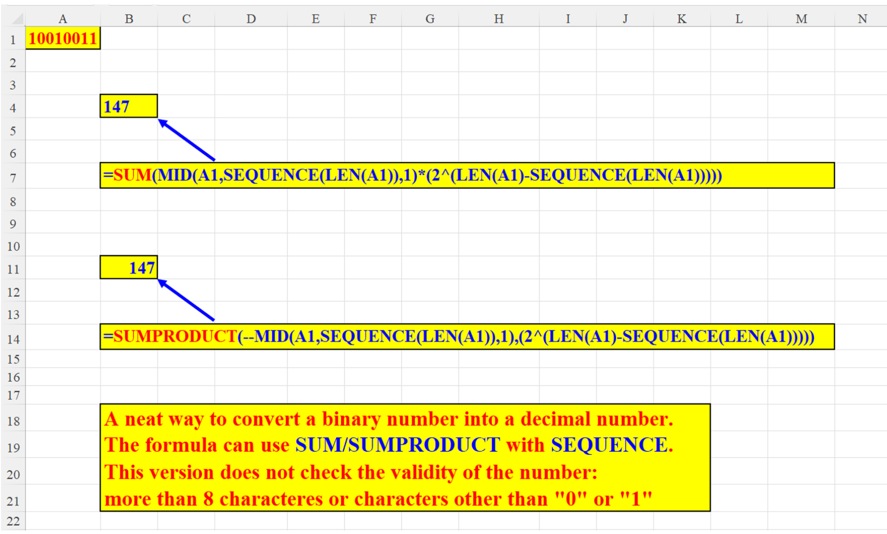
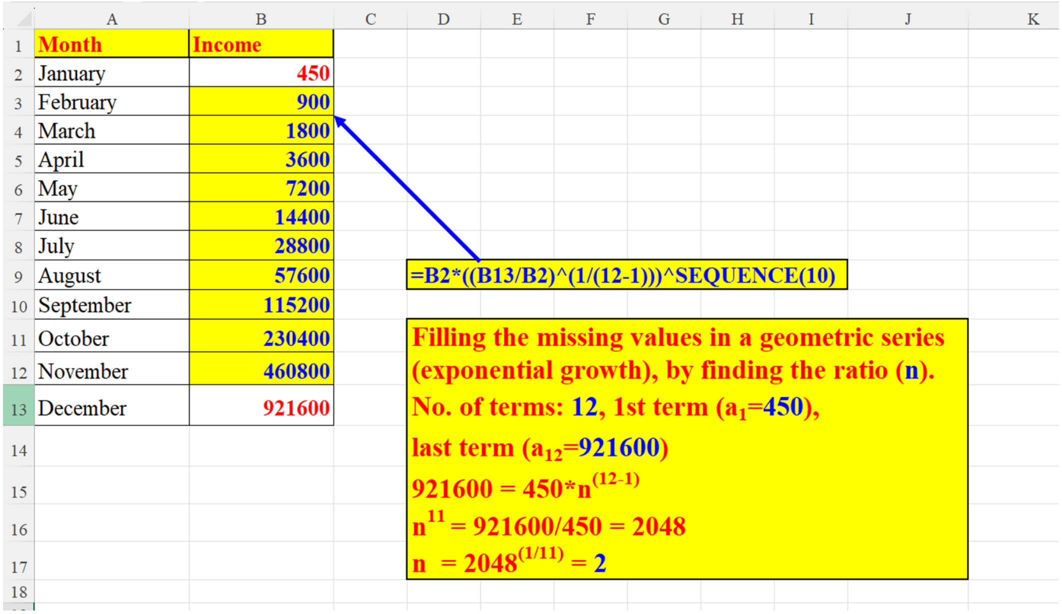


Figure 7.19: BIN2DEC – SUM (or SUMPRODUCT) and SEQUENCE

Filling the missing values in a geometric series

Suppose you have amounts of money spread over twelve months. You need to know the exact amount for each month, but all you know are the extremes in column B: the amounts of January (smallest) and December (largest). You know that the sum grows exponentially (thus creating a geometric series). The formula in B3 calculates the ratio of the series (the series grows by the power of 2) and correctly loads the amounts of the missing months:



Month	Income
January	450
February	900
March	1800
April	3600
May	7200
June	14400
July	28800
August	57600
September	115200
October	230400
November	460800
December	921600

***Figure 7.20**: Filling the missing values in a geometric series*

Trigonometry with SEQUENCE

Figure 7.21 presents two trigonometric functions in Excel: SIN() and COS() through a full cycle (360°).

On the left-hand side the table of numeric values for each function is displayed. It is presented in degrees, according to the parameter specified in cell M1.

On the right-hand side a graphical exposition of this cycle can be seen as shown in the following screenshot.

Please pay attention to the notation of the formulae in cells: B2 and C2.

The # in the A2# denotes the Spilled Range Operator. A2# is the array created by the formula in cell A2:

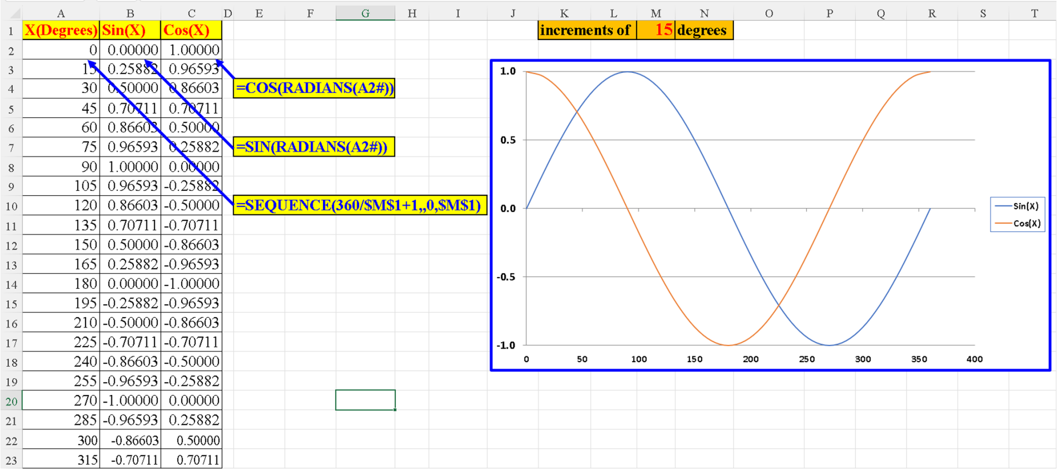


***Figure 7.21**: Trigonometry with SEQUENCE*

An array of duplicate numbers generated by bit operations

Suppose you have a vertical array of consecutive numbers, but you want to duplicate each member of the array. This can easily be done with BIT operations. The **`SEQUENCE`** function creates a 14-member array starting with 2 and ending with 15. The **`BITXOR`** function converts every odd number to even, and vice versa. Finally, the **`BITRSHIFT`** divides each number by 2, returning the correct answer as shown in the following screenshot:

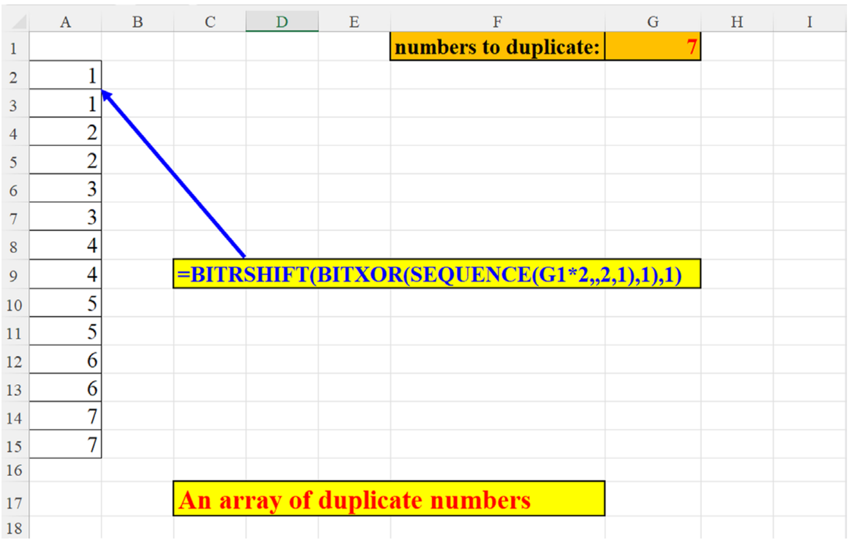
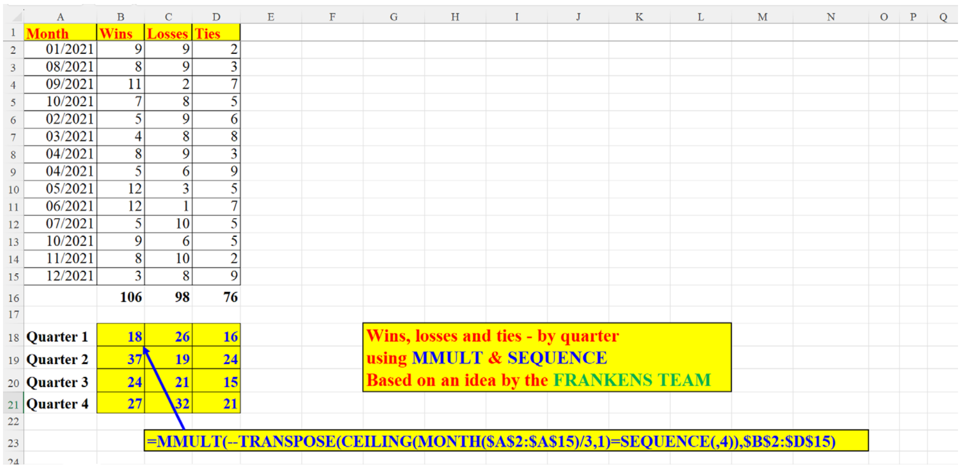


***Figure 7.22**: An array of duplicate numbers generated by bit operations*

Using MMULT and SEQUENCE to track wins, losses, and ties in each quarter

This formula was inspired by the legendary Frankens Team.

The challenge is this: we have a data set of our football team, which competed in many games over a period of several months. Each entry specifies the number of wins, losses, and ties for that month. But sometimes, we have more than one entry per month. We want to analyze the data by the quarter: how many wins, losses and ties do we have in each quarter. The formula uses the **MMULT** function: the dates in column A are converted to the year's quarters and are compared to the relevant quarter. This creates an array of **TRUEs** and **FALSEs** which is then multiplied by the games results (cells B2:D15), that yields the correct outcome as shown in the following screenshot:



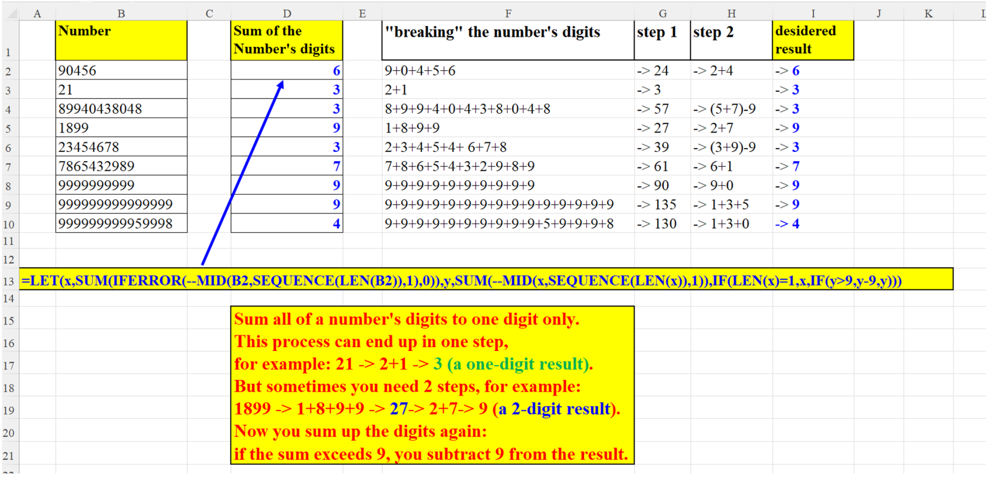
Month	Wins	Losses	Ties
01/2021	9	9	2
08/2021	8	9	3
09/2021	11	2	7
10/2021	7	8	5
02/2021	5	9	6
03/2021	4	8	8
04/2021	8	9	3
04/2021	5	6	9
05/2021	12	3	5
06/2021	12	1	7
07/2021	5	10	5
10/2021	9	6	5
11/2021	8	10	2
12/2021	3	8	9
	106	98	76
Quarter 1	18	26	16
Quarter 2	37	19	24
Quarter 3	24	21	15
Quarter 4	27	32	21

Figure 7.23: *Using MMULT and SEQUENCE to track wins, losses, and ties in each quarter*

Digital root

The digital root is the process by which you take a number and add all its digits (iteratively) until you are left with only one digit. There are, of course, several algorithms to solve this challenge. This solution was devised before Microsoft introduced **LAMBDA** and its auxiliary functions.

The algorithm implemented here is that the whole process does not require more than two steps, as illustrated in the examples: The process can end in one step (for example: 440 -> 4 + 4 + 0 ->8) or two. If it ends in two steps, then in case the result at the end of step two is two digits (for example: 2345678 -> 2 + 3 + 4 + 5 + 4 + 6 + 7 + 8 -> step 1: 39 -> 3 + 9 -> step 3: 12), we subtract 9 from the result, so the solution has only one digit (12 – 9 = 3) as shown in the following screenshot:



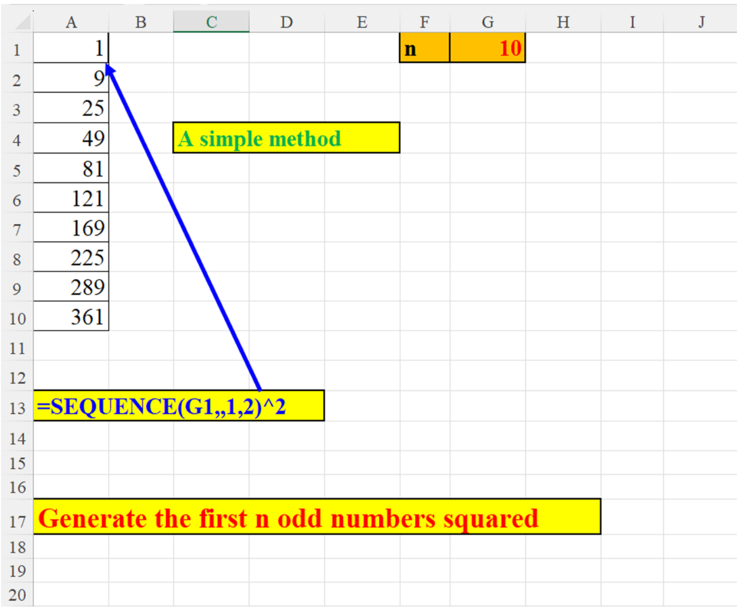
Number	Sum of the Number's digits	"breaking" the number's digits	step 1	step 2	desidered result
90456	6	9+0+4+5+6	-> 24	-> 2+4	-> 6
21	3	2+1	-> 3		-> 3
89940438048	3	8+9+9+4+0+4+3+8+0+4+8	-> 57	-> (5+7)-9	-> 3
1899	9	1+8+9+9	-> 27	-> 2+7	-> 9
23454678	3	2+3+4+5+4+ 6+7+8	-> 39	-> (3+9)-9	-> 3
7865432989	7	7+8+6+5+4+3+2+9+8+9	-> 61	-> 6+1	-> 7
9999999999	9	9+9+9+9+9+9+9+9+9+9	-> 90	-> 9+0	-> 9
999999999999999	9	9+9+9+9+9+9+9+9+9+9+9+9+9+9+9	-> 135	-> 1+3+5	-> 9
999999999959998	4	9+9+9+9+9+9+9+9+9+9+5+9+9+9+8	-> 130	-> 1+3+0	-> 4

```
=LET(x,SUM(IFERROR(--MID(B2,SEQUENCE(LEN(B2)),1),0)),y,SUM(--MID(x,SEQUENCE(LEN(x)),1)),IF(LEN(x)=1,x,IF(y>9,y-9,y)))
```


Figure 7.24: *Digital root*

First n odd numbers squared (A simple solution)

We can easily list the squares of the first n odd natural numbers (n is a parameter in cell G1) with this simple formula. In our example, we display the squares of the first 10 odd positive integers as shown in the following screenshot:



A		F	G
1		n	10
9			
25			
49			
81			
121			
169			
225			
289			
361			

Figure 7.25: *First n odd numbers squared (a simple solution)*

First N odd numbers squared (A complex solution)

A more complex solution to the challenge presented in the previous section (see *Figure 7.25*) is manifested in the following figure. The **`SEQUENCE(2*g1,,0)`** creates a sequence of 20 numbers, starting from 0 up to 19. The multiplication of **`BITOR`** of the array with **`BITXOR`** of the array engenders an array of alternate odd and even numbers. What is interesting about this array is that the numbers in the odd locations of the array are the numbers we are looking for, that is, an array of squares of the first n odd natural numbers. All that is left for us to do is to get rid of the even numbers of the array by the **`FILTER`** function which includes only the odd numbers (numbers that leave a remainder of 1 when divided by 2) as shown in the following screenshot:

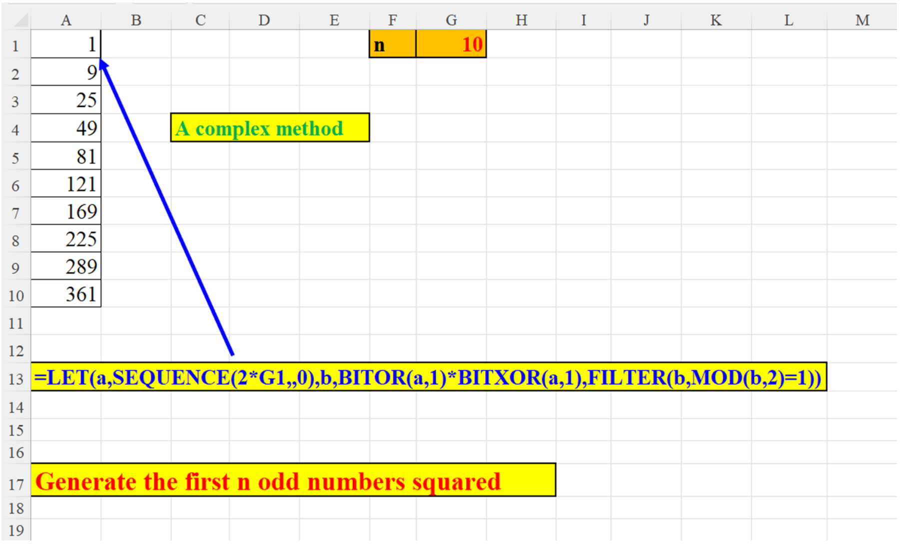


***Figure 7.26**: First n odd numbers squared (a complex solution)*

Find first divisor of a number (divisor found)

In the following section we are going to demonstrate a method to find the first divisor of a number given in a parameter (cell G1). The divisor must be an integer between 2 and 10. We skip the divisor 1, since every number is divisible by 1. One can, of course, extend the range of divisors by changing the first argument of the **`SEQUENCE`** function (10) to any desired number.

We first find all the remainders of the corresponding divisors (in cells A2:A10), and then find that the first 0 (which means that the dividend (in G1) is divisible by that number without any remainder).

In our example, the first divisor of 150 is 2. The **MATCH** function finds the first 0 and then we add 1 to the result, since our first divisor was 2 and not 1 as shown in *Figure 7.27*.

The **SEQUENCE(9,,2)** returns the array: {2,3,4,5,6,7,8,9,10}

The **MOD(G1,SEQUENCE(9,,2))** returns the array of numbers in the range: A2:A10.

Each 0 in that range signifies the fact that the number (in cell G1) is divisible (with no remainder) by that number. Since our **SEQUENCE** array starts with 2 (because, as stated above, every number is divisible by 1), the first divisor of the number in cell G1 is 2. Therefore, we add 1 to the result of the **MATCH** function, which finds the first 0 in the array A2:A10:

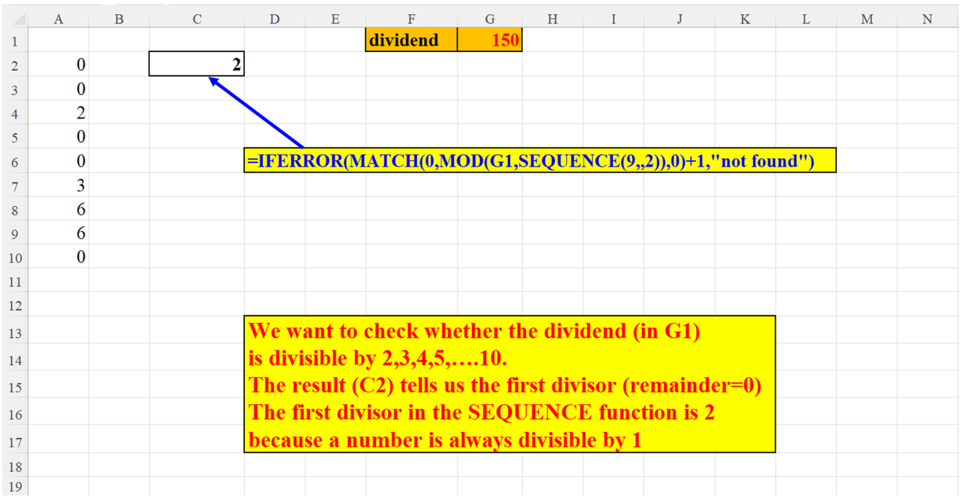


Figure 7.27: *Find first divisor of a number (example 1)*

Find first divisor of a number (divisor not found)

This example is similar to the one shown in the preceding section. However, here we could not find a divisor in the defined range (2-10). In such cases, we need to cater to errors. Therefore, the result here is **not found**, that is, the dividend in cell G1 (151) is not divisible by any number in the range defined within the **SEQUENCE** function: the 9 integers from 2 to 10:

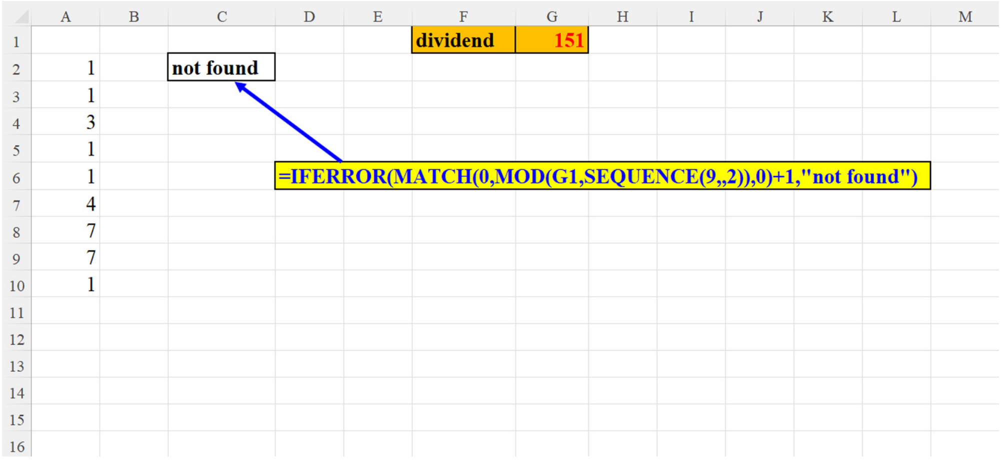


Figure 7.28: *Find first divisor of a number (example 2)*

Conclusion

In this chapter, we have described and presented many formulae that integrate the **SEQUENCE** function with the domain of mathematics. To name a few mathematical fields employed in the examples:

- Square roots
- Fractions
- Exponentiation
- Bit operations
- Trigonometry
- Geometric series
- Multiplication table
- Conversion of binary into decimal
- Matrix product of arrays
- Digital root

In the next chapter, we shall discuss the implementation of **SEQUENCE** in more complex challenges. For example, how to implement **SEQUENCE** in data validation of text (certain sequence of characters in an alphabet), how to use **SEQUENCE** in a more flexible method than the traditional nested IF, how to calculate the check digit of a number using the Luhn algorithm and more. We will also demonstrate how to carry out Excel challenges with the **`LAMBDA`** function.

Points to remember

- **`SEQUENCE`** is essential when working with series, either arithmetic or geometric.
- It is very convenient to use it in trigonometric functions, especially if we want to unfold the visual manifestation of these functions.
- Multiplication of arrays (or matrix products of arrays) can be achieved by combining **`SEQUENCE`** with the **`MMULT`** function.
- Bit operation functions in tandem with **`SEQUENCE`** can produce results that might be difficult to achieve in alternative attitudes.
- **`SEQUENCE`** is also very handy in dealing with other mathematical *entities*: fractions, power operations, divisibility, and so on.

CHAPTER 8
SEQUENCE and Other Animals

Introduction

This is the book's last chapter. It consists of some more complex examples of using **`SEQUENCE`** under various challenges in Excel. Some of them will explain in detail the use of the newest and most challenging functions in Excel 365: the **`LAMBDA`** function and some of its helper functions.

Structure

This chapter will demonstrate the application of new concepts with the assistance of **`SEQUENCE`**:

- Examples of **`SEQUENCE`** with other animals
  - Better than nested **`IF`**
  - Fetch the first and last digits from a string
  - Data validation – only Hebrew letters
  - Data validation – only uppercase English letters
  - Splitting cell by chunk size and separator (two examples)
  - Remove all digits from string

- Remove names and split numbers to separate cells
- Removing "A", "B" and "C" from string – Two methods
- **`INDEX-SQRT`** instead of **`FILTER`**
- Remove all uppercase or lowercase letters from string
- Verifying the validity of a check digit with the Luhn algorithm

Objectives

The objective of this chapter is to show you the advantage of using **`SEQUENCE`** when dealing with complex operations. As you already know, since **`SEQUENCE`** is an array function, it can speed up your calculations by executing several solutions concurrently. Learning these techniques will undoubtedly save you a lot of time, and effort.

Examples of SEQUENCE with other animals

The following examples manifest the versatility of **`SEQUENCE`** in conjunction with other functions to effectuate dynamic solutions in complicated problems.

Better than nested IF

This section will demonstrate the difference between the old, *traditional* nested IF function and the more flexible and sophisticated combination of **`XLOOKUP`** and **`SEQUENCE`**. The example chosen is conversion of grade points (0-100) to marks (1-5).

Traditional solution – nested IF

We are all familiar with the IF function and its younger sister, IFS (introduced in Excel 2019). This function is perhaps the most used function in Excel, neck to neck with **`SUM`** and **`VLOOKUP`**. Here is an example of utilizing nested IF in translating grade points (numbers) to marks (scale of numbers from 1 to 5). The table on the left-hand side depicts the conversion rules to be implemented in the formula. One can clearly see that the nested **`if`** is both lengthy and inflexible, which makes it hard to debug as shown in the following screenshot:

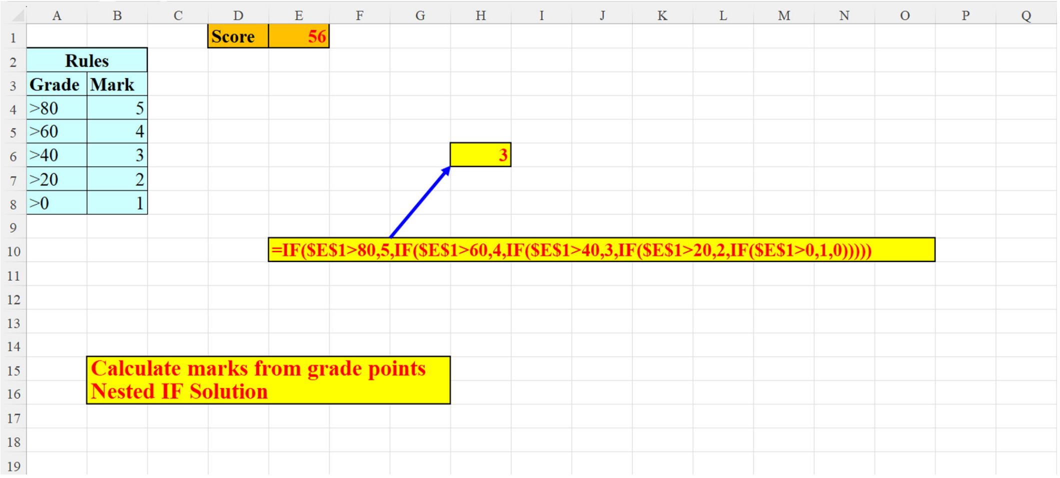


***Figure 8.1**: Converting grade points to marks (nested if)*

A different attitude is presented in the next three examples. The implementation of the conversion rules is dynamic since both the gaps between the grades and the marks scale – are dynamic (in parameters): you can change the number of marks (see example 2) and see the impact. Of course, you can change the highest score and the result will adapt itself to the new *upper limit* of the grades (as can be seen in the third example).

XLOOKUP and SEQUENCE instead of nested IF (example 1)

First, we check to see that only valid entries were keyed in the score field (cell E1): a number not greater than the highest score (in this example it is 100, but we shall see in the next example a different *highest score* and how the flexibility of the formula caters for such cases).

`XLOOKUP`'s first argument is, of course, the score to be *translated* (cell E1).

The second argument to the **`XLOOKUP`** function:

`SEQUENCE(,K1,N1-(N1/K1)+1,-(N1/K1))` yields the array {1,21,41,61,81}

The expression: (N1/K1) determines the size of each *scale*: we divide the highest grade (100, in cell N1) by the number of marks (5, in cell K1): 100/5 = 20. So, each mark is equivalent to 20 grade points.

The third argument to the **`XLOOKUP`** function:

`SEQUENCE(,K1,K1,-1)` produces the array {5,4,3,2,1} according to the number of marks (cell K1).

XLOOKUP's fourth argument tells the formula what to do in cases of errors, like, if the number entered in E1 is negative.

The fifth and last argument in our formula (since we skip the sixth one) defines the match mode. Its value (-1) tells Excel to find the exact match or the next smallest item. In our case, since there is no exact match, Excel returns the last smallest match: 56 between the third and fourth members of the array that we created in the second argument of **XLOOKUP** ({1,21,41,61,81}):41<56<61. So, **XLOOKUP**'s result is: 3. (The table on the left-hand side is displayed only for clarification):

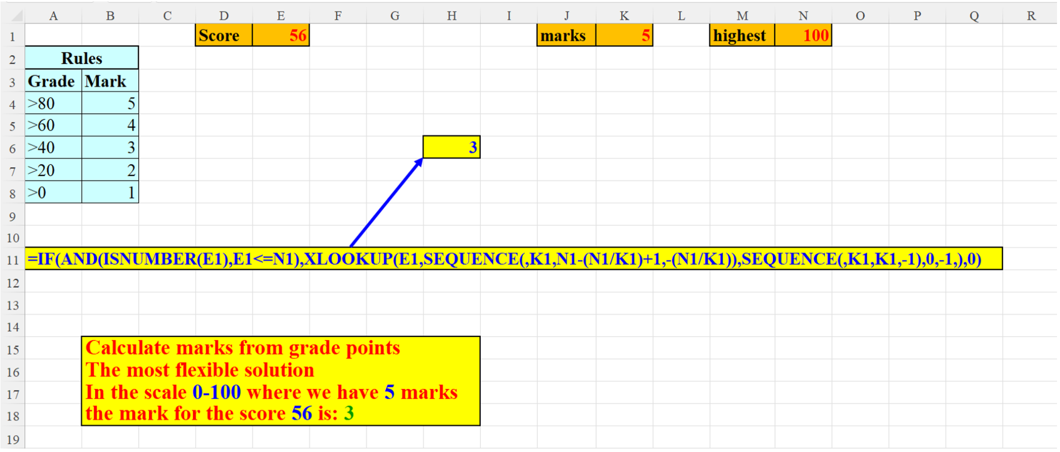


Figure 8.2: *Converting grade points to marks (a more flexible attitude – example 1)*

XLOOKUP and SEQUENCE instead of nested IF (example 2)

The same formula used in the previous example is implemented here. The only difference made is that we now want a scale of only four marks (1:4). The formula: **`=IF(AND(ISNUMBER(E1),E1<=N1),XLOOKUP(E1,SEQUENCE(,K1,N1-(N1/K1)+1,-(N1/K1)),SEQUENCE(,K1,K1,-1),0,-1,),0)`** applies this change effortlessly.

Here, the second argument to the **XLOOKUP** function is:

`SEQUENCE(,K1,N1-(N1/K1)+1,-(N1/K1))` which yields the array {1,26,51,76}

and the third argument to the **XLOOKUP** function is:

`SEQUENCE(,K1,K1,-1)` which produces the array {4, 3, 2, 1}

Since the score (56) falls between 51 and 76, **XLOOKUP** returns the corresponding mark: 3 (in the third location). (The table on the left-hand side is displayed for clarification):

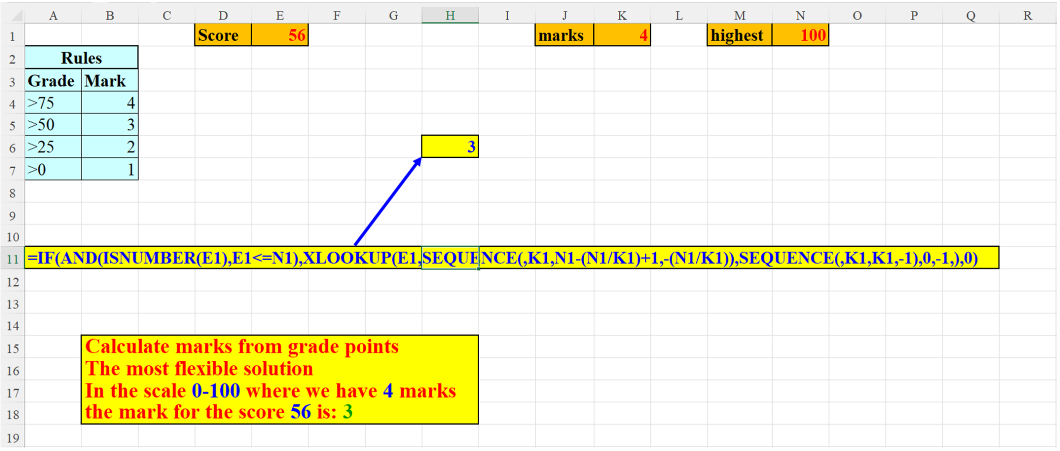


Figure 8.3: *Converting grade points to marks (a more flexible attitude – example 2)*

XLOOKUP and SEQUENCE instead of nested IF (example 3)

In our third and last example, we will change the highest possible score to 70. The formula adapts itself flawlessly to the new range. (The table on the left-hand side is displayed for clarification):

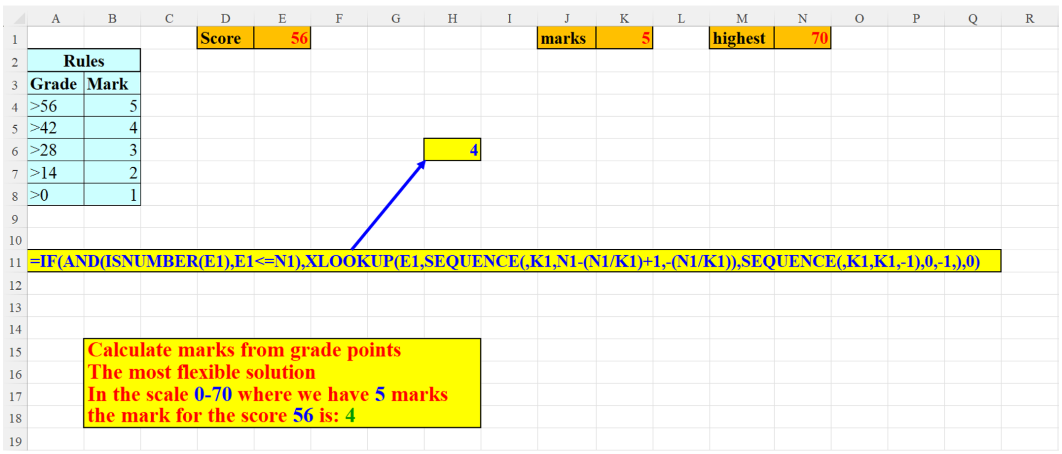


Figure 8.4: *Converting grade points to marks (a more flexible attitude – example 3)*

Fetch the first and last digits from a string

The formula depicted in cell B3 *Figure 8.5* extracts the first and the last digits from the string in A3. If there are at least two digits in A3, the first and the last digits are extracted into cells B3 and C3, accordingly. If only one digit is found (for example, in cell A7), cell C7 is left empty. If no digits were found (cell A5) , both A5 and C5 are empty.

Follow these steps for fetching the first and last digits from a string:

1. Remove all non-digits from the string. Only digits are extracted and concatenated by the **`TEXTJOIN`** function. (result: "0456")
2. A " " is suffixed to the first extracted digit (which is 0 and the result is "0 ")
3. If the length of the string created in *Step 1* is greater than 1 (it is), then the last digit of the string in *Step 1* is extracted (the digit: 6)
4. The result of *Step 2* is concatenated to the result of *Step 3* (result: "0 6")
5. **`TEXTSPLIT`** splits the string created in *Step 4* ("0 6") by the delimiter (" "), thus returning the final result in cells B3 and C3:

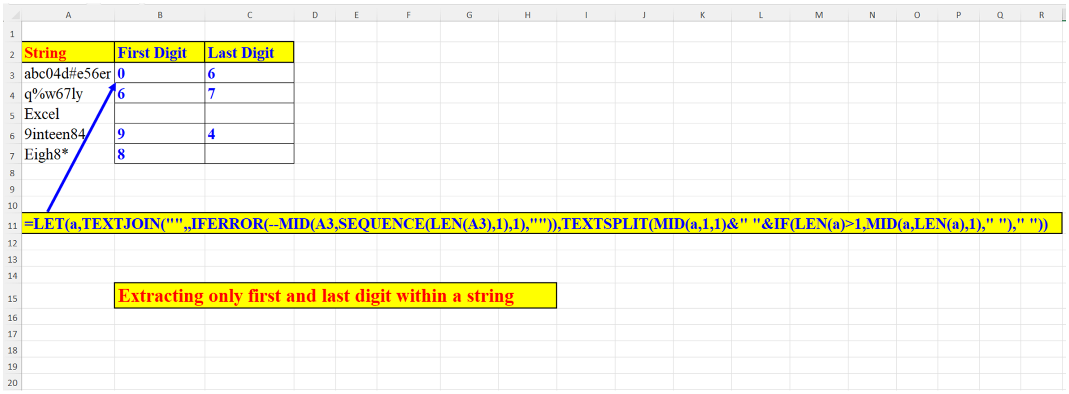


Figure 8.5: *Fetch the first and the last digits from a mixed string*

Data validation – only Hebrew letters

The technique used here allows only Hebrew letters in the data validation cell (B1). More than that, we can limit the range of allowed letters. If you enter in B1, any letter greater than the upper limit (parameter in cell G1) or smaller than the lower limit (parameter in F1), the result is **`FALSE`** as shown in the following screenshot:

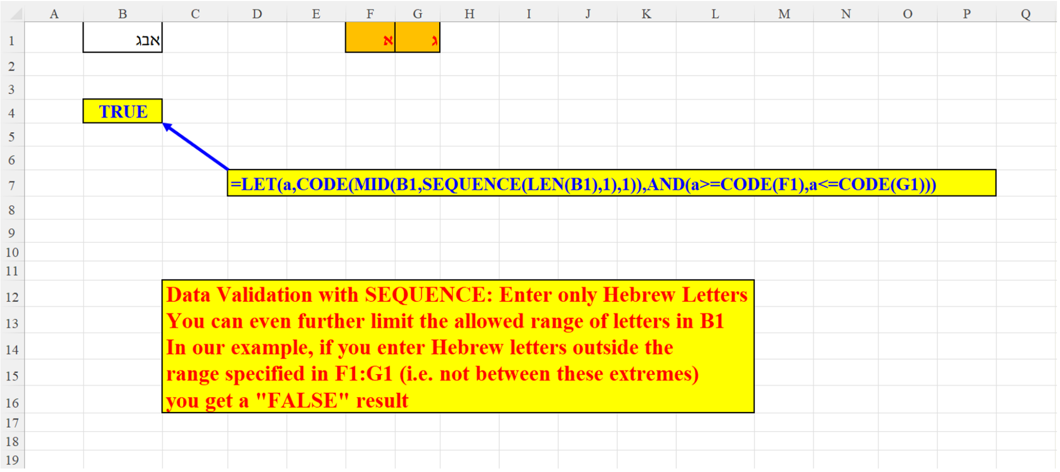


***Figure 8.6**: Data validation – only Hebrew letters*

The rule applied in the data validation can be seen in the following figure. The **`CODE`** function converts the ASCII character into its numeric value, so that every character is checked to make sure it is valid. The full formula can be seen in *Figure 8.6*:

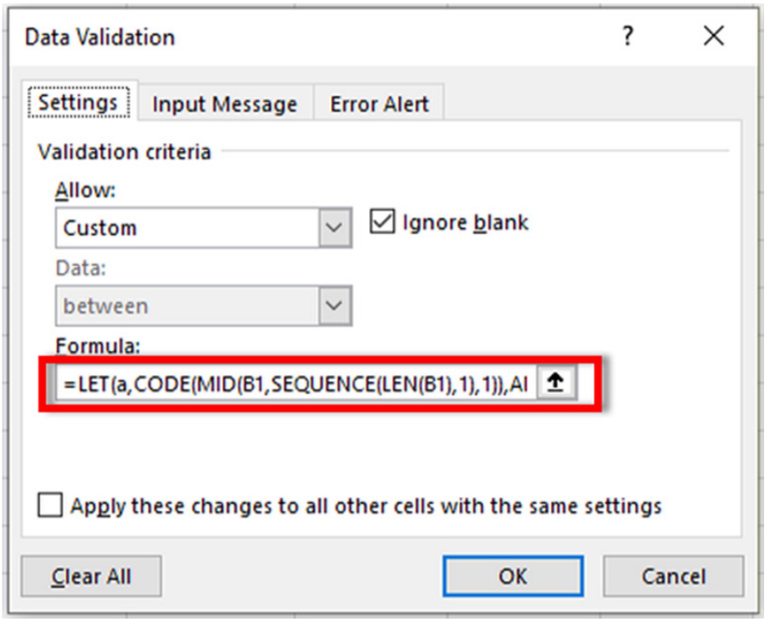


***Figure 8.7**: Data validation – only Hebrew letters (the rule)*

Data validation – only uppercase English letters

This solution is similar to the one applied in the previous example. Here, we will check that only uppercase English letters are entered in cell B1. Again, we employ the same rule: the letters entered should not be below "A" (parameter in F1) or above "Z" (parameter in G1). If you enter letters outside this range, the formula returns: **FALSE**.

As in the previous example, we display the rule defined in the data validation pane. The full formula can be seen in the following figure (D7):

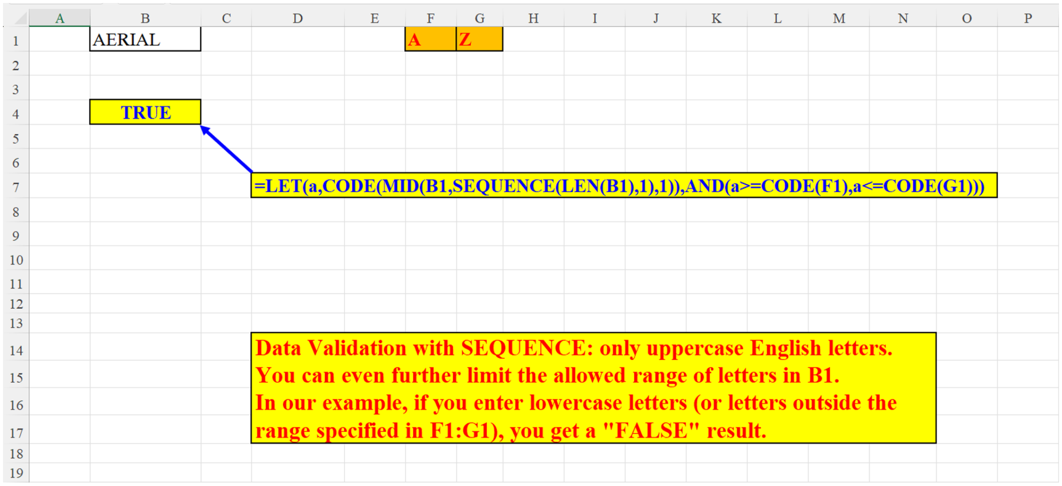


***Figure 8.8**: Data validation – only uppercase English letters*

The full formula can be seen in *Figure 8.8* (cell D7). The following screenshot depicts the Data Validation rule applied:

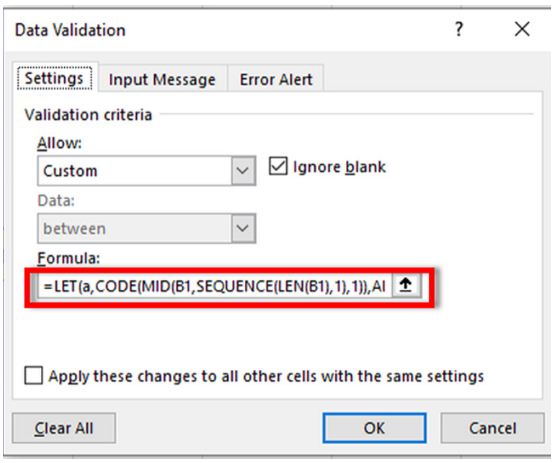


***Figure 8.9**: Data validation – only uppercase English letters (the rule)*

Splitting cell by chunk size and separator (two examples)

Suppose we have a string in a cell, and we want to split it by a separator into equal "chunks". The chunk size is defined in cell G1, and the separator is defined in cell I1. The technique is demonstrated in the next figure.

Explanation of the formula can be implemented through the following steps:

1. The **`TEXTJOIN`** function, which *wraps* the **`MID`** function creates the following string: **`"AB/CD/EF/GH/I/////"`**.
2. The **`FIND`** function searches for the location of A3's last character ("I") within the result in *Step 1* and returns: 13. This is the length of the string we are looking for: the string created by the **`TEXTJOIN`** without the additional separator characters at the end.
3. The **`LEFT`** function returns only the first 13 characters of cell A3. In cell C4 we can see a practical utilization of this technique: the number in cell A4 is converted to: 12/02/20 which is a valid date. If we multiply C4 by 1 (to convert the string to a number), the result (in E4) will be a valid Excel date:

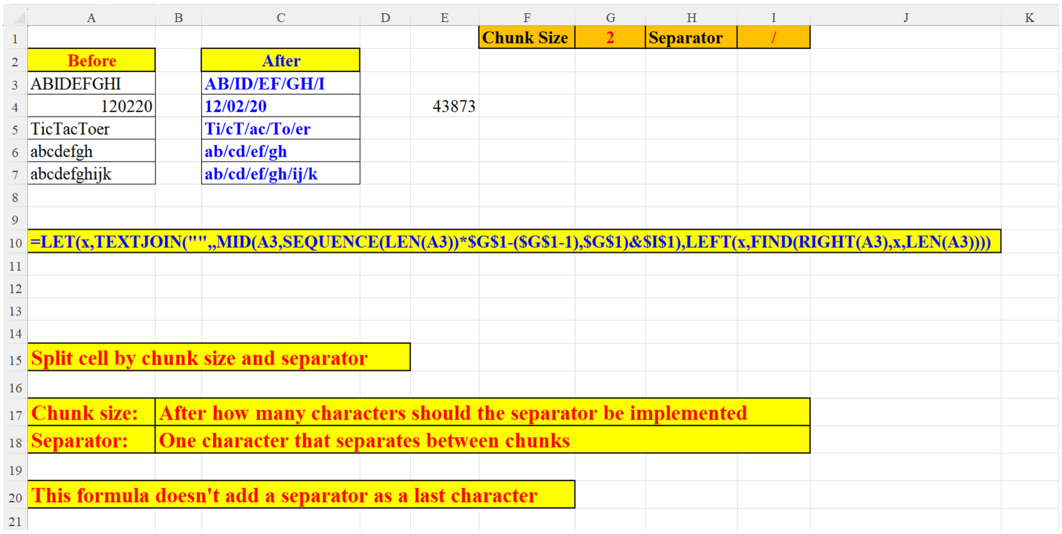


***Figure 8.10**: Split cell by chunk size and separator (example 1)*

Another example demonstrates the flexibility of the solution. Here, the separator is composed of two characters, not just one:

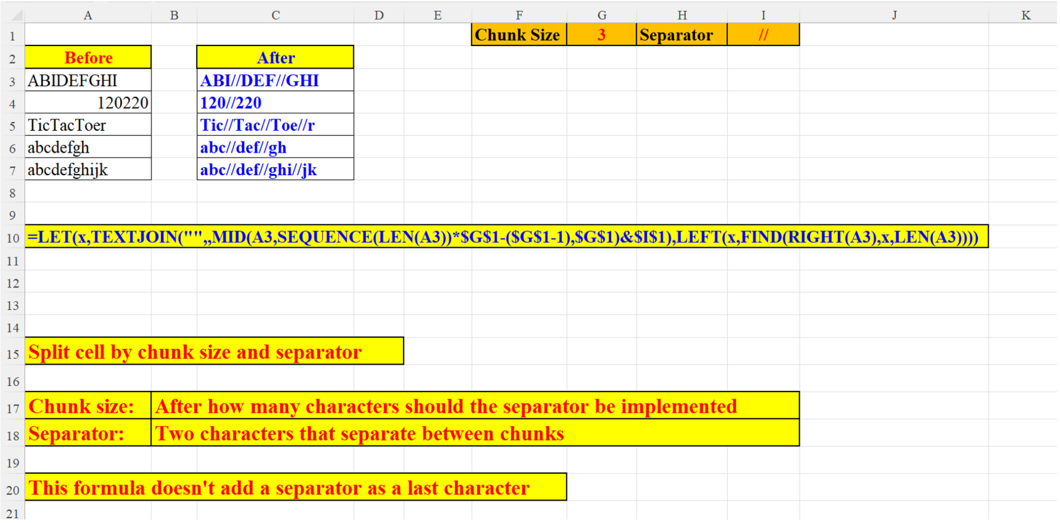


***Figure 8.11**: Split cell by chunk size and separator (example 2)*

Remove all digits from string

This solution combines two new functions: **`LAMBDA`** and a helper function, **`REDUCE`**.

The **`REDUCE`** is an *ancillary* function, which means that it cannot operate independently. It can be implemented only in conjunction with **`LAMBDA`**.

The **`SEQUENC(10,,0)`** creates an array of the digits: 0-9. The **`LAMBDA`** function then removes these digits from the string, replacing them with null by using the **`SUBSTITUTE`** function:

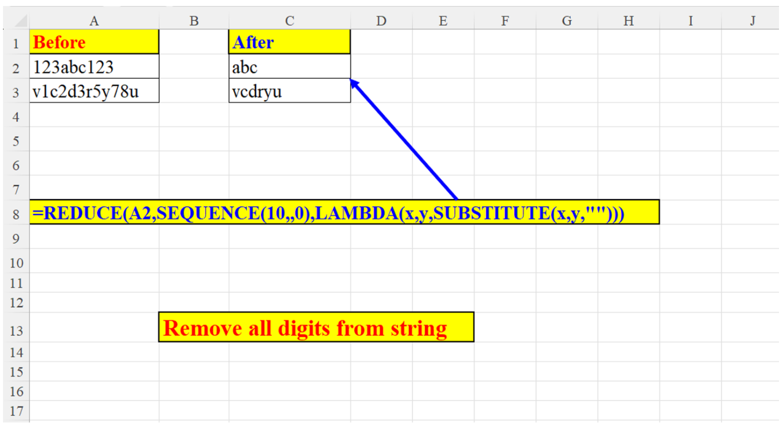


***Figure 8.12**: Remove all digits from string*

Remove names and split numbers to separate cells

The main two functions (**`LAMBDA`** and its **`helper`** function: **`REDUCE`**) create a *stack* of all ASCII non-numeric characters (1:47, 58:255):

The **`CHAR(SEQUENCE(47,,1))`** creates an array of all the ASCII characters preceding the first digit (CHAR(48) which is 0) and all the ASCII characters following the last digit (CHAR(57) which is 9): **`CHAR(SEQUENCE(198,,58))`**.

Then, all these characters are removed from the original string and are replaced by **`" "`**.

We are left with only numbers, separated by spaces. The **`TEXTSPLIT`** then splits these numbers by the separator (" "), which leaves us with the three numbers as shown in the following screenshot:

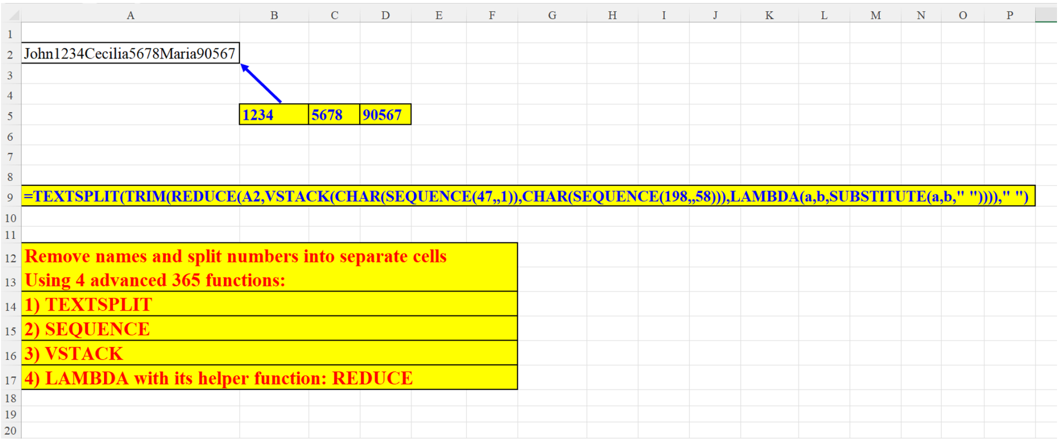


Figure 8.13: *Remove names and split numbers into separate consecutive cells*

Removing "A", "B" and "C" from string – two methods

The idea here is to remove the first three uppercase English letters from a string.

This solution combines two new functions: **`LAMBDA`** and a helper function: **`REDUCE`**.

`REDUCE` is an *ancillary* function, which means that it cannot operate independently. It can be implemented only in conjunction with **`LAMBDA`**.

Method 1

In this solution, the values to be removed are hard coded within the formula, which is not an ideal solution as shown in the following screenshot:

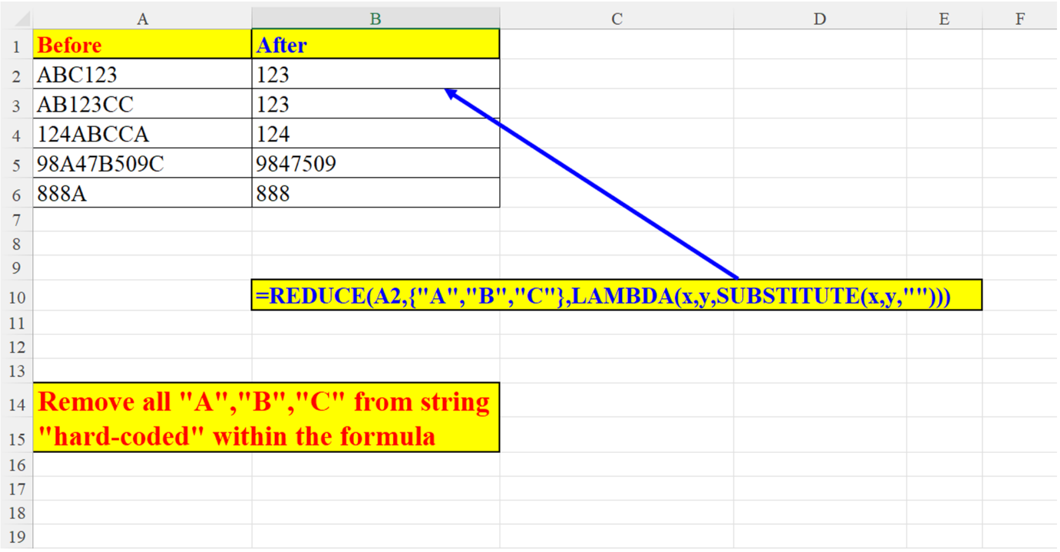


Figure 8.14*: Removing "A", "B", "C" from string – method 1*

Method 2

This is a better implementation of the problem posed in the previous figure. Instead of hard-coded values, we use two parameters: the first one specifies the first letter to remove, and the second defines the number of alphabetic characters to remove. In our case we have three, which means that the formula is supposed to eliminate the first three lowercase alphabet letters.

This solution also uses **`LAMBDA`** and **`REDUCE`**.

It accepts two arguments:

1. The first one is the initial value (in our case, it is the entire string in A2) and
2. The second is the expression: **`CHAR(SEQUENCE($J$1,,CODE($E$1),1)`** which yields the array of three characters: **`"a";"b";"c"`**

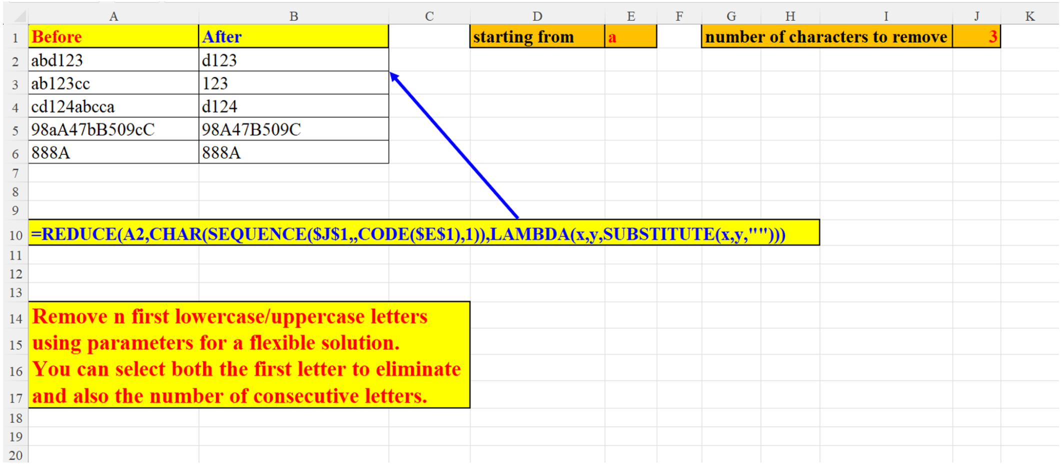
These are *fed* into the **`LAMBDA`** function which removes the occurrence of any character of the second argument from the first argument.

The result: A string *stripped off* from the letters specified in the parameters.

This solution is dynamic, because:

- You can start with any letter you want
- You may specify any number of consecutive letters, starting with the letter defined in the first argument.

Since we start with *a*, the formula will remove the first three lowercase letters, as shown in the following screenshot:



Before	After
abd123	d123
ab123cc	123
cd124abcca	d124
98aA47bB509cC	98A47B509C
888A	888A

starting from	a

number of characters to remove	3

=REDUCE(A2,CHAR(SEQUENCE($J$1,,CODE($E$1),1)),LAMBDA(x,y,SUBSTITUTE(x,y,"")))

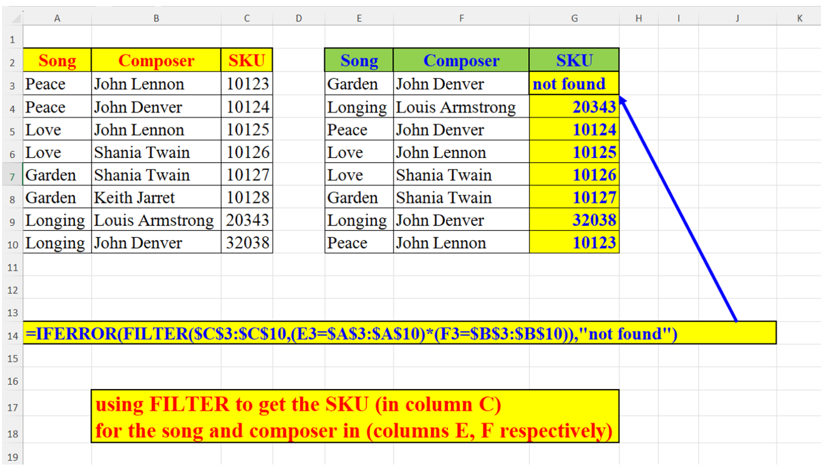
Remove n first lowercase/uppercase letters using parameters for a flexible solution. You can select both the first letter to eliminate and also the number of consecutive letters.

***Figure 8.15**: Removing three first lowercase letters from string – method 2*

INDEX-SQRT instead of FILTER

In cells A3:C10 we have a data set of songs and composers. Each combination of song and composer has one unique SKU. In cells G3:G10, we need to find the SKU that matches the song (in E3:E10) and the composer (F3:F10).

Of course, the simplest method would be using the **`FILTER`** function:



Song	Composer	SKU
Peace	John Lennon	10123
Peace	John Denver	10124
Love	John Lennon	10125
Love	Shania Twain	10126
Garden	Shania Twain	10127
Garden	Keith Jarret	10128
Longing	Louis Armstrong	20343
Longing	John Denver	32038

Song	Composer	SKU
Garden	John Denver	not found
Longing	Louis Armstrong	20343
Peace	John Denver	10124
Love	John Lennon	10125
Love	Shania Twain	10126
Garden	Shania Twain	10127
Longing	John Denver	32038
Peace	John Lennon	10123

=IFERROR(FILTER($C$3:$C$10,(E3=$A$3:$A$10)*(F3=$B$3:$B$10)),"not found")

using FILTER to get the SKU (in column C) for the song and composer in (columns E, F respectively)

***Figure 8.16**: Using FILTER to get the SKU for the song and composer (columns E,F)*

But, we have devised an alternative solution which uses the **`SEQUENCE`** function in tandem with **`INDEX`** and **`SQRT`**. You might wonder that **`SQRT`** is a mathematical function that has nothing to do with search functions. How is that possible?

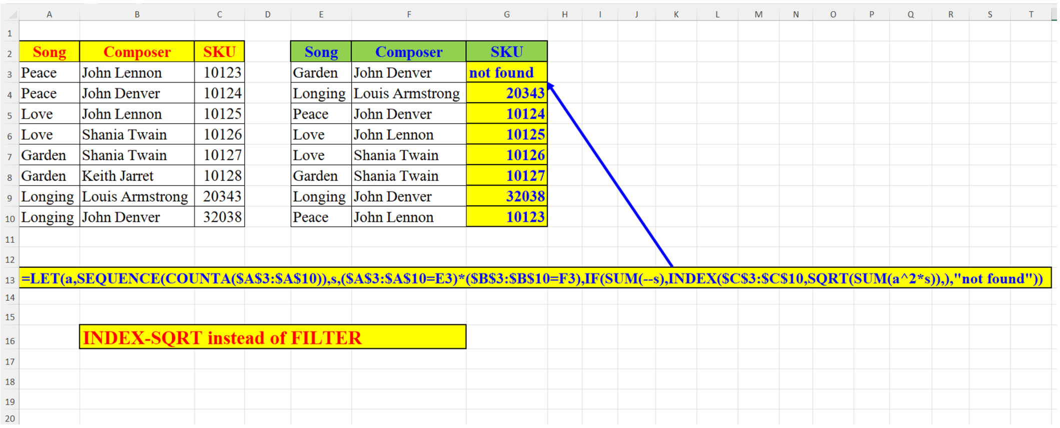
Let us check it first on cell **G3** and then on cell **G4**.

In cell G3, the product: **`($A$3:$A$10=E3)*($B$3:$B$10=F3)`** yields 0. This happened because in the original data set, there is no SKU for the song *Garden* whose composer is *John Denver*. So, the formula returns: *not found*.

In cell G4, the product: **`($A$3:$A$10=E4)*($B$3:$B$10=F4)`** yields 1, because the combination of the song *Longing* composed by *Louis Armstrong* was found in column C. We need to find on which row (within the range: C3:C10) this combination exists. The expression:

`SQRT(SUM(a^2*s))` is the crux of the formula.

`a^2` is the expression. **`SEQUENCE(8)`** raised to the second power, produces the following array: {1;4;9;16;25;36;49;64}. This element is multiplied by **`($A$3:$A$10=E4)*($B$3:$B$10=F4)`** whose result is: {0;0;0;0;0;0;1;0} because this combination was found on the seventh row. The sum of these two arrays is: 49. Now, what is left for us to do is find the **`SQRT`** of the number: 7. So, the **`INDEX`** function fetches the 7th element in C3:C10, which is: 20343. The **`SQRT`** serves here as a replacement for **`MATCH`** as shown in the following screenshot:



Song	Composer	SKU		Song	Composer	SKU
Peace	John Lennon	10123		Garden	John Denver	not found
Peace	John Denver	10124		Longing	Louis Armstrong	20343
Love	John Lennon	10125		Peace	John Denver	10124
Love	Shania Twain	10126		Love	John Lennon	10125
Garden	Shania Twain	10127		Love	Shania Twain	10126
Garden	Keith Jarret	10128		Garden	Shania Twain	10127
Longing	Louis Armstrong	20343		Longing	John Denver	32038
Longing	John Denver	32038		Peace	John Lennon	10123

```
=LET(a,SEQUENCE(COUNTA($A$3:$A$10)),s,($A$3:$A$10=E3)*($B$3:$B$10=F3),IF(SUM(--s),INDEX($C$3:$C$10,SQRT(SUM(a^2*s)),),"not found"))
```

INDEX-SQRT instead of FILTER

***Figure 8.17**: INDEX-SQRT instead of FILTER*

Remove all uppercase or lowercase letters from string

This solution combines the **`LAMBDA`** and **`REDUCE`** functions in a similar manner to the examples in *Figure 8.11* to *Figure 8.14*.

The **REDUCE** function accepts two arguments:

- The first one is the initial value (in our case, it is the entire string in A2).
- The second argument is the expression:

  CHAR(SEQUENCE(26,$E$2,1) which generates all the uppercase English letters (if cell E1 is "A") or all the lowercase letters (if cell E1 contains "a").

The **LAMBDA** function then removes every occurrence of the 26 uppercase letters starting from "A", the first argument in cell E1. The result string in cell A2 is "stripped off" from its uppercase letters.

This solution is dynamic, because you can choose whether to get rid of only the uppercase letters or the lowercase letters too as shown in the following screenshot:

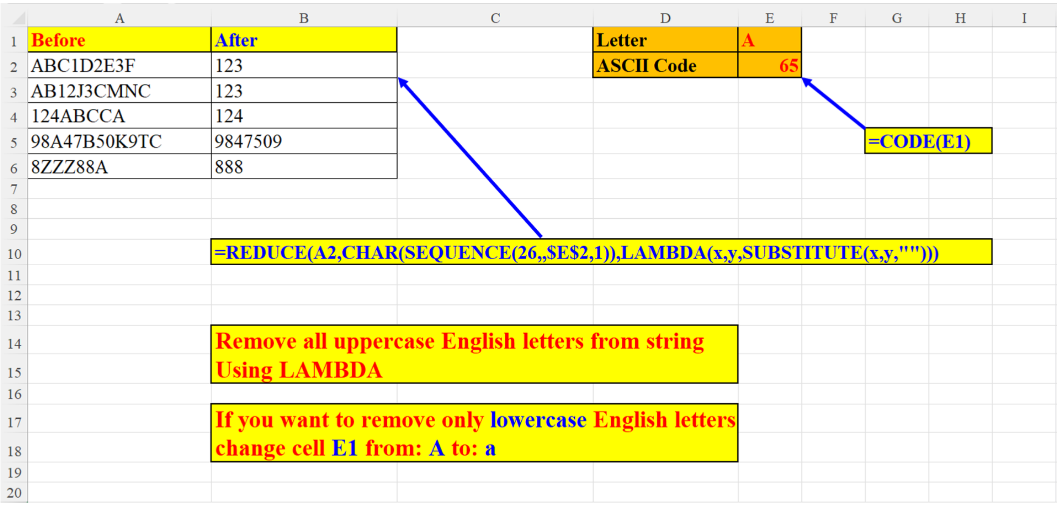


***Figure 8.18**: Remove all uppercase or lowercase letters from string*

Verifying the validity of a check digit with the Luhn algorithm

The chapter's last example will demonstrate the implementation of the Luhn algorithm to verify the check digit of a 9-digit number, whose last digit is the check digit.

The algorithm is computed as follows:

Each even-place digit is multiplied by 2. If the result is greater than 9, we add the two digits that make up the result. For example, if the original digit was 6 and we multiplied it by 2, the result is 12. Since this number is greater than 9, we add the two digits: 1+2 =3.

No calculation is executed on the odd-place digits. At the end of this computation, we sum up all the results. If the result is divisible by 10 without any remainder, then the check digit (9th digit) is correct as shown in the following screenshot:

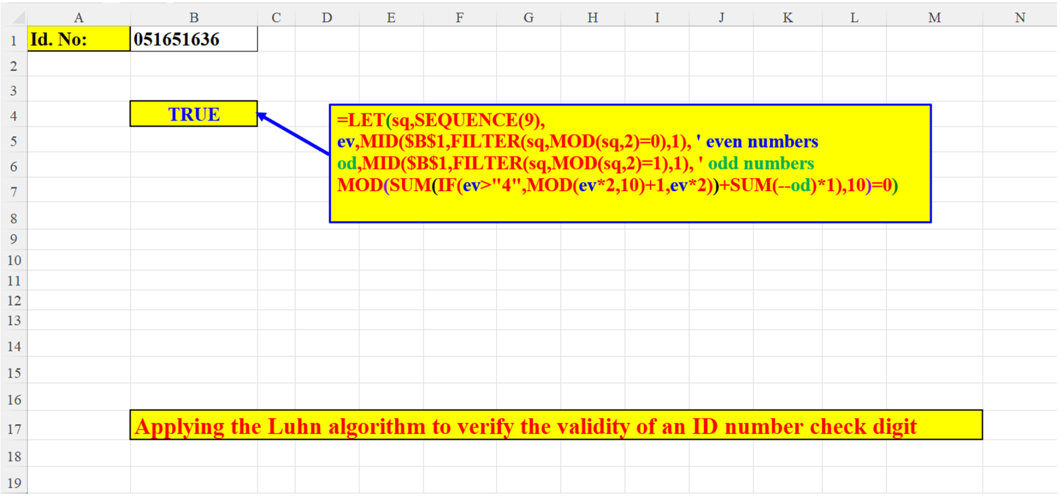


***Figure 8.19**: The Luhn algorithm applied to verify the check digit of the ID no. in cell B1*

The next figure will explain the three steps of the process:

1. Extracting the even-place digits (2nd , 4th , 6th and 8th digits) (in C4#) and the odd-place digits (1st, 3rd, 5th, 7th, 9th digits) (in C12#)

2. Each even-place digit is multiplied by 2 (see explanation above). If any digit in the array of the even-place digits is greater than 4, then the product will be 10 or more. In such cases, we add 1 to the remainder of division of this number to 10 (which is the same as adding these two digits).

   For example, if the original digit was 6 and we multiplied it by 2, the result is: 12. Since this number is greater than 9, we add the two digits: 1+2 =3.

   For example: 5, the first even-place digit, is greater than 4. so, we multiply it by 2 (5*2=10), find the remainder of division by 10 (=0, no remainder) and then add 1. (0+1=1).

   Another example: 6, the second even-place digit, is also greater than 4. So, we multiply it by 2 (6*2=10), find the remainder of division by 10 (=2) and then add 1. (2+1=3). Then, we sum the 4 results of all 4 even-place digits (1+3+2+6)=12.

   The odd-place digits are *summed* without calculation: (0+1+5+6+6)=18.

3. We now *combine* the 2 sums: 12+18 = 30 and divide the total sum (30) by 10. If there is no remainder, then the number is a valid ID number according to the Luhn algorithm:

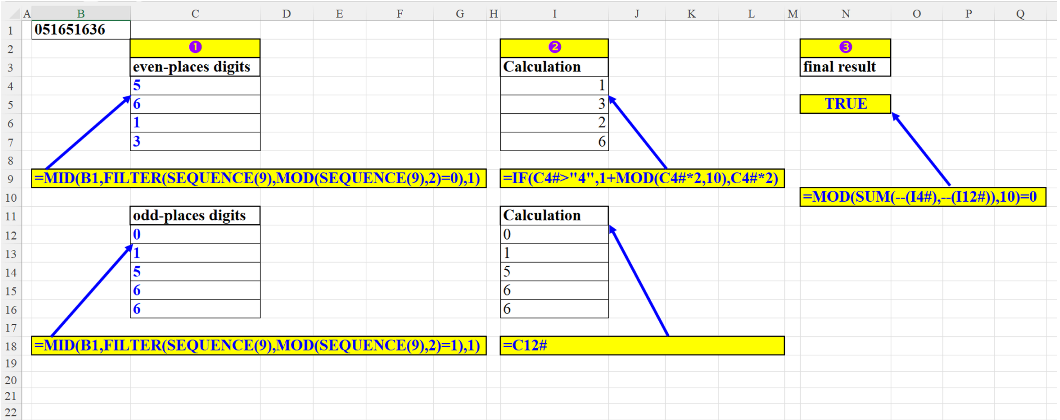


***Figure 8.20**: The three steps of the algorithm implemented in the formula*

Conclusion

In this chapter you learnt some advanced uses of **SEQUENCE** with other Excel 365 functions (for example **LAMBDA** with its helper functions: **SCAN** and **REDUCE**). Besides that, some sophisticated solutions with **SEQUENCE** (for example, the use of **INDEX-SQRT** instead of **FILTER**, or the implementation of the Luhn algorithm to verify an ID no, check digit's validity – in one formula) were demonstrated.

In this book, we covered a huge scope of the **SEQUENCE** function in various Excel categories: text, numbers, arrays, date and time, finance, and mathematics.

You will best benefit from this book if you read it thoroughly and practice the examples that might be of interest to you.

You must travel over a rough road to reach the stars.

Points to remember

- **SEQUENCE** works seamlessly with the new **LAMBDA** function.
- It is easily applied in data validation formulas, where you need to verify a sequence of characters within a range.
- It is crucial when separating numbers from text or when splitting strings by predefined rules.
- Combining **SEQUENCE** with other Excel functions enables us to create more flexible solutions.

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Mastering SEQUENCE

DESCRIPTION

The SEQUENCE function in Excel 365 allows you to generate sequences of numbers or values based on specific criteria. By utilizing this function, you can effectively manage a wide range of numerical and data manipulation tasks. If you're looking to leverage its dynamic capabilities to enhance your productivity, this book is an ideal resource for you.

This book provides the most comprehensive coverage of the SEQUENCE function, which is widely considered the most versatile function in Excel 365. It serves as a detailed introduction to the new Dynamic Array Functions, offering examples for a better understanding of this new revolutionary concept. Additionally, the book delves into the extensive applications of SEQUENCE in various areas, including text functions, number manipulation, arrays, date and time operations, financial calculations, math, and complex formulae involving SEQUENCE, with a special focus on the super-function: LAMBDA. With over 200 examples, this book allows you to actively engage and explore the multifaceted dynamism of the SEQUENCE function.

By the end of the book, you will be able to confidently apply the SEQUENCE function in your own Excel workflows, enhancing your productivity and efficiency.

KEY FEATURES

- Unleash the power of SEQUENCE to simplify complex array calculations and automate repetitive tasks.
- Discover techniques to efficiently perform calculations, text manipulation, financial and numerical analysis using SEQUENCE.
- Learn how to integrate SEQUENCE with other Excel functions and tools.

WHAT YOU WILL LEARN

- Explore advanced techniques to enhance text-based analysis using SEQUENCE.
- Understand how SEQUENCE can generate dynamic arrays with custom patterns, sizes, and dimensions.
- Learn how to use the LAMBDA function to solve complex calculations
- Gain insights into using SEQUENCE to streamline financial modeling and forecasting
- Get tips and tricks to optimize date and time-related calculations using SEQUENCE.

WHO THIS BOOK IS FOR

This book is for everyone who is eager to explore innovative approaches in Excel, expand their knowledge, and improve their problem-solving skills. It serves as a valuable resource, offering a wide range of techniques that you can apply to enhance their Excel proficiency.

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