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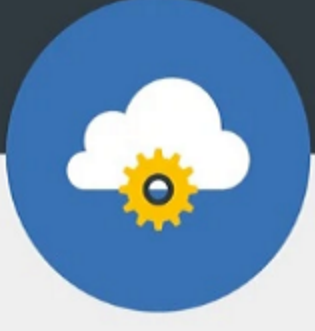

Guide to Prepare for the AI-900 Exam

Krunal S. Trivedi

Apress®

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Microsoft Azure AI Fundamentals Certification Companion: Guide to Prepare for the AI-900 Exam

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ISBN-13 (pbk): 978-1-4842-9220-4 ISBN-13 (electronic): 978-1-4842-9221-1
https://doi.org/10.1007/978-1-4842-9221-1

Managing Director, Apress Media LLC: Welmoed Spahr
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Cover designed by eStudioCalamar

Distributed to the book trade worldwide by Apress Media, LLC, 1 New York Plaza, New York, NY 10004, U.S.A. Phone 1-800-SPRINGER, fax (201) 348-4505, e-mail orders-ny@springer-sbm.com, or visit www.springeronline.com. Apress Media, LLC is a California LLC and the sole member (owner) is Springer Science + Business Media Finance Inc (SSBM Finance Inc). SSBM Finance Inc is a **Delaware** corporation.

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Printed on acid-free paper

To my mother Mrs. Nayna Sunil Trivedi.

Thank you for teaching me how to hold a pen, mummy.

Table of Contents

About the Author

Krunal S. Trivedi is a Microsoft Certified Trainer and has been a Microsoft Azure MVP for the past five years. He has provided technical training on a variety of Microsoft and non-Microsoft technologies to IT corporations all over the world for the past 14 years. He is an enthusiastic speaker, trainer, writer, and author. Krunal is actively involved in project architecting, building solutions using modern edge technologies such as React, Angular, Docker, and Microsoft Azure, in addition to training. He has worked on numerous projects and products, from requirement gathering to project deployment using the Agile methodology and DevOps pipeline.

About the Technical Reviewer

Don Reamey is currently a Principal Software Engineering Manager at Microsoft Corporation. Previously, he worked at Apptio Software as a Principal Software Engineer Manager. Don also managed engineering teams at TIBCO Software and Bank of America. He enjoys learning and creating new programming languages, creating web-based applications, playing guitar, and weightlifting.

Acknowledgments

Writing a book is one of the most challenging tasks I've undertaken, and it gives me a great sense of accomplishment. Without the love and support of many people, this would not be possible. To begin, I want to express my gratitude to my loved ones.

The value of my loved ones' support to me is immeasurable. Mrs. Nayna Sunil Trivedi, my late mother, was an avid reader. As early as I can remember, mom instilled in me a love of reading, and later, while I was pursuing a profession as an information technology trainer, she shared some of her thoughts and shed some light on an idea I'd had to write a book.

When writing this book, I was always encouraged by my family: wife Hina, son Aaditya, and father Mr. Sunil Trivedi.

Nelson D'Souza and Prashant Pavshe, two of my closest friends and bosses, thank you for being the leaders in whom I have faith and who I truly honor and respect. I will always be grateful for the opportunity to represent you and SPAN LABS. I truly have no words to express my gratitude to you. I will forever be thankful to the universe for connecting me to you. Thank you for always being there for me through every trial and triumph.

The other side of the ocean is home to Peter De Tender, who has changed the lives of many people through his work as an IT trainer, mentor, cloud consultant, Microsoft MVP, and current Microsoft employee. I will forever be thankful to the universe for connecting me to Peter. He has been a huge source of inspiration for me during my time as an IT trainer. Besides being an inspiration, I can always count on him to be there for me, whether I have a question or need help with something technical. He connected me with Jill Balzano, Mark Powers, and Smriti Sachdeva, and the journey began.

It is as difficult as it sounds to convert an idea into a book. Internally, the experience is both demanding and gratifying. I want to thank everyone on the Apress and Springer Nature teams, especially Smriti Sachdeva, Shobhna Srinivasan, Laura Berendson, Mark Powers, and Don Reamey. What a fantastic book is emerging, thanks to your consistent care and insightful suggestions.

Introduction

This book will be invaluable to anyone interested in learning more about artificial intelligence (AI) and how to use Microsoft Azure's services to create AI solutions. This book covers the fundamentals of Azure AI as well as more advanced topics, so it should make learning about Azure AI a breeze. The book has a hands-on, practical style that lets you see AI in action and try out Azure AI services. You will gain both theoretical and practical knowledge of Azure artificial intelligence by working through the lab exercises that are included in each chapter of this book. These exercises correspond to specific sections of the official Microsoft certification exam. This book is split into five chapters, with each one covering a different module of the AI-900: Microsoft Azure AI Fundamentals Examination. At the end of Chapters 2, 3, 4, and 5, you will work through some multiple-choice questions to test the knowledge that you have gained in the chapters and a few Microsoft Learn reference links.

There is no actual coding on either the exam or the book.

Chapter 1 is the beginning, and it tells you about the AI-900: Microsoft Azure AI Fundamentals exam. It talks about the exam overview, prerequisites, how to sign up for the exam, exam cost, and exam format. It also describes each module of the exam, along with their weightage.

Chapter 2 talks in detail about the fundamentals of artificial intelligence. It talks about a number of AI tasks, like machine learning, anomaly detection, computer vision, natural language processing, and knowledge mining. It also walks you through the principles of responsible AI. Later in this chapter, you will also learn how Microsoft Azure supports artificial intelligence and various AI-related services.

Chapter 3 discusses machine learning fundamentals in detail. You will learn about machine learning and its main parts, such as datasets, features, labels, the machine learning algorithm, and the machine learning workflow. You will learn about various types of machine learning and various tools offered by Microsoft Azure for machine learning in the cloud.

At the end of the chapter, you will find a tutorial to walk you through the cloud environment, which will make you familiar with the Azure Machine Learning environment and tools.

Chapter 4 is about the Computer Vision service provided by Microsoft Azure. This chapter tells you about the speech, language, vision, decision, and OpenAI services that Microsoft Azure offers. After that, you will learn more about computer vision and its main parts, like how to classify images and find objects. In the later part of the chapter, you will learn about various services offered under the vision service, such as computer vision, custom vision, face recognition, and form recognition.

Chapter 5 covers natural language processing. Here, you will learn about core NLP responsibilities, such as text analysis and entity recognition, sentiment analysis, speech recognition, synthesis, and machine translation. You will also learn about Microsoft Azure offerings for natural language processing and the Microsoft Azure platform for conversational AI.

CHAPTER 1

Overview of AI-900 Exam Preparation

Greetings, readers! Artificial intelligence (AI) has the potential to revolutionize many industries, including healthcare, finance, and environmental protection, to name a few. The advent of artificial intelligence has enabled endeavors that seemed impossible even a day ago.

If you're just getting started in the field of AI, I am confident that this book will give you a leg up by covering the basics of the field and the main ideas behind AI. This book will teach you how to use Microsoft Azure AI-related services to create AI solutions, and it will appeal to anyone curious about artificial intelligence.

To help you certify for the AI-900 exam, this book dives deep into all the modules and scenarios that will be tested. To help you see AI in action and experiment with Azure AI services, the book takes a practical, hands-on approach in addition to a detailed explanation of the theory.

Exam Overview

The AI-900 exam is designed to assess your understanding of fundamental AI and machine learning concepts, as well as your familiarity with the relevant Microsoft Azure services. By learning the basics of AI, you'll be

K. S. Trivedi, *Microsoft Azure AI Fundamentals Certification Companion*,
Certification Study Companion Series, https://doi.org/10.1007/978-1-4842-9221-1_1

well on your way to a successful career and ready to explore Azure's many technical options.

Not only does the exam cover broad AI and ML topics, but it also tests how well people know the features of different Azure AI services.

Like the exam, this book is meant to give you an overview of artificial intelligence and how it can be used, as well as the most common AI services in Microsoft Azure.

This book goes over every significant topic that will be on the exam.

Exam Prerequisites: Who Will Take This Examination?

Everyone who is involved in the process of developing and using solutions that make use of AI should have a solid understanding of artificial intelligence (AI).

To take part in the exam, you do not need to fulfill any prerequisite requirements, such as gaining experience or passing another exam.

The Azure AI Fundamentals exam does not require you to earn any of the other role-based certifications offered by Azure, such as Azure Data Scientist Associate or Azure AI Engineer Associate. However, it is recommended as a preparation for those certifications.

I think people taking the AI-900 exam should have already studied the materials provided by Microsoft Learn, either independently or with an instructor.

This exam is designed for candidates who come from a variety of different backgrounds, including technical and nontechnical ones. For this role, you don't need to have experience in data science or software engineering, but it would be helpful to know how cloud computing and client-server applications work.

Taking the Exam

There are a few things that need to be done before you can take this exam.

First Thing First: Signing Up

Registration is the first step before actually taking the exam. This is done on the Microsoft website:

https://learn.microsoft.com/en-us/certifications/exams/ai-900

The exam costs 99 USD in the United States, but the fee could be different in other countries or regions depending on where the proctoring takes place.

Practice Test

If you would like, you can put your knowledge to the test by taking the official practice exam before you take the real one:

https://in.mindhub.com/ai-900-microsoft-azure-ai-fundamentals-microsoft-official-practice-test/p/MU-AI-900?utm_source=microsoft&utm_medium=certpage&utm_campaign=msofficialpractice

If you have never taken a Microsoft exam before, you will need to make a certification profile after clicking "Schedule the Exam." If you have already taken a Microsoft exam, you will be taken to your account's profile page.

When you show up for the exam, you'll need to bring a copy of some sort of official identification. According to the Pearson Vue website, the following identification documents are accepted:

- Passport
- Driver's license

- Non-US Military ID (including spouse and dependents)
- Identification card (national or local)
- Registration card (green card, permanent residence, visa)

Tip 1 If you're creating a profile for the first time, make sure your name matches your ID. If not, your sign-in may be challenged.

Tip 2 Use a work-safe email address. Hotmail, Outlook, or your own domain works best.

You will be taken to the "Exam Discount" page after verifying your profile. This is where you will be able to enter any discount codes you have received. Now, it's time to schedule the exam.

Scheduling the Exam

You have the option of taking the exam either online or at the testing center, whichever is more convenient for you. You get to choose.

Choosing Your Time Block

When you go to schedule an online exam, you will be presented with a calendar that shows you the dates and times that are open for appointments. (There are no vacant time slots on the dates that are grayed out.) You have the option of selecting the kind of clock you would like to use (12- or 24-hour). Make sure that your computer is set to the time zone that you will be in when you take the exam.

Choose the exam's start time. Check-in begins 30 minutes before the event. You can always start the exam early, but if you have problems checking in, you may need the entire 30 minutes.

After you set up your exam, you'll get a confirmation email to the address in your profile.

Cheers! You are all set to certify now!

Exam Format

The Microsoft Azure AI Fundamentals (AI-900) examination includes between 40 and 60 questions. The following are examples of the different types of questions that could be on the Microsoft Azure AI-900 exam:

- Scenario-based single answer questions
- Multiple-choice questions
- Arrange in the correct sequence type questions
- Drag and drop questions
- Mark review, drag, and drop, etc.

However, to pass the exam, a candidate needs to earn a score that is at least 700 points high.

Modules and Weightage in the Exam

Modules emphasized in the AI-900 exam are listed in Table 1-1.

Table 1-1. *AI-900 modules and their weightage*

Module Name	Weightage
Describe artificial intelligence workloads and considerations	20–25%
Describe fundamental principles of machine learning on Azure	25–30%
Describe features of computer vision workloads on Azure	15–20%
Describe features of natural language processing (NLP) workloads on Azure	25–30%

Module Description

In this section, you'll look at each module closely and try to figure out how it fits into the whole experience.

Module 1: Describe Artificial Intelligence Workloads and Consideration (20–25%)

Module 1 talks about the fundamentals of artificial intelligence as well as artificial intelligence in Azure.

This module teaches you two lessons.

Lesson 1: Identify Features of Common AI Workloads

- Identify features of anomaly detection workloads
- Identify computer vision workloads
- Identify natural language processing workloads
- Identify knowledge mining workloads

Lesson 2: Identify Guiding Principles of Responsible AI

- Describe considerations for fairness in an AI solution
- Describe considerations for reliability and safety in an AI solution
- Describe considerations for privacy and security in an AI solution
- Describe considerations for inclusiveness in an AI solution
- Describe considerations for transparency in an AI solution
- Describe considerations for accountability in an AI solution

Module 2: Describe Fundamental Principles of Machine Learning on Azure (25–30%)

The module introduces machine learning as well as machine learning in Azure.

This module teaches you three lessons.

Lesson 1: Identify Common Machine Learning Types

- Identify regression machine learning scenarios
- Identify classification machine learning scenarios
- Identify clustering machine learning scenarios

Lesson 2: Describe Core Machine Learning Concepts

- Identify features and labels in a dataset for machine learning
- Describe how training and validation datasets are used in machine learning

Lesson 3: Describe Capabilities of Visual Tools in Azure Machine Learning Studio

- Automated machine learning
- Azure Machine Learning Designer

Module 3: Describe Features of Computer Vision Workloads on Azure (15–20%)

This module talks about core computer vision concepts and computer vision solutions in Azure.

The module teaches you two lessons.

Lesson 1: Identify Common Types of Computer Vision Solutions

- Identify features of image classification solutions
- Identify features of object detection solutions
- Identify features of optical character recognition solutions
- Identify features of facial detection, facial recognition, and facial analysis solutions

Lesson 2: Identify Azure Tools and Services for Computer Vision Tasks

- Identify capabilities of the Computer Vision service
- Identify capabilities of the Custom Vision service
- Identify capabilities of the Face service
- Identify capabilities of the Form Recognizer service

Module 4: Describe Features of Natural Language Processing (NLP) Workloads on Azure (25–30%)

This module shows you how to build a natural language processing model on Azure and teaches you the basics of natural language processing.

The module teaches you three lessons.

Lesson 1: Identify Features of Common NLP Workload Scenarios

- Identify features and uses for key phrase extraction
- Identify features and uses for entity recognition
- Identify features and uses for sentiment analysis
- Identify features and uses for language modeling
- Identify features and uses for speech recognition and synthesis
- Identify features and uses for translation

Lesson 2: Identify Azure Tools and Services for NLP Workloads

- Identify the capabilities of the language service
- Identify the capabilities of the speech service
- Identify the capabilities of the translator service certification

Lesson 3: Identify Considerations for Conversational AI Solutions on Azure

- Identify features and uses for bots
- Identify capabilities of the Azure Bot Service

Summary

In this chapter, we have learned about the core modules tested for the AI-900 exam and their weightage. We also learned about the exam overview, exam format, and how to register for the exam. In the next chapter, you will learn about the basics of AI and the main tasks that it is used for. We will also learn about the principles of responsible AI and how to use Microsoft Azure for the AI and AI services that Microsoft Azure offers.

CHAPTER 2

Fundamentals of Artificial Intelligence

With the help of AI, we can create machines that can learn and reason just like humans. So, artificial intelligence (AI) needs to look into how the human brain learns and makes decisions as it works to solve problems and do tasks. The main AI tasks covered in this chapter are machine learning, finding out when something isn't right, computer vision, natural language processing, and knowledge mining. When making an AI tool, you have to work hard to make sure it follows the ethical rules for AI that are explained in this chapter. This chapter will explain what artificial intelligence is and the different types of AI, such as strong AI and weak AI. You will also learn about various AI workloads and the main principles of responsible AI. Later in the chapter, you'll learn about artificial intelligence in Microsoft Azure and the various AI-related services it provides.

K. S. Trivedi, *Microsoft Azure AI Fundamentals Certification Companion*,
Certification Study Companion Series, https://doi.org/10.1007/978-1-4842-9221-1_2

What Is Artificial Intelligence?

With the help of AI, we can make amazing software that could improve healthcare, help people overcome physical limitations, create amazing entertainment, and even save the planet.

To put it another way, artificial intelligence (AI) is the development of software that simulates human behaviors and capabilities.

The following are key elements of AI:

- Making decisions based on data and previous experience
- Detecting anomalies in data, network, speech, and visuals
- Interpreting visual input
- Understanding written and spoken languages
- Engaging in casual conversations

The other two broad categories into which we fall are weak artificial intelligence (also known as "narrow AI" or "specialized AI") and strong artificial intelligence (also known as "artificial general intelligence").

Strong AI

An AI system that can mimic human behavior and capabilities is considered "strong." Artificial general intelligence (AGI) is intelligent in the same ways that humans are, able to figure out solutions to problems and pick up new abilities quickly. A strong AI is able to generalize its knowledge and apply it to new situations, anticipate future events based on the available data, and adjust to new circumstances. Because AGI doesn't exist yet, the only true examples are in science fictions like *Star Trek: The Next Generation*, *WALL-E*, and *Her*, and they usually depict a futuristic or fictional version.

Weak AI

Weak AI is often referred to as "specialized AI" due to its limited capabilities and focus on a narrow set of tasks. When referring to these AI systems, the word "weak" can give the impression that they lack the power to complete practical tasks, which is not the case. So far, all of the AI applications we've seen are examples of narrow AI. Weak AI is able to outperform humans at a single task because it is narrowly focused and operates under more restrictions than even the most basic form of human intelligence. Its limited abilities make it perfect for automating that specific task, and its laser-like focus has led to many technological advances in recent years. Deep Blue, an IBM computer, beat world chess champion Garry Kasparov in 1997. (Kasparov won their first match a year earlier.) Deep Blue chose from hundreds of millions of moves and "saw" 20 moves ahead of its opponent, a feat no human has yet accomplished.

Examples of Weak AI

- Google Maps
- Apple autocorrect
- Chatbots
- Smart assistants such as Siri, Alexa, and Cortana

Understanding Artificial Intelligence Workloads

Some of the common AI-related workloads are as follows:

- *Machine learning*: Machine learning is the process by which we "teach" a computer model to make predictions and draw conclusions based on data.

This process is often the foundation for an artificial intelligence (AI) system. Machine learning models are a type of AI-related computer program used to detect trends in data and extrapolate future outcomes. To build these models, developers use machine learning algorithms.

- *Anomaly detection*: The term "anomaly detection" is used to describe any method that seeks out and identifies data that doesn't fit the norm. These outliers may indicate abnormal network activity, the presence of a faulty sensor, or the need to clean the data before further analysis.
- *Computer vision*: With the help of cameras, videos, and still images, computer vision allows software to perceive its surroundings.
- *Natural language processing*: Processing of natural language refers to the ability of a computer to understand spoken or written language.
- *Knowledge mining*: Knowledge mining is the process of extracting information from various data sources in order to build a knowledge repository that can be searched.

Now, let us understand them in a little bit more detail.

Machine Learning

The question then is how do machines learn?

The answer can be gleaned from the data. As we go about our lives in today's world, we generate enormous amounts of data. This data can be used in a variety of ways. We produce a massive amount of information

every day, from the texts, emails, and social media posts that we send to the photographs and videos that we take on our phones. Millions of sensors built into our homes, cars, cities, public transportation systems, and factories continue to produce more data.

Machine learning relies heavily on algorithms. These huge amounts of data are fed into machine learning algorithms so that they can learn from them. In general, the more data that is provided to a machine learning algorithm, the higher the level of accuracy that it achieves.

Anomaly Detection

Imagine that you are making a piece of software that will track the purchases made with credit cards and look for any strange patterns of use that could be signs of fraud. Such a type of anomaly is known as a "point anomaly." When one observation stands out from the rest of the data points being looked at, this is called a "contextual anomaly." For example, say you have hundreds of pictures of famous buildings, and your machine learning model filters out a picture of mountains that was added to the set by mistake. This occurred because the mountains were in the wrong dataset. When it comes to these kinds of anomalies, something that is considered an anomaly in one context might not be considered an anomaly in another context.

Computer Vision

The branch of artificial intelligence known as "computer vision" focuses on the processing of images. Let's investigate a few of the many opportunities that come with using computer vision.

The app "Seeing AI" is a fantastic illustration of the power that computer vision can provide. The Seeing AI app was developed specifically for people who are blind or have low vision. It makes use of the power of artificial intelligence to open up the visual world and describe nearby people, text, and objects.

Most computer vision solutions come from machine learning models, which can be used to analyze visual data from cameras, videos, or still images.

Natural Language Processing

"Natural language processing," or NLP, is a branch of artificial intelligence that works on making software that can understand both written and spoken languages.

Behind the scenes, natural language processing looks at how sentences are put together and what each word means. To put it another way, it deciphers human speech so that it can carry out various tasks without any human intervention. Virtual assistants like Google Assistant, Siri, and Amazon's Alexa are among the most well-known applications of natural language processing. Words and phrases like "Hey Alexa, increase the volume, please." can be translated into numbers that machines can understand with the help of natural language processing.

NLP makes it possible to

- Identify emotions in text and classify opinions as positive, negative, or neutral. Companies can learn about customer sentiment toward their brands and products by sifting through customer comments posted on social media, product reviews, and online surveys. You could, for instance, monitor tweets about your company in real time to look for signs of dissatisfied customers.

- Extract specific data from text, using text extraction. This tool is useful for identifying and extracting relevant keywords, features (such as item codes, colors, and characteristics), and named entities from large datasets (like names of people, locations, company names, emails, etc.).
- Design chatbots to interact with humans through text or speech.

For instance, Human Interact's virtual reality (VR) game *Starship Commander* is set in a science fiction universe and allows players to pilot their own spaceship. Because the game uses natural language processing, the players can control the story and interact with the game's characters and starship systems.

Knowledge Mining

"Knowledge mining" is the process of creating a searchable store of information. This word is also used to talk about ways to get information out of a lot of unstructured data.

Azure Cognitive Search is one of these knowledge mining solutions. It is a private enterprise search solution that includes tools for building indexes. The indexes can then be used for internal purposes only or to make content searchable on Internet assets that the public can see.

When it comes to performing knowledge mining on documents, Azure Cognitive Search is able to make use of the built-in AI capabilities of Azure Cognitive Services. Some of these skills are image processing, content extraction, and processing of natural language. The product's artificial intelligence lets it index documents that couldn't be searched before and quickly pull insights from large amounts of data and show them on the surface.

Principles of Responsible AI

Microsoft uses a set of six rules to make decisions about how to build software with artificial intelligence. These rules are meant to make sure that AI applications give great answers to hard problems and don't have any unintended bad effects.

The following are the six principles of responsible AI:

- Fairness
- Reliability and safety
- Privacy and security
- Inclusiveness
- Transparency
- Accountability

Now, let us understand these principles in some detail.

Fairness

All people ought to be treated equally by AI systems. Take, for example, the case where you create a machine learning model to help a bank's loan approval application. Without favoritism, the model should decide if the loan application should be accepted or turned down. This bias could be based on gender, race, or anything else that leads to unfair advantages or disadvantages for certain groups of applicants.

Azure Machine Learning gives you the ability to understand models and measure how much each part of the data affects the model's prediction. Data scientists and developers can use this feature to figure out where the model is biased and take steps to fix it.

Microsoft's implementation of responsible AI with the Face service is another example. This service used to have facial recognition features that could be used to try to figure out how someone is feeling and what their name is. These capabilities can be used to identify individuals. If these features are used in the wrong way, people may be stereotyped, treated unfairly, or have services taken away from them.

Reliability and Safety

AI systems should be able to work reliably and without any possible risks. Take, for example, a software system for a self-driving car that is based on artificial intelligence (AI) or a model that uses machine learning to figure out what's wrong with a patient and suggest a treatment plan. Both of these are examples of software systems that are based on artificial intelligence. If these kinds of systems aren't reliable enough, it can be a change from what is usually done. This should still be standard practice, even though artificial intelligence is still in its early stages.

Transparency

AI systems must be easy to understand, even for people who have never used a computer before. Users are responsible for making sure they have a full understanding of not only how the system works but also how it works but also what kinds of limits they should be ready for when using it. This understanding isn't just about how the system works; it includes everything about the system. This comprehension is not restricted to merely focusing on the operation of the system.

Accountability

People must be held accountable for the decisions made by artificial intelligence systems. When designing and developing their products, designers and developers of AI-based solutions should do so within the context of a governance and organizational principles framework. This will ensure that, even though artificial intelligence is still in its early stages, this should be the case. For the best results, you should do these steps within the limits of an AI-based solution.

Note For more information about Microsoft's principles for responsible AI, visit the Microsoft Responsible AI site: https://www.microsoft.com/en-us/ai/responsible-ai.

Understanding Artificial Intelligence in Microsoft Azure

The goal of the group of technologies known as "artificial intelligence" (AI) is to make intelligent systems that can see, think, and help people. The goal of AI, which stands for "artificial intelligence," is to give computers abilities that are similar to those of humans. This goal is to make computers that can do things as humans can. If AI is incorporated into the process, businesses will be able to create digital experiences that are intelligent, quick, and helpful to end users. This will give AI the ability to empower businesses.

Artificial intelligence gives businesses the chance to start over, which has the potential to change not only business processes but also whole industries and the way customers interact with businesses.

The Microsoft Azure AI development framework is a powerful tool that can be used for the creation of artificial intelligence solutions in a variety of different fields. Some of these fields are conversational AI, machine learning, data sciences, robotics, the Internet of Things, and many more.

Microsoft makes it possible to use information no matter where it is stored.

All of these different kinds of data are collectively referred to as "business data." Some examples of business data are sensor data from IoT devices, productivity data from Office 365, and business data from your business applications. During the process of optimization, both the time to market and the flexibility of the solution were taken into consideration.

Microsoft Azure is a cloud platform for AI that is reliable and scalable. It includes data storage, ML compute, and services.

Data Storage

Azure Storage is a cloud-based service that provides highly available, scalable, and secure storage for a wide variety of data objects.

Compute

The cloud computing service from Microsoft Azure gives users an infrastructure that lets them run applications and change the amount of capacity based on their needs.

There are four primary compute types available in Azure ML:

- Compute instances
- Compute clusters
- Inference clusters
- Attached compute

Compute Instances

Azure Compute instances give you fully managed virtual machines that already have most of the important frameworks and libraries for doing machine learning and data science experiments. This saves you time because you don't have to set up your local computer for ML experiments.

Compute Clusters

When compared to compute instances, compute clusters can have more than one compute node. We can customize the hardware specs of these compute nodes to suit our needs. A compute cluster may need to be set up for hyperparameter tuning, GPU-based complex computations, and running multiple machine learning models in parallel. You will need a compute cluster to run computations when using Azure ML for automated machine learning experiments.

Inference Clusters

Azure Machine Learning web services can be set up as REST endpoints in one of two ways:

1. *Implement ACI (Azure Container Instances)*: For smaller, more localized deployments of the REST web service, ACI is the way to go.
2. *Provision AKS (Azure Kubernetes Service)*: AKS is the way to go for larger, more enterprise-wide deployments. The AKS cluster can be adjusted to your specifications via the Azure portal and Azure ML.

Attached Compute

Azure Machine Learning isn't just about computing on compute clusters. You can use Azure Databricks, Data Lake Analytics, HDInsight, or a VM you already have as a computing resource for your workspace. Keep in mind that Azure Machine Learning only works with Ubuntu virtual machines. Azure Machine Learning will not manage these compute targets. Because of this, you might need to take some extra steps to make sure they work with your experiments.

Services

Azure's services follow a pay-as-you-go business model and are made available to customers over the Internet. Servers, storage, databases, networking, software, analytics, and a variety of services are available for the AI and ML category, including Azure Cognitive Services, Azure Machine Learning service, Azure Cognitive Search, and Azure Bot Services, to name a few.

AI Services in Microsoft Azure

The main goal of Azure Applied AI Services is to help developers quickly find value in their data by integrating AI into their most important business scenarios. Machine learning and other forms of artificial intelligence are used to do this.

Azure Applied AI Services has been updated to help with important tasks such as monitoring and diagnosing metric anomalies, mining knowledge from documents, improving the customer experience through transcription analysis, improving literacy in the classroom, and many other uses.

On top of the AI application programming interfaces (APIs) that Azure Cognitive Services offers, these services were built. In the past, companies had to orchestrate multiple AI skills, add business logic, and make a user interface (UI) in order to move from the stage of developing their scenario to the stage of deploying it. Time, expertise, and resources were all necessities for completing each of these steps.

The following is a description of a few of the most important AI-related services that Azure has to offer:

- Azure Machine Learning
    - A platform that can be used for the training, deploying, and management of machine learning models
- Cognitive Services
    - A collection of services that are supported by four primary pillars: vision, speech, language, and decision
- Azure Bot Service
    - A platform that runs in the cloud and is used to create and manage bots
- Azure Cognitive Search
    - Extraction of data, enhancement of existing data, and indexing in preparation for intelligent searching and knowledge mining

Now let us understand these services in some detail.

Azure Machine Learning

Azure is a powerful service that meets the needs of businesses all over the world in terms of development and deployment. It also has the ability to do machine learning. With Azure Machine Learning, you will have access to some of the most cutting-edge machine learning capabilities. These features include the ability to build learning models, train those models, and use those models. All of these things can quickly make your work system more efficient.

When it comes to artificial intelligence (AI), Microsoft was the first company to achieve human parity in vision, speech, and language. Machine learning is not an exception to this trend. If you set up the system with the help of your tools and framework, you will be able to use automation to build models more quickly. You will also be able to manage deployment across the cloud and edge, and you will be able to tailor everything to the needs of each of your teams. Machine learning can be done on either Windows or Linux, and it comes in a number of different models. It also works with other Azure apps and services, such as Azure DevOps Services and Azure Pipelines. Because it is open source and offered by ONNX, you will have the ability to quickly move elements between different frameworks and hardware platforms. Microsoft Azure Machine Learning helps to simplify processes that are otherwise difficult.

Azure Cognitive Services

Azure Cognitive Services are a type of artificial intelligence (AI) service that is hosted in the cloud. With these services, software developers can add cognitive features to their apps without having to be experts in AI or data science. Both client library software development kits (SDKs) and REST application programming interfaces (APIs) make it possible to access them in a wide range of commonly used programming languages. By using cognitive solutions that can see, hear, speak, and analyze data,

Azure Cognitive Services makes it easy for developers to add cognitive capabilities to their apps. These cognitive solutions can see, hear, speak, and analyze data. The following are the categories of Azure Cognitive Services:

- Vision
  - Computer Vision
  - Custom Vision
  - Face
- Speech
  - Speech service
- Language
  - Language Service
  - Translator
  - Language Understanding (LUIS)
  - QnA Maker
- Decision
  - Anomaly detector
  - Content moderator
  - Personalizer

Azure Bot Service

The Azure Bot Service gives its users access to an integrated development environment (IDE) where they can build bots that use the service. Because of its integration with Power Virtual Agents, a fully hosted low-code platform, developers with different levels of technical skill can now

build conversational AI bots without having to write any code at all. A graphical user interface (GUI) that requires very little to no coding can be used to create, test, and distribute bots. This makes the process of bot creation more accessible. In addition to the benefits that have already been mentioned, you will also be able to automatically track important bot telemetry and predict what topics will come up next.

Also, very few changes need to be made to the code in order to connect to channels like telephony and Microsoft Teams. This is an advantage over other solutions. An exciting and long-awaited change is that you can now deploy bots in a way that is safe and still meets compliance and governance standards. This opportunity is now available to you.

Azure Cognitive Search

You will find hidden information in every piece of content and piece of data that you collect. Documents, media, images, and other types of content that go beyond what is considered to be simple reference material can give you new ideas and ways to use them. You won't be able to see any hidden meanings, connections, or uses for these components if you don't approach them from the top down.

Azure Cognitive Search uses cloud search services with built-in artificial intelligence to find connections between pieces of content that you might not have seen otherwise. These are connections that you would not have been able to find. With a single search, you can find content patterns, emotional connections, key phrases that are used in more than one document, and a lot more. Based on the specifications you give, AI can figure out how important something is and give you an overview of any elements that match the description and how they relate to other data with a similar structure. Also, artificial intelligence can give a summary of any parts that don't match the description. Azure Cognitive Search is the only

service with cutting-edge AI features. It can quickly and easily pull out the most important information from all of your content, making it the best service you can get.

When you combine Azure Cognitive Services and Bot Services in your applications, you have the potential to deliver experiences that are light years ahead of your competitors. You will have access to the best AI models in the business, which are used in powerful Microsoft products like Office 365, Bing, and Xbox. These models are leaders in their respective fields. You can change each model so that it fits the needs of your project. You can also add your own data to the models and use them wherever you want in your own environment.

Azure has been put through a lot of tests to make sure that you will get a product that will give your project the boost it needs to be successful. This guarantee has been made in order to provide you with peace of mind. Your data may be put to use in the process of modifying the AI models that are a part of Cognitive Services. Cognitive Services are a collection of AI models that are tailored to specific domains. Because these AI models have already been built and trained, all you have to do is enter the differences. Then you can sit back and watch the AI do its thing. Bot Service is an environment for the development of bots that comes with prebuilt templates that are ready to use immediately and can be modified to meet your specific requirements. These templates can be accessed through the Bot Service dashboard. With Azure AI, you have access to all the tools and resources you need to improve the overall quality of your projects even more than before.

The Azure AI platform gives you the ability to improve your project in a variety of ways, such as by improving the application creation, data analysis, or machine learning capabilities of your project. Azure AI can help you improve your work in a lot of different ways, and it also has a lot of customizable options that you can use to make these services fit your needs.

Introspective Practice

Now it's time to check your knowledge before we move ahead with the next chapter.

1. You need to build a model that uses past data, such as the number of bicycles rented each day and weather observations, to make predictions about future demand. How do you know which Azure service to use?

    a. Azure Bot Service

    b. Azure Cognitive Search

    c. Azure Machine Learning

2. You are tasked with developing an AI program that analyzes photos of people's faces for cues about their moods and feelings. What is a helpful AI workload?

    a. Anomaly detection

    b. Natural language processing

    c. Computer vision

3. The credit cards of certain financial institutions are now available. Credit limits could be assigned mechanically to those who applied for the cards online. The bank makes sure that the algorithm's decision about the credit limit is the same no matter what gender the applicant is. Which of the principles of AI accountability is being met here?

    a. Transparency

   b. Reliability and safety

   c. Accountability

4. A translation feature and automatic language detection for multilingual search are features sought after by a commercial online store. Which Azure AI service it should rely on?

   a. Natural language processing

   b. Azure Machine Learning

   c. Azure Cognitive Search

5. Providers of insurance products want to use artificial intelligence to create a tool that aids policyholders in making informed choices. Which service do you think is best at directing clients in the direction they need to go?

   a. Azure Bot Service

   b. Natural language processing

   c. Azure Machine Learning

Solutions to Practice Test

1. Question 1 – a
2. Question 2 – c
3. Question 3 – a
4. Question 4 – c
5. Question 5 – a

References: Microsoft Learn

I firmly believe that the chapter would have prepared you for your AI-900 certification. Before we move on to the next chapter and learn more about Azure Machine Learning, I strongly suggest that you go through the Microsoft Learning Azure AI Fundamentals: Get Started with Artificial Intelligence module, using the following link:

Get Started with AI on Azure: https://learn.microsoft.com/en-us/training/modules/get-started-ai-fundamentals/

Summary

The development of AI has made it possible to come up with and use effective solutions to a wide range of problems. Artificial intelligence (AI) systems can take on human traits to analyze the world around them, make predictions or inferences, and act on those inferences in ways we couldn't even imagine a short time ago.

The authority is accompanied by certain responsibilities. As the people who make AI-based solutions, we have a duty to follow a set of rules that will make sure that everyone will benefit from AI and that no one or group of people will lose out.

In this chapter, you learned about the fundamentals of AI along with core AI workloads. You also learned about the most popular AI services on Microsoft Azure, such as Azure Machine Learning, Azure Cognitive Services, Azure Bot Service, and Azure Cognitive Search. You also learned about the guiding principles of responsible AI applications. In the next chapter, you will learn about the basics of machine learning and its most important components, like datasets, features, labels, different machine learning algorithms, and the machine learning workflow.

CHAPTER 3

Machine Learning Fundamental Concepts

This chapter takes you on an introductory machine learning journey to familiarize you with all the fundamental basics of this topic. This chapter begins by defining machine learning and then goes on to describe core machine learning concepts like datasets, features and labels, machine learning algorithms, machine learning workflow, and model evaluation metrics. The chapter also covers different types of machine learning, such as supervised and unsupervised learning, as well as machine learning in Microsoft Azure. You'll also learn about machine learning tools like Azure Machine Learning Studio and Azure Machine Learning Designer here.

What Is Machine Learning?

In simple words, machine learning is all about the use of algorithms and statistical models to analyze and carve out inferences and patterns in data, which are then used to control or develop a system that works and progresses properly without depending upon clear instructions from its user. Broadly defined as the capability of a machine to learn and

K. S. Trivedi, *Microsoft Azure AI Fundamentals Certification Companion*,
Certification Study Companion Series, https://doi.org/10.1007/978-1-4842-9221-1_3

imitate natural human behavior, machine learning is the backbone of any artificially intelligent application or model. Also, machine learning (ML) is a type of artificial intelligence (AI) that lets software applications get better at predicting outcomes without being explicitly programmed to do so.

Machines learn from the huge volume of data and past experiences. Machine learning tries to imitate how people learn by using data and algorithms to get better and better over time.

Along with being data consumers, we humans are also good at producing huge amounts of data every day. The emails, the daily searches, the media, and the scrolling on social media websites produce a lot of data about us nearly every single hour. This data can help us because it can be used to train machine learning models, which are good at making conclusions and smart enough to find connections between the data we give them.

Core Machine Learning Concepts

As a complete field and a huge knowledge area on its own, machine learning stands upon some core pillars that need some understanding before we can go on and fathom the depths of machine learning itself. These concepts are datasets, machine learning algorithms, machine learning workflow, and model evaluation metrics. As our goal is to figure out how machine learning works, we will now talk about and study each of the preceding features one by one.

Dataset, Features, and Labels

Without an original and ready dataset, a machine learning application proves to be nothing. A good dataset is like the fuel that flows inside the knowledge streams of a machine learning model. Without it, the model itself is useless and lifeless.

Dataset

A dataset is a group of related units of facts and information that is composed of unique elements that, however, can be manipulated as a single unit by a computer. The main purpose of a dataset is to teach an algorithm of a machine how to find patterns in the whole dataset. The algorithm will then be able to predict patterns in the whole dataset.

The importance of a dataset is undeniable, so much so that to run a successful business, one has to be entirely aware of the data concerned with that business. For example, a shopping mall or even a small grocery store needs to understand the local favorites in products and also the preferences of their customers in terms of cost. Along with it, they are to know about the good and bad seasons for business to better cater to the inflow of money and attract more customers. For this, if these shops have a good and relevant dataset, they can create a good business model to run the business. Philosophically similar to this phenomenon, a good machine learning model also requires an exquisite dataset to learn and run the best algorithms for their tasks.

The common types of data include text data, image data, audio data, video data, and numeric data.

In the field of machine learning, a dataset serves two primary functions:

- To learn and improve the models in flowing consistency
- To determine the accuracy of a model after it has been educated completely

In general, the dataset is divided into three subsets as shown in Figure 3-1.

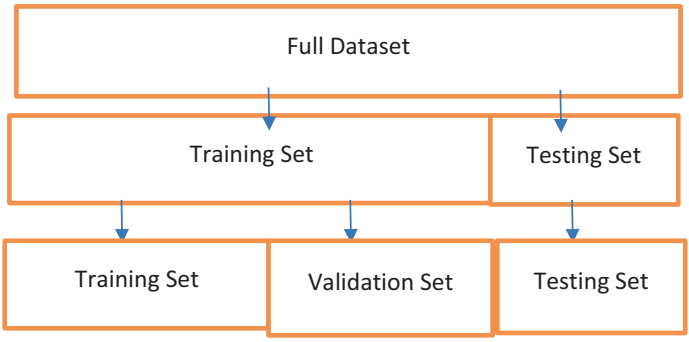

Figure 3-1. *Splitting a full dataset into a training set, a validation set, and a testing set*

Training Set

This classification of the dataset is the most rudimentary part of it. This part of the dataset has all the information that is needed to teach and train a machine learning model. It is used to fine-tune the parameters of a machine learning model and train it by example. Training datasets are also called "learning sets." It helps machine learning models make accurate predictions or complete tasks. Overall, this subset teaches a model how to look for the data that would make it learn better. Also, this data needs to be broken down even more before it can be used by a system. For example, a system that is good at recognizing buildings would be able to do so with the help of image data and labels that show the size and location of the building.

Validation Set

The validation set is there to be used to train AI, with the goal of making it smart enough to learn from past mistakes and solve any problems that may come up in the future. This dataset is used to give an estimate of model skill while tuning the model's hyperparameters. In other words, a set of

examples is used to calibrate a classifier's parameters, such as the number of hidden units in a neural network. This way, this dataset calculates and concludes whether a model is under- or overfit for the task it is designed for. This dataset, which helps set the score of a model's competency, proves vital for engineers to extract the accuracy of the output given by it.

Testing Set

This dataset comes at the bottom of the flow of training. It is used at the end of the training process to calculate a model's success based on how well it performed. The engineers and professionals only use this dataset at the end of the training phase because the model cannot have access to it until after the training phase is over. There is much confusion in applied machine learning about how the testing set differs from the validation set, mainly because both subsets are used to assess the parameters of the model. In spite of this similarity, the testing set is used to measure how well a fully specified classifier works, while the validation set is used to fine-tune a classifier's parameters.

Note Approximately 60% of the total dataset is made up of the training dataset. The validation dataset accounts for somewhere in the neighborhood of 20% of the total dataset. The amount of data used for testing accounts for 20% of the total amount.

Features and Labels

In simple words, a feature is an input, while a label is an output. For instance, you want to conduct research on a dataset containing population statistics. Likely, every person in that dataset is an observation, and the characteristics of those observations are known as features. In this

case, features would be gender, age, location, etc. If you want to extract information about a certain group of people in this dataset, you would input the desired features into the system to get back an output.

Tip A feature is a variable that can be changed independently.

Words within the email's text, the sender's address, the time the email was sent, and a select few words within the email itself are some of the features that could be included in an email spam detector application.

A label is an element we're anticipating – the y variable in a graph. The label can be the future price of oats, the kind of plant shown in a photo, the summary of an audio clip, or whatever can symbolize or define a piece of content. In other words, it can also be called "tagging." And these tags are made and imposed upon the element in question based on the prior knowledge of that element prestored in the system.

Simple examples of labeled data are

- A picture of a fruit, with an associated label "apple" or "orange"
- A text description for a product review and the score assigned to that product by a user

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Note The label is the thing we are predicting – the final output of the prediction. In machine learning applications, we can use both labeled and unlabeled data.

Machine Learning Algorithm

A methodology or a framework in accordance with which an AI system conducts itself and its tasks or simply a set of instructions that give directions to the entire system on how to learn from data and improve over

time without depending upon any human support. These algorithms are agile, precise, probabilistic, and technically adequate enough to guide a whole system on how to scan out hidden patterns in entangled, noisy, and complex datasets.

The essentials of machine learning can be found in all the following algorithms:

- Linear regression
- Logistic regression
- CART (Classification and Regression Trees)
- Naïve Bayes
- KNN (K-Nearest Neighbors)
- Apriori
- K-means
- PCA (Principal Component Analysis)
- Bagging with random forests
- Boosting with AdaBoost

Note All of the preceding algorithms can be broken down into smaller groups, such as supervised learning algorithms, unsupervised learning algorithms, and ensembling methods. However, the book doesn't go into the specifics of how these algorithms work. To pass the AI-900 exam, you don't need to know a lot about these algorithms.

Machine Learning Workflow

The process of machine learning can be broken down into three easy-to-understand steps:

(1) Data processing

(2) Data modeling

(3) Deployment

It is very easy to understand the preceding three phases as shown in Figure 3-2.

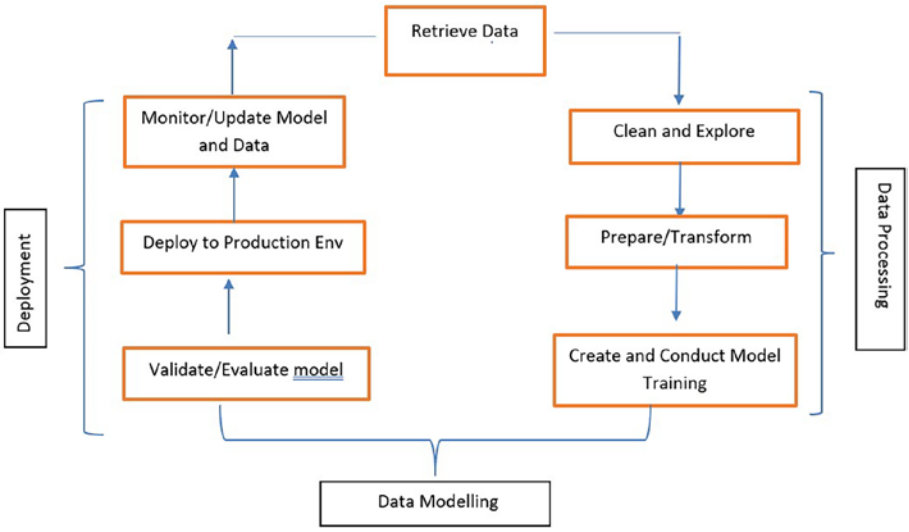


Figure 3-2. *Machine learning workflow*

Data Processing

The whole point of data processing is to make a set of data more useful and relevant by processing it in different ways and getting it into a more desirable and informative shape by using machine learning algorithms, statistics, and mathematical modeling.

It is almost essential to state here that 80% of your problems are solved if you have been assigned or are working with a dataset that is already in good and relevant shape.

You can further divide data processing into three stages:

- *Data collection*: Collecting raw data from relevant and accurate sources so that the collection in question is usable and not irrelevant. The term "raw data" can refer to a variety of different things, such as monetary figures, website cookies, profit-and-loss statements of a company, user behavior, etc.
- *Cleaning data*: In this stage, the raw data collection is checked for possible errors, inadequacies, duplication, and miscalculations. All the unwanted data is removed so that the data can be prepared for the next stage of processing. Data cleaning is also known as data preparation because here the data is made ready for being used in further processes.
- *Data processing*: In this stage, the unprocessed data is put through a variety of data processing procedures, including those based on machine learning and artificial intelligence algorithms, in order to generate the result that was aimed for. This step might be different from one process to the next depending on the origin of the data that is being processed, as well as the purpose for which the output is going to be used.

Data Modeling

It is the process of modeling the data flow. In machine learning, a model represents a decision process in an abstract manner. It is the process of designing how the data will flow in and out of the databases during the system's operation. This part, which is both very interesting and necessary for any machine learning application, can be broken down into two stages:

- *Develop and train the model*: On the basis of the training dataset, multiple models are constructed with the assistance of various algorithms.
- *Create and conduct model training*: After the training stage, the models are validated and fine-tuned with the help of the validation dataset. Additionally, the test dataset is utilized in the process of evaluating and selecting the single most effective model.

Deployment

The process of moving a machine learning model from an offline environment and integrating it into a live space with a real production environment is known as "deployment" in machine learning, for instance, in an application that is live. Being a critical step, it needs to be dealt with carefully because the working of a model depends upon its complete and appropriate deployment. Luckily, we do have a highly accurate model with which to address this problem.

This component can be further divided into two stages:

- *Model deployment*: Once a working model is testified and approved by the supervising team, the deployment team takes it upon themselves to deploy the model in a live environment. This phase usually consists of several steps within itself, and they are as follows:

    1) Moving the model into an environment that includes servers and middleware. At this stage, our model gets access to all the hardware and data facilities it requires.

2) The model is then integrated into a process using APIs or incorporated into the user's software connecting to the end user's computer.

3) And in the final stage, the users access the model, run it, and access its outputs.

- *Monitor/update the model and data*: As more time passes, there is a possibility that the patterns in the data will undergo abrupt or seasonal shifts, which may result in a decline in the performance of the model. In these kinds of situations, the model needs to be updated, which means going back to the phases of retrieving data, which ultimately brings the workflow full circle.

Model Evaluation Metrics

Model evaluation is the process of figuring out how well a machine learning model works and what its strengths and weaknesses are by using different evaluation metrics. Since the results are one of the most important parts of any model, we should always look at them after each testing cycle. From our end, the analysis should keep going back and forth until we get results that match the model's goal.

Here is a list of the metrics that are used to judge machine learning models:

- Confusion matrix
- Logarithmic loss
- Classification accuracy
- Area under a curve
- F1 score

- Mean absolute error
- Mean squared error

Note The book and the AI-900 exam don't go into detail about model evaluation metrics.

Types of Machine Learning

There are two general approaches to machine learning: supervised and unsupervised machine learning as shown in Figure 3-3.

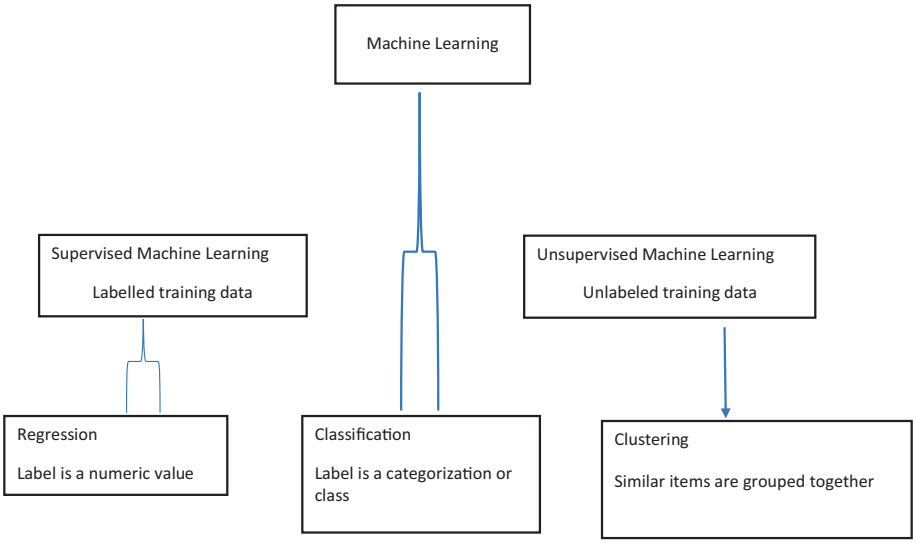


Figure 3-3. *Types of machine learning*

Both supervised and unsupervised machine learning are aimed at modeling an equation that uses available data to make predictions that are as close to the real value as possible.

Both ways need data, but one needs data with labels, and the other needs data without labels.

Supervised Machine Learning

This type of machine learning is defined by its use of labeled data that is used to train algorithms that make further predictions. When it comes to using it, we need some of our data to be labeled, which we can then use on unlabeled data. In other words, the labeled data acts as a teacher for the system to learn from, make the right calls, and produce the right outputs. In this learning, a training set is used to teach models to produce the desired output. This training dataset has inputs and correct outputs, which help the model learn over time. The model also figures out how accurate it is by using the loss function and getting better over time.

Both the input data and the expected output data are given to connect the dots once by making a connection between x and f(x) in the function. This causes our model to learn its function and its nature so that it can make accurate predictions for the future on its own.

The purpose of supervised learning is to train a model of how to classify data by labeling a dataset with relevant information. After the model has been trained, it is checked with test data and then used to make predictions about the output.

Note Labels are what we want to predict, such as shapes, fruit names, the number of soft drinks sold in the summer, and the number of bike rentals based on weather.

The Two Classes of Supervised Machine Learning

- Regression
- Classification

Regression

Basically, regression is a model that was made to find the relationship between the independent variable (features) and the dependent variable (output). In machine learning, it is used for predictive modeling, where an algorithm anticipates a series of continuous outcomes. Its result is a continuous numerical value, like the current temperature, the number of items sold, the price of the item, or the total number of customers who have visited the store during the holiday season.

Regression techniques that are typically used include

- Linear regression
- Decision tree
- Random forest
- Neural networks

Classification

Classification models are the second type of supervised learning technique. Being a model that classifies data into different groups, it can be used on both structured and unstructured data. Predictive modeling classification is the task of approximating the mapping function from discrete input variables to discrete output variables. The main goal is to identify which class or category the new data will fall into. Assign probabilities between zero and one to all classes of data. Primarily, classification algorithms are used to make predictions about two classes and to divide the results of their work into various categories. Classification algorithms could use the content of an email to figure out if it is spam, just as they could use clinical measurements to figure out if a patient is at risk for a heart attack or diabetes.

In machine learning, there are two types of classifications:

- *Binary classification*: If the problem has only two possible classes, it is called a binary classifier.

- *Multiclass classification*: If the problem has more than two possible classes, it is a multiclass classifier.

The following are some popular classification algorithms:

- Naïve Bayes
- Logistic regression
- Support vector machine

Unsupervised Machine Learning

This model is all about finding the hidden patterns in unstructured data without any supervision or guidance from labeled data. Unsupervised learning doesn't use any labeled data to find its direction or to train itself. It sees groups based on their features and characteristics and classifies them into different units. Using machine learning algorithms to analyze and cluster unlabeled datasets, we find hidden patterns in the data without any help or support from any label.

Clustering

It is an unsupervised learning method that involves putting data into different groups based on how similar or different they are. Clustering can also be thought of as grouping the data together. Items with the most similarities are kept together in the same cluster, as opposed to objects from other clusters that have no or very few similarities with them. A clustering model can show the relationship between features without using labels. In this model, the features are grouped together based on their similarities. In the real world, we can use clustering to group shrubs, herbs, and trees based on their unique traits. In the same way, we can use a car's emissions to classify it as either electric or gas powered.

The following are some popular clustering algorithms:

- Hierarchical clustering

- DBSCAN
- K-means clustering

The Two Important Elements: Model Training and Validation

Training is where the machine learns something. As much as possible, the goal is to record the connections between features and their respective labels. Algorithms can be "trained" by making small changes over and over until they fit the data better or capture the relationships that are important.

When the training phase of the model is complete, it is time to put the model through the testing phase.

It is not recommended to use the same dataset for model training and model validation at any point. To build a reliable machine learning model, you need to split your dataset into a training set, a validation set, and a test set.

As was covered earlier in this chapter, there are a wide variety of evaluation metrics that can be applied to the model so that it can be evaluated. The thing that we need to keep in mind is that the purpose of machine learning is to locate a model that comes as close as it can to accurately predicting the label that will be applied.

Note Always keep in mind that even the most accurate model can still have a certain deviation.

We can conclude the training and validation process in the following steps:

1. Develop a training set and a validation set out of the available dataset.

2. Use a fitting algorithm to create a model from the training data.
3. Relationships in the data are captured by the trained model.
4. Predict results focusing on the validation data using the model.
5. Measure the degree to which clusters are distinguishable from one another or contrast predicted labels with actual ones using evaluation metrics.
6. Start another cycle from step 1.

Introducing Azure Machine Learning

Developers can build, deploy, and improve high-quality machine learning models with Azure's machine learning tools and user-friendly platform. It adds more value to a project by reducing the time to value with industry-leading machine learning operations (MLOps), open source interoperability, and integrated tools. This trusted platform is designed for responsible AI applications in machine learning. In addition, Microsoft Azure manages the Azure Machine Learning service offering.

Today, a lot of software engineers, data scientists, and machine learning professionals use the Azure Machine Learning service to build machine learning applications. These applications do things like train and deploy machine learning models and manage machine learning pipelines.

To use Azure Machine Learning, you need a Microsoft Azure subscription. Below in the Table 3-1 you understand the various Azure Machine learning components.

Table 3-1. *Important components of Azure Machine Learning*

Azure ML Components	Description
Azure Machine Learning workspace	This is a centralized, top-level place to work on our projects. With all the artifacts and tools to work with, this workspace stores training logs, metrics, output, and script snapshots. Machine learning tasks read and write artifacts to your workspace, such as when you run an experiment to train a model; it logs the job run results to the workspace; and when you use Automated ML to train a model, it writes training results to a workspace.
Compute	Azure Compute provides developers with all the infrastructure they need. Whether it is for building an app or deploying it, Compute has got it. It is an infrastructure-as-a-service platform for hosting and managing application workloads. It comes with a wide range of service offerings, such as virtual machines, the Azure Container Service, Azure App Services, Azure Batch, and Azure Service Fabric.
Data	A cloud-based data integration service that allows one to initiate and automate data movement and transformation. This service comes in handy when supporting data migrations, getting data from a server or online data to an Azure Data Lake, carrying out various data integration processes, and integrating data from different ERP systems and loading it into Azure Synapse for reporting.
Jobs	Microsoft Azure job defines, schedules, monitors, and controls operations related to Microsoft Azure virtual machines. You can add one or more Microsoft Azure jobs to the job stream that automates your business process flow, to provide a flexible and dynamic allocation of cloud resources to your workload.

(*continued*)

Table 3-1. (*continued*)

Azure ML Components	Description
Services	When you are ready to start using the model in your applications, you can publish those applications as services that can be accessed through public and private endpoints.

Tools for Azure Machine Learning

Azure Machine Learning offers various tools to build your ML solutions. Anyone on an ML team can use their preferred tools to get the job done.

Azure Machine Learning Studio

The Microsoft Azure Machine Learning Studio is the main place where machine learning services in the Microsoft Azure Cloud are run. The original Microsoft Machine Learning Studio Classic will be discontinued in 2024. Microsoft's Azure ML Studio has steadily gained more features and options over time.

The Azure ML Studio menu can be broken down into its three primary components: author, assets, and manage.

The Author tab is all about writing the code and organizing the infrastructure for your machine learning process.

Assets hold the components, like pipelines, that are developed and saved in the Author tab. It controls the whole process of using the available resources, from the time datasets are put into a pipeline to the time the workflow ends at the endpoints.

The Manage tab is for administering the server infrastructure. It includes data storage, integrations with other systems, and computational clusters and instances.

Azure Machine Learning Designer

Pipelines in Azure Machine Learning are multistep workflows that are used to process data, train models, and manage models. Azure Machine Learning Designer is a visual interface for building ML applications without writing any code. In the Azure Machine Learning Designer, all you have to do to build your ML pipelines is drag and drop.

Azure Machine Learning Designer has more than 60 modules that can be used to change data; input and output data; select features; use statistical functions; do regression, clustering, and classification; train models; and evaluate models. Simply select the modules and connect them, and your pipeline is complete.

What Is Automated Machine Learning?

Using automated machine learning, models can be easily created with no coding required. The most complicated models are hard to make, but they are useful for figuring out how well a standard model works for the first time or comparing different models. You have complete control over the primary metric, the number of models to run, the threshold, the number of cross-validations, the option to block the algorithm, and many other options.

Depending on the type of task, you can easily choose the algorithm from a menu that includes regression, classification, and time series. To enable deep learning, simply click the corresponding box.

You will be able to see the model's specific explanations and metrics once it has been successfully deployed.

When data scientists use cloud-based computing resources that scale well to run multiple training experiments at the same time, automated machine learning makes them more efficient by automating many of the time-consuming tasks that come with training model components.

Tip To gain a better understanding of Microsoft Azure's AI offerings, I recommend reading through each reference link in the book's "References" section. These links will take you to the module's Microsoft Learn training section.

Practical Labs

It's time to get down to business. By following along with the practical lab here, you can see the whole process of making a machine learning model and learn about the different kinds of machine learning components and the linear regression technique in machine learning.

Note The purpose of the labs is to give you a solid understanding of Azure ML and the tools provided by Azure ML.

Using Azure Machine Learning Designer to Build a Regression Model

Sign in to your Azure Portal using your Azure subscription credentials.

Create Azure Machine Learning Workspace

1. Click "**+ Create a resource**" and then search for "machine learning" to provision an Azure Machine Learning resource as shown in Figure 3-4.

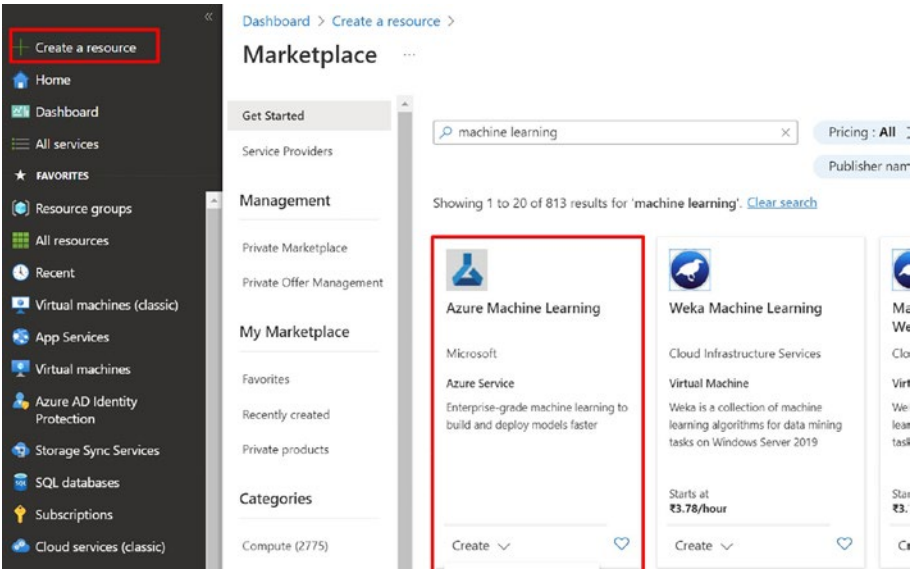


Figure 3-4. *Creating a new Azure ML resource*

2. As shown in Figure 3-5, fill in the information on the "**Basic**" tab, and on the last blade, select Review + Create, and then select Create. You have to provide a subscription, resource group, workspace name, and region. Here, the container registry is none, while storage account, key vault, and application insights are provisioning new. Wait for your workspace to be created.

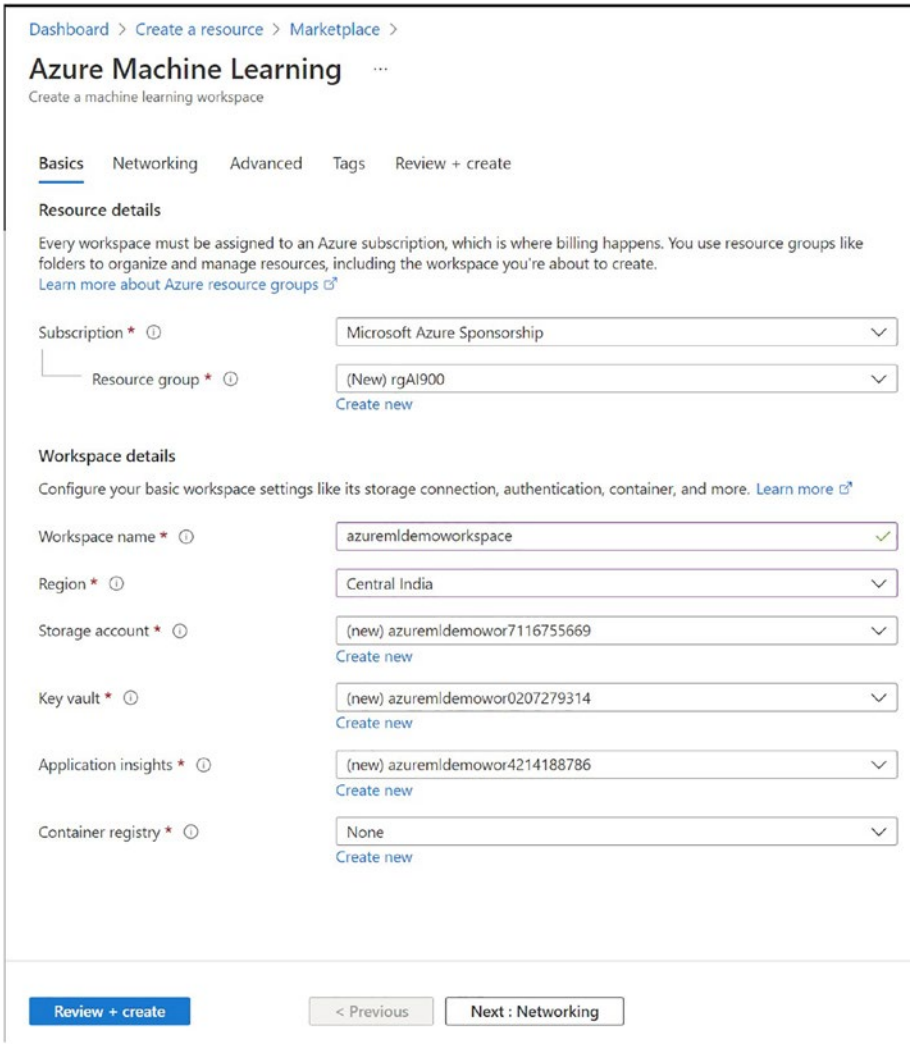


Figure 3-5. *Creating a new Azure Machine Learning workspace*

3. Then, navigate to Azure Machine Learning Studio in the new tab, and sign in using your Microsoft account as shown in Figure 3-6.

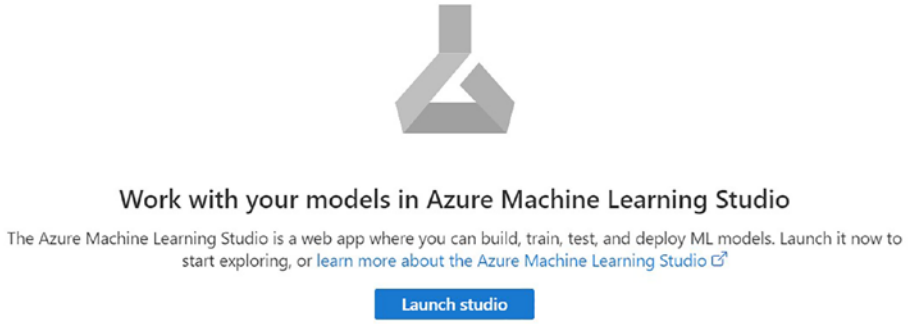


Figure 3-6. *Navigate to the newly created resource group and launch Azure ML Studio*

4. As shown in Figure 3-7, your newly provisioned workspace will appear here.

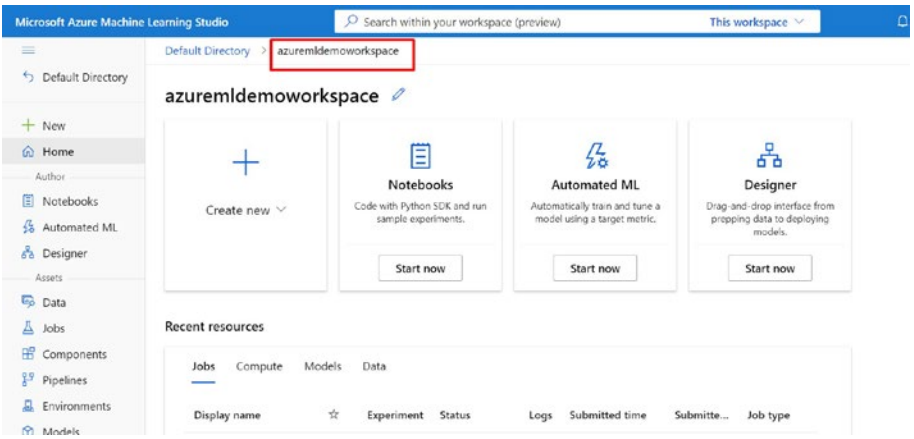


Figure 3-7. *Azure ML workspace*

Create Compute

1. Now, select the Compute tab (under **Manage**) and select **Compute clusters** as shown in Figure 3-8.

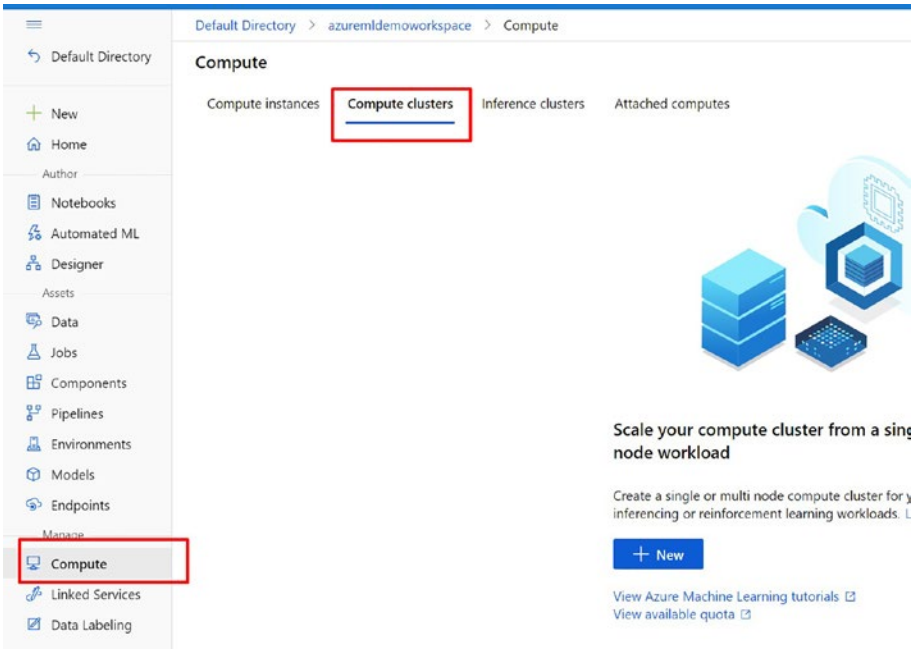


Figure 3-8. *Azure Machine Learning workspace: creating and selecting compute clusters*

2. On the Compute page, select Compute clusters and add a new one to train a machine learning model. As shown in the Figure 3-9 and Figure 3-10, provide the location, virtual machine tier, virtual machine type, the minimum number of nodes, and a maximum number of nodes, and click Create.

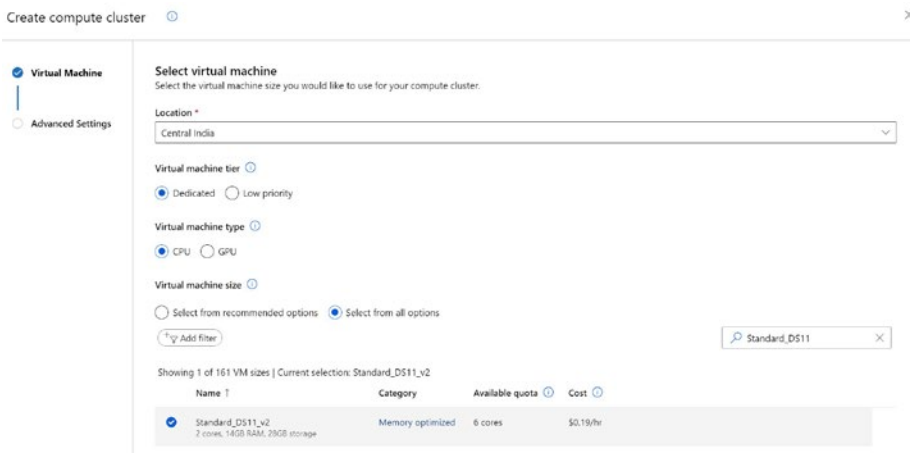


Figure 3-9. *Provisioning a virtual machine in compute clusters*

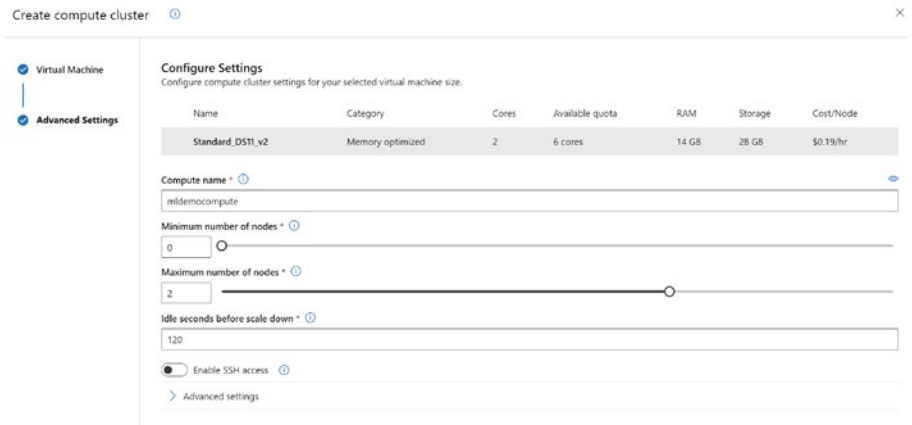


Figure 3-10. *Advanced setting for compute clusters*

Create Pipeline in Designer

1. Expand the left pane in Azure Machine Learning Studio by clicking the three lines icon. Under Author, select Designer and + to create a pipeline as shown in Figure 3-11.

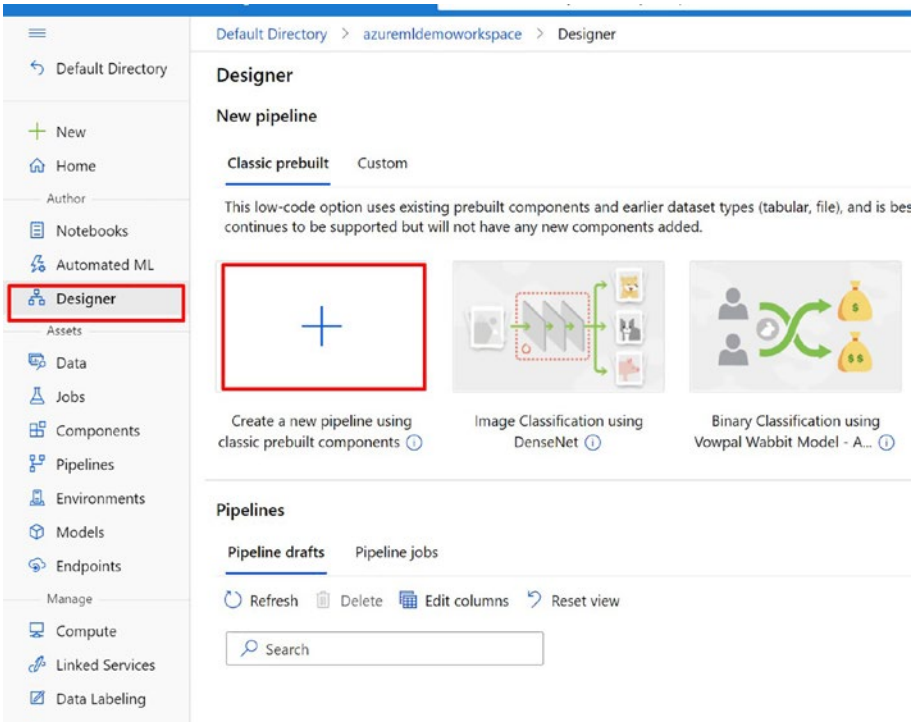


Figure 3-11. *Selecting Designer in the Azure Machine Learning Studio*

2. At the top right-hand side of the screen, select **Settings**. If the **Settings** pane is not visible, select the wheel icon next to the pipeline name at the top.

3. As shown in Figure 3-12, in **Settings**, you must specify a compute target on which to run the pipeline. Under **Select compute type**, select **Compute cluster**. Select the previously created Azure ML to compute cluster.

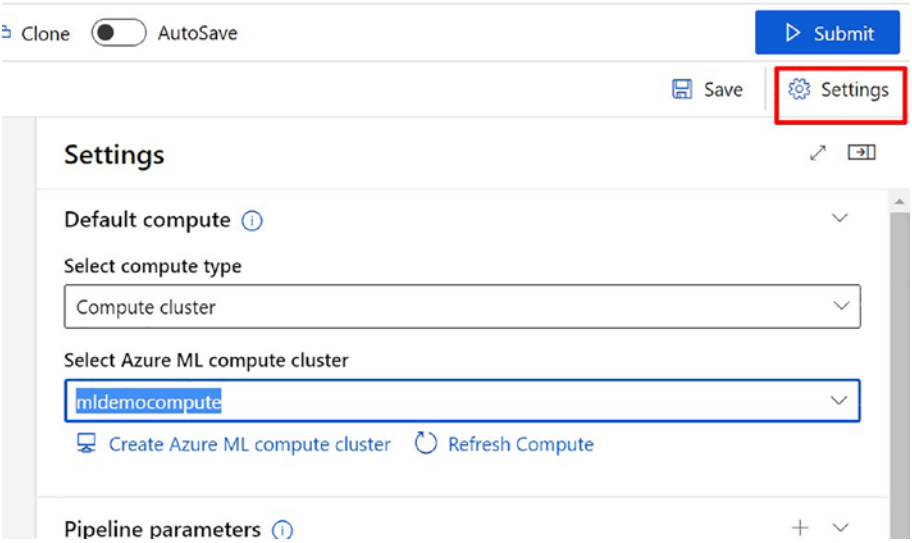


Figure 3-12. *Configuring compute for the pipeline*

4. In **Settings**, under **Draft Details**, change the draft name (**Pipeline-Created-on-date**) to **Auto Price Training**, as shown in Figure 3-13. Select the close icon on the top right of the **Settings** pane to close the pane.

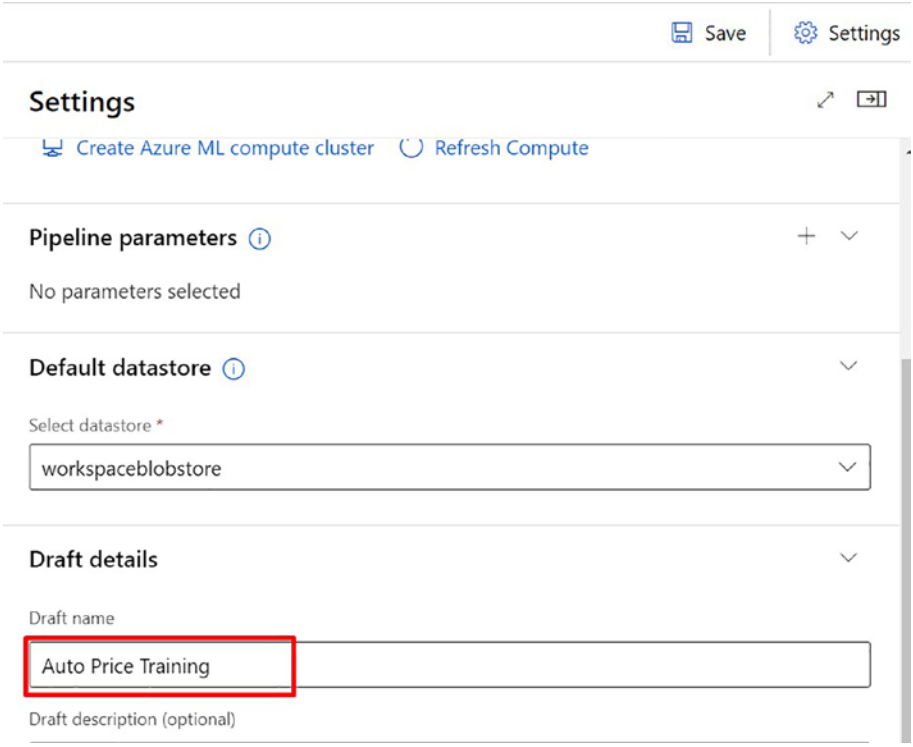


Figure 3-13. *Configuring settings for the pipeline*

Add and Explore a Dataset

1. Next to the pipeline name on the left, select the arrows icon to expand the panel if it is not already expanded. The panel should open by default to the **Asset library** pane, indicated by the book's icon at the top of the panel. There is a search bar to locate assets on the pane and two buttons, **Data and Component**.

2. Click **Component**. Search for and place the **Automobile price data (Raw)** dataset onto the canvas as shown in Figure 3-14.

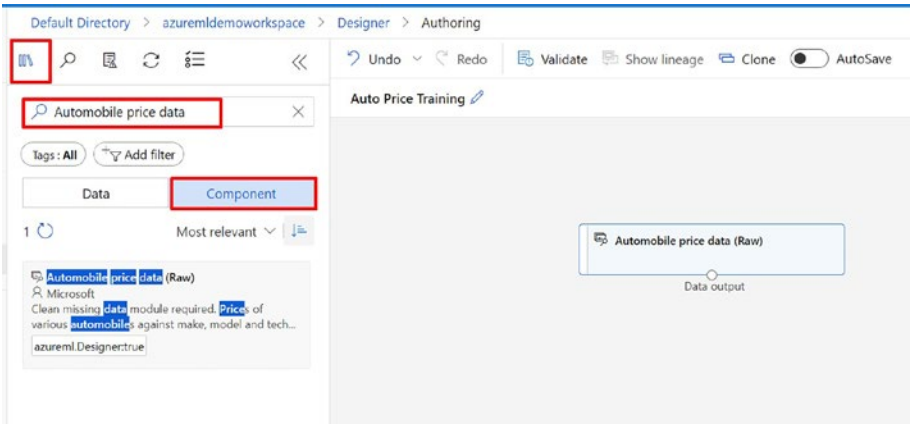


Figure 3-14. *Adding a dataset*

3. Right-click (Ctrl+click on a Mac) the Automobile price data (Raw) dataset on the canvas as shown in Figure 3-15 and click "Preview data."

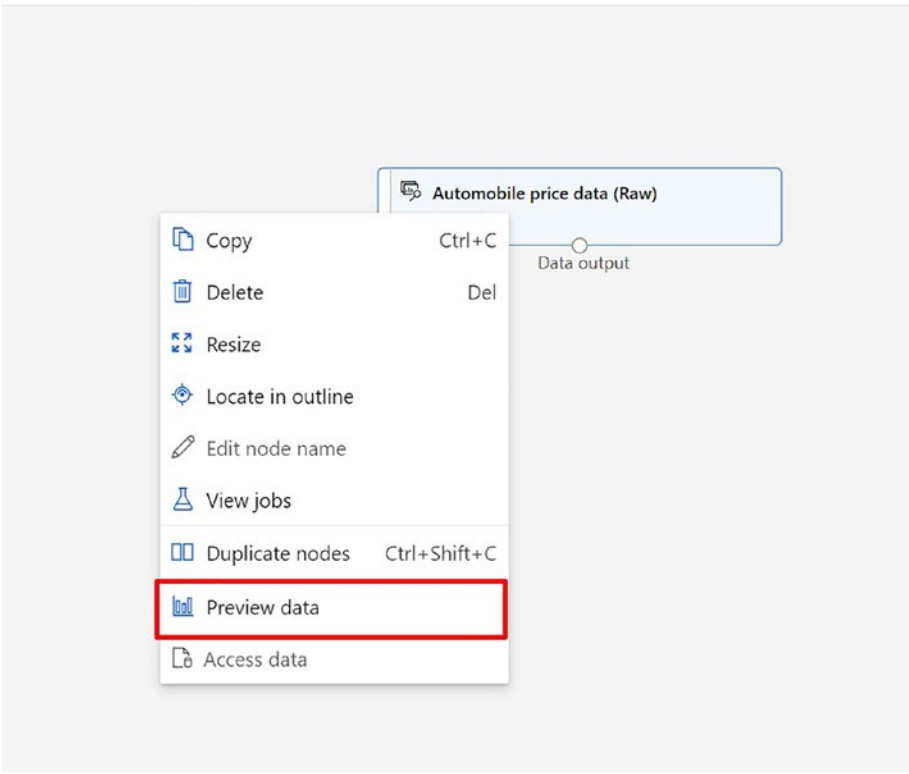


Figure 3-15. *Preview data*

4. Look at the data's output schema, noting that you can use histograms to see how the different columns are spread out.
5. Scroll right to see the Price column, which your model predicts.

6. Scroll back to the left and select the "normalized losses column" header as shown in Figure 3-16. Then review the statistics for this column. Note that there are quite a few missing values in this column. If the column has missing values, it can't be used to predict the price label as well, so you might want to leave it out of the training.

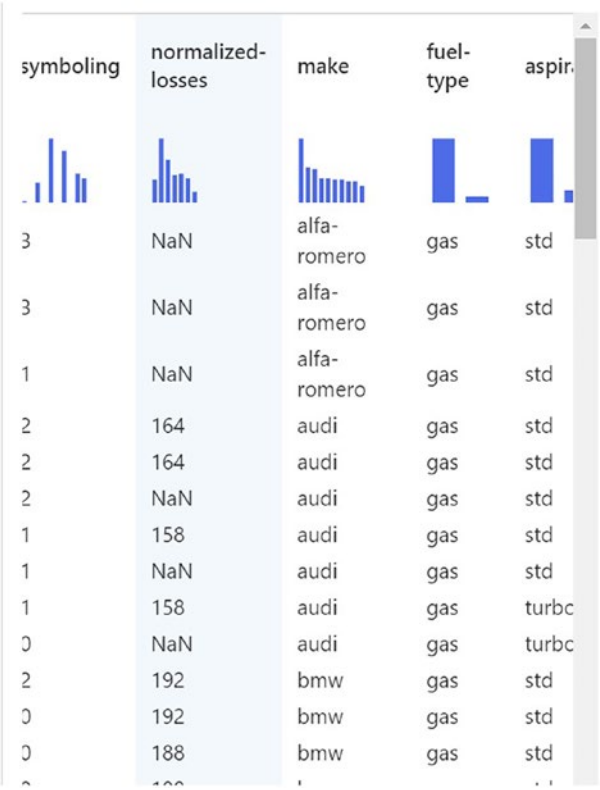


Figure 3-16. *Observing the distribution of various columns*

Close the Automobile price data (Raw) result visualization window so that you can see the dataset on the canvas as shown in Figure 3-17.

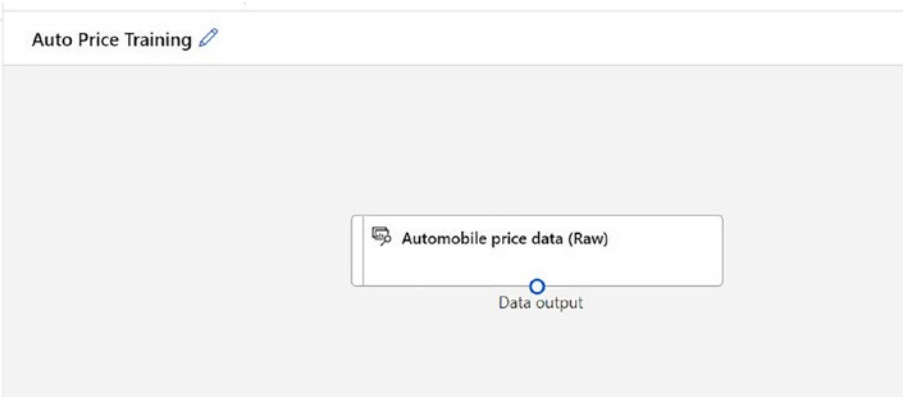


Figure 3-17. *Dataset on the canvas*

Add Data Transformations

1. In the Asset library pane on the left, click Component, which contains a wide range of modules you can use for data transformation and model training. You can also use the search bar to quickly locate modules.
2. Place a Select Columns in Dataset module below Automobile price data (Raw). Connect the Automobile price data (Raw) module's output to the Select Columns in Dataset module's input, as shown in Figure 3-18.

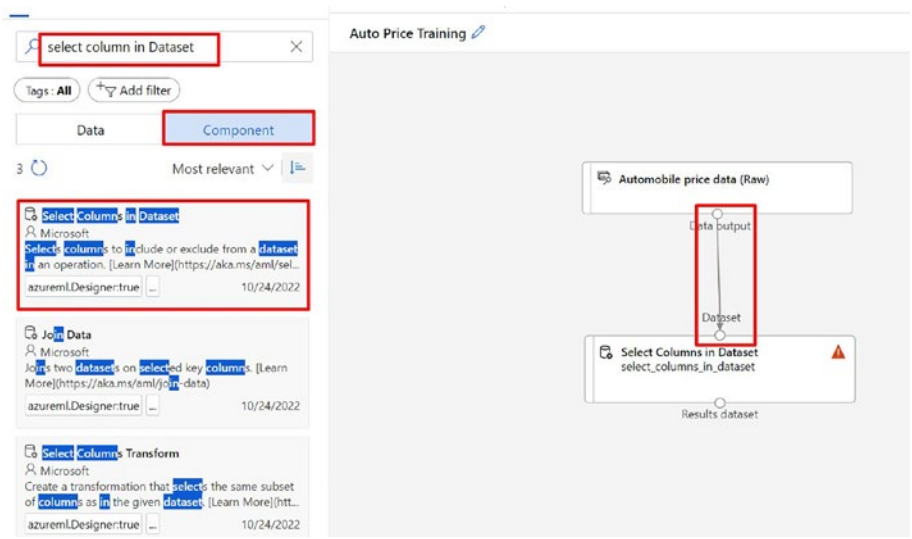


Figure 3-18. *Carrying out data transformation*

3. Double-click the **Select Columns in Dataset** module to access a settings pane on the right. Select the **Edit column**. Then in the **Select columns** window, include **All Columns** and **Add all** to add all the columns. Then remove **normalized-losses**, so your final column selection looks like Figure 3-19.

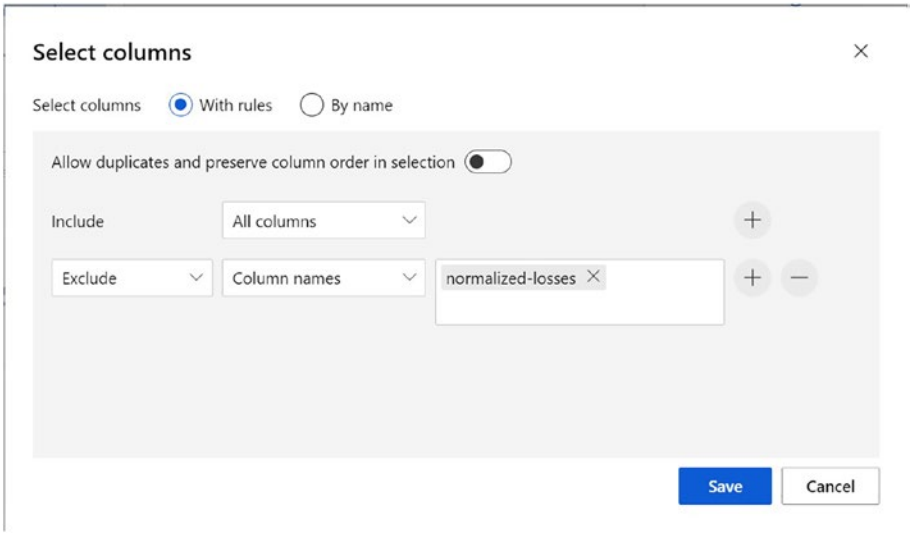


Figure 3-19. *Final column selection on the dataset*

Cleaning

1. Find the **Clean Missing Data** module in the Asset library and place it on the canvas. Connect Select Columns in Dataset to Clean Missing Data as shown in Figure 3-20.

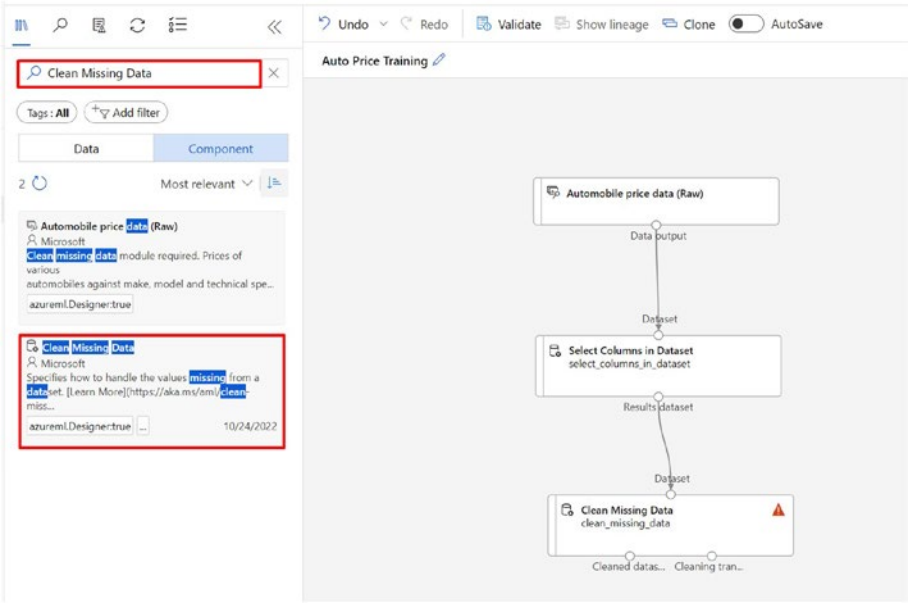


Figure 3-20. *Adding the Clean Missing Data module*

2. Double-click the **Clean Missing Data** module, and in the pane on the right, click **Edit column**. Then in the **Columns to be cleaned** window, select **With rules**, and in the **Include** list, select All Columns and as shown in Figure 3-21 click Save.

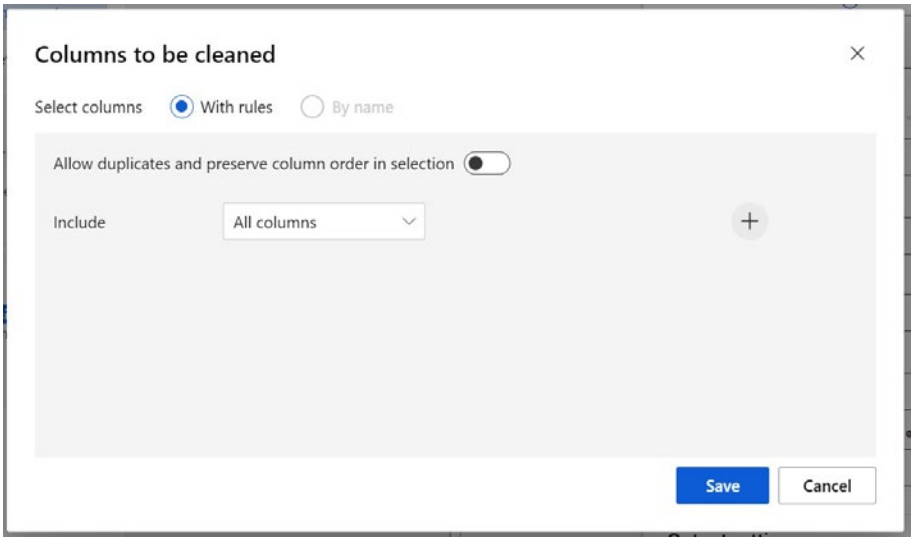


Figure 3-21. *Customizing the Clean Missing Data module*

3. Set the following configuration settings in the right pane while the "Clean Missing Data" module is still selected as shown in Figure 3-22:

   - **Minimum missing value ratio: 0.0**
   - **Maximum missing value ratio: 1.0**
   - **Cleaning mode: Remove entire row**

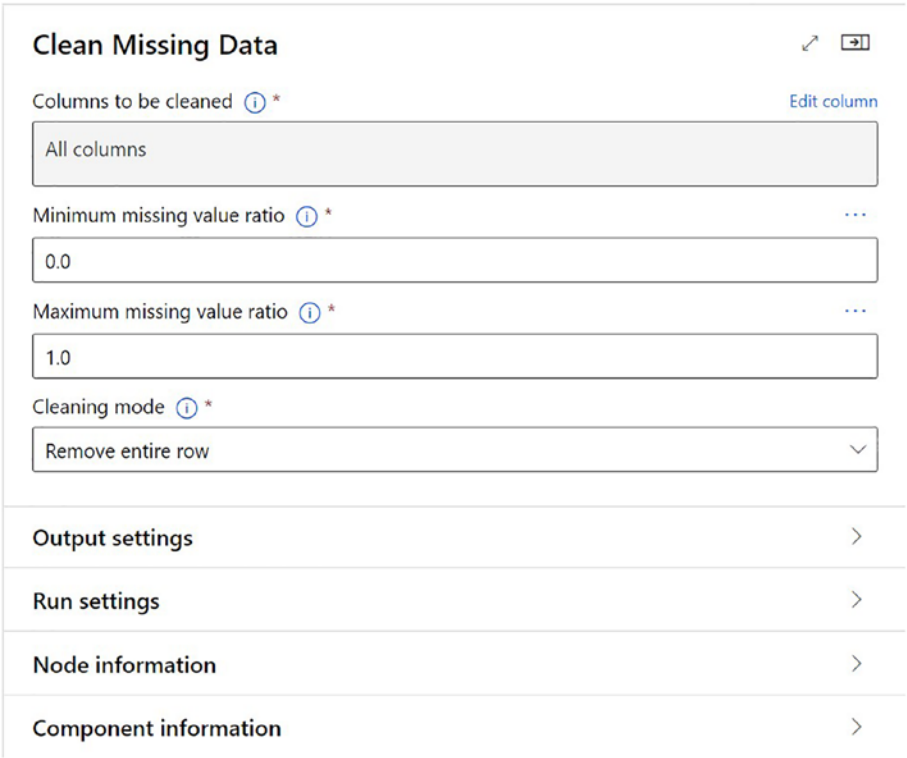


Figure 3-22. *Configuring the Clean Missing Data module*

Training Our Model

1. We add the **Split Data** component to separate training and testing data as shown in Figure 3-23.

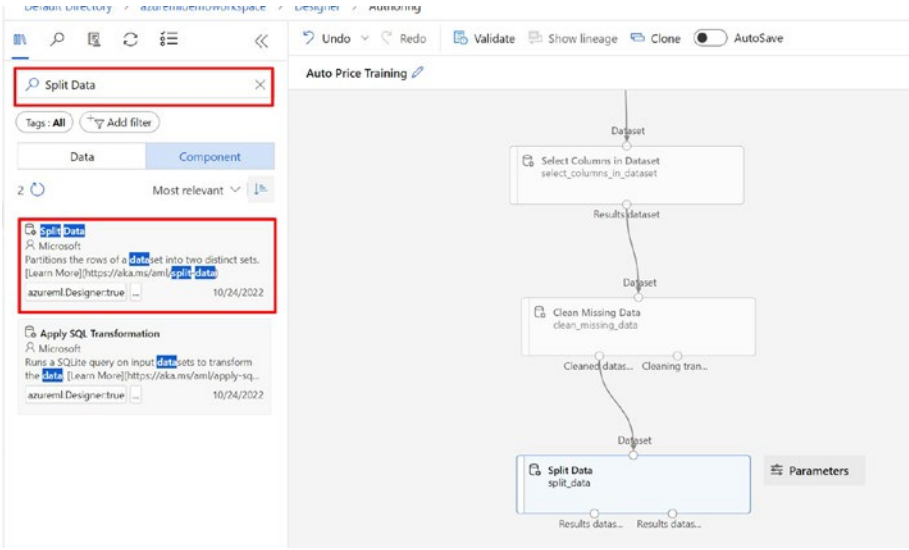


Figure 3-23. *Adding the Split Data module*

2. Set 70% of the first output data for training and 30% for testing as shown in Figure 3-24. Configure Split Data by double-clicking it.

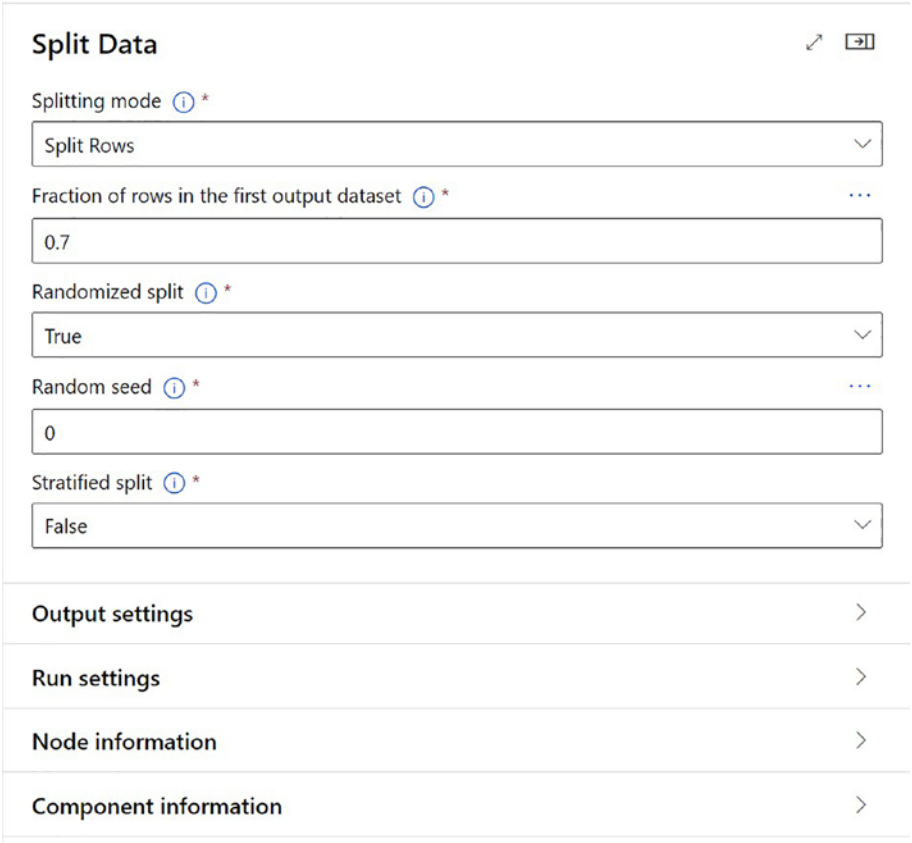


Figure 3-24. *Splitting 70% data for training and 30% data for testing*

3. Find and drag **Linear Regression** to the canvas.
4. We also add the **Train Model** component as shown in Figure 3-25.

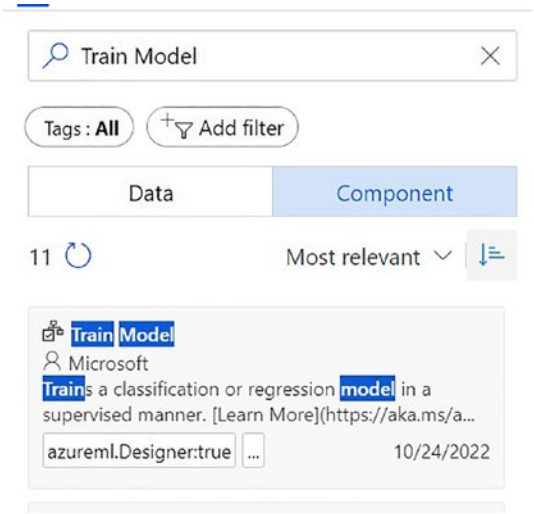


Figure 3-25. *Adding the Train Model component*

5. It's time to connect and move tabs. Linear regression's output is Train Model's left input, while Split Data's left output is Train Model's right input as shown in Figure 3-26.

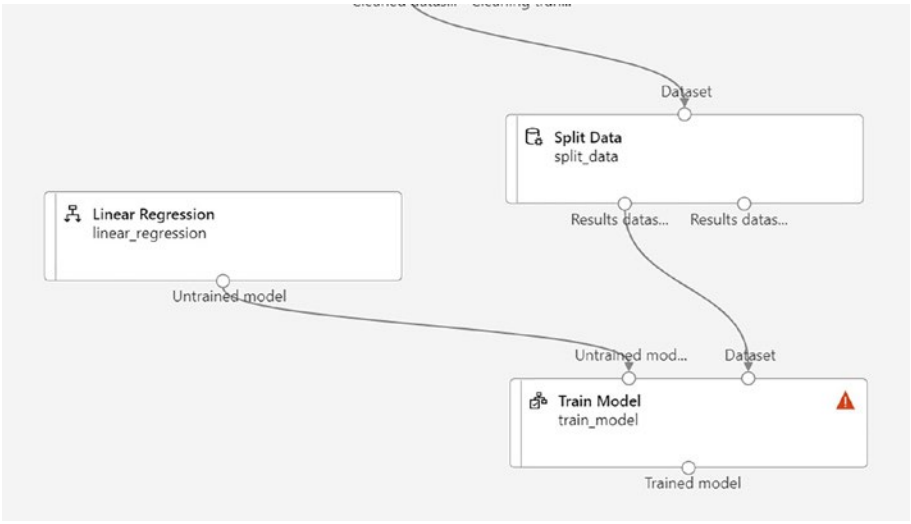


Figure 3-26. *Rearranging the tabs*

6. Select **Edit Column** from the Train Model by double-clicking Train Model as shown in Figure 3-27.

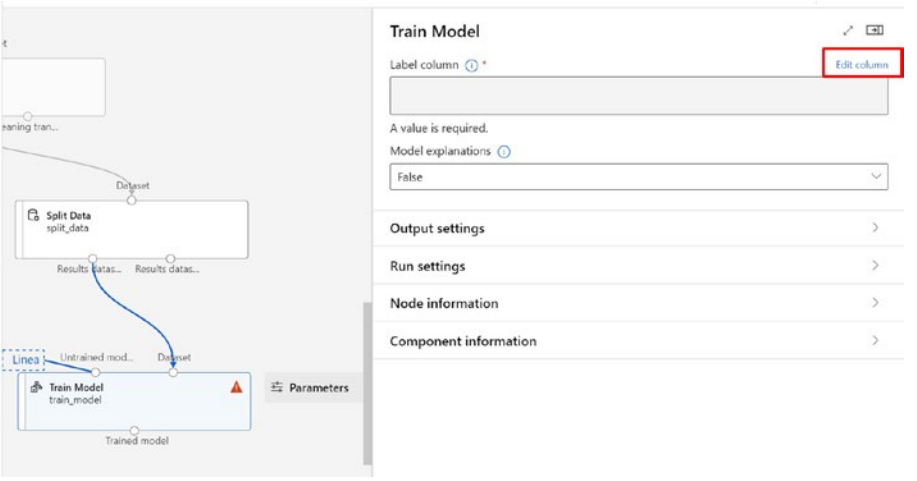


Figure 3-27. *Editing the model component*

7. Here, select the column names, choose the price as shown in Figure 3-28, and click Save.

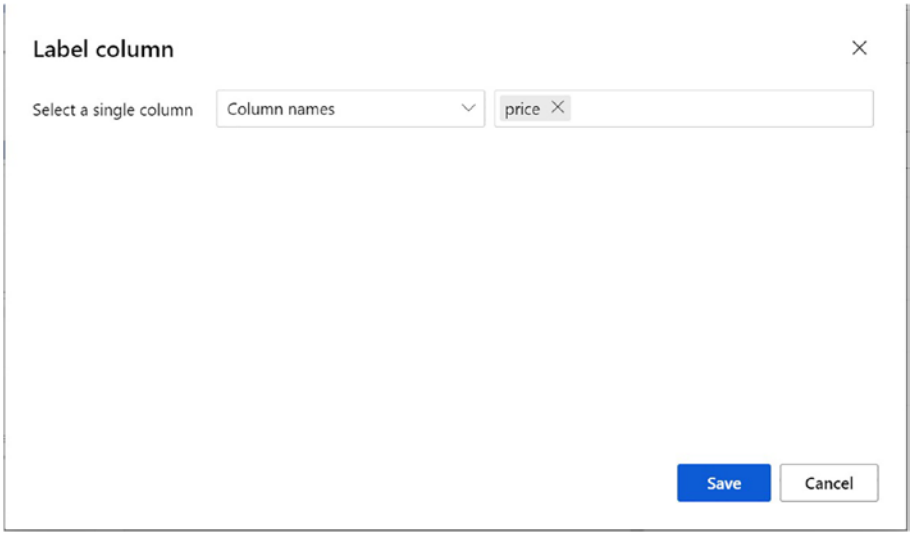


Figure 3-28. *Configuring a train model component by adding the price column in the column names*

Scoring Model

1. Search the **Score Model** component and drag it to the canvas.
2. Connect the Score Model's left input to the Train Model's output and the right input to the Split Data output as shown in Figure 3-29.

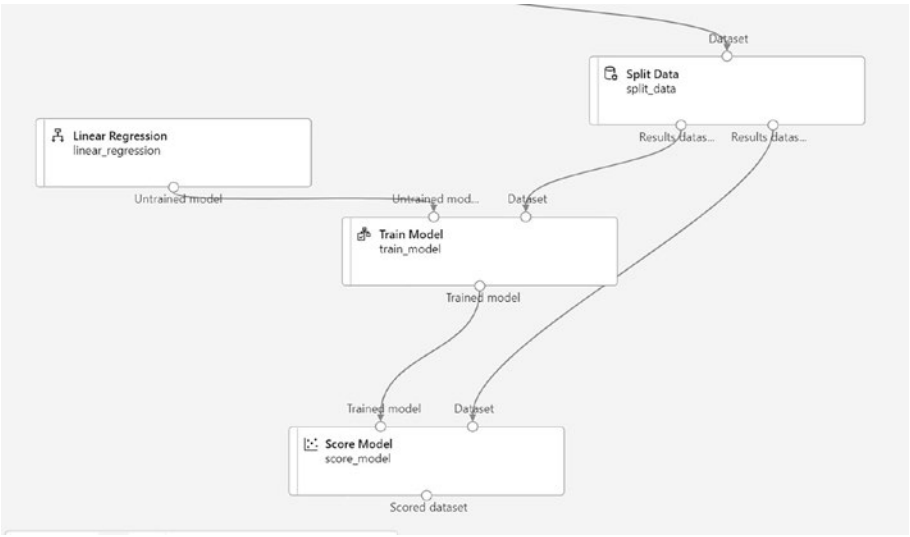


Figure 3-29. *Adding and configuring the scoring model*

Evaluation

1. Find and drag the **Evaluate Model** component in the canvas. Connect the Score Model's output to Evaluate Model as shown in Figure 3-30.

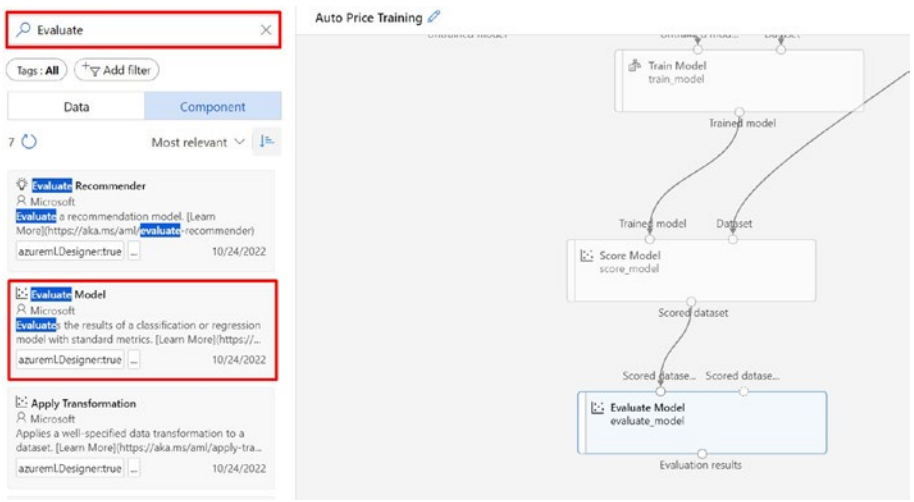


Figure 3-30. *Adding and configuring the evaluation model*

Submission

1. Click the Submit button to run our model as shown in Figure 3-31.

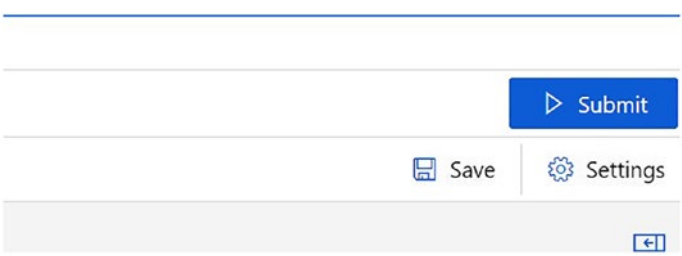


Figure 3-31. *Running our machine learning model*

2. Click **Create new**.
3. Name our experiment.
4. Hit Submit as shown in Figure 3-32.

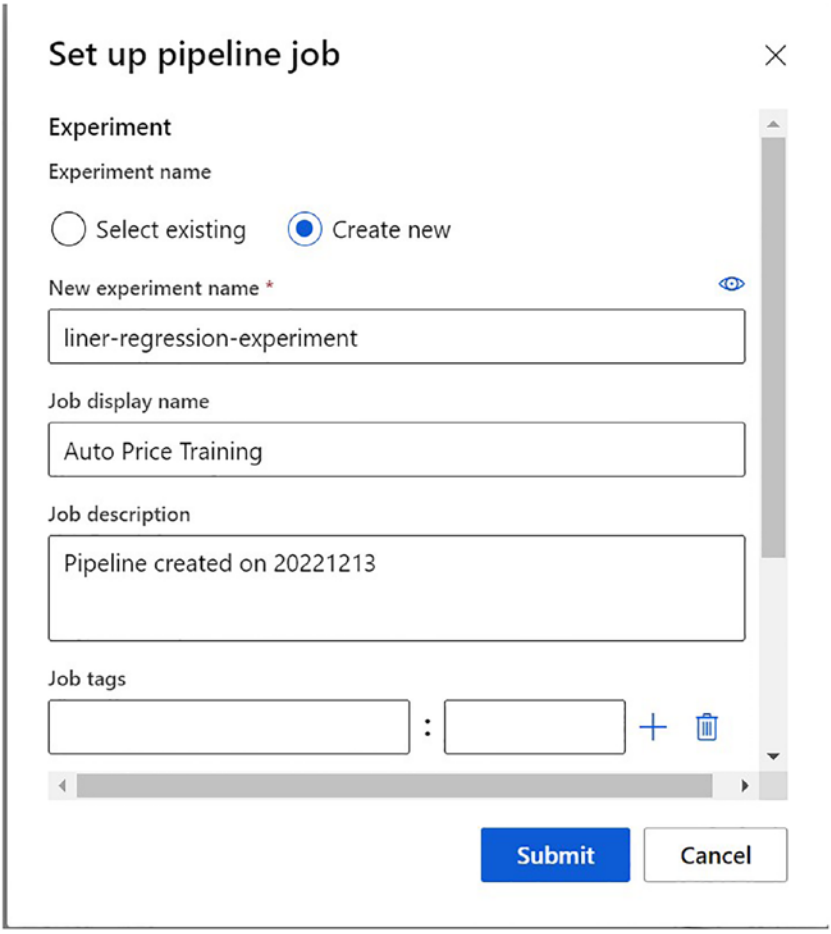


Figure 3-32. *Naming the experiment*

We see "Completed" marks in some tabs and "Running" in others as shown in Figure 3-33.

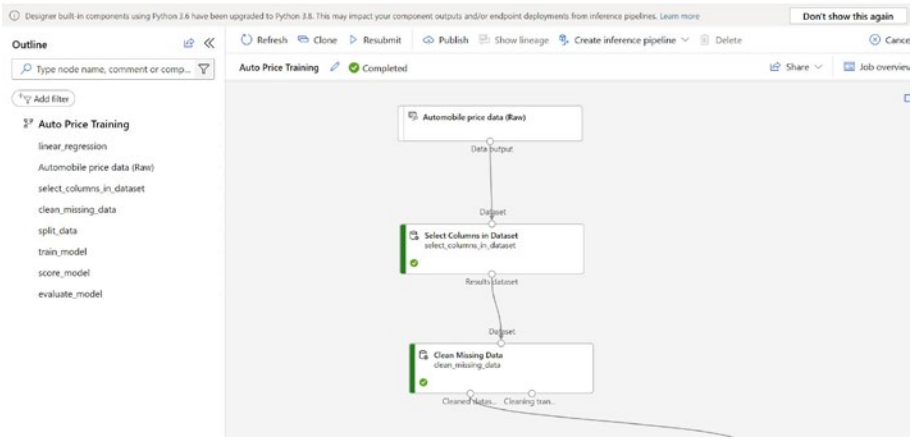


Figure 3-33. *We can see the completed modules and running modules as the workflow progresses.*

5. Click the **Job Detail** as shown in Figure 3-34.

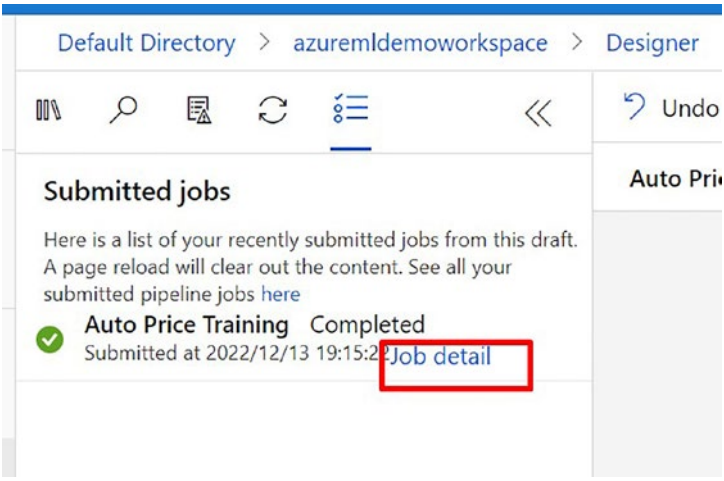


Figure 3-34. *Click the job detail to check the status of the model*

Scored Labels

1. Check the Score Model's scored labels. Select **Scored dataset** under "Preview Data" by right-clicking the Score Model component as shown in Figure 3-35.

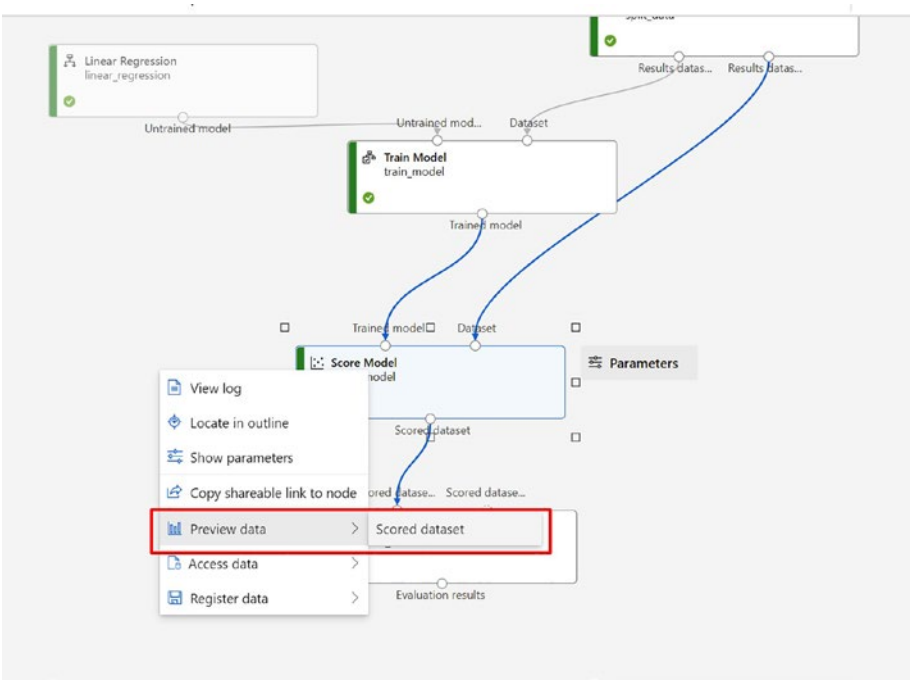
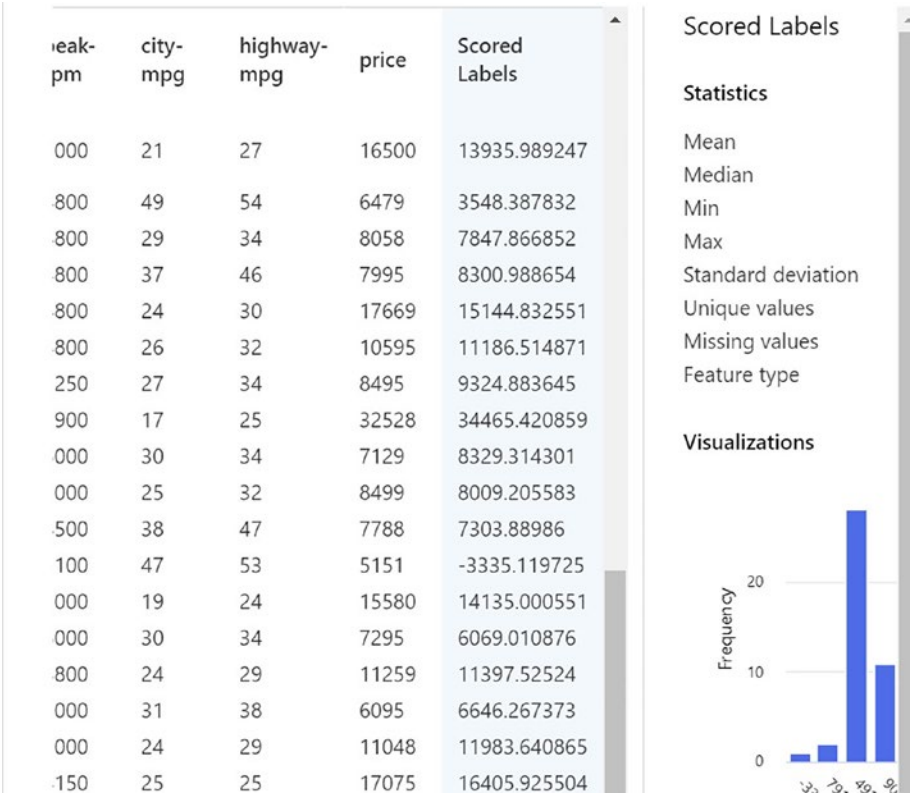


Figure 3-35. *Checking the scored labels*

2. The Scored Labels column is now available. Our regression model predicts these prices as you can see in Figure 3-36.



eak-pm	city-mpg	highway-mpg	price	Scored Labels
000	21	27	16500	13935.989247
800	49	54	6479	3548.387832
800	29	34	8058	7847.866852
800	37	46	7995	8300.988654
800	24	30	17669	15144.832551
800	26	32	10595	11186.514871
250	27	34	8495	9324.883645
900	17	25	32528	34465.420859
000	30	34	7129	8329.314301
000	25	32	8499	8009.205583
500	38	47	7788	7303.88986
100	47	53	5151	-3335.119725
000	19	24	15580	14135.000551
000	30	34	7295	6069.010876
800	24	29	11259	11397.52524
000	31	38	6095	6646.267373
000	24	29	11048	11983.640865
150	25	25	17075	16405.925504

Figure 3-36. *The Scored Labels column has been added*

Evaluation Result

1. Select "**Evaluation Result**" under "Preview Data" by right-clicking the "Evaluate Model" component as shown in Figure 3-37.

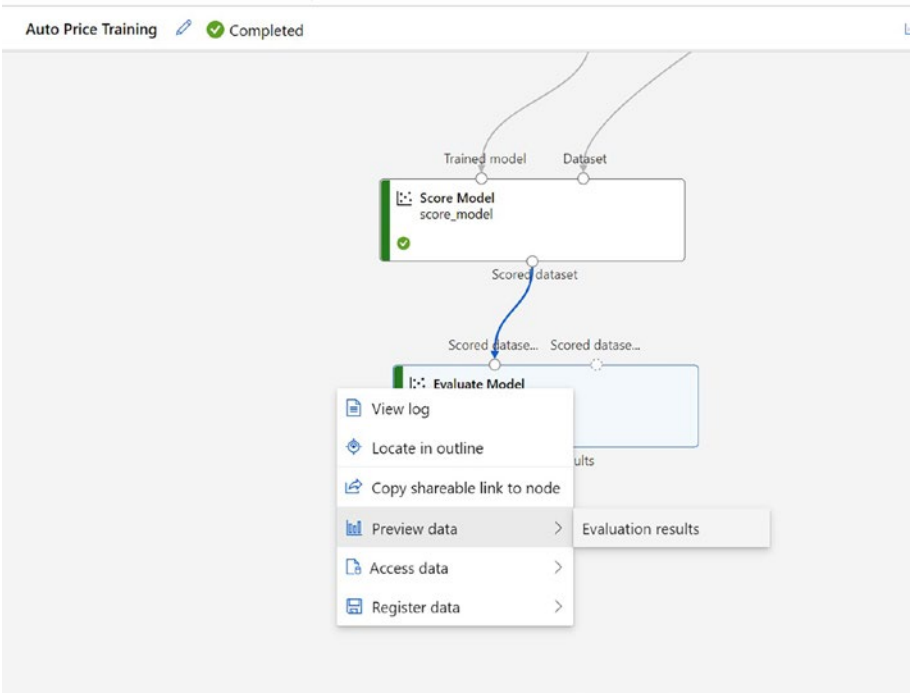


Figure 3-37. *Examining evaluation results*

2. The mean absolute error, coefficient of determination, root mean squared error, and others are shown here as shown in Figure 3-38.

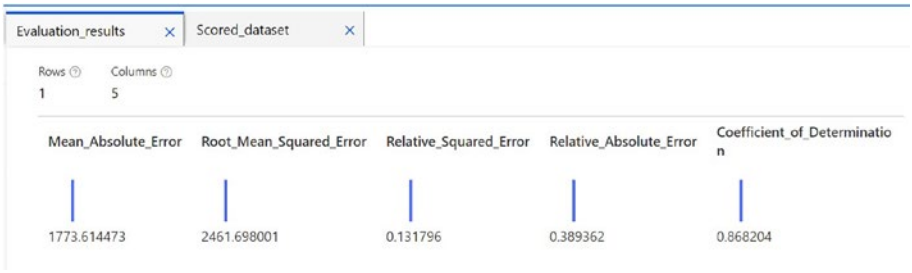


Figure 3-38. *Evaluation results*

This includes data preparation, model training, testing, scoring, and evaluation.

Exploration

The "**Usage + Quotas**" section of the ML workspace shows the dedicated core usage as shown in Figure 3-39.

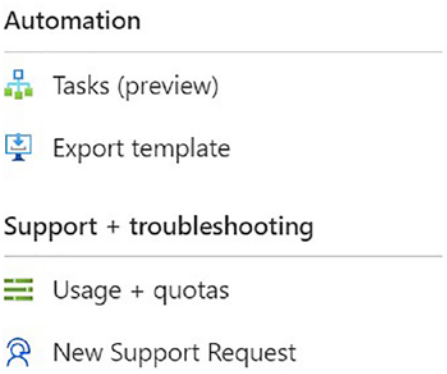


Figure 3-39. *Exploring usage + quota*

Delete Resources

To avoid any charges, it is critical to delete the resources once the ML model is no longer needed. Figure 3-40 shows Delete button to delete the ML model.

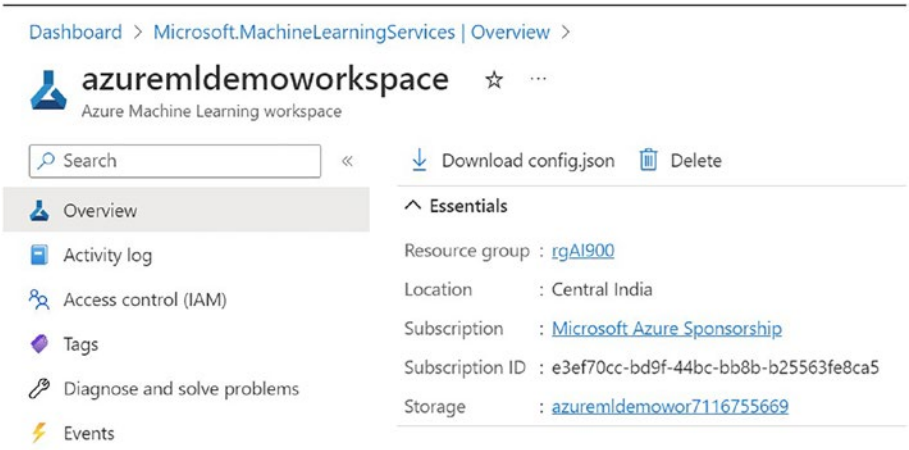


Figure 3-40. *Deleting the model*

Introspective Practice

After you've finished reading the chapter, it's time for you to take a quiz to see how much you remember.

1. Clinical measurements will help hospitals predict diabetes risk. How should the hospital use automated machine learning?

   a. Classification

   b. Regression

   c. Time series forecasting

2. A real estate marketing research company in the United States wants to predict the price of residential units based on given features such as the location, area of the house in sq. feet, number of bedrooms, etc. Which category of machine learning model should be implemented?

   a. Regression

b. Classification

c. Clustering

3. You have a full dataset available. Your requirement is to prepare a training and validation subset based on the given dataset randomly. Your dataset consists of features and labels. You have a two-class decision forest module and a training module. You have to score modules and evaluate modules to test the trained model using a validation set. What module should you add to your Azure ML pipeline?

   a. Join Data

   b. Split Data

   c. Select Columns in Dataset

4. What are the building blocks available in Azure ML Studio's drag-and-drop interface for authoring regression machine learning pipelines?

   a. Designer

   b. Automated ML

   c. Notebooks

5. You're training and testing a k-means clustering model with Azure ML. Your model should cluster items into three groups. Which k-means clustering property should you set?

   a. Set iterations to 3

   b. Set the random number seed to 3

   c. Set the number of centroids to 3

Solutions to the Practice Test

1. Question 1 – a
2. Question 2 – a
3. Question 3 – b
4. Question 4 – a
5. Question 5 – c

References: Microsoft Learn

I firmly believe that the chapter would have prepared you for your AI-900 certification. Before we move on to the next chapter and learn more about computer vision, I strongly suggest that you go through the various modules of Azure AI Fundamentals: Explore visual tools for machine learning in Microsoft Learn, using the following links:

1. https://learn.microsoft.com/en-us/training/modules/create-regression-model-azure-machine-learning-designer/
2. https://learn.microsoft.com/en-us/training/modules/create-classification-model-azure-machine-learning-designer/?ns-enrollment-type=learningpath&ns-enrollment-id=learn.wwl.create-no-code-predictive-models-with-azure-machine-learning
3. https://learn.microsoft.com/en-us/training/modules/create-clustering-model-azure-machine-learning-designer/?ns-enrollment-

type=learningpath&ns-enrollment-id=learn.wwl.create-no-code-predictive-models-with-azure-machine-learning

4. https://learn.microsoft.com/en-us/training/modules/use-automated-machine-learning/?ns-enrollment-type=learningpath&ns-enrollment-id=learn.wwl.create-no-code-predictive-models-with-azure-machine-learning

Summary

Machine learning is the backbone of most AI solutions. It makes it possible to make models that can predict unknown values and draw conclusions from data they have already seen.

Massive datasets are used by data scientists, ML engineers, and AI experts and are broken down into training, testing, and validation sets. The most important parts of machine learning are getting and processing data, making and training a model, validating the model's output, iterating the model until the end goals are met, and putting the model online as a service.

Supervised machine learning and unsupervised machine learning are two of the most common ways to use machine learning. Supervised machine learning makes use of a dataset that has been labeled, whereas unsupervised machine learning works with data that is unknown. Clustering is an example of unsupervised learning. Regression and classification, on the other hand, are examples of supervised learning.

People use Azure Machine Learning to manage the whole life cycle of machine learning projects, from designing machine learning apps to training, validating, and quickly deploying them. Infrastructure security and role-based access control are things that businesses that use Microsoft Azure Machine Learning will be familiar with.

In the next chapter, you will learn about the computer vision field of artificial intelligence. You will also learn about the speech, language, vision, decision, and OpenAI cognitive services that Azure offers. Also, the chapter talks about different kinds of vision services, such as computer vision, custom vision, face recognition, form recognition, and optical character recognition (OCR).

CHAPTER 4

Computer Vision

Computer vision is an essential field of artificial intelligence (AI). Under the scope of this field, the software is made to perceive the data through cameras, pictures, and videos. Although computers do not have a biological vision of their own, they are still very capable of processing an image by themselves. Under the scope of computer vision, numeric values are used as features to train machine learning models that can make actual predictions about an image and its contents. Scientists often use a combination of machine learning models and PaaS solutions, such as the cognitive services offered by Microsoft Azure, to bridge the gap between what a person sees and what a computer can do with it. The beginning of the chapter gives an overview of Azure Cognitive Services and why you should use them. In this section, you will learn about Azure Cognitive Services such as speech, language, vision, decision, and the OpenAI service. Following that, you will learn about computer vision and its key components, such as image classification and object detection. Following that, you will learn about the various computer vision applications and services that Azure supports, such as computer vision, custom vision, and face and form recognizers.

K. S. Trivedi, *Microsoft Azure AI Fundamentals Certification Companion*,
Certification Study Companion Series, https://doi.org/10.1007/978-1-4842-9221-1_4

Getting Started with Azure Cognitive Services

Azure Cognitive Services are cloud-based artificial intelligence (AI) services that help developers add cognitive intelligence to their apps without having to know much about AI or data science. Azure Cognitive Services offer a set of machine learning–based APIs that are already built and hosted in Azure. These APIs are called Azure REST APIs. With these Azure Cognitive Services APIs and services, it's easy to add intelligent features like face recognition, voice recognition, emotion and sentiment detection, vision and speech recognition, knowledge search, and language understanding to the web, mobile, and desktop applications. These APIs are cross-platform and device independent.

Benefits of Cognitive Services

Before we start talking about the different Azure Cognitive Services, let's talk about why you might want to use them:

1. *More gain with less strain*: No previous skill is required to use Azure Cognitive Services. Anyone can avail of the benefits of these services at the expense of a single API call and pretrained AI models. You can add Azure Cognitive Services capabilities to your application with just a single API call and pretrained AI models.

2. *Creating a good user experience*: Azure has a content moderator and a personalizer to improve the user experience by removing any inappropriate content, keeping data safe, and giving users new experiences.

3. *Cross-platform support*: The agile compatibility of Azure with any and all operating systems makes it easier for anyone to incorporate its services into their applications written in nearly any language, including C#, Python, Java, Node.js, etc.

4. *Use deeper insights*: The computer vision, custom vision, face, form, and ink recognition engines included in the vision API will assist you in gaining more in-depth insights from any type of document containing text, whether that document is an image containing a variety of objects, an invoice, or a face. In addition, the ink recognition engine will help you identify handwriting.

Azure Cognitive Services

Speech, language, vision, decision, and OpenAI services are the five most important types of Azure Cognitive Services. In the following section, we will take a deep look into each of these categories.

Speech

Speech services allow users to make applications that recognize speech. People who have dealt with Dragon NaturallySpeaking, Windows Speech Recognition, Braina, or Sonix can better appreciate the ease that comes with Azure speech recognition services. Also, Azure's speech-to-text and text-to-speech services are more accurate and precise than similar services that don't use AI. The following are the types of speech services provided by Azure:

- *Speech-to-text*: Real-time conversion of audio streams to text

- *Text-to-speech*: Helps turn text into computer-generated speech
- *Speech translation*: Enables speech translation in multiple languages in real time
- *Voice assistants*: Assist developers in creating conversational interfaces for applications
- *Speaker recognition*: Provides APIs for speaker recognition
- *Intent recognition*: Assists in the identification of speech, entities, and intent

Language

A language service can make an application literate enough to understand any language input into it. This really adds up to a better user experience as the system gets a lot better at understanding what has been requested of it in any possible language. Microsoft Azure has a lot of tools that can look at chunks of text and figure out what they mean. This lets it find and understand different languages.

The following are a few examples of how language services can be used:

- Language detection and sentiment analysis
- Entity recognition and key phrase extraction
- Language understanding and Q&A
- Process unstructured domain-specific text
- Converse with chatbot and devices

Vision

This service is an application that can look at any image or video and figure out what objects are in it, classify the objects in the image or video, do an analysis of the image, and read text from an OCR reader. This service records and changes information in any medium so that it can be used later when it is needed.

The following are the types of vision services provided by Azure:

- *Computer Vision*: It allows users to take advantage of cutting-edge image processing and retrieval algorithms. It can be used for things like recognizing text from an optical character reader, smart cropping, image analysis, and finding common objects.
- *Face*: You can use the Face service to detect, recognize, and analyze human faces in images. It is used in many scenarios such as identity verification, face blurring, finding similar faces, and identifying facial features.
- *Custom Vision service*: It provides capabilities to build image classifiers and custom object detection.

Decision

This service helps developers add recommendations for users to refer to when making decisions. With this availability, a user can make much better decisions.

The following are the types of decision-making services Azure provides:

- *Personalizer service*: This service allows the applications to ensure the best user experience by using APIs to recommend options to users when they are confused. These options are entirely personalized

and based on users' legal feedback and reaction to products. In addition, a reward score is set for the service to make it aware of any improvements needed in the context of personalization.

- *Anomaly detector*: This service detects any anomalies in the user's data. The irregularities are recorded through dips and spikes in various data fields.
- *Content moderator*: As the name suggests, this service finds any strong content and dilutes it for the user by removing it.

OpenAI Service

This service is for anything that has to do with understanding or making code from natural language. You can also embed your own model, and OpenAI has a long list of flexible models that are ranked differently based on how powerful they are. Creating original content, semantic searches, and classification of things can all be done using this service.

Exquisite language models like GPT-3, Codex, and Embeddings are made easily available through REST APIs in OpenAI. With the preceding models, it's easy to do things like write critical content, summarize it, figure out what it means, or even turn a natural language into code. On top of it, the accessibility of this service is made quite easy as you can use it from three different sources: REST APIs, Python SDKs, or Azure's web-based interface in Azure OpenAI Studio.

OpenAI GPT-3, Codex, and DALL-E models and Azure's security and enterprise promise are all part of the Azure OpenAI Service. Azure OpenAI and OpenAI work together to make sure that the APIs are compatible and that moving from one to the other is easy. Microsoft Azure customers who use Azure OpenAI get the security capabilities of Microsoft Azure while

running the same models as OpenAI. Azure OpenAI provides private virtual networking, supported in three regions (the East US, South Central US, and West Europe), and responsible AI content filtering.

What Is Computer Vision

Computer vision is a core area of artificial intelligence (AI) that focuses on developing solutions that allow AI-enabled applications to "see" and make sense of the world.

Precisely stated, computer vision is the essence of AI. It is about AI-enabled applications having a humanlike vision through which they can make computing devices have and grow a sense of perception for any given content.

Even though the lack of biological lenses is a big problem, it doesn't stop computers from turning huge images and videos into a set of pixels or data. This data can then be used to train machine learning models that can be used in a system.

There are APIs that can be used as a computer vision tool to analyze and read a piece of media. Azure APIs, for one, allow you to have a deep and thorough dive into the contents of an image or video. You can use these services to turn these images into text, predict how the people in the images feel, and also get a description of what an image holds in its pixels.

Computer Vision Core Elements: Image Classification and Object Detection

The Computer Vision service revolves around two core elements: image classification and object detection.

Image Classification

In other words, "image recognition" is also referred to as "image classification," which is the process of labeling an image. When a single label is attached to an image, this process is known as single-label classification, and when many labels are attached to a single image, this process is known as multilabel classification. An entire machine learning model should be trained before we use it for image classification. It is also critical to train this model specifically for the task at hand. For example, a model can be taught to use the visual feed to look for smoke or fire in a certain area and can be taught to find and label both the sizes and grades of these elements.

Object Detection

Object detection is the process of finding and separating real-world objects in a picture or video. This technique can find a human face, flowers, cars, etc., out of an image of any given size. Object detection depends a lot on derived features and learning algorithms because it needs to work in real time and give results in real time.

Computer Vision Application

Most computer vision solutions use machine learning to analyze camera, video, or image input.

In addition to object classification and object detection, Computer Vision applications are all of the following.

Semantic Segmentation

A technique called "semantic segmentation" separates a group of pixels based on the object to which they belong. For example, in a traffic detection system, a layer of color is added to different object types.

Image Analysis

This technique works around machine learning models that add tags to various images describing what is inside them. Image classification is used here to label images, and then a complete description is laid out for whatever is happening inside the image.

Optical Character Recognition (OCR)

You can read a piece of text from an image using OCR. This technique extracts any and all the text that it detects in an image. It can be used by traffic management agencies to read out traffic signs. On other occasions, it can also be used to scan out important information from papers such as invoices, letters, or bills.

Exploring Various Vision Services

In this section, you'll find out about the different vision services that Microsoft Azure Cognitive Services have to offer.

Computer Vision

The Computer Vision API is an essential and significant tool offered by Azure. Using the Computer Vision Image Analysis API, we can get a full analysis of an image. This API gives each part of an image's contents a

score and gives a detailed description of all of those parts. Also, the final result is a list of image features that are ordered from most confident to least confident based on their confidence score. In addition, hints and clues are added where there is a dearth of exact information.

The different services and their benefits provided by this API are described as follows.

Detecting Object

We can use this API to detect an object, record its coordinates, and scan for any more instances of the same object. For instance, for an image containing objects like cats, dogs, etc., the Detect API will return a list of objects that are similar, along with their coordinates in the image. This API can be used to correlate the relationships between the objects in an image. Moreover, tags in an image can also be detected.

Detect Texts

Brand names can be detected on the images. Using these, we can actually determine the popularity of a brand on social media.

Categorizing an Image

"Image classification" is the process of sorting and labeling groups of pixels or vectors in a found image according to a set of rules that have already been decided. The categorization law could be made with the help of one or more spectral or textural characteristics. The terms "supervised" and "unsupervised" refer to two broad categories of classification methods**.**

The supervised classification method is a process that involves visually selecting samples (called "training data") from an image and putting them into preselected groups, such as roads, buildings, bodies of water, plants, etc., so that statistical measures can be made that can be used on the whole image. Supervised classification methods can be found in

image processing and computer vision. The terms "maximum likelihood" and "minimum distance" are two ways that training data is often used to classify an entire image.

The unsupervised classification method is a process that is entirely automated and does not make use of training data in any way. During the stage of processing images, a suitable algorithm is used to find the features that are needed in a systematic way. In this case, "image clustering" and "pattern recognition" are the two ways that things are put into groups. "ISODATA" and "K-mean" are the names of two popular algorithms that are utilized.

Describe the Image

The confidence score for each feature and the set of tags in each image are used to figure out what an image is about. These descriptions can be used in special cases, such as when an image doesn't load soon enough on social media or when intricate details of an image are to be known.

Detecting Faces

We can have this service detect and scan a face out of an image. This becomes really useful when we have to blur a face in a video for security purposes. Furthermore, this service is in high demand for face-swapping and gender-swapping AI apps.

Detect the Color Scheme

Color schemes can be used to find out which color is the main one in an image and which is an accent color. This service is highly used by photo editors on mobile phones.

Get the Area of Interest

With this method, we can look at an image's contents and get the coordinates of the area of interest.

Custom Vision

Custom Vision in Azure is a service that lets you build, deploy, and improve your own custom-built image identifier model. An image identifier is the biggest tool for image classification in any system. It gives labels to different things in an image based on what they look like.

Image Classification Using the Azure Custom Vision Service

With almost no amount of coding, we can get the Azure Custom Vision service to make us an image classification model to add tags to the images for the classification of objects in them. Once these models have been properly tested, a prediction key and a prediction URL make it easy to use them.

Object Detection Using Azure Custom Vision Service

Multiple objects can be detected using the Azure Custom Vision service. After having them detected, we can draw boxes around these objects to classify them. Once our object detection model is tested, we can run it anywhere, for example, in our application.

Face

This service gives you an algorithm that analyzes, recognizes, and looks for human faces in an image. Face recognition is used for things like checking someone's identity, letting people in without touching anything, and blurring images for privacy and safety.

The following are some of the use cases of the Azure Face API.

Identifying Faces in a Group

Social media sites can figure out who owns an account by comparing the faces in a group and picking the one that looks most like the person in question.

Identifying Similar Faces

With this service, we can find a whole person with the same face or just a face that is the same.

Face Detection

We can get the Face API to detect faces for us. It also returns the attributes of a face, divided into smile, hair, facial hair, etc., along with 27 other attributes.

Emotion Recognition

The Face API can read emotions like anger, contempt, disgust, fear, happiness, neutrality, sadness, surprise, and shock. We can get emotional recognition of the faces in the image by using this service, which will return the emotion on each face as well as its confidence score.

Face Grouping

We can use the Face Grouping API to organize unidentified faces into groups based on how similar they are in terms of their features. We can use a "face list," which might be one face, a group of faces, a single person, or a group of men and women, to help create and control groups of faces. It lets us find faces that look alike in a group of pictures, which could be of famous people, close friends, or family members.

Form Recognizer

Azure Form Recognizer's main goal is to pull out words, key-value pairs, and other information from a document. With this algorithm, you can find tables, structures, patterns, and other useful information in a bunch of data. This quality lets it turn documents into useful and usable data so that the user's focus is kept on acting on the given data rather than finding it out. The following are some features and benefits of an Azure Form Recognizer.

Simple Text Extraction

Prebuilt search and extraction models make it easy to find useful data without having to label it by hand.

Customized Results

We can improve the results that are already tailored to our layouts through smart, customized extraction by getting feedback from people.

Flexible Deployment

Data can be taken in from the cloud or the edge and used in search indexes, business automation workflows, and other places.

Built-In Security

You can trust that your data and any trained models will have the same level of security and privacy as an enterprise.

Understanding of Optical Character Reader

It is not a secret that images contain text. Some are more important than others. Images might contain brand names, traffic signs, instructions, letters, invoices, bank statements, or even those notes taken on a whiteboard during a crucial meeting. To read all these texts from all these images, whatever the image type (JPEG or PNG), Azure has introduced the OCR service. You can read a piece of text from an image using OCR. This technique extracts any and all the text that it detects in an image. It can be used by traffic management agencies to read out traffic signs. On other occasions, it can also be used to scan out important information from papers such as invoices, letters, or bills.

The OCR essentially depends on an API for its functioning.

This API works in a way that gives immediate results and can read the text in many different languages.

When you use the OCR API to process an image, it returns a hierarchy of information that consists of

- Regions in the image that contain text
- Lines of text in each region
- Words in each line of text

The OCR API also gives back bounding box coordinates for each of these elements. These coordinates define a rectangle that shows where in the image the region, line, or word is.

And this is how small pieces of text are extracted from an image using OCR.

Tip To gain a better understanding of Microsoft Azure's AI offerings, I recommend reading through each reference link in the book's "References" section. These links will take you to the module's Microsoft Learn training section.

Practical Labs

This lab will introduce you to the Microsoft Azure Computer Vision API. We have two options when working with the Computer Vision API service:

- Automate image analysis and description
- Automate text extraction from images

Computer Vision API – Text Extraction

With the help of code from Microsoft, this lab will show how to set up the Computer Vision API service. In this lab, you will

- Provision a Computer Vision resource
- Connect a C# console application to the previously created Computer Vision service instance

---

Note As writing code to create a client application is out of the context of the exam, which is just testing your knowledge in the context of AI services offered by Azure, for the lab purpose, you will use the code given by Microsoft. The link to download or reference the code is given in the second section of Practical Labs, "Connect a Console App to Computer Vision Resource."

Create Computer Vision Resource

In this section, you will learn how to create a computer vision resource using the Azure portal, and after the computer vision service instance is created, you will copy the key and endpoint and save them for later use.

1. Log in to the Azure portal. Select Create Resource. Under the AI+Machine Learning category, select Computer Vision, as shown in Figure 4-1.

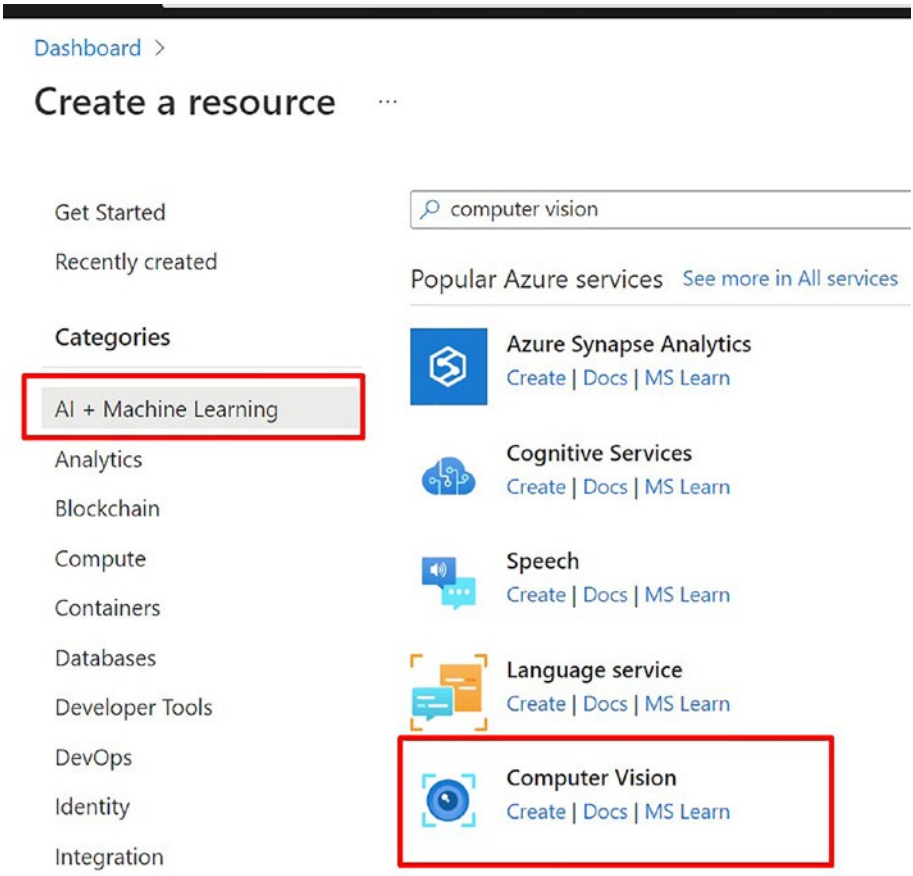


Figure 4-1. *Finding the Computer Vision service*

2. Give a subscription, resource group, region, resource name, and pricing tier, then click Create as shown in Figure 4-2.

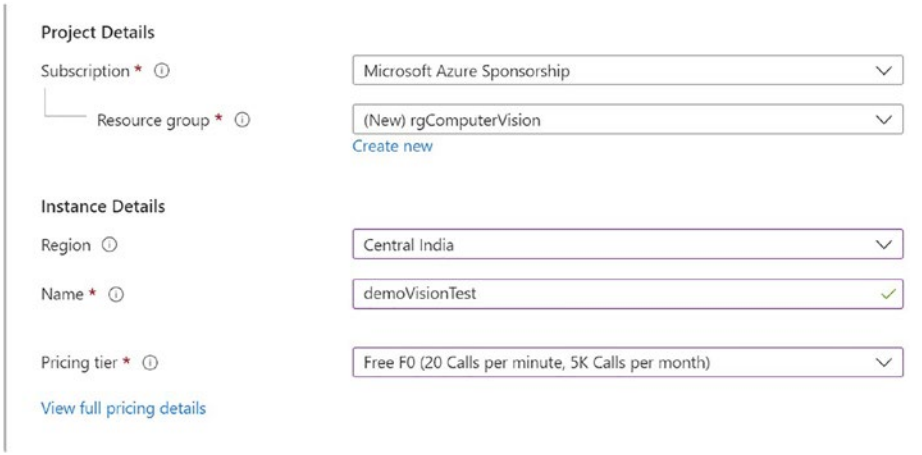


Figure 4-2. *Select region, resource name, and pricing tier*

3. *After a few minutes, you would get your newly deployed Computer Vision service instance as shown in Figure 4-3.*

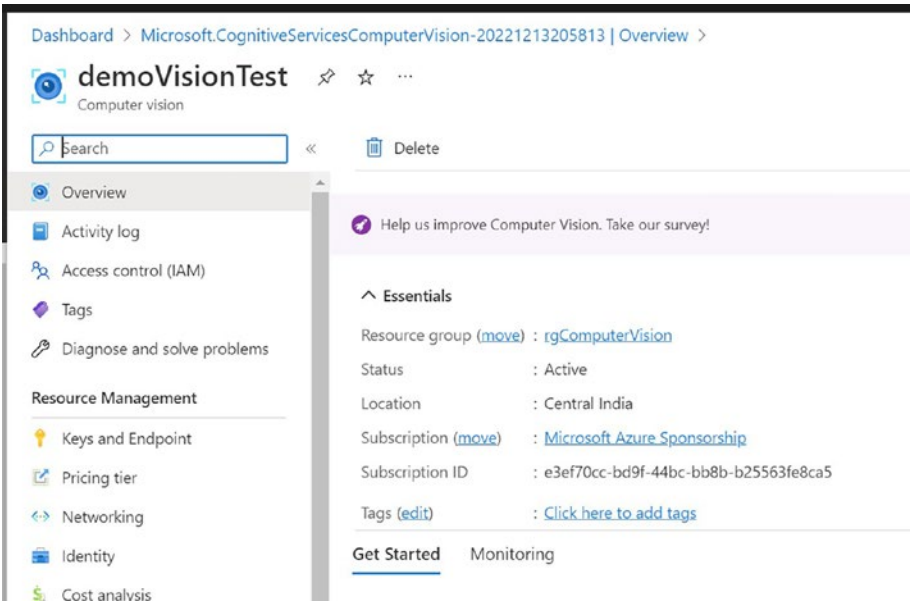


Figure 4-3. *Newly provisioned computer vision resource*

4. Under Resource Management, copy Key 1 and Endpoint as shown in Figure 4-4.

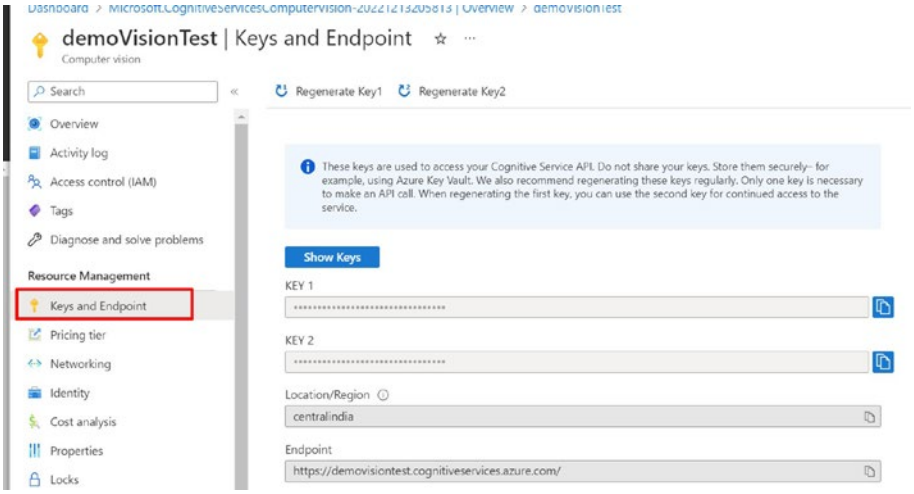


Figure 4-4. *Copy the Key 1 and Endpoint*

Connect a Console App to Computer Vision Resource

1. Download the code provided by Microsoft from the link:

   https://github.com/Azure-Samples/cognitive-services-quickstart-code/blob/master/dotnet/ComputerVision/REST/CSharp-analyze.md#handwriting-recognition-c-example

2. Now, create a new C# console app in Visual Studio as shown in Figure 4-5 and Figure 4-6.

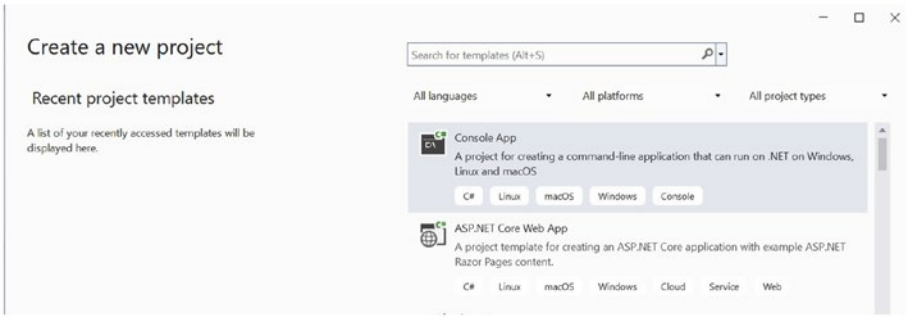


Figure 4-5. *Select the Console App template in Visual Studio*

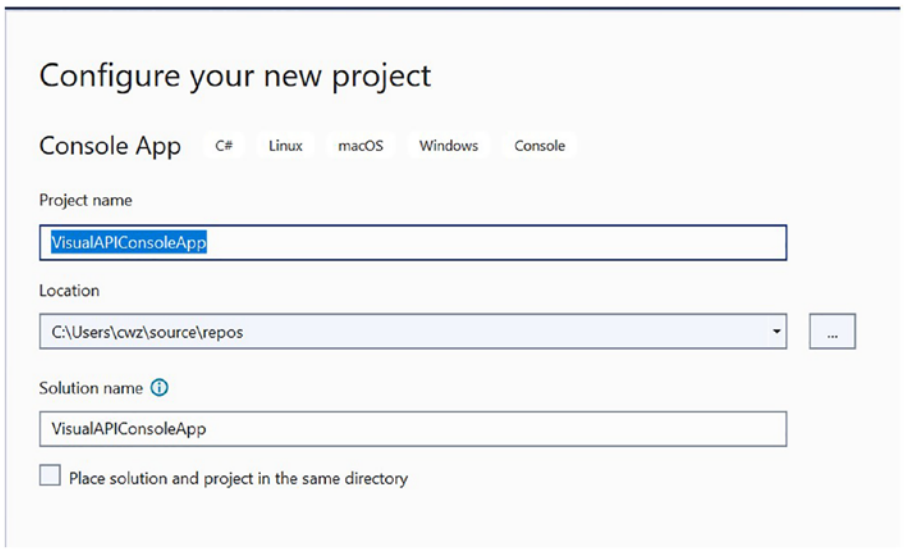


Figure 4-6. *Provisioning a console application*

3. Choose .NET 6.0 (Long-term support) as the Framework option as shown in Figure 4-7.

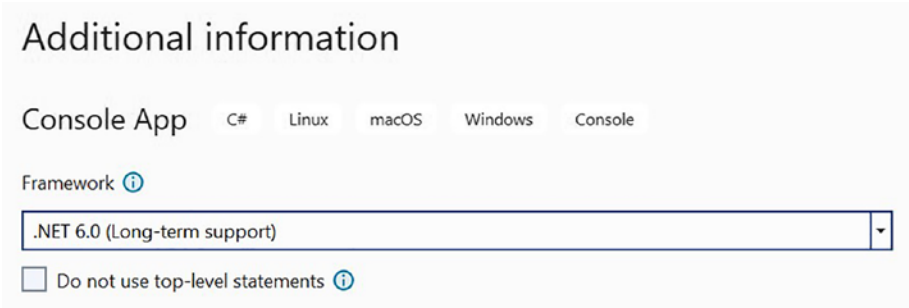


Figure 4-7. *Choose .NET 6.0*

4. Using the NuGet Package Manager, add the Newtonsoft.Json package as shown in Figure 4-8.

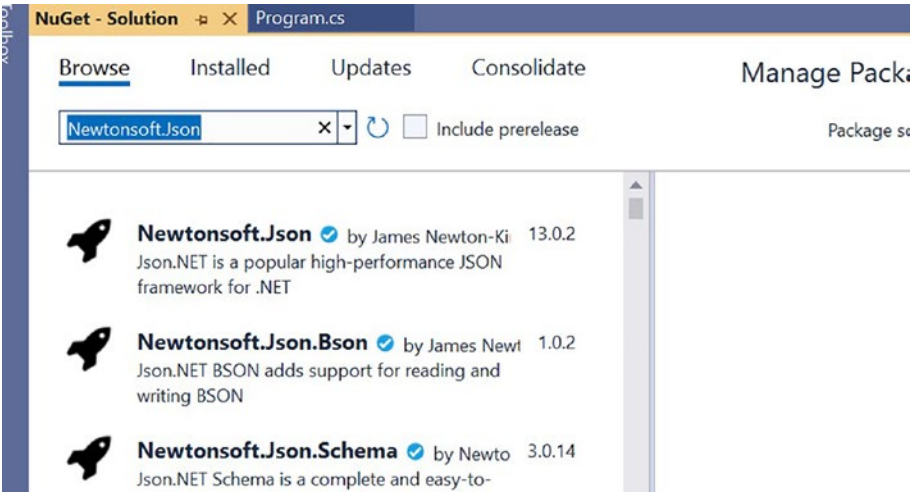


Figure 4-8. *Add Newtonsoft.Json using the NuGet Package Manager*

5. Under Browse, click Install on Newtonsoft.Json as shown in Figure 4-9.

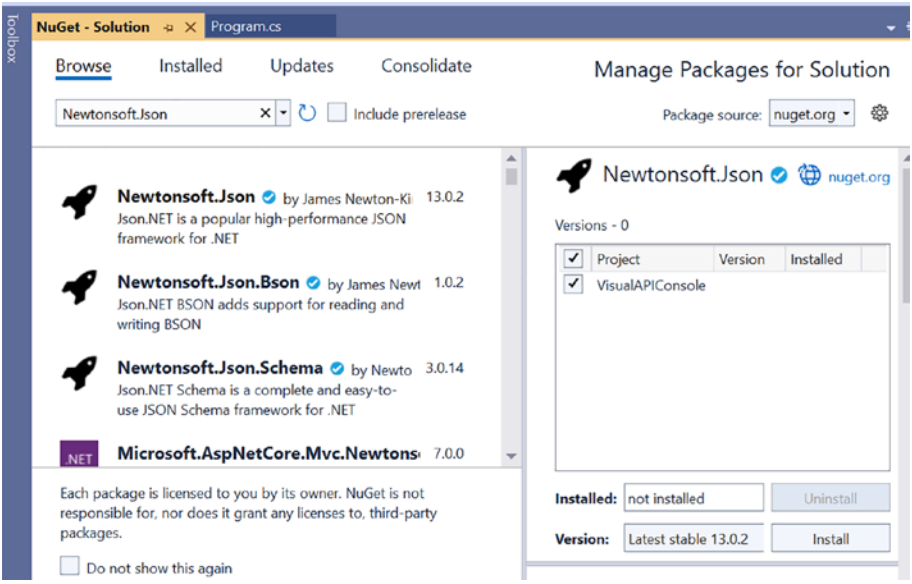


Figure 4-9. *Installing the latest stable version of Newtonsoft.Json*

6. Replace the Subscription Key and Endpoint from our Azure Portal and paste them into the Program.cs file as shown in Listing 4-1.

Listing 4-1. Replace the Key and Endpoint, which you copied from your recently deployed Computer Vision service

```
namespace CSHttpClientSample{
    static class Program {
        //Add your Computer Vision subscription key and base
        endpoint.
        static string subscriptionKey = "PASTE_YOUR_COMPUTER_
        VISION_Resource_KEY_HERE";
        static string endpoint = "PASTE_YOUR_COMPUTER_VISION_
        ENDPOINT_HERE";
```

7. Also, instead of analyze, you must call the OCR endpoint as shown in Listing 4-2.

Listing 4-2. Changing endpoint to ocr

```
// the Analyze method endpoint
  static string uriBase = endpoint + "vision/v3.1/ocr";
```

8. Get some images for the Vision API to parse. I have my two images here as shown in Figure 4-10. You can download a few images from the given link here:

   https://github.com/Azure-Samples/cognitive-services-sample-data-files/tree/master/ComputerVision/Images

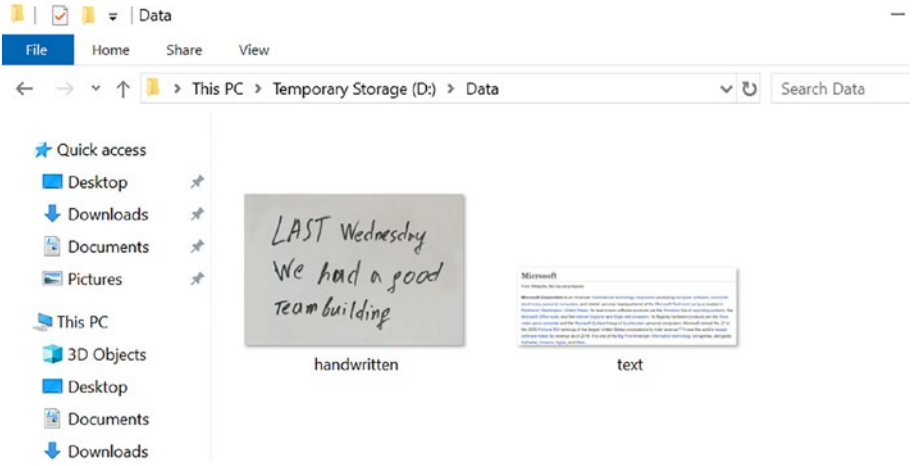


Figure 4-10. *Images used to be tested by the Vision API*

9. Set the "imageFilePath" variable to the image's location and run the code as shown in Listing 4-3.

Listing 4-3. Providing an image path in the code to be parsed for

```
 //the Analyze method endpoint
static string uriBase = endpoint + "vision/v3.1/ocr";

// Image you want to be analyzed (add to your bin/debug/
netcoreappX.X folder)

static string imageFilePath = @"D:\\Data\\handwritten.jpg";
```

10. When you run the application, you will see the output as shown in Listing 4-4 for the image "handwritten.jpg."

Listing 4-4. Output for the image "handwritten.jpg"

```
Response:{
"language":"en",
"textAngle":-0.07155849933176689,
"orientation":"Up",
"regions":[
{
        "boundingBox":"96,88,330,373",
        "lines":[
        {
                "boundingBox":"96,88,210,121",
                "words":
                {
                        "boundingBox":"96,98,145,111",
                        "text":"LIU"
                },
                {
                        "boundingBox":"246,88,60,97",
                        "text":"T
```

```
                }
            ]
        },
                {
                        "boundingBox":"106,239,320,101",
                        "words":[
                        {
                                "boundingBox":"106,247,111,90",
                                "text":"we"
                        }
                    ]
                }
            ]
        }
    ]
}
```

11. Change the path to the other image, "text.jpg," as shown in Listing 4-5, and then run the application.

Listing 4-5. Passing another image named "text.jpg" to the code

```
//the Analyze method endpoint
static string uriBase = endpoint + "vision/v3.1/ocr";

// Image you want to be analyzed (add to your bin/debug/
netcoreappX.X folder)

static string imageFilePath = @"D:\\Data\\text.jpg";
```

12. When you execute the program, you will see the output shown below in the Listing 4-6 for the image "text.jpg."

Listing 4-6. Output for the image "text.jpg"

```
Response:{
"lanugage":"en",
 "textAngle":0.0,
 "orientation":"Up",  "regions":[
        {
            "boundingBox":"20,26,1111,376",
            "lines":[
                {
                    "boundingBox":"21,26,184,33",
                    "words":[
                        {
                            "boundingBox":"21,26,184,33",
                            "text":"Microsoft"
                        },
                    ]
                },
                {
                    "boundingBox":"22,91,326,18",
                    "words":[
                        {
                            "boundingBox":"22,91,43,14",
                            "text":"From"
                        },
                        {
                            "boundingBox":"71,91,88,18",
                            "text":"Wikipedia"
                        }
                    ]
                }
            ]
```

```
        }
    ]
}
```

Introspective Practice Test

After you have finished reading the chapter, it is time for you to take a test to evaluate how much you have retained from what you have read.

1. Which of the following characteristics should you obtain in order to locate specific items in the image with the help of a computer vision service?
    a. Tags
    b. Categories
    c. Objects
2. What is the one factor that may impair facial recognition?
    a. Glasses
    b. Slow shutter speed
    c. Fast shutter speed
    d. Extreme angles
3. Which API can assist in automating tasks to act on inappropriate content, making content-sharing sites safe and straightforward to use?
    a. Content moderator
    b. Sharing
    c. Ink recognizer
    d. Digital recognizer

4. Which API will be used to read information from an electricity bill?
    a. Text recognition
    b. Receipt recognition
    c. Image recognition
    d. Form recognition
5. You have been tasked with identifying commercial brands. Which feature or API are you going to use?
    a. Computer Vision
    b. Custom Vision
    c. Image recognition
    d. Object detection

Solutions for the Practice Test

1. Question 1 – a
2. Question 2 – d
3. Question 3 – a
4. Question 4 – d
5. Question 5 – a

References: Microsoft Learn

I'm confident that if you have read this chapter, you will be prepared for your AI-900 certification. Before we move on to the next chapter and learn about natural language processing, I strongly suggest that you go through the Microsoft Learning Azure AI Fundamentals: Explore various Computer Vision modules in Microsoft Learn, using the following links:

1. https://learn.microsoft.com/en-us/training/modules/analyze-images-computer-vision/
2. https://learn.microsoft.com/en-us/training/modules/classify-images-custom-vision/
3. https://learn.microsoft.com/en-us/training/modules/detect-objects-images-custom-vision/
4. https://learn.microsoft.com/en-us/training/modules/detect-analyze-faces/
5. https://learn.microsoft.com/en-us/training/modules/read-text-computer-vision/
6. https://learn.microsoft.com/en-us/training/modules/analyze-receipts-form-recognizer/

Summary

Computer vision is an essential field of artificial intelligence (AI). In this field, the software is made to understand the data that comes from cameras, pictures, and videos. Scientists often use a combination of machine learning models and PaaS solutions, such as the cognitive services offered by Microsoft Azure, to bridge the gap between what a person sees and what a computer can do with it. Azure's fully hosted, prebuilt, and cross-platform REST APIs make it easier for any user to add

features like face recognition, speech recognition, knowledge search, etc., to their Android, desktop, or web apps on all platforms. Speech, language, vision, decision, and OpenAI services are the five most important types of Azure Cognitive Services. The Computer Vision service revolves around two core elements: image classification and object detection. In the next chapter, you'll learn about how natural language processing is used in different business applications, how it works, the different stages of NLP, and the core responsibilities of NLP. You will also learn about various Azure offerings for implementing NLP.

CHAPTER 5

Fundamentals of Natural Language Processing

The goal of natural language processing is to create machines that comprehend text or voice data and respond in a manner similar to how humans do by responding with their own text or speech. In this chapter, you will learn what natural language processing is, how it works, and its various stages. After that, you'll learn about core NLP tasks like text analysis and entity recognition, sentiment analysis, speech recognition and synthesis, machine translation, and semantic language modeling. Additionally, we'll cover AI for conversational interaction and its benefits, as well as Microsoft Azure NLP offerings. Here, you'll learn about core Azure NLP workloads like language, speech, and translator. Finally, under the section "Microsoft Azure Platform for Conversational AI," you will learn about Power Virtual Agents and the Azure Bot Service.

K. S. Trivedi, *Microsoft Azure AI Fundamentals Certification Companion*,
Certification Study Companion Series, https://doi.org/10.1007/978-1-4842-9221-1_5

Getting Started with Natural Language Processing

In this section, you will learn about natural language processing fundamentals such as what it is, business applications of NLP, how it works, stages of natural language processing, and core NLP responsibilities.

What Is Natural Language Processing?

Natural language processing (NLP) is a type of artificial intelligence (AI) that lets computers understand both written and spoken human language. It was made so that software could be made that creates and understands natural language. This way, a person could talk to a computer in a natural way instead of using programming or artificial languages like Java or C.

It is the practice of using computer techniques and artificial intelligence to allow computers to identify and respond to human speech. There are various approaches to NLP, but they all involve segmenting a speech or text into its component parts and correlating those parts to a library that shows how those parts fit together based on previous events. Text-to-speech apps, which are now available on most iOS and Android devices, as well as smart speakers like the Amazon Echo (Alexa) or Google Home, are good examples of NLP.

Natural language processing (NLP) is a kind of machine learning that enables computers to decipher, modify, and understand natural speech. The amount of voice and text data that businesses produce today through email, text messages, social media news feeds, video, audio, and other forms of communication is enormous. Using NLP workloads, they decipher this information on demand, figure out what the message is trying to say or how people feel about it, and respond to human dialogue in real time.

Natural language processing (NLP) is required for in-depth analysis of text and verbal data. To prepare data for use in various applications, NLP software employs preprocessing techniques like tokenization, stemming, and stop word removal.

It can work around language differences, slang, and weird grammar that happen in everyday conversation. Businesses use it to automate a wide range of tasks, including

- Text file inspection for important terms and recognition of entities
- Carrying out sentimental examination to assume the negativity or positivity in used language
- Translation of noted down or spoken words intelligently across languages
- Deciphering given directions and deciding on the best course of action for the given task

NLP can also be used to improve customer communication in client applications. For example, a chatbot looks at customer questions and sorts them by how common they are. It automatically answers the most common questions and sends the more complicated ones to customer service. This automation lowers charges, saves agents hours on repetitive questions, and boosts customer satisfaction.

What Are the Business Applications of NLP?

Businesses use software and tools for natural language processing (NLP) to make tasks easier, automate them, and streamline them in an accurate way. The following are some examples of use cases:

- Businesses in the insurance, legal, and healthcare industries process and retrieve a high volume of sensitive documents, such as medical records, financial information, and private data.

- Firms apply NLP technology to redact personally identifiable information and protect private information instead of manually evaluating data.
- Chisel AI, for example, uses Amazon Comprehend to extract insurance numbers, expiry dates, and other specific customer information from unstructured text.
- Chat- and voicebots can converse with customers in a more humanlike manner thanks to NLP technologies. Companies use chatbots to expand customer service capability and performance while bringing down overhead expenses. PubNub, a chatbot software developer, utilizes Amazon Comprehend to provide its global customers with regionalized chat functionality. T-Mobile uses NLP to find certain terms in customers' text messages and offer tailored recommendations. Using machine learning technology, Oklahoma State University has implemented a Q&A chatbot system to respond to inquiries from students.

Amazon Comprehend and Amazon Lex are two examples of natural language processing (NLP) technologies that marketing firms use to get a full picture of how customers see a company's products and services. They can ascertain the emotions and moods of clients by looking at their comments. For instance, Success KPI provides natural language processing services that let organizations focus on particular areas of sentiment analysis and call analytics in order to get insightful information.

How Does NLP Function?

Natural language processing (NLP) uses a mix of computational linguistics, machine learning, and deep learning models to understand how people talk:

- Computational linguistics is the science of using computers and software technologies to understand and build human language models. For example, researchers use computational linguistics techniques like syntactic and semantic analyses to help robots understand how people talk in conversation. Computational linguistics underpins language translators, text-to-speech synthesizers, and speech recognition software.
- Machine learning is the process of teaching a computer to be more proficient by using example information. Satire, analogies, language structure variations, and grammatical and usage outliers are all aspects of human language that take years to master. Deep learning is a branch of machine learning that trains computers to learn and reason similar to people. It employs a neural network, which consists of computer processing nodes intended to replicate the human brain in terms of data flow.
- Deep learning gives computers the ability to recognize, classify, and equate intricate patterns in incoming data. The initial stage in NLP implementation is often gathering and processing unorganized writing or audio data from sources such as cloud data warehouses, surveys, emails, or internal business process applications.

These techniques are broken down as follows.

Researchers teach NLP models to do specific tasks based on the textual information they have access to by using machine learning and data that has already been processed. Large data samples must be incorporated into

the program to improve NLP algorithms' accuracy. Experts in machine learning then use the model in production or add it to a production environment that already exists. In response to what is put into it, the NLP model can predict a result for the use case it was made for.

Stages of Natural Language Processing (NLP)

The field of natural language processing (NLP) is a mix of computational linguistics, computer science, and artificial intelligence.

Three steps may be identified in the process.

In the basic text NLP, users enter a sentence or a paragraph, and the NLP can perform the work.

The primary challenge is for NLP to deal with ambiguity in natural language. When compared to a programming language with strict syntax, ambiguity in the user's code is seen as an exception. For voice recognition, the computer uses a statistical model. At a high level, you will most likely have a parse tree that represents the grammatical understanding of the language. The parse tree can be passed to a large language model, where it can be evaluated to pull different classes of NLP subfields from the parse tree. It does this by parsing and tokenizing a current speech into pieces and comparing those pieces to pieces from a preceding speech. The output, or result in the text output, identifies statistically the most probable words and sentences that were spoken. The first task is the speech-to-text conversion.

Part-of-speech tagging, sometimes referred to as "word-category disambiguation," is the work that comes next. This method uses a set of computer-coded rules to identify words as nouns, verbs, adjectives, past tense words, etc., based on how they are put together. The machine is probably going to comprehend what you're saying if you accomplish these two things.

Phase III of an NLP is text-to-speech conversion. At this step, a voice or text version of the computer programming language that is easy to understand is produced. Most likely, a financial news chatbot would check online finance sources for information about Google stock to answer a question about something. It might only give the price and volume of the stock.

Core NLP Responsibilities

Text analysis and entity recognition, sentiment analysis, audio recognition and synthesis, machine translation, and semantic language modeling are some of the most crucial things that NLP performs. You will comprehend each of these fundamental NLP duties in the following area.

Text Analysis and Entity Recognition

Text analysis is the process of looking at different parts of a document or phrase to figure out what it's about. Entity recognition is often needed to look at a written document to figure out what its main points are or to find dates, places, and people who are mentioned in it.

Text Analysis

Humans are generally capable of reading material and comprehending its meaning. Even if you don't know the grammar rules of the language the text is written in, you can still get some ideas from it. For example, you could read a text and pick out the key phrases that show what the text is about. You might also recognize people's names or well-known places like the Eiffel Tower. Although it may be difficult at times, you may be able to gain a sense of how the individual felt when they wrote the piece, also known as "sentiment."

Here are a few text analysis techniques:

Text analytics is the process by which an artificial intelligence (AI) program running on a computer looks at some properties in text to get specific insights. To obtain insights, a person will often rely on their own experiences and knowledge. To execute the work, a computer must be equipped with similar knowledge. The following are some regularly used strategies for developing text analysis software:

- Statistical analysis of textual terms. For example, deleting common "stop words" (words such as "the" or "a," which offer little semantic information about the text) and running frequency analysis on the remaining words (counting how frequently each word appears) can yield indications about the text's major subject.
- Extending frequency analysis to multiterm phrases (a two-word phrase is a bigram; a three-word phrase is a trigram, and so on).
- Using stemming or lemmatization techniques to standardize words before counting them, such that terms like "power," "powered," and "powerful" are all considered as the same word. Stemming is the process of removing the last few characters from a word, which often results in incorrect meanings and spelling. Stemming is used when there is a large dataset and performance is an issue. Lemmatization takes the context into account and converts the word to its meaningful base form, which is known as a lemma. Because it involves lookup tables and other such things, lemmatization is computationally expensive.

- Applying linguistic structure norms to sentence analysis, such as breaking sentences down into tree-like structures such as a noun phrase, which contains nouns, verbs, adjectives, and so on.
- Words or keywords are encoded as numeric features that can be used to train a machine learning model, for example, to categorize a text document based on the terms contained inside it. This technique is frequently used to perform sentiment analysis, which classifies a document as positive or negative.
- Developing vectorized models for capturing semantic links between words by assigning them to locations in n-dimensional space. For example, this modeling technique may assign values to the terms "flower" and "plant" that place them close to one another, whereas "skateboard" may be assigned a value that places them much further away.

While these strategies can be quite effective, programming them can be difficult. Microsoft Azure's Language Cognitive Service can help with app development by using pretrained models that can

- Find out what language a text or document was written in (e.g., French or English).
- Perform sentiment analysis on text to determine whether it is favorable or negative.
- Extract important phrases from the text that may reveal the major themes.
- Identify and classify things in the text. Entities can be persons, locations, organizations, or even everyday objects like dates, times, and quantities.

Entity Recognition

A company, for example, could use AI to look at articles in industry magazines to find ones that talk about their products or executives or to figure out what each article is really about.

Named entity recognition (NER) automatically finds and classifies named entities in a document. Names, organizations, locations, dates, amounts, monetary values, and percentages are entities. With named entity recognition, you can get important information from a document to determine its subject or add it to a database. It helps quickly identify names, locations, brands, monetary values, and more. Extracting a text's main points makes it easier to sort unstructured data and find important information when working with large datasets.

Here are some noteworthy applications of named entity recognition.

Organize Tickets in Customer Support

If you are getting more and more customer service requests, you can answer them more quickly by using named entity recognition algorithms. Automate repetitive customer service tasks, like grouping customers' questions and concerns, to save time and improve how quickly problems are solved. You can also use entity extraction to pull important information, like the names of products or serial numbers, which makes it easier to send tickets to the right agent or team to handle the problem.

Learn from Customer Feedback

Online reviews are an effective way for your clients to give you feedback about your products and business. NER systems can be used to organize all of this feedback from clients and find problems that keep coming up. For instance, you could use NER to find places that are often mentioned in negative customer feedback. This could help you focus on a certain office branch.

Content Suggestion

Many popular apps, like Netflix and YouTube, use recommendation systems to give their users the best experience possible. Many of these systems use named entity recognition as one of the best possible options, which can make suggestions based on what the user has looked for in the past. If you watch a lot of comedies on Netflix, the entity Comedy will make you more recommendations.

Resumes of Processes

Recruiters spend a lot of time every day reading through resumes to find the right person for a job. Each resume has the same information, but they are often formatted and printed in different ways. This is a classic example of unstructured data. Recruiting teams can quickly get the most important information about candidates by using an entity extractor. This includes personal information such as name, address, phone number, date of birth, and email address, as well as training and experience information such as certifications, degrees, company names, skills, etc.

Sentiment Analysis

This is a common type of text analysis in which a score is assigned to indicate whether a text extract is positive (or negative). For example, a store might look at customer reviews to see which ones are good and which ones are bad. Sentiment analysis is an important part of natural language processing (NLP) in the world today. Sentiment analysis, also called "opinion mining," is a way to figure out how someone feels about a body of text. So, how does this apply to our world? Social media has been an essential component of life since the Internet's inception. When we search, post, and interact online, whether on social media or elsewhere, we can make things happen or be affected by what other people do. Sentiment analysis is therefore a powerful tool for political campaigns, marketing, business, and making decisions based on what people say they will do.

Corporations use NLP techniques to figure out how people feel and what they think, especially in the areas of semantics and figuring out what someone means. "Word sense disambiguation" in NLP means being able to figure out what a word means in a certain situation. Voice tagging and other NLP techniques are often used in social media to figure out things like the subject, verb, and object of a sentence. NLP-based sentiment analysis is then used to find an underlying relationship and figure out whether the tone of the sentiment is positive, neutral, or negative.

Text analytics tools provided by the Language Service can analyze labels and text to determine the sentiment of the text. It provides some context for the sentiment the author wanted to convey. This feature can find both good and bad feelings in online forums, customer reviews, and social media. The text is analyzed by the service using a machine learning classification model. It then gives the text a score between 0 and 1 based on how it makes the reader feel. Scores closer to 1 show a positive attitude. For scoring, the point in the middle of the range (0.5) is considered neutral or indecisive.

Sentiment analysis might be applied to the following two restaurant reviews, for example:

- "Yesterday, we came here for lunch, and the first thing I observed was how kind the staff was. After a kind greeting, we were immediately directed to our table. The food was delicious, the chairs were comfortable, and the ambiance was so warm."
- "One of my worst eating experiences ever happened at this establishment." Both the meal and the service were subpar. "Never again will I dine in this establishment."

The second review can reduce the score to as low as 0.1, whereas the first review is much better and the score could be as high as 0.9.

Indeterminate Sentiment

The score of 0.5 could mean that the text in question is vague and enigmatic. It shows that the text doesn't have enough conviction in a certain tone and needs more clarity. Other times, a 0.5 could mean that the text wasn't even written in the target language. For example, if you chose Spanish but had to turn in text written in German, you would get a score of 0.5. And this would show the lack of clarity in the text.

Speech Recognition and Synthesis

AI systems that can understand spoken language as input and produce spoken output are becoming more common. An in-car system, for example, may allow you to communicate hands-free by reading out loud incoming text messages and allowing you to dictate a response with your voice. Think about the increasing quantity of home and vehicle systems that can be controlled by conversing – delivering instructions like "turn off the lights" and asking queries like "will it snow today?"

An AI system must have two characteristics to accommodate this form of interaction:

- The ability to recognize and interpret spoken information is referred to as speech recognition.
- Speech synthesis is the capability of producing spoken output.

Speech Recognition

The ability of software to detect and convert spoken words into understandable text is known as "natural language processing," sometimes referred to as "speech-to-text." Simple speech recognition software has a small vocabulary, so it can only recognize words and phrases when

they are spoken in the right way. Modern software can handle various languages, accents, and natural speech. Computer science, linguistics, and computer engineering have all contributed to the development of speech recognition. A lot of modern gadgets and apps that focus on text have speech recognition features that make it easier to use the device without your hands.

Speech recognition systems take spoken words and use computer algorithms to process and analyze them before turning them into text. A software program turns the sound recorded by a microphone into written language that computers and people can understand. Human speech is very diverse and context specific; thus, speech recognition software must adapt. Different speech patterns, speaking styles, languages, dialects, accents, and phrasings are used to train the software algorithms that process and organize audio into a pattern that the NLP-based application can understand. The software can also tell the difference between what is being said and the background noise that is often present during a transmission.

Its goal is to turn spoken words into data that can be used to do other things. Often, this is done by typing them out. The spoken words can be recorded as an audio file or as live audio from a microphone. Speech patterns in audio are looked at to find patterns that can be used to translate speech into words. To accomplish this, the software often uses a variety of models, such as

- An acoustic model that translates the audio stream into phonemes (representations of specific sounds)
- A language model that maps phonemes to words, typically through the use of a statistical algorithm that predicts the most likely sequence of words based on the phonemes

The words that are found are often turned into text, which can be used for many things, such as closed captioning for recorded or live videos, making a transcript of a phone call or meeting, using automated note dictation, and identifying intended user input for subsequent processing.

Speech Synthesis

In many ways, voice synthesis is the inverse of speech recognition. It deals with vocalizing data, typically by transforming text into speech. A speech synthesis solution normally requires the following information:

- The text to be uttered
- The voice to be used to vocalize the speech

To make synthetic speech, the system usually breaks the text into words and gives each word a phonetic sound. The phonetic transcription is then broken up into prosodic units, such as phrases, clauses, or sentences, to make phonemes that will be transferred to audio format. Then, these phonemes are turned into sound by using a person's voice to figure out things like pitch and timbre and making an audio waveform that can be sent to a speaker or saved to a file.

The output of speech synthesis can be used for a variety of applications, including

- Generating spoken responses to user input
- Creating voice menus for telephone systems
- In hands-free situations, reading email or text messages aloud
- Broadcasting announcements in public places such as train stations and airports

Let us take a look at the numerous uses for speech recognition systems. Here is a selection of them.

Mobile Phones

Voice commands are used in smartphones for call routing, speech-to-text processing, voice calling, and voice search. Users can respond to text messages without glancing at their phones. Speech recognition powers the keyboard and Siri, Apple's virtual assistant, on iPhones.

Word Processing Software

Software like Microsoft Word can also recognize speech, so users can say words and have them turned into text.

Education

The use of speech recognition software is a common practice in language education. The user's voice is recognized by the program, which then provides assistance with pronunciation.

Customer Care

Automated voice assistants respond to consumer inquiries by providing relevant resources.

Applications in Healthcare

Doctors may instantly convert ideas into medical records using speech recognition software. Deaf people can understand what is being said by employing closed captions and speech recognition software to translate spoken words into text. People who have trouble using their hands to type on keyboards can use speech recognition to interact with computers.

Reporting in Court

To transcribe courtroom proceedings, software can be used, eliminating the need for human transcribers.

Recognizing Emotions

This device may examine particular voice traits to ascertain the speaker's emotional state. This can be used in conjunction with sentiment analysis to determine how a customer feels about a product or service.

Hands-Free Communication Is Possible

Voice control lets people use phones, radios, and global positioning systems without using their hands.

Machine Translation

International and cross-cultural teamwork is often necessary for success, and you need to be able to get past language barriers to do this. AI can be used to automate the translation of written and spoken languages. For example, an inbox add-in could be used to automatically translate emails that come in or go out, or a conference call presentation system could show a transcript of the speaker's words in different languages at the same time.

Machine translation (MT) is a type of automated translation in which software is used to translate a text from one natural language (like English) to another (like Spanish) while keeping the meaning of the original text. For any translation, whether it's done by a person or by a computer, to work, the meaning of a text in its original (source) language must be completely recreated in the target (or translated) language. While it appears simple on the surface, it is significantly more complicated. A translator application must look at and think about every

part of the text and know how each word affects the whole. To do this, you need to have a solid grasp of grammar, syntax (how sentences are put together), semantics (what they mean), and other parts of the source and target languages, as well as each local area. Both human and machine translations present their own challenges. For example, it's unlikely that two human translators will come up with the same translation of the same text in the same language pair, and it may take more than one try to make the customer happy.

The Use of Rules in Machine Translation

Rule-based machine translation uses a large number of built-in language rules and millions of bilingual dictionaries for each language pair. The software reads the text and turns it into a transitional representation, which is then used to make text in the target language. This method needs huge dictionaries with information about morphology, syntax, and meaning, as well as large sets of rules. The program uses these complicated sets of rules to change the grammar of the source language into the grammar of the target language.

Translations are based on massive dictionaries and complex linguistic concepts. One can improve the quality of an out-of-the-box translation by adding their own terms to the translation process. In this scenario, you'd generate user-defined dictionaries that change the system's defaults. Most of the time, there are two steps: an initial investment that makes a big difference and doesn't cost much and a continuous investment that makes a difference over time. While rule-based MT helps businesses reach the necessary quality threshold and beyond, the process can be time-consuming and expensive.

Statistics in Machine Translation Technology

Statistical machine translation uses statistical translation models whose parameters are based on the study of both monolingual corpora and bilingual corpora. Statistical translation models are easy to make, but the technology depends a lot on existing multilingual corpora. For a specific topic, you need at least two million words and a lot more for general language. In theory, it is possible to meet the quality criterion, but most businesses don't have the huge amounts of existing multilingual corpora needed to build the necessary translation models. Also, statistical machine translation uses a lot of CPU and needs a complicated hardware setup to run translation models at an average level of performance.

Semantic Language Modeling

Language can be difficult to understand because there are so many different ways to say the same thing. For instance, a driver might ask, "Where can I get gas near here?" or "Where is the closest gas station?" All of these terms basically mean the same thing. To figure out what the driver wants, you need to understand the meaning of the words being used. A car company could teach a language model to understand statements like these and give the right satellite navigation directions in response.

A semantic language model is a method that ranks the likelihood of words in a phrase based on how they make sense together. When the semantic language model is used in a conversational system, the dialog state and domain semantics can be added on the fly to help guide the speech recognizer during the decoding process. We talk about one of these applications that uses a semantic language model to handle spontaneous speech in a reliable way. Even though the semantic language model can be made without data, data-driven machine learning approaches can help it a lot. An example-based method is also presented here to demonstrate a possible approach.

AI for Conversational Interactions

Conversational AI is a system that allows an AI agent and a human to converse. "Bots" are generic terms for conversational AI agents. Bots can interact through numerous channels:

- Web chat interfaces
- Email platforms
- Social media platforms
- Voice

Conversational AI is built on top of AI tasks that are already being done, like processing natural language, machine learning, and maybe even computer vision. Bots are generally referred to when the term "conversational AI" is used. People often think of a chat interface when they hear the word "bot," but this is just one (very common) way to interact with a bot. Bots can be linked to a variety of channels, such as email, social media, and phone calls.

It is a type of artificial intelligence that allows mortals and machines to communicate clearly and successfully through speech or text. Conversational AI picks up on input voice or written sequences, guesses what they want, and then responds with an automated script that can be changed. The most advanced conversational AI platforms we have today can create interactions that are very real and natural.

Conversational AI applications are currently being employed in a wide range of sectors. Whether it be customer service or security, the smart programs under discussion are making it possible for companies to talk to their customers and employees in ways that have never been done before. Conversational AI has become a key part of many businesses' digital transformations since the global pandemic. Not all conversational AI attempts, however, are created equal. Research says that firms that stand out in their industries plan better than their competitors, who go

in without one. By asking intriguing questions initially, such as "What are your goals?", "Do you want to provide more information to your website visitors?", and "Do you want to create leads?", rather than relying on "plug-and-play" chatbots, voice assistants, and other solutions, firms can personalize the technology to their needs.

As technology advances, new opportunities to exploit conversational AI emerge. Home automation, vehicles, marketing, advertising, and e-learning are among the future uses that are already in the works. Conversational AI will become more important in our daily lives as we use more interactive technology and want to use it more. AI Three technological advances have fueled conversational AI as we know it. Natural language processing (NLP) software, for example, looks at how people naturally speak and write, figuring out the context and pulling out relevant information. The data is then used by artificial intelligence (AI) to forecast communication patterns. Lastly, machine learning (ML) lets AI-based systems "learn" from their experiences and get better without being specifically programmed to do so. NLP, AI, and ML are now used to power search engines, email spam filters, language translation software, voice assistants, grammar checkers, and even systems for managing social media.

Advantages of Conversational AI for Businesses

Conversational AI has the solution for both major and minor customer service issues. In fact, a lot of flourishing firms have started using AI-instigated answers to their many practical questions and problems. These well-learned and well-developed agents have already helped many businesses boost their sales through all the different aspects of their work. And as this science matures, these agents and applications will only get smarter and more efficient.

In the following text, you can see some ways that companies are using conversational AI to increase revenue right now.

Improve Client Service

Most successful businesses now handle customer service with AI that can talk to people. Customers don't know this yet. Whether it be in the shape of a chatbot or voicebot, large industries are increasingly using these services. Because of the reduced competitive advantage, the group of those who continue to do not use is becoming scarce in number and even more elusive in identity.

Drive Marketing and Sales Initiatives

Because AI-powered solutions are sophisticated enough to better learn about a user's persona and their likes and dislikes, they are slowly becoming the best tool for customer service for this generation. These tools can really tune up the conversations with customers, and with the right knowledge, these services can really increase the conversion of sales and expand the profit range for a business. Having the sentimental analyzer, it can also read the sentiments of users, giving it another edge over other businesses.

These services really draw a line under human intervention wherever they are integrated. By taking over the more mundane tasks like replying to emails and making phone calls, it allows the human mind to be put to a better and more complex use. Because of the intelligence and acute sense of reality that these services now possess, they are more reliable to hold real-world conversations or fill out much of the manual entry stuff for businesses, saving them time to achieve newer goals in place of strenuous important tasks.

Improve Agent Skills

Conversational AI can add practical ideas and a knowledge base to its traits when talking to customers in real time. For instance, an agent would be hit with a reminder to send the useful information if it forgets to do so on its own. Also, these agents can make long calls shorter by using the important information they wrote down during previous calls.

Reduce Response Times

Present-day customers lack patience. For their problems, they seek an urgent solution. Conversational AI could cut response times for all forms of communication, such as social media, email, web chat, phone calls, and questions from review sites and third-party aggregators, by a large amount.

Personalize the Customer Experience

Conversational AI has the potential to offer each client a degree of personalization that has never before been possible. Despite what most people think, machines don't understand people any better than many other people. Machines, unlike humans, do not have emotions, hobbies, or memory lapses; they only function on facts. Conversational AI can create a very personalized path to a solution by getting to know each customer, their choices, and their own set of problems. Conversational AI systems may acquire, assess, and derive valuable conclusions from prior user data. They can make detailed portraits of their clients that show their interests, preferences, and other parts of their personalities.

Also, these algorithms can pick up on speech patterns, trends, and psychological clues from customers that real people might miss. By personalizing their experiences, businesses may better understand their customers, including what drives them to take action and why they leave. Conversational AI can help predict problems and offer quick solutions to stop clients from leaving. Conversational AI can find individual sales and lead opportunities in the same way that it can find maintenance problems. Ultimately, businesses need to find ways to grow their income and profits, so they need solutions for this.

Conversational AI lowers the cost of providing customer service by automating tasks that would normally need a person's help. This leads to substantial savings in personnel and HR costs, as well as in waste and other costs. Conversational AI could increase growth and income by making customers happier, getting them to spend more, and telling

their friends about your business. Conversational AI is now seen by businesses as a key part of a highly competitive customer service strategy. As customer needs grow, AI solutions will be a lifesaver for businesses of all sizes, letting them provide high-quality customer service at scale. Conversational AI makes it possible for people and machines to talk to each other more clearly and effectively than was thought possible before, often over large networks and several channels.

Microsoft Azure for NLP

Microsoft Azure provides a wide variety of NLP-related services for application development. Table 5-1 shows the list of cognitive services to be used to build solutions for natural language processing in Microsoft Azure.

Table 5-1. *List of cognitive services to be used to build NLP solutions in Microsoft Azure*

Service	Capabilities
Language	Language detection Key phrase extraction Entity detection Sentimental analysis Question answering Conversational language understanding
Speech	Text-to-speech Speech-to-text Speech translation
Translator	Text translation
Azure Bot Service	Platform for conversational AI

All of the preceding offerings can be broken down into their core NLP tasks, which will be discussed in the next section.

Core Azure NLP Workloads: Language, Speech, and Translator

Language, speech, and translators are the three main pillars of language processing, which is served by Microsoft Azure NLP Services.

Language

The main things that can be done with language are language detection, key phrase extraction, entity detection, and semantic analysis.

Language Detection

The Azure Cognitive Service for Language is a cloud-based set of machine learning and AI algorithms that can be used to make smart apps that use written language. One of the things it can do is detect languages. Language detection can figure out what language a text is written in and give a language code for a wide range of languages, variations, dialects, and regional or cultural languages.

The first step in any text analysis or natural language processing pipeline is to figure out what language is being used. If the language of a document is not picked up correctly, all language-specific models that follow will give wrong results. If there are mistakes at this step, they can add up and lead to wrong results, like when an English language analyzer is used on a French text. It is critical to determine the language of each document and whether any sections are in another language. Depending on the country and culture, it is pretty common for documents to have more than one language section.

Most of the time, statistical profiles of languages are used to figure out the language of a document that only has one language. Language recognition sorts content into categories and improves search results, especially for multilingual documents or anything with text: social media, image captions, news headlines, email subject lines, tweets, metadata, keywords, queries, files, logs, and more. Basis Technology leads the pack.

Use the Language Service's language detection tool to find out what language a piece of text is written in. You may submit numerous documents for analysis at the same time. The service will detect the following for all documents that are submitted to it:

- Language title (e.g., "English").
- ISO 6391 is the language code (e.g., "en").
- A confidence score for language detection.

Consider the following scenario: you own a restaurant where guests can fill out questionnaires and provide comments on the cuisine, service, and personnel, among other things. Assume you've received the following client feedback:

- *Review 1*: "A wonderful lunch spot. The soup was fantastic."
- *Review 2*: "Excellent food and service."
- *Review 3*: "The croque monsieur with frites was excellent. Good appetite!"

You can use the Language Service's text analytics to find out what language each of these evaluations was written in, and it might give you the results in Table 5-2.

Table 5-2. *Result of the Language Service's text analytics*

Document	Language Name	ISO 6391 Code	Score
Review 1	English	en	1.0
Review 2	Spanish	Es	1.0
Review 3	English	En	0.9

Even though the content is in both English and French, English is the language that Review 3 recognizes. The primary language of the text will be the focus of the language detection service. The service employs a system to determine the dominant language based on variables such as phrase length or the percentage of text in the language. The prevailing language will be indicated by the value and language code returned. The mixed-language content may cause the confidence score to be below one.

Key Phrase Extraction

The Azure Cognitive Service for Language is a cloud-based collection of machine learning and AI algorithms that can be used to make smart apps that use written language. One of the services it offers is keyword extraction. To quickly identify the main concepts in a text, use key phrase extraction. For example, in the text "The food was delicious and the staff were wonderful," key phrase extraction will return the main topics: "food" and "wonderful staff."

"Keyword extraction" is the process of looking at the text of a document to find out its most important points. Consider the preceding restaurant scenario. Reading through the reviews can take a long time, depending on how many surveys you have collected. You can instead use the Language Service's tools for finding keywords to sum up the main points.

You might get a review like this:

> "We had a wonderful evening after coming here for a birthday supper. A kind waiter welcomed us right away and led us to our table. The lunch was fantastic, the setting was informal, and the service was top-notch. If you appreciate excellent food and friendly service, you should check out this restaurant."

By identifying the following phrases as key phrases, you can add context to this review:

- Prompt service
- Wonderful birthday celebration
- Fantastic lunch
- Friendly hostess
- Dinner setting
- Place

You can leverage sentiment analysis to determine not just whether or not this review is good but also to emphasize important elements of the review.

Entity Detection

Entity extraction, also called named entity recognition (NER), is a part of natural language processing that entails identifying key information in the text and categorizing it into a set of predefined categories. It is the most common data preprocessing task. It finds the most relevant information (entities) in free form text (e.g., news, web pages, and text fields). Names of people, places, organizations, and things; dates; email addresses; phone numbers; and similar pieces of information are all examples of

entities. Once entities are extracted, they can be used to complete a textual database entry. This framework makes it possible to do more complex analyses, such as those involving entity relationships, event detection, and sentiment analysis. NLP is essentially a two-step process, with the two steps listed as follows:

- Identifying the entities in the text
- Grouping them into broad segments

The unstructured text you give the language service will be turned into a set of entities that you can use.

Sentiment Analysis

Sentiment analysis is a form of opinion mining that uses natural language processing (NLP) to ascertain the underlying emotional tone of a piece of text. This is a common way for businesses to find out what customers think about a product, service, or idea and put those thoughts into groups. It involves using data mining, machine learning (ML), and artificial intelligence (AI) to mine text for information about how people feel and what they think.

Sentiment analysis tools help companies get information from unstructured text. Algorithms use rule-based, automatic, or hybrid methods to automate or replace manual data processing. Rule-based systems use predefined, lexicon-based rules to figure out how people feel, while automatic systems use machine learning techniques to learn from data. Methodologies are combined in a hybrid sentiment analysis. Opinion mining can also figure out the subject, the person who has the opinion, and the degree to which the opinion is positive or negative.

Also, sentiment analysis can be done at different levels, such as the document, the paragraph, the phrase, and the subsentence. Some of the companies that offer sentiment analysis platforms or SaaS applications

are Brandwatch, Hootsuite, Lexalytics, NetBase, Sprout Social, Sysomos, and Zoho. Businesses that use these tools can look at customer feedback more often and respond more quickly to changes in the market. Sentiment analysis is a way to figure out how people feel from text data by using artificial intelligence. NLP software looks through the text for words or phrases that show sadness, happiness, doubt, regret, and other feelings that aren't obvious.

Sentiment analysis is the process of applying natural language processing, text analysis, and statistics to determine how customers feel about a specific subject. The best companies comprehend their clients' emotions, including what they say, how they say it, and what it means. You can find out how customers feel about your brand from tweets, comments, reviews, and other places where they talk about it. Sentiment analysis is the study of determining how people feel using software, and developers and business leaders in the modern workplace must be able to conduct this analysis. Deep learning has brought sentiment analysis to the forefront of the most advanced algorithms, just as it has done in many other fields. People now use natural language processing, statistics, and text analysis to determine how words affect people's emotions and categorize them as positive, negative, or neutral.

Brand Monitoring with Sentiment Analysis

Sentiment analysis is often used to get a 360-degree view of how your customers and other important people think about your brand, product, or company. Product reviews and social media can tell you a lot about the strengths and weaknesses of your business. Companies can employ sentiment analysis. Companies such as Unamo can also use sentiment analysis to determine how a new product, an ad campaign, or a customer's response on social media to recent news about the company impacts sales or customer satisfaction. Customer service representatives frequently use sentiment or intent analysis to classify incoming customer emails as

"urgent" or "not urgent" based on how the email makes the customer feel. This allows them to identify dissatisfied customers prior to contacting them. The agent then prioritizes the resolution of the user's most urgent requests. As machine learning makes customer service more automated, it is becoming increasingly important to comprehend each case's disposition and objective.

Market Research and Analysis Using Sentiment Analysis

In business intelligence, sentiment analysis is used to find out why consumers do or don't like something (e.g., why do people buy a certain product? What are their thoughts on the user experience? Did the customer service match their expectations?)

Sentiment analysis can also be used in political science, sociology, and psychology to, among other things, look at patterns, ideological biases, opinions, and reactions. Many of these applications are already operational. Bing's Multi-Perspective Answers solution now includes sentiment analysis. Hedge firms very likely use the technology to forecast price movements based on public mood. CallMiner, for example, provides sentiment analysis for client interactions as a service.

Question Answering

Question answering (QA) is a subfield of artificial intelligence that combines natural language processing and information retrieval to make systems that can answer people's questions in their own words. By querying a knowledge base, which is a structured database of facts, or a collection of unstructured natural language documents, question-answering computers can locate responses. There exist both closed-domain (responding to requests from a single domain) and open-domain question-answering systems (relying on general ontologies and widespread knowledge).

Watson by IBM is an illustration of the latter type of quality assurance system. Open-domain answering systems convert questions posed in natural language into structured queries. Keyword extraction is used to establish the inquiry type (who, where, how many). Part-of-speech tagging and syntactic parsing methodologies (person, place, number) can be used to determine the sort of response. The search terms are then entered into an information retrieval system. The response is then transformed into comprehensible text by parsing.

Conversational Language Understanding

Conversational Language Understanding, or CLU, is a conversational AI service that is mostly used in bots to get relevant information from what users say (natural language processing). The CLU analysis includes two projects: dialogue and orchestration. You can use the "conversation" project if you want to pull out intents (the meaning behind a user's words) and custom entities. To get the best response, you can also use the "orchestration" project, which brings together different language apps like Question Answering, Luis, and Conversation.

As the scenarios where AI is used get more complicated, people are using their voices to talk to digital apps more and more. In some cases, the conversations with AI agents can even turn out to be humanlike, approving them to be of good use for customer support apps and home automations.

Computers should not only be able to read what is typed into them, but they should also be able to translate it while keeping its semantic roots, so that the input doesn't lose any of its real meaning. The Azure Conversational Language Understanding Service supports the comprehension of language. To use this service, the user has to understand three concepts: utterances, entities, and intentions.

Utterances

All the words a user might say that our system has to listen to and understand are called "utterances." For instance, a user of a home automation system would say, "OK Google."

- "Show me the picture of Golden Gate Bridge."
- "Turn off the music."

Entities

A subject to which our speech relates is called an "entity" for our system. Examples include "Golden Gate Bridge" and "music" in the following sentences:

- "Show me the picture of Golden Gate Bridge."
- "Turn off the music."

Intents

A direction or the final aim in the user's speech is called an intent. For example, both of the previous commands have an intent. This means that we can build a system in our language interpreter that can wrap up and summarize these intentions.

A model of intentions and entities is defined by a language understanding program. For a given input, the model is trained to predict the right intent and the entities it will be applied to by using phrases.

Intents and entities are used to build a model, while utterances connect the two and tell the language understanding application what to do with the entity based on the intent.

Speech

Text-to-Speech

The method of generating a simulated voice from text is known as "text-to-speech." This technology is used to interact with users when it is either challenging or impossible to see text on a screen. This opens up new opportunities for using information and apps, and it may also make the world more accessible to those who struggle to read words on displays. The technology behind text-to-speech has advanced over the past few decades. Deep learning can now make speech that sounds very natural in terms of pitch, rhythm, pronunciation, and inflection.

Today, a variety of apps use computer-generated speech, which is also showing up more frequently in user interfaces. Newsreaders, games, public address systems, e-learning, phone systems, Internet of Things apps and devices, and personal assistants are just a few examples. Speech synthesis makes apps easier to use by letting users read and understand information without having to focus on a screen.

Here's a quick rundown of some of the main benefits of using text-to-speech:

- People who are unable to read due to a disability or literacy challenges have another option for getting information thanks to text-to-speech technology.
- By allowing for both visual and audio presentation, text-to-speech can help boost comprehension, memory, language skills, motivation, and confidence. It aids e-learning by being utilized in online content.
- Text-to-speech technology can turn any digital content into a multisensory experience, enabling individuals to enjoy listening to news, blog posts, or even a PDF document while they're on the road or juggling other

tasks. Implementing text-to-speech has become rapid and easy with cloud computing, and it is also affordable because of the cloud's economics. Applications for voice communication are becoming more and more common.

- Authors and content companies may quickly and easily convert books, articles, and any other textual data into audio using text-to-speech technology.
- With the use of text-to-speech technology, it is simple to transform educational materials into a form that can be distributed more affordably and successfully in a variety of languages.
- By employing real-sounding voices, text-to-speech may enhance the quality of interactive contact centers and communication services.
- When it comes to operationalizing the audio creation process in preproduction and development, text-to-speech may also save expenses and increase efficiency.

Speech-to-Text

Speech-to-text, which is also called "speech recognition," lets audio sources be turned into text in real time. This is referred to as "computer voice recognition." This software can convert audio streams to text and act on them in real time. Linguistic algorithms use Unicode characters to sort auditory information and translate it into words. As a command input, this text can be read, shown, and used by applications, tools, and devices.

A speech text is different from other types of writing because it uses specialized words, is organized in a certain way, and focuses on key ideas. It also enables users to control programs and gadgets using speech and dictation. There are a few real-world examples of speech-to-text: apps can

be used to dictate long messages. They can be used to send text messages, emails, and documents. Voice commands can be used to initiate specific actions. Two examples of command and control are using your voice to type in query text and choose menu items. Customers can communicate with users who speak different languages using speech-to-text technology.

Voice search gadgets have become a part of 72% of people's everyday routines, according to research. Businesses are increasingly employing speech recognition technology to increase customer service efficiency and accuracy. So far, the following are some of the most important applications of voice recognition:

- Quick turnaround on documents. There are various digital solutions and mobile apps that use speech-to-text software for individuals who require transcribing with a speedy turnaround.
- In an era when so many of us rely on our mobile devices for working and living, practical speech-to-text software, which is incredibly accessible via a smartphone app, makes things easier when we need it. It can be a convenient and user-friendly alternative to typing, whether for dictation, word editing, or web browsing.

Speech Translation

Text is produced from audio input using speech recognition. For this method to work, you have to understand how dialects, slurs, intonation, and grammar are used in everyday speech. You also have to break up words into smaller pieces. Speech recognition is widely used for transcription, which may be carried out using speech-to-text services like Amazon Transcribe.

The process of translating and speaking out loudly spoken sentences in a second language in real time is known as "speech translation." This is different from phrase translation, where the system only translates a set number of phrases that have been entered into the system. Speech translation technology allows speakers of different languages to converse with one another. Because of this, it has a huge amount of value for science, understanding other cultures, and doing business around the world. Automatic speech recognition (ASR), machine translation (MT), and voice synthesis are three software technologies that are commonly used in speech translation systems (TTS).

The person speaking language A talks into a microphone, and the speech recognition module figures out what language is used. It compares the input to a phonological model that is made up of a lot of speech data from a lot of different speakers. Using the dictionary and grammar of language A, a large amount of text written in language A is turned into a string of words. The machine translation module is then applied to this string. At first, each word in language A was replaced by a word from language B that meant the same thing. Current translation systems do not use word-for-word translation to determine the correct translation. Instead, they consider the entire context of the input to determine the correct translation. The translation result is sent to the voice synthesis module, which uses a corpus of speech data in language B to predict how and in what tone the string of words should be spoken. This database is queried for waveforms that correspond to the text, which speech synthesis links and generates.

Translator

Text translation is the key capability of the translator workload in NLP.

Text translation is a cloud-based REST API part of the Translator service. It uses neural machine translation technology to translate text from the source language to the target language in real time in all of the languages it supports.

Getting rid of language barriers has become important as more businesses and people try to communicate with people from different cultures and parts of the world. Finding bilingual or even multilingual individuals to translate between languages is one approach. But this strategy might be hard to scale up if people don't have these skills and there are a lot of different language pairs. Automated translation, commonly referred to as "machine translation," is increasingly being used to address this issue.

Literal and Semantic Translation

During a literal translation, a word is transcribed into its adjacent word in the other language, and this is what machine translation looked like previously. Nonetheless, this procedure has its disadvantages. For one, there mightn't be a parallel word in the target language. In other cases, the translation could be totally off point from what it was intended to be.

Things get a lot worse when the linguistic context of two languages has a gap for a lot of concepts. To mention one, we can say that "fermer la lumière" is a perfectly fine French sentence that tells its reader to switch off the light. However, when translated literally in English, the literal meaning changes to "close the light," which would make no sense to even the most basic English speaker. Here, semantic translation is useful because the context of meaning is not lost while translating. A semantic translation of the former French sentence would be "turn off the light," which is perfect and understandable.

The AI at work here should be adequate enough to contain the semantic meaning of words and sentences so as to make translations of even richer texts in other languages, such as poetry and prose, a lot easier and more accessible to read.

Text and Speech Translation

Text translation makes it easy to translate documents, emails, and other media from other countries, whether they are official or not. This service even provides an option to translate the web pages. Social media sites use this tool for their users to take advantage of it and understand the posts made in any foreign language. On the other hand, the speech translation service gets our audio words transcribed into the target language either through direct speech or by outputting it as a text document.

Microsoft Azure provides us tools that make speech and text translation easy and convenient. The following are two services by them:

- Text-to-text translation is supported by the Translator service.
- Speech-to-text and speech-to-speech translation are offered by the speech service.

You can also make a cognitive services resource that lets you use both services through a single Azure resource. Now, applications can reach both services with a single endpoint and authentication key. This makes billing easier.

Also, a cognitive services resource can be made to make it easier to use both services. When there is only one endpoint and one authentication key, it is easier to use a resource, bill for it, and get access to it.

Microsoft Azure Platform for Conversational AI

Power Virtual Agents and the Azure Bot Service are the most important parts of Microsoft Azure's conversational AI service.

Azure Bot Service

Azure Bot Service is a platform for creating, publishing, and maintaining Azure bots. After you've created and published it, you can use the Azure Bot Service as a client to receive content from the knowledge base and provide it to consumers via a bot.

Develop a Knowledge Base

Having the freedom to create our own custom bot and doing so with our own code is a fantastic feature of Azure. Using the Microsoft Bot SDK, we use our own knowledge of QnA Maker to set up our bot. To create, publish, and develop a bot based on our own knowledge base, we don't even have to invest a lot of time.

Custom Question Answering

QnA Maker is now available in Azure Portal as a custom question-answering service under the Language Service category. You can create a knowledge base out of question-and-answer pairs by using the Language Studio's custom question-answering feature. You can get these questions and answers from an existing FAQ document or website, or you can type them in and edit them by hand. Most of the time, all of these methods are used together to make a knowledge base, starting with a source dataset of questions and answers from an existing FAQ document and adding more manual entries to the knowledge base. You can also assign an alternate phrase to the questions in the knowledge base. For example, "What is your school name?" may have the alternate phrase "In which school do you study?"

Test the Knowledge Base

You must save a set of question-and-answer pairs after you have created it. This process looks at your literal questions and answers and uses a built-in NLP model to match the right answers to your questions, even if the answers aren't exactly worded the way you said they should be in your question definitions. Then, you can use Language Studio's built-in test interface to see how much you know by asking questions and reading the answers.

Extend and Customize the Bot

- After you've set up your bot, you can change it by going to the Azure portal, where you can: Use an appropriate testing interface to test your bot.
- Logging, analytics, and interaction with other services should be configured.
- To make it more advanced, rewrite the code and release the updated version of the bot.

You can edit both codes at once within the Azure portal for brief modifications. But in case you want to make more modifications, you may download the source code and manipulate it on your own computer before republishing the bot without delay to Azure.

Join Channels

When your bot is ready to be shared, you can connect it to different channels so that people can talk to it through online chat, email, Microsoft Teams, and other popular ways to communicate. Users can ask the bot questions through any of its channels, and it will answer with the best answer from the knowledge base it is built on.

Tip To gain a better understanding of Microsoft Azure's AI offerings, I recommend reading through each reference link in the book's "References" section. These links will take you to the module's Microsoft Learn training section.

Practical Labs

Using a custom question-answering template, you will provision a simple knowledge base that serves the purpose of an informational bot. With the help of an information bot, you can get information quickly through simple text chat.

In customer service, bots that can understand and answer the most common questions asked by customers via text chat, email, or voice interface are becoming more common. The bot can give an appropriate answer because it has access to a database of questions and knows how to answer them.

The lab consists of four steps:

- Provisioning a question-answering knowledge base
- Editing the knowledge base
- Knowledge base training and testing
- Provisioning a bot to consume the knowledge base

Creating a Custom Question-Answering Knowledge Base

A Frequently Asked Question (FAQ) URL or a document can be used to feed questions and answers into a QnA Maker service, which then puts them all together. Here's how it works:

1. Log in to the Azure portal. Select **Create Resource**. Under the **AI+Machine Learning** category, select **Language Service**, as shown in Figure 5-1.

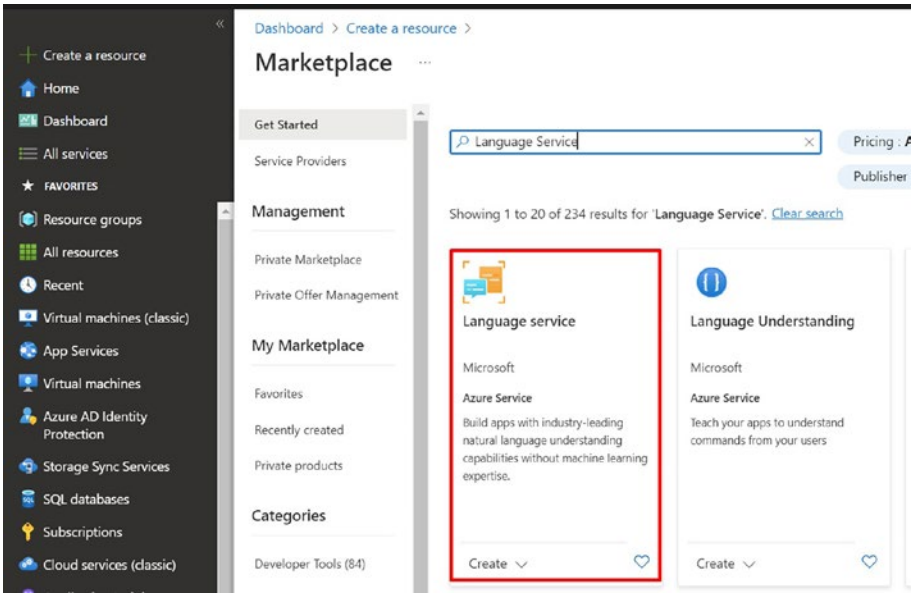


Figure 5-1. *Choosing a Language Service from the Azure Marketplace*

For the custom features, select the "**Custom question answering"** option, as shown in Figure 5-2.

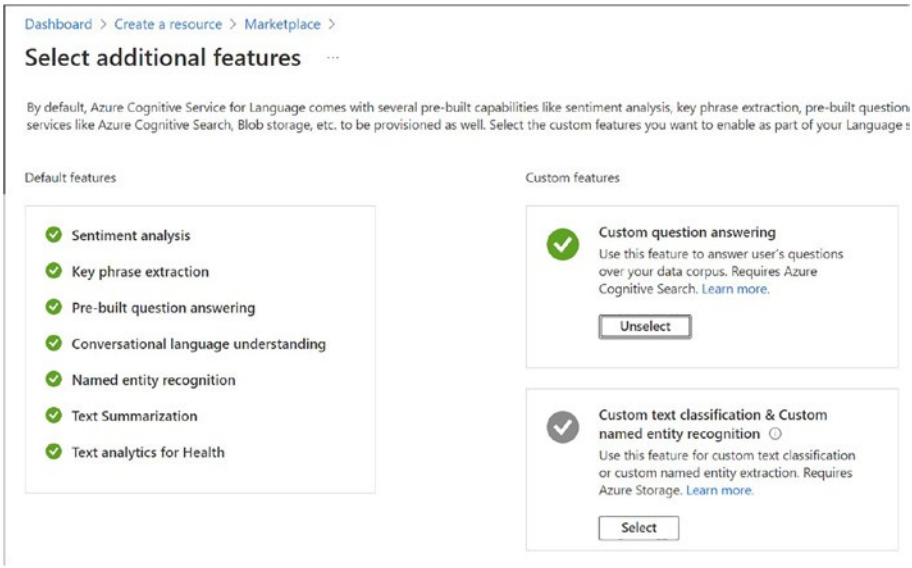


Figure 5-2. *Keeping all default features and adding custom question answering as a custom feature*

2. As shown in Figure 5-3, provide the subscription, resource group, unique name for your language resource, pricing tier, and other details.

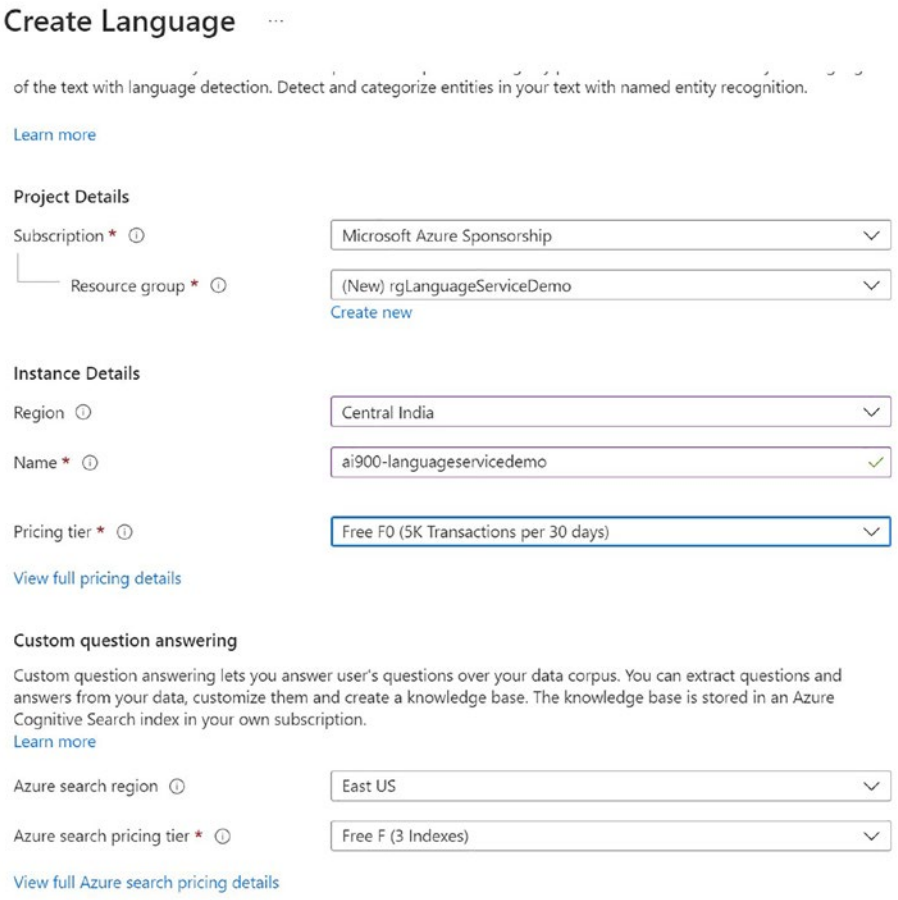


Figure 5-3. *Creating new language services*

3. Select Review + Create, followed by Create. Wait until the Language Service is up and running before you use it in your own knowledge base.

4. In the new tab, navigate to the Language Studio portal. Sign in with your Azure account, fill out the information for Azure directory and subscription, and choose the language resource that was already set up as shown in Figure 5-4.

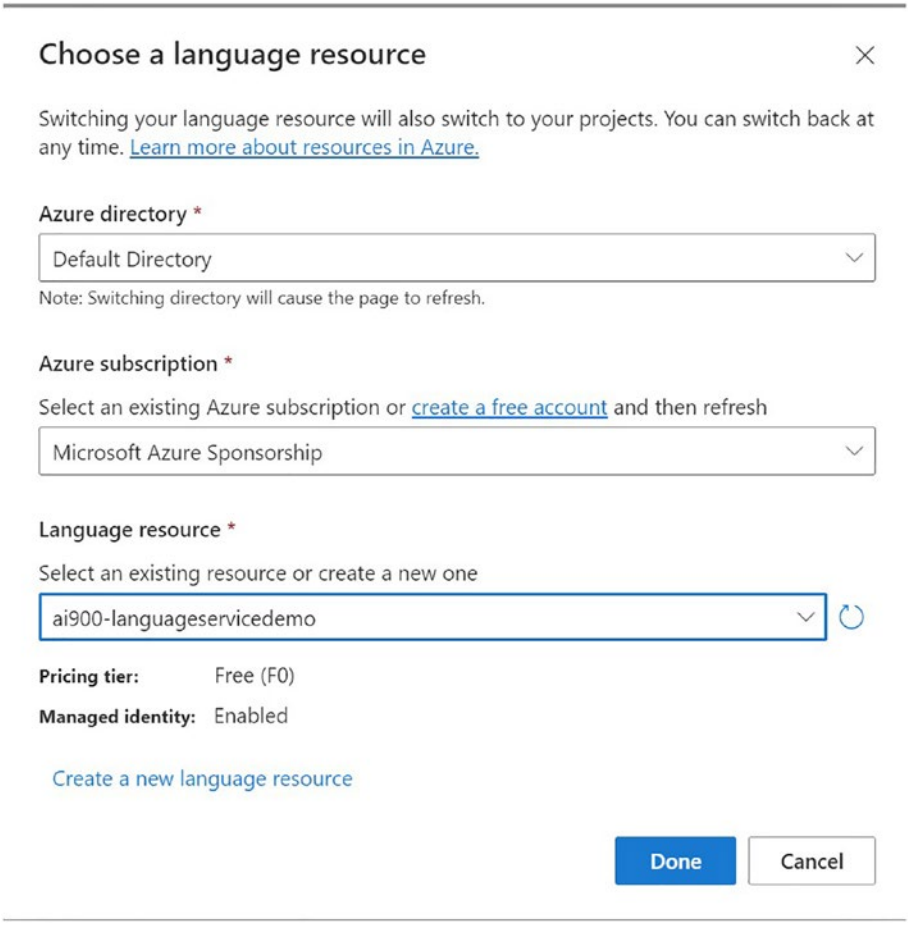


Figure 5-4. *Choosing the language resource to be used by the custom question-answering service*

5. On the Language Studio home page, look for the "**Understand questions and conversational language**" menu and choose "**Custom question answering**" as shown in Figure 5-5.

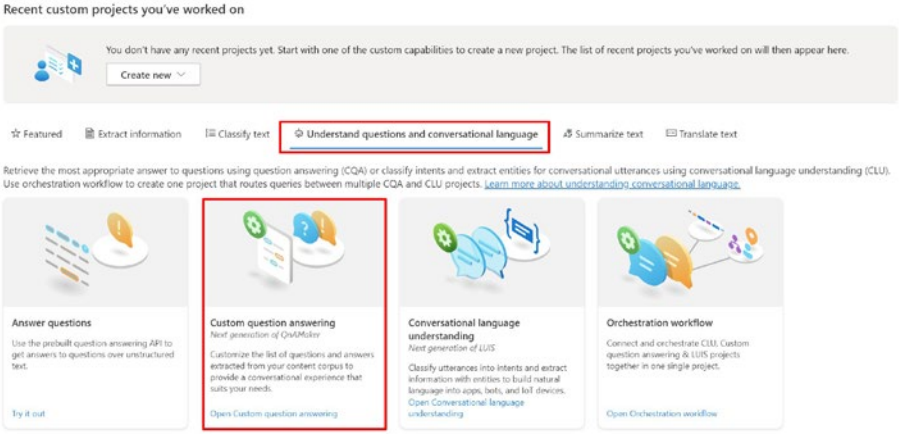


Figure 5-5. *Selecting the custom question-answering service option*

6. Click **+Create new project** on the Language Studio page as shown in Figure 5-6 to create a new Language Studio Project.

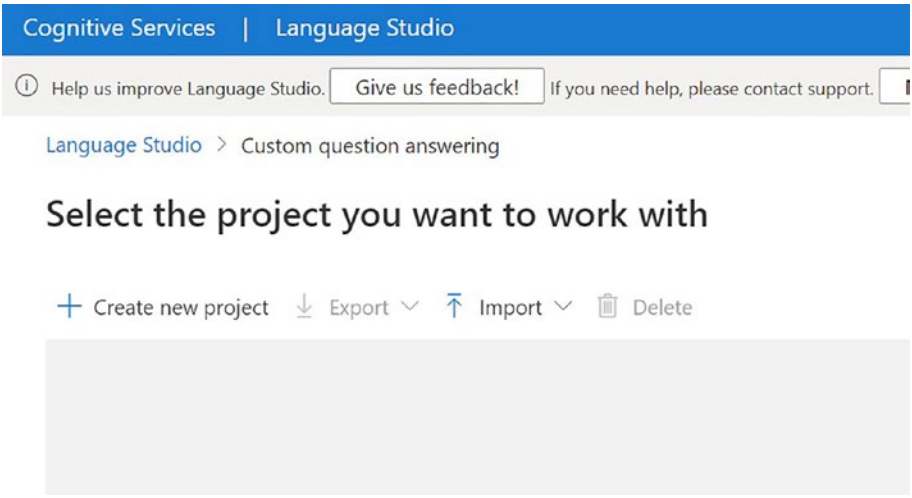


Figure 5-6. *Creating a new Language Studio project*

7. On the **Choose language setting for resource page**, select **"I want to select the language when I create a project in this resource"** and click Next as depicted in Figure 5-7.

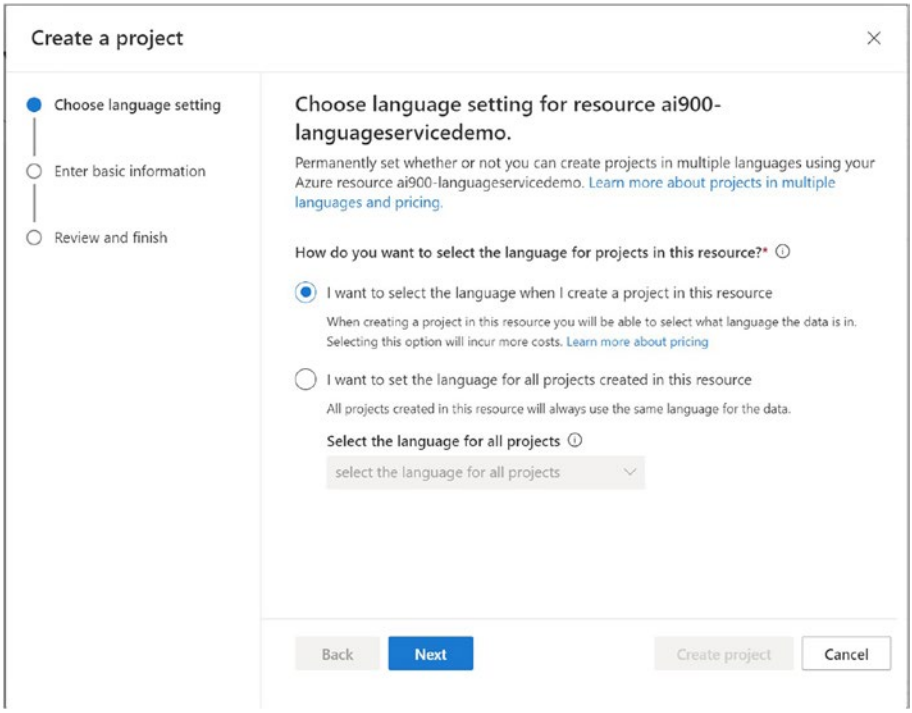


Figure 5-7. *Configuring language settings for the knowledge base project*

8. Figure 5-8 shows how to enter basic information for the question-answering knowledge base. On the Enter basic information page, enter the details such as name, description, source language, and default answer. Here, we keep the default language resource and Azure search resource:

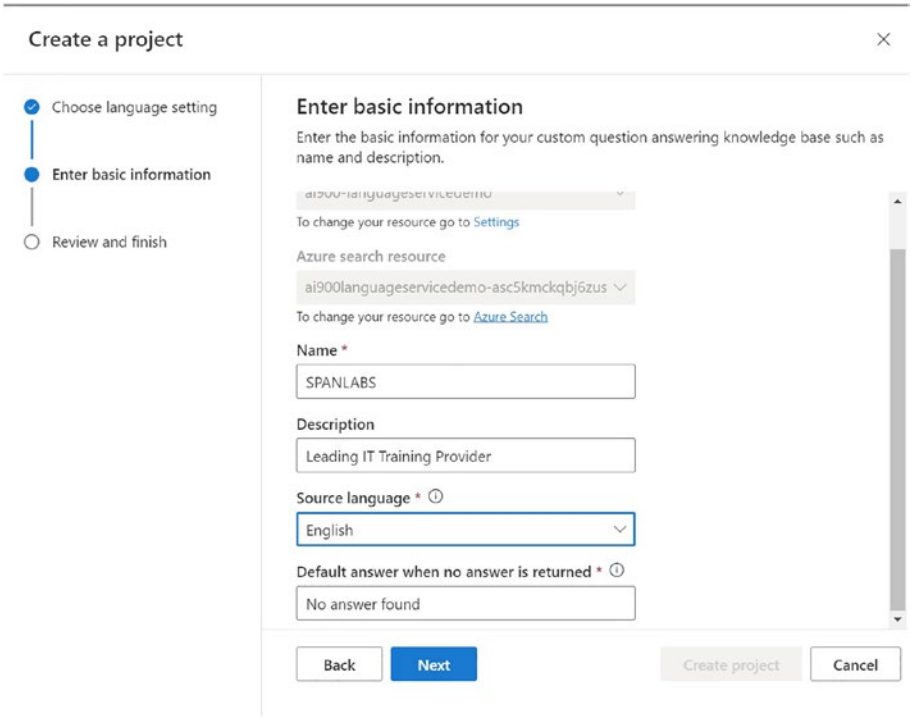


Figure 5-8. *Entering basic information for custom question-answering knowledge base*

9. Finally, click **Create project** to provision the resource.

10. You'll be redirected to the Manage sources page; here on Manage Sources page, select URLs by clicking Add source as shown in Figure 5-9.

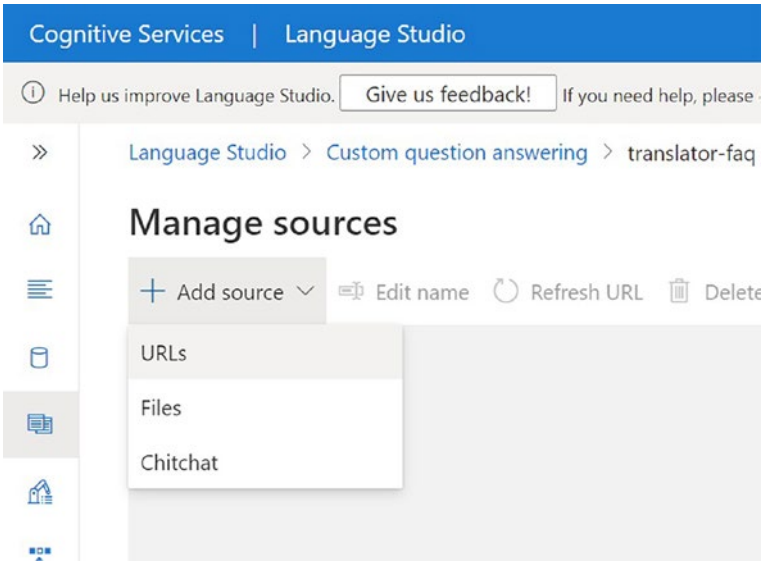


Figure 5-9. *Choosing URLs to include as knowledge base sources*

11. Click + Add URL in the Add URLs box. Fill in the details and select Add All as shown in Figure 5-10:
    - URL name: SPANLABS-FAQ
    - URL: `https://ai900faqstorage.blob.core.windows.net/spanlabs/spanlabs_faq.docx`
    - Classify file structure: Auto-detect

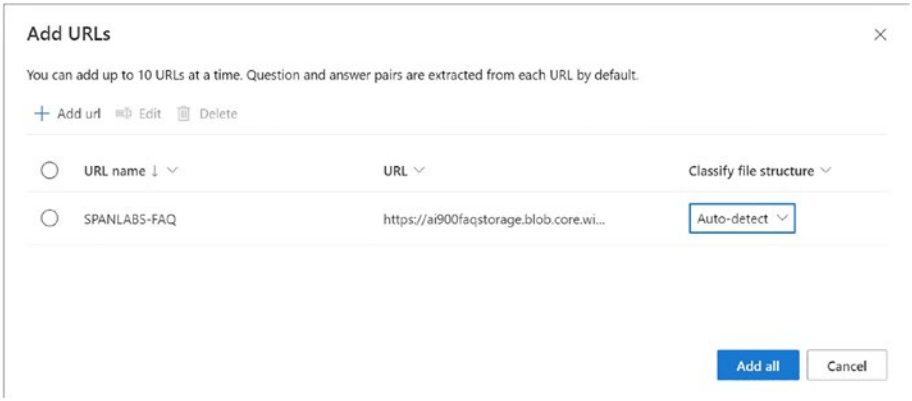


Figure 5-10. *Providing the URL for the knowledge base source*

12. You can see the recently added knowledge base source.

Editing Your Knowledge Base

1. Click Edit knowledge base on the left-hand panel as shown in Figure 5-11.

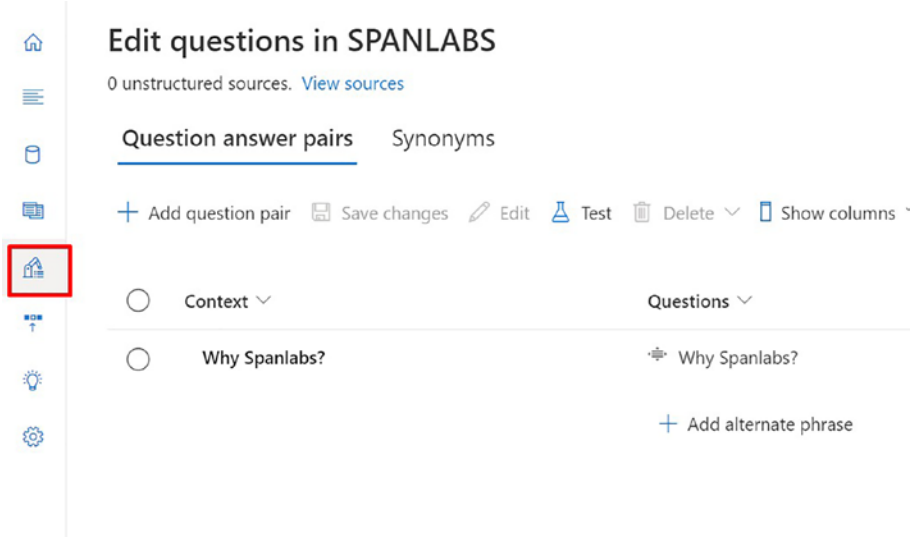


Figure 5-11. *Clicking Edit knowledge base*

2. Select + **Add question pair**.
3. In the Questions box, type "**Good Morning**," then click **Submit changes**.
4. Click + **Add alternate phrase** and type "**Good Day**," then click **Submit changes**.
5. In the Answer and prompts box, type "**Good Day**." Keep the **Source: Editorial**.
6. Click **Submit** and click **Save changes**. Figure 5-12 shows the final output once you click on **Save changes**.

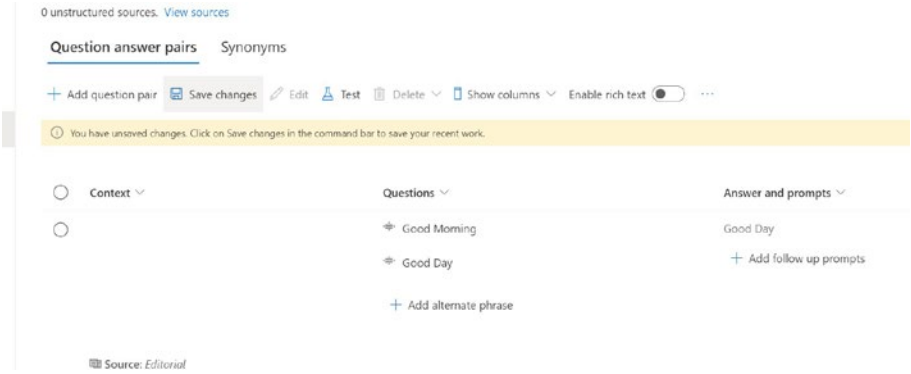


Figure 5-12. *Editing the knowledge base*

Training and Testing the Knowledge Base

1. Click Test to test your knowledge base as shown in Figure 5-13.

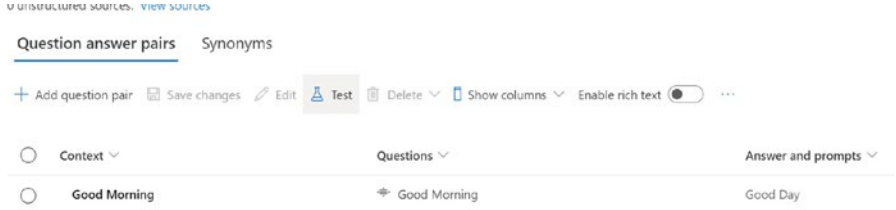


Figure 5-13. *Testing the knowledge base*

2. In the test pane, at the bottom enter the message Good Morning. The response Good Day should be returned.

3. In the test pane, at the bottom enter the message Why SPAN LABS? You will see the response from the FAQ. You can see the output in the Figure 5-14.

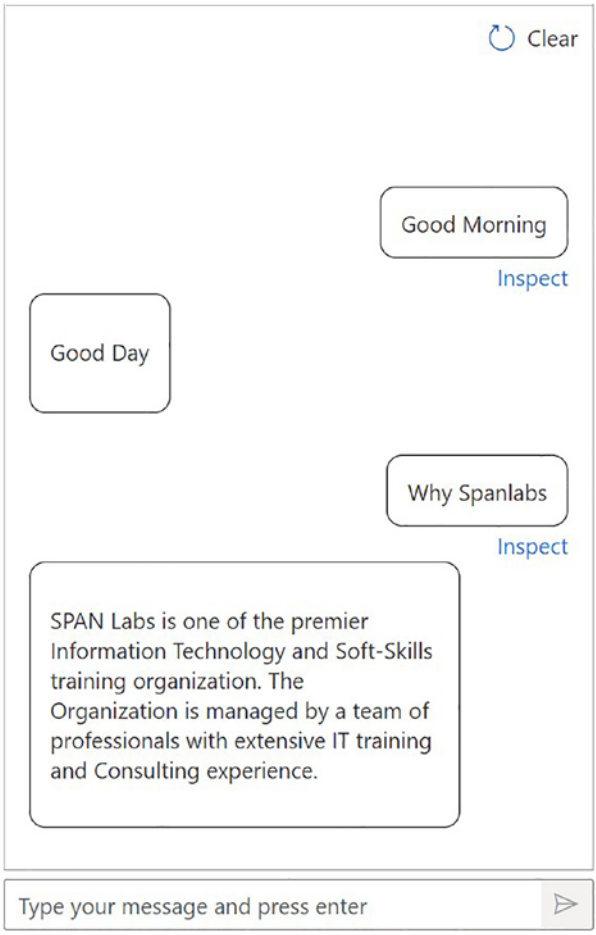


Figure 5-14. *Testing the knowledge base*

Creating an Informational Bot for the Knowledge Base

The knowledge base acts as a backend service for bots. Bots are common client apps. To make a bot's knowledge base accessible, publish it as an HTTP service. With the Azure Bot Service, you can make and host a bot that uses the knowledge base to answer questions from users.

1. At the left of the Language Studio page, click Deploy knowledge base.
2. At the top of the page, click Deploy, and then click Deploy again as shown in Figure 5-15.

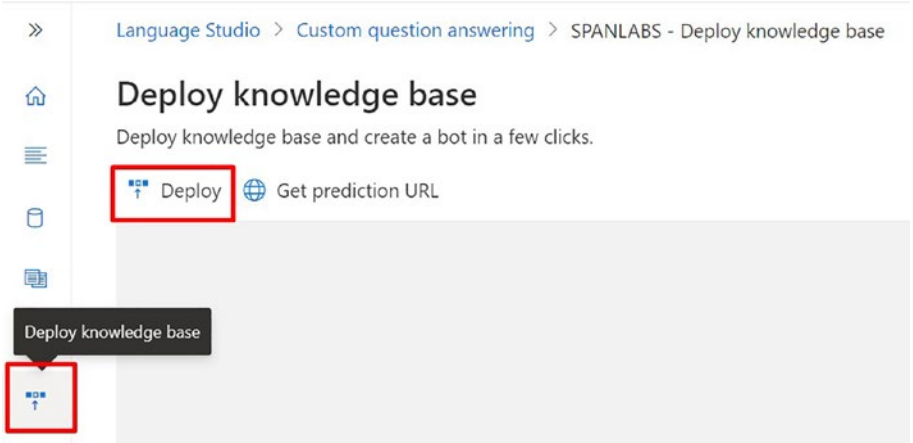


Figure 5-15. *Deploying the knowledge base*

3. After the service has been deployed, click Create a bot.
4. Figure 5-16 is about Provisioning a new bot resource. Create a Web App Bot. Provide a unique name for the bot, select a pricing tier, and select the new user managed identity.

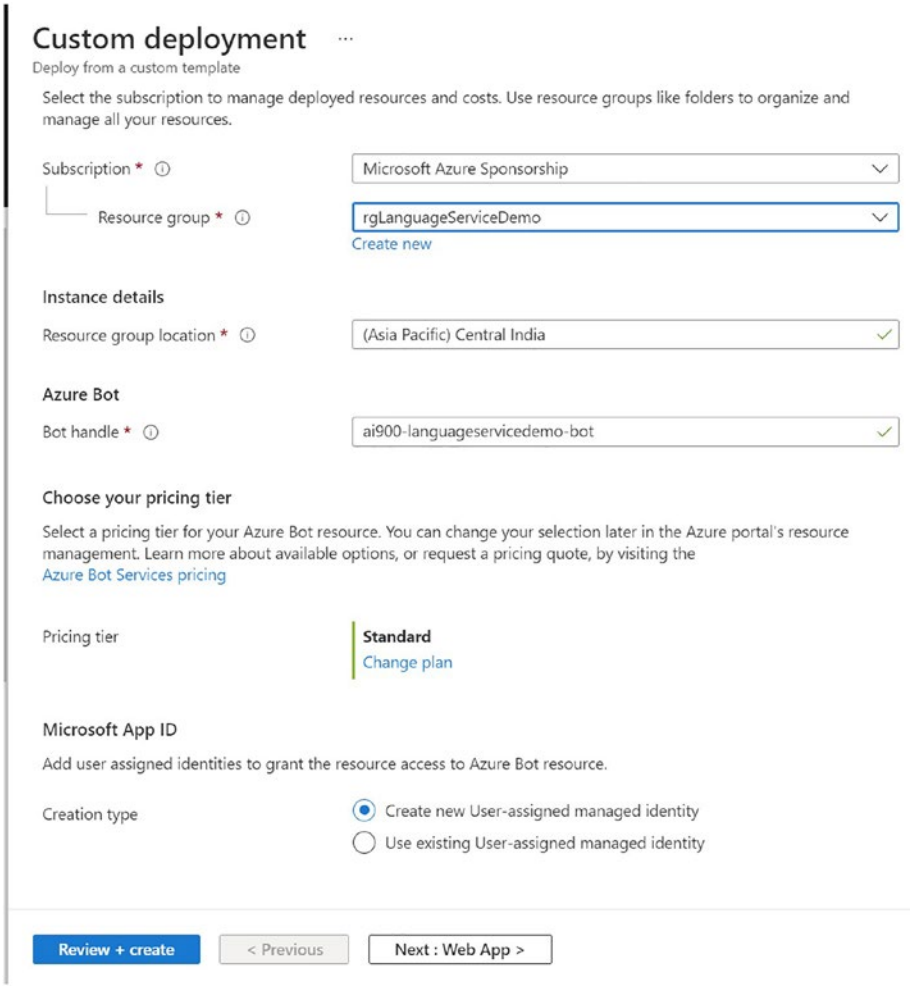


Figure 5-16. *Provisioning a new bot resource*

5. Select Next: Web App.

6. You can go with the default name provided for the app name option. Choose C# or Node as the SDK language, and then click Create New App Service

Plan. In the case of the Language Resource Key, go to your Language Service project and copy the key as shown in Figure 5-17.

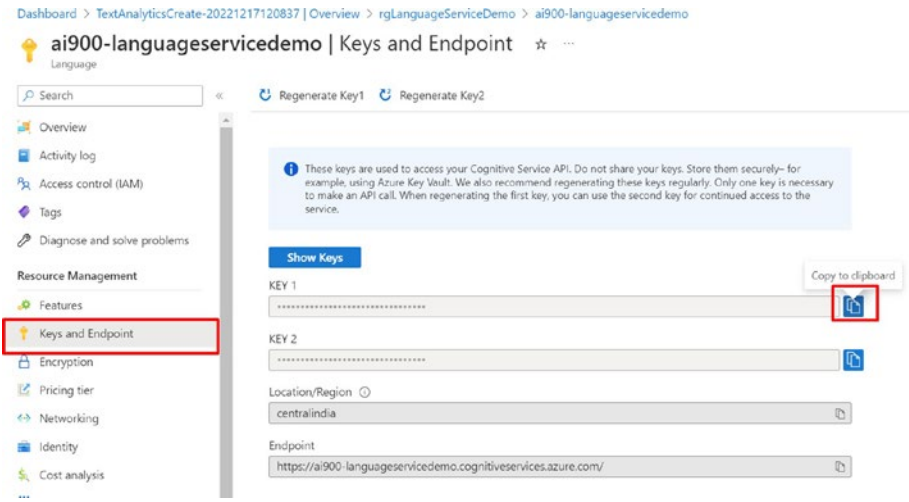


Figure 5-17. *Copying the key from the Language Service project*

7. Select **Review + Create**, and at last click **Create**.
8. Once your bot is created, click Go to resource group and select the Azure bot you have just provisioned.
9. To test the newly provisioned bot, select Test in Web Chat as shown in Figure 5-18.

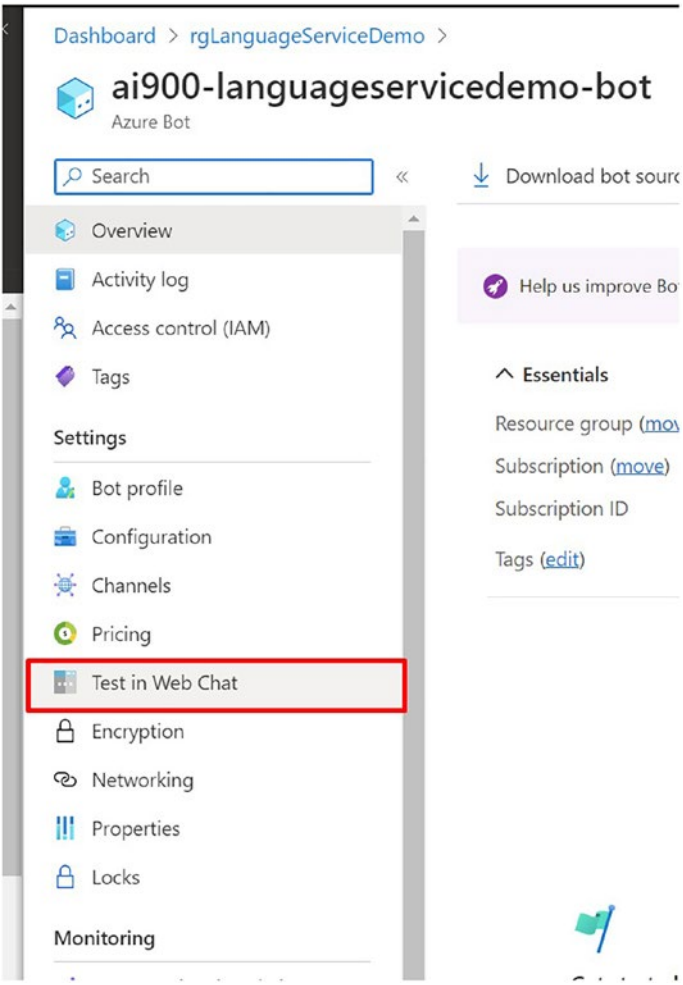


Figure 5-18. *Once inside the newly created bot instance, click Test in Web Chat*

10. Wait until the bot displays the message Hello and Welcome (it may take a few seconds to initialize).

11. Use the test chat interface to test your bot as shown in Figure 5-19.

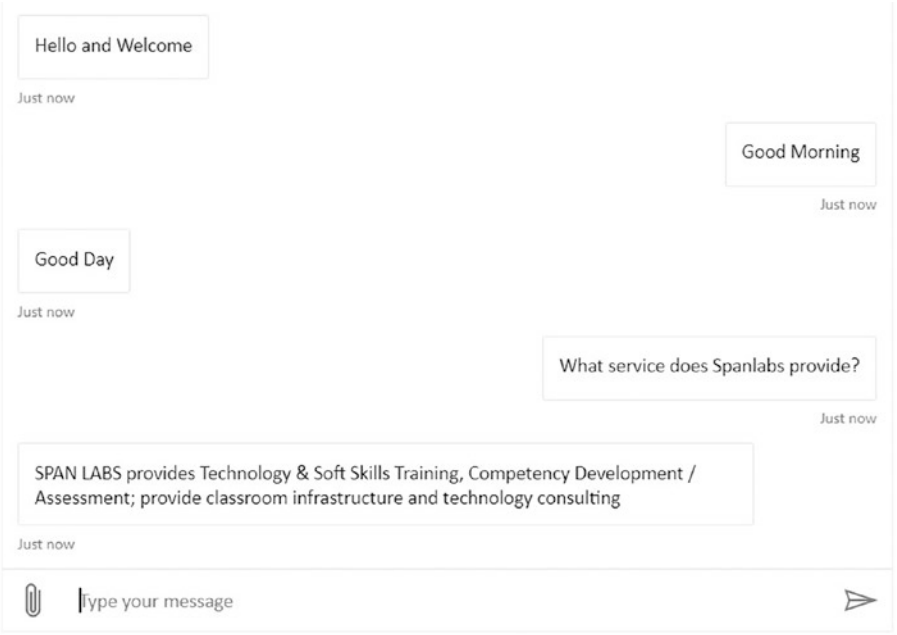


Figure 5-19. *Testing the bot*

Introspective Test

After reading the chapter, it's time for you to test your knowledge.

1. Which Azure service is used to create a knowledge base for bots?

   a. Question Answering

   b. Azure Bot Service

   c. Conversational Language Understanding

2. You are making an application for Conversational Language Understanding to find out the weather in the city. You want users to be able to ask for the weather in a certain city right now, for example, "How is the weather in Edinburg?". What is your option?

   a. Create an intent for each city, each with an utterance that asks for the weather in that city.

   b. Add the utterance "What weather is it in the city?" to the "none" intent.

   c. Define a "city" entity and a "GetWeather" intent with utterances that indicate the city intent.

3. You are making an app that needs to take Spanish input from a microphone and turn it into English text in real time. Which service should you use?

   a. Speech

   b. Translator

   c. Language

4. You want to use the speech service to build an application that reads the sender name of incoming notifications aloud. Which API should you use?

   a. Speech-to-text

   b. Text-to-speech

   c. Translate

5. When might "NaN" be returned as a score in language detection?

   a. When the language is ambiguous

   b. When the score calculated by the service is outside the range of 0 to 1

   c. When the predominant language in the text is mixed with other languages

Solutions to the Practice Test

1. Question 1 – a
2. Question 2 – c
3. Question 3 – a
4. Question 4 – b
5. Question 5 – a

References: Microsoft Learn

If you have read this chapter, you will be well prepared for the AI-900 exam. In the following, there are links to a Microsoft Learn course called Microsoft Learning Azure AI Fundamentals: Explore natural language processing modules. I highly recommend going through this module, where we'll learn about natural language processing:

1. https://learn.microsoft.com/en-us/training/modules/analyze-text-with-text-analytics-service/
2. https://learn.microsoft.com/en-us/training/modules/recognize-synthesize-speech/
3. https://learn.microsoft.com/en-us/training/modules/translate-text-with-translation-service/
4. https://learn.microsoft.com/en-us/training/modules/create-language-model-with-language-understanding/

Summary

As we covered in the first chapter of the book, this module has the highest weightage in the context of the examination. It sums up to around 25–30%. In this chapter, you learned how the language service provides high-level NLP on unprocessed text and has four main features: sentiment analysis, key phrase extraction, language detection, and named entity recognition. Speech synthesis is the process of turning text data into something that can be heard, while speech recognition is the process of turning spoken words into text. The speech language cognitive service can help you out with either of these jobs. We learned that when languages can be translated automatically, it becomes easier for people from different backgrounds to work together. Azure's translator and speech service use cloud-based intelligence to translate text and speech. This opens a number of use cases for both real-time and batch processing. The goal of Conversational Language Understanding is to make it easier to build a model that can figure out what people mean and what they are talking about by looking at written versions of spoken dialogue. Then, a client application can use this trained model to understand what a user says in natural language. Custom question answering lets you create and share a knowledge base of questions and answers. Using the Azure Bot Service and a knowledge base, you can make a bot that can answer users' questions and have a guided conversation.

Index

A

K. S. Trivedi, *Microsoft Azure AI Fundamentals Certification Companion*,
Certification Study Companion Series, https://doi.org/10.1007/978-1-4842-9221-1

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