



Designing and Implementing a Microsoft Azure AI Solution [AI-102]

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Date



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About this course

What we'll cover

In this course, you will learn how to develop solution using Azure AI Services. Topics covered include natural language understanding, computer vision, document intelligence and generative AI. Specifically, you'll learn how to:

- Provision Azure resources and use the service studios
- Train and customize various Azure AI models
- Use APIs and SDKs to consume models from client applications

Intended audience

The primary audience for this course is application developers seeking to include Azure AI functionality in their applications.

Although most Azure AI services can be used with web studios, to use the APIs and SDKs effectively, a basic knowledge of Microsoft C# or Python is recommended.

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Course schedule

	Day 1	Day 2	Day 3	Day 4
Early morning	Introduction Get started with Azure AI Service	Wrap up from previous day Develop natural language processing solutions with Azure AI Services	Wrap up from previous day Develop generative AI solutions with Azure OpenAI Service	Develop solutions with Azure AI Search
Break				
Late morning	Get started with Azure AI Service (continued)	Develop natural language processing solutions (continued)	Develop generative AI solutions (continued)	Develop knowledge mining solutions (continued)
Lunch				
Early afternoon	Develop computer vision solutions with Azure AI Services	Develop natural language processing solutions (continued)	Develop generative AI solutions (continued)	Develop solutions with Azure AI Document Intelligence
Break				
Late afternoon	Develop computer vision solutions (continued)	Develop natural language processing solutions (continued)	Develop generative AI solutions (continued)	Develop solutions with Azure AI Document Intelligence (continued) Q&A

Trainers:

Find the proposed schedule in the Trainer Prep Guide (PDF) and customized if needed. Delete this note before publishing.

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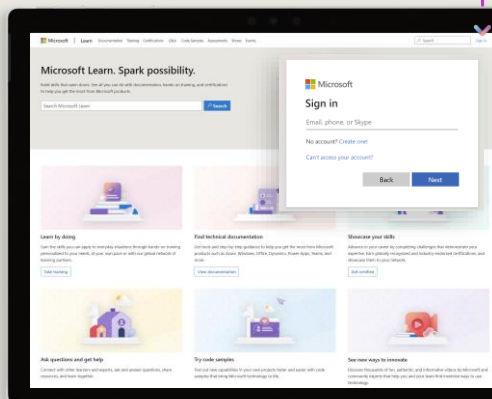
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- We'll go through this content together and as the course progresses, I will advise you on which modules to review.
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Need help? See our [troubleshooting guide](#) or provide specific feedback by [reporting an issue](#).

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This course includes labs:

- Detailed lab instructions are included in your lab environment.
- Each exercise is standalone and requires:
 - A Microsoft Azure subscription
 - For Azure OpenAI exercises, approved access to the Azure OpenAI service. Request through the form at aka.ms/oaiapply

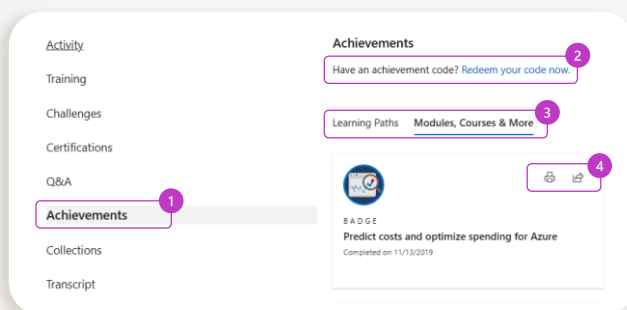
<https://aka.ms/azure-ai-credential>

5

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Get your achievement recognized and earn your badge for completing this course

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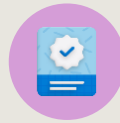


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¹ "2023 Value of IT Certification | Candidate Report," Pearson VUE, 2023 ² Microsoft fundamentals certifications don't expire

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Get ready for your Microsoft Certification exam

Exam AI-102: Designing and Implementing a Microsoft Azure AI Solution covers the features and capabilities of Microsoft Azure AI Services, including Azure OpenAI Service

Understand the skills measured by the exam

Study area	Percentage
Plan and manage an Azure AI solution	15–20%
Implement decision support solutions	10–15%
Implement computer vision solutions	15–20%
Implement natural language processing solutions	30–35%
Implement knowledge mining and document intelligence solutions	10–15%
Implement generative AI solutions	10–15%

Percentages indicate the relative weight of each area on the exam
The higher the percentage, the more questions you are likely to see in that area

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Build confidence in your skills



Find in the exam page resources to help prepare

- Watch exam prep videos
- Review the exam study guide
- Demo the exam experience with the exam sandbox
- Take a practice assessment

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Introduction to AI and AI on Azure

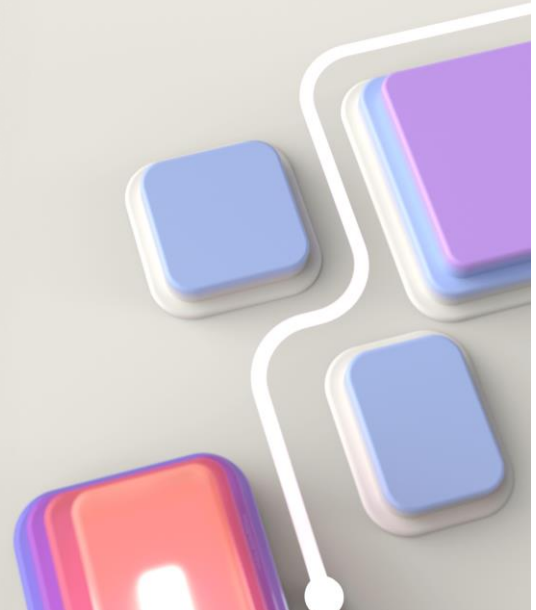
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Introduction to AI and Azure AI services

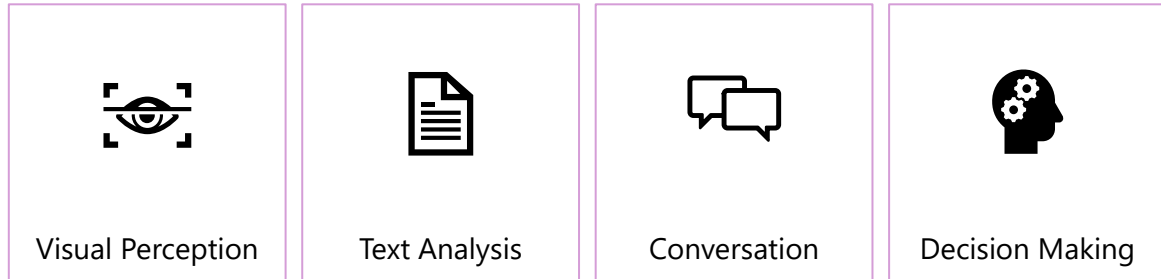
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What is Artificial Intelligence?

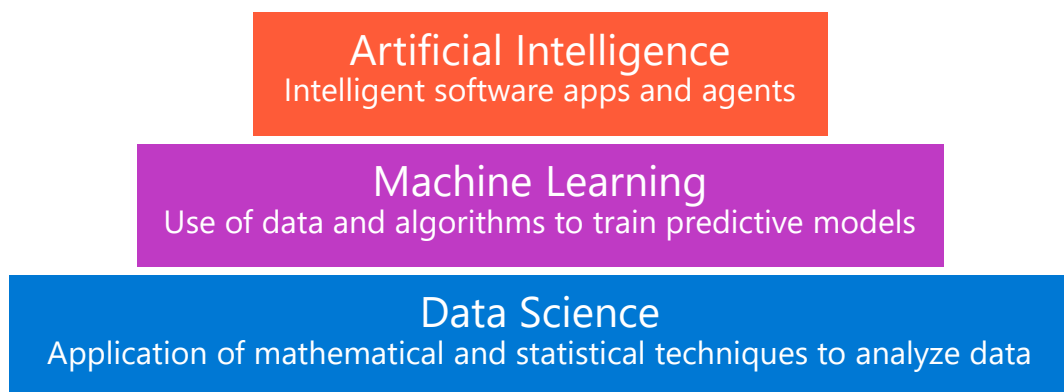
Software that exhibits human-like capabilities, such as:



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Data Science, Machine Learning, and AI



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AI for Software Engineers

Software Development Skills

- Coding (C#, Python, Node.js, ...)
- Consuming APIs (REST or SDKs)
- DevOps (source control, CI/CD)



Conceptual AI Understanding

- Model training and inferencing
- Probability and confidence scores
- Responsible AI and ethics

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Considerations for Responsible AI

Fairness



Reliability & Safety



Privacy & Security



Inclusiveness



Transparency



Accountability



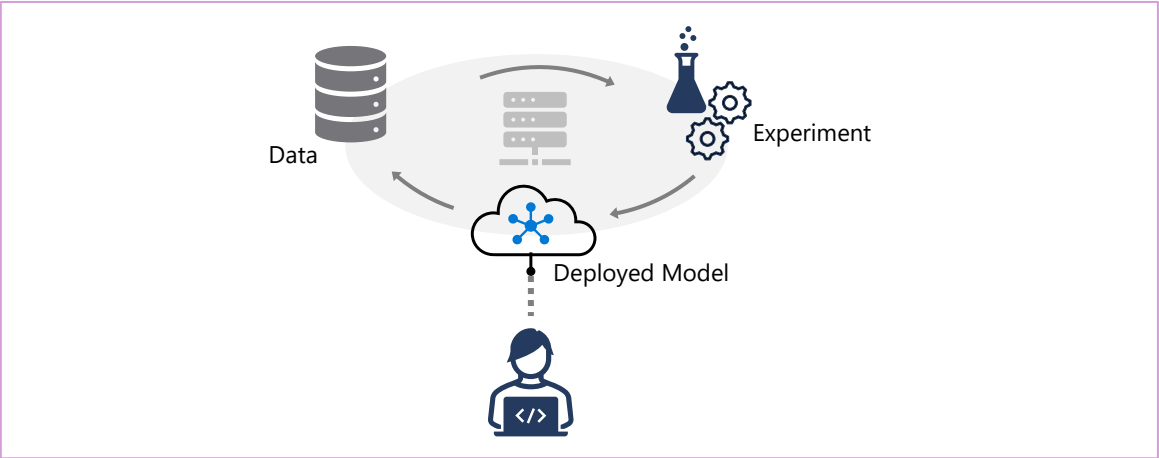
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Azure Machine Learning

Cloud platform for creating and operating machine learning solutions



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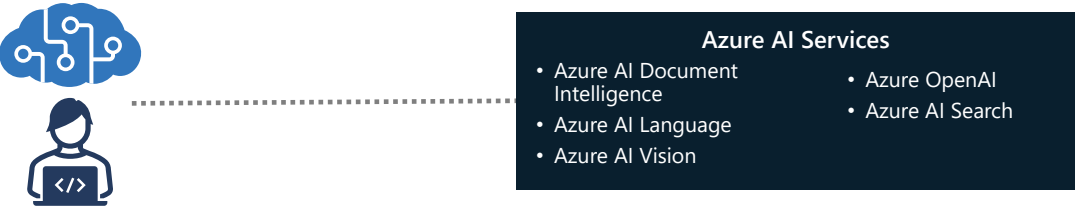
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Azure AI Services

Prepackaged AI services you can integrate into solutions

Capabilities include:

Language	Speech	Vision	Generative
<ul style="list-style-type: none">• Text analysis• Question answering• Language understanding• Translation	<ul style="list-style-type: none">• Speech recognition• Speech synthesis• Speech Translation• Speaker Recognition	<ul style="list-style-type: none">• Image and video analysis• Image classification• Object detection• Optical character recognition	<ul style="list-style-type: none">• Generate text completions• Image generation

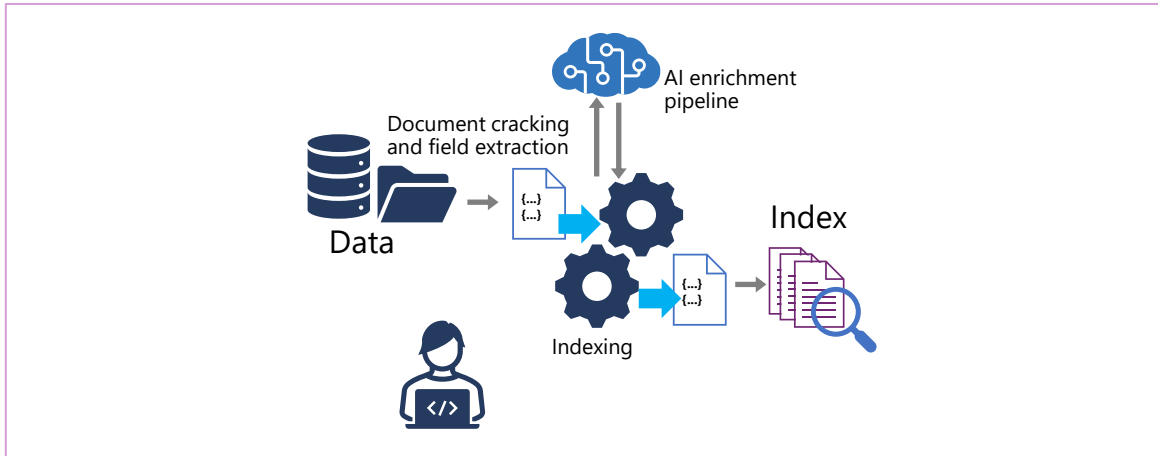


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Azure AI Search

AI-enriched indexing for search and knowledge mining



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Get Started with Azure AI services

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Provisioning Azure AI Services resources

Create a resource in your Azure subscription

- You will create either a *single-service* resource or a *multi-service* resource:
- Multi-service resource (**Azure AI Services**):
 - Access multiple Azure AI Services with a single key and endpoint.
 - Consolidates billing from the services you use.
- Single-service resource (for example, **Language**):
 - Access a single Azure AI service with a unique key and endpoint for each service created.
 - Use the free tier to try out the service.

The screenshot shows the 'Create Azure AI services' portal. The 'Basics' tab is selected. It includes a 'Project Details' section with 'Subscription' and 'Resource group' dropdowns. The 'Instance Details' section has 'Region' set to 'East US' and a 'Name' field. A 'Pricing tier' dropdown is set to 'Standard S0'. There is a 'Responsible AI Notice' section with a checkbox for terms acceptance. Navigation buttons at the bottom are 'Previous', 'Next', and 'Review + create'.

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Endpoints, Keys, and Locations

Information required to connect

Endpoint:

- URL at which service can be consumed
- Required by *most* SDK clients

Keys:

- Use *either* key to authenticate

Location:

- Azure data center in which resource is provisioned
- Required by *some* SDK clients

The screenshot shows the 'Show Keys' dialog box. It contains four fields: 'KEY 1' and 'KEY 2' (both masked with asterisks), 'Endpoint' (showing 'https://ai102-cog.cognitiveservices.azure.com/'), and 'Location' (showing 'eastus'). Each field has a copy icon to its right.

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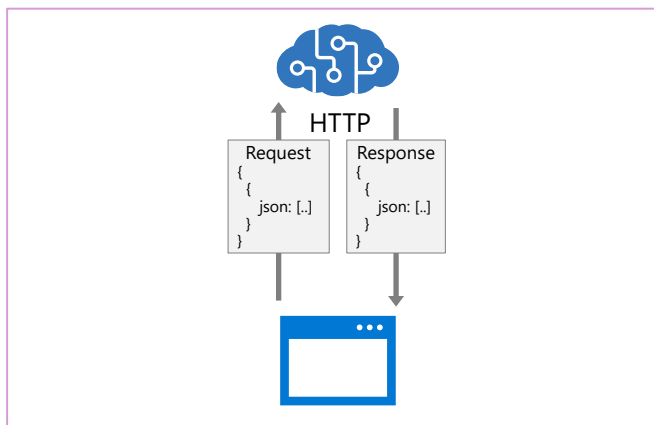
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Azure AI Services REST APIs

Clients submit HTTP requests to the resource endpoint

- Key specified in request header
- Input data in JSON format
- Specific schema varies by service and method

Service returns JSON response



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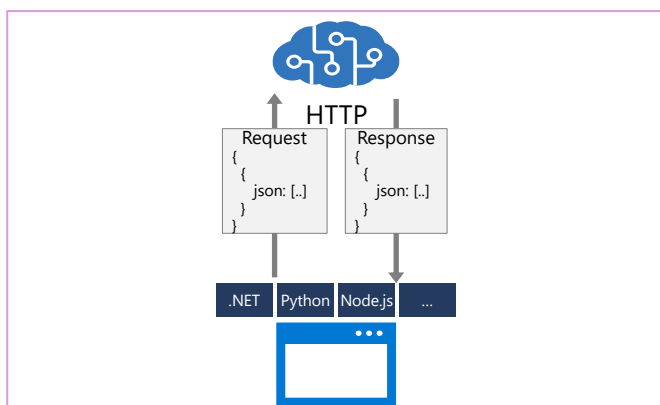
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Azure AI Services SDKs

Runtime library abstracts REST interface

Multiple SDKs for each service:

- .NET
- Python
- Node.js
- Java
- Others...



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Exercise – Get Started with Azure AI Services



Provision an Azure AI Services resource

Use a REST interface

Use an SDK

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Using Azure AI Services for enterprise applications

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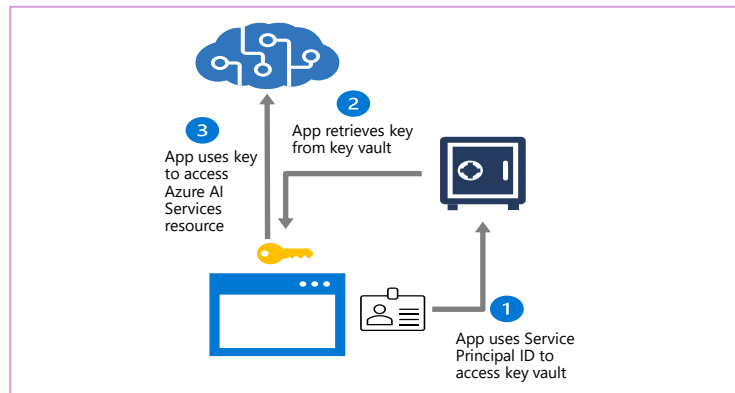
Considerations for Azure AI Services security

Regenerate keys regularly to protect access

- To avoid service interruption, switch apps to use key 2 before regenerating key 1; and vice-versa

Consider protecting keys by storing them in Azure Key Vault

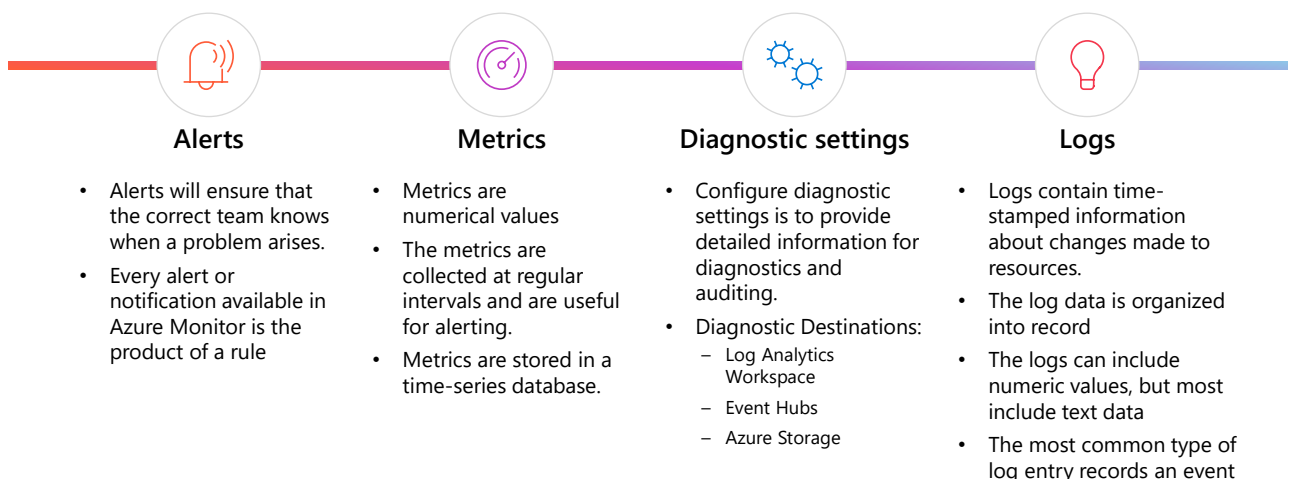
- Apps can use a Service Principal as a managed identity to retrieve keys from Key Vault



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Monitoring Azure AI Services Activity



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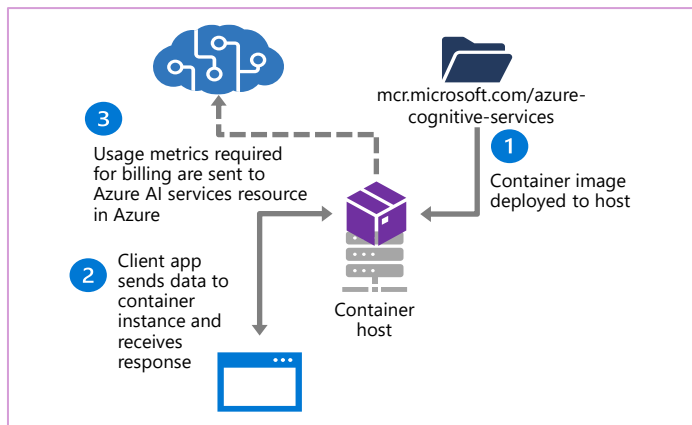
Azure AI Services and Containers

Container images are available for commonly used Azure AI services APIs

- Deploy containers to:
- Local Docker hosts
- Azure Container Instances
- Azure Kubernetes Services clusters
- others...

Enables more control over data sent to public Azure AI service endpoint

- An Azure AI services resource is still required, and the container must communicate with it to send billing data



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Extended interactive exercises – Use an Azure AI Services container



<https://aka.ms/ai-services-lp>

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Develop computer vision solutions with Azure AI Vision

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Analyze and manipulate images

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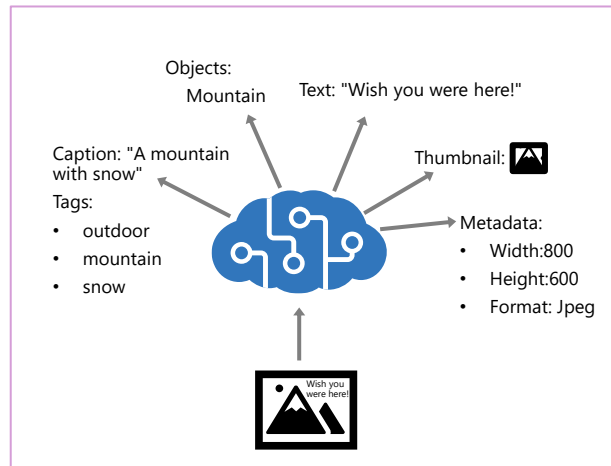
Azure AI Vision – Image Analysis

Image analysis:

- Caption and tag generation
- Object detection
- People detection
- Optical character recognition
- Smart crop thumbnails
- Background removal
- Multi-modal embeddings
- Product recognition

Can be used as:

- Standalone **Azure AI Vision** resource
- Multi-service **Azure AI Services** resource
- * Some new features are limited to specific regions



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Image Analysis APIs

- Single **Analyze** call to retrieve specified features in **VisualFeatures** enum
 - VisualFeatures.Caption
 - VisualFeatures.DenseCaptions
 - VisualFeatures.Tags
 - VisualFeatures.Objects
 - VisualFeatures.SmartCrops
 - VisualFeatures.People
 - VisualFeatures.Read
- SDKs define the **client**, then call the **analyze()** function from it
 - Client defines endpoint and key of resource
- **Analyze()** needs
 - Image data from file or URL
 - Visual features to analyze for
 - (Optional) Analysis options: Which features, language, and other options for the analysis

REST

```
https://<endpoint>/computervision/imageanalysis:analyze?
features=caption,people&model-version=latest&
language=en&api-version={version}
```

C#

```
ImageAnalysisResult result = client.Analyze(
    new Uri("<uri-to-image>"),
    VisualFeatures.CAPTION |
    VisualFeatures.PEOPLE,
    analysisOptions // Optional
);
```

Python

```
result = client.analyze(
    image_url="<uri-to-image>",
    visual_features=[
        VisualFeatures.CAPTION,
        VisualFeatures.PEOPLE,
    ],
    <analysis_options> # Optional
)
```

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Lab – Analyze Images with Azure AI Vision



Generate captions

Create tags

Detect objects and people

Remove background

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Azure AI Vision - OCR

Use **Image analysis** with READ feature

Vision OCR vs Document Intelligence:

- OCR: General, non-document images with smaller amounts of text. Synchronous API.
- Document Intelligence: Ideal for larger text heavy documents. Asynchronous API.

Results in JSON (REST) or object (SDK) of similar structure

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Lab – Read Text in Images



Use the Azure AI Vision for OCR

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Detecting Faces with the Azure AI Vision

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Options for Face Detection, Analysis, and Recognition

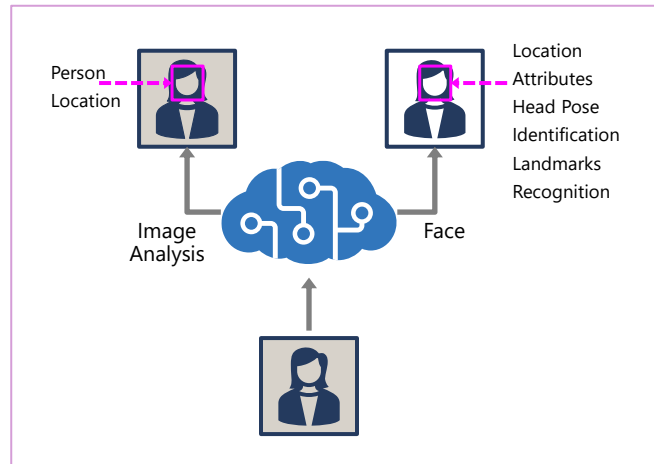
Image Analysis

- People detection
- Only location provided

Face Service

- Face detection
- Comprehensive facial feature analysis
- Face comparison and identification*
- Facial recognition*

* Require Limited Access approval



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The Face Service

Face detection

Face attribute analysis

Facial landmark location

- Nose, eyes, mouth, ...

Face comparison*

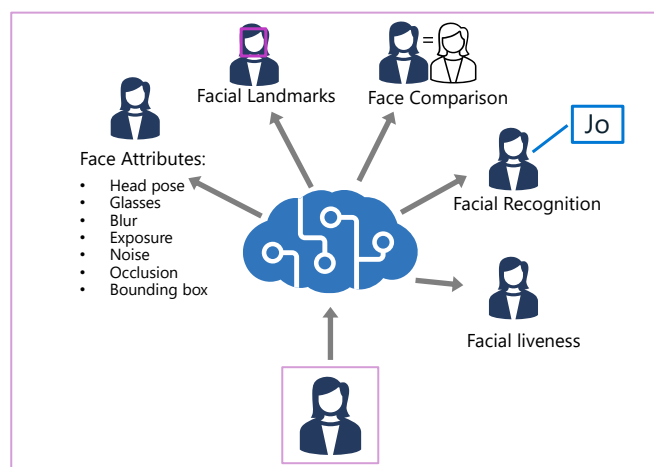
Facial recognition and identification*

Facial liveness*

Can be used as:

- Standalone **Face** resource
- Multi-service **Azure AI Services** resource

* Require Limited Access approval



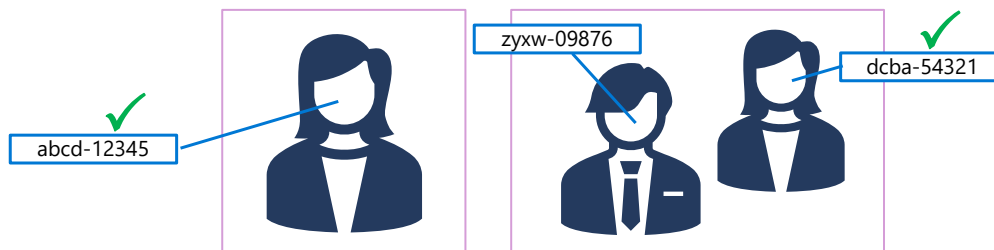
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Detected Face Identification

Every *detected* face is assigned an anonymous ID

- Retained in your service resource for 24 hours
- Can be used to compare faces in multiple images
 - *Verify* faces to determine if they're the same individual
 - *Find similar* faces to identify faces with similar features



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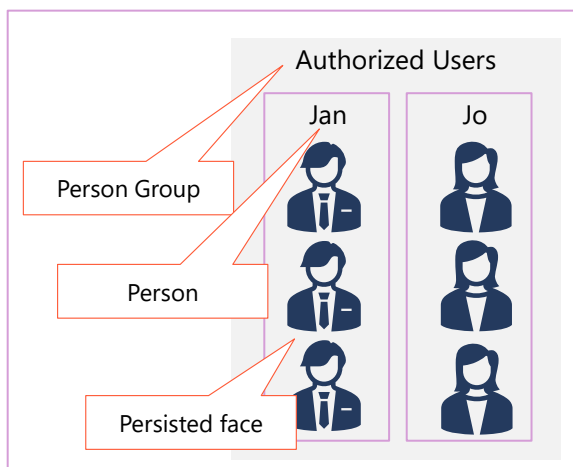
Persisted Face Recognition

Train a facial recognition model using face images

1. Create a **Person Group** for the people you want to identify
2. Add a **Person** for each individual
3. Add multiple detected **Faces** to each person
 - These become *persisted faces*
4. Train the model

Use the model for facial recognition

- *Identify* an individual person
- *Verify* the face of an individual person
- *Find* similar faces to a persisted face



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Custom vision models with Azure AI Vision

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Two types of custom vision models

Azure AI Custom Vision (previous service)

- Portal: **customvision.ai**
- Base model:
 - Convolutional neural network (CNN)
- Tasks:
 - Image classification
 - Object detection
- Labeling:
 - Customvision.ai
- Minimum training data needed:
 - 15 images per category
- Training data storage
 - Uploaded to Custom Vision service

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Custom AI Vision models (new Florence model)

- Portal: **Vision Studio**
- Base model:
 - Transformer (multi modal)
- Tasks:
 - Image classification
 - Object detection
 - Product recognition
- Labeling:
 - AML Studio or COCO file
- Minimum training data needed:
 - 2-5 images per category
- Training data storage
 - In user's blob storage account

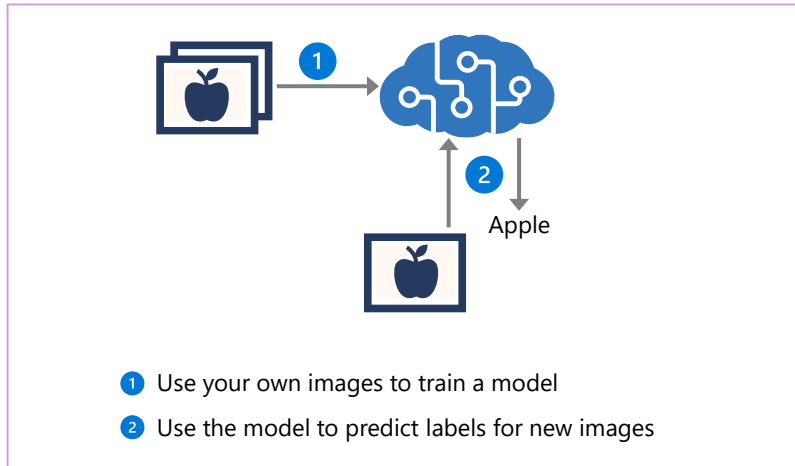
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Custom Azure AI Vision model

Train custom models with your own images

- Upload your images
- Label your images
- Train your model
- Query your model with new images to predict labels

Labeling data lives in COCO file



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What is Image Classification?

Train a model to predict the class label for the image

In other words, what is this a picture of?



Apple



Banana



Orange

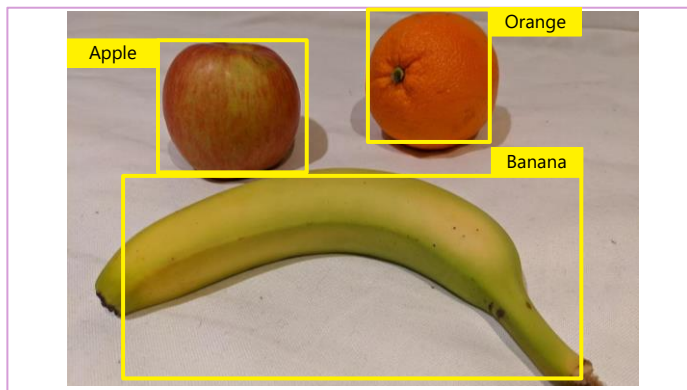
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What is Object Detection?

Train a model to detect and locate specific classes of object in images

In other words, what objects are in this image, and where?



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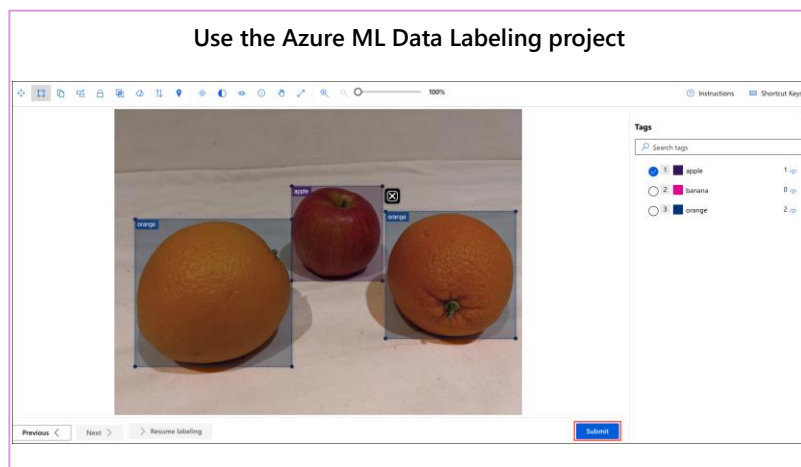
Train a custom model

Use the Azure Vision Studio

1. Create a custom model project, or retrieve an existing one
2. Select your resource, if necessary
3. Add your dataset(s) and specify model type
 1. Image classification: Assign label to each image
 2. Object detection: Define bounding boxes for objects in each image
4. Create your Azure ML project and label your images (if no COCO file exists)
5. Add COCO file (from Azure ML project or previously built)
6. Train a new model

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Use the Azure ML Data Labeling project



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Lab – Classify Images with Azure AI Vision custom model



Create a custom model

Add COCO file

Integrate custom model into app

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Analyzing Videos

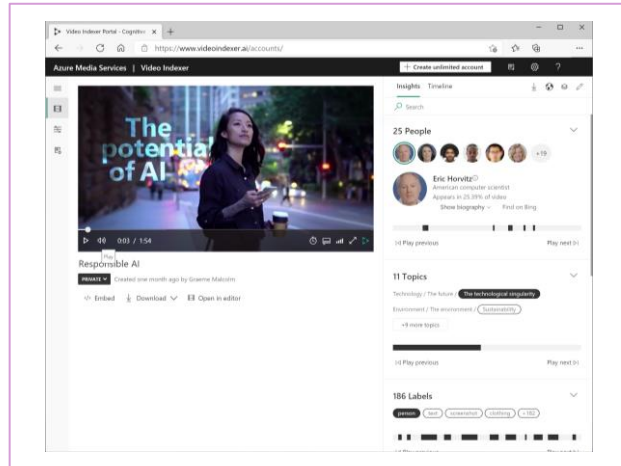
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Video Indexer

Video analysis:

- Facial recognition (limited access)
- Optical character recognition
- Speech transcription
- Topics
- Sentiment
- Labels
- Content moderation
- Scene segmentation




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Custom Insights

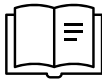
Pre-defined models for recognizing language, well-known celebrities, brands, ...

Create your own models for:




People

Train facial recognition* from sample images



Language

Recognize industry/organization-specific terms



Brands

Recognize brand names for products, companies, projects...

* Facial recognition and celebrity identification requires Limited Access approval, in accordance with our Responsible AI Standard

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Develop natural language processing solutions

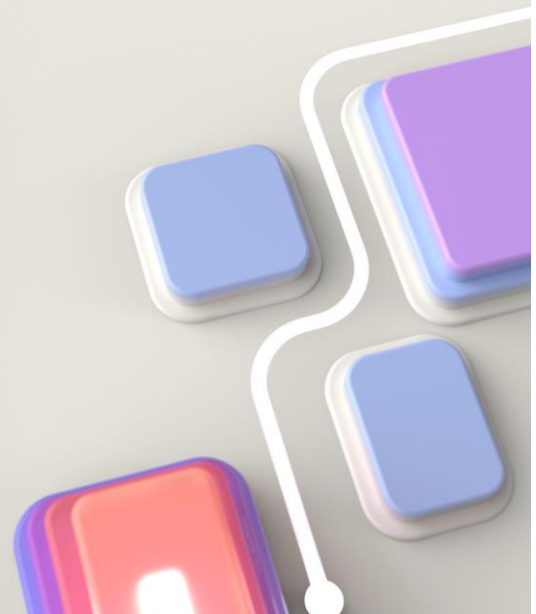
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Analyzing text

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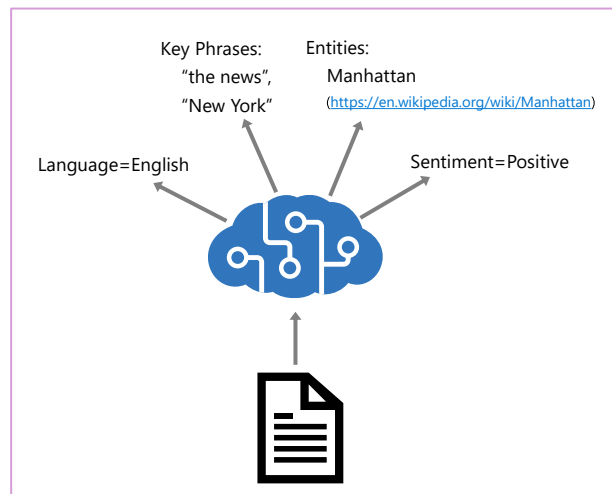
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The Azure AI Language Service

Preconfigured features:

- Language detection
- Key phrase extraction
- Sentiment analysis
- Named entity recognition
- Entity linking
- Summarization
- PII detection

Customizable features are covered in another section

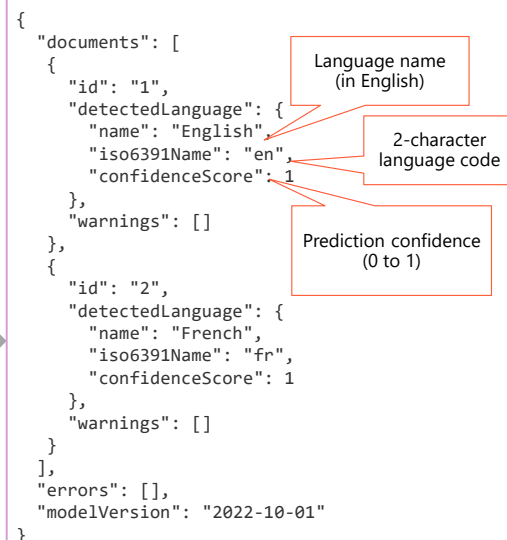
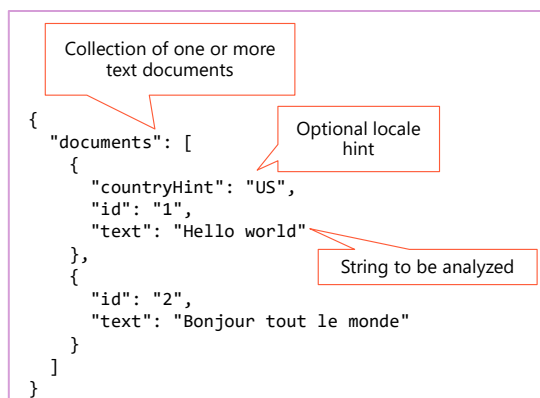


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Language detection

- Determine the language in which text is written
- Often useful as a pre-cursor to further analysis that requires a known language



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Key phrase extraction

- Identify the main "talking points" of the text
- Works best with larger documents (up to 5,120 characters)

```
{
  "documents": [
    {
      "id": "1",
      "language": "en",
      "text": "You must be the change you wish
to see in the world."
    },
    {
      "id": "2",
      "language": "en",
      "text": "The journey of a thousand miles
begins with a single step."
    }
  ]
}
```

Language (defaults to English if not present)

```
{
  "documents": [
    {
      "id": "1",
      "keyPhrases": [
        "change",
        "world"
      ],
      "warnings": []
    },
    {
      "id": "2",
      "keyPhrases": [
        "miles",
        "single step",
        "journey"
      ],
      "warnings": []
    }
  ],
  "errors": [],
  "modelVersion": "2021-06-01"
}
```

List of key phrases in document 1

List of key phrases in document 2

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Sentiment analysis

- Scores overall document sentiment and individual sentence sentiment
- Sentence sentiment is based on confidence scores for *positive*, *negative*, and *neutral*
- Overall document sentiment is based on sentences:
 - All sentences are *neutral* = **neutral**
 - Sentences include *positive* and *neutral* = **positive**
 - Sentences include *negative* and *neutral* = **negative**
 - Sentences include *positive* and *negative* = **mixed**

```
{
  "documents": [
    {
      "language": "en",
      "id": "1",
      "text": "Smile! Life is good!"
    }
  ]
}
```

```
{
  "documents": [
    {
      "id": "1",
      "sentiment": "positive",
      "confidenceScores": {
        "positive": 0.99,
        "neutral": 0.01,
        "negative": 0.00
      },
      "sentences": [
        {
          "text": "Smile!",
          "sentiment": "positive",
          "confidenceScores": {
            "positive": 0.97,
            "neutral": 0.02,
            "negative": 0.01
          },
          "offset": 0,
          "length": 6
        },
        {
          "text": "Life is good!",
          ...
        }
      ],
      "warnings": []
    }
  ],
  "errors": [],
  "modelVersion": "2022-11-01"
}
```

Overall sentiment

Overall confidence

Breakdown by sentence

Sentence sentiment

Sentence confidence

Sentence location

Next sentence

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Named entity recognition

- Identifies entities that are mentioned in the text
- Entities are grouped into categories and subcategories, for example:
 - Person
 - Location
 - DateTime
 - Organization
 - Address
 - Email
 - URL
 - Others...

```
{
  "documents": [
    {
      "language": "en",
      "id": "1",
      "text": "Joe went to London on Saturday"
    }
  ]
}
```

```
{
  "documents": [
    {
      "id": "1",
      "entities": [
        {
          "text": "Joe",
          "category": "Person",
          "offset": 0,
          "length": 3,
          "confidenceScore": 0.62
        },
        {
          "text": "London",
          "category": "Location",
          "subcategory": "GPE",
          "offset": 12,
          "length": 6,
          "confidenceScore": 0.88
        },
        {
          "text": "Saturday",
          "category": "DateTime",
          "subcategory": "Date",
          "offset": 22,
          "length": 8,
          "confidenceScore": 0.8
        }
      ],
      "warnings": []
    }
  ],
  "errors": [],
  "modelVersion": "2021-01-15"
}
```

Person entity

Location entity

DateTime entity

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Entity Linking

- Used to disambiguate entities of the same name
 - For example, is "Venus" a planet or a goddess?
- Wikipedia provides the knowledge base
- Specific article links are determined based on entity context within the text

"I saw Venus shining in the sky":

<https://en.wikipedia.org/wiki/Venus>

"Venus, the goddess of beauty":

[https://en.wikipedia.org/wiki/Venus_\(mythology\)](https://en.wikipedia.org/wiki/Venus_(mythology))

```
{
  "documents": [
    {
      "language": "en",
      "id": "1",
      "text": "I saw Venus shining in the sky"
    }
  ]
}
```

```
{
  "documents": [
    {
      "id": "1",
      "entities": [
        {
          "bingId": "89253af3-5b63-e620-9227-f839138139f6",
          "name": "Venus",
          "matches": [
            {
              "text": "Venus",
              "offset": 6,
              "length": 5,
              "confidenceScore": 0.01
            }
          ],
          "language": "en",
          "id": "Venus",
          "url": "https://en.wikipedia.org/wiki/Venus",
          "dataSource": "Wikipedia"
        }
      ],
      "warnings": []
    }
  ],
  "errors": [],
  "modelVersion": "2021-06-01"
}
```

Named entity

Wikipedia unique article ID

Article link

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Exercise – Analyze Text



Detect Language

Evaluate Sentiment

Identify Key Phrases

Extract Entities

Extract Linked Entities

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Translating Text

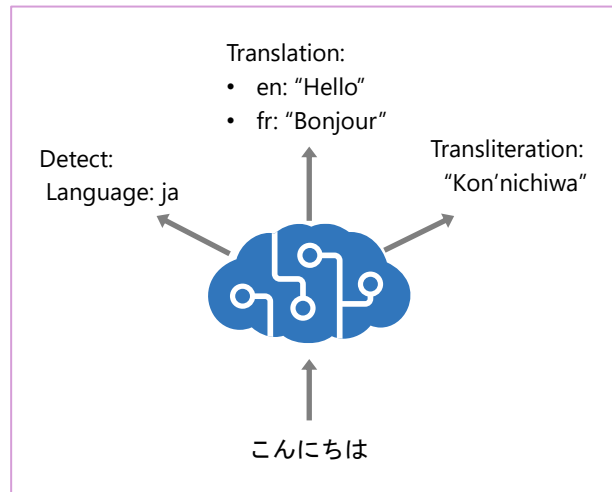
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The Translator Service

Multilingual text translation REST API

- Language *detection*
- One-to-many *translation*
- Script *transliteration*



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Detection, Translation, and Transliteration

Detection

`https://api.cognitive.microsofttranslator.com/detect?api-version=3.0`

Body: [
 { 'Text': 'こんにちは' }
]

```
[
  {
    "isTranslationSupported": true,
    "isTransliterationSupported": true,
    "language": "ja",
    "score": 1.0
  }
]
```

ISO Language code

Translation

`https://api.cognitive.microsofttranslator.com/translate?api-version=3.0`
`&from=ja&to=en&to=fr`

Body: [
 { 'Text': 'こんにちは' }
]

Add **to** parameters for each target language

```
[
  {
    'translations': [
      { 'text': 'Hello', 'to': 'en' },
      { 'text': 'Bonjour', 'to': 'fr' }
    ]
  }
]
```

Transliteration

`https://api.cognitive.microsofttranslator.com/transliterate?api-version=3.0`
`&language=ja&fromScript=Jpan&toScript=Latn`

Body: [
 { 'Text': 'こんにちは' }
]

Source text language code

Source text script

Target text script

```
[
  {
    "script": "Latn",
    "text": "Kon'nichiwa"
  }
]
```

Headers omitted for brevity

62

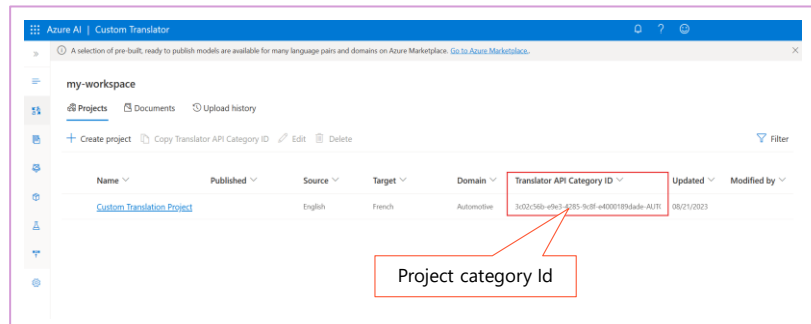
Custom Translation

Create a custom translation model

1. Use the Custom Translator portal
2. Link a workspace to your Azure AI Translator resource
3. Create a project
4. Upload training data files
5. Train a model

Call your model through the Translator API

- Specify a **category** parameter with the project category Id



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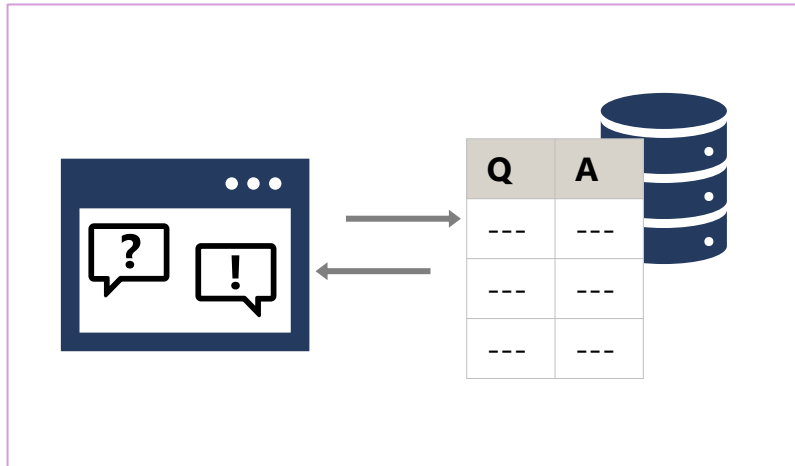
Build a question answering solution

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Introduction to Question Answering

- Knowledge base of question and answer pairs with natural language understanding
- Published as a REST endpoint for applications to consume
- Available through language specific SDKs



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Question Answering vs Language Understanding

Question answering

- User submits a question, expecting an answer
- Service uses natural language understanding to match the question to an answer in the knowledge base
- Response is a static answer to a known question
- Client application presents the answer to the user

Language understanding

- User submits an utterance, expecting an appropriate response or action
- Service uses natural language understanding to interpret the utterance, match it to an intent, and identify entities
- Response indicates the most likely intent and referenced entities
- Client application is responsible for performing appropriate action based on the detected intent

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Creating a Knowledge Base

Use the Language Studio portal

1. Create an **Azure AI Language service** resource in your Azure subscription
2. In Language Studio, select your Azure AI Language resource and **create a Custom question answering** project.
3. Populate the knowledge base:
 - Import from existing FAQ web page
 - Upload document files
 - Add pre-defined "chit-chat" pairs
5. Create the knowledge base and edit question and answer pairs

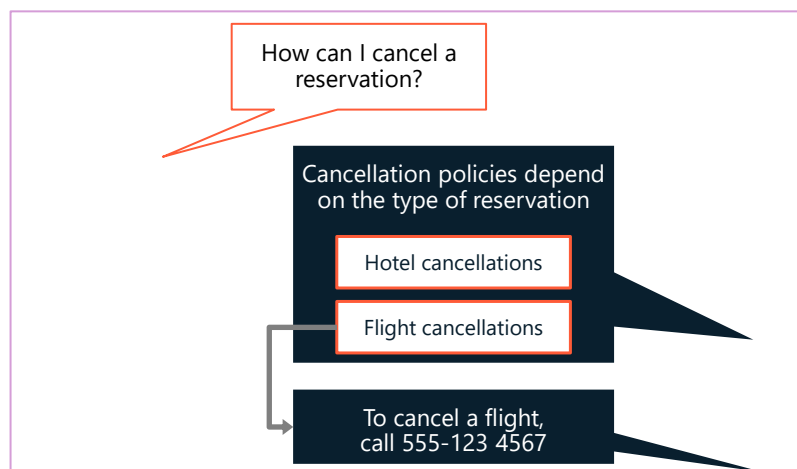
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Multi-turn conversation

Add follow-up prompts to define multi-turn exchanges

- Can reference existing question and answer pairs
- Can be restricted to follow-up responses only



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Testing and publishing a Knowledge Base

Test interactively in Language Studio

- Inspect results to see confidence scores
- Add alternative phrases to improve scores as necessary

Publish the trained knowledge base

- Creates an HTTP REST-based endpoint for client apps to consume
- Published knowledge base can be used with SDKs within your app

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Exercise – Create a Question Answering solution



Create and edit a knowledge base

Train, test, and deploy the knowledge base

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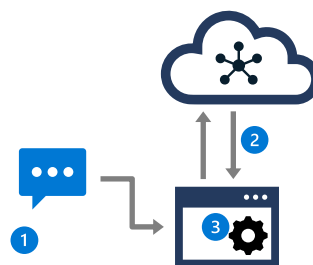
Build a conversational language understanding app

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Introduction to language understanding

- 1 An app accepts natural language input from a user
- 2 A language model is used to determine semantic meaning (the user's *intent*)
- 3 The app performs an appropriate action



Natural Language Processing (NLP) requires a language model to interpret user input

Often this activity is referred to as *natural language understanding* (NLU)

Conversational language understanding (CLU) is an Azure service to enable you to build natural language understanding component to be used in an end-to-end conversational application.

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Intents and utterances

To train a language understanding model:

- Specify *utterances* that represent expected natural language input
- Map utterances to *intents* that assign semantic meaning

Utterance	Intent
What time is it?	GetTime
Tell me the time.	
What is the weather forecast?	GetWeather
Do I need an umbrella?	
Turn the light on.	TurnOnDevice
Switch on the fan.	
Hello	None

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Entities

Define *entities* to add specific context to intents

Utterance	Intent	Entities
What is the time?	GetTime	
What time is it in <u>London</u> ?	GetTime	Location (London)
What's the weather forecast for <u>Paris</u> ?	GetWeather	Location (Paris)
Will I need an umbrella <u>tonight</u> ?	GetWeather	Time (tonight)
What's the forecast for <u>Seattle tomorrow</u> ?	GetWeather	Location (Seattle), Time (tomorrow)
Turn the <u>light</u> on.	TurnOnDevice	Device (light)
Switch on the <u>fan</u> .	TurnOnDevice	Device (fan)

Entity types:

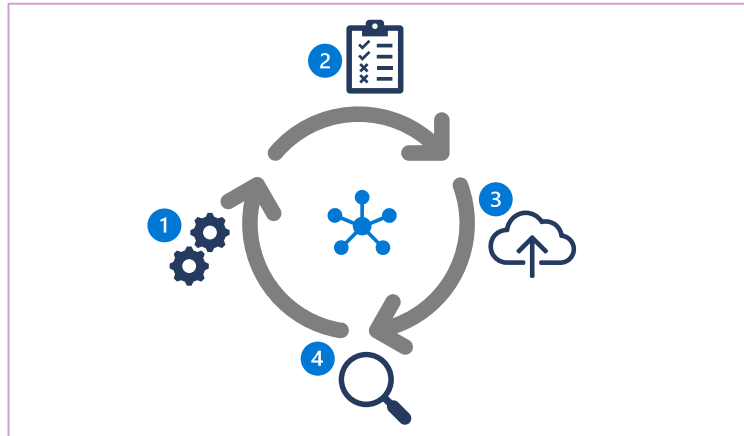
Learned	List	Prebuilt
Machine learned through training	Term in a defined list	Common types like numbers and date/times

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Training, testing, publishing, and reviewing

- 1 Train a model to learn intents and entities from sample utterances
- 2 Test the model interactively or using a testing dataset with known labels
- 3 Deploy a trained model to a public endpoint so client apps can use it
- 4 Review predictions and iterate on utterances to train your model



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Exercise – Create a conversational language understanding app



Create intents

Create entities

Test and publish a language model

Query your model from a client app

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Custom classification and named entity extraction

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Custom Text Classification

Assign custom labels to documents

1. Connect to documents in Azure
2. Define class labels to assign to your documents
3. Label documents
4. Train your model

Call your model through the Language API

- Specify project and deployment name

Can be single label or multi label projects

Language Studio > Custom Text Classification > ClassifyLab - Data labeling

Data labeling ✓ Saved

Select a document to categorize it into a class or [use Azure Machine Learning to label](#). After labeling the documents and adding them to training or testing sets, you'll be ready to create a model with this data in [Training Jobs](#).

All documents view Search Filter

Document name	Labeled as	Dataset
Article 1.txt	Sports	Training
Article 10.txt	News	Training
Article 11.txt	Entertainment	Testing
Article 12.txt	News	Testing
Article 13.txt	Sports	Testing

Activity pane

Labels Distribution Recommendations

Ready for training

+ Add class Auto-label

None
Classifieds
Sports
News
Entertainment

Add additional classes

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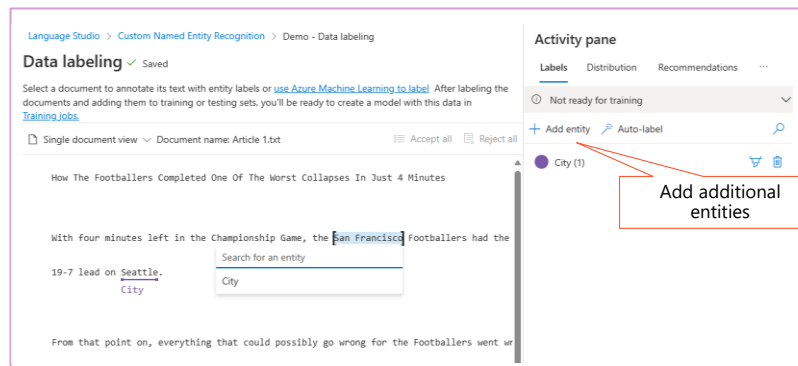
Custom Named Entity Recognition

Assign custom labels to entities in your documents

1. Connect to documents in Azure
2. Define entity labels to assign to your documents
3. Label documents completely and consistently
4. Train your model

Call your model through the Language API

- Specify project and deployment name

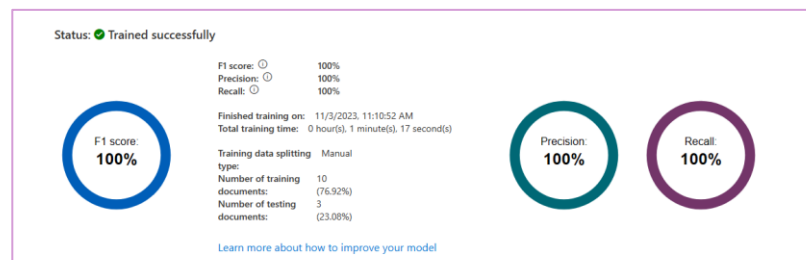


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Review and improve a model

- 1 Train a model to teach labels or entities
- 2 Review model performance to determine how to improve performance, including Confusion matrix
- 3 Determine what cases need to be added to your training data
- 4 Retrain your model with new data included, and repeat as necessary



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Speech recognition, translation and synthesis

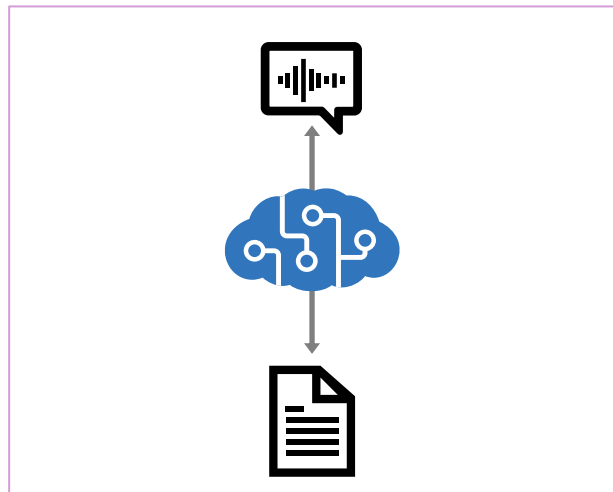
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The Speech Service

Speech APIs

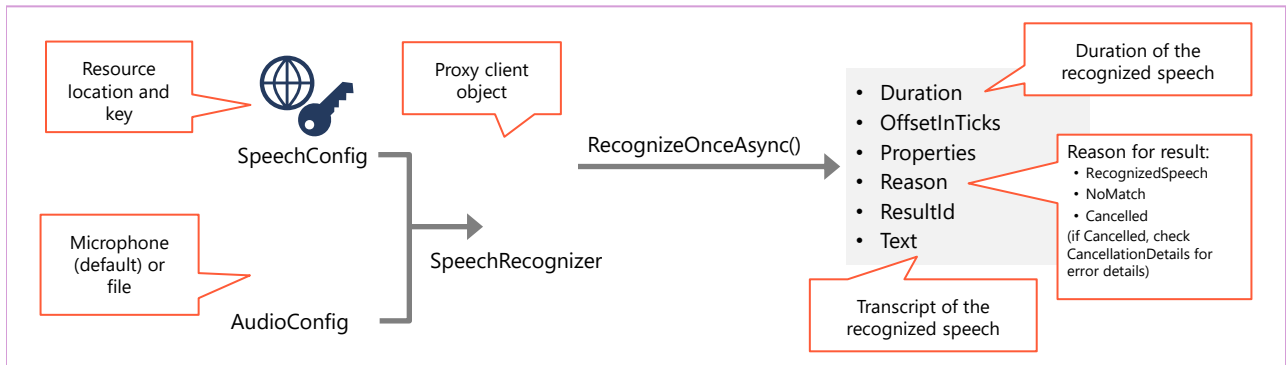
- Speech-to-Text API (speech recognition)
- Text-to-Speech API (speech synthesis)
- Speech Translation API
- Speaker Recognition API
- Intent Recognition (uses conversational language understanding)



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Speech-to-Text



Two REST APIs:

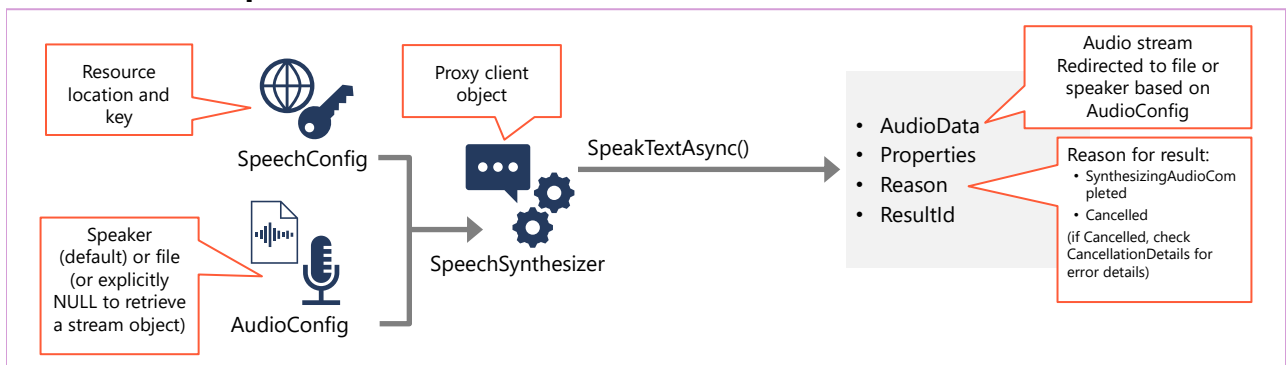
- Speech-to-text API – Used by Azure AI Speech SDK – preferred for most scenarios
- Speech-to-text Short Audio API – Useful for short (up to 60s) of audio

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Azure AI Speech SDK (.NET, Python, JavaScript, etc.)

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Text-to-Speech



Two REST APIs:

- Text-to-speech API – Suitable for most scenarios
- Batch synthesis API – Convert large volumes of text to audio files

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Azure AI Speech SDK (.NET, Python, JavaScript, etc.)

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Audio Format and Voices



Audio Format

Select an audio format to specify:

- Audio file type
- Sample-rate
- Bit-depth



Voices

- Standard voices: Synthetic voices created from audio samples
- Neural voices: Natural sounding voices created using deep neural networks

```
speechConfig.SetSpeechSynthesisOutputFormat(SpeechSynthesisOutputFormat.Riff24Khz16BitMonoPcm);

speechConfig.SpeechSynthesisVoiceName = "en-GB-George";
```

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Exercise – Recognize and Synthesize Speech



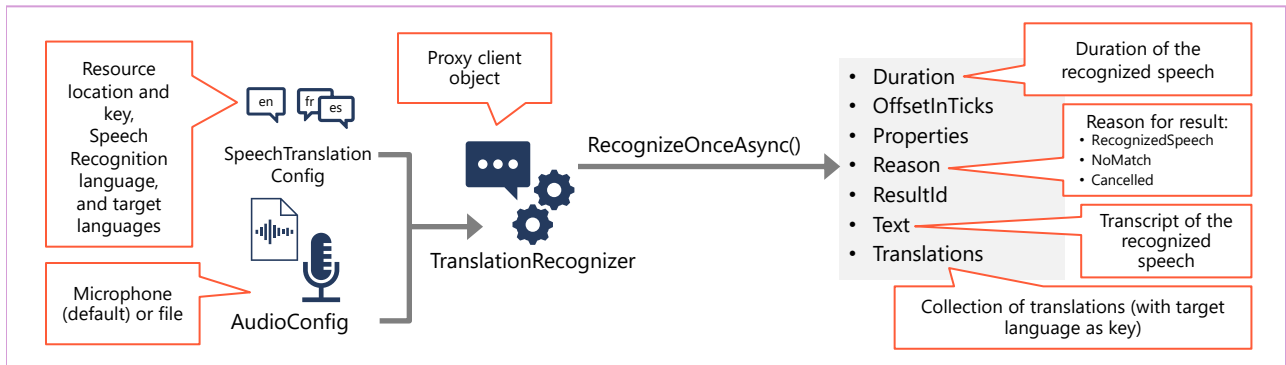
Recognize Speech

Synthesize Speech

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Translating Speech to Text



Translation builds on speech recognition:

1. Recognize and transcribe spoken input in speech recognition language
2. Return translations for one or more target languages

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Extended interactive exercises



Custom text classification

Translate speech

<https://aka.ms/azure-ai-language-lp>

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Develop Generative AI Solutions with Azure OpenAI Service

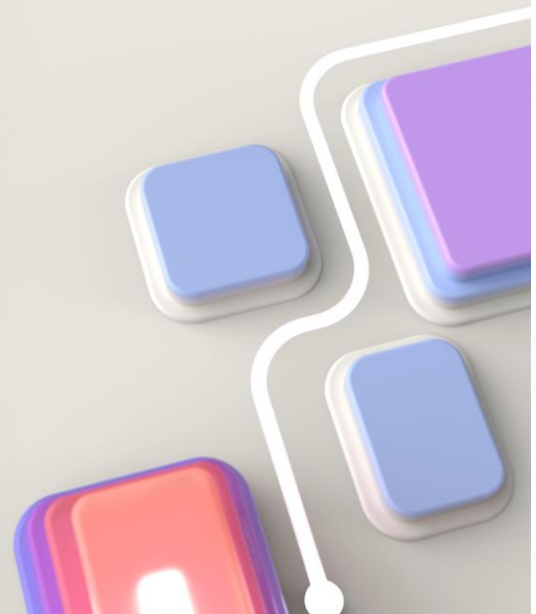
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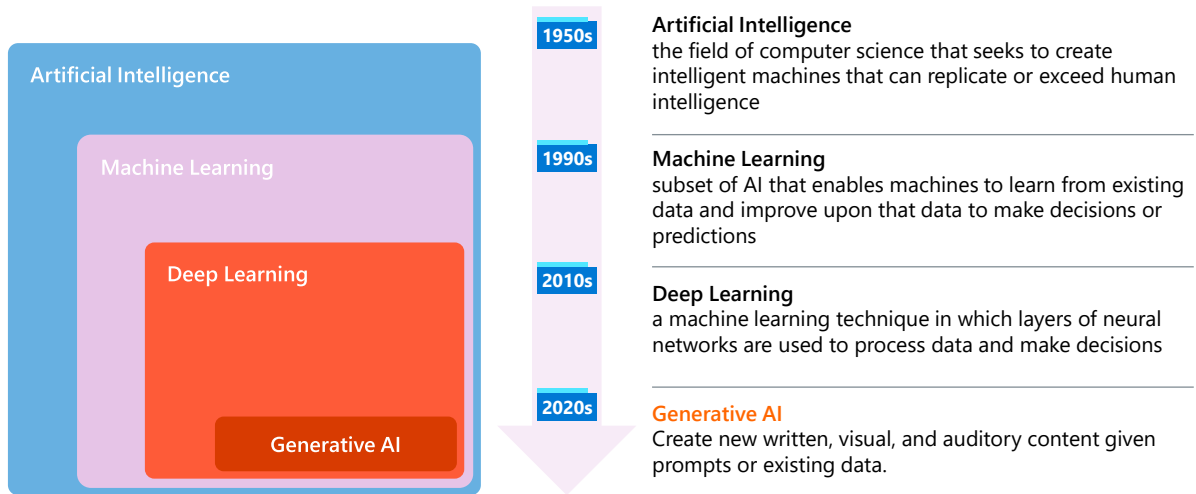
Get started with Azure OpenAI Service

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What is generative AI?



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Provision an Azure OpenAI resource in Azure

Deploy a model in Azure OpenAI Studio to use it

1. Apply for access to the Azure OpenAI service: <https://aka.ms/oaiapply>
2. Create an **Azure OpenAI** resource in the Azure portal

Alternatively, use the Azure CLI

```
az cognitiveservices account create \
-n MyOpenAIResource \
-g MyResourceGroup \
-l eastus \
--kind OpenAI \
--sku s0 \
--subscription subscriptionID
```

Home > Azure AI services | Azure OpenAI >

Create Azure OpenAI ...

1 Basics 2 Network 3 Tags 4 Review + submit

Enable new business solutions with OpenAI's language generation capabilities powered by GPT-3 models. These models have been pretrained with trillions of words and can easily adapt to your scenario with a few short examples provided at inference. Apply them to numerous scenarios, from summarization to content and code generation.

[Learn more](#)

Project Details

Subscription *

Resource group *

[Create new](#)

Instance Details

Region

Name *

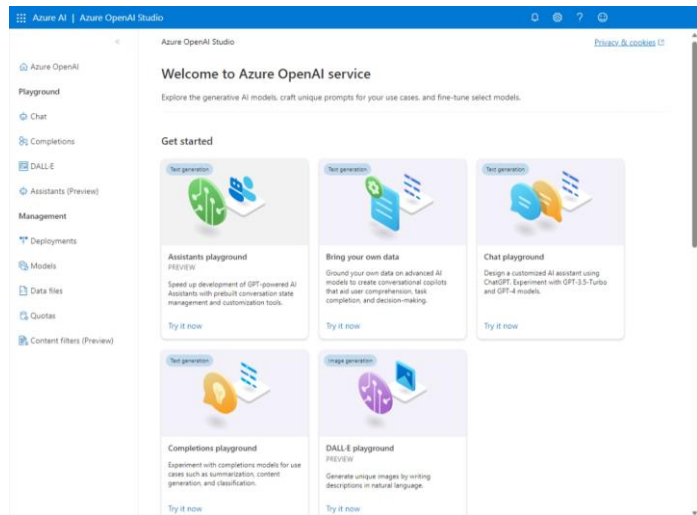
Pricing tier *

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Azure OpenAI Studio

- Web portal for working with Azure OpenAI models:
<https://oai.azure.com/>
- View and deploy base models
- Connect your own data source
- Manage fine tuning and data files for custom models
- Test models in visual playgrounds:
 - **Chat** (GPT-3.5-Turbo and later models)
 - **Completions** (GPT-3 and earlier models)
 - **DALL-E** (Image generations)
 - **Assistants** (Custom and Copilot-like experiences)

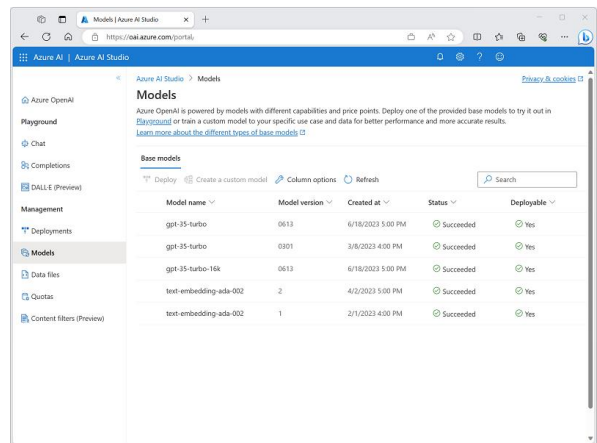


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Types of generative AI model

Model Family	Description
GPT-4	Newest, most capable chat-based models for language and code generation
GPT-3	Natural language and code-generation models
Embeddings	Models that use embeddings for specific tasks (similarity, text search, and code search)
DALL-E	Image-generation model (<i>preview, restricted regions</i>)



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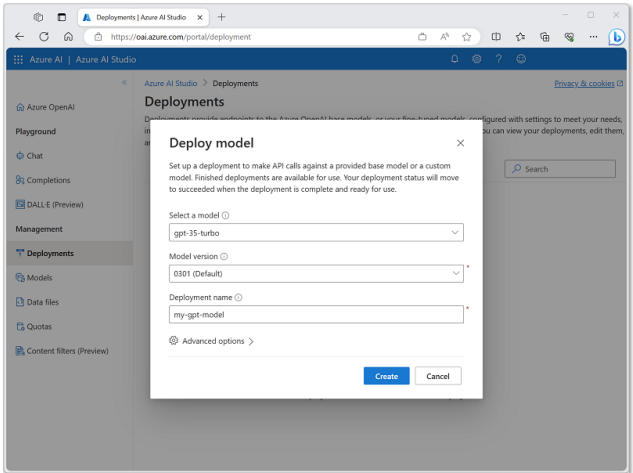
94

Deploying generative AI models

Deploy a model in Azure OpenAI Studio to use it

- You can deploy one or more instances of each available model
- The number of deployments depends on your quota, which you can see in the portal
- Alternatively, use the Azure CLI

```
az cognitiveservices account deployment create \  
-g myResourceGroupName \  
-n MyOpenAIResource \  
--deployment-name my-gpt-model \  
--model-name gpt-35-turbo \  
--model-version "0301" \  
--model-format OpenAI \  
--scale-settings-scale-type "Standard"
```



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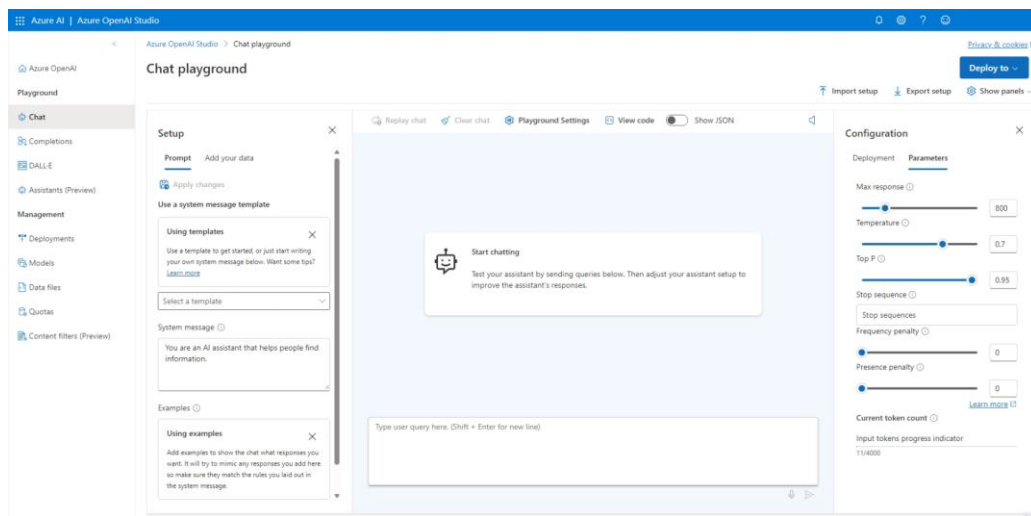
Using prompts to get completions from models

Task	Prompt	Completion
Classifying content	Tweet: I enjoyed the training course. Sentiment:	Positive
Generating new content	Write a poem about databases	Databases, oh databases, You keep our information safe, From the small to the large, You store our data in a place.
Transformation/Translation	English: Hello French:	Bonjour
Summarization	Scotland is [long description of Scotland...] Summarize the previous text	Scotland is [summarized description...]
Continuation	One way to grow tomatoes is to	start with seeds...
Question answering	How many moons does Earth have?	Earth has one moon.
Chat	Setup, followed by messages...	A sequence of relevant responses

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Testing models in Azure OpenAI Studio playground



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Develop apps with Azure OpenAI Service

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Integrating Azure OpenAI into your app

Applications submit prompts to deployed models. Responses are completions.

Three REST API endpoints:

- **Completion** - model takes an input prompt, and generates one or more predicted completions
- **Embeddings** - model takes input and returns a vector representation of that input
- **ChatCompletion** - model takes input in the form of a chat conversation (where roles are specified with the message they send), and the next chat completion is generated

ChatCompletion will be the endpoint we focus on for this course

Use **Completion** and **Embeddings** with GPT-3 based models
Use **ChatCompletion** with GPT-3.5-Turbo and later models

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Using the Azure OpenAI REST API

Completion Endpoint

<https://endpoint.openai.azure.com/openai/deployments/deployment/completions>

Embedding Endpoint

<https://endpoint.openai.azure.com/openai/deployments/deployment/embeddings>

ChatCompletion Endpoint

<https://endpoint.openai.azure.com/openai/deployments/deployment/chat/completions>

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Using the Azure OpenAI SDKs

Language specific SDKs are available for use in your applications, in both C# and Python.

Code structure follows a similar pattern for both languages.

Parameters such as *Max Response* and *Temperature* are defined in the chat options.

Both synchronous and asynchronous API versions are available.

Pseudo code structure:

```
<include library>

<create client>

<define chat messages and options>

<send request>

<extract response content>
```

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Exercise: Integrate Azure OpenAI into your app



Configure your application to connect to Azure OpenAI

Test your app by sending a request to your deployed model

Use the hosted lab environment if provided, or view the lab instructions at the link below:

<https://aka.ms/mslearn-azure-openai-api>

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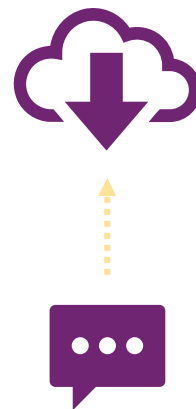
Apply prompt engineering with Azure OpenAI Service

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What is Prompt Engineering?

Constructing prompts to:

- Maximize relevancy and accuracy of completions
- Specify formatting and style of completions
- Provide conversational context
- Mitigate bias and improve fairness



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Providing clear instructions

Write a product description for a new water bottle



Introducing the latest addition to our product line - the innovative and eco-friendly water bottle. Made from high-quality, BPA-free materials, this bottle is designed to keep your beverages at the perfect temperature for hours. Its sleek and stylish design makes it the perfect accessory for any outdoor activity or workout session. With its convenient carrying handle and leak-proof lid, you can take it with you wherever you go, without worrying about spills or leaks. Plus, its easy-to-clean design ensures that you can use it again and again, making it the perfect choice for anyone looking for a reliable and sustainable water bottle.

Write a product description for a new water bottle that is 100% recycled. Be sure to include that it comes in natural colors with no dyes, and each purchase removes 10 pounds of plastic from our oceans



Introducing our newest water bottle, the eco-friendly choice for the conscious consumer. Made from 100% recycled materials and available in natural colors with no dyes, this bottle is not only stylish but also sustainable. Each purchase of this bottle removes 10 pounds of plastic from our oceans, making it a responsible choice for those who care about the environment. Its durable and leak-proof design makes it perfect for outdoor activities, while its easy-to-carry handle makes it convenient to take on the go. Join us in our mission to reduce plastic waste and choose this eco-friendly water bottle for your daily hydration needs.

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Primary, supporting, and grounding content

Section markers
(--- or ###)

Primary content to be
summarized, translated, etc.

Supporting content to provide
clarity / specificity

Grounding content to define
scope for questions

Thanks for your interest in our summer school program.
We're looking for your ideas for webinars on topics such as AI, web development, ... <more...>

Topics I'm very interested in: AI, webinar dates, submission deadlines
Extract the key points from the above email, and put them in a bulleted list

Artificial Intelligence (AI) has evolved over many years ... <more...>

Where and when did the field of AI start?

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Cues

- Cues provide a starting point on which the completion builds
- Use cues to set the scope and format for the output
- Cues are particularly useful when generating code. For example:
 - Provide the first keyword in a SQL SELECT statement
 - Define a name and parameters for a Python function

```

---
Review: The writing was good but the movie was too long.
Review: The special effects were terrible.
<more>...
---

Summarize the reviews above.
Most common complaints:
-

```



- The movie was too long.
- The special effects were terrible.

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Requesting output composition

Write a table in markdown with 6 animals in it, with their genus and species



Animal	Genus	Species
Red Panda	Ailurus	fulgens
African Elephant	Loxodonta	africana
Snow Leopard	Panthera	uncia
Arctic Fox	Vulpes	lagopus
Chimpanzee	Pan	troglydytes
Siberian Tiger	Panthera	tigris altaica

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Using a system message

When using the ChatCompletions API, a system message sets context that can affect completions

```
{
  "role": "system", "content": "You are a casual, helpful assistant.  
You will talk like an American old western film character."
}, {
  "role": "user", "content": "Can you direct me to the library?"
}
```



```
{
  "role": "assistant", "content": "Well howdy there, stranger! The library, huh?  
Y'all just head down the main road till you hit the town  
square. Once you're there, take a left and follow the street  
for a spell. You'll see the library on your right, can't  
miss it. Happy trails!"
}
```

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Conversation history and *few shot* learning

- Including previous messages helps retain the context and style of a conversation
- Starting a conversation with user-defined messages and responses (*few shot* learning) sets examples for the expected responses

```
{
  "role": "system", "content": "You are an assistant that evaluates the sentiment of customer  
feedback."
}, {
  "role": "user", "content": "That was an awesome experience"
}, {
  "role": "assistant", "content": "positive"
}, {
  "role": "user", "content": "I won't do that again"
}, {
  "role": "assistant", "content": "negative"
}, {
  "role": "user", "content": "That was not worth my time"
}, {
  "role": "assistant", "content": "negative"
}, {
  "role": "user", "content": "You can't miss this"
}
```



```
{
  "role": "assistant", "content": "positive"
},
```

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Chain of thought

Ask a model to break down its response and explain its reasoning

What sport is easiest to learn but hardest to master? Give a step by step approach of your thoughts, ending in your answer

Step 1: Identify the criteria for "easy to learn" and "hard to master" sports.

For a sport to be considered easy to learn, it should have simple rules and require minimal equipment. For a sport to be considered hard to master, it should require years of practice to perfect and have a large variety of techniques and strategies...

Step 2: Consider different sports that fit these criteria.

Some sports that could be considered easy to learn but hard to master include:

- Tennis: Simple rules, easy to pick up, but requires years of practice to master all the different shots and strategies.
- Golf: Basic swing mechanics are easy to learn but perfecting them takes a lifetime of practice.
- ...

Step 3: Evaluate each sport based on the criteria.

Tennis and golf both require expensive equipment, which could make them less accessible to beginners. In terms of skill ceiling and time required to master, tennis and golf both have a high skill ceiling and require years of practice to perfect....

Step 4: Make a decision based on the evaluation.

Based on the above criteria and evaluation, I would say that tennis is the sport that is easiest to learn but hardest to master. While it may require expensive equipment, it is still accessible to many people. The basic rules and techniques are easy to learn, but mastering all the different shots and strategies takes years of practice...

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Exercise: Utilize prompt engineering in your app



Explore prompt engineering techniques

Connect your app to Azure OpenAI and test prompts with increasing prompt engineering

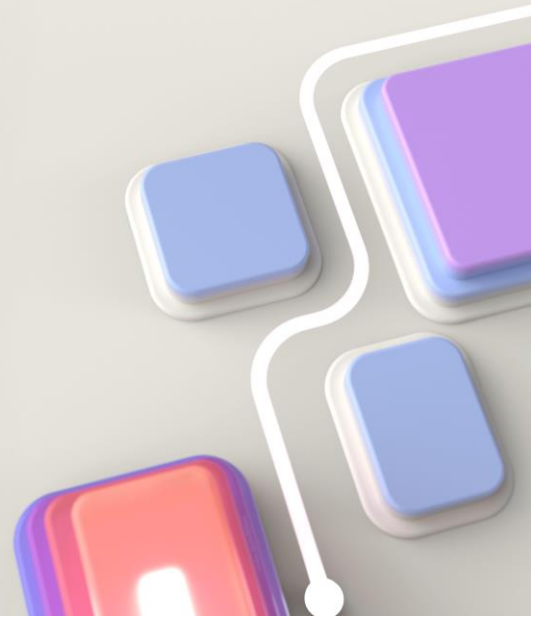
Use the hosted lab environment if provided, or view the lab instructions at the link below:

<https://aka.ms/openai-prompt-engineering-lab>

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Implement Retrieval Augmented Generation (RAG) with Azure OpenAI Service



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How Azure OpenAI can use your data



Set up your data source

- Use an existing data source, such as an Azure search resource
- Use the Azure OpenAI studio to create that data source, if you don't already have one
- When creating the data source, you can use data already in your account such as blob storage



Configure the studio or your app to connect to that data source

- In the studio, set up the connection by pointing it to the data source
- In your app, specify the data source in the prompt parameters
- Both configurations allow the search resource to augment the prompt



Use the Azure OpenAI model, which now uses your data for grounding

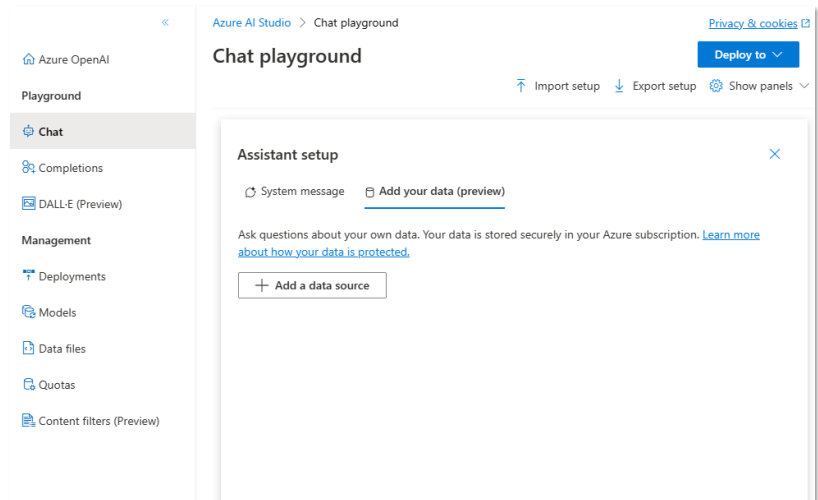
- Chat with the AI models like normal
- If the data source has relevant information about the prompt, it will use that data
- You can specify if the AI model is limited to just your data source

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Connect to your data source

- Add your data source in the Chat playground, under Assistant setup
- Use an existing data source, or use that wizard to create a new one
- Once connected, a new chat session will start. Chat like normal, and see how the AI model references that data



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Using the Azure OpenAI REST API

Using your own data

<https://endpoint.openai.azure.com/openai/deployments/deployment/chat/completions?api-version=version>

- With each call, you need to specify the data source values, along with the messages array and any other parameters
- Authentication in the data source definition is for your search resource, not your Azure OpenAI resource

```
{
  "data_sources": [
    {
      "type": "azure_search",
      "parameters": {
        "endpoint": "<your_search_endpoint>",
        "index_name": "<your_search_index>",
        "authentication": {
          "type": "system_assigned_managed_identity"
        }
      }
    }
  ],
  "messages": [
    ...
  ]
}
```

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Using the Azure OpenAI SDKs

Language specific SDKs are available for use in your applications, in both C# and Python.

Code structure follows a similar pattern for both languages.

Current supported data sources are:

- Azure AI Search
- Azure Cosmos DB for MongoDB vCore
- Plus others in preview, soon to be released GA

Pseudo code structure:

```
<include library>

<create client>

<define chat messages and options>

<define data source object to include with request>

<send request>

<extract response content>
```

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Exercise: Implement Retrieval Augmented Generation (RAG) with Azure OpenAI Service



Set up and connect your data in the chat playground

Configure your app to use your own data for augmenting the prompt

Use the hosted lab environment if provided, or view the lab instructions at the link below:

<https://aka.ms/mslearn-openai-own-data>

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Extended interactive exercises



Generate code

Generate images

<https://aka.ms/develop-azure-openai>

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Creating a Knowledge Mining Solution

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Implementing an Intelligent Search Solution

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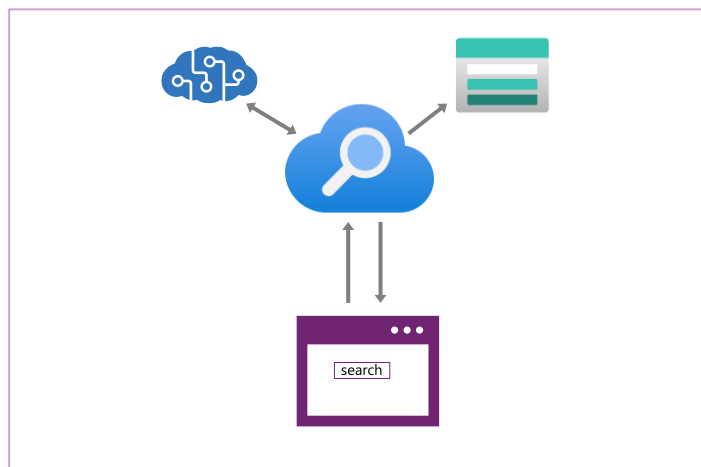
Azure AI Search

AI-Powered Knowledge Mining

- Index documents and data from a range of sources
- Use skills to enrich index data
- Store extracted insights in a knowledge store for analysis and integration

Azure Resources:

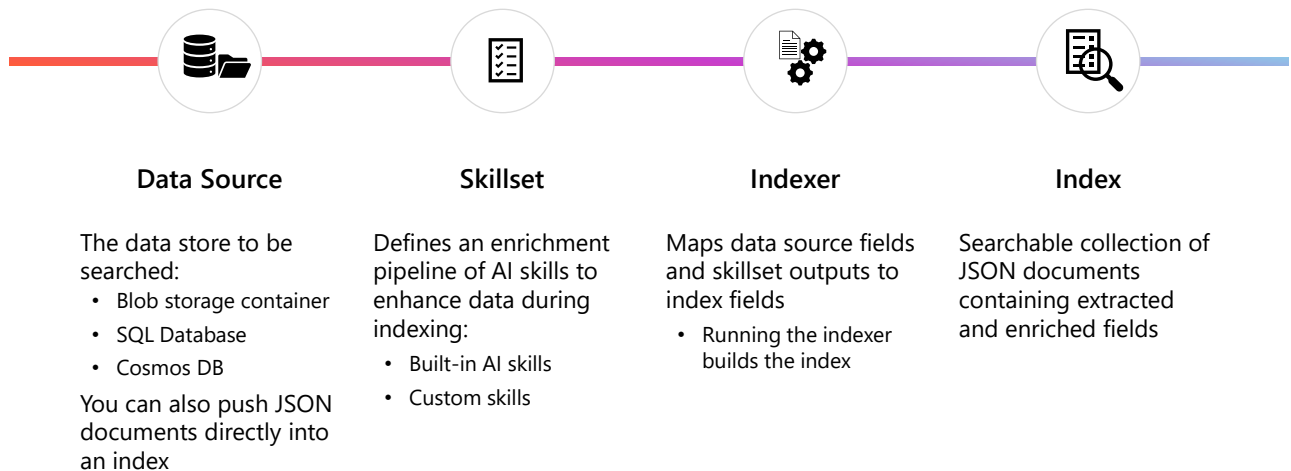
- **Azure AI Search** for core indexing and querying
- **Azure AI Services** for index enrichment
- **Storage account** for knowledge store persistence



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Core Components of a AI Search Solution



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Create a custom skill for Azure AI Search

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Introduction to Custom Skills

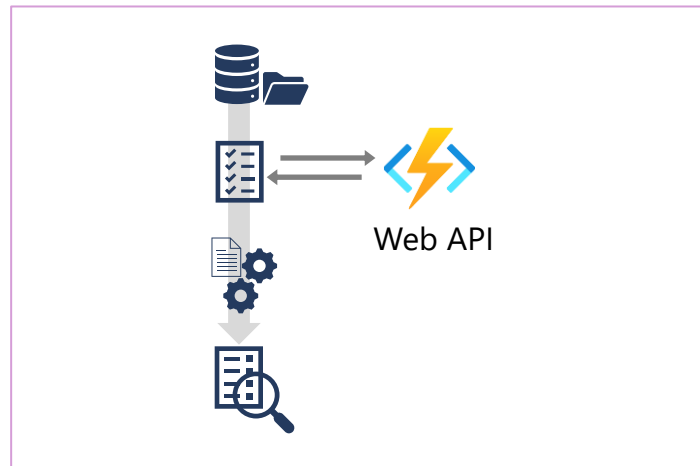
When built-in skills don't provide what you need...

Create a custom skill, for example:

- Integrate Document Intelligence
- Consume an Azure Machine Learning model
- Any other custom logic

Custom skills are implemented as Web APIs

- Commonly Azure Functions



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Exercise – Create a Custom Skill for Azure AI Search



Use an Azure Function to implement a custom skill
Integrate a custom skill into a skillset

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Creating a Knowledge Store

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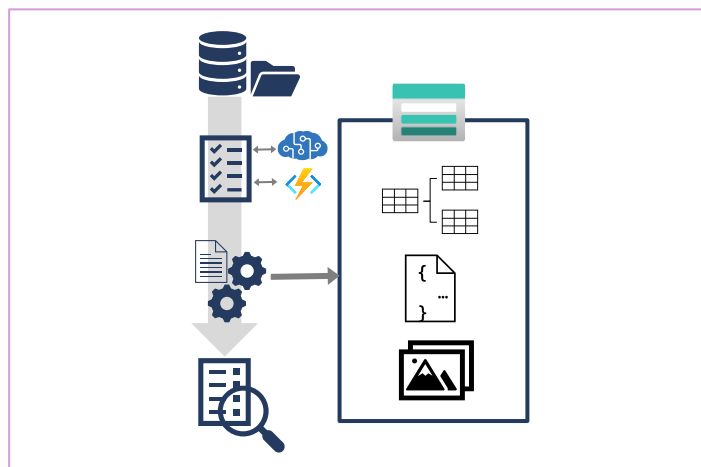
What is a Knowledge Store?

Persisted insights extracted by indexing process

Stored as *projections* in Azure Storage

- **Tables:** Relational tables with keys for joining
- **Objects:** JSON structures of document fields
- **Files:** Extracted images saved in JPG format

Used for analysis or integration into data processing workflows



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Extended interactive exercises – Create a Knowledge Store with Azure AI Search



<https://aka.ms/km-ai-lp>

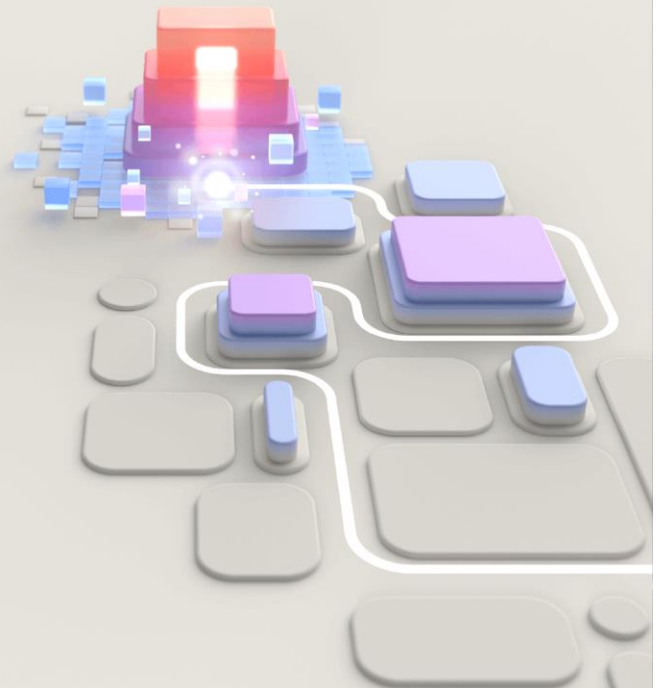
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Develop solutions with Azure AI Document Intelligence

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Develop a Document Intelligence solution

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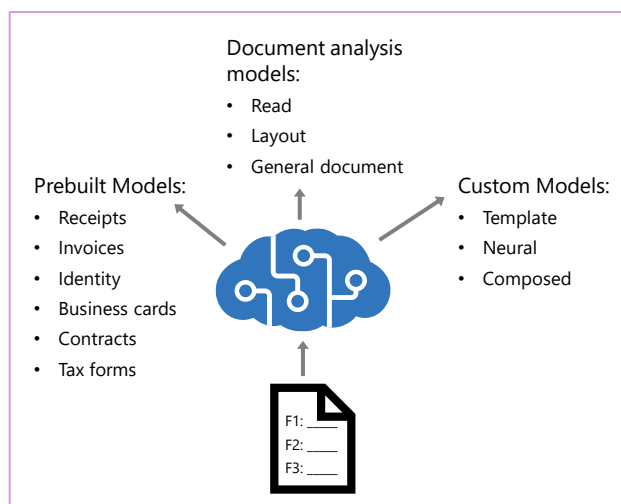
The Document Intelligence Service

Data extraction from forms and documents:

- Document analysis from general documents
 - Read: OCR for printed and written text
 - Layout: Extract text and structure
 - General document: Extract text, structure, and key-value pairs
- Prebuilt models for common form types
 - Receipts
 - Invoices
 - Identity
 - Business cards
 - Contracts
 - Tax forms
- Train custom models for your own forms
 - Custom template: Extract data from static layouts
 - Custom neural: Extract data from mixed-type documents
 - Custom composed: Collection of multiple models assigned to a single model

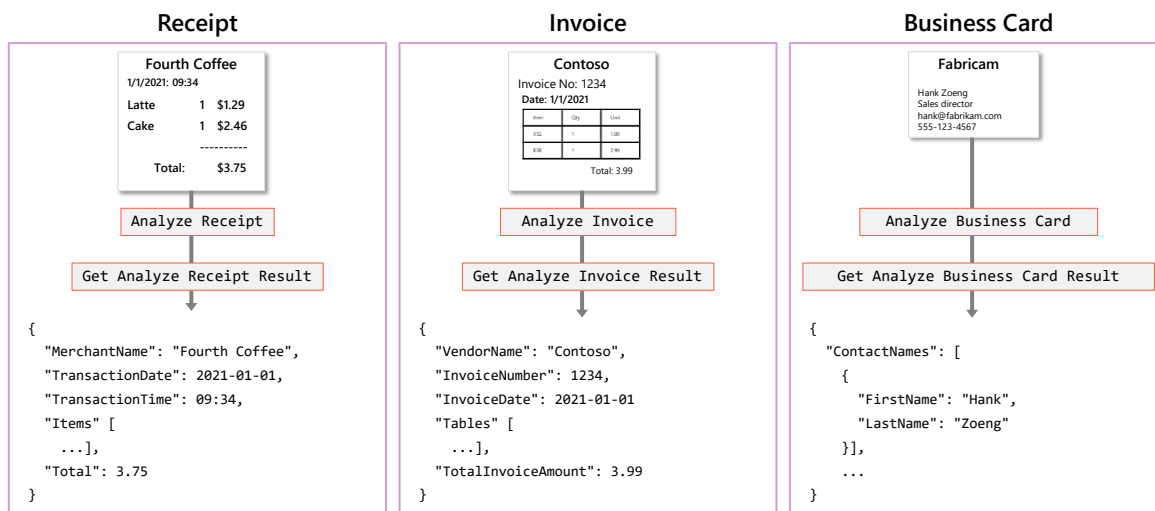
Provision as single-service **Document Intelligence** resource or multi-service **Azure AI Services** resource

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Prebuilt models



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Calling the API

- Each request is configured with your resource endpoint and needs your resource key
- Send the request, which when successful returns a poller to get the results
 - REST returns it in Operation-Location header
 - SDKs return an object from the request
- Query the poller received for the extracted data

REST

Request POST:

```
{endpoint}/documentintelligence/documentModels/prebuilt-layout:analyze?api-version={version}
```

Operation-Location:

```
{endpoint}/documentintelligence/documentModels/prebuilt-layout/analyzeResults/ab12345c-12ab-23cd-b19c-2322a7f11034?api-version={version}
```

C#

```
AnalyzeDocumentOperation operation = await
client.AnalyzeDocumentFromUriAsync(WaitUntil.Completed,
"prebuilt-layout", fileUri);
```

```
AnalyzeResult result = operation.Value;
```

Python

```
poller=document_analysis_client.begin_analyze_document_
from_url("prebuilt-document", docUrl)
```

```
result = poller.result()
```

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API response

- Response is broken down by page, lines, and words
- Subset of REST response included here
- SDK response objects have similar structure, broken down similarly
- Additional data about detected text or selection marks, such as bounding box and handwritten style

```
{
  "analyzeResult": {
    "apiVersion": "{version}",
    "modelId": "prebuilt-invoice",
    ...
    "pages": [{
      "pageNumber": 1,
      "angle": 0,
      "width": 8.5,
      "height": 11,
      "unit": "inch",
      "words": [{
        "content": "Margie's",
        "boundingBox": [
          0.5911,
          0.6857,
          1.7451,
          0.6857,
          1.7451,
          ...
        ],
        "confidence": 1,
        "span": {...}
      }],
      "confidence": 1,
      "span": {...}
    }],
  }
}
```

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Types of custom models

Custom classification

- Apply a label to the entire document
- Ideal for sorting large numbers of incoming documents into types
- Requires two different classes, and a minimum of five labeled documents per class
- One type of training model

Custom extraction

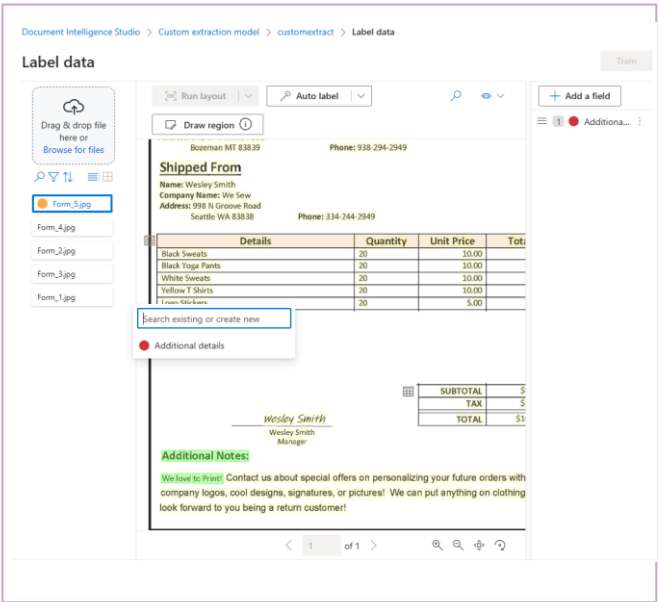
- Apply label to specific text
- Ideal for extracting custom labels from documents
- Requires five examples of the same document type
- Two training methods:
 - **Custom template (custom form)**
 - Training time: 1-5 minutes
 - Document structure: forms, templates, other structured documents
 - **Custom neural (custom document)**
 - Training time: 20-60 minutes
 - Document structure: structured and unstructured documents

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Training Custom Models

- 1 Create project and upload training files to your project, or connect to blob storage containing files
- 2 Add data type (such as field or signature) to start labeling your dataset
- 3 Select a word in the document, and assign one of the fields to label it
- 4 Repeat for all fields and files in your dataset
- 5 Layout and auto label (using a prebuilt model) can assist in this process
- 6 Train the model, providing a Model ID used in API requests



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Accuracy and confidence scores

- After training, a custom model has an estimated accuracy score
- Score is calculated by running combinations of training data predictions against the labeled values
- Confidence score is the same as using prebuilt models, indicated how accurate the model thinks that specific prediction is
- Confidence scores are provided in the response from the model for each predicted label

Accuracy

Email	80.00 %
CompanyAddress	80.00 %
Signature	80.00 %

Confidence

Signature #1	44.80%
Wesley Smith	
CompanyAddress #1	66.70%
342 W Wrinkle Road Bozeman MT 83839	
Email #1	95.30%
accounts@herolimited.com	

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Lab – Extract Data from Forms



Train a custom model in Document Intelligence Studio

Test your custom Document Intelligence model

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