Microsoft

Develop natural language processing solutions

Agenda

- Analyzing and translating text
- Build a question answering solution
- Build a conversational language understanding app
- Custom classification and named entity extraction
- Speech recognition, synthesis, and translation

Analyzing text

Learning Objectives

After completing this module, you will be able to:

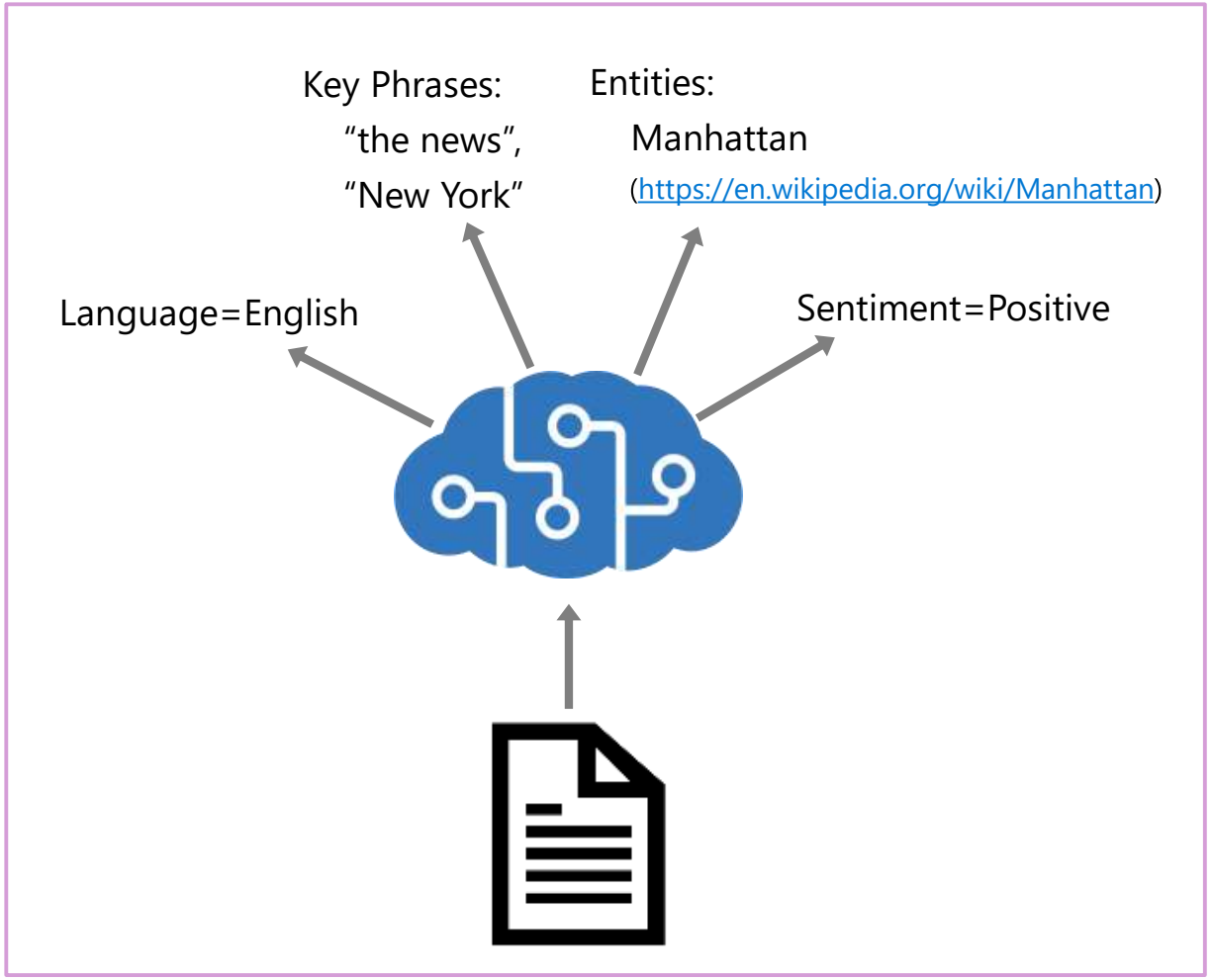
1. Detect language and extract key phrases
2. Analyze sentiment and detect PII
3. Summarize text
4. Extract entities and linked entities
5. Translate text

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



Language detection

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

Collection of one or more text documents

Optional locale hint

String to be analyzed

```
{
  "documents": [
    {
      "countryHint": "US",
      "id": "1",
      "text": "Hello world"
    },
    {
      "id": "2",
      "text": "Bonjour tout le monde"
    }
  ]
}
```

```
{
  "documents": [
    {
      "id": "1",
      "detectedLanguage": {
        "name": "English",
        "iso6391Name": "en",
        "confidenceScore": 1
      },
      "warnings": []
    },
    {
      "id": "2",
      "detectedLanguage": {
        "name": "French",
        "iso6391Name": "fr",
        "confidenceScore": 1
      },
      "warnings": []
    }
  ],
  "errors": [],
  "modelVersion": "2022-10-01"
}
```

Language name (in English)

2-character language code

Prediction confidence (0 to 1)

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"
}
```

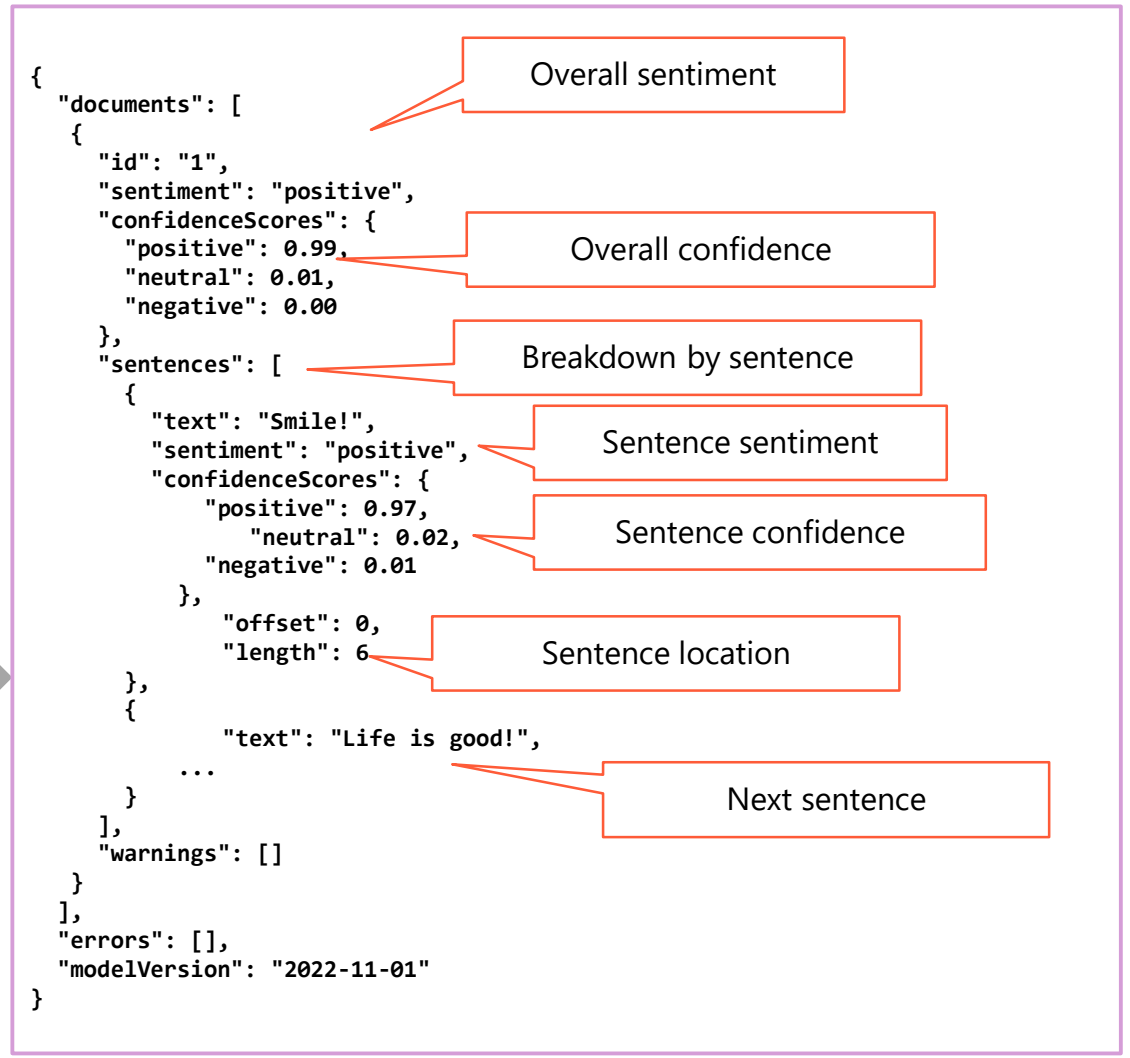
List of key phrases in document 1

List of key phrases in document 2

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***

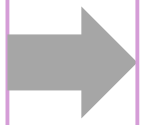
```
{
  "documents": [
    {
      "language": "en",
      "id": "1",
      "text": "Smile! Life is good!"
    }
  ]
}
```



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

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)

```
{
  "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

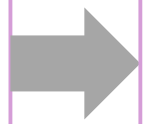
Wikipedia unique article ID

Article link

Summarization

- Can provide two different types of summarization
  - Extractive summarization: Produces summary by using most important sentences
  - Abstractive summarization: Produces a summary capturing the main idea, but not necessarily using the same words as the source document
- Can be customized by training on your own data

```
{
  “analysisInput”: {
    "documents": [{
        "language": "en",
        "id": "1",
        "text": “<long paragraph about Microsoft and
technology>"
     }]
    },
    “tasks": [{
      “kind": "ExtractiveSummarization",
      “taskName": “docExtSummary1",
      “parameters": {
        “sentenceCount”: 2
      }
    }
  ]
}
```



```
{
  “documents”:
    [
      {
        “id”:”1”,
        “sentences":[
          {
            “text": “<first sentence best summarizing document>”
            “rankScore": 0.71
            “offset": 0
            “length”: 135
          },
          {
            “text": “<first sentence best summarizing document>”
            “rankScore":“0.67",
            “offset": 721
            “length”: 203
          },
        ],
        “warnings”:[]
      }
    ],
  “errors”:[],
  “modelVersion”:“latest"
}
```

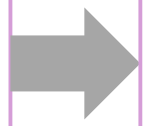
Array of sentences specified

Sentence rank score

Personally Identifiable Information detection

- Used to detect and remove sensitive information
- Entity categories include Person, PhoneNumber, Email, Address, Credit card, and financial account identification
- Can be used in situations like applying sensitivity labels, removing information to reduce bias, and clean data for data science

```
{
  "documents":[
    {
      "id":"1",
      "language": "en",
      "text": "Call our office at 312-555-1234, or send an email
to support@contoso.com"
    }
  ]
}
```



```
{
  "documents":
    [
      {
        "redactedText": "Call our office at ************, or send
           an email to ********************",
        "id": "1",
        "entities": [{
          "text": "312-555-1234",
          "category": "PhoneNumber",
          "offset": 19,
          "length": 12,
          "confidenceScore": 0.8
        }, {
          "text": "support@contoso.com"
          "category": "Email",
          "offset": 53,
          "length": 19,
          "confidenceScore": 0.8
        }],
        "warnings": []
      }
    ],
  "errors":[],
  "modelVersion":"2021-06-01"
}
```

Text with PII removed

All entities detected

Type of PII detected

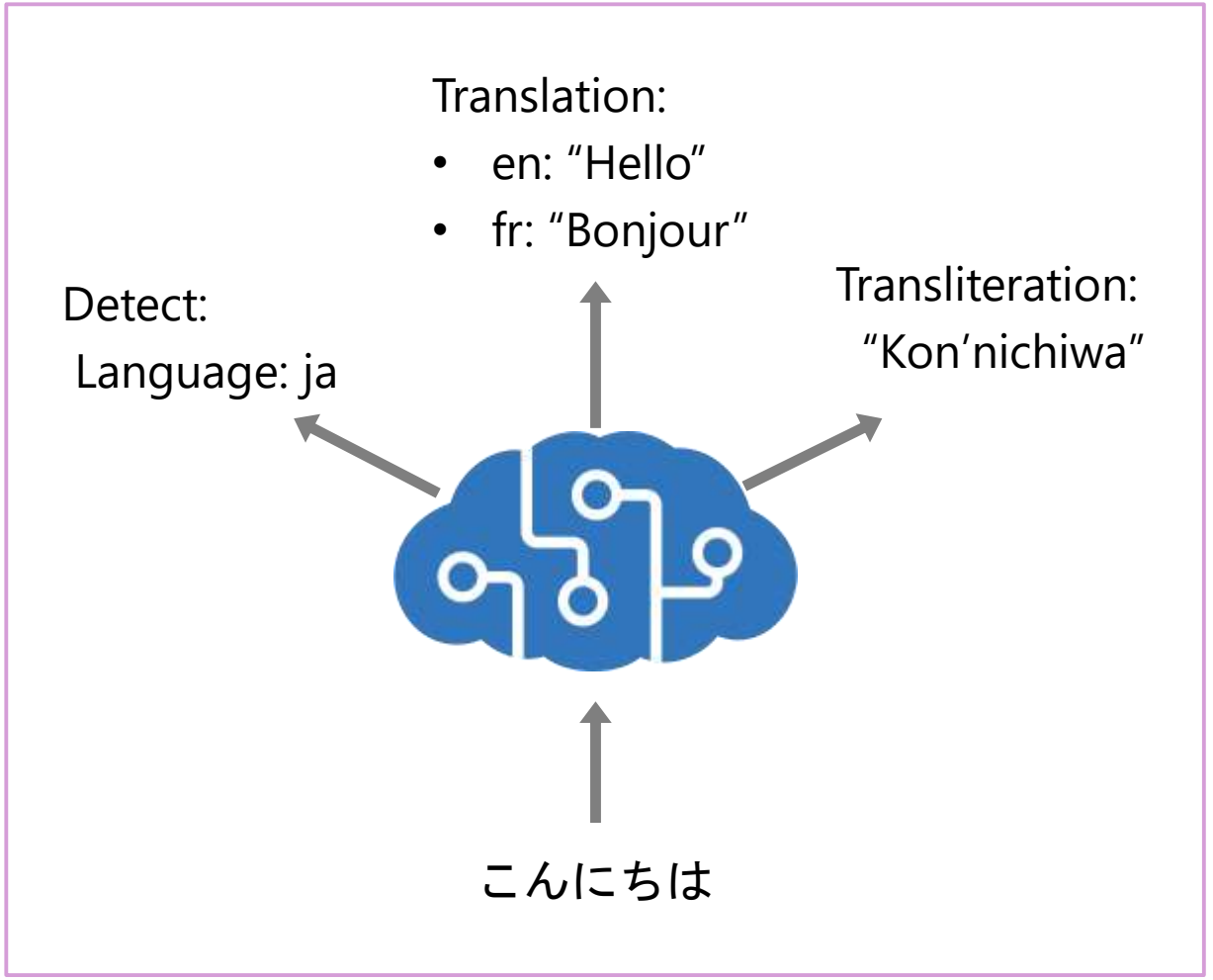
Confidence score

Translating Text

The Translator Service

Multilingual text translation REST API

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



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

Translation Options

Word Alignment

```
https://api.cognitive.microsofttranslator.com/translate?api-version=3.0
                                        &from=en&to=zh& includeAlignment=true

Body: [
        { 'Text' : 'Smart Services' }
      ]
```

```
[
  {'translations':
    [
      {'text': '智能服务', 'to': 'zh-Hans',
       'alignment': {'proj': '0:4-0:1 6:13-2:3'}
      }
    ]
  }
]
```

Chars 0-4 in the source are chars 0-1 in the translation

Chars 6-13 in the source are chars 2-3 in the translation

Sentence Length

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

Body: [
        { 'Text' : 'Hello world!' }
      ]
```

```
[
  {'translations':
    [
      {'text': 'Salut tout le monde!', 'to': 'fr',
       'sentLen':{'srcSentLen':[12], 'transSentLen':[20]}
      }
    ]
  }
]
```

Source is 12 characters

Translation is 20 characters

Profanity filtering

```
https://api.cognitive.microsofttranslator.com/translate?api-version=3.0
                                        &from=en&to=de&profanityAction=Marked

Body: [
        { 'Text' : 'JSON is [redacted]great!' }
      ]
```

```
[
  {'translations':
    [
      {'text': 'JSON ist *** erstaunlich.', 'to': de'}
    ]
  }
]
```

Default marker for obscenity is asterisk

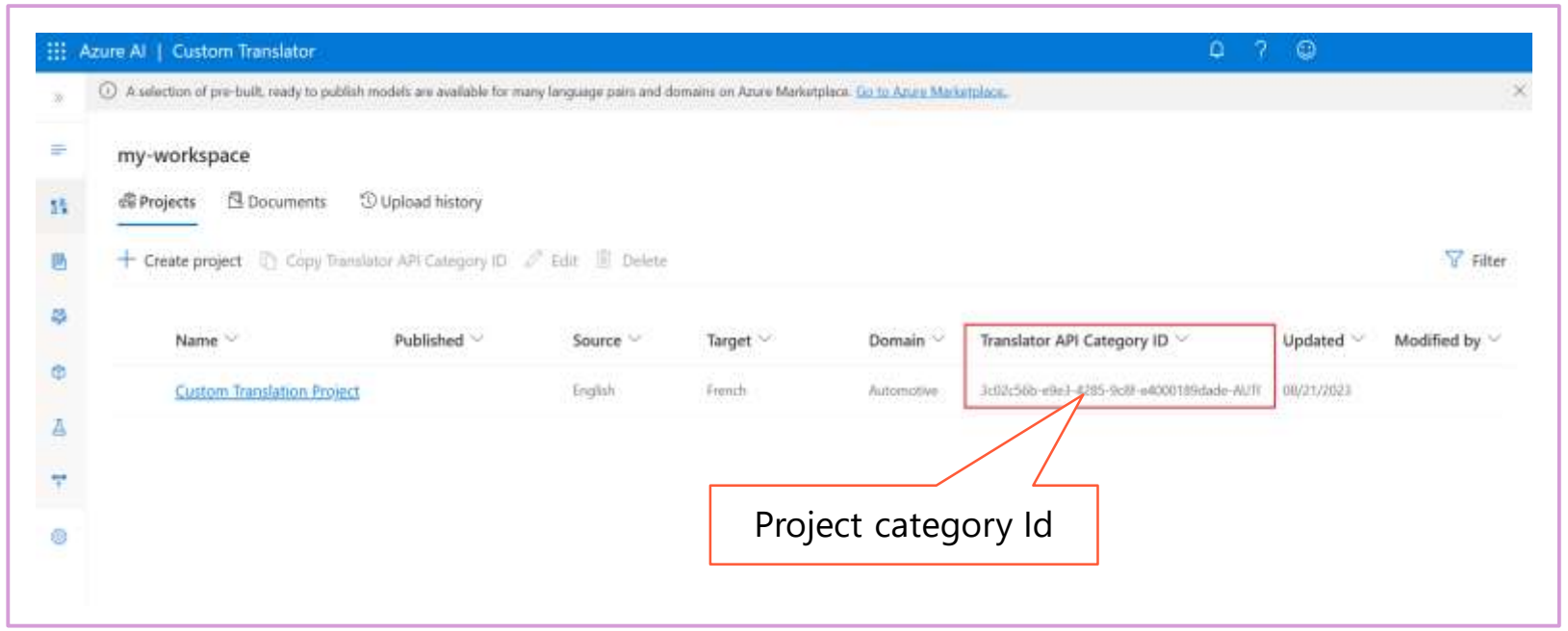
Custom Translation

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



Build a question answering solution

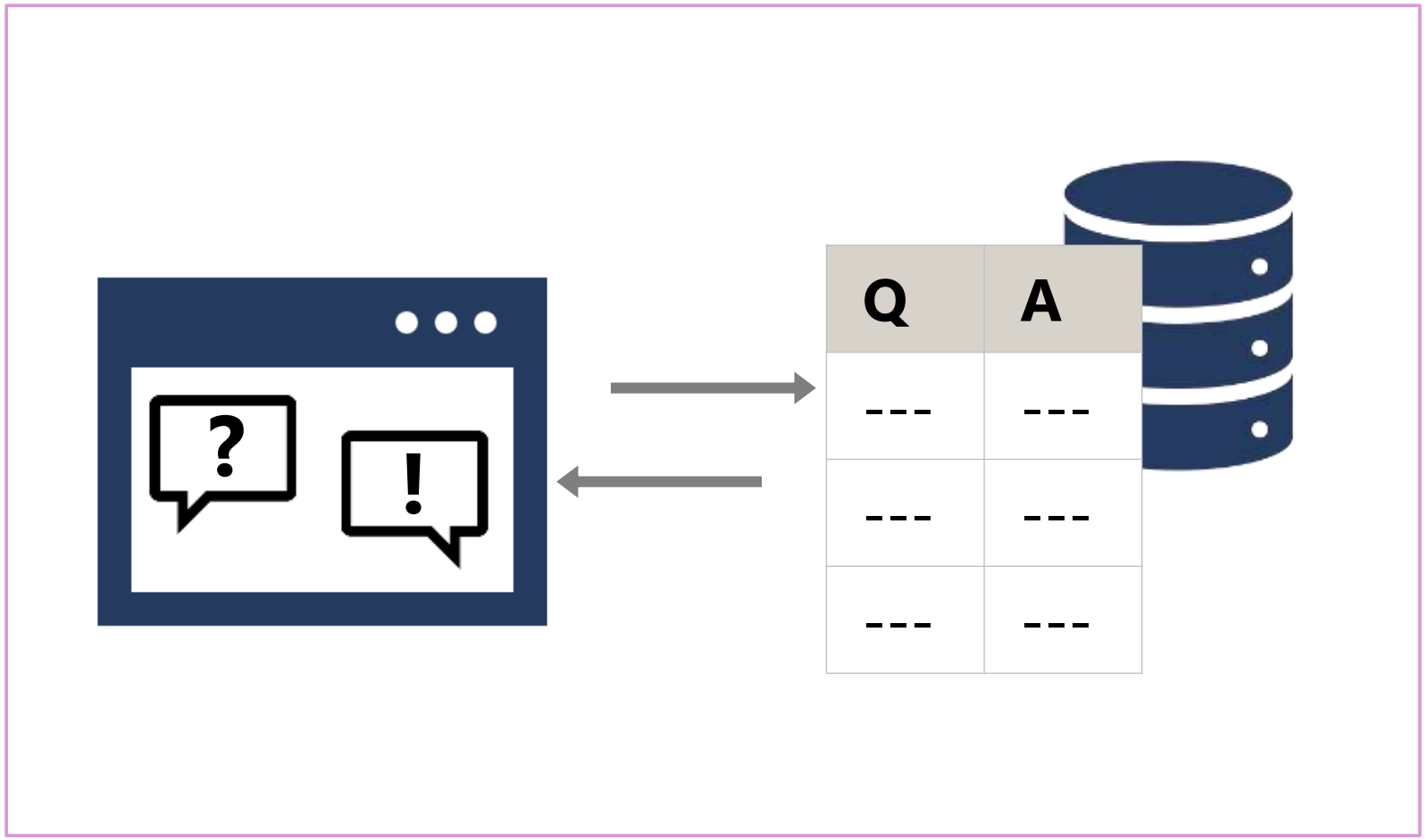
Learning Objectives

After completing this module, you will be able to:

1. Describe the question answering capabilities of Azure AI Language.
2. Describe the differences between question answering and conversational language understanding.
3. Create a knowledge base.
4. Implement multi-turn conversation.
5. Test and publish a knowledge base.
6. Consume a published knowledge base.
7. Implement active learning.

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



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

Creating a Knowledge Base

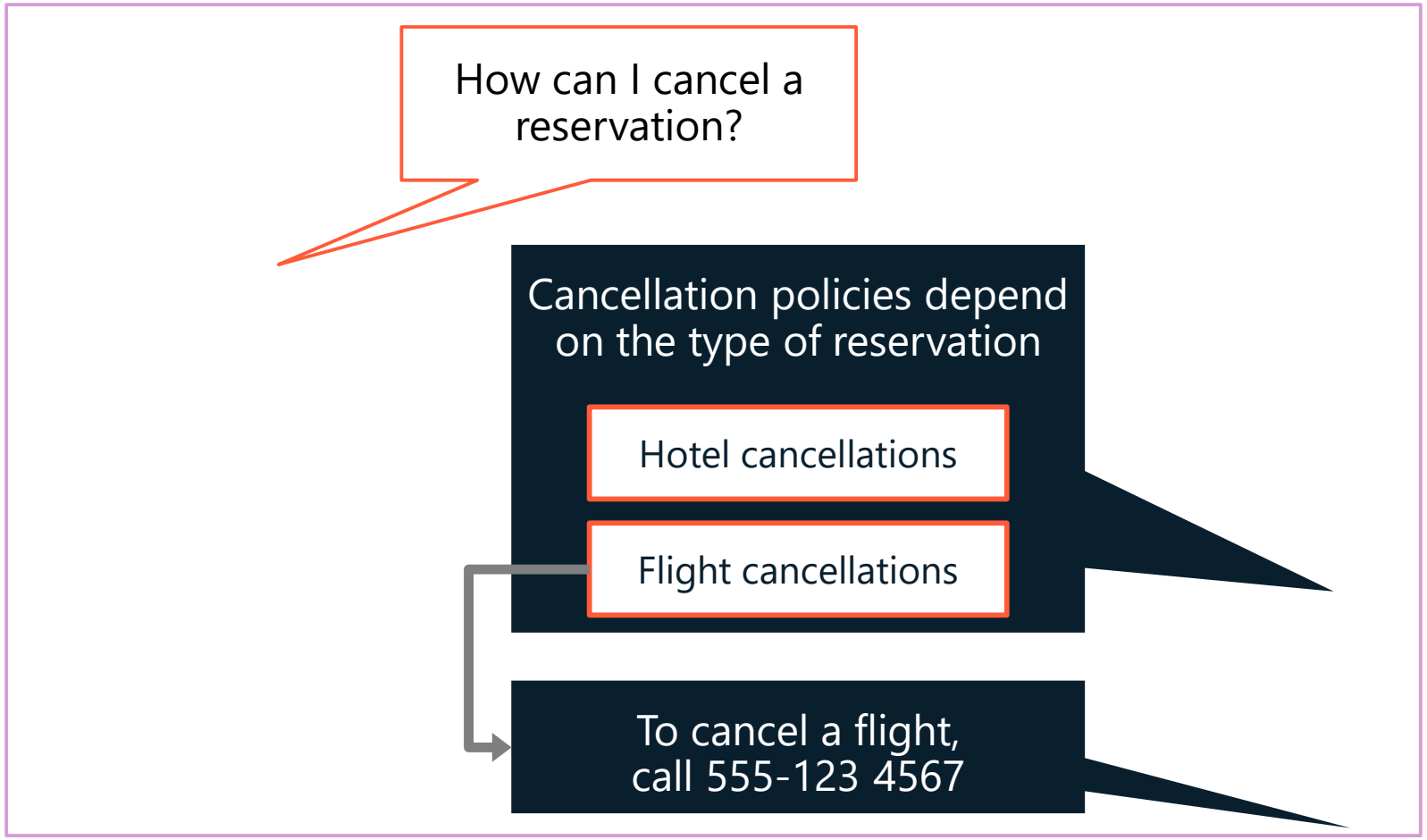
Use the Language Studio portal

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

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



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

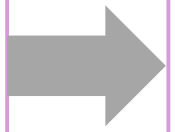
Publish the trained knowledge base

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

Creating client apps

- REST Interface or SDKs
- Submit questions to the endpoint

```
{
  "question": "What do I need to do to
cancel a reservation?",
  "top": 2,
  "scoreThreshold": 20,
  "strictFilters": [
    {
      "name": "category",
      "value": "api"
    }
  ]
}
```



```
{
  "answers": [
    {
      "score": 27.74823341616769,
      "id": 20,
      "answer": "Call us on 555 123 4567 to
cancel a reservation.",
      "questions": [
        "How can I cancel a reservation?"
      ],
      "metadata": [
        {
          "name": "category",
          "value": "api"
        }
      ]
    }
  ]
}
```

Confidence score

Answer text

Best question match

Improving Question Answering Performance

Enable *Active Learning* to suggest alternatives when multiple questions have similar scores for user input

- **Implicit**: The service identifies potential alternative phrases for questions; and presents suggestions in the Language Studio. Periodically review and accept/reject the suggestions.
- **Explicit**: The service returns multiple possible question matches to the user, and the user identifies the correct one. The client app then uses the API to submit feedback items, identifying the correct answer.

Create *Synonyms* for terms with the same meaning

- Add synonyms to the knowledge base through the API or Language Studio interface.

Build a conversational language understanding app

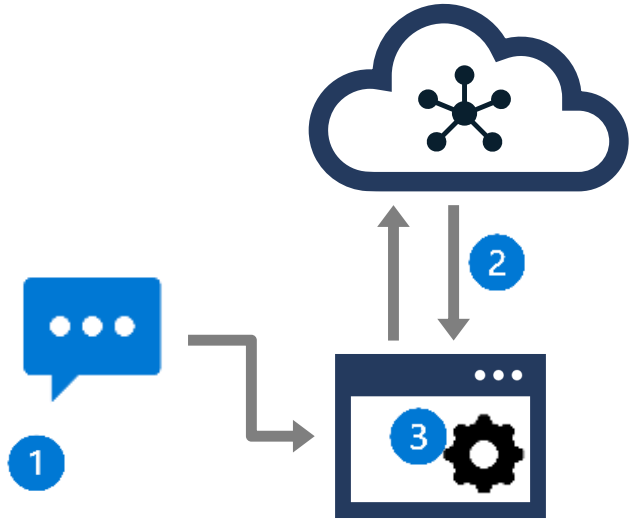
Learning objectives

After completing this module, you will be able to:

1. Provision an Azure AI Language resource
2. Define intents, entities, and utterances
3. Use patterns to differentiate similar utterances and use pre-built entity components
4. Train, test, publish, and review a model
5. Describe Azure AI Language Understanding features

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.

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

Entities

Define *entities* to add specific context to intents

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

Entity types:

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

Prebuilt entity components

Prebuilt components automatically predict common types from utterances:

Quantities

- Age, Number, Percentage, Currency, others…

Datetime

- "June 23, 1976", "7 AM", "6:49 PM", "Tomorrow at 7 PM", "Next Week".

Email

- "user@contoso.com"

Phone number

- US Phone Numbers such as "+1 123 456 7890" or "(123)456-7890".

URL

- "https://learn.microsoft.com/"

Azure AI Language service capabilities

Features fall into two categories:

Preconfigured features – Can be used without labeling or training:

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

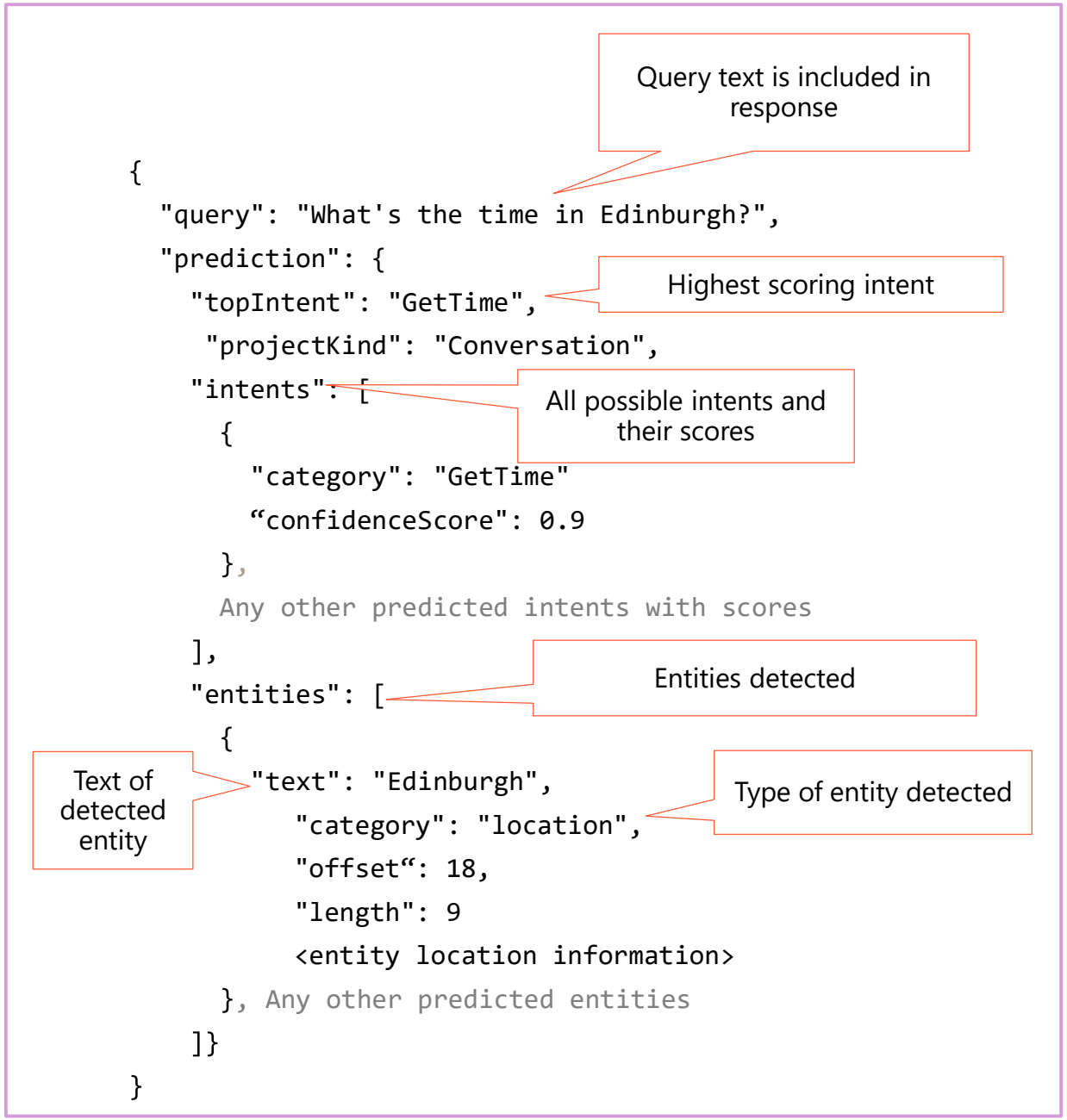
Learned features – Require labeling, training, and deploying to utilize

- Conversational language understanding
- Custom named entity recognition
- Custom text classification
- Question answering

Processing predictions

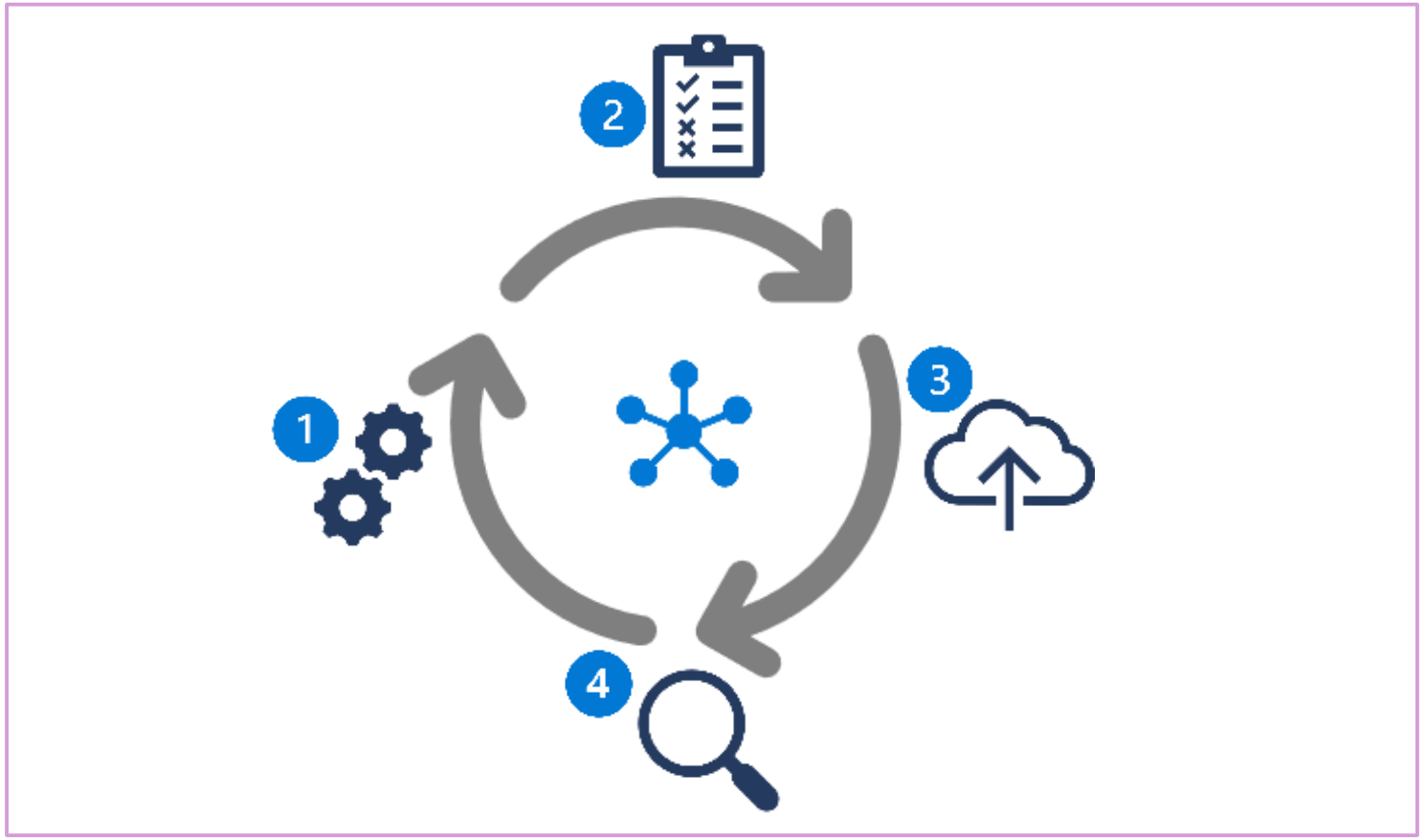
Submit a request to a published slot, specifying:

- **Kind –** Indicates which language feature you're requesting. For example, **kind** is defined as *Conversation* for conversational language understanding, or *EntityRecognition* to detect entities
- **Parameters –** Indicates the values for various input parameters. These parameters vary depending on the feature.
- **Analysis input –** Specifies the input documents or text strings to be analyzed by the Azure AI Language service.



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



Custom classification and named entity extraction

Learning Objectives

After completing this module, you will be able to:

1. Label documents, train and deploy models for custom classification
2. Understand model performance and see where to improve your model
3. Use your custom model in an app

Custom Text Classification

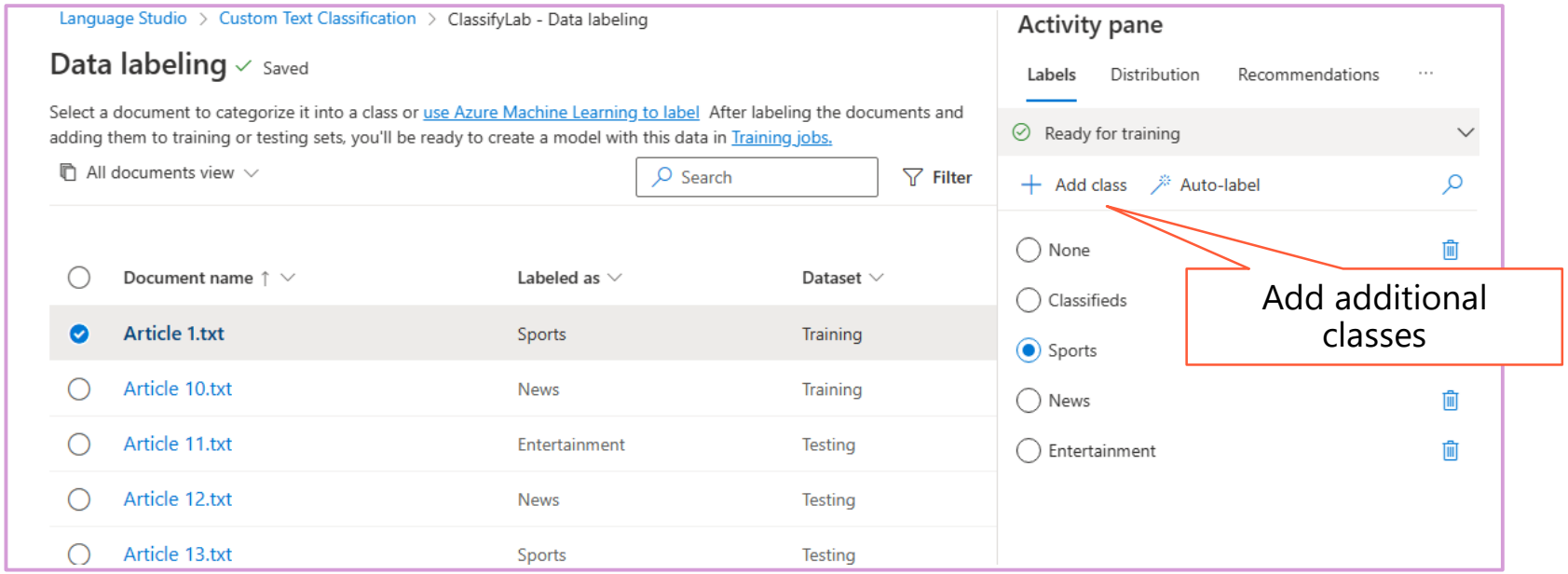
Assign custom labels to documents

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



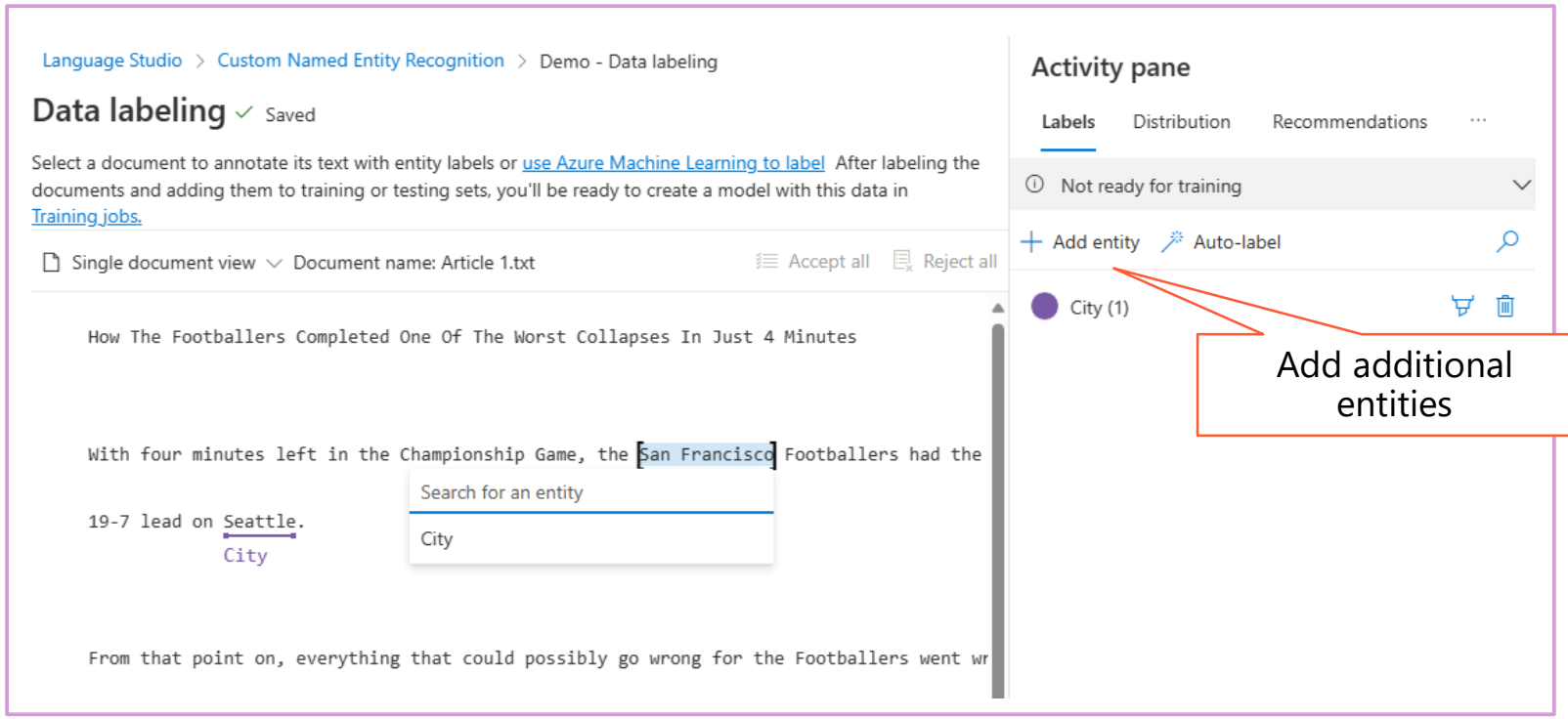
Custom Named Entity Recognition

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

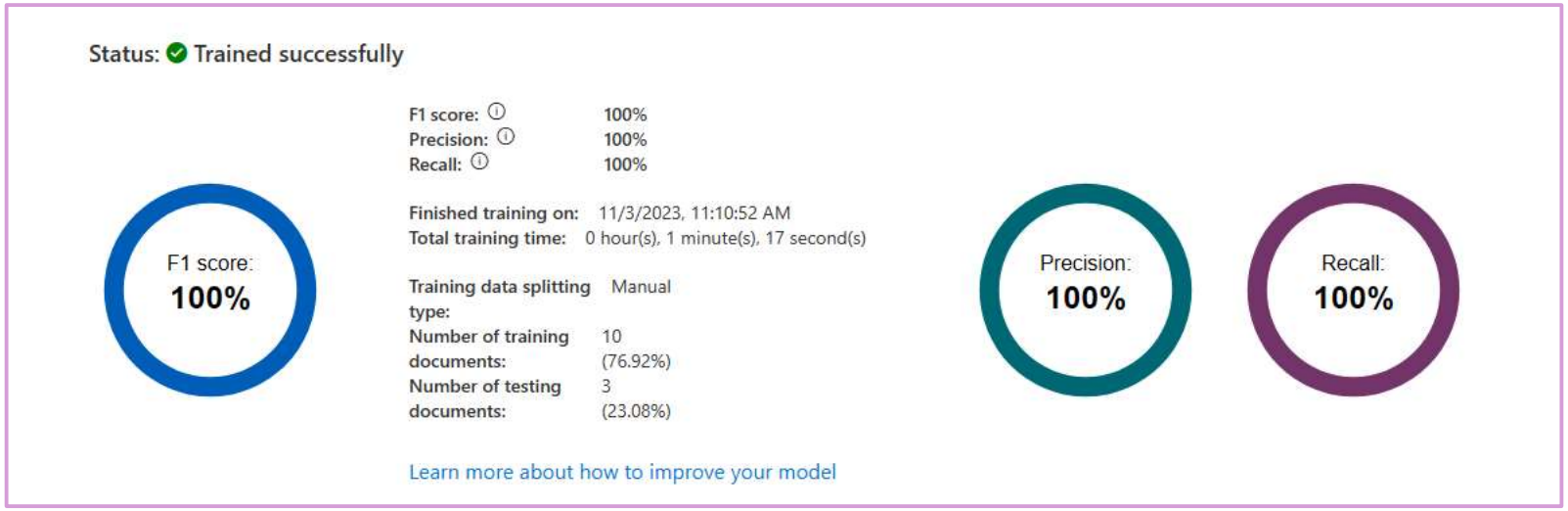
Call your model through the Language API

- Specify project and deployment name



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



Speech recognition, translation and synthesis

Learning Objectives

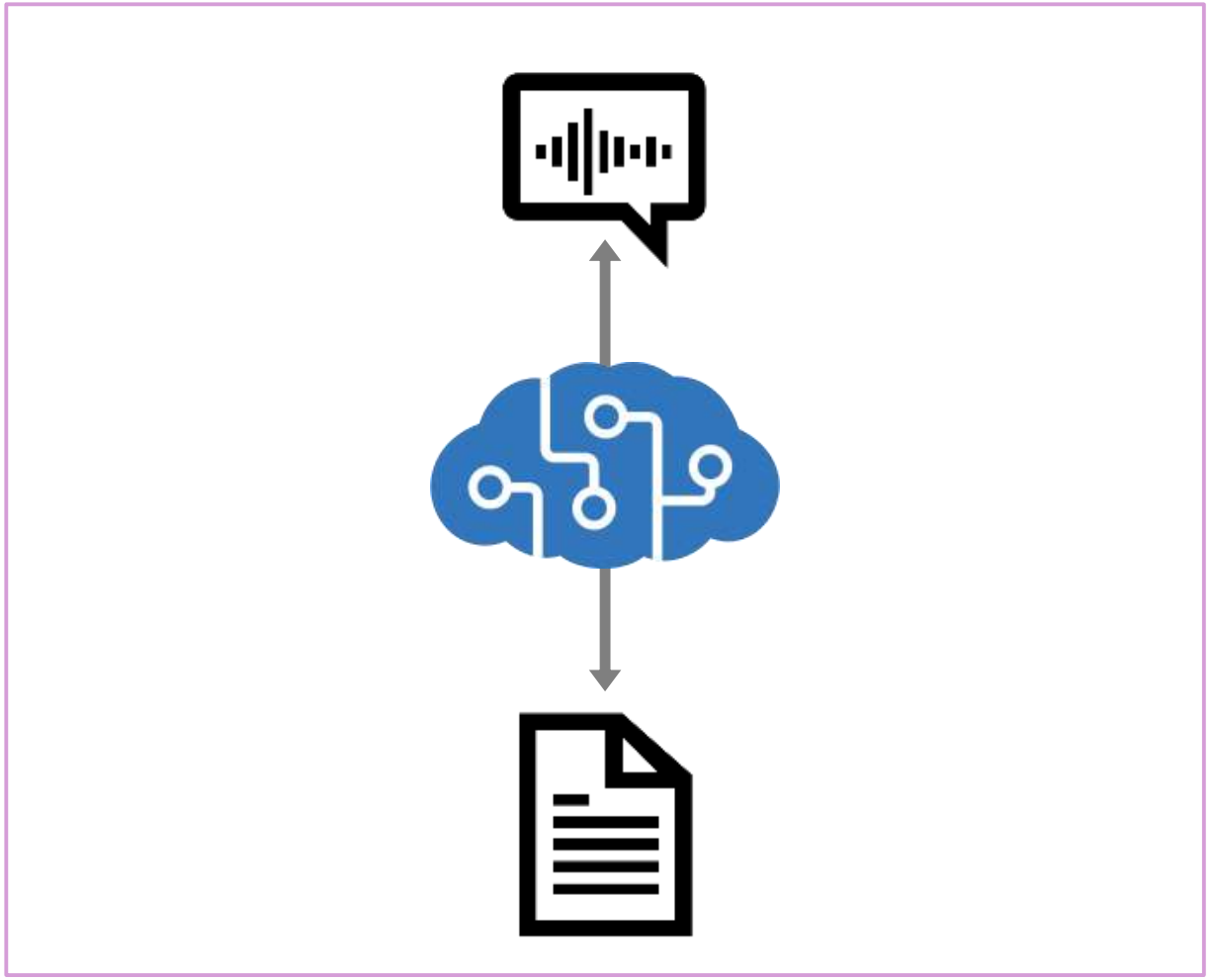
After completing this module, you will be able to:

1. Provision an Azure resource for the Azure AI Speech service
2. Use the Speech to text API to implement speech recognition
3. Use the Text to speech API to implement speech synthesis
4. Configure audio format and voices
5. Use Speech Synthesis Markup Language (SSML)

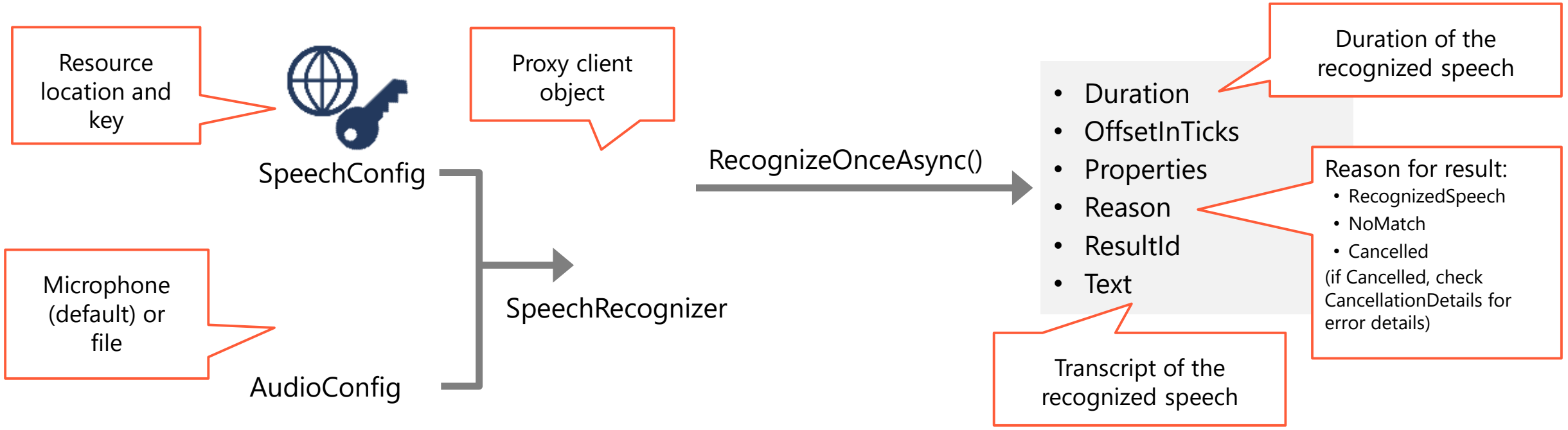
The Speech Service

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)



Speech-to-Text

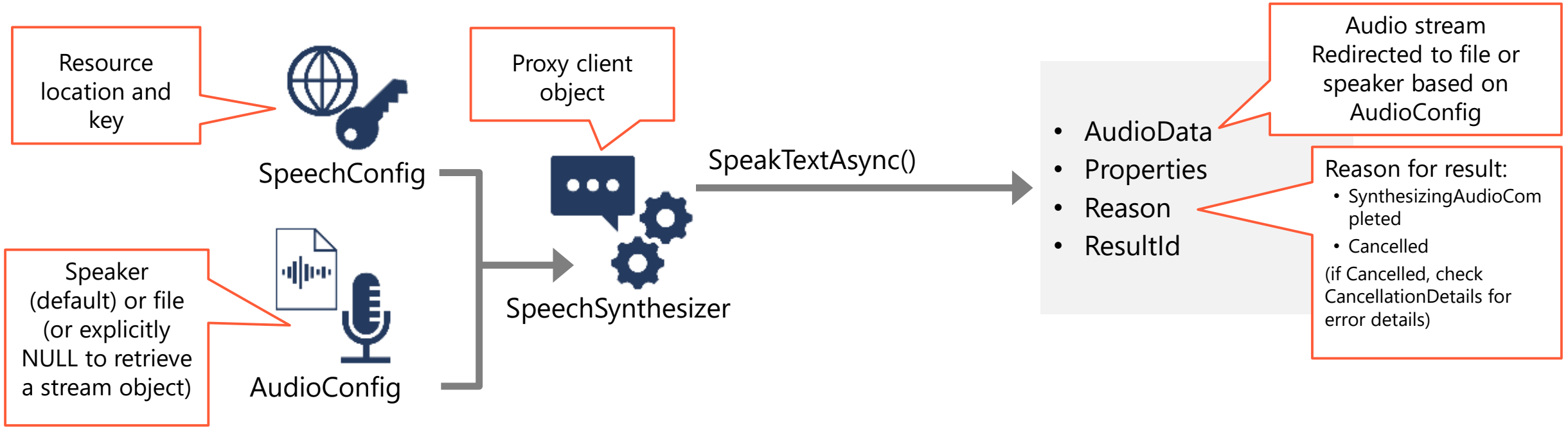


Two REST APIs:

- 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

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

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

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

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";
```

Speech Synthesis Markup Language (SSML)

XML-based language with customization options:

- Speaking styles (Neural voices only)
- Pauses and silence
- Phonemes (phonetic pronunciations)
- Prosody (speaking pitch, range, rate, etc.)
- "say-as" (number, date, time, address, etc.)
- Insert recorded speech or background audio

```
SpeakSsmlAsync( ssml-string );

<speak version="1.0" xmlns="http://www.w3.org/2001/10/synthesis"
                     xmlns:mstts="https://www.w3.org/2001/mstts" xml:lang="en-US">
    <voice name="en-US-AriaNeural">
        <mstts:express-as style="cheerful">
          I say tomato
        </mstts:express-as>
    </voice>
    <voice name="en-US-GuyNeural">
        I say <phoneme alphabet="sapi" ph="t ao m ae t ow"> tomato </phoneme>.
        <break strength="weak"/>Lets call the whole thing off!
    </voice>
</speak>
```

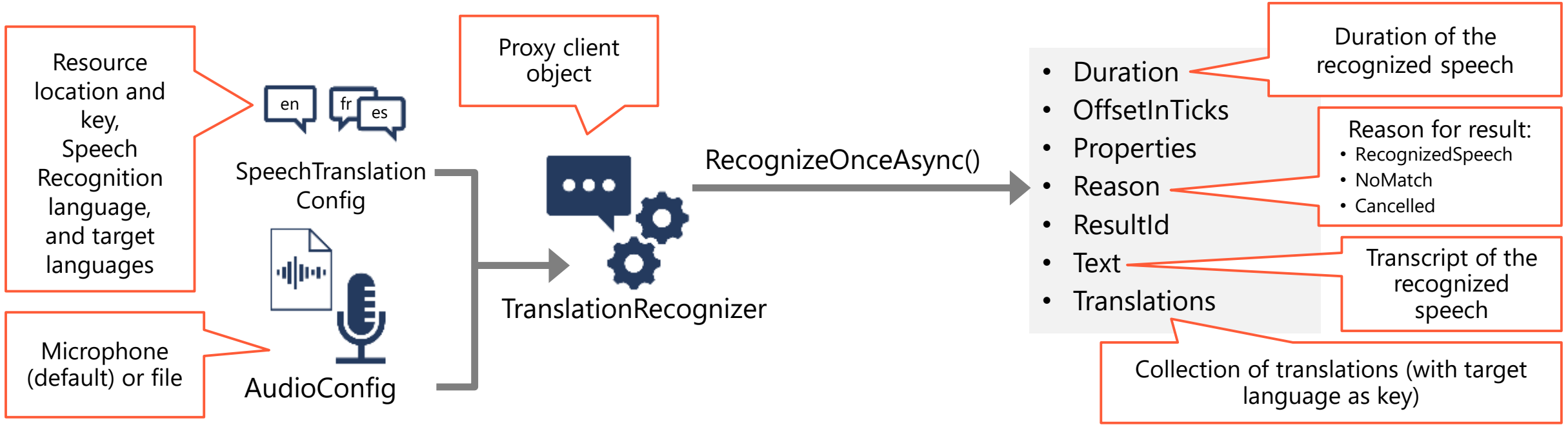
Multiple voices in a single synthesis

Speaking style

Phonetic pronunciation

Pause

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

Synthesizing Translations as Speech

Event-based synthesis

- Only supported for 1:1 translation (single target language)
- Specify desired voice in the **TranslationConfig**
- Use the **Synthesizing** event to retrieve audio stream
- Create an event handler
- Use Result.GetAudio() to retrieve byte stream

Manual synthesis

- Use for multiple target languages
- Translate to text then use Text-to-Speech API to synthesize each translation in the results

Learning Path Recap

In this learning path, we learned to:

- Analyze and translate text
- Build a conversational language understanding model
- Build a question answering solution
- Speech recognition, synthesis, and translation
- Connect an app to Azure AI Language resources