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Is Everyone AI-ing Without Me?

A .NET Developer's Guide to AI

Jonathan "J." Tower

Yes, **AI** is a **Buzzword**, But...

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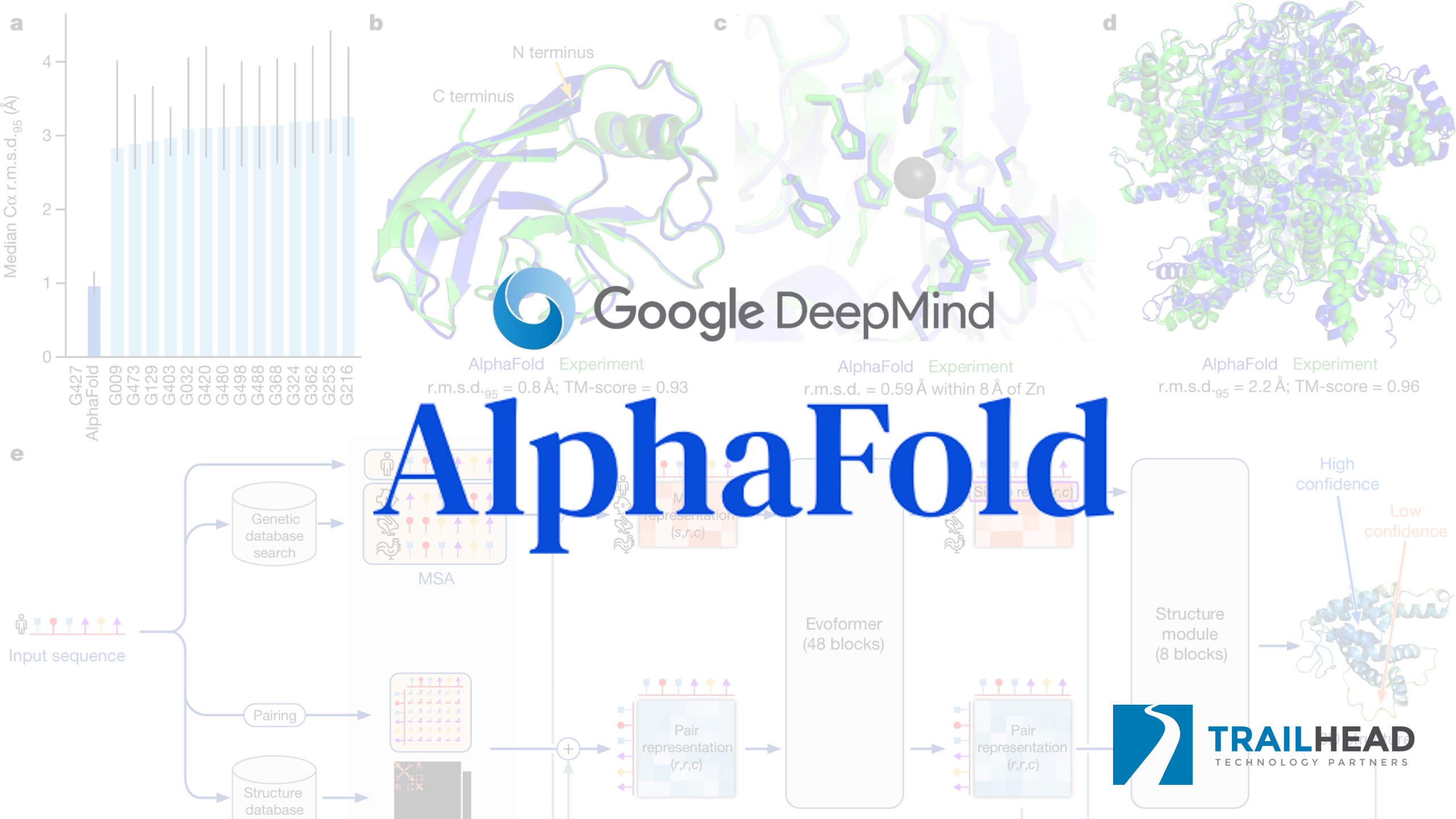
a
Median Cα r.m.s.d.95 (Å)
0
1
2
3
4
G427
AlphaFold
G009
G473
G129
G403
G032
G420
G480
G498
G488
G368
G324
G362
G253
G216
b
N terminus
C terminus
AlphaFold Experiment
r.m.s.d.95 = 0.8 Å; TM-score = 0.93
c
AlphaFold Experiment
r.m.s.d. = 0.59 Å within 8 Å of Zn
d
AlphaFold Experiment
r.m.s.d.95 = 2.2 Å; TM-score = 0.96
Google DeepMind
AlphaFold
e
Genetic database search
MSA
Input sequence
Pairing
Structure database
Pair representation (r,r,c)
Evoformer (48 blocks)
Pair representation (r,r,c)
Structure module (8 blocks)
High confidence
Low confidence
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AI: Not **JUST** a Buzzword?

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What AI Is;

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What AI Is;
When To Use It;

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What AI Is;
When To Use It;
How To Integrate it Into Your **.NET Applications**;

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Jonathan "J." Tower

Principal Consultant & Partner

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Microsoft MVP in .NET

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jtowermi

jtower

FREE

CONSULTATION

bit.ly/th-offer

github.com/trailheadtechnology/ai-for-dotnet

Understanding the AI Landscape

Artificial Super Intelligence (ASI)

Artificial General Intelligence (AGI)

Artificial Narrow Intelligence (ANI)

Artificial Super Intelligence (ASI)

Artificial General Intelligence (AGI)

Artificial Narrow Intelligence (ANI)

Specialized; Narrow Scope;
Not Self-Aware; Human Oversight

Artificial Super Intelligence (ASI)

Artificial General Intelligence (AGI)

Generalized; Versatile Scope;
Self-Aware; Novelty; Autonomy

Artificial Narrow Intelligence (ANI)

Specialized; Narrow Scope;
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Artificial Super Intelligence (ASI)

Surpasses Humans; Rapid Self-Learning
Unbound Scope

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Weak AI

Artificial Super Intelligence (ASI)

Surpasses Humans; Rapid Self-Learning
Unbound Scope

Artificial General Intelligence (AGI)

Generalized; Versatile Scope;
Self-Aware; Novelty; Autonomy

Strong AI

Artificial Narrow Intelligence (ANI)

Specialized; Narrow Scope;
Not Self-Aware; Human Oversight

Weak AI

We Are Here

Artificial Super Intelligence (ASI)

Surpasses Humans; Rapid Self-Learning
Unbound Scope

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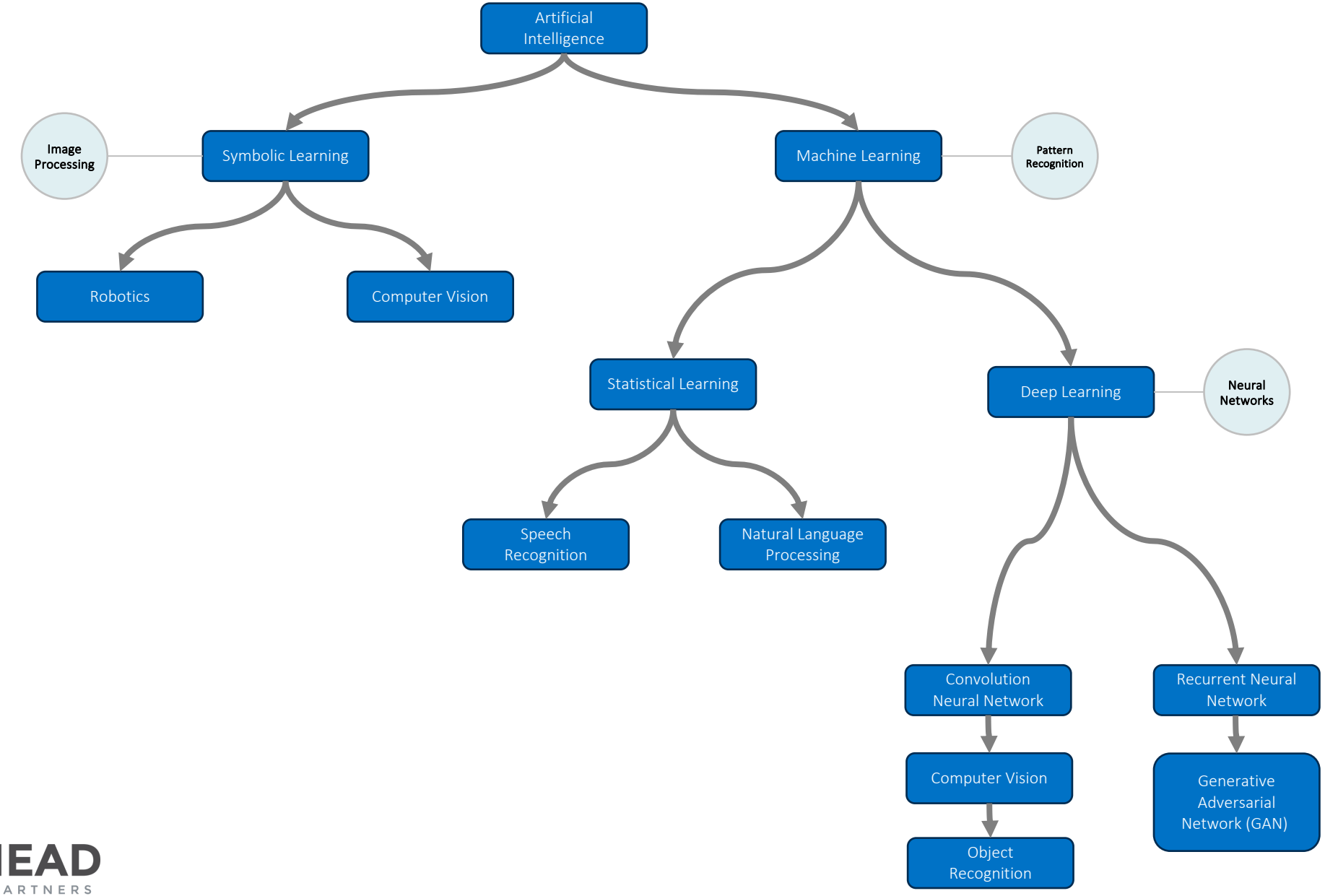
Weak AI



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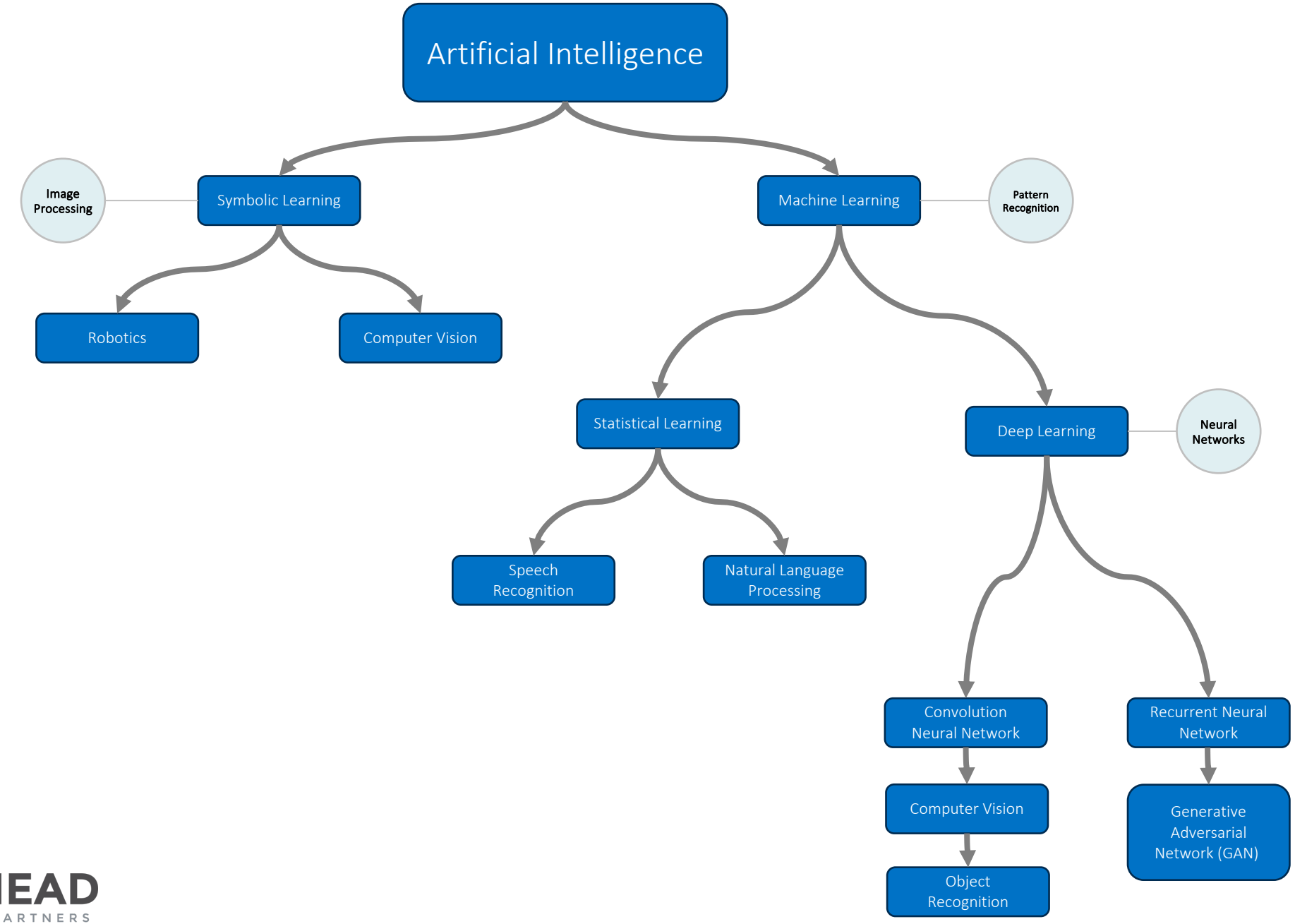

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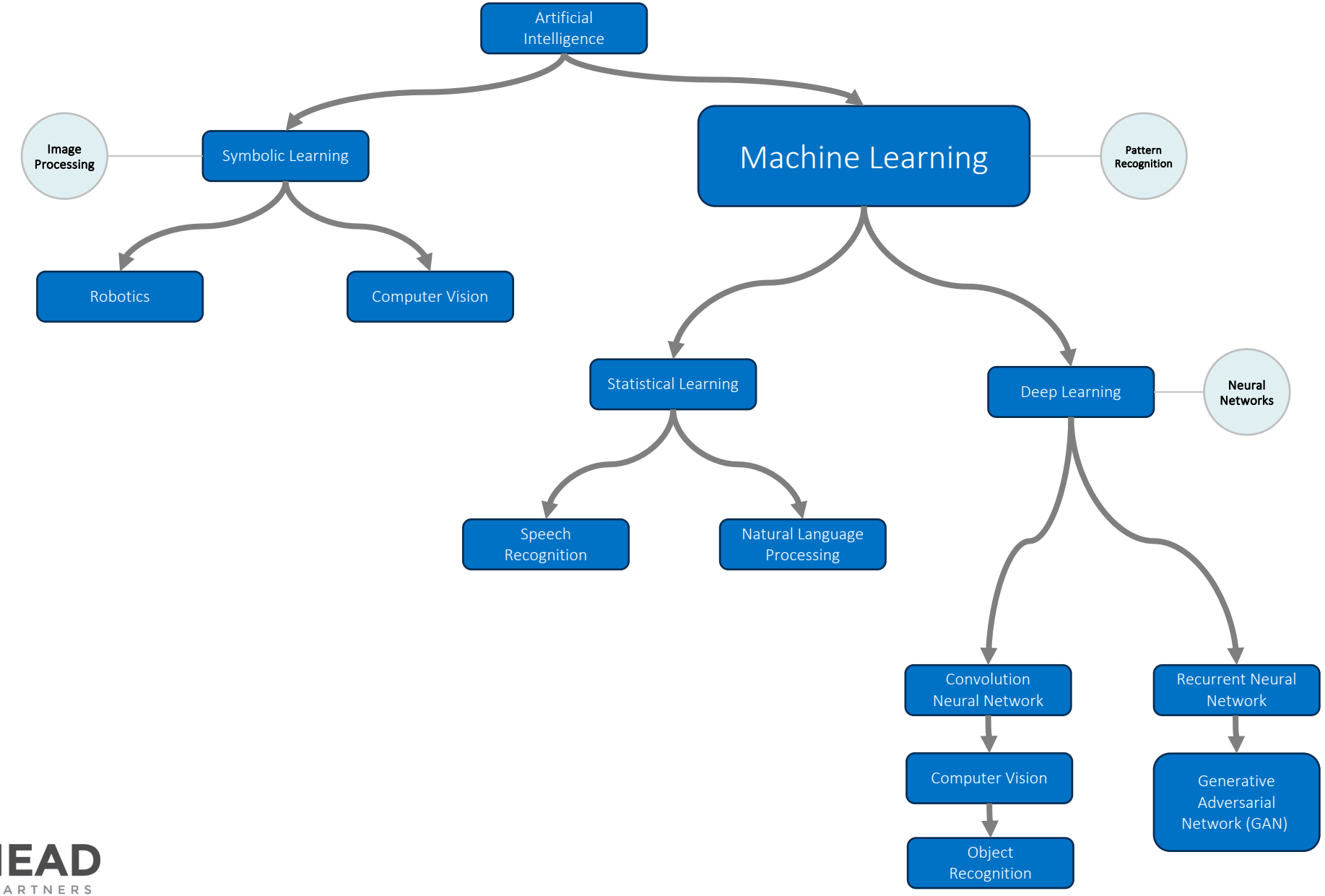

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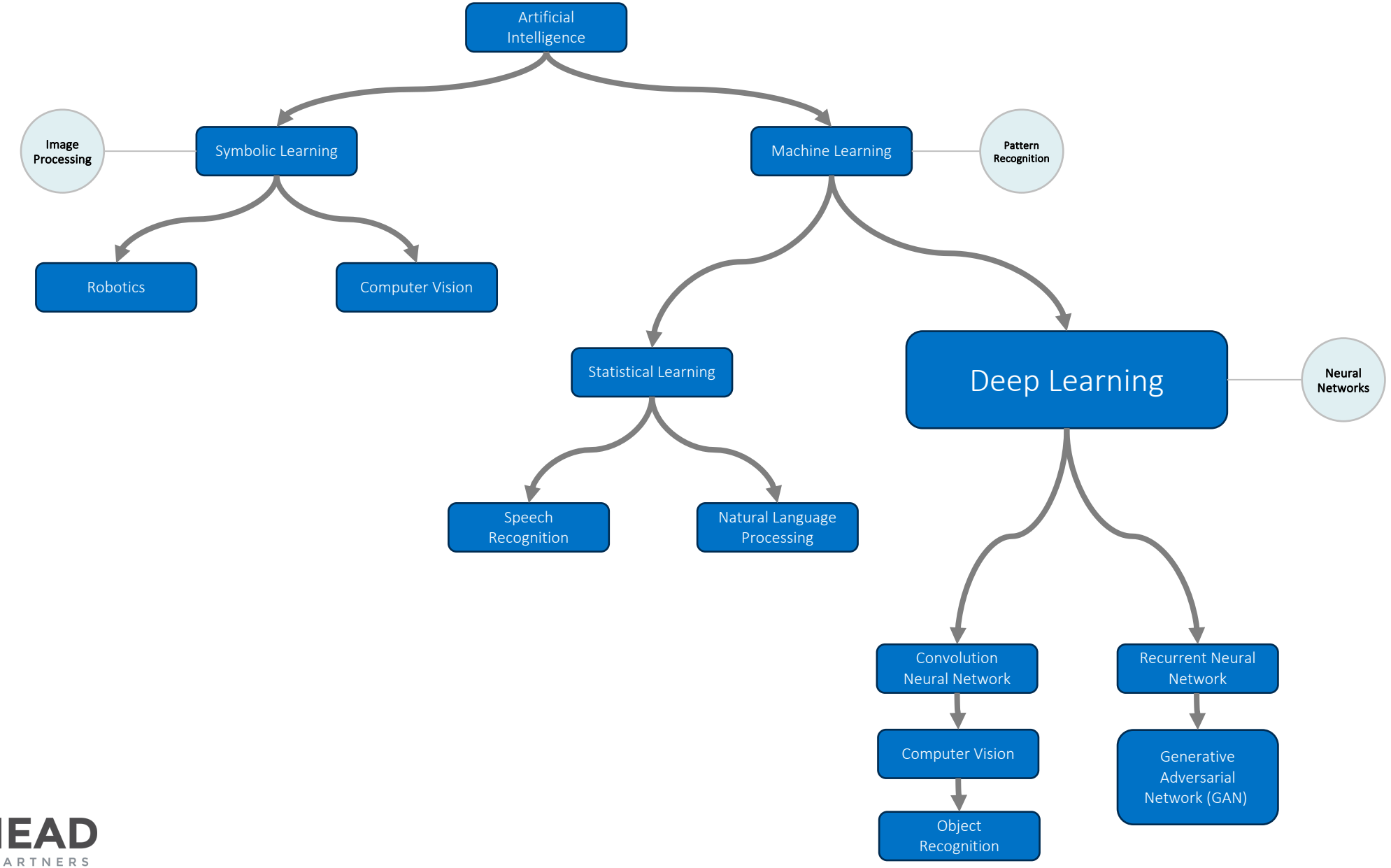

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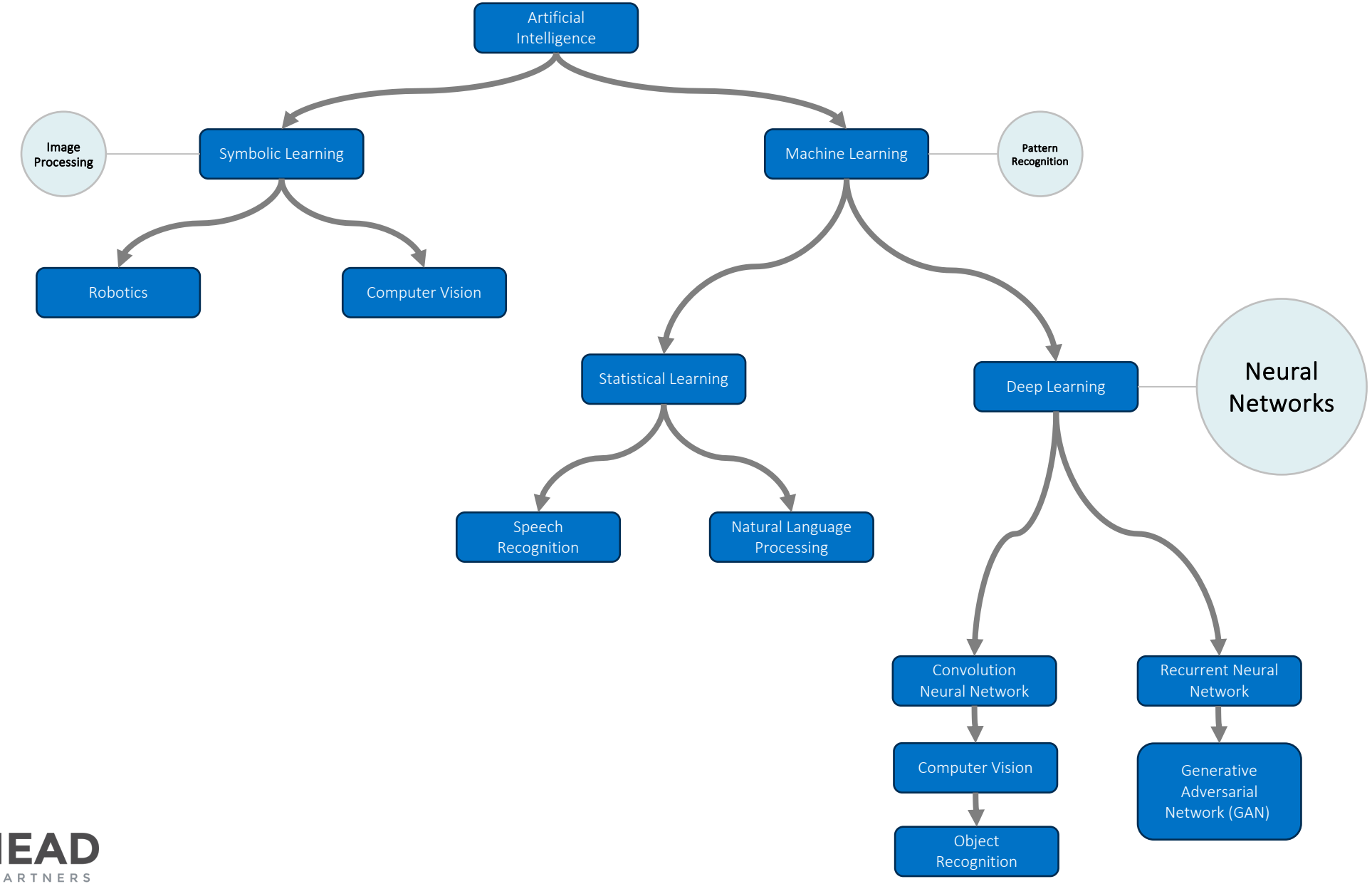

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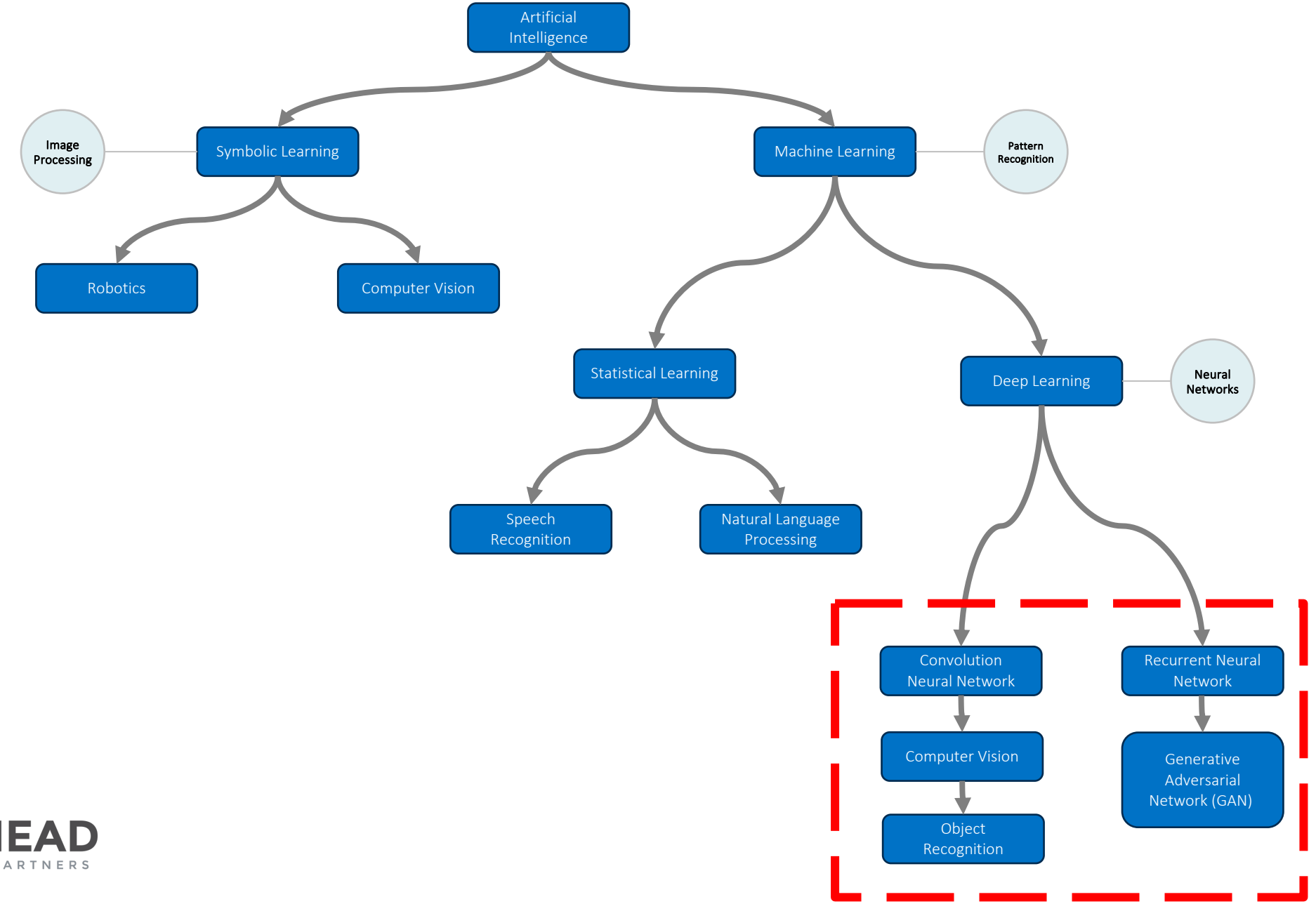

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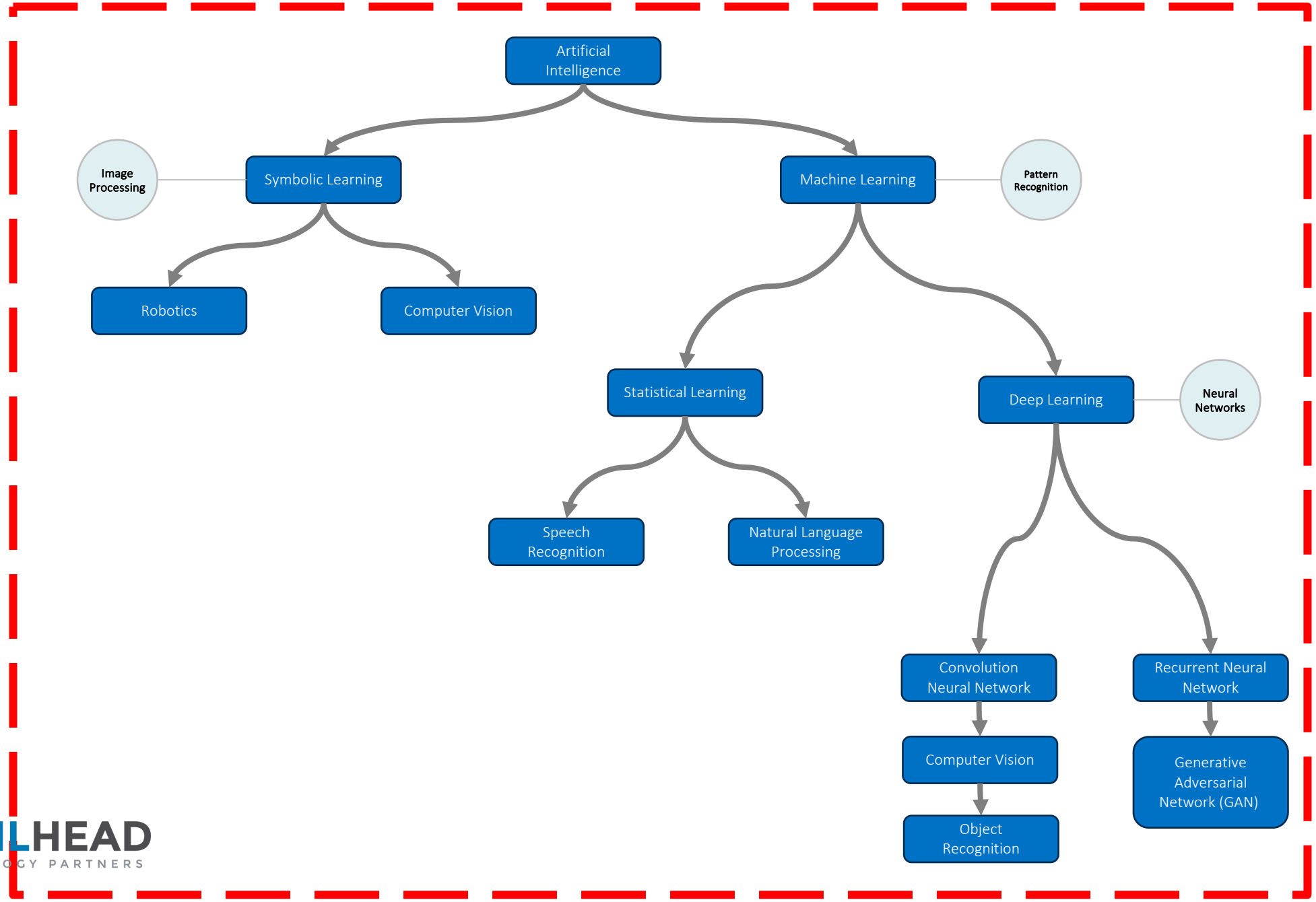

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When To Use AI vs Traditional Algorithms


"If the only tool you have is a hammer, it is tempting to treat everything as if it were a nail."
- Abraham Maslow

When To Use AI?

Use AI

Image Recognition

Text Classification & Natural Language Processing

Speech Recognition & Synthesis

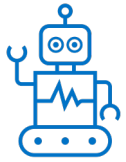
Recommendation Systems

Anomaly Detection

Predictive Analytics

Pattern Recognition

Content Generation



Chat Bots

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When To NOT Use AI?

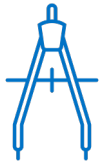
Use Traditional Algorithms

Rule-based Systems

Deterministic Rules

Forms Over Data

Predictability & Transparency



Precision & Simplicity

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Hybrid Approach

Going forward, most software will either:

1. Use ***BOTH*** AI and traditional algorithms, or
2. Use ***ONLY*** AI

Less and less software will use only traditional algorithms.

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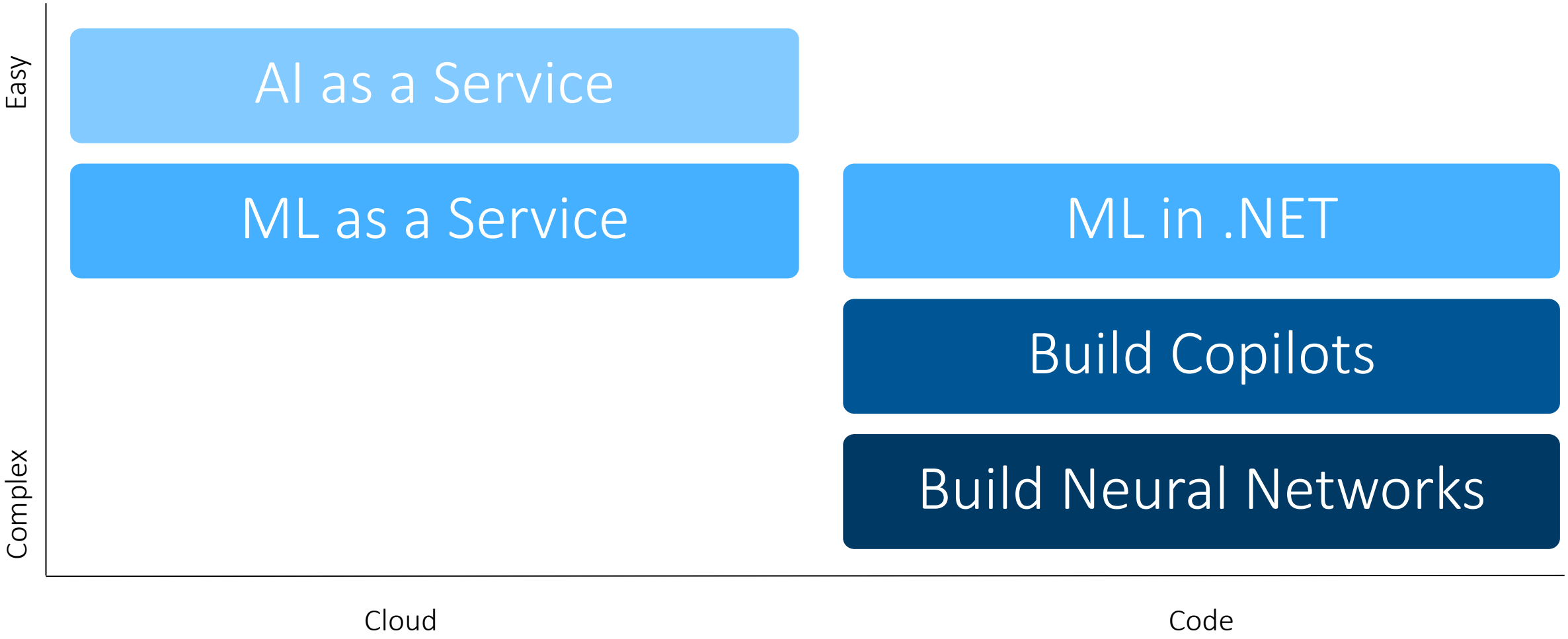
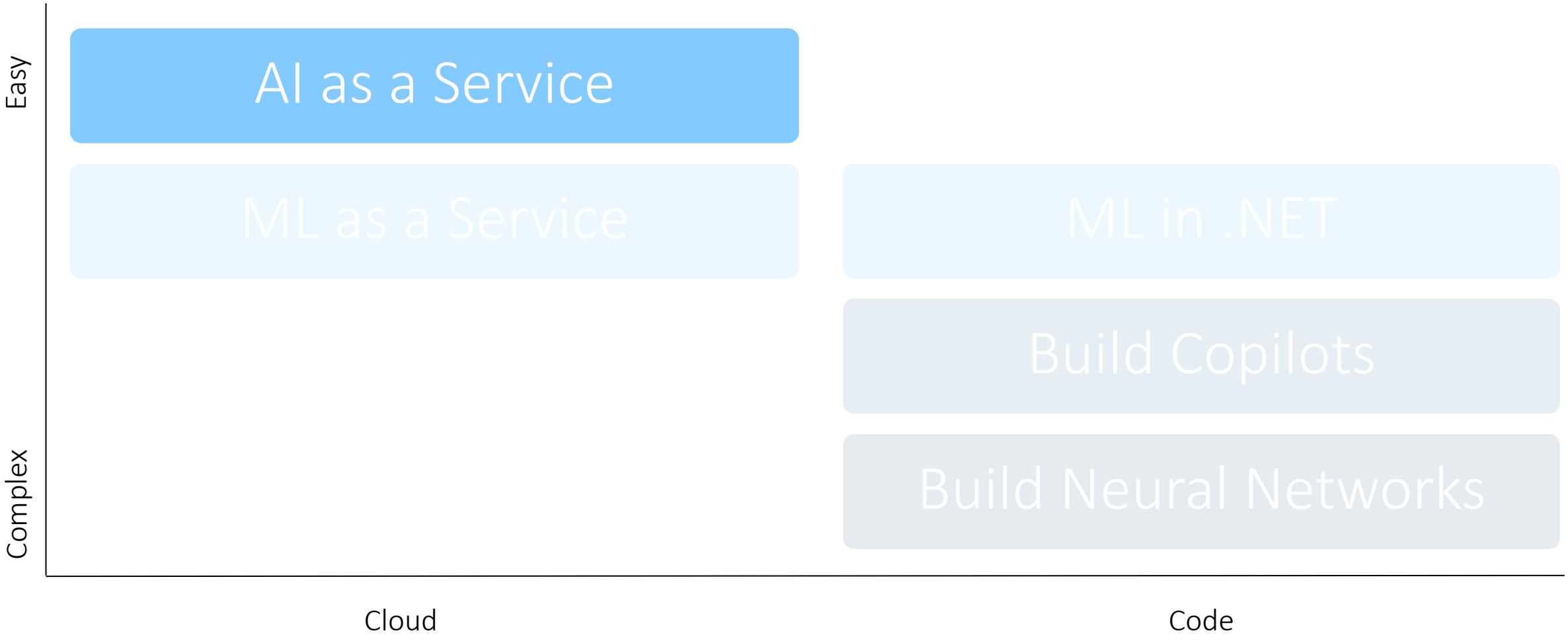
AI Tools & Services for .NET Developers

AI Tools & Services



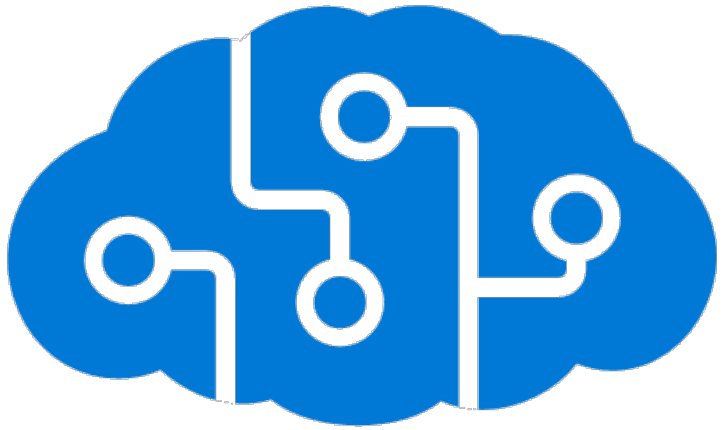
AI Tools & Services



Azure AI Service

Outsource your AI to the Cloud

Cognitive Services



- Anomaly Detection
- Azure AI Search
- Azure OpenAI
- Bot Service
- Content Moderator
- Content Safety
- Custom Vision
- Document Intelligence
- Face
- Immersive Reader
- Language
- Language Understanding
- Metrics Advisor
- Personalizer
- QnA maker
- Speech
- Translator
- Video Indexer
- Vision

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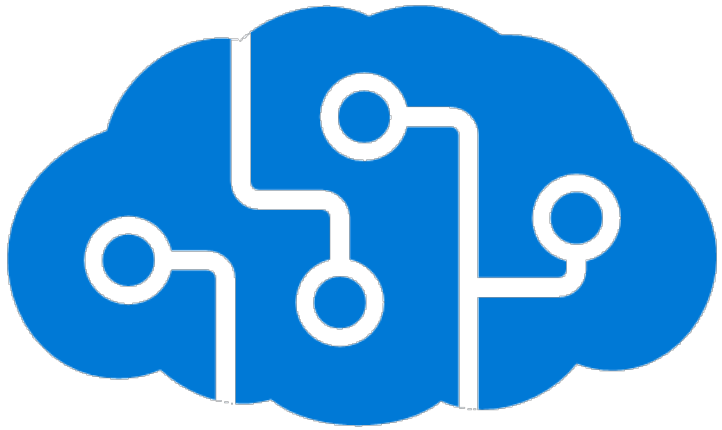
~~Cognitive Services~~ Azure AI Service



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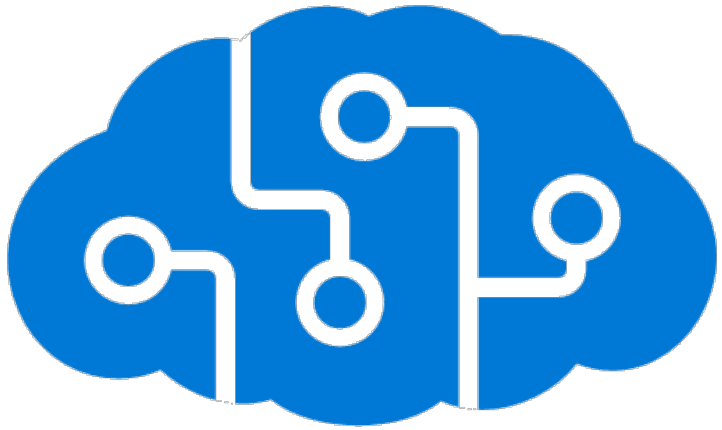
~~Cognitive Services~~ Azure AI Service



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Azure OpenAI Service

Access to OpenAI's generative models

Azure.AI.OpenAI package

Compatible with **Azure OpenAI** and **OpenAI** APIs

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OpenAI API

```
var endpointUri = new Uri("https://your-azure-openai-resource.com/");
var apiKey = "your-azure-openai-resource-api-key";

var client = new OpenAIClient(endpointUri, new AzureKeyCredential(apiKey));

var chatCompletion = client.GetChatCompletions("Tell me a joke!");

Console.WriteLine($"ChatGPT says: {chatCompletion.Message}");
```

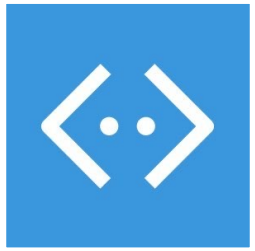
Azure OpenAI vs OpenAI

	Azure OpenAI	OpenAI
Doesn’t use your data for training	✅	✅
Can opt-out of data retention	✅	✅
Can choose region(s)	✅	❌
Virtual networking	✅	❌
Private link	✅	❌
Access control	✅	❌

Azure AI Bot Service

A platform that enables developers to build, deploy, and manage intelligent bots capable of natural language understanding and conversation management.

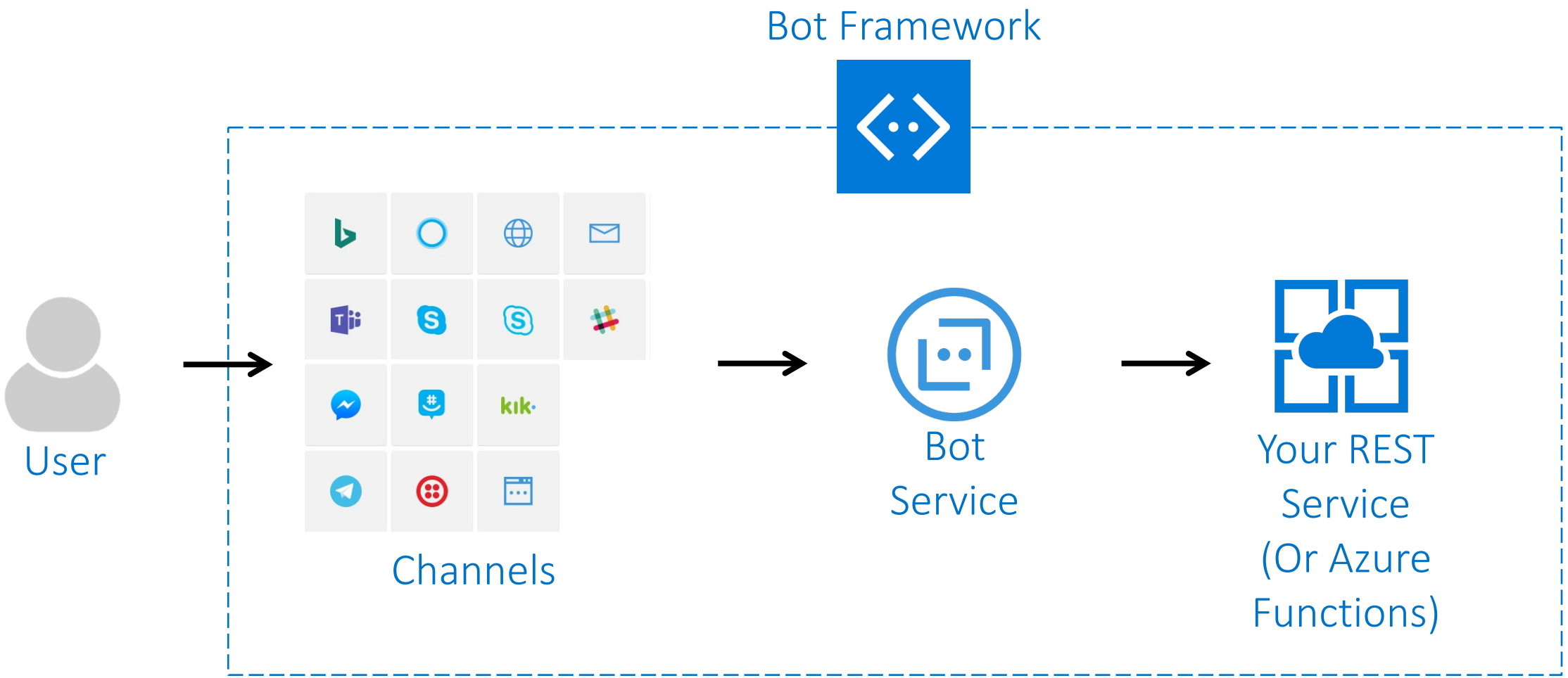
Bot Framework Composer



Bot Framework SDK

Power Platform Virtual Agents

How Azure Bot Service Works



Azure AI Bot Service

```
public class MessagesController: ApiController {

  public async Task<Message> Post([FromBody] Message message) {
    if (message.Type == "Message") {
      int length = (message.Text ?? string.Empty).Length;

      return message.CreateReplyMessage($"You sent {length} characters");
    } else {
      return HandleSystemMessage(message);
    }
  }

  private Message HandleSystemMessage(Message message) {
    ...
  }
}
```

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Azure AI Face

Detect

Recognize

Analyze

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Azure AI Face

- Face Detection
- Face Recognition
- Emotion Analysis
- Age and Gender Estimation
- Facial Landmarks
- Face Attributes
- Face Verification
- Face Grouping
- Face Similarity
- Face Identification

Azure AI Face

```
string subscriptionKey = "YOUR_SUBSCRIPTION_KEY";
string endpoint = "YOUR_FACE_API_ENDPOINT";

IFaceClient faceClient = new FaceClient(new ApiKeyServiceClientCredentials(subscriptionKey)) {
  Endpoint = endpoint
};

// Detect faces in a remote image
string imageUrl = "https://example.com/your-image.jpg";
IList<DetectedFace> detectedFaces = await faceClient.Face.DetectWithUrlAsync(imageUrl);

foreach(var face in detectedFaces) {
  Console.WriteLine($"Face ID: {face.FaceId}");
  Console.WriteLine($"Age: {face.FaceAttributes.Age}");
  Console.WriteLine($"Gender: {face.FaceAttributes.Gender}");
  Console.WriteLine();
}
```

Azure AI Language

Build apps with industry-leading natural language understanding capabilities

Merges:

- Text Analytics
- QnA Maker
- Language Understanding (LUIS)

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Azure AI Language

Named Entity Recognition (NER)

Personally Identifiable Information (PII) Detection

Language Detection

Sentiment Analysis and Opinion Mining

Summarization

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Azure AI Language

```
string endpoint = "YOUR_TEXT_ANALYTICS_ENDPOINT";
string apiKey = "YOUR_TEXT_ANALYTICS_API_KEY";
var client = new TextAnalyticsClient(new Uri(endpoint), new AzureKeyCredential(apiKey));

var sentimentResults = await client.AnalyzeSentimentBatchAsync(reviews);

foreach(var result in sentimentResults.Value) {
  if (result.Sentiment == TextSentiment.Positive) positiveCount++;
  else if (TextSentiment.Negative) negativeCount++;
  else if (TextSentiment.Neutral) neutralCount++;
}

Console.WriteLine($"Positive: {positiveCount}, Negative: {negativeCount}, Neutral: {neutralCount}");
```

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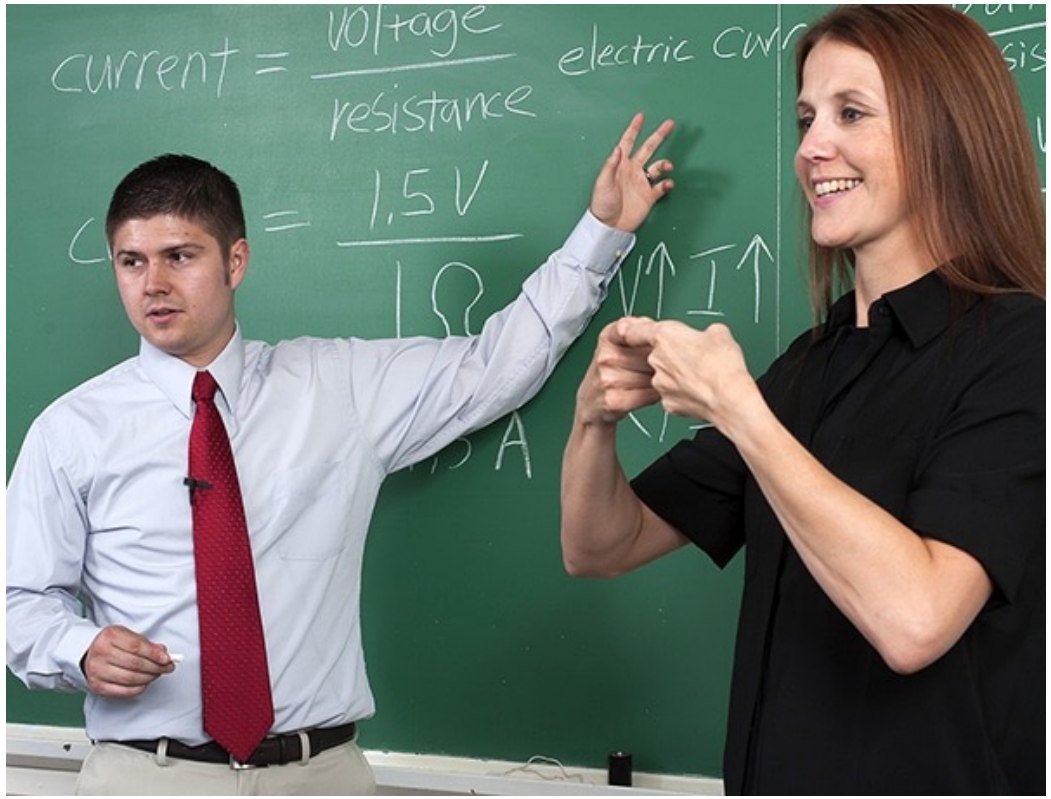
Azure AI Speech



Provides advanced **speech recognition** and **synthesis** capabilities, enabling developers to integrate speech processing into applications for converting **spoken language into text** and synthesizing **speech from text**.

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Azure AI Speech

```
var config = SpeechConfig.FromSubscription(
    "SUBSCRIPTION_KEY",
    "SERVICE_REGION");

config.SpeechSynthesisVoiceName = "en-US-JennyNeural";

using(var audioConfig = AudioConfig.FromDefaultSpeakerOutput())
{
    using(var synthesizer = new SpeechSynthesizer(config, audioConfig))
    {
        await synthesizer.SpeakTextAsync("Hello, world.");
    }
}
```

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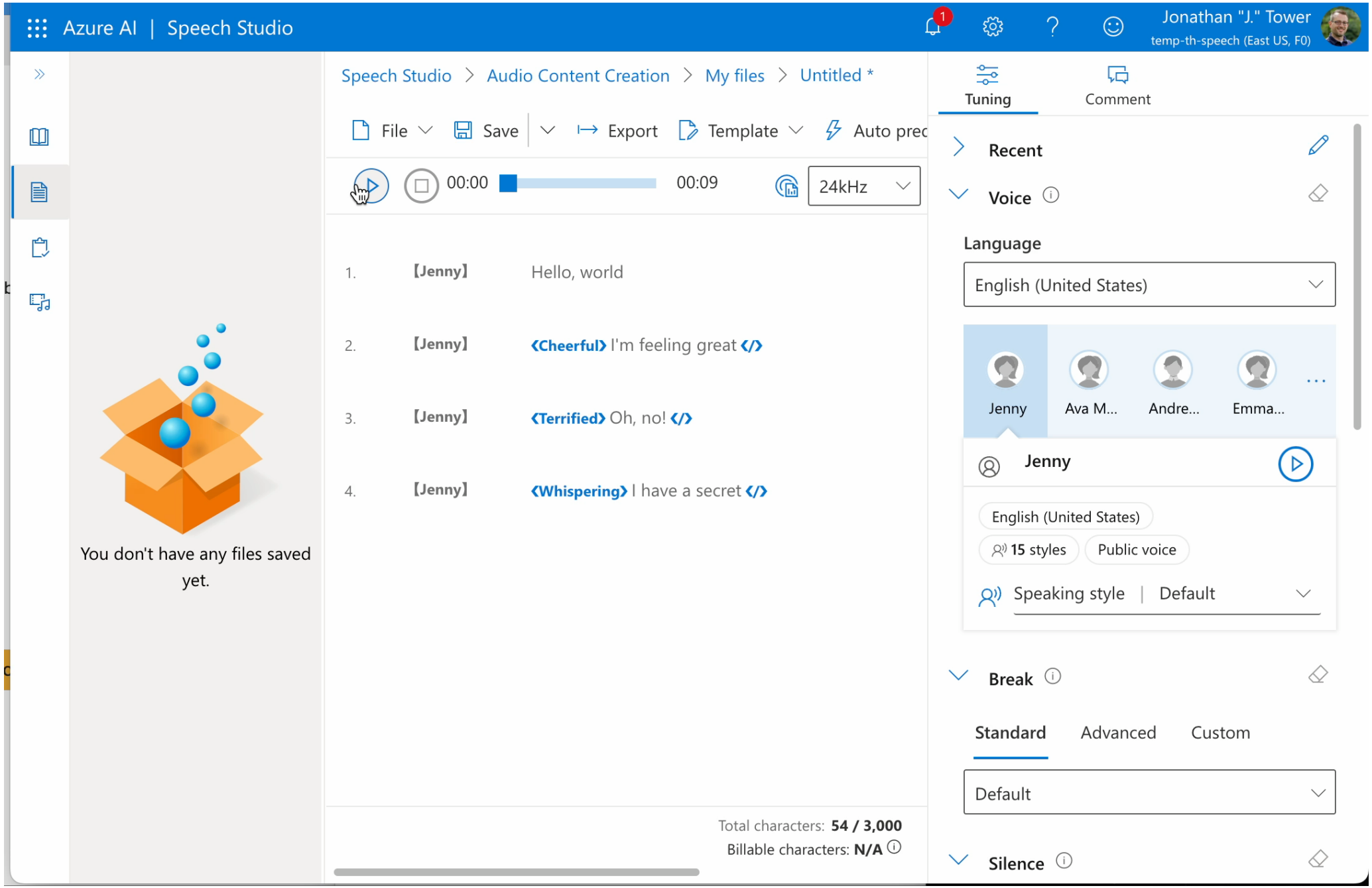
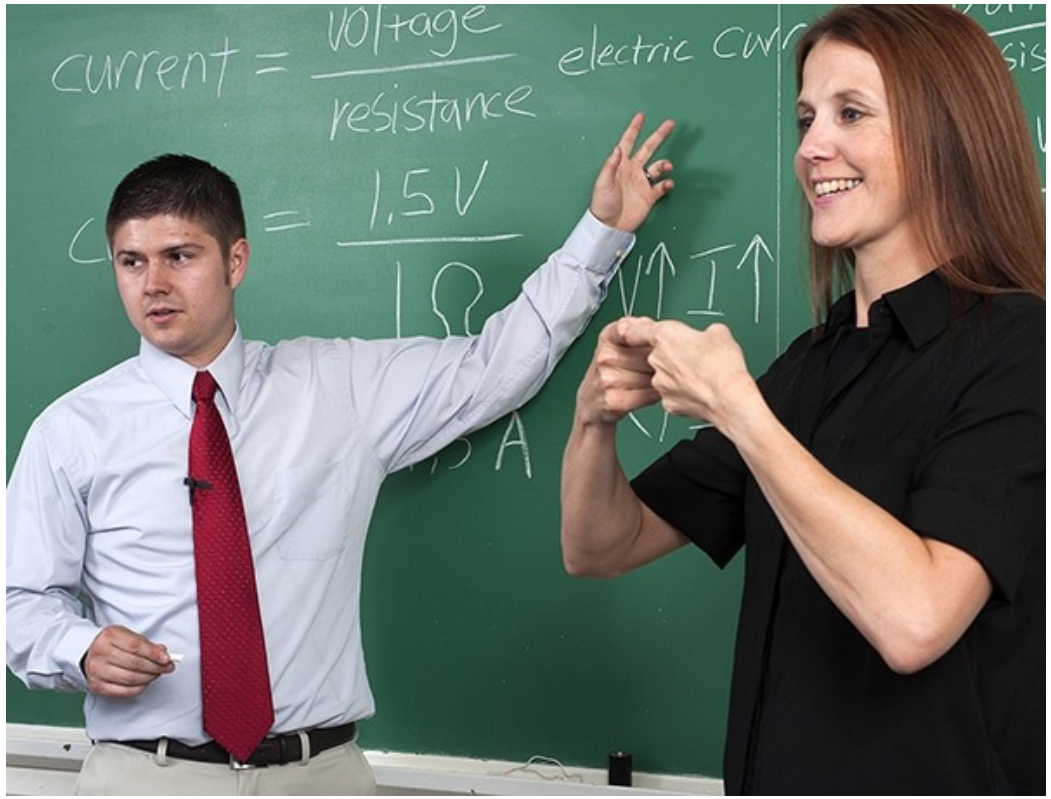

Azure AI | Speech Studio
Jonathan "J." Tower
temp-th-speech (East US, F0)
Speech Studio > Audio Content Creation > My files > Untitled *
File
Save
Export
Template
Auto prec
00:00
00:09
24kHz
1. 【Jenny】 Hello, world
2. 【Jenny】 <Cheerful> I'm feeling great </>
3. 【Jenny】 <Terrified> Oh, no! </>
4. 【Jenny】 <Whispering> I have a secret </>
You don't have any files saved yet.
Total characters: 54 / 3,000
Billable characters: N/A
Tuning
Comment
Recent
Voice
Language
English (United States)
Jenny
Ava M...
Andre...
Emma...
Jenny
English (United States)
15 styles
Public voice
Speaking style | Default
Break
Standard
Advanced
Custom
Default
Silence

Azure AI Translator



Translate text instantly or in batches across more than **100 languages**. Support a wide range of use cases, such as translation for **call centers**, multilingual **conversational agents**, or **in-app** communication.

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Azure AI Translator

```
string endpoint = "YOUR_TEXT_ANALYTICS_ENDPOINT";
string apiKey = "YOUR_TEXT_ANALYTICS_API_KEY";
var client = new TextAnalyticsClient(new Uri(endpoint), new AzureKeyCredential(apiKey));

Uri sourceSasUri = new Uri("YOUR_SOURCE_SAS_URI");
Uri frenchTargetSasUri = new Uri("YOUR_FRENCH_TARGET_SAS_URI");

var input = new DocumentTranslationInput(sourceSasUri, frenchTargetSasUri, "fr"); // Translate to French
DocumentTranslationOperation operation = await client.StartTranslationAsync(input);

await operation.WaitForCompletionAsync();

BlobClient targetBlobClient = new BlobClient(frenchTargetSasUri);
using(MemoryStream memoryStream = new MemoryStream()) {
  await targetBlobClient.DownloadToAsync(memoryStream);
  string translatedText = System.Text.Encoding.UTF8.GetString(memoryStream.ToArray());
  Console.WriteLine("Translated Document:");
  Console.WriteLine(translatedText);
}
```

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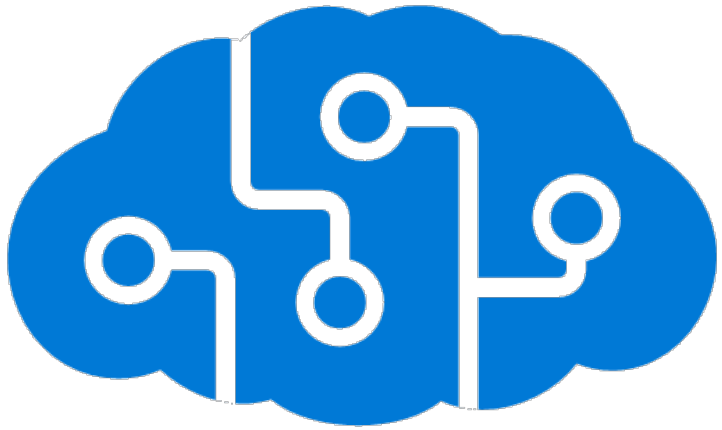
Azure AI Service



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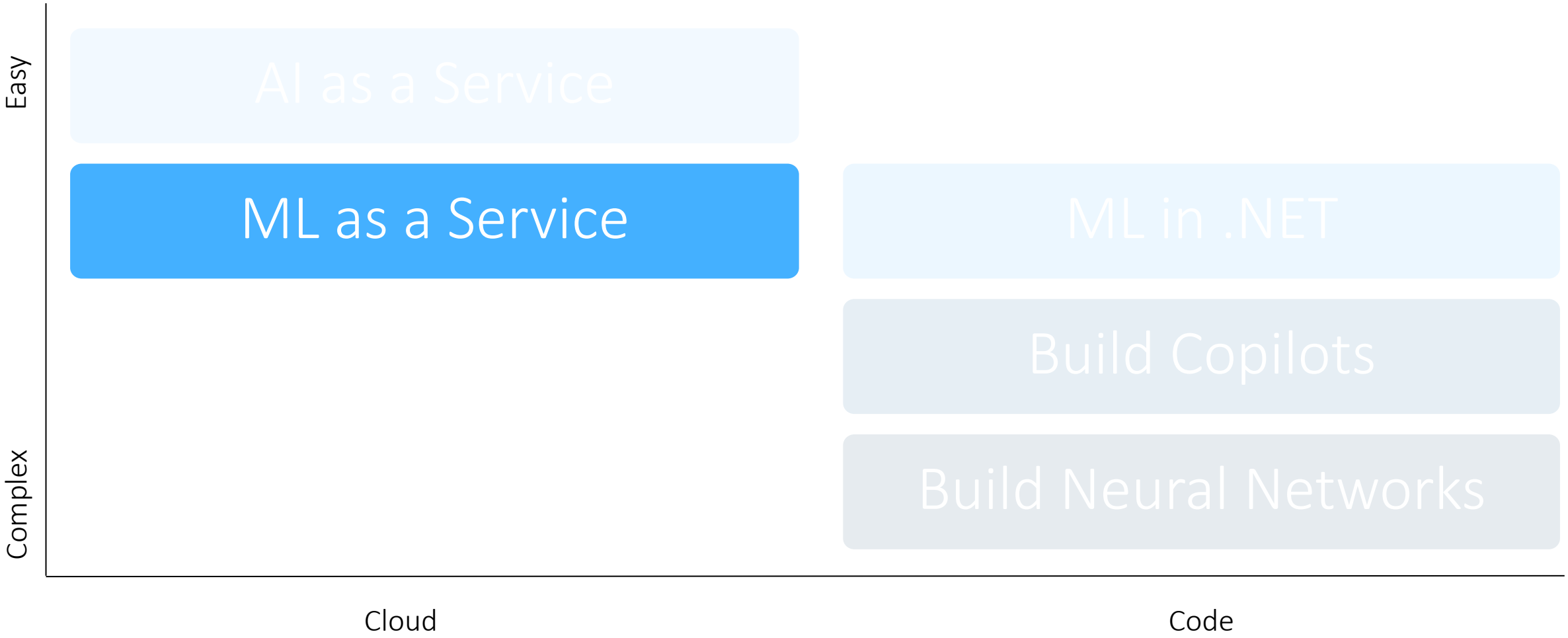
AI Tools & Services



Azure Machine Learning

ML in the Cloud

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Azure Machine Learning

Azure Machine Learning Studio UI

AutoML

Model Catalog for Sharing and Versioning

Managed Endpoints

Responsible AI tools

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Azure Machine Learning

```
using (var client = new HttpClient()) {
    client.DefaultRequestHeaders.Add("Authorization", $"Bearer <YOUR_API_KEY>");

    var data = new StringContent(JsonSerializer.Serialize(new InputData {
        Temperature = 25.0f,
        Humidity = 60.0f
    });

    var response = await client.PostAsync(
        "<YOUR_ENDPOINT>",
        data,
        System.Text.Encoding.UTF8,
        "application/json"));

    if (response.IsSuccessStatusCode)
        return JsonSerializer.Deserialize<float>(await response.Content.ReadAsStringAsync());

    throw new Exception($"Prediction request failed with status code {response.StatusCode}");
}
```

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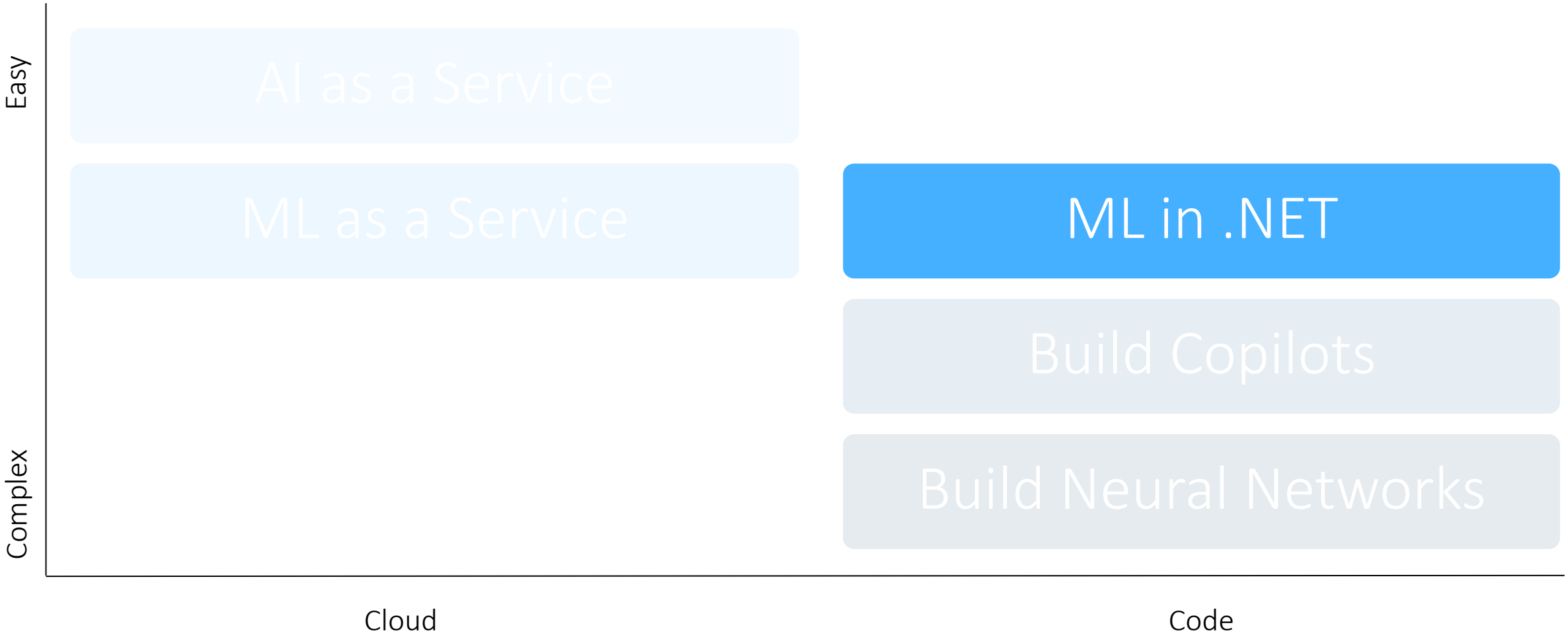
AI Tools & Services



ML.NET

ML in .NET

ML.NET

ML.NET is a free, open-source, and cross-platform machine learning framework for the .NET developer platform.

Allow you to:

- Train models
- Build models
- Ship models

Key Features:

- AutoML
- ML.NET CLI
- ML.NET Model Builder

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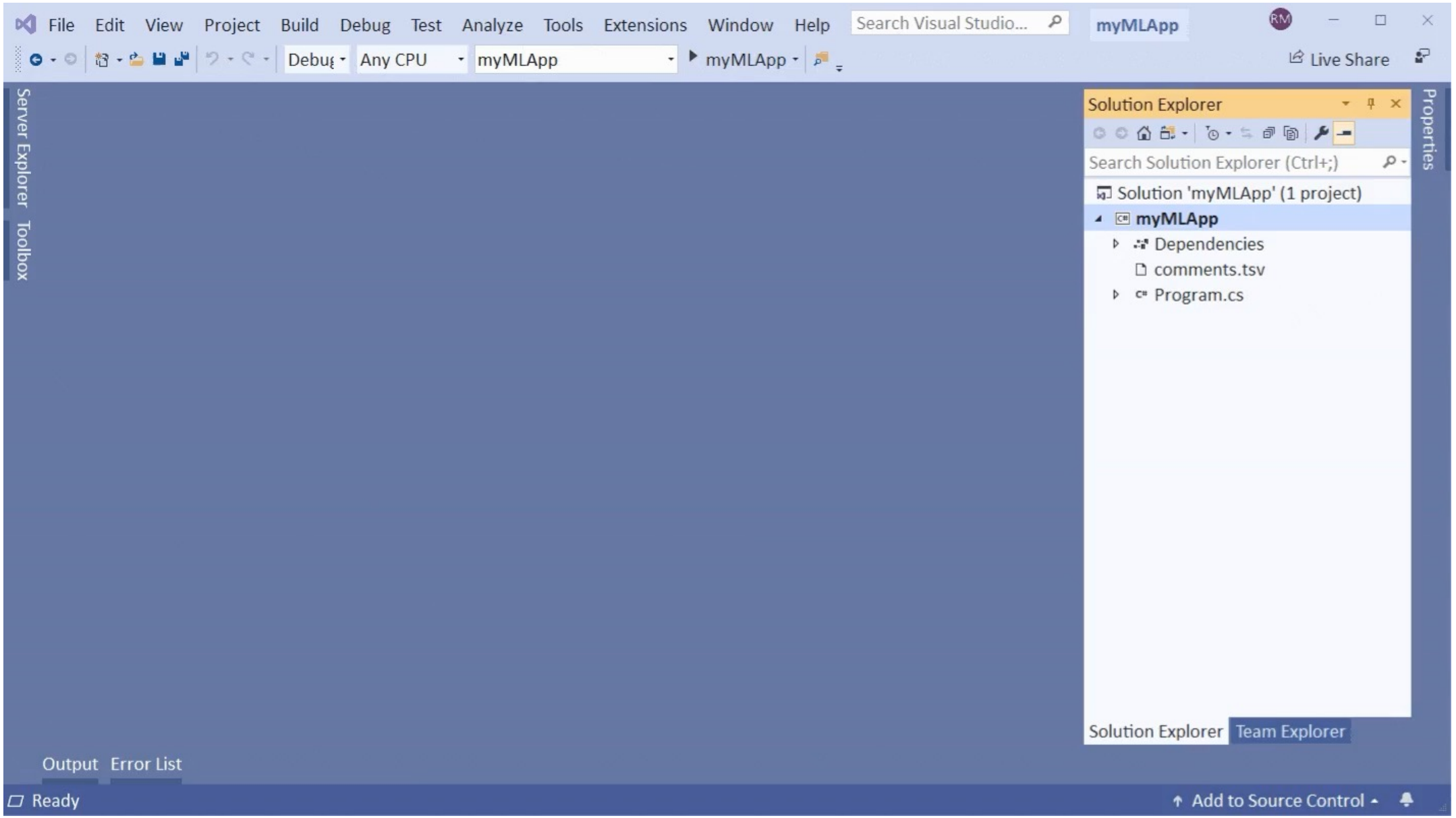
ML.NET Model Builder



ML.NET

```
var mlContext = new MLContext();
var model = mlContext.Model.Load("model.zip", out var modelSchema);

// Create a prediction engine
var predictionEngine = mlContext.Model.CreatePredictionEngine<InputData, OutputData>(model);

// Define input data
var inputData = new InputData {
  Temperature = 25.0f, Humidity = 60.0f
};

// Make predictions
var outputData = predictionEngine.Predict(inputData);

// Display the prediction result
Console.WriteLine($"Predicted rainfall (mm): {outputData.Prediction}");
```

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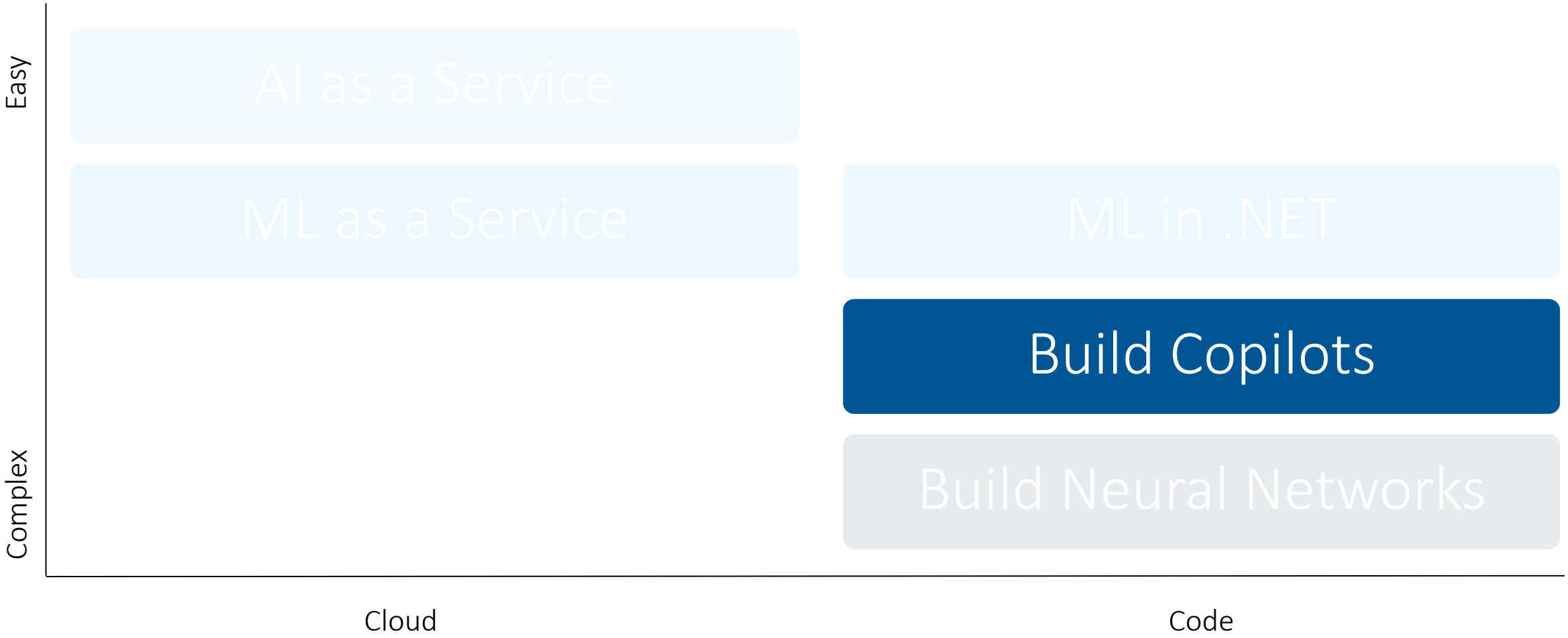
AI Tools & Services

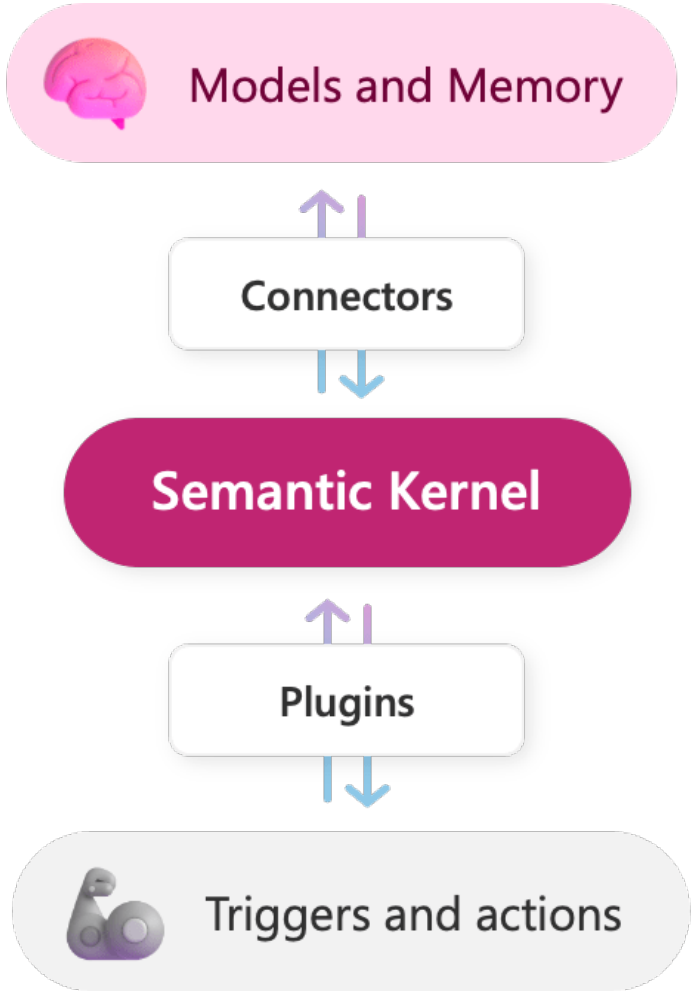


Semantic Kernel

Orchestrates all Microsoft’s Copilots

Semantic Kernel

Semantic Kernel is an open-source SDK developed by Microsoft that allows you to seamlessly integrate cutting-edge Large Language Models (LLMs) like OpenAI, Azure OpenAI, and Hugging Face with conventional programming languages like C#, Python, and Java.



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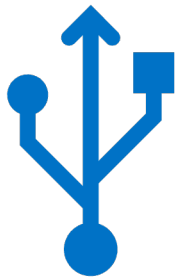
Semantic Kernel



Plugins

Planners

Connectors

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Semantic Kernel

Semantic Kernel

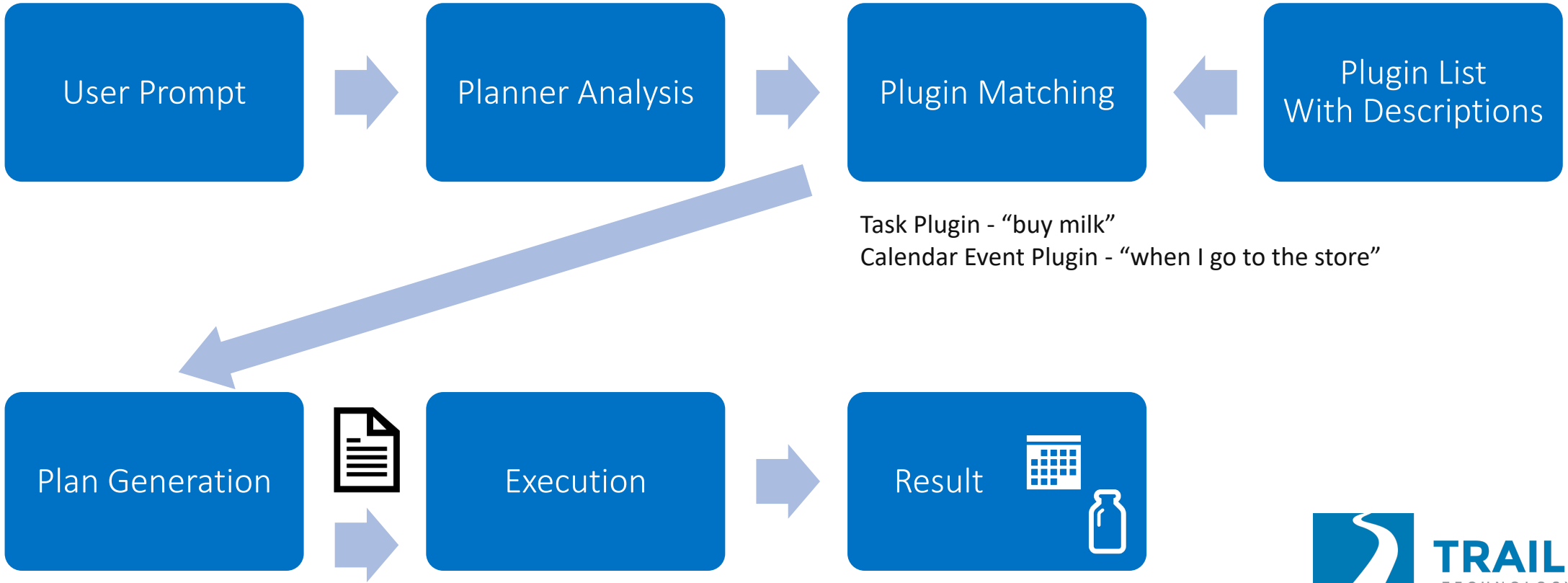
```
[AVAILABLE FUNCTIONS]

### `{{TaskPlugin.CreateTask}}`
Description: Add two numbers
Inputs:
  - task string – The task to be
                  described (required)
Output: string

### `{{CalendarEventPlugin.CreateEvent}}`
Description: Creates calendar event
...
```

"Remind me to buy milk when I go to the store."

"buy milk" (task)
"when I go to the store" (calendar event)



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Semantic Kernel

```
dotnet add package Microsoft.SemanticKernel
```

Semantic Kernel

```
var config = new ConfigurationBuilder()
    .AddJsonFile(“appsettings.josn”)
    .Build();

var builder = Kernel.CreateBuilder();
builder.Services.AddAzureOpenAiChatCompletion(
    "DEPLOYMENT_MODEL",
    "AZURE_OPENAI_ENDPOINT",
    "AZURE_OPENAI_KEY");



var kernel = builder.Build();

var result = await kernel.InvoicePromptAsync("What are the best hikes in Utah?");

Console.WriteLine(results);
```

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Semantic Kernel

```
var config = new ConfigurationBuilder()
    .AddJsonFile(“appsettings.josn”)
    .Build();

var builder = Kernel.CreateBuilder();
builder.Services.AddAzureOpenAiChatCompletion(
    "DEPLOYMENT_MODEL",
    "AZURE_OPENAI_ENDPOINT",
    "AZURE_OPENAI_KEY");

builder.Plugins.AddFromType<MyPluginClass>();

var kernel = builder.Build();

var result = await kernel.InvoicePromptAsync("What are the best hikes in Utah?");

Console.WriteLine(results);
```

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Semantic Kernel

```
public class LightPlugin
{
    public bool IsOn { get; set; } = false;

    [KernelFunction]
    [Description("Gets the state of the light.")]
    public string GetState() => IsOn ? "on" : "off";

    [KernelFunction]
    [Description("Changes the state of the light.'")]
    public string ChangeState([Description("The new state of the light.")] bool newState)
    {
        this.IsOn = newState;
        var state = GetState();
        return state;
    }
}
```

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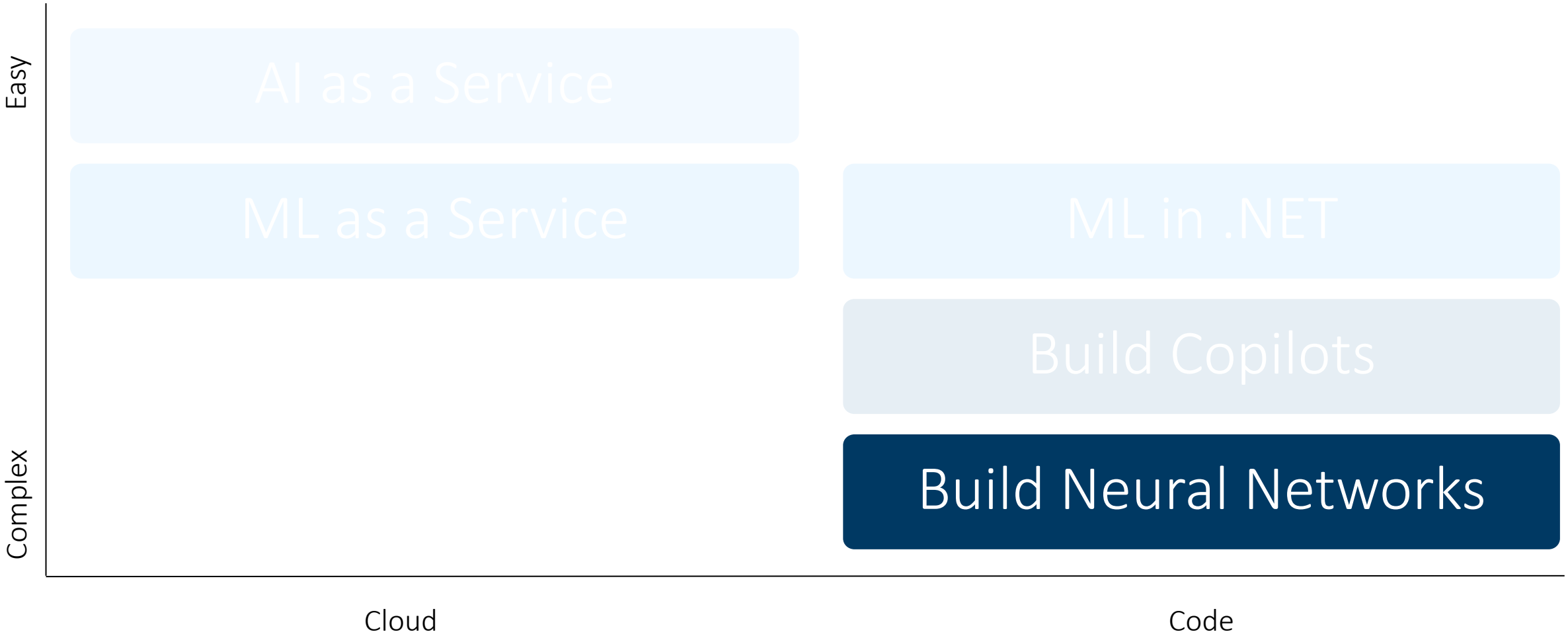
AI Tools & Services



Cognitive Toolkit

Build Your Own Deep Learning Model

Microsoft Cognitive Toolkit (CNTK)

An open-source toolkit for commercial-grade deep learning

- Feed-forward DNNs
- Convolutional neural networks (CNNs)
- Recurrent neural networks (RNNs/LSTMs)

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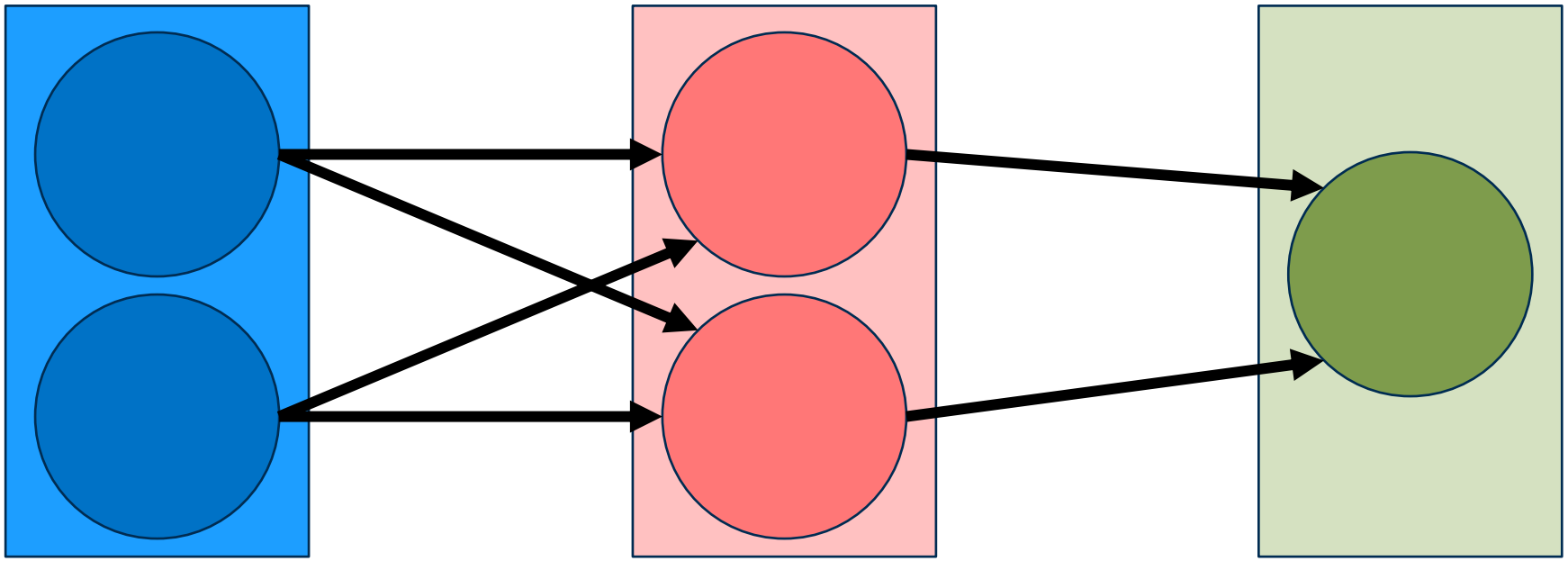
Feed Forward Neural Network (FFNN)



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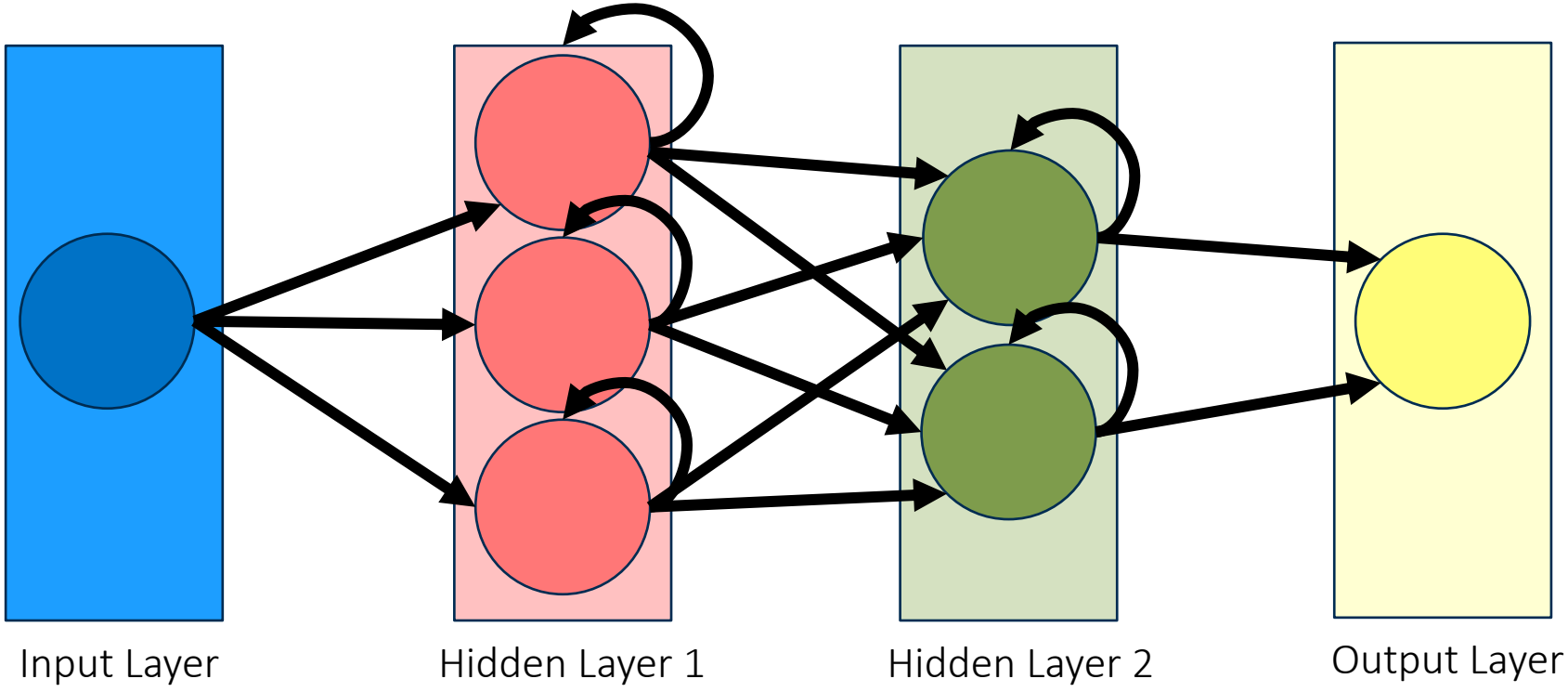
Recurrent Neural Network (RNN)



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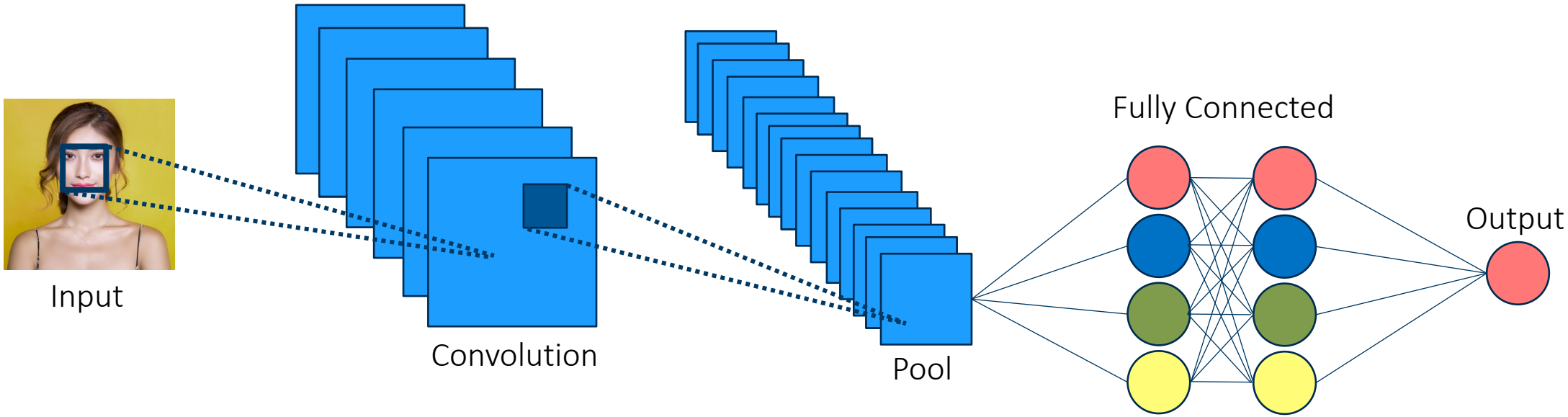
Convolutional Neural Network (CNN)



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Microsoft Cognitive Toolkit (CNTK)

```
var convParams1 = new Parameter(
    new int[] { kernelWidth1, kernelHeight1, numInputChannels, outFeatureMapCount1 },
    DataType.Float, CNTKLib.GlorotUniformInitializer(convWScale, -1, 2), device);
var convFunction1 = CNTKLib.ReLU(CNTKLib.Convolution(
    convParams1, input,
    new int[] { 1, 1, numInputChannels } ));
var pooling1 = CNTKLib.Pooling(convFunction1, PoolingType.Max,
    new int[] { poolingWindowWidth1, poolingWindowHeight1 }, new int[] { hStride1, vStride1 }, new bool[] { true });

var convParams2 = new Parameter(
    new int[] { kernelWidth2, kernelHeight2, outFeatureMapCount1, outFeatureMapCount2 },
    DataType.Float, CNTKLib.GlorotUniformInitializer(convWScale, -1, 2), device);
var convFunction2 = CNTKLib.ReLU(CNTKLib.Convolution(
    convParams2, pooling1,
    new int[] { 1, 1, outFeatureMapCount1 } ));
var pooling2 = CNTKLib.Pooling(convFunction2, PoolingType.Max,
    new int[] { poolingWindowWidth2, poolingWindowHeight2 }, new int[] { hStride2, vStride2 }, new bool[] { true });

var imageClassifier = TestHelper.Dense(pooling2, numClasses, device, Activation.None,   "ImageClassifier");
```

Some Others Worth a Look

TensorFlow.NET

Accord.NET

ONNX

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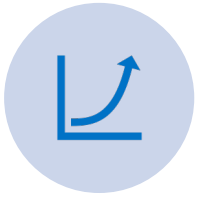
Challenges & Considerations

Challenges & Considerations

Data Quality & Quantity

Ethical Concerns

Black Box Nature



Scalability & Resource Requirements

Maintenance & Monitoring

Summing Up

1. AI is important, can be integrated with traditional algorithms
2. AI is only good for some types of problems
3. Use Azure AI for packages services in cloud
4. Use Azure ML for MLaaS
5. Use ML.NET for .NET-hosted ML
6. Use Semantic Kernel for your own copilots
7. Use Cognitive Toolkit for building own neural networks
8. AI has some drawbacks to consider

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Thanks! Questions?

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FREE

CONSULTATION

bit.ly/th-offer

github.com/trailheadtechnology/ai-for-dotnet