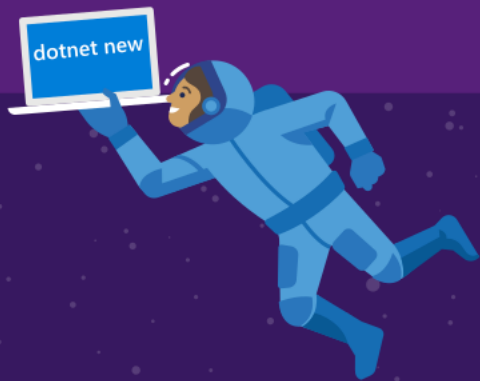
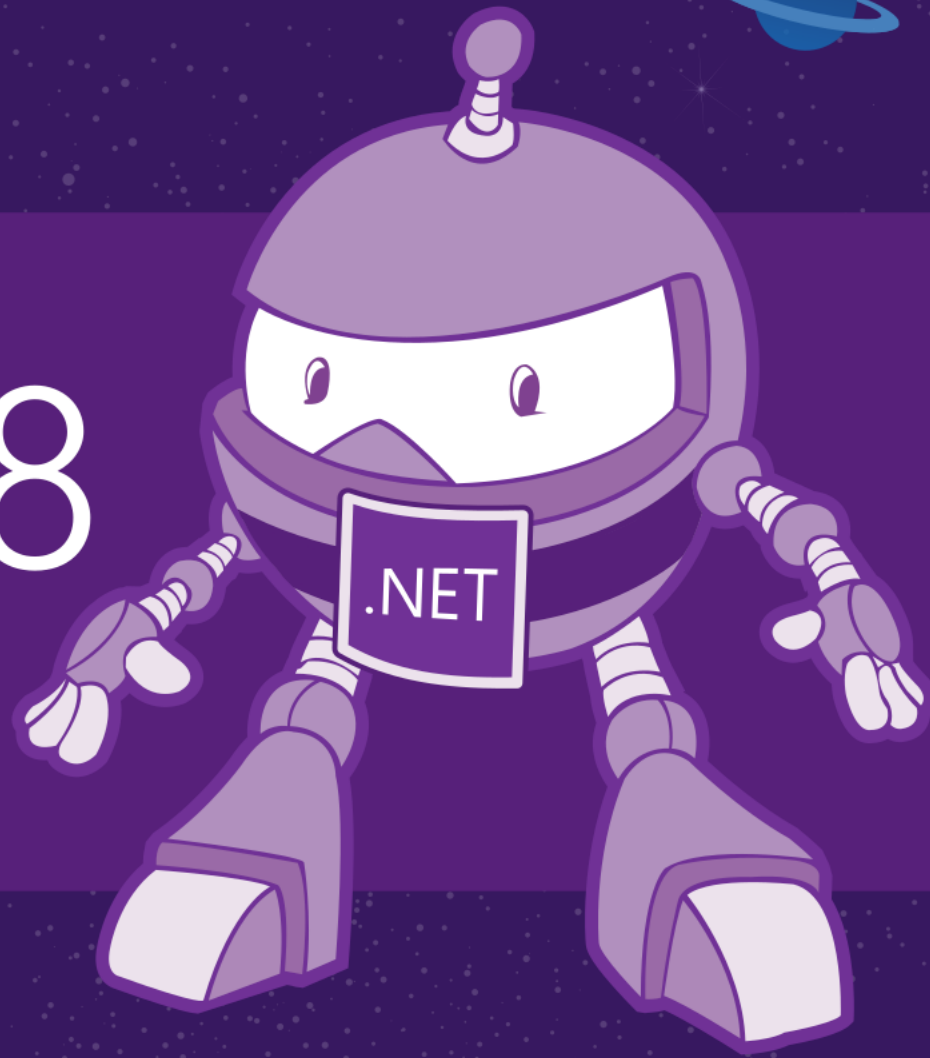


# .NET Conf 2018

Discover the world of .NET

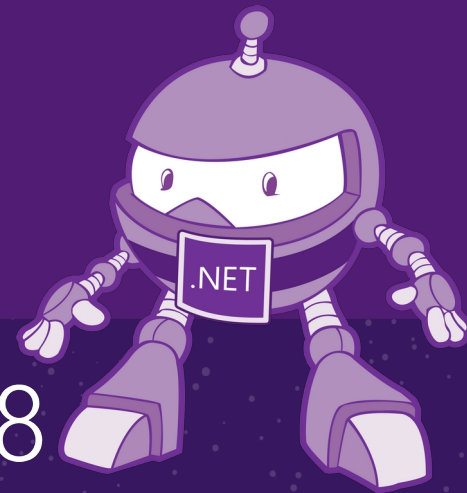


# Artificial Intelligence and Machine Learning for Every .NET Developer

Cesar de la Torre  
Principal Program Manager  
.NET & ML.NET Product Group  
Microsoft Corp.

cesardl@microsoft.com  
Twitter: CESARDELATORRE

.NET Conf 2018



**What is Machine Learning?**

# Machine Learning

“Programming the UnProgrammable”

Is this a face?



$f(x)$

Price of Shirt?

“It has **exquisite** buttons ...  
with **long sleeves** ...works for  
casual as well as **business**  
**settings**”

$f(x)$

# Machine Learning

“Programming the UnProgrammable”

Machine Learning creates a

$f(x)$

*Model*

Using this data



Face



Face



Not a face



Not a face

But it needs a lot of sample training data in order to predict properly... ;)

**What problems can you solve with Machine Learning?**

# Many Machine Learning Tasks!

**Supervised ML** (Infers label)

**Unsupervised ML** (Infers structure)

**Linear Discriminant Analysis**

Structured prediction

**Regression**

Naïve Bayes

Linear regression  
Logistic regression

**Decision Trees**

Binary Classification

**Multi-class Classification**

k-nearest neighbor

**Neural Networks**

(MultiLayer Perception, etc.)

Support Vector Machines

**Clustering**

( K-means  
Mixture models  
Hierarchical clustering)

**Topic Modeling**

Dimensionality Reduction

**Anomaly detection**

Latent variable models

Topic modeling

**Neural Networks**

(Autoencoders,  
Self-organizing maps, etc.)

# THE GOAL

*"Democratize Machine Learning and AI in general, for developers"*

## Cost function

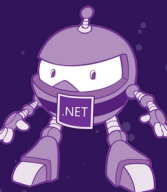
Logistic regression:

$$J(\theta) = -\frac{1}{m} \left[ \sum_{i=1}^m y^{(i)} \log h_{\theta}(x^{(i)}) + (1 - y^{(i)}) \log(1 - h_{\theta}(x^{(i)})) \right] + \frac{\lambda}{2m} \sum_{j=1}^n \theta_j^2$$



What AI, Machine Learning and Deep Learning technologies can you use in .NET applications?

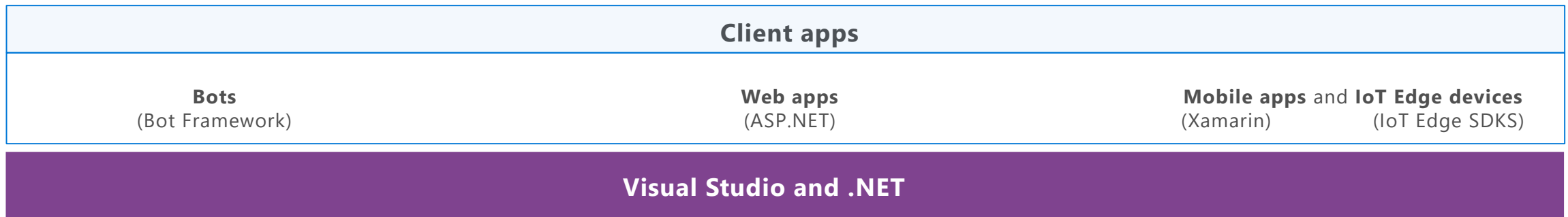
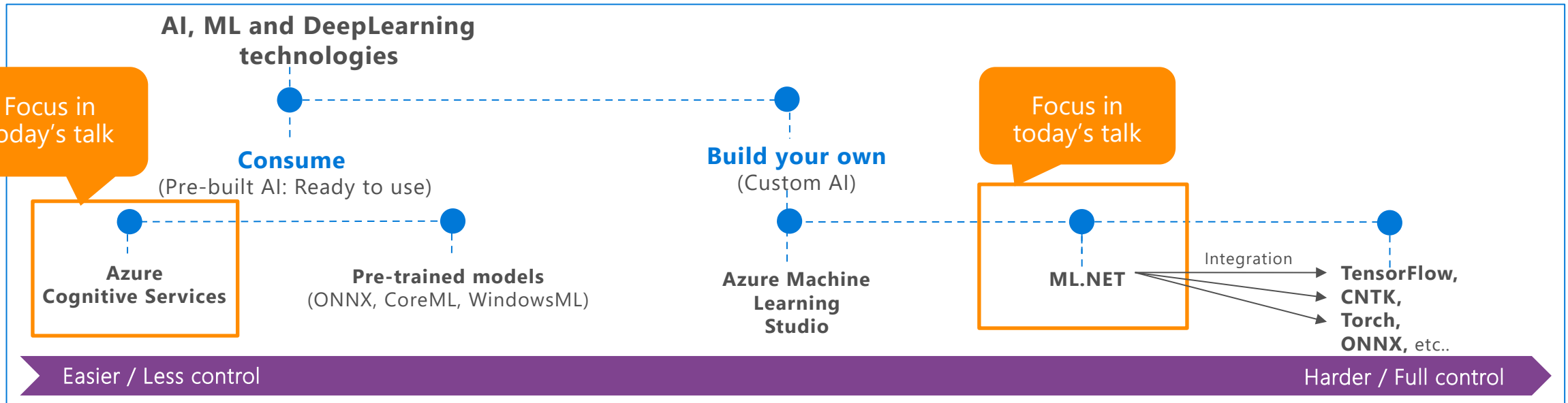
.NET



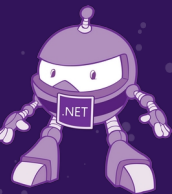
.NET Conf 2018

# AI & ML portfolio for .NET applications

Consume pre-built/pre-trained models or build your own custom model?

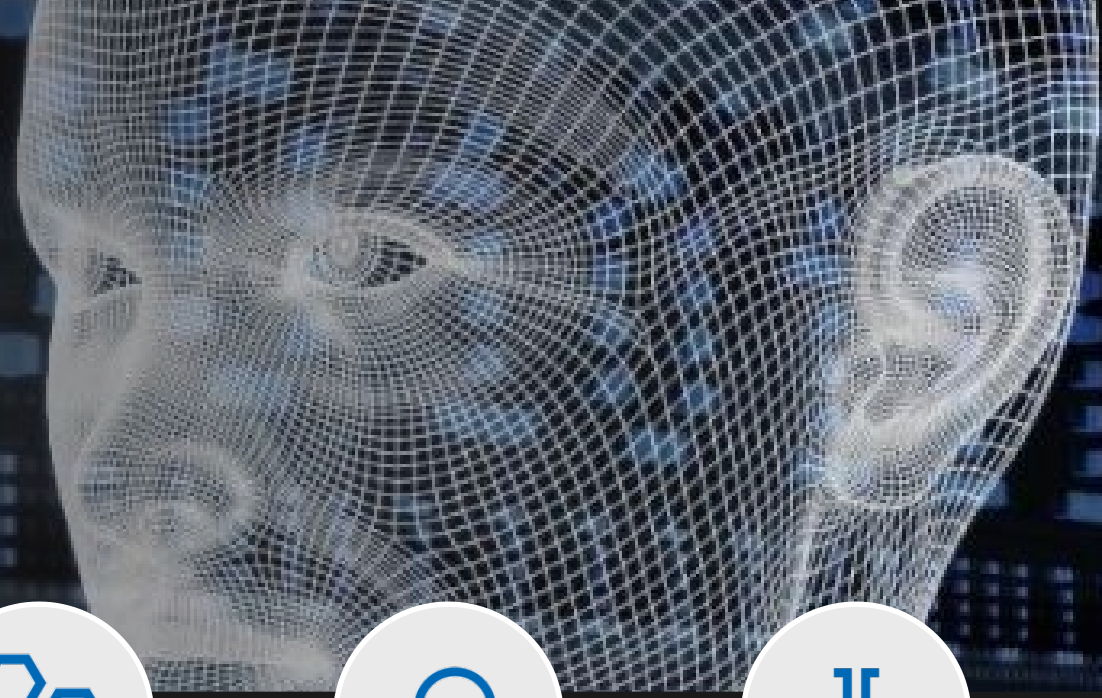


# Pre-built AI: Using Azure Cognitive Services in .NET applications



# Microsoft Cognitive Services

## Commoditized AI



### Vision

From faces to feelings, allow your apps to understand images and video



### Speech

Hear and speak to your users by filtering noise, identifying speakers, and understanding intent



### Language

Process text and learn how to recognize what users want



### Knowledge

Tap into rich knowledge amassed from the web, academia, or your own data



### Search

Access billions of web pages, images, videos, and news with the power of Bing APIs

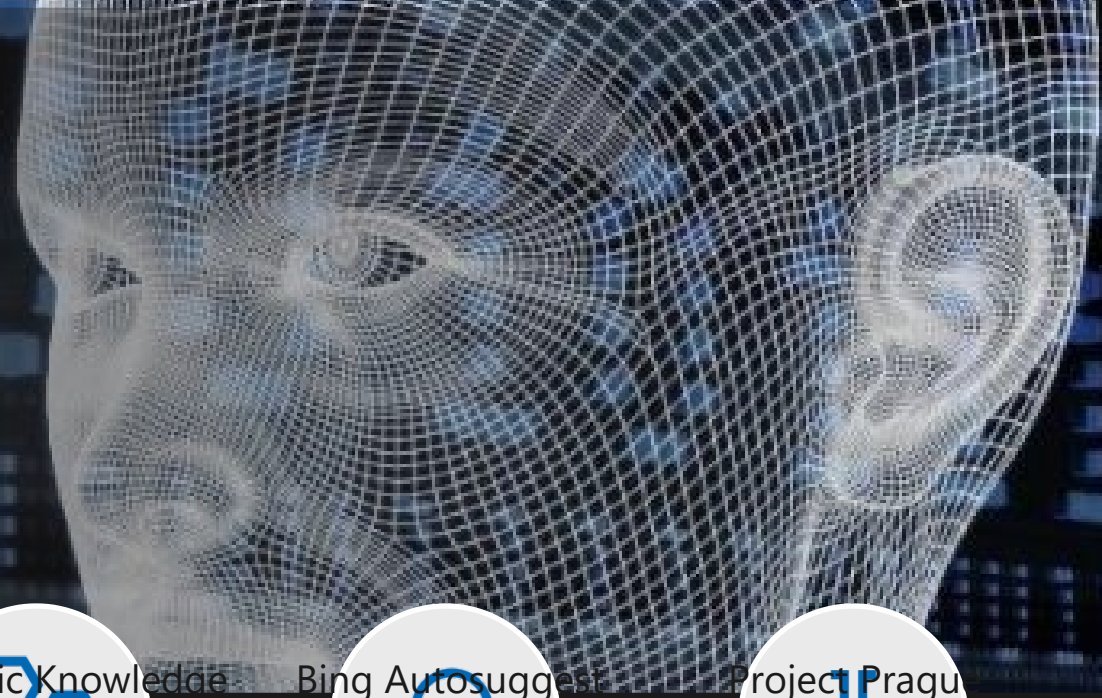


### Labs

An early look at emerging Cognitive Services technologies: discover, try and give feedback on new technologies before general availability

# Microsoft Cognitive Services

## Commoditized AI



Demo for today

Computer Vision

Bing Speech  
Speaker Recognition

Bing Spell Check  
Linguistic Analysis

Academic Knowledge  
Entity Linking

Bing Autosuggest  
Bing Image Search

Project Pragu (gesture)

Content Moderator  
Emotion  
Face  
**Vision**  
Video Indexer

Custom Speech  
**Speech**

Text Analytics  
Translator Text & Speech  
**Language**

Knowledge Exploration  
Recommendations  
**Knowledge**

Bing News Search  
Bing Video Search  
**Search**  
Bing Web Search

Project Cuzco (events)  
Project Johannesburg (labels)

Custom Vision Service

Web Language Model

QnA Maker  
Custom Decision Service

Bing Entity Search  
Bing Custom Search

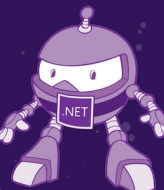
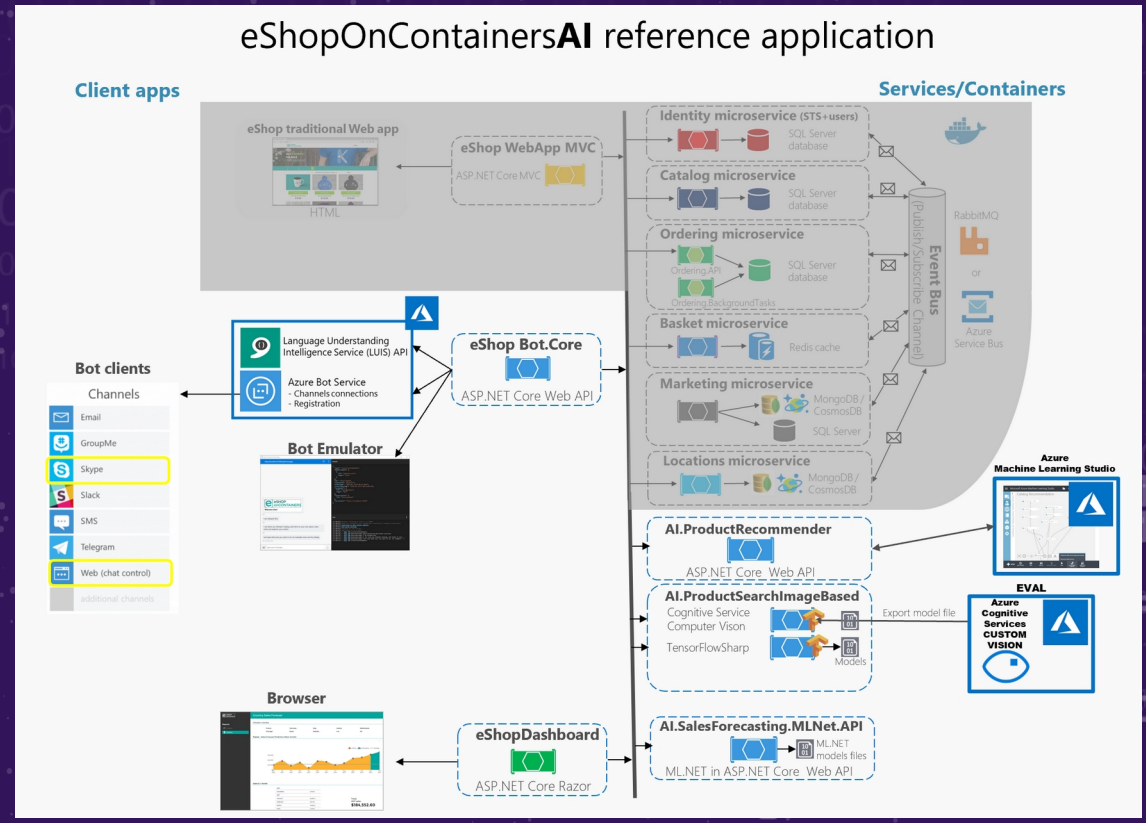
Project Nanjing (isochrones)  
Project Abu Dhabi (distance matrix)  
Project Wollongong (location)

Demo for today

# Demo

## Using Cognitive Services:

*Computer Vision & Custom Vision  
in eShopOnContainers**AI** app*



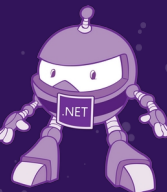
# EXAMPLE: When to use “Azure Custom Vision”

If using **Azure ComputerVision** (which is always online), it doesn't recognize a “Frisbee” picture. Recognizes it as “Dishware”, not a good identification → Need **Custom Vision** for these cases:

The screenshot displays the Azure Custom Vision interface. The top navigation bar includes 'Custom Vision', 'eShopOnContainersAI', 'TRAINING IMAGES', 'PERFORMANCE', and 'PREDICTIONS'. The left sidebar shows a project tree with 'UnitTest (37)' selected. The main area displays a grid of 12 frisbee images. A search filter 'frisbee' is applied, showing 23 results. A 'Watch 1' panel on the left shows the 'name' property of the 'visionApiResponse' object. On the right, a code editor shows a snippet of C# code: 'Object<Vis...; should)) eashold) ng thresho... eBased.AzureCo... eBased.AzureCo... eBased.AzureCo...'

# Custom Machine Learning: Using ML.NET

.NET



.NET Conf 2018



Is pre-trained/pre-built Machine Learning enough for you?  
i.e. Azure Cognitive Services, etc.

*As always.. the answer is... : "It depends..." ;)*

# Pre-built ML Models (Azure Cognitive Services)



Vision



Speech



Language



Labs



Knowledge



Search

Consume (C#, VB, F#)

e.g. Sentiment Analysis using Azure Cognitive Services

```
TextAnalyticsAPI client = new TextAnalyticsAPI();
client.AzureRegion = AzureRegions.Westus;
client.SubscriptionKey = "1bf33391DeadFish";

client.Sentiment(
    new MultiLanguageBatchInput(
        new List<MultiLanguageInput>()
            {
                new MultiLanguageInput("en", "0",
                    "This is a great vacuum cleaner")
            }
    ));
```

😊 96% positive

# Pre-built ML Models (Azure Cognitive Services)



Vision



Speech



Language



Labs



Knowledge



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Consume (C#, VB, F#)

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        {
            new MultiLanguageInput("en", "0",
                "This vacuum cleaner sucks so much dirt")
        }
    ));
```

☹️ 9% positive

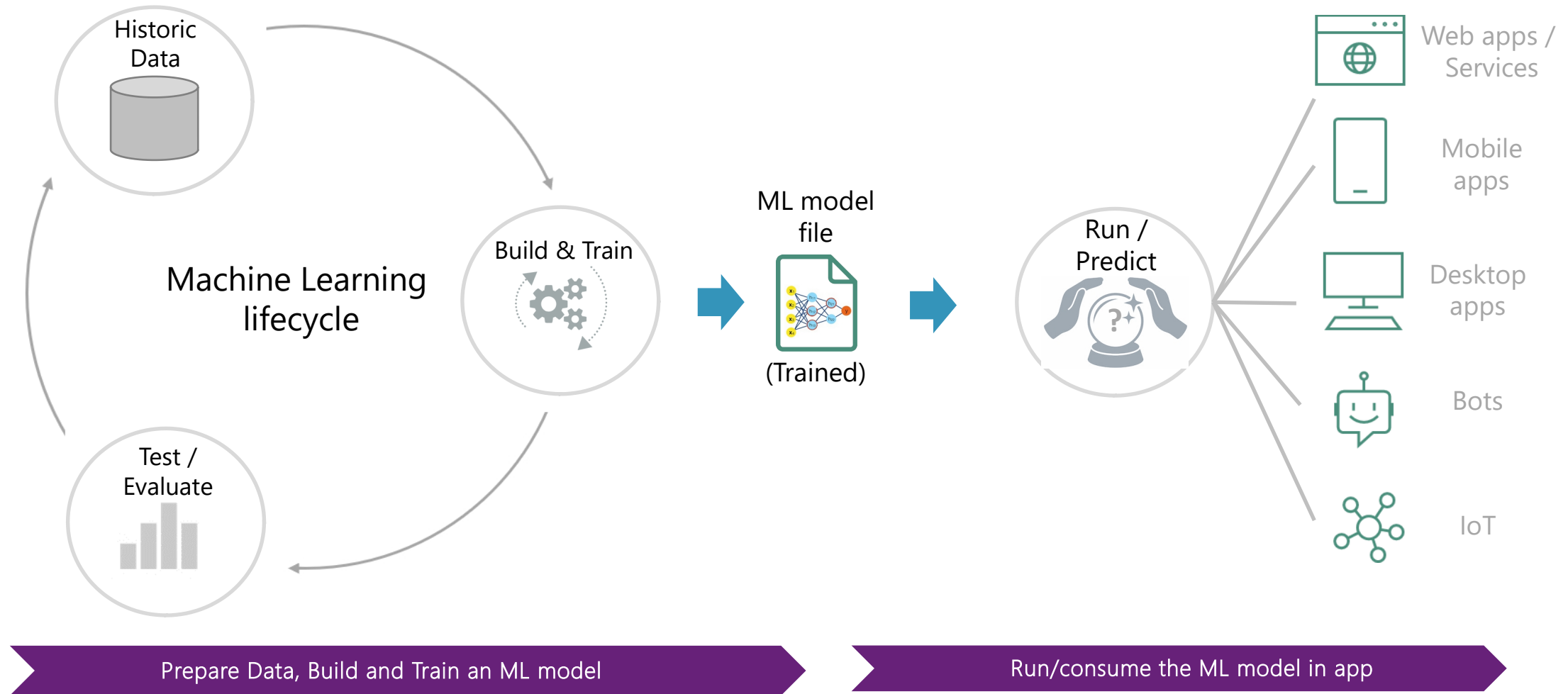
# Build your own (custom) ML Models

**Prepare Your Data**

**Build, Train  
& Evaluate**

**Run**

# Processes for Building your own (custom) ML Models



# Introducing ML.NET

Currently in **v0.5**  
preview Sept-2018

Machine Learning **framework** made for .NET developers

(Supported on Windows, Linux, and macOS)



Build your own



Developer Focused



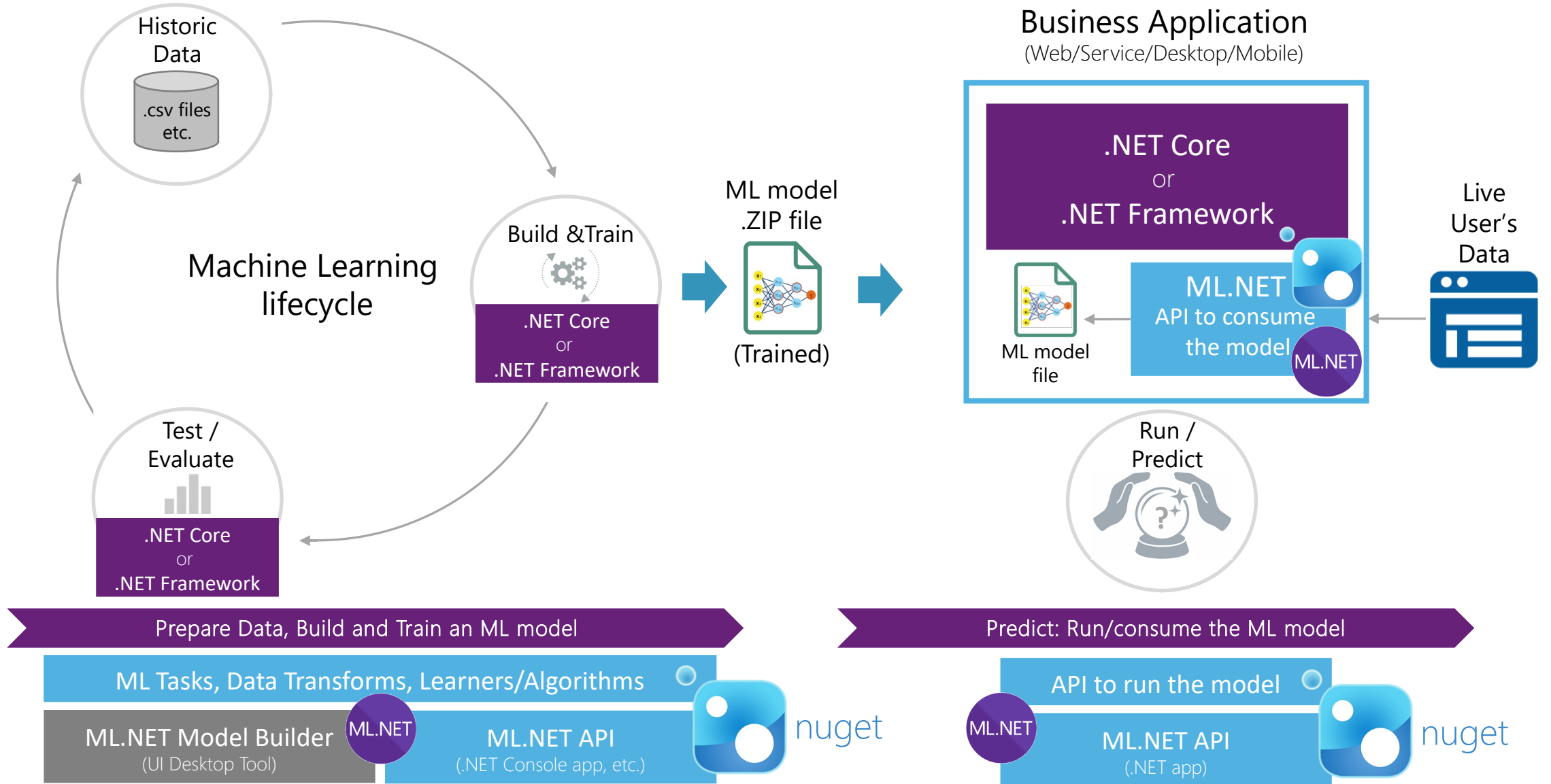
Proven & Extensible



Open Source  
&  
Cross Platform

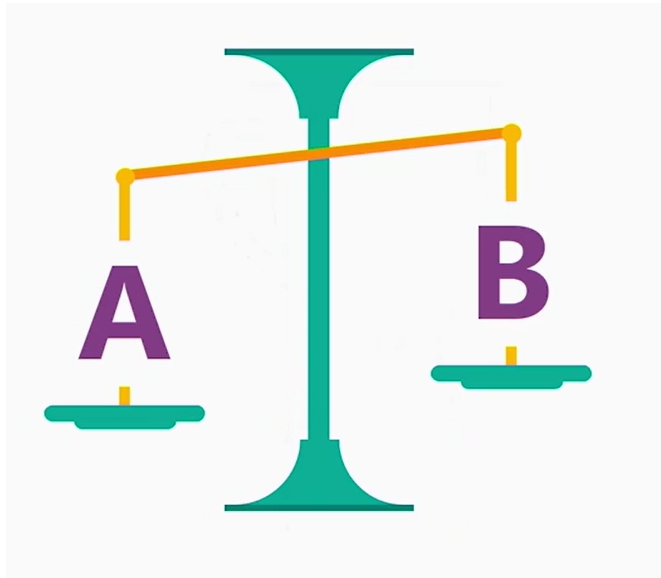
<https://github.com/dotnet/machinelearning>

# ML.NET is a **framework** for custom ML

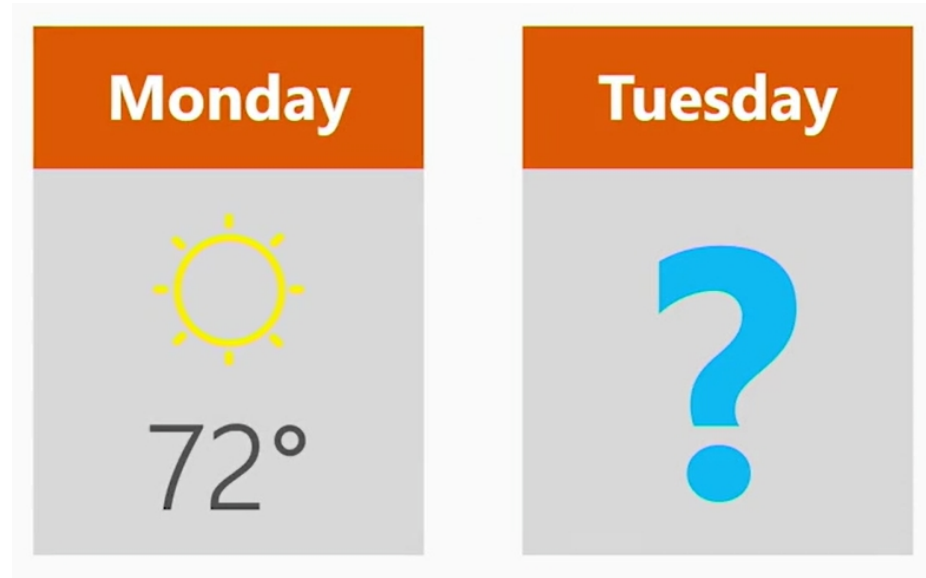


# A few problems you can solve with ML.NET

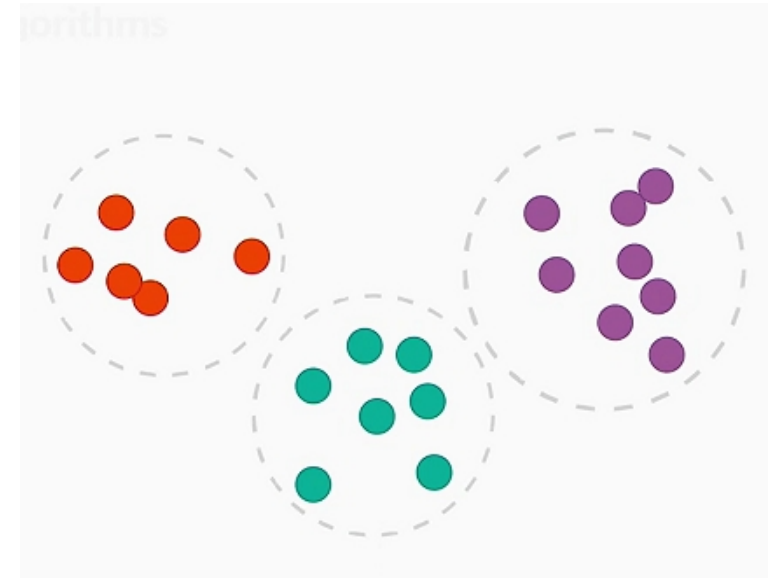
Is this A or B?



How much? How many?

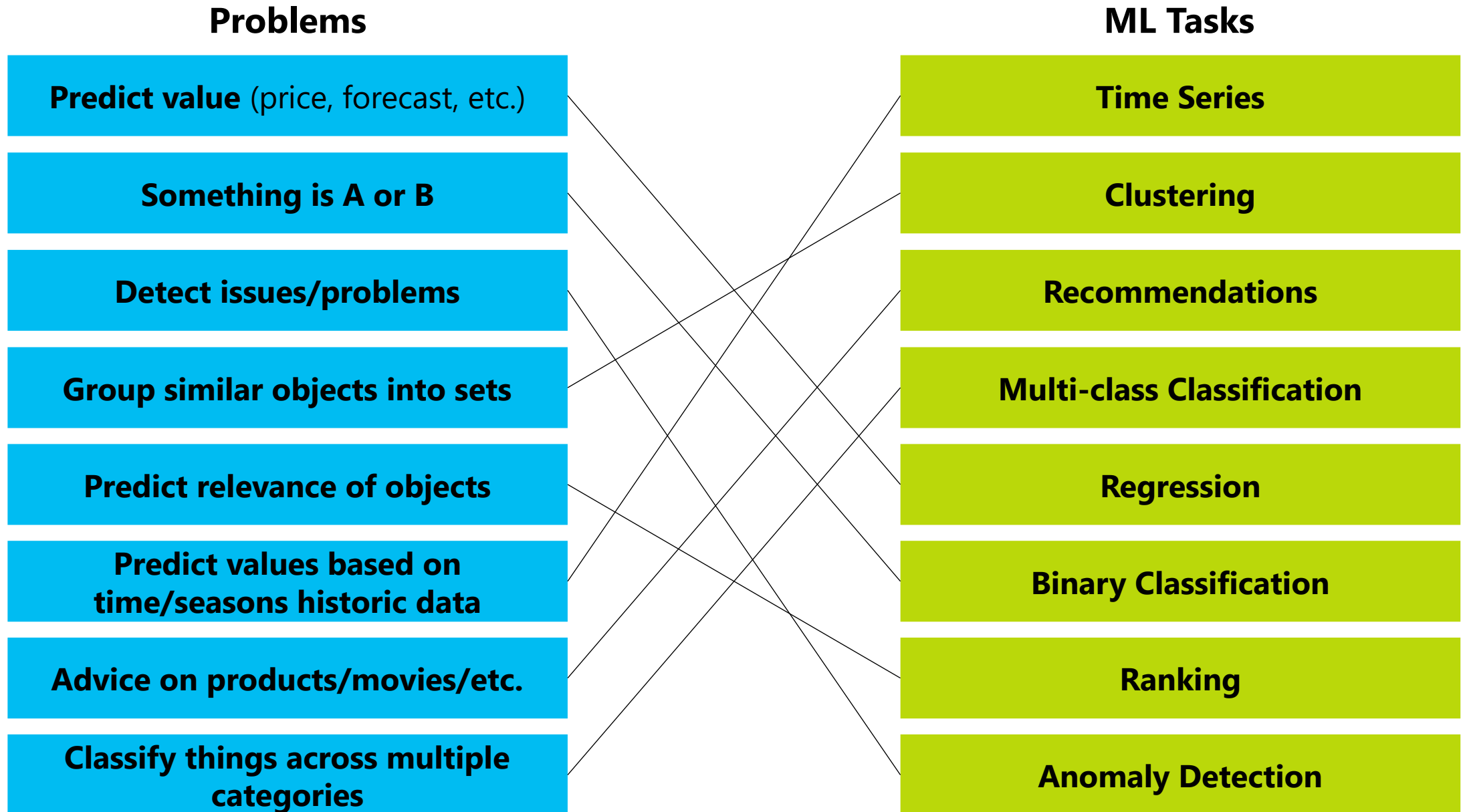


How is this organized?



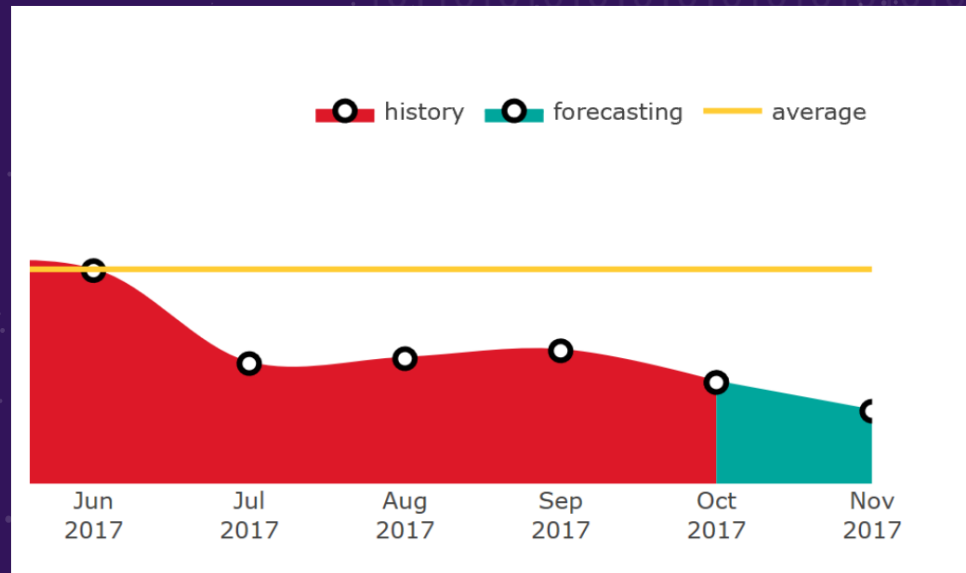


# Mapping from Problems to ML Tasks

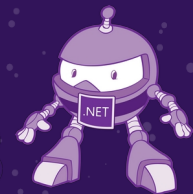


# Demo

Sales forecast – eShopDashboardML  
(Regression problem predicting sales forecast)



Sales Forecasting



# ML.NET is a framework first



Developer-friendly ML APIs to:

- **Build & Train** ML.NET models
- **Run** any model

.NET Standard  
.NET Core  
.NET Framework

## Transforms

Text

Schema

Missing values

Categorical

Normalization

Feature Selection



## Learners

Linear

Boosted Trees

Svm

K-Means



## Misc.

ML Data framework

Evaluators

Calibrators

Data loaders



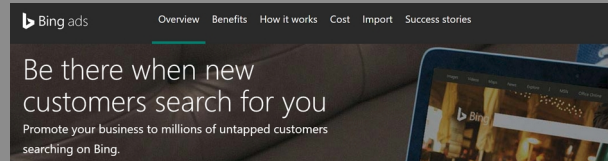
Preliminary support of TensorFlow scoring in ML.NET is available since v0.5



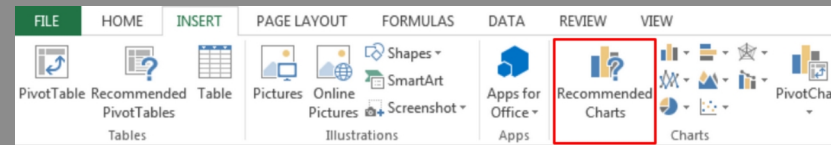
# ML.NET: Proven at large scale in Microsoft



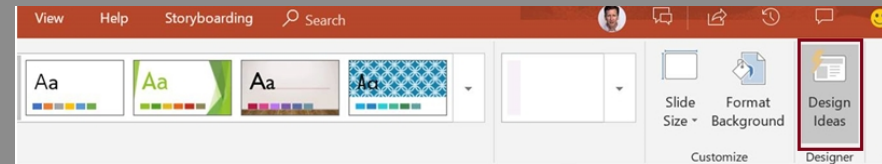
Bing Ads



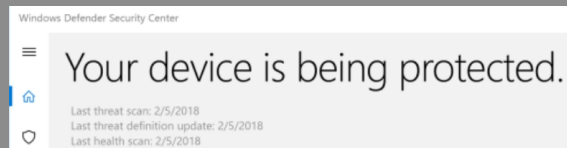
Excel



Power Point



Windows 10



+ more!

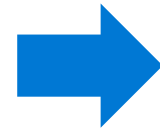
# The Goal for ML.NET ?

*Democratize Machine Learning custom models for **.NET developers** with a framework and tools especially tailored for developers*

## Cost function

Logistic regression:

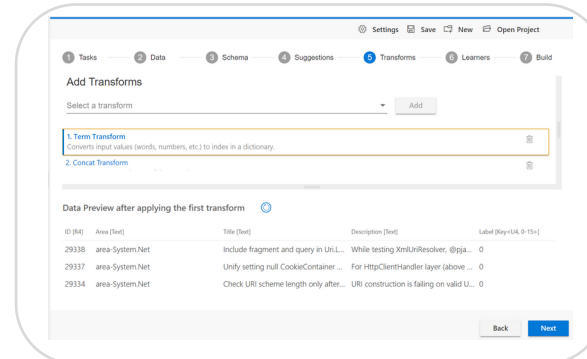
$$J(\theta) = -\frac{1}{m} \left[ \sum_{i=1}^m y^{(i)} \log h_{\theta}(x^{(i)}) + (1 - y^{(i)}) \log(1 - h_{\theta}(x^{(i)})) \right] + \frac{\lambda}{2m} \sum_{j=1}^n \theta_j^2$$



```
var pipeline = new LearningPipeline();
pipeline.Add(new TextLoader<TaxiTrip>
(DataPath, useHeader: true, separator: ","));
pipeline.Add(new CategoricalOneHotVectorizer
("vendor_id",
"rate_code",
"payment_type"));
pipeline.Add(new ColumnConcatenator("Features", "vendor_id", "rate_code", ...);
pipeline.Add(new FastTreeRegressor());
pipeline.Train<TaxiTrip, TaxiTripFarePrediction>();
```

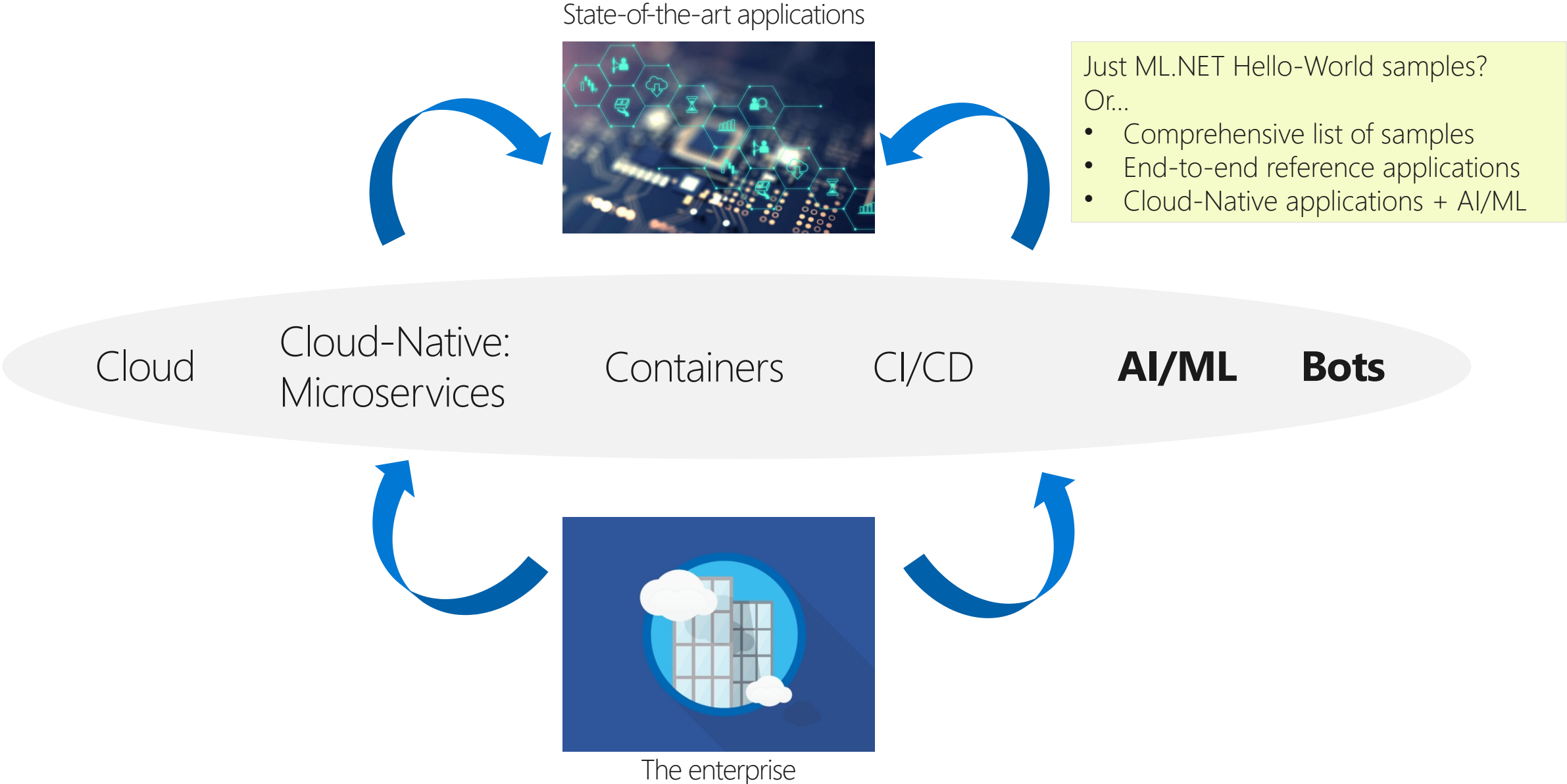


.NET code-first approach to build & train custom models



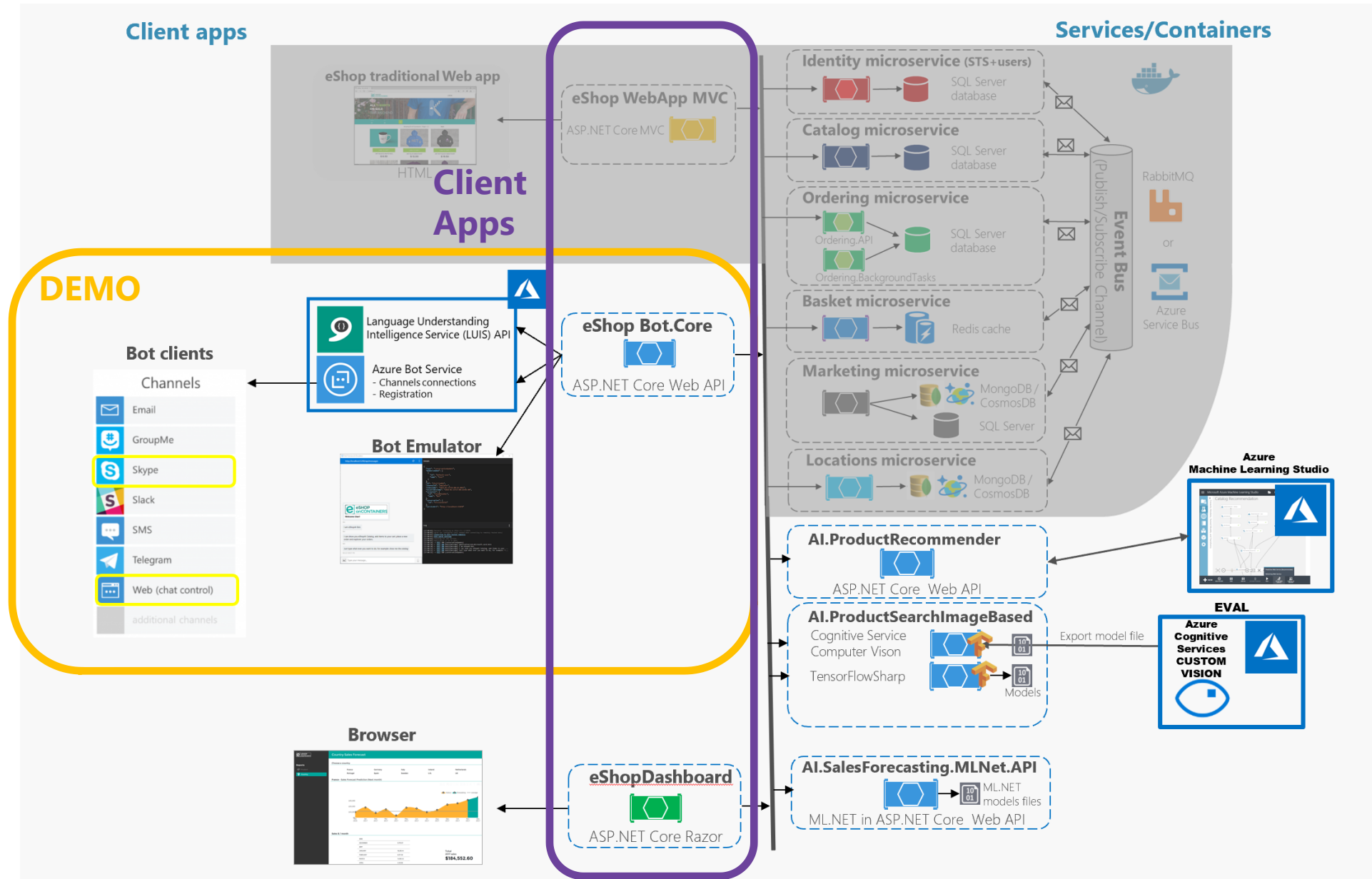
UI tool, easy to get started for .NET developers (\*) To be released

# Enterprise innovation goes across all technologies, not just AI...



# Demo: Surfacing AI with Microsoft Bot Framework + L.U.I.S.

<https://github.com/dotnet-architecture/eShopOnContainersAI/>



# Demo

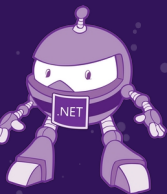
## eShopOnContainers**AI**:

End-to-end AI scenario: Cloud-Native + AI/ML

- + ML.NET
- + Cognitive Services  
Custom Vision
- + **Bot Framework**
- + **LUIS (Language Understanding)**



<https://github.com/dotnet-architecture/eShopOnContainersAI/>





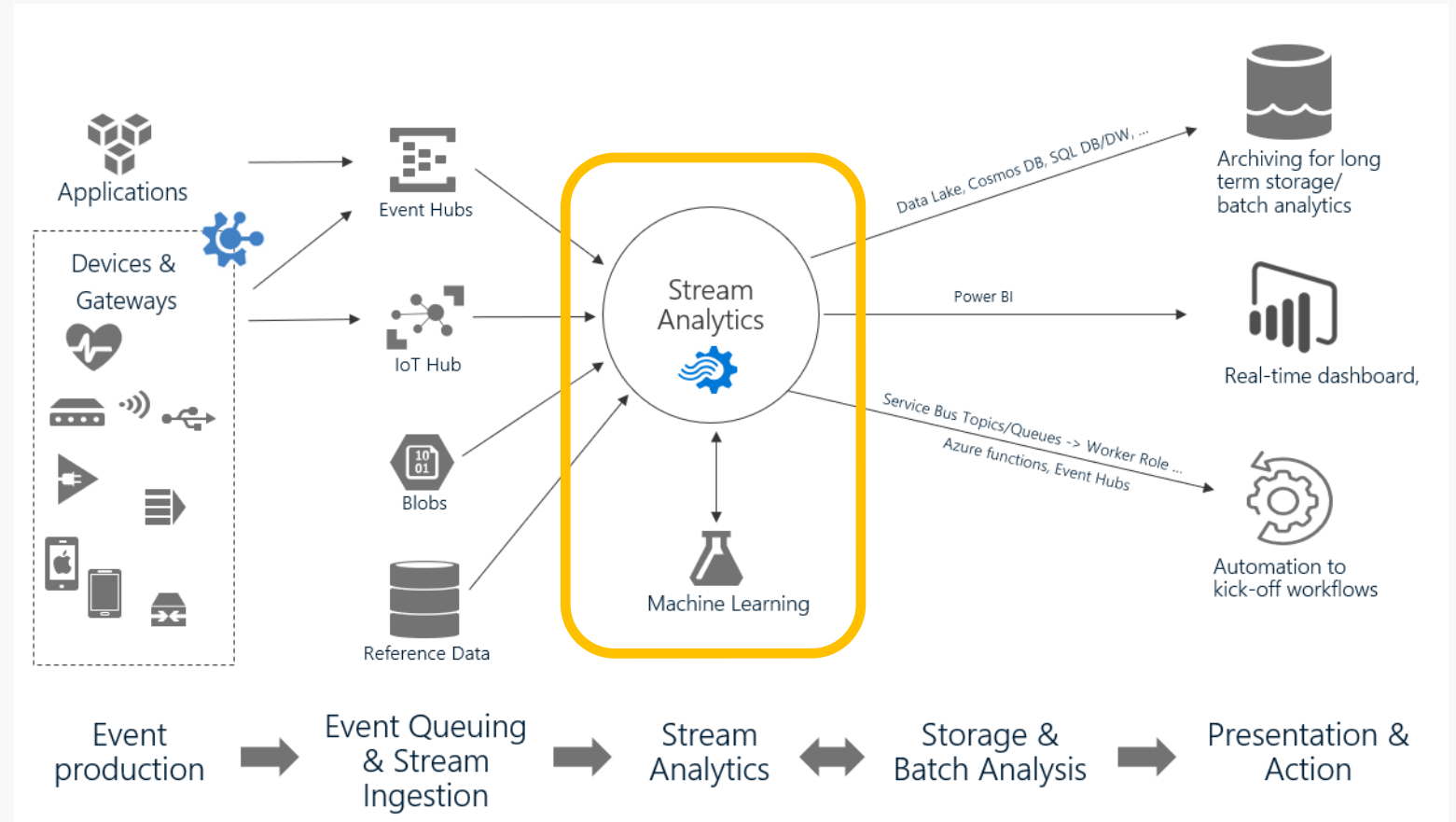
# Azure Stream Analytics

- Fully managed PaaS service for real-time analytics and complex event processing with built-in integration with over dozen services in Azure
- Author powerful queries with simple SQL like language
- Available in the cloud and on Azure IoT Edge runtime

## Key solution scenarios:

- Remote **monitoring**
- **Predictive maintenance**
- Real-time dashboarding
- Fleet monitoring and connected cars
- IT infrastructure and network monitoring
- Monitor online gaming

Generally Available



# .NET extensibility in ASA on IoT Edge

Extend existing query language with **C# UDF (User defined functions)** to enable new possibilities:

- Complex math functions
- **Machine learning on Edge w/ ML.NET**
- String/Date manipulations
- Data imputation

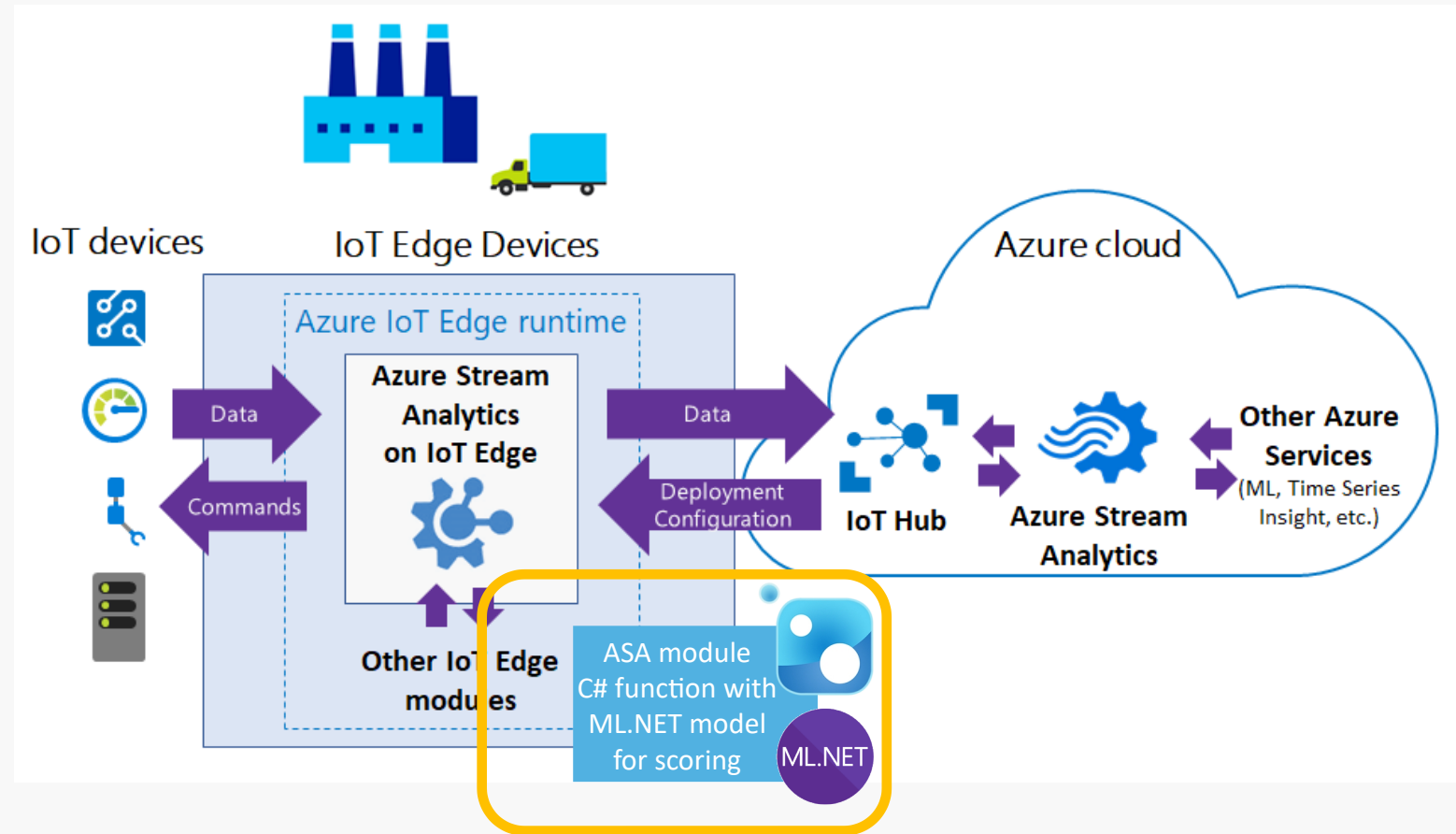
Custom De-serializers can support any data formats including:

- Protobuf
- Parquet
- XML etc,



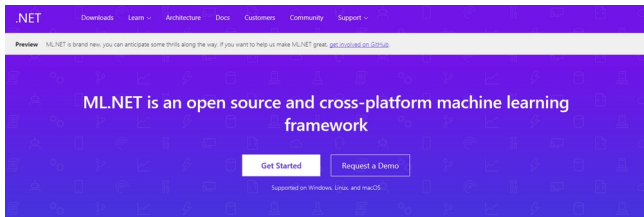
Request access to Preview  
<https://aka.ms/ASAPreview1>

Private Preview



# Resources

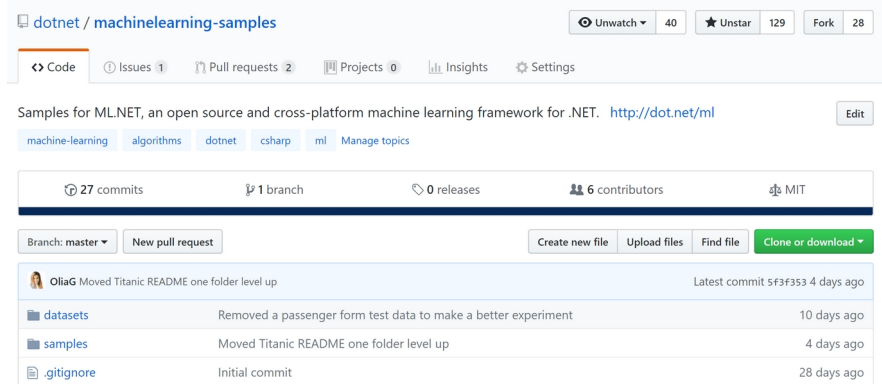
**Get Started**  
[dot.net/ml](https://dot.net/ml)



Machine Learning made  
for .NET

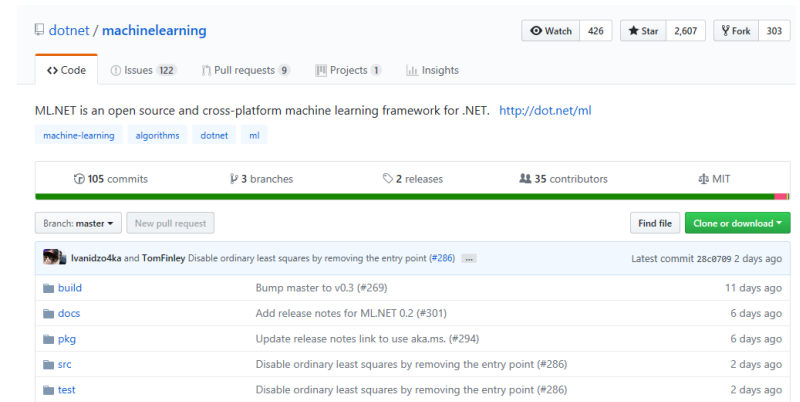
**ML.NET Samples**  
(eShopDashboard, etc.)

<https://github.com/dotnet/machinelearning-samples>



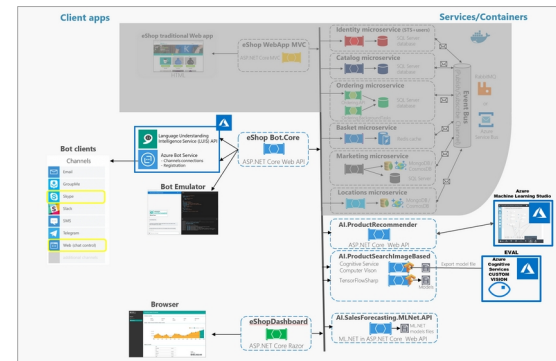
**Get Involved in OSS**

<https://github.com/dotnet/machinelearning/>  
<https://aka.ms/newapifeedback/>



**End-to-end Native App eShopOnContainersAI:**

<https://github.com/dotnet-architecture/eShopOnContainersAI>



# Related sessions in .NET Conf 2018

- Machine Learning in .NET (ML.NET) - [Ankit Asthana](#) [Gal Oshri](#)
- Cognitive Services in Xamarin Applications - [Veronika Kolesnikova](#)
- Artificial Intelligence and Machine Learning for Every .NET Developer - [Cesar De la Torre Llorente](#)



Cesar de la Torre

Principal Program manager  
.NET & ML.NET Product Group

[cesardl@microsoft.com](mailto:cesardl@microsoft.com)

Twitter: CESARDELATORRE

# ONNX

OPEN NEURAL NETWORK EXCHANGE FORMAT  
The new open ecosystem for interchangeable AI models

<https://onnx.ai/>



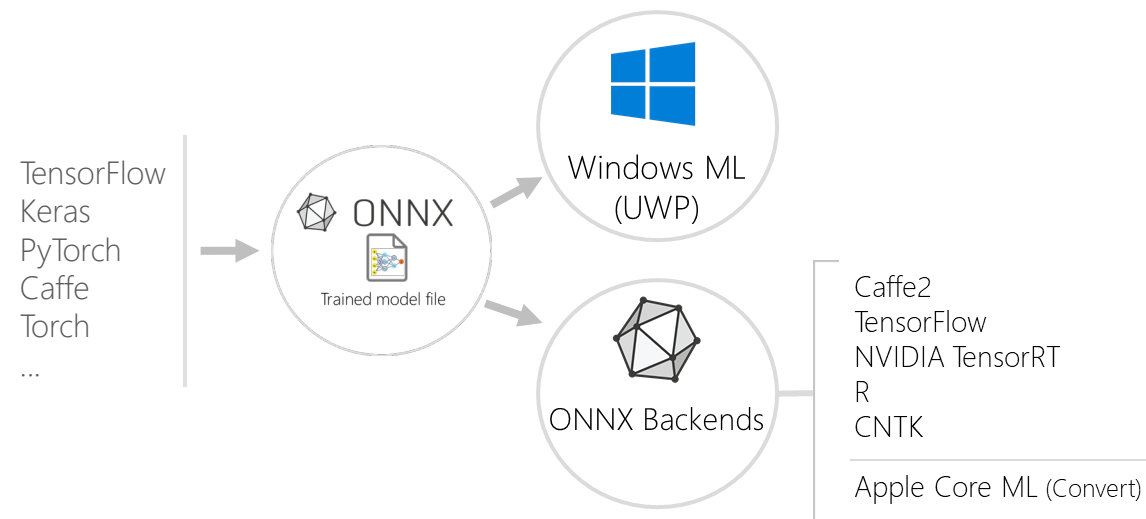
"Open, interoperable and standard format to represent deep learning and machine learning models".

AI developers can more easily move models between platforms.

Two variants of the standard:

- **ONNX** → Deep Learning / DNN
- **ONNX-ML** → Classical Machine Learning

## ONNX for Deep Learning / DNN models



## ONNX-ML support since ML.NET v0.3



*Apple CoreML and other ONNX backends will be coming for ML.NET export.*

# Sample ML Problem:

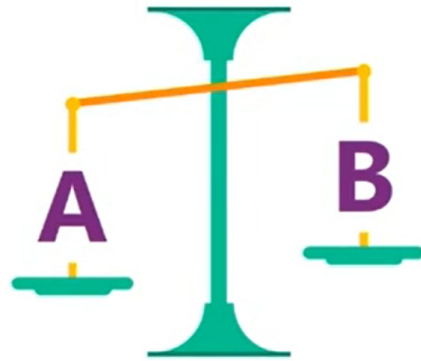
Classify things across multiple categories



Multi-class Classification

## GitHub Issue Tagger (Classification Problem)

Is this A or B?



Which label should this issue be assigned?

area-Microsoft.CSharp

area-Microsoft.VisualBasic

area-Microsoft.Win32

area-Serialization

area-System.AppContext

area-System.Buffers

area-System.CodeDom

# GitHub Issue Example

dotnet / corefx

Watch 1,567 Star 13,864 Fork 3,983

Code Issues 2,209 Pull requests 58 Projects 0 Wiki Insights

## IsolatedStorage fails on Mac if ~/.local/share directory does not exist #29354

New issue

Open jasongin opened this issue 5 days ago · 13 comments



jasongin commented 5 days ago

### Repro steps:

1. Start with a clean Mac OS machine, or at least a clean user account on Mac that does not have any `~/.local/share` directory created yet.
2. From a .NET Core app, call `IsolatedStorageFile.GetUserStoreForAssembly()`

### Result

### Assignees

maryamariyan

### Labels

- area-System.IO
- bug
- os-mac-os-x



# Features (Input)

Features

The screenshot shows a GitHub issue page for the repository 'dotnet/corefx'. The issue title is 'IsolatedStorage fails on Mac if ~/.local/share directory does not exist #29354'. The issue is marked as 'Open' and was opened by 'jasongin' 5 days ago with 13 comments. The description includes repro steps and a result. The issue is assigned to 'maryamariyan' and has labels 'area-System.IO', 'bug', and 'os-mac-os-x'.

**Title** IsolatedStorage fails on Mac if ~/.local/share directory does not exist #29354

**Description**

**Repro steps:**

1. Start with a clean Mac OS machine, or at least a clean user account on Mac that does not have any ~/.local/share directory created yet.
2. From a .NET Core app, call `IsolatedStorageFile.GetUserStoreForAssembly()`

**Result**

**Assignees** maryamariyan

**Labels** area-System.IO, bug, os-mac-os-x

# Label (Output)

Label

dotnet / corefx


Watch 1,567 Star 13,864 Fork 3,983

Code Issues 2,209 Pull requests 58 Projects 0 Wiki Insights

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2. From a .NET Core app, call `IsolatedStorageFile.GetUserStoreForAssembly()`

**Result**

**Assignees**

 maryamariyan

**Labels**

- area-System.IO
- bug
- os-mac-os-x

# Reviewing code using the new upcoming API (v0.6 and later)

## Build/train the model (Console app)

```
var env = new TlcEnvironment(new SysRandom(0), verbose: true);

string dataPath = "corefx-issues-train.tsv";

// Create reader with specific schema.
// string :ID, string: Area, string:Title, string:Description
var reader = TextLoader.CreateReader(env, ctx =>
    (area: ctx.LoadText(1),
     title: ctx.LoadText(2),
     description: ctx.LoadText(3),
     dataPath,
     useHeader: true));

var estimator = reader.MakeEstimator()
    .Append(row => (
        // Convert string label to key.
        label: row.area.Dictionaryize(),
        // Featurizes 'description'
        description: row.description.FeaturizeText(),
        // Featurizes 'title'
        title: row.title.FeaturizeText()))
    .Append(row => (
        // Concatenate the two features into a vector.
        features: row.description.ConcatWith(r.title),
        // Preserve the label
        label: row.label))
    .Append(row => r.label.PredictSdcaMultiClass(row.features));

// Read the data
var data = reader.Read(dataPath);

// Fit the data (Train the model)
var model = estimator.Fit(data);

// Save the model to a file
await model.WriteAsync("github-Model.zip");
```

## Run the model to **predict** (Scoring/Inferencing)

*Web app, Desktop app, etc.*

```
var model = await PredictionModel.ReadAsync("github-Model.zip");
var predictor = model.MakePredictionFunction<IssueInput,
    IssuePrediction>();

var prediction = predictor.PredictSdcaMultiClass(new IssueInput
{
    ID = "29338\t",
    Title = "Include fragment in Uri.LocalPath on Unix\t",
    Description = "While testing XmlUriResolver, @pjanotti
discovered that any segments of a file path following a '#'
symbol will be cut out of Uri.LocalPath on Unix. Based on
additional tests, this also occurs for the '?' symbol. This is
happening because the Unix specific case for local path only uses
the path component of the URI});
}
```

