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Agenda

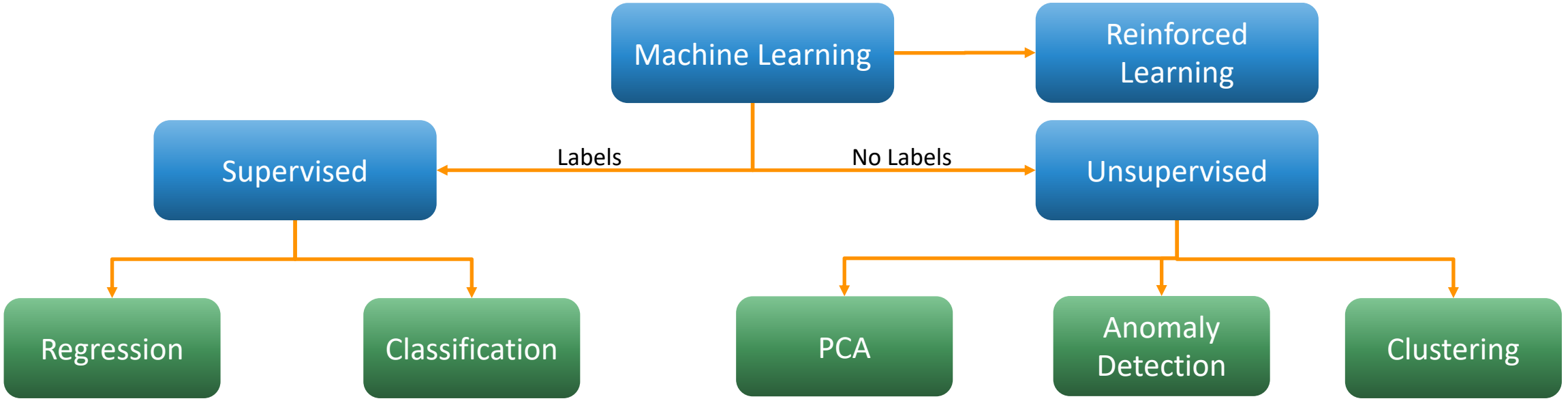
What are we going to cover?

1. What is Machine Learning? A brief introduction to machine learning
2. What is ML.NET?
3. The ML.NET workflow
4. ML.NET in action
   a. Regression
   b. Classification
   c. Recommendation
   d. Clustering
5. Deep learning in ML.NET (integration with TensorFlow)
6. AutoML

Why should you use ML.NET?

- Want to stay in .NET ecosystem for Machine Learning
- Don’t want to worry about low-level complexities of ML
- Want to train a custom model
- Want to consume a pre-trained model

Machine Learning Types



Why F# for machine learning

- Exploratory programming
- Interactive environment
- Data Pipelines
- Functions Composition
- Algebraic data types
- Advanced pattern matching
- Strong and Duck typing

$$y = f(x_1, x_2 \ldots x^n)$$

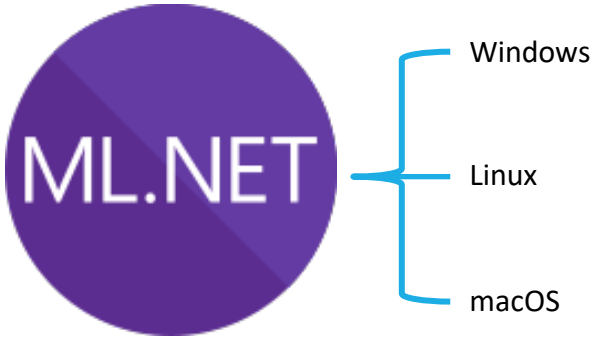
```
let trainData = context.Data.LoadFromTextFile<Passenger>(trainDataPath, hasHeader = true, separatorChar = ', ')
// set up a training pipeline
let pipeline = EstimatorChain()
                .Append(context.Transforms.Conversion.ConvertType("Age", outputKind = DataKind.Single))
                .Append(context.Transforms.Concatenate("Features", "Age", "Pclass", "SibSp", "Parch", "Sex", "Embarked"))
                .Append(context.BinaryClassification.Trainers.FastTree())

// train the model
let model = trainData |> pipeline.Fit

// make predictions and compare with ground truth
let metrics = testData |> model.Transform |> context.BinaryClassification.Evaluate


// set up a prediction engine
let engine = context.Model.CreatePredictionEngine model


   // create sample records
   let passenger = { Pclass = 1.0f; Sex = "female”; RawAge = "48”; Ticket = "B”; Fare = 30.0f }
// make the prediction
let prediction = engine.Predict passenger
```

Where ML.NET is used?

Trusted and Proven at Scale

What is ML.NET

- Open Source & Cross Platform
- Machine learning SDK that works offline
- Simple and powerful
- Support other ML models like TensorFlow and ONNX
- Great documentation available online
- Reuse .Net Skills



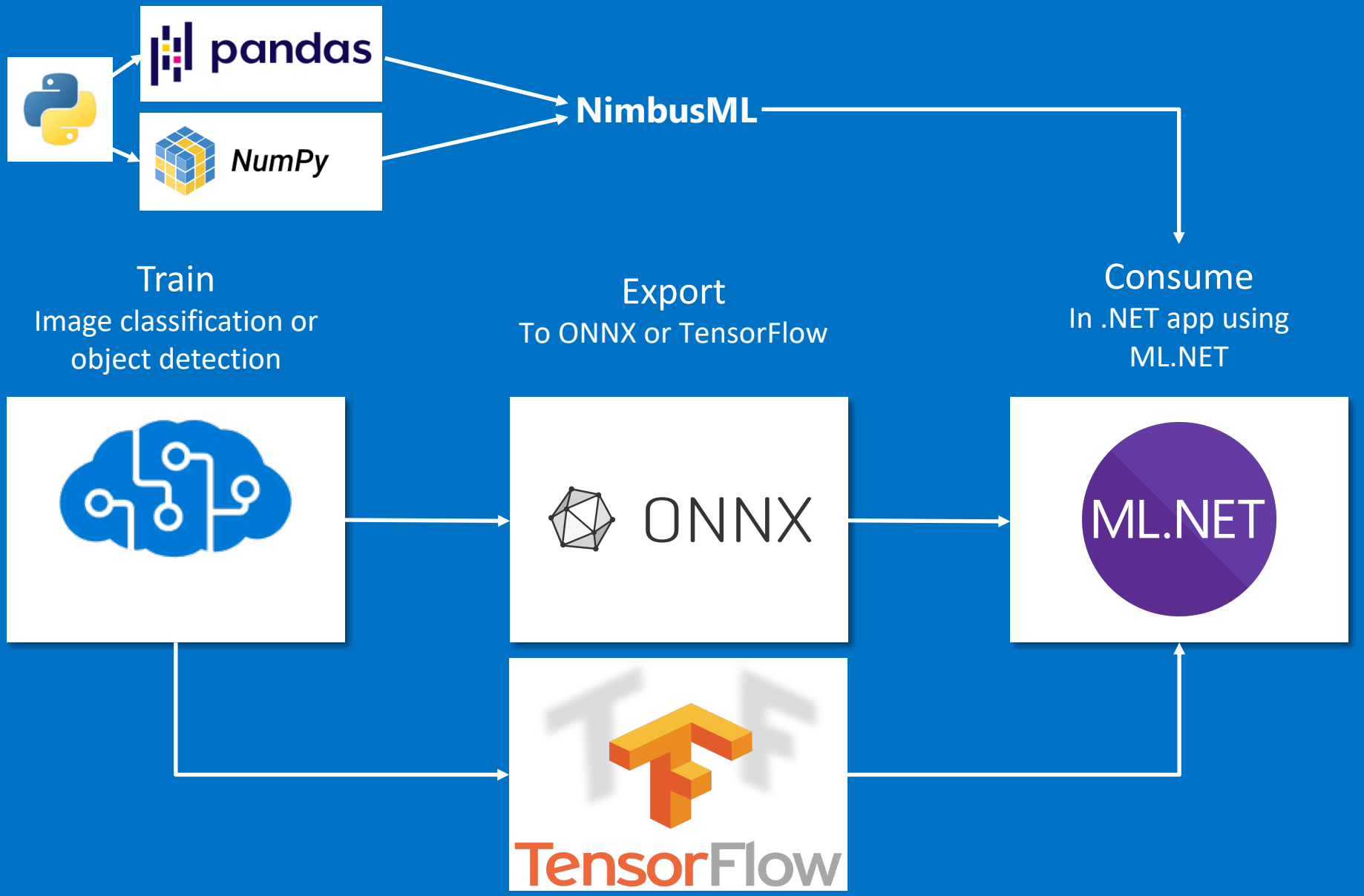
Built for

.NET Developers

Can use existing C# and F# skills to integrate ML into .NET apps

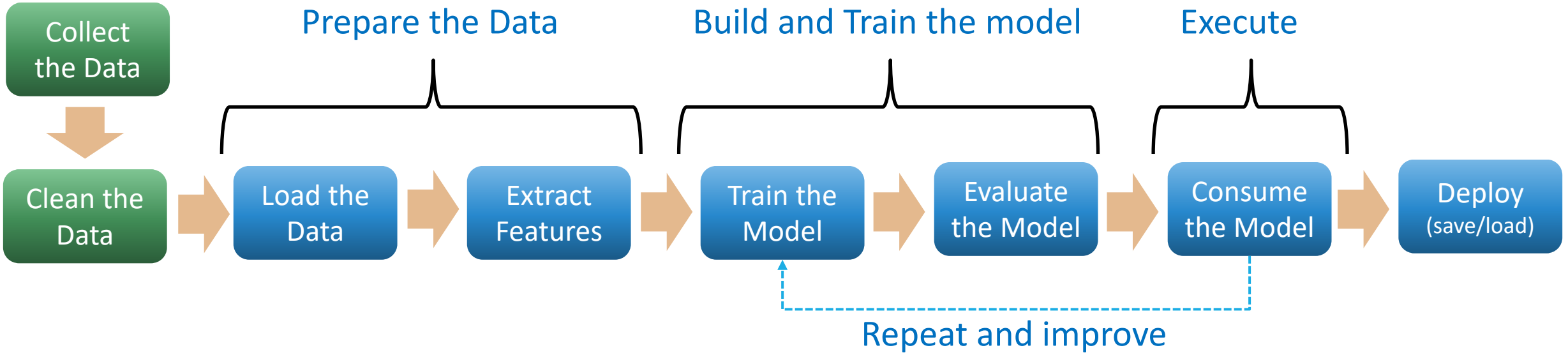
Data science & ML experience not required

ML.NET integration with other ML techs



The ML.NET workflow

Building an ML Model involves few steps



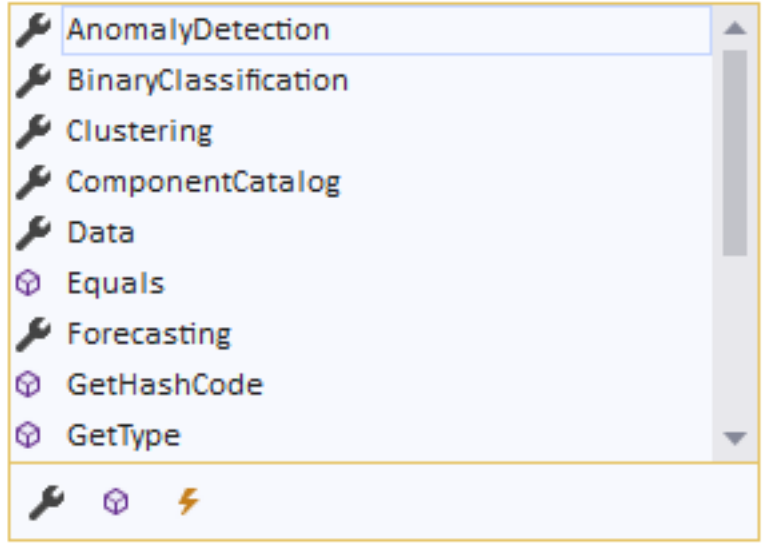
ML.NET Pipeline step by step

- **Create ML.NET Context**
- Load data
- Transform data
- Train model
- Evaluate model
- Consume model

Create ML.NET Context

```
// Create MLContext to be shared across the model
// Set a random seed for repeatable/deterministic
// results across multiple trainings.
let mlContext = MLContext(seed = Nullable 1)
```

```
var mlContext = new MLContext();
mlContext.
```



Create the Data schema

- Create ML.NET Context
- **Load data**
- Transform data
- Train model
- Evaluate model
- Consume model

Dataset

FlowerType	SepalLength	SepalWidth	PetalLength	PetalWidth
Iris-setosa	5.1	3.5	1.4	0.2
Iris-versicolor	7.0	3.2	4.7	1.4
Iris-setosa	4.9	3.0	1.5	0.1
...				

Labels

Features

Class definition of schema

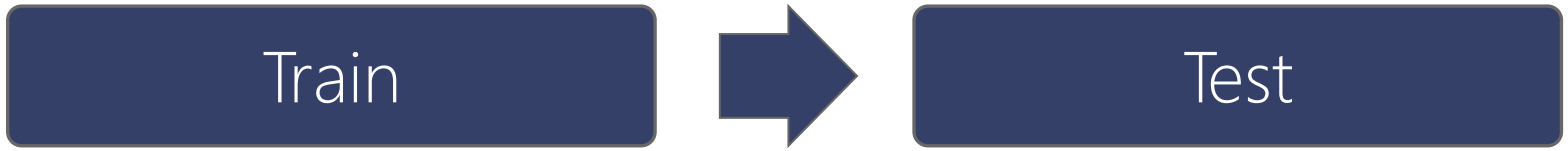
```
[<CLIMutable>]
type IrisData = {
   [<LoadColumn(0)>] SepalLength : float32
   [<LoadColumn(1)>] SepalWidth : float32
   [<LoadColumn(2)>] PetalLength : float32
   [<LoadColumn(3)>] PetalWidth : float32
   [<LoadColumn(4)>] Label : string
}

[<CLIMutable>]
type IrisPrediction = {
   [<ColumnName("PredictLabel")>]
   PredictedLabel : uint32
   Score : float32[]
}
```

ML.NET Pipeline step by step

- Create ML.NET Context
- **Load data**
- Transform data
- Train model
- Evaluate model
- Consume model

Load the Data

```
let trainData : IDataView =
                context.Data.LoadFromTextFile<Passenger>("train.csv",
                                                         hasHeader = true, separatorChar = ',')

let testData : IDataView =
                context.Data.LoadFromTextFile<Passenger>("test.csv",
                                                         hasHeader = true, separatorChar = ',')
```



Use ~80%

Use ~20%

Clean and Normalize Data

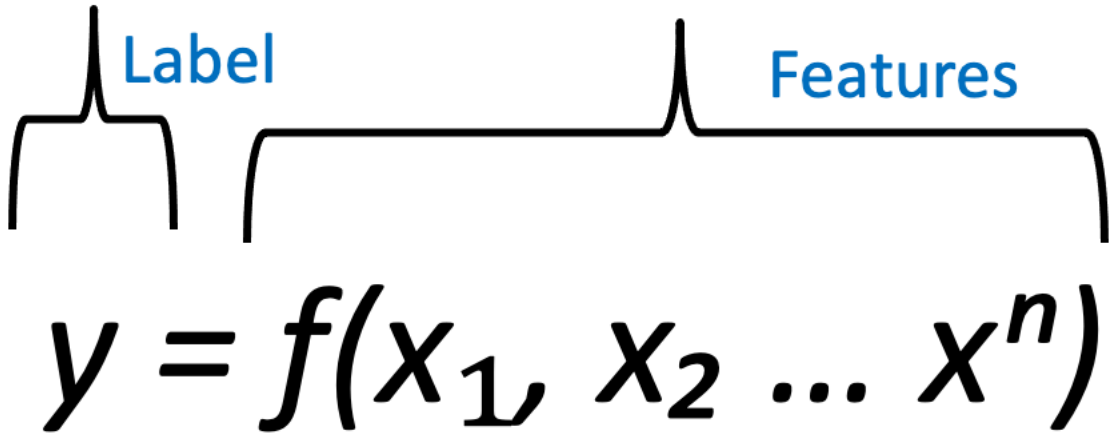
- Create ML.NET Context
- Load data
- **Transform data**
- Train model
- Evaluate model
- Consume model


```
// one-hot encode all text features
.Append(context.Transforms.NormalizeMimMax(”Price"))
.Append(context.Transforms.Categorical.OneHotEncoding("Make"))
.Append(context.Transforms.Categorical.OneHotEncoding("Model"))
.Append(context.Transforms.Conversion.ConvertType("Year", outputKind = DataKind.Single))
.Append(context.Transforms.Conversion.ConvertType("Mileage", outputKind = DataKind.Single))
```

ML.NET Pipeline step by step

- Create ML.NET Context
- Load data
- Transform data
- **Train model**
- Evaluate model
- Consume model

Training the Model



ML.NET Pipeline step by step

- Create ML.NET Context
- Load data
- Transform data
- Train model
- **Evaluate model**
- Consume model

Evaluate the Model and improve accuracy

```
let metrics =
        trainData
        |> model.Transform
        |> context.MulticlassClassification.Evaluate

// show evaluation metrics
printfn "  Accuracy:        %f" metrics.Accuracy
printfn "  Auc:             %f" metrics.AreaUnderRocCurve
printfn "  Auprc:           %f" metrics.AreaUnderPrecisionRecallCurve
printfn "  F1Score:         %f" metrics.F1Score
printfn "  LogLoss:         %f" metrics.LogLoss
printfn "  LogLossReduction:  %f" metrics.LogLossReduction
printfn "  PositivePrecision: %f" metrics.PositivePrecision
printfn "  PositiveRecall:    %f" metrics.PositiveRecall
printfn "  NegativePrecision: %f" metrics.NegativePrecision
printfn "  NegativeRecall:    %f" metrics.NegativeRecall
```

Cross-Validating Regression Models

- Regression CrossValidate divides a dataset into “folds” and scores each fold separately
- R-squared, Mean Absolute Error (MAE), Mean Squared Error (MSE), etc.
- Use mean of scores from all folds to get a more robust measure of accuracy

```
// Evaluate the model using cross-validation
let scores = context.BinaryClassification.CrossValidate(data = data,
                                                        estimator = pipeline, numberOfFolds = 5)

let mean = scores |> Seq.averageBy(fun x -> x.Metrics.F1Score)
Common.printRed (sprintf "Mean cross-validated F1 score: %A" mean)
```

ML.NET Pipeline step by step

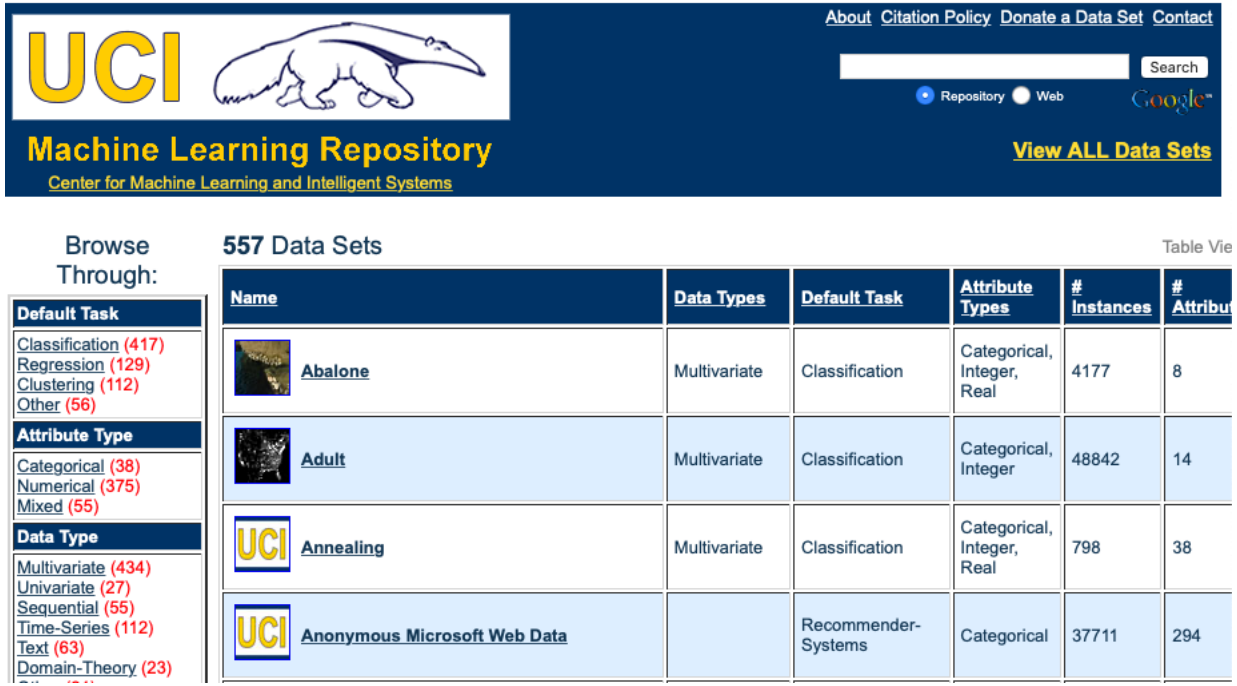
- Create ML.NET Context
- Load data
- Transform data
- Choose algorithm
- Train model
- Evaluate model
- **Consume model**

Consume the model

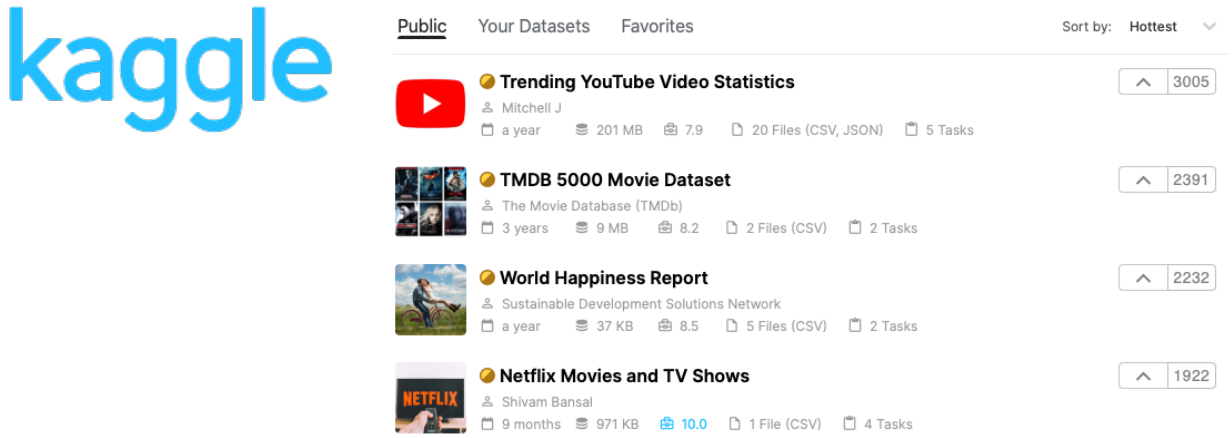
```
// train the model on the training set
let model = partitions.TrainSet |> pipeline.Fit

// get predictions and compare them to the ground truth
let metrics = partitions.TestSet |> model.Transform |> context.MulticlassClassification.Evaluate

// set up a prediction engine
let engine = context.Model.CreatePredictionEngine model

// create sample messages
let messages = [
   { Message = "Why pay more for expensive meds when you can order them online and save $$$?" }
   { Message = "free price $250 weekly competition just text the word WIN to 80086 NOW" }
   { Message = "Home in 30 mins. Need anything from store?" }
]

let run () =
   // make the predictions
   printfn "Model predictions:"
   messages |> List.iter(fun m ->`
      let p = engine.Predict m
      printfn "  %f %s - Classification %s" p.Probability m.Message (if p.IsSpam then "Spam" else "Ham"))
```

Online Datasets

http://archive.ics.uci.edu/ml/datasets.php



https://www.kaggle.com/datasets

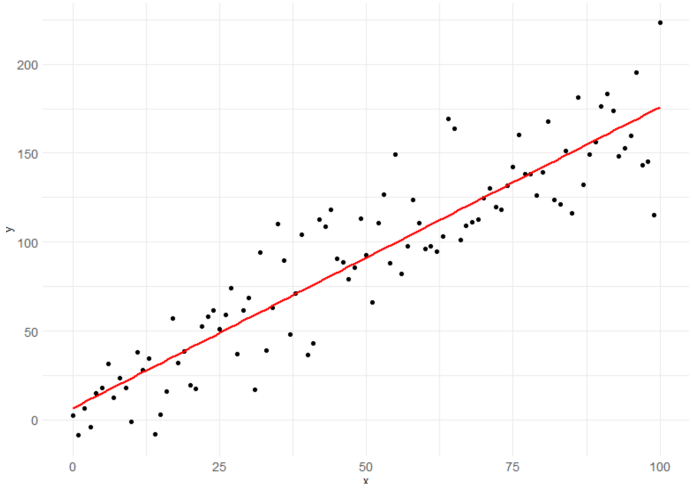


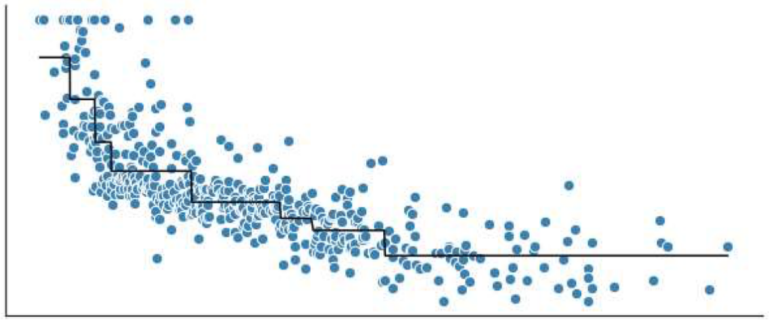
Regression Decision Trees and Random Forests

How much / how many

Examples:
- Predict the temperature
- Predict house prices
- Predict next month's sales

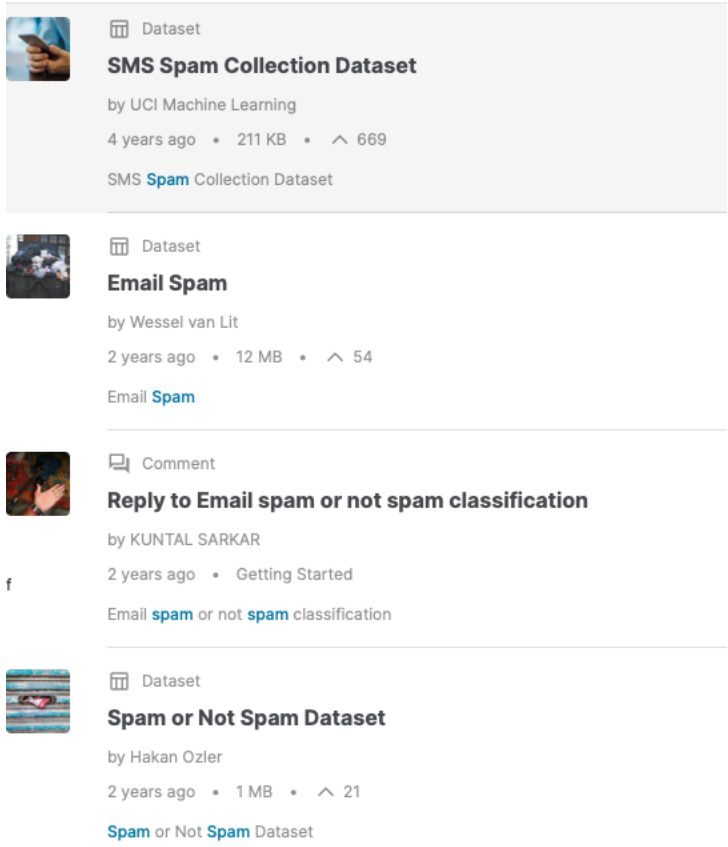
Predict price of used car





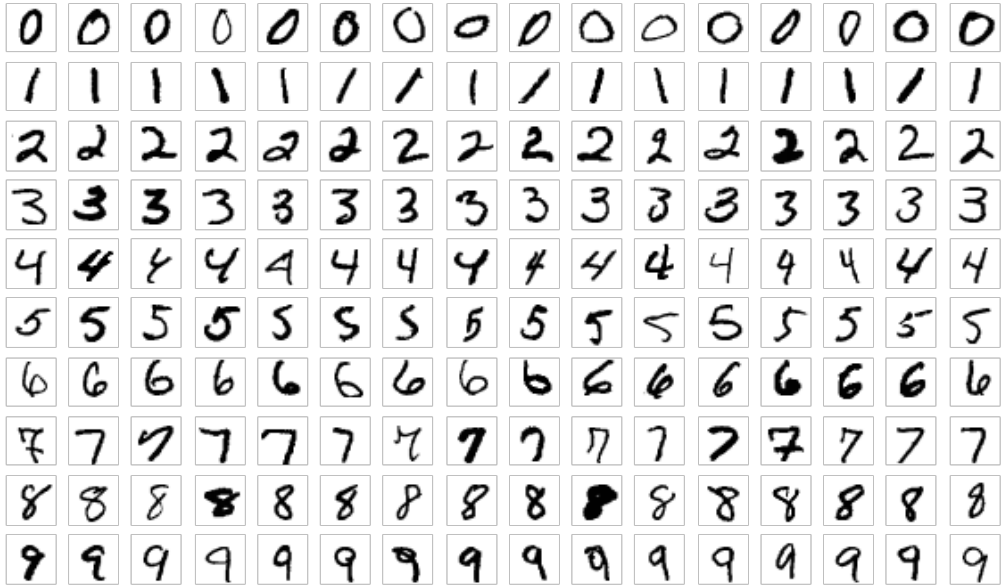
Classification

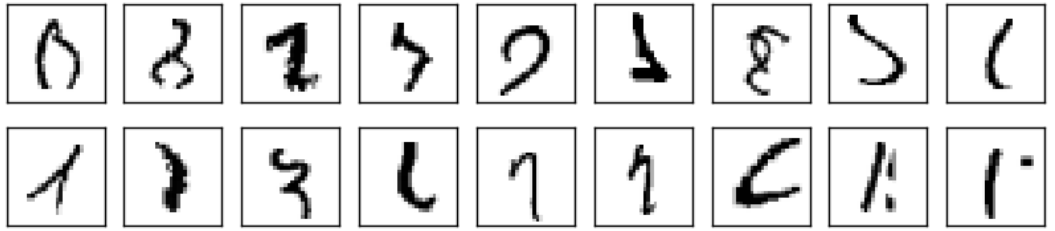
SMS Spam Detection



MultiClass Classification

Optical Character Recognition

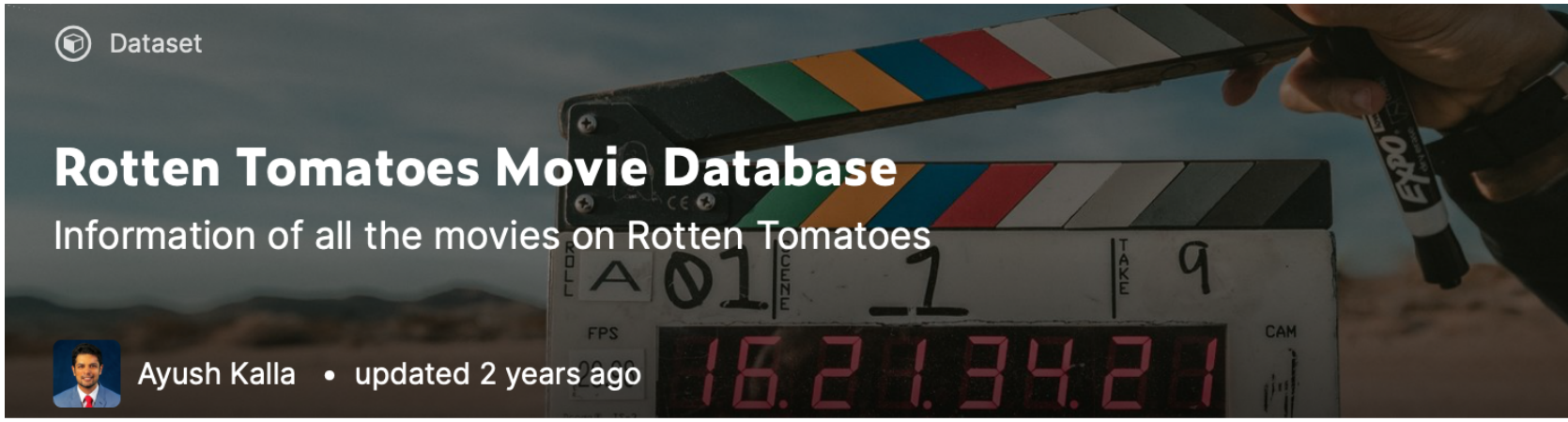




Recommendation

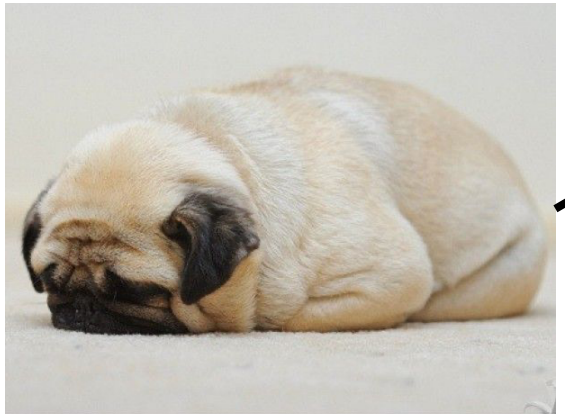
Movie recommendation

kaggle



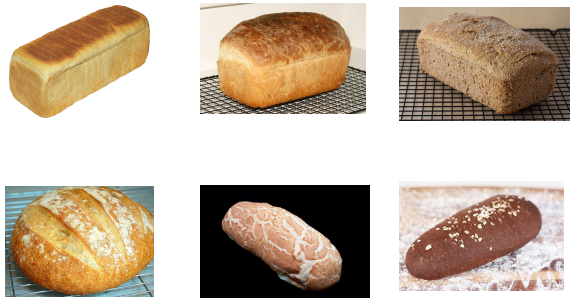
ML.NET integration with TensorFlow Transfer Learning

Image classification based on deep neural network

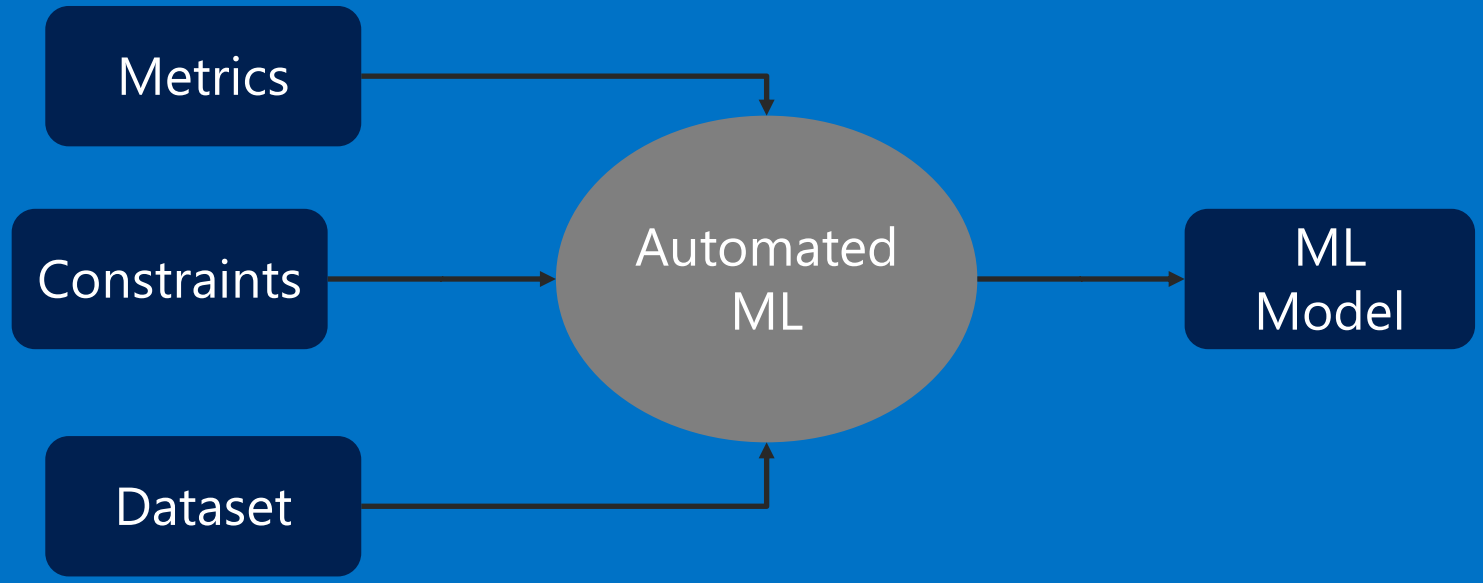


Bread
or
Pug?

Bread



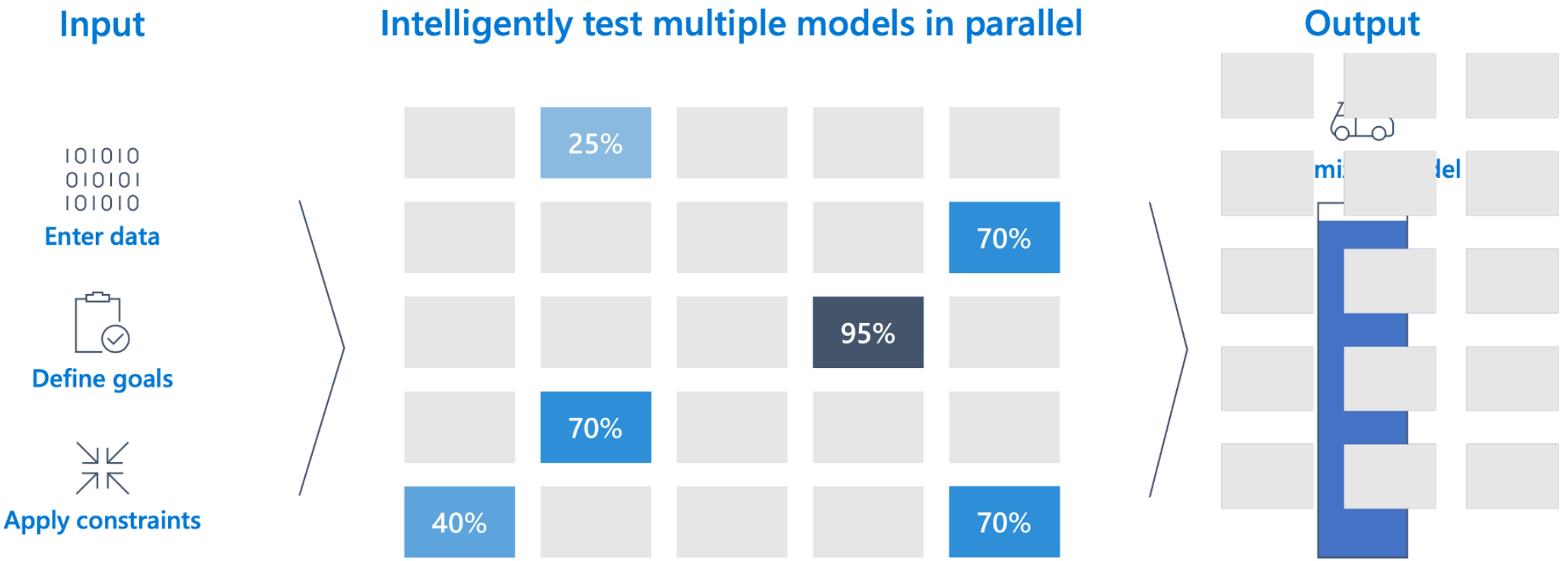
Pug



AutoML
Automated Machine Learning

Available in three from factors

- ML.NET CLI (Command Line)
- ML.NET Model Builder (Graphical User Interface)
- ML.NET AutoML API (Application)



What is automated machine learning?

Automated ML Accelerates Model Development

ML.NET CLI

- Easily build custom ML models with AutoML
- Generates code for training and consumption
- Model Builder
  - Currently in Visual Studio only
  - Integration with Azure ML
- ML.NET CLI
  - Cross platform