Predicting the future (of equipment) using ML.NET

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R&D Engineering Manager at 7-ELEVEN

- Machine Learning
- C# Devs
- Maintenance Personnel
- Fortune Tellers
- Crystal Gazing/Scrying

Agenda

- Predictive Maintenance
- What is Machine Learning?
- ML.NET
- ML.NET Model Builder
- Demo

Evolution of Maintenance Strategies

REACTIVE

WAITS FOR FAILURE

PREVENTATIVE

SCHEDULED

CONDITION-BASED

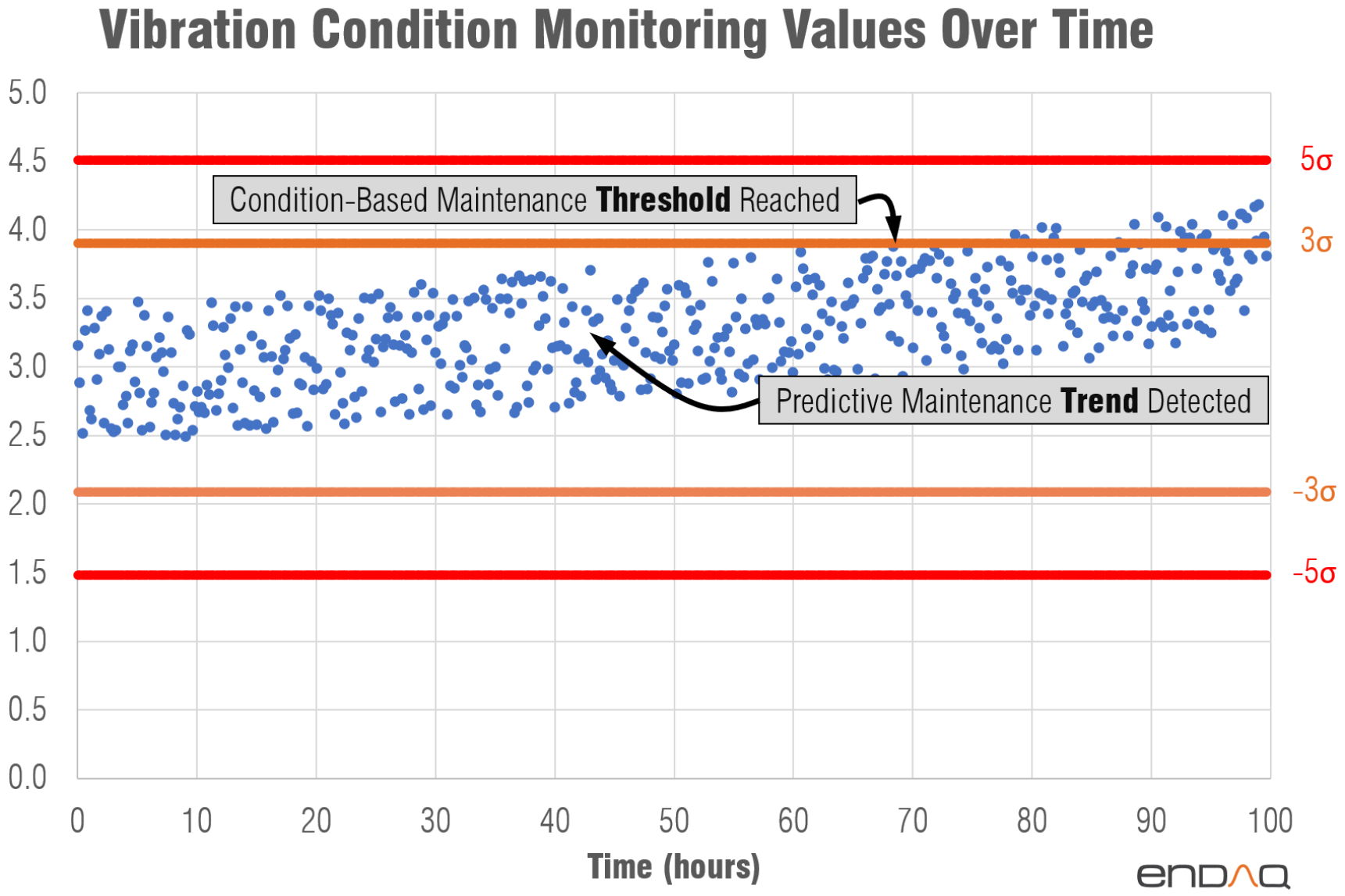
THRESHOLD

PREDICTIVE

ANALYTICS

PRESCRIPTIVE

ROOT-CAUSE



https://blog.endaq.com/differences-between-condition-based-predictive-and-prescriptive-maintenance

Predictive maintenance

- maintenance strategy
- predict WHEN equipment or machines MAY fail / need maintenance
- to take care of machines
- to keep running smoothly
- To prevent unexpected break down

Regular Check-ups

@rondagdag

Industrial Machinery

- Advance sensors
- ML Algorithms
- Data Analysis

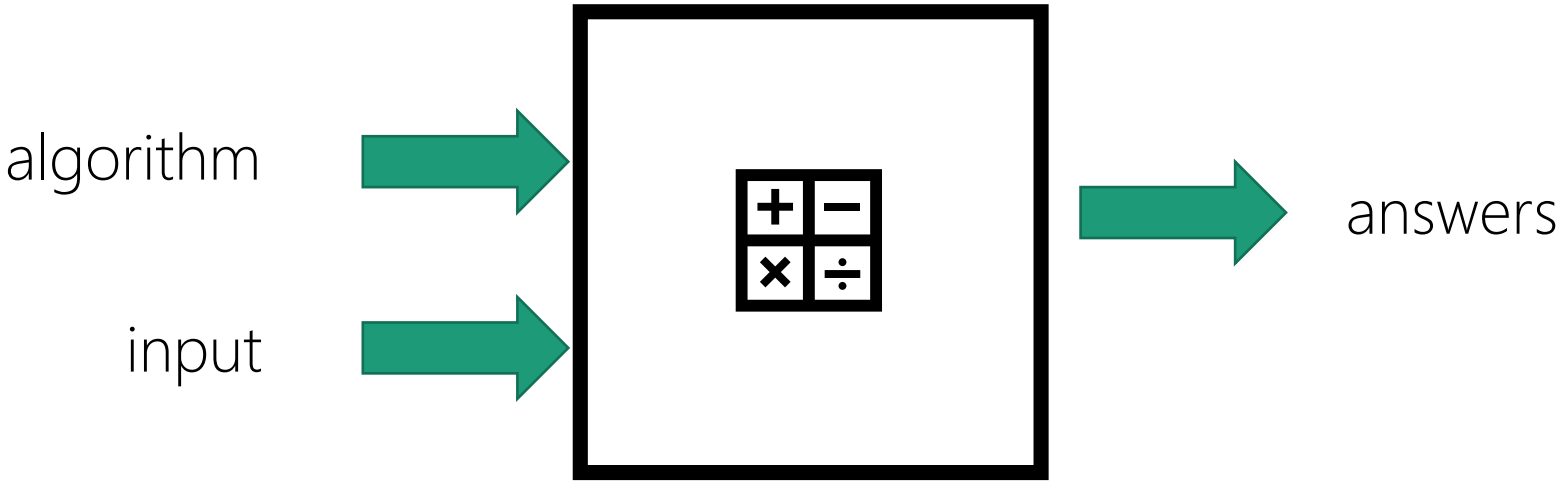
- Predict future problem
- Fix before breakdown
- Save time and Money - Unscheduled downtime and maintenance costs.

Roman crystal ball with the Greek palindrome
3rd century CE

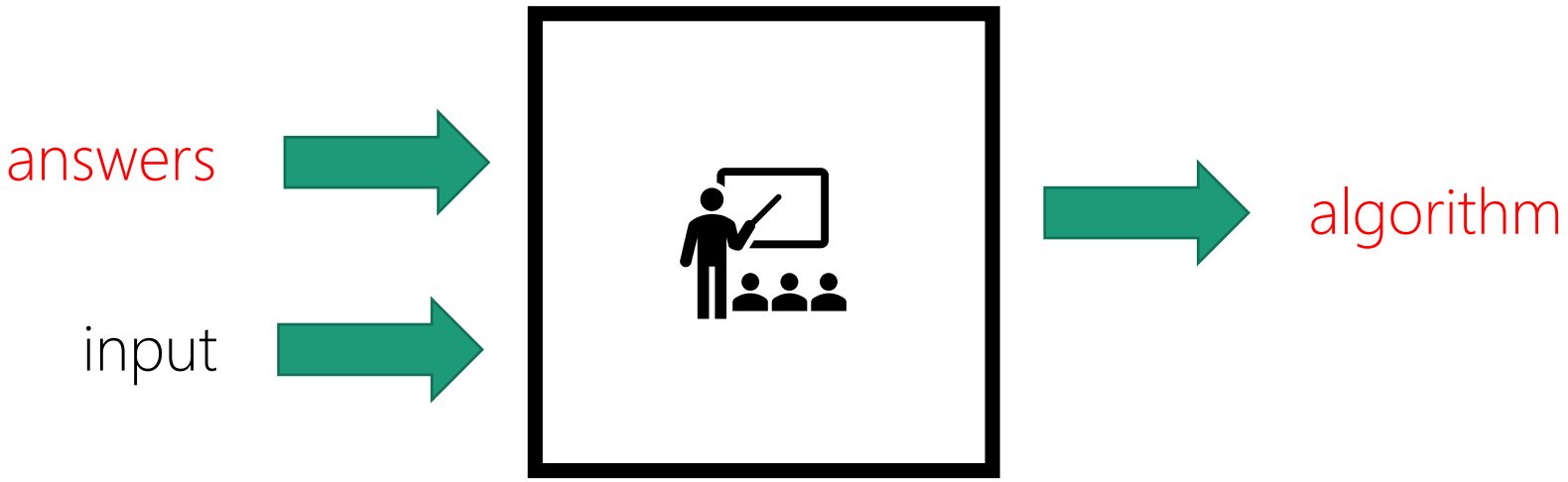
ΑΒΛΑΘΑΝΑΛΒΑ

ABLANATHANALBA
“You are our father”

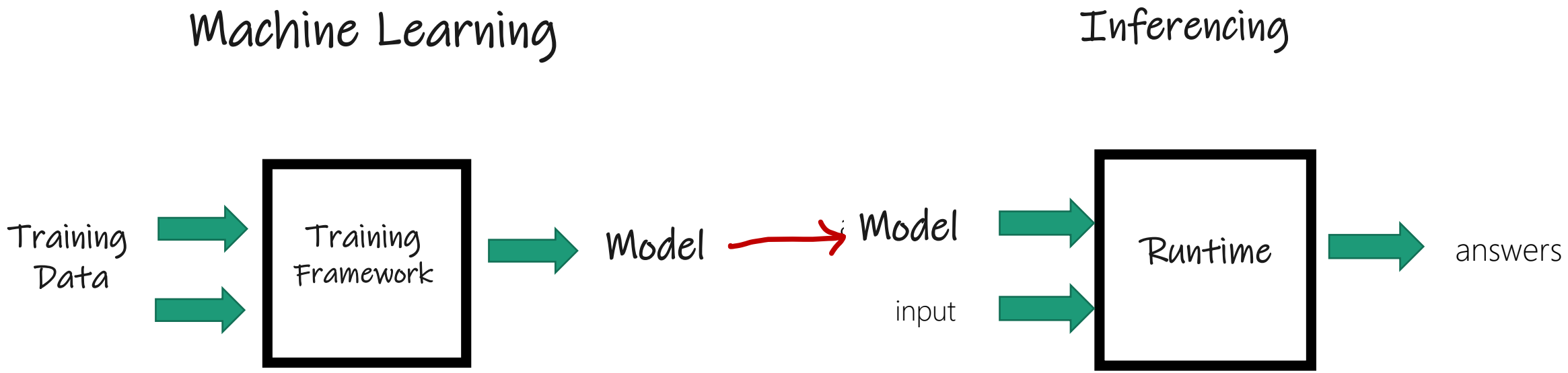
programming



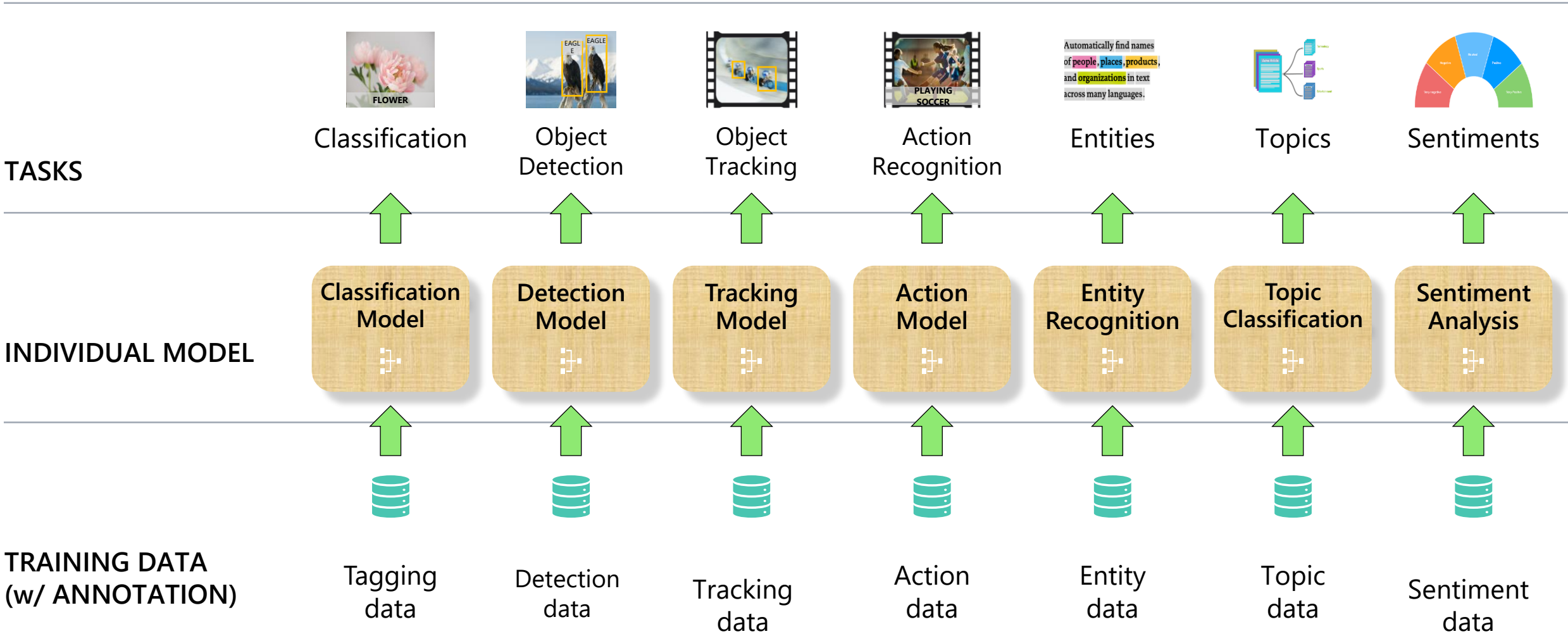
machine learning



ML Primer


Machine Learning
Inferencing
Training Data
Training Framework
Model
Model
input
Runtime
answers

Model development

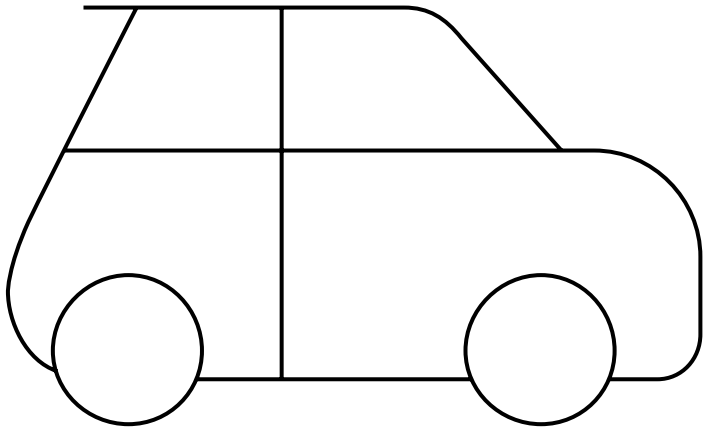


ML.NET

- machine learning to .NET applications
- Add automatic predictions to apps
- online or offline
- ML.NET can generate machine learning **model**.
- **model** = steps to transform input data into a prediction
- import pre-trained TensorFlow and ONNX models
- Supports Windows, Linux, and macOS

AutoML with ML.NET

ML.NET tool accelerates productivity



How much is the taxi fare for 1 passenger going from Airport to Downtown?

machine learning made easy

ML.NET takes the guess work out of data prep, feature selection & hyperparameter tuning

Which features?

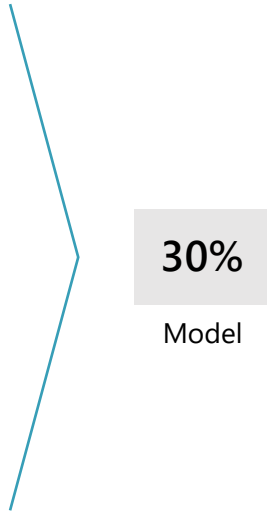
- **Distance**
- Trip time
- **Car type**
- **Passengers**
- Time of day
- …

Which algorithm?

- **Gradient Boosted**
- Nearest Neighbors
- SGD
- Bayesian Regression
- LGBM
- …

Which parameters?

- Parameter 1
- Parameter 2
- Parameter 3
- Parameter 4
- XYZ
- …



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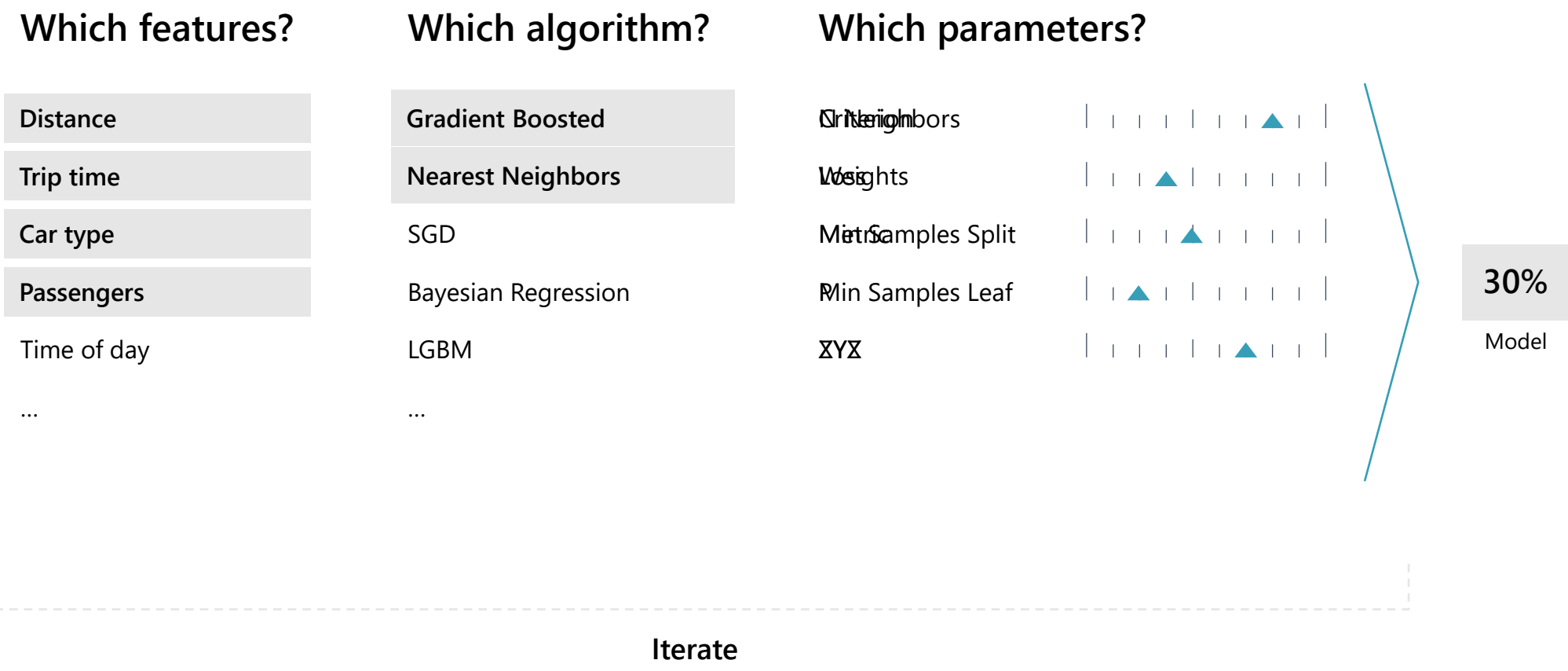
Model

machine learning made easy

ML.NET takes the guess work out of data prep, feature selection & hyperparameter tuning



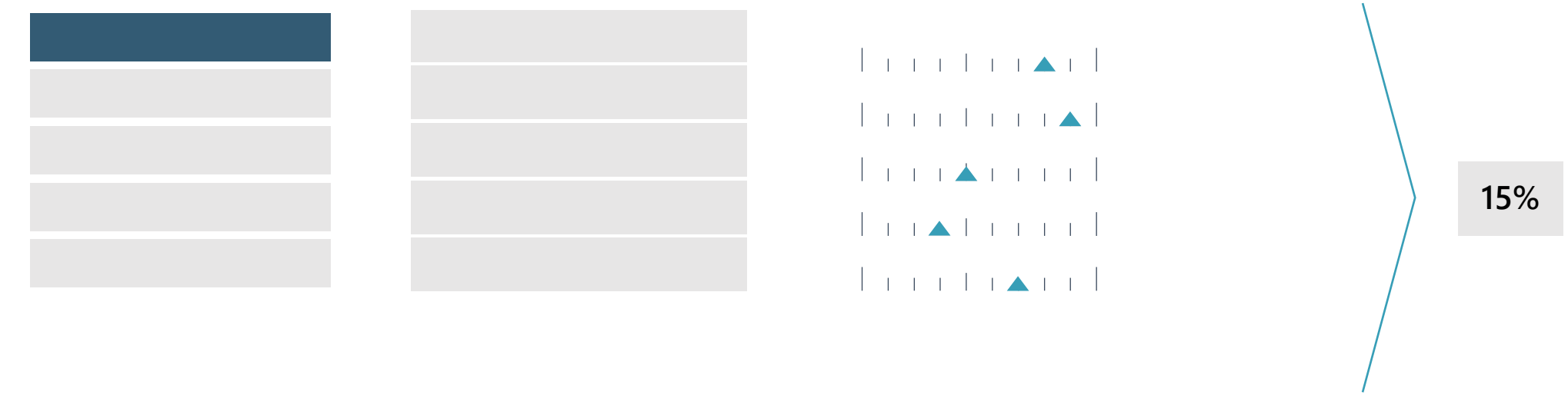
machine learning made easy

ML.NET takes the guess work out of data prep, feature selection & hyperparameter tuning

Which features?

Which algorithm?

Which parameters?



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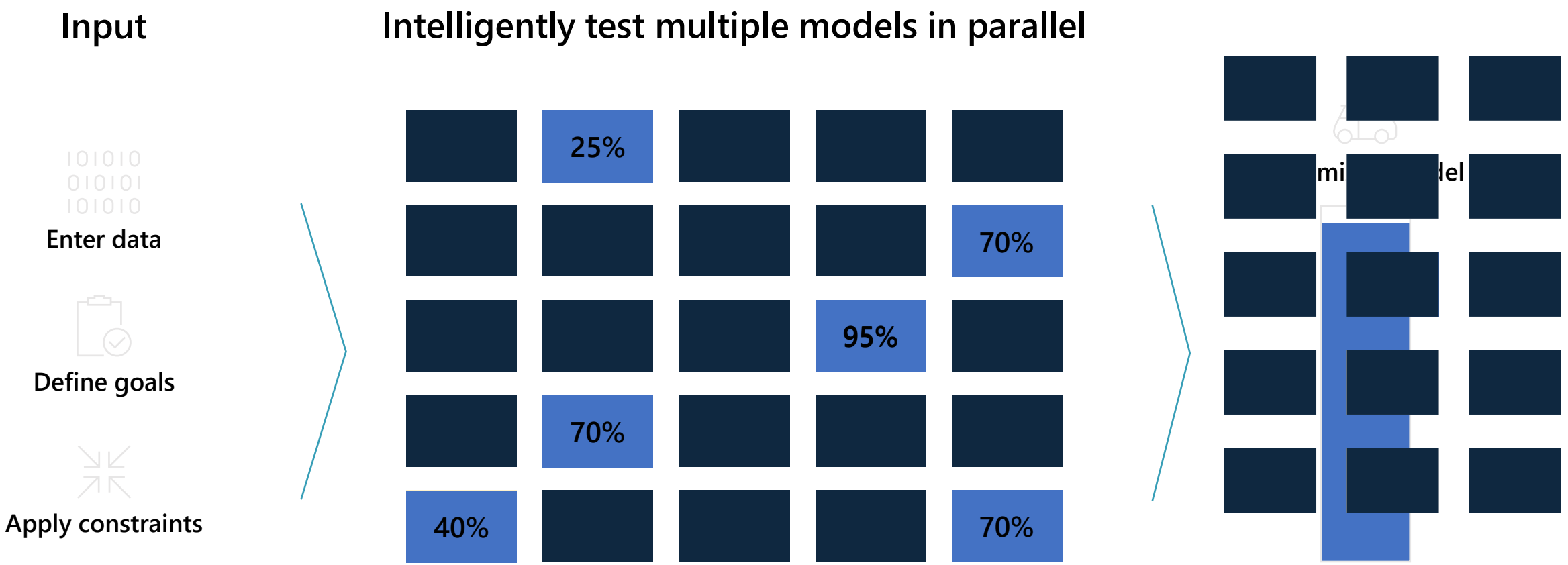
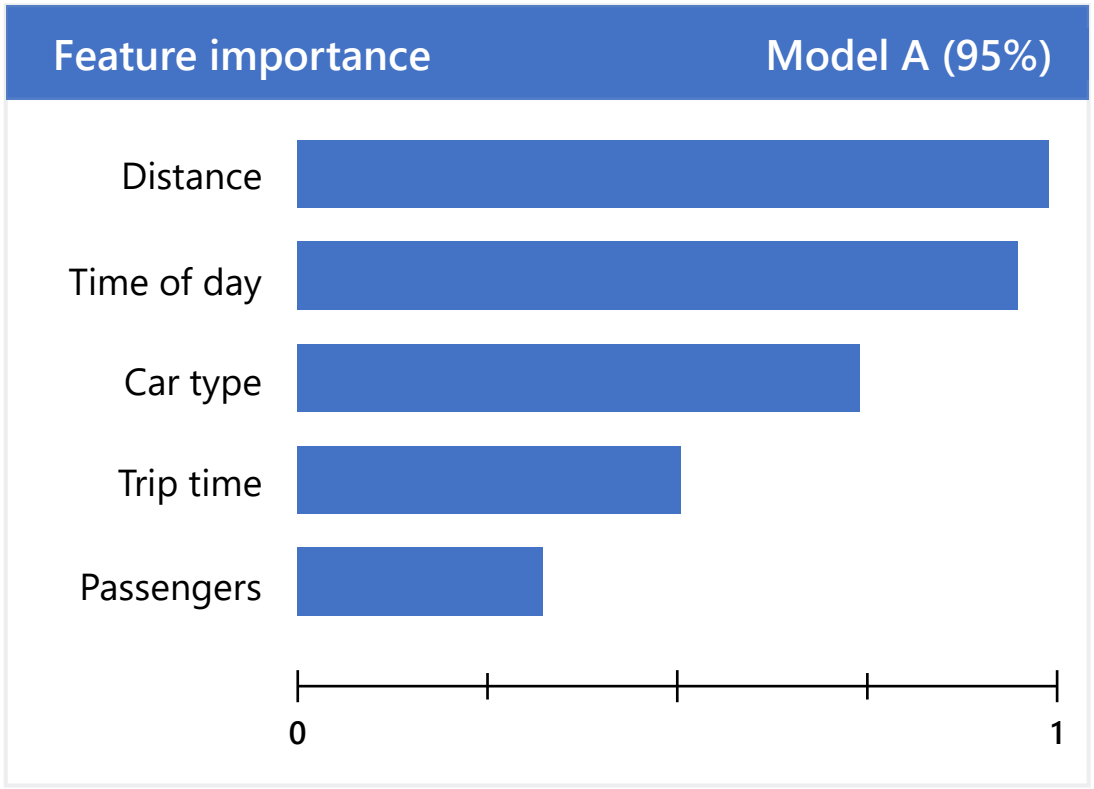
Iterate

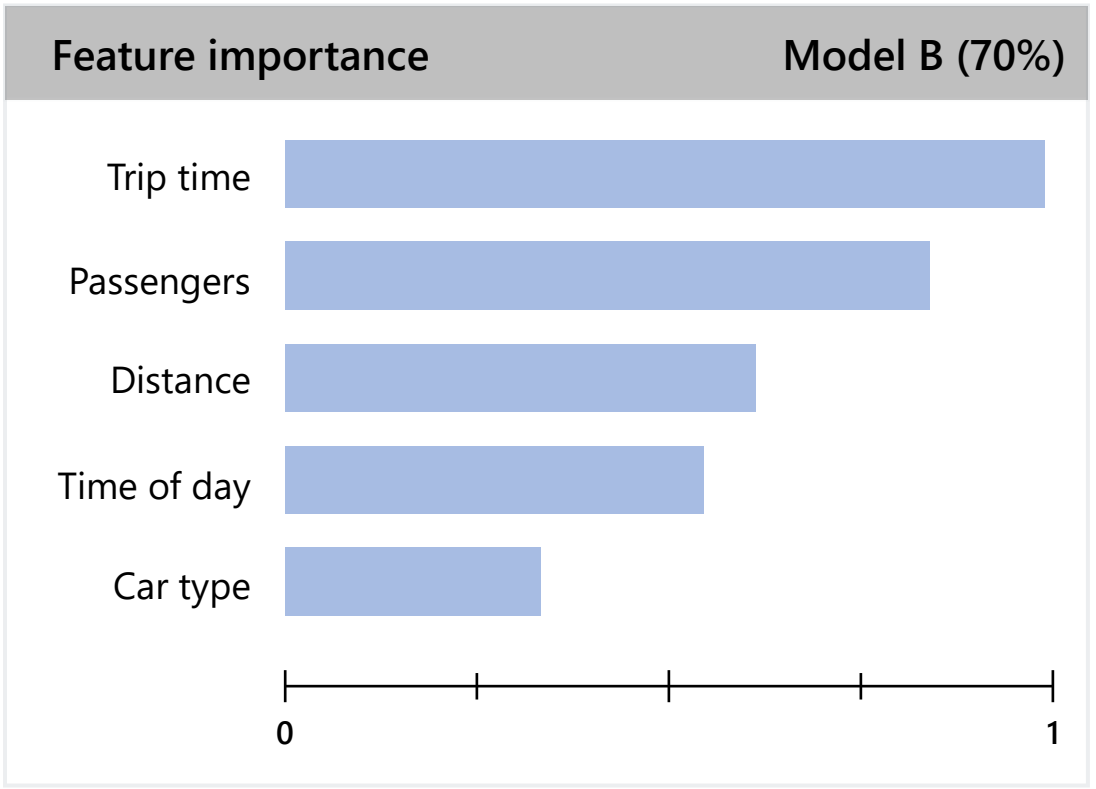
ML.NET accelerates model development



ML.NET accelerates model development

with **model explainability**

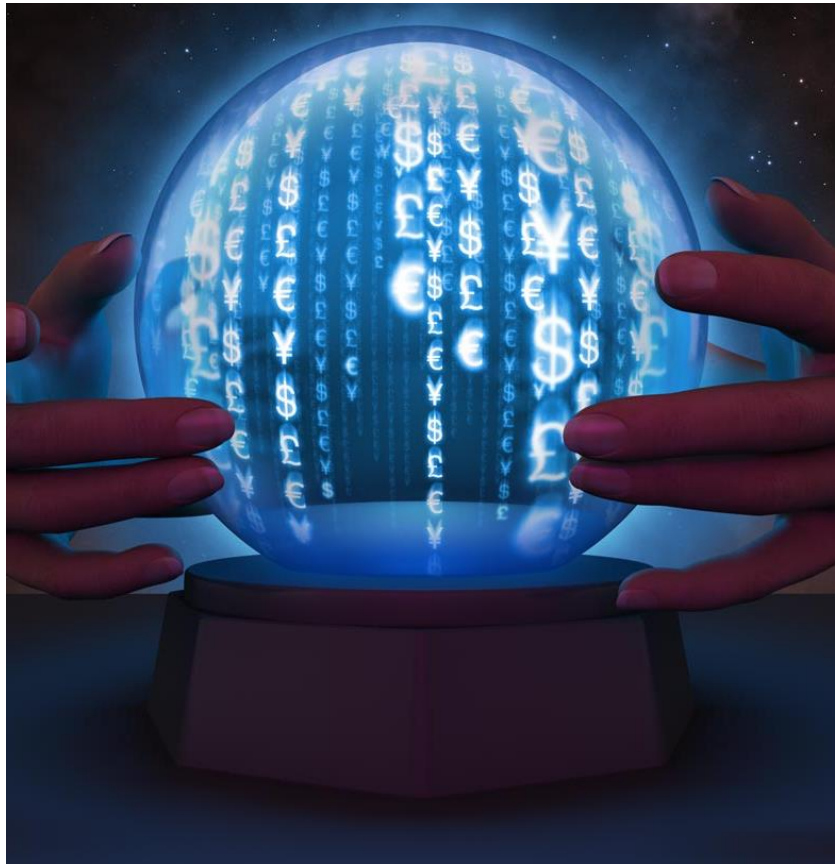




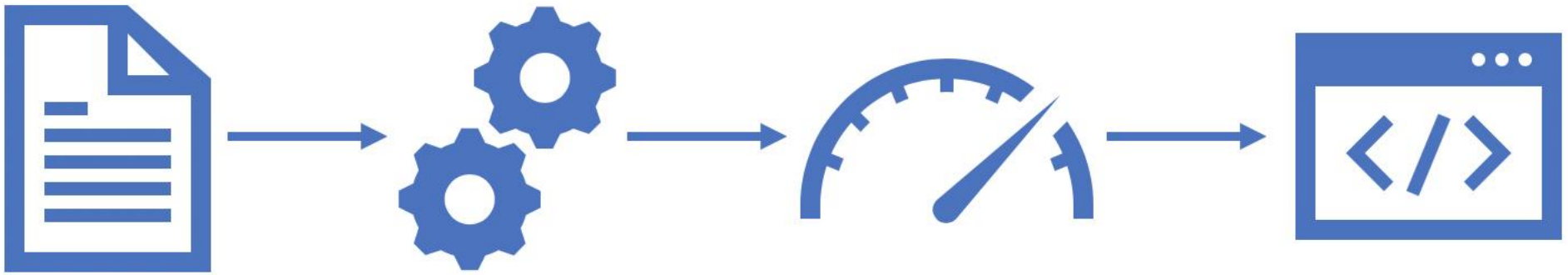
- Largest-known true crystal ball
- Smithsonian in Washington, D.C.
- 106.75 lbs. (48.42 kg)
- 12.9 in diameter (32.7 cm)
- 1800s in China, mineral is from Burma

ML.NET Model Builder

- Simple UI tool in Visual Studio
- Runs locally to build, train and ship ML projects
- build/train in Azure
- Generates Custom ML models



Model Builder



Types of problems

Data Classification
Classify if machine needs maintenance or not

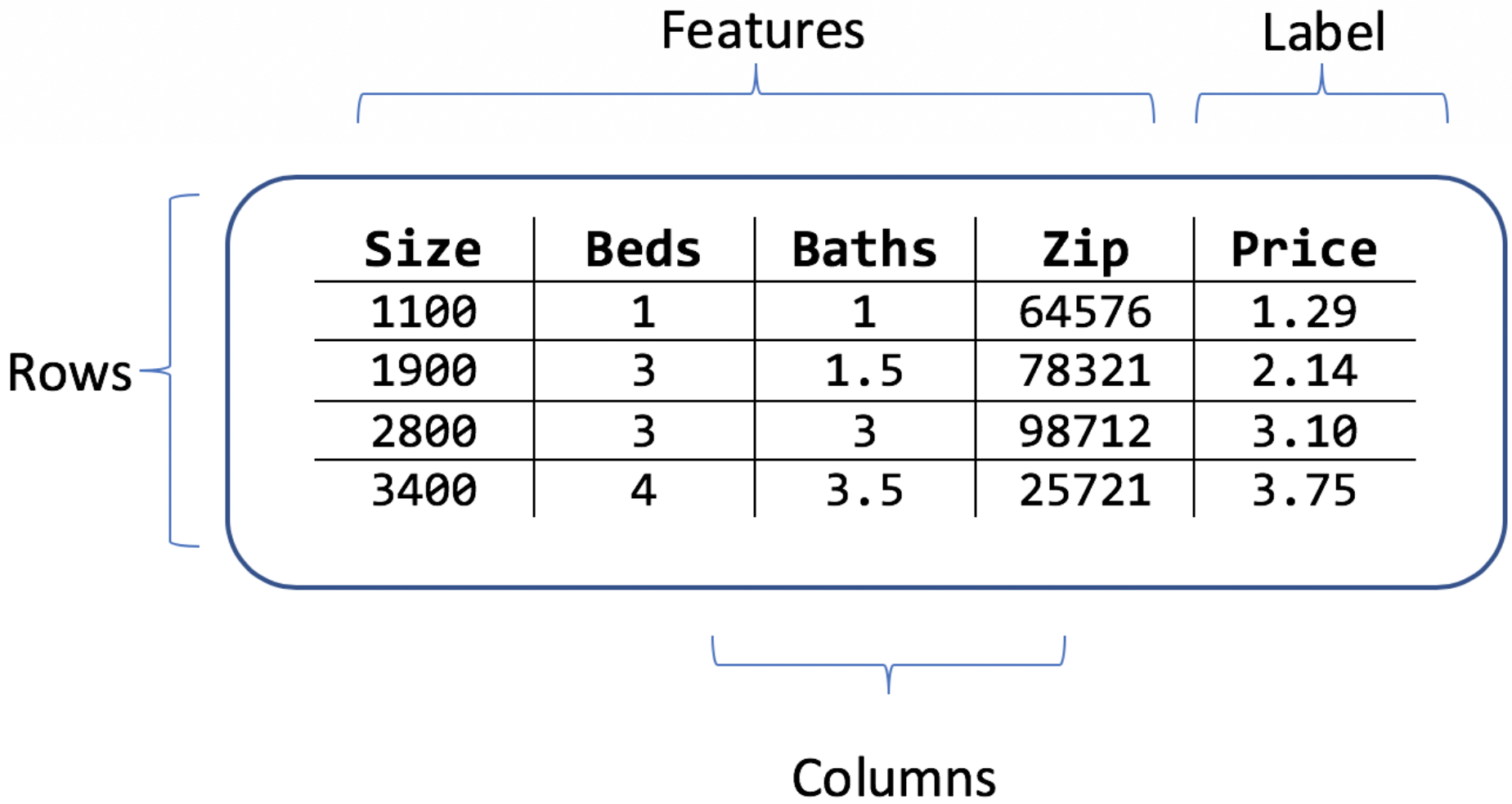
Value Prediction
Estimate the volume of liquid needed

Forecasting
Predict future values based on observed time series values. Forecast demands

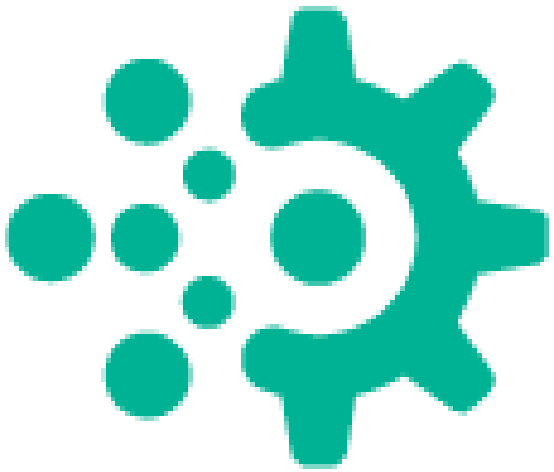
Recommendation
Recommend suppliers.

Classifying images
Tag an image based on its contents. Alert defects

Detecting objects in an image:
Detect personnel is working in a safe area


Features
Label
Rows
Size
Beds
Baths
Zip
Price
1100
1
1
64576
1.29
1900
3
1.5
78321
2.14
2800
3
3
98712
3.10
3400
4
3.5
25721
3.75
Columns

Model Builder DEMO



In Visual Studio, install:
ML.NET Model Builder VS Extension

Model Builder

Scenario	Local CPU	Local GPU	Azure
Data classification	✓	✗	✗
Value prediction	✓	✗	✗
Recommendation	✓	✗	✗
Forecasting	✓	✗	✗
Image classification	✓	✓	✓
Object detection	✗	✗	✓
Text classification	✓	✓	✗

Model Builder

Dataset size	Average time to train
0 - 10 MB	10 sec
10 - 100 MB	10 min
100 - 500 MB	30 min
500 - 1 GB	60 min
1 GB+	3+ hours

These numbers are a guide only. The exact length of training is dependent on:

- the number of features (columns) being used to as input to the model
- the type of columns
- the ML task
- the CPU, disk, and memory performance of the machine used for training

- 2nd largest perfect crystal sphere known
- Japan, Meiji period, 19th century
- silica and oxygen—in the form of silicon dioxide

What is .NET MAUI?

- .NET MAUI is open-source
- cross-platform framework
- native mobile and desktop apps with C# and XAML.
- develop apps on Android, iOS, macOS, and Windows
- single shared code-base
- evolution of Xamarin.Forms

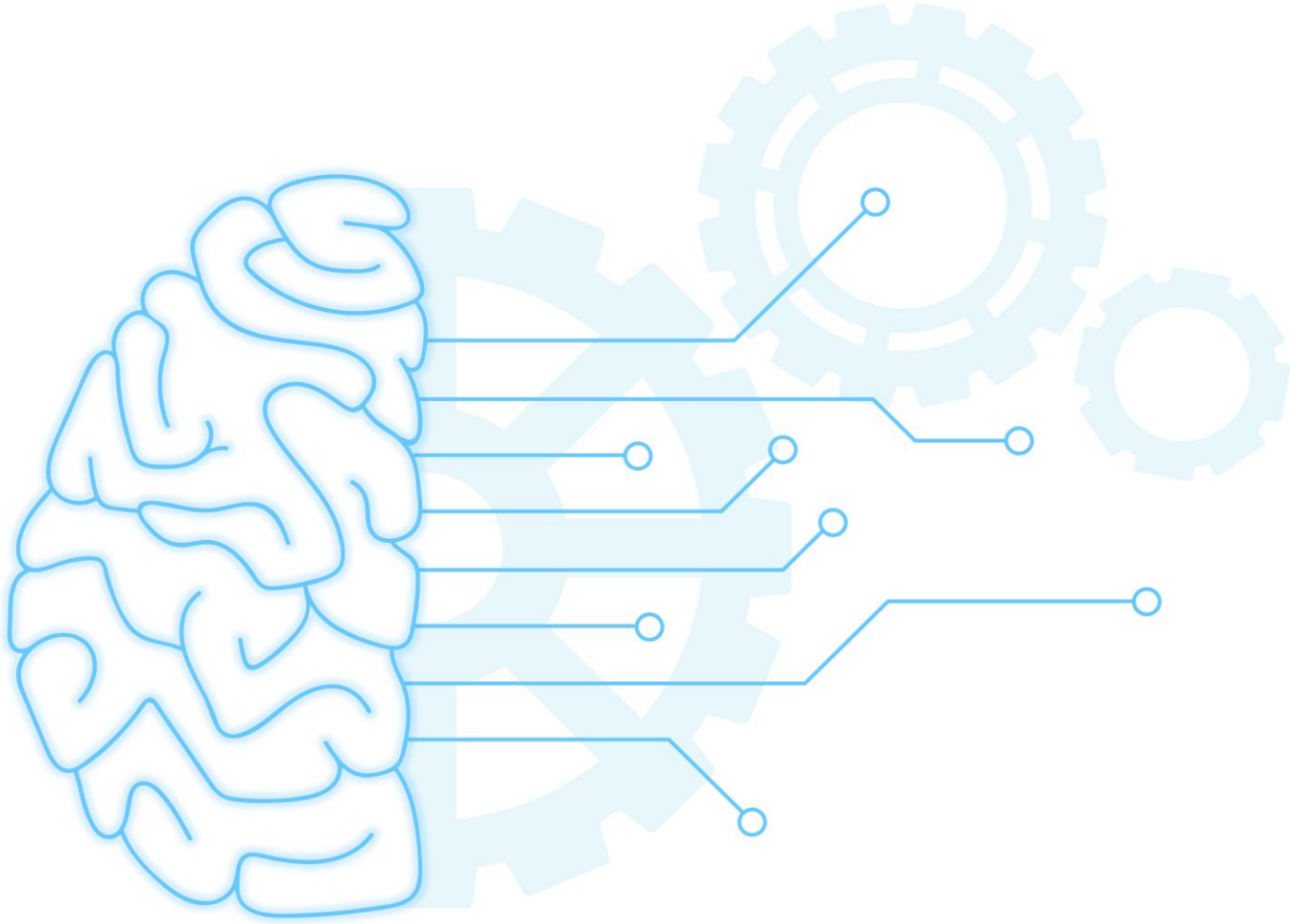
.NET MAUI provides:

- Layout engine for designing pages
- Multiple page types for rich navigation types.
- Data-binding support
- Customize handlers
  - UI elements are presented
- Cross-platform APIs
  - native device features

.NET MAUI provides:

- Cross-platform graphics functionality,
  - supports drawing, painting shapes,images
  - compositing operations
  - graphical object transforms
- A single project system
- multi-targeting to target
  - Android
  - iOS
  - macOS
  - Windows
- .NET hot reload

MAUI and ML.NET



DEMO

Wicked Witch's crystal ball

- From the movie "The Wizard of Oz“
- sold for $129,000 at an auction in 2001
- Walker Library of the History of Human Imagination
- 25 inches in diameter
- handblown glass and is actually slightly egg-shaped

https://www.livescience.com/59205-facts-about-crystal-balls.html

Summary

- Predictive Maintenance
  - Predict before equipment fail
- What is Machine Learning?
  - training and inferencing
- ML.NET
  - Machine Learning for .NET Developers

Summary

- AutoML
  - Machine Learning made easy
- ML.NET Model Builder
  - Generates Custom ML models in Visual Studio
- MAUI
  - develop apps Android, iOS, macOS, and Windows

Let Me Predict your future!

https://github.com/rondagdag/predictive-maintenance-mlnet-talk

About Me

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  www.linkedin.com/in/rondagdag/
- Thanks for geeking out with me about Machine Learning, ML.NET, AutoML, MAUI, Crystal Ball

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