

# Azure Machine Learning & ML.NET: Better Together



# Who?



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.NET User Group Zürich



# Agenda

- Quick refresher on AI
- Azure Machine Learning
- ONNX
- Generating an ONNX Model
- ML.NET
- Consuming an ONNX Model



# AI Refresh!

## AI

The ability of machines/software to  
mimic  
Human behavior.

## ML

The ability of machines to learn and  
make predictions based on its  
experience(data).

1980

## Deep Learning

The ability of machines to learn  
upon mimicking the human brain  
structure, essentially multiple layers  
of artificial neural networks.

2010

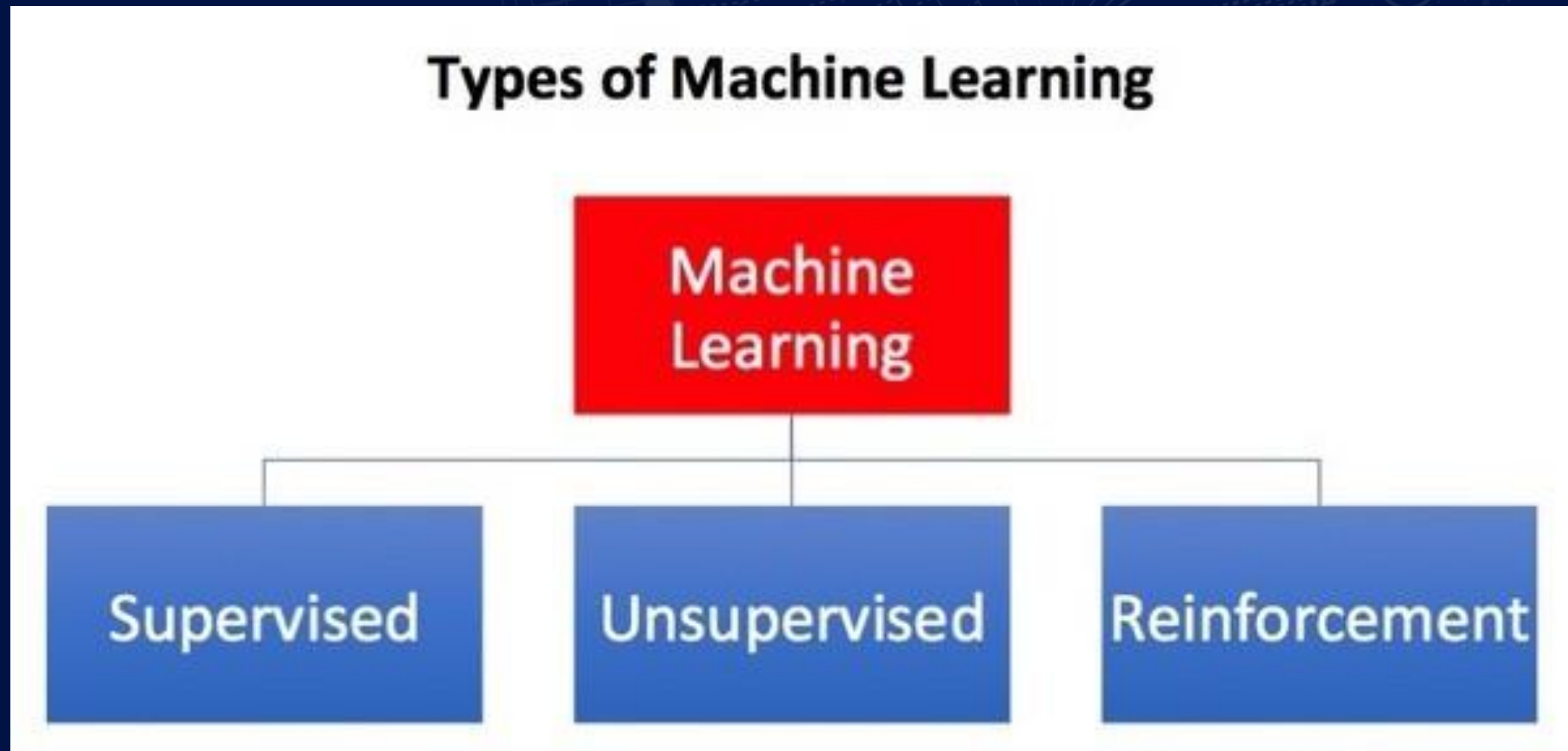
# How does Machine Learning work?





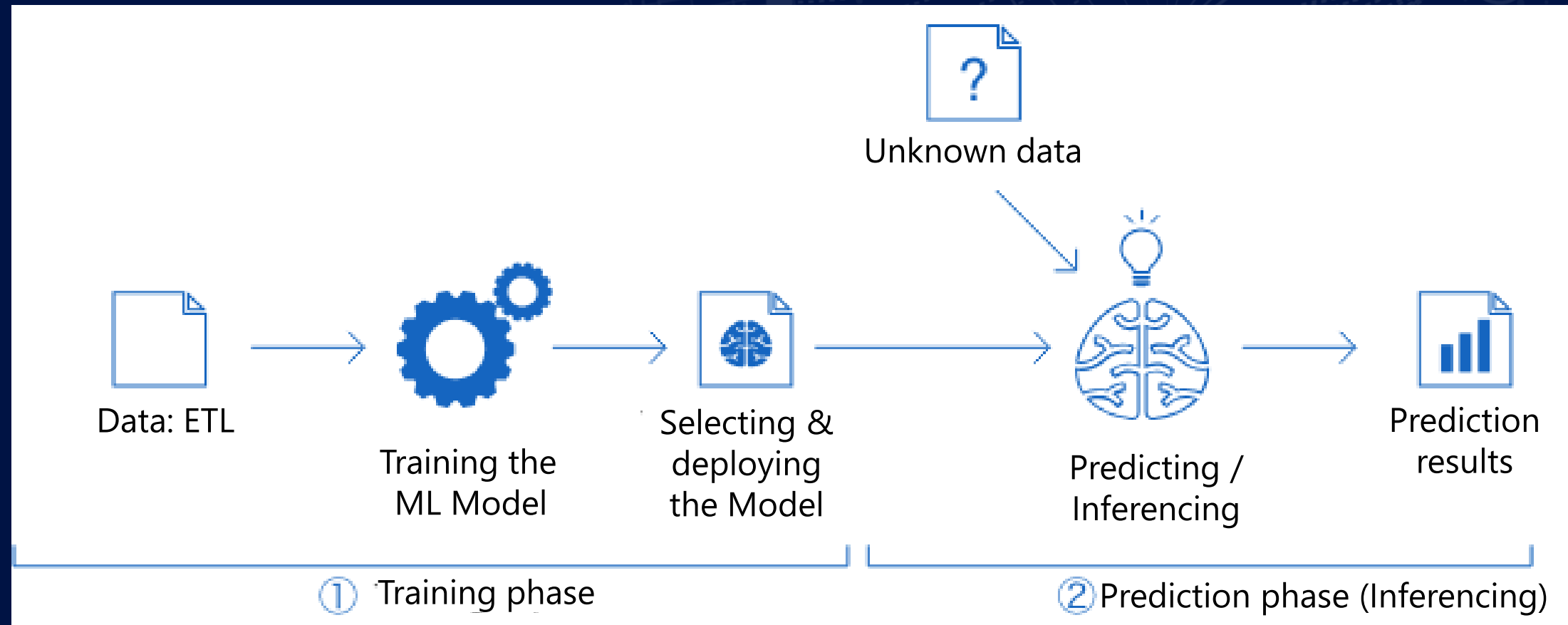
# ML Algorithms

- Generally, we have three main Categories/Techniques: Supervised, Unsupervised & Reinforcement learning.



# The Machine Learning Workflow

- The process of training a ML model which involves several steps which we can summarize on the following picture.



# Azure Machine Learning

Bring AI to everyone with an end-to-end, scalable, trusted platform



Boost your data science productivity



Increase your rate of experimentation



Deploy and manage your models everywhere



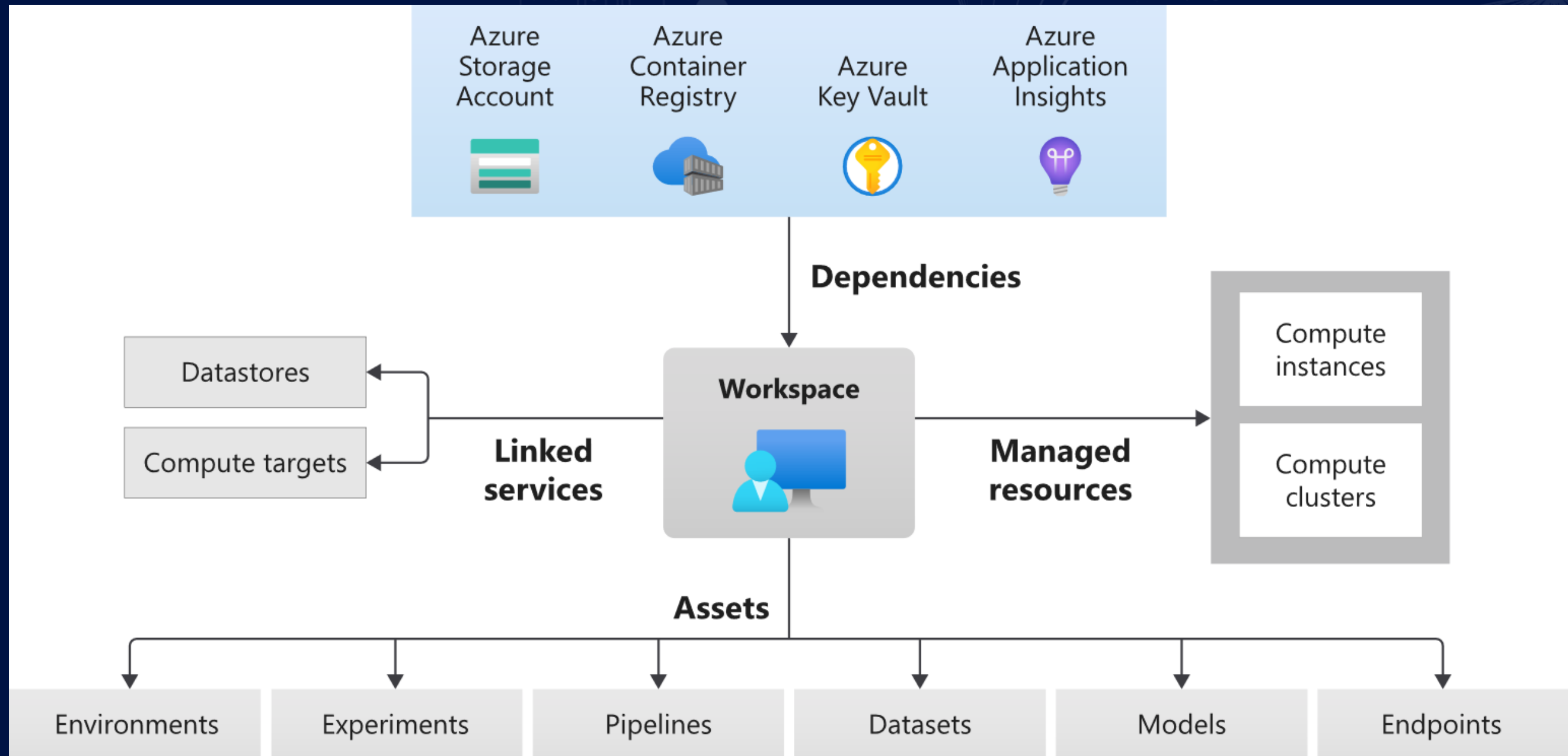
Built with your needs in mind

- Automated machine learning
- Managed compute
- Simple deployment
- DevOps for machine learning
- Support for open source frameworks
- Tool agnostic Python SDK

Seamlessly integrated with the Azure Portfolio



# Azure Machine Learning WORKSPACE



# Azure Machine Learning Studio

Set of Azure  
Cloud Services



Python  
SDK

That enables you to:

- Prepare Data
- Build Models
- Train Models
- Manage Models
- Track Experiments
- Deploy Models



# An overview of the Azure ML Studio



# How to create

The screenshot shows the Microsoft Azure portal interface. The left sidebar contains navigation links: Create a resource, Home, Dashboard, All services, FAVORITES, All resources, Resource groups, App Services, Function App, SQL databases, Azure Cosmos DB, Virtual machines, Load balancers, Storage accounts, Virtual networks, Azure Active Directory, Monitor, Advisor, Microsoft Defender for Cloud, Cost Management + Billing, and Help + support.

The main content area is divided into several sections:

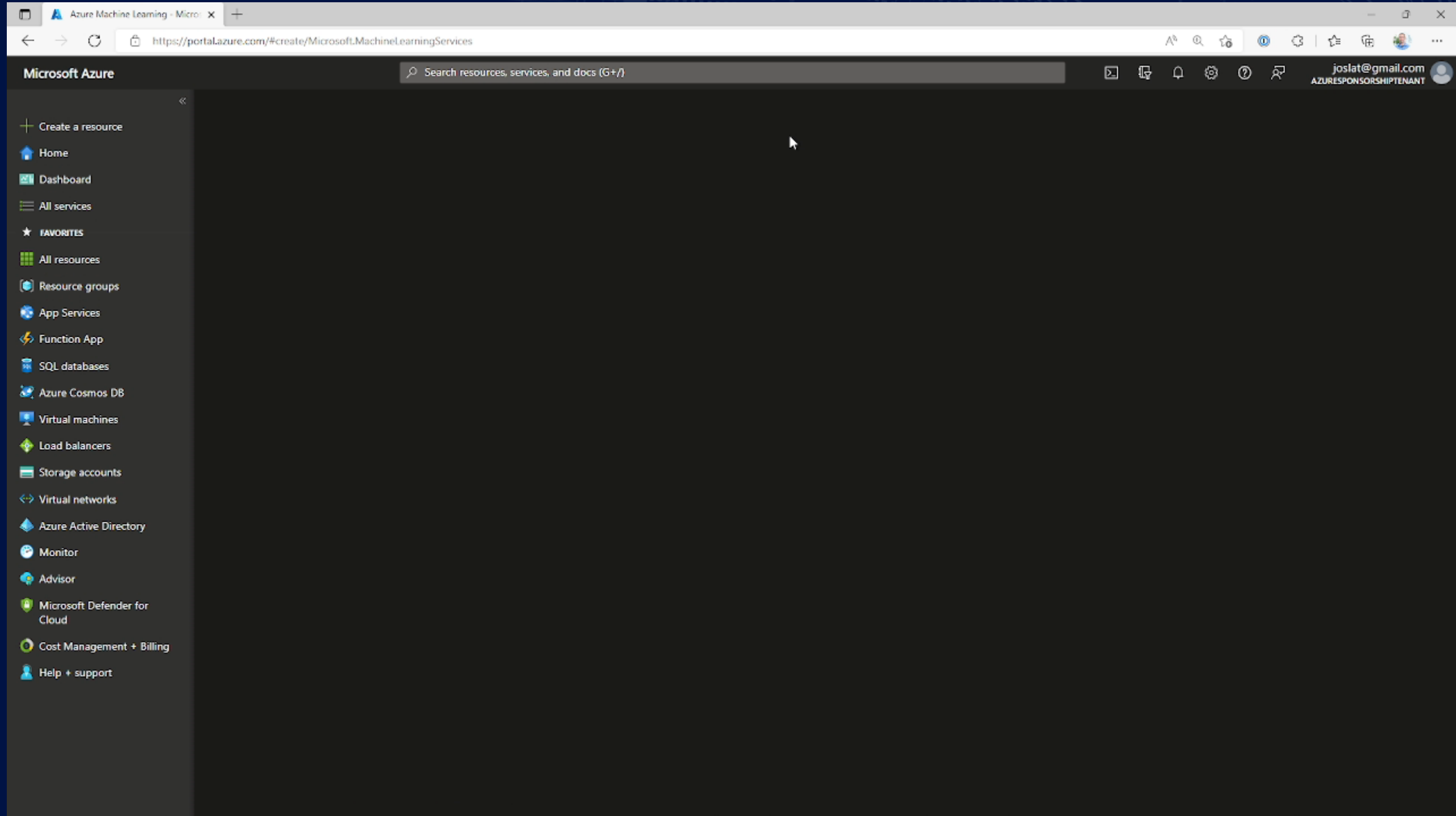
- Azure services:** A row of icons for various services: Create a resource, Resource groups, SQL databases, Storage accounts, Subscriptions, Microsoft Defender for Cloud, Advisor, Virtual networks, App Services, and More services.
- Resources:** A table showing recent resources.
- Navigate:** A row of icons for Subscriptions, Resource groups, All resources, and Dashboard.
- Tools:** A row of icons for Microsoft Learn, Azure Monitor, Microsoft Defender for Cloud, and Cost Management.

The 'Resources' table has the following data:

Name	Type	Last Viewed
<a href="#">NDC-Copenhagen</a>	Azure Machine Learning	2 days ago
<a href="#">NDC-Copenhagen</a>	Resource group	2 days ago
<a href="#">timeserieslearning</a>	Azure Machine Learning	3 days ago
<a href="#">timeseriesml</a>	Resource group	3 days ago
<a href="#">timeserieslear9983718140</a>	Storage account	a month ago



# Overview



# Azure Machine Learning Designer


Drag-and-drop interface to create pipelines for training models, inferencing or data processing.

Microsoft Azure Machine Learning Studio

Home > Designer

Designer

New pipeline



Easy-to-use prebuilt modules ⓘ







Image Classification using DenseNet ⓘ




Binary Classification using Vowpal Wabbit Model - A... ⓘ




Wide & Deep based Recommendation - Restau... ⓘ




Regression - Automobile Price Prediction (Basic) ⓘ




Regression - Automobile Price Prediction (Compare algo... ⓘ




Binary Classification with Feature Selection - Income... ⓘ



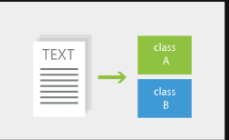
Binary Classification with custom Python script - Cre... ⓘ




Binary Classification - Customer Relationship Prediction ⓘ




Use custom R script - Flight Delay Prediction ⓘ



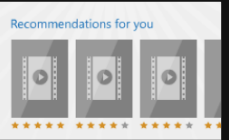
Text Classification - Wikipedia SP 500 Dataset ⓘ



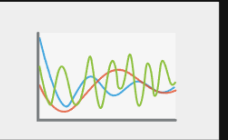
Cross Validation for Binary Classification - Adult Inco... ⓘ




Permutation Feature Importance ⓘ



Recommendation - Movie Rating Tweets ⓘ



Tune Parameters for Binary Classification - Adult Inco... ⓘ



Multiclass Classification - Letter Recognition ⓘ

Pipelines

Pipeline drafts

Pipeline runs

Refresh

Delete

Edit columns

Reset view

Search

Created by

All filters

Clear all

Showing 1-9 of 9 pipelinedrafts

Page size: 10

Name	Pipeline type	Updated on ↓	Created by
Pipeline-Created-on-10-20-2021	Training	Oct 20, 2021 4:56 PM	JoseLuis.Lato...
Pipeline-Created-on-10-20-2021	N/A	Oct 20, 2021 4:51 PM	JoseLuis.Lato...
Auto-price-prediction (JL)	Training	Oct 19, 2021 11:26 PM	Jose Luis Lat...
Regression - Automobile Price Predictio...	Training	Oct 19, 2021 11:12 PM	Jose Luis Lat...

Select a pipeline from list to preview



# Designer

Microsoft Azure Machine Learning Studio

AzureSponsorshipTenant > NDC-Copenhagen > Designer

## Designer

### New pipeline

Easy-to-use prebuilt components ⓘ

Image Classification using DenseNet ⓘ

Binary Classification using Vowpal Wabbit Model - A... ⓘ

Wide & Deep based Recommendation - Restau... ⓘ

Regression - Automobile Price Prediction (Basic) ⓘ

Regression - Automobile Price Prediction (Compare algo... ⓘ

Binary Classification with Feature Selection - Income... ⓘ

Show more samples ▾

### Pipelines

Pipeline drafts Pipeline jobs

Refresh Delete Edit columns Reset view

Search View my only Created by: joslat@gmail.com Millás ▾ All filters Clear all

Showing 1-3 of 3 pipeline drafts Page size: 10 ▾

Name	Pipeline type	Updated on ↓	Created by
Pipeline-Created-on-05-30-2022	N/A	May 30, 2022 11:26 PM	joslat@gmail...
NDC-Copenhagen-Designer	N/A	May 29, 2022 3:23 PM	joslat@gmail...
Regression - Automobile Price Predictio...	Training	May 29, 2022 3:09 PM	joslat@gmail...

Select a pipeline from list to preview

# Automated ML, aka AutoML

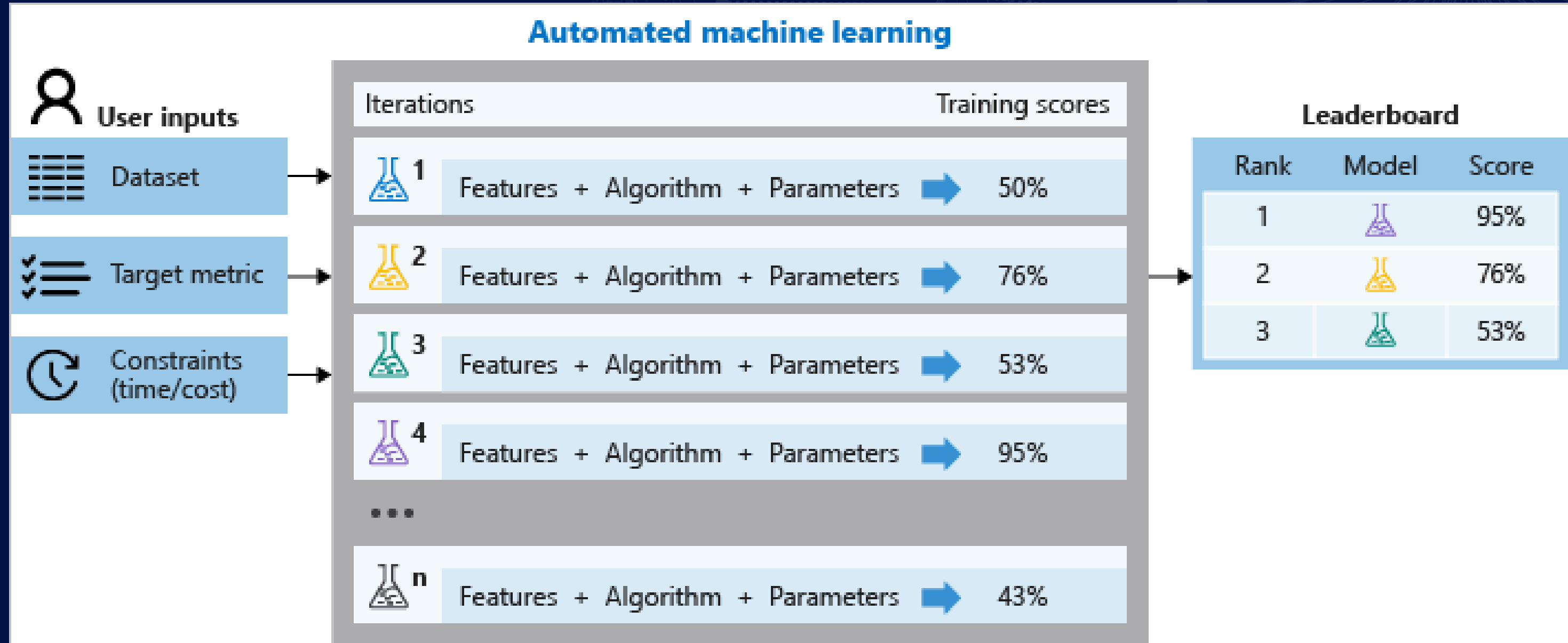
Machine Learning to create Machine Learning, ETL, Model Selection, Hyperparameter tuning and more done for you.

- Feature selection & engineering
- Data guardrails
- Best Model selection
- Hyperparameter tuning
- Model explanation & insights (feature importance)
- Different supported tasks (Classification, Regression, time series)
- A Data Scientist “in a box”
- To me, the dream of an “aficionado” Data Scientist



# Automated ML, aka AutoML

AutoML Simplifies the ML training process greatly, doing the feature engineering, model selection, hyperparameter tuning...



# Let the machine do the work!

Microsoft Azure Machine Learning Studio

≡

+ New

🏠 Home

Author

📖 Notebooks

**⚡ Automated ML**

🧩 Designer

Assets

📊 Datasets

🧪 Experiments

Home > Automated ML > Start run

Create a new Automated ML run

☒ Select dataset

☐ Configure run

☐ Select task and settings

Select dataset

Select an input dataset from the list below, or create a new dataset. Automated ML will automatically select the best model for your dataset.

+ Create dataset

↺ Refresh

☒ Show supported datasets

🔍 Search

Showing 1-3 of 3 datasets

Dataset name	Dataset type
--------------	--------------

# AutoML

Microsoft Azure Machine Learning Studio

+

AzureSponsorshipTenant

+ New

Home

Author

Notebooks

Automated ML

Designer

Assets

Data

Jobs

Components

Pipelines

Environments

Models

Endpoints

Manage

Compute

Datastores

Linked Services

Data Labeling

AzureSponsorshipTenant > NDC-Copenhagen > Automated ML

Automated ML

Let Automated ML train and find the best model based on your data without writing a single line of code. [Learn more about Automated ML](#)

+ New Automated ML job

Refresh

Recent Automated ML runs

View all experiments →

Display name	Experiment	Status	Created on	Duration	Created by	Compute target	Tags
<a href="#">orange_bread_yf4hlmy</a>	Tutorial-NYCTaxi	✓ Completed	May 29, 2022 7:54 PM	18m 51s	josat@gmail.com ...	local	<a href="#">best_pipeline : Vol</a> ...
<a href="#">magenta_line_hx855l6s</a>	Tutorial-NYCTaxi	✓ Completed	May 29, 2022 7:29 PM	20m 16s	josat@gmail.com ...	local	<a href="#">best_pipeline : Vol</a> ...
<a href="#">calm_neck_1y1db1pw</a>	NDC-Copenhagen-AutoML	✓ Completed	May 29, 2022 3:47 PM	27m 26s	josat@gmail.com ...	ndc-cluster	<a href="#">dynamic_allowlist</a> ...

Documentation

View all documentation ↗

🔬

Concept: What is Automated ML?

🔬

Tutorial: Create your first classification model with Automated ML

🔬

Blog: Build more accurate forecasts with new capabilities in Automated ML

https://ml.azure.com/automl/welcome?wsid=/subscriptions/56c2b2b8-7e8a-400c-9957-15d7dc736bde/resourcegro...



# ONNX

Open Neural Network exchange



[GET STARTED](#) | [SUPPORTED TOOLS](#) | [NEWS](#) | [ABOUT](#) | [SLACK](#) | [GITHUB](#)

## Open Neural Network Exchange

The open standard for machine learning interoperability

[GET STARTED](#)

ONNX is an open format built to represent machine learning models. ONNX defines a common set of operators - the building blocks of machine learning and deep learning models - and a common file format to enable AI developers to use models with a variety of frameworks, tools, runtimes, and compilers. [LEARN MORE](#) >

*"It's like NuGet for AI Models" – Jose L. Latorre, 2021*

# ONNX

Open Neural Network exchange

## Create

### Frameworks



Native support

Converters

### Services



Native support



## Deploy

### Azure

Azure Machine Learning services

Ubuntu VM

Windows Server 2019 VM

### Windows Devices

### Other Devices (iOS, etc)

Native support

Converters





# Let's build an ONNX model

Based on:

<https://docs.microsoft.com/en-us/azure/machine-learning/tutorial-auto-train-models>



# ONNX Model Creation

The screenshot displays the Microsoft Azure Machine Learning Studio web interface. The browser address bar shows the URL: <https://ml.azure.com/fileexplorerAzNB?wsid=/subscriptions/56c2b2b8-7e8a-400c-9957-15d7dc736bde/resourcegroups/NDC-Copenhagen/workspaces/NDC-Copenhagen&tid=768c0f4a-b8ad-407d-803d-c710bcc4638a>.

The interface includes a left-hand navigation pane with the following sections:

- Author**
  - New
  - Home
  - Notebooks
  - Automated ML
  - Designer
- Assets**
  - Data
  - Jobs
  - Components
  - Pipelines
  - Environments
  - Models
  - Endpoints
- Manage**
  - Compute
  - Datastores
  - Linked Services
  - Data Labeling

The main workspace is titled "Notebooks" and shows a file explorer with the following structure:

- joslat
  - onnx
  - regression-automl-nyc-taxi-data

The notebook titled "regression-automater" is open. The top toolbar indicates the "Compute Instance" is "ndc-compute" and is "Stopped". A message states: "Your document is currently not connected to a compute. To connect, you can run a cell, switch to a running compute or create a new compute."

The notebook content includes:

- Copyright (c) Microsoft Corporation. All rights reserved.
- Buttons for "+ Code" and "+ Markdown".
- Tutorial: Use automated machine learning to predict taxi fares**
- Text: "In this tutorial, you use automated machine learning in Azure Machine Learning service to create a regression model to predict NYC taxi fare prices. This process accepts training data and configuration settings, and automatically iterates through combinations of different feature normalization/standardization methods, models, and hyperparameter settings to arrive at the best model."
- Text: "In this tutorial you learn the following tasks:"
- List of tasks:
  - Download, transform, and clean data using Azure Open Datasets
  - Train an automated machine learning regression model
  - Calculate model accuracy
- Text: "If you don't have an Azure subscription, create a free account before you begin. Try the [free](#) or [paid](#) version of Azure Machine Learning service today."
- Prerequisites**
- List of prerequisites:
  - Complete the [setup tutorial](#) if you don't already have an Azure Machine Learning service workspace or notebook virtual machine.
  - After you complete the setup tutorial, open the [tutorials/regression-automated-ml.ipynb](#) notebook using the same notebook server.
- Text: "This tutorial is also available on [GitHub](#) if you wish to run it in your own [local environment](#)."

# ONNX generation from Azure ML

Only supported at the moment from Notebooks

Only the following changes are needed when adapting an existing Notebook that trains a model:

1. Add support for ONNX on the AutoML Configuration, AutoMLConfig:

- `enable_onnx_compatible_models=True,`

2. Once the model is built, to export it as ONNX....

1. First, retrieve the model


- `best_run, onnx_md1 = local_run.get_output(return_onnx_model=True)`

2. Second, convert and save it

- `from azureml.automl.runtime.onnx_convert import OnnxConverter`
- `onnx_fl_path = "./best_model.onnx"`
- `OnnxConverter.save_onnx_model(onnx_md1, onnx_fl_path)`

# ML.NET

An open source and cross-platform machine learning framework, VS Code & Visual Studio supported.

 **.NET** Why .NET ▾ Features ▾ Learn ▾ Docs ▾ Downloads Community ▾ 

LIVE TV

All Microsoft ▾

Home > Machine learning > ML.NET

Let's Learn .NET: Machine Learning Let's learn the fundamentals of building Machine Learning apps with .NET! Livestreamed on Learn TV on Thursday, October 28. [Register for the event >](#) ✕


# ML.NET

## An open source and cross-platform machine learning framework

Get started


Model Builder

Supported on Windows, Linux, and macOS




### Built for .NET developers

With ML.NET, you can use your existing .NET skills to easily integrate ML into your .NET apps without any prior ML experience.




### Custom ML made easy with AutoML

ML.NET offers AutoML and productive tools to help you easily build, train, and deploy high-quality custom ML models.



### Extended with TensorFlow & more

ML.NET allows you to leverage other popular ML libraries like Infer.NET, TensorFlow, and ONNX for additional ML scenarios.



### Trusted and proven at scale

Use the same ML framework used by recognized Microsoft products like Power BI, Microsoft Defender, Outlook, and Bing.



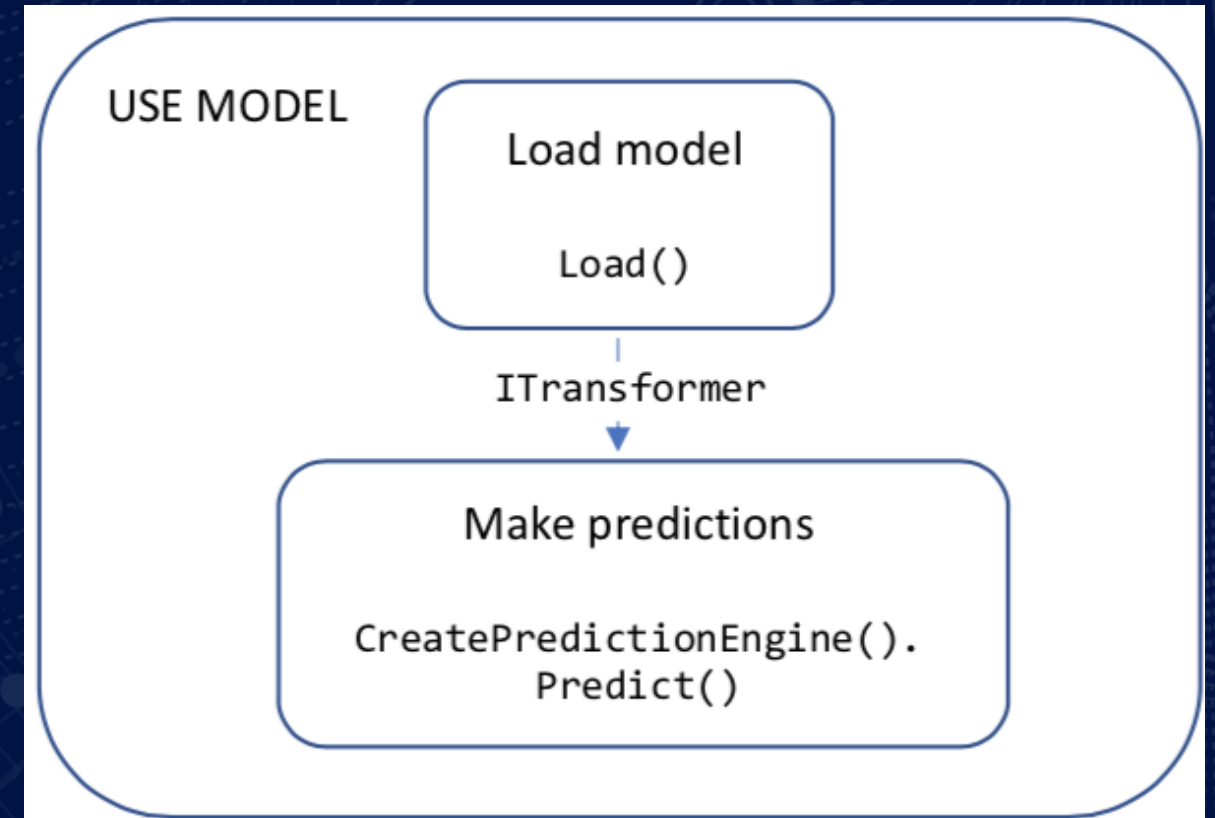
```
graph TD; A[Collect and load data<br/>IDataView] --> B[Create pipeline<br/>Append()]; B -- IEstimator --> C[Train model<br/>Fit()]; C -- ITransformer --> D[Save model<br/>Save()]; C -- ITransformer --> E[Improve model<br/>Evaluate()]; E -- ITransformer --> A;
```

The diagram illustrates the machine learning workflow within a rounded rectangle labeled "BUILD MODEL". The process consists of five main steps, each in a rounded rectangle:

- Collect and load data** (IDataView)
- Create pipeline** (Append())
- Train model** (Fit())
- Save model** (Save())
- Improve model** (Evaluate())

The flow is as follows:

- An arrow points from "Collect and load data" to "Create pipeline".
- An arrow points from "Create pipeline" to "Train model", labeled "IEstimator".
- An arrow points from "Train model" to "Save model", labeled "ITransformer".
- An arrow points from "Train model" to "Improve model", labeled "ITransformer".
- An arrow points from "Improve model" back to "Collect and load data", labeled "ITransformer".



# ML.NET

- Model Builder with AutoML support
- Everything local also cloud in some cases.
- Native Integration with tools & DevOps
- Any .NET app is supported (.NET Standard)
- Open Source Project
- Supports TensorFlow & more
- ONNX is supported
- High Performance & accuracy

# Using ONNX on ML.NET

Based on:

<https://docs.microsoft.com/en-gb/azure/machine-learning/how-to-use-automl-onnx-model-dotnet>



# Conclusions & take aways

Some points to remember and take away with you...

- Azure Machine Learning rocks
- ML.NET is also really cool
- We can generate an ONNX model with Notebooks!
- And consume it from ML.NET

# Q & A





# THANK YOU!

- <https://github.com/joslat/NDC-Copenhagen-AML-ML.NET>
- <https://docs.microsoft.com/en-us/azure/machine-learning/>
- <https://dotnet.microsoft.com/en-us/apps/machinelearning-ai/ml-dotnet>
- <https://onnx.ai/>
- <https://github.com/onnx>
- <https://docs.microsoft.com/en-us/azure/machine-learning/how-to-use-automl-onnx-model-dotnet>
- 

