Microsoft

Train and deploy a Machine Learning Model with Azure Machine Learning

Date

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About this course

After completing this course, students will be able to:

- Make data available in Azure Machine Learning.
- Work with compute targets in Azure Machine Learning.
- Run a training script as a command job in Azure Machine Learning.
- Track model training with MLflow in jobs.
- Register an MLflow model in Azure Machine Learning.
- Deploy a model to a managed online endpoint.

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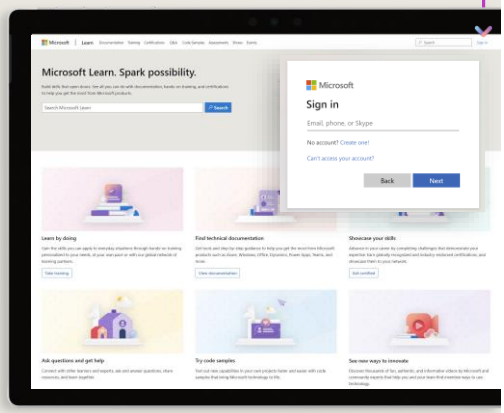

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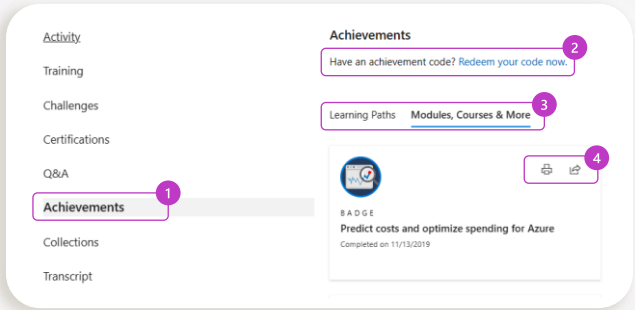

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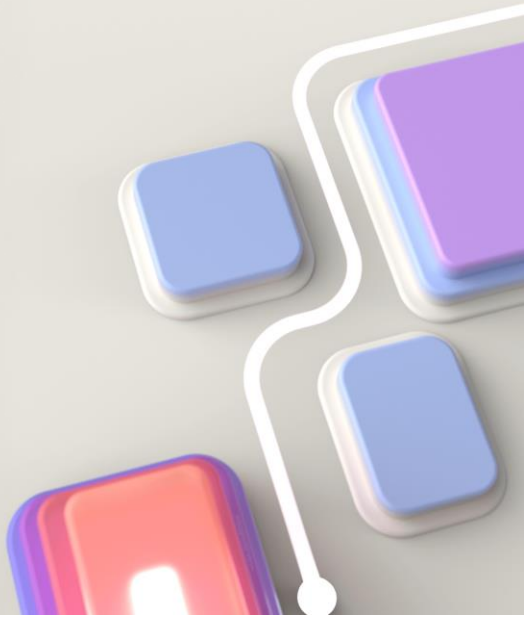
Configure the Azure Machine Learning workspace



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Explore Azure Machine Learning

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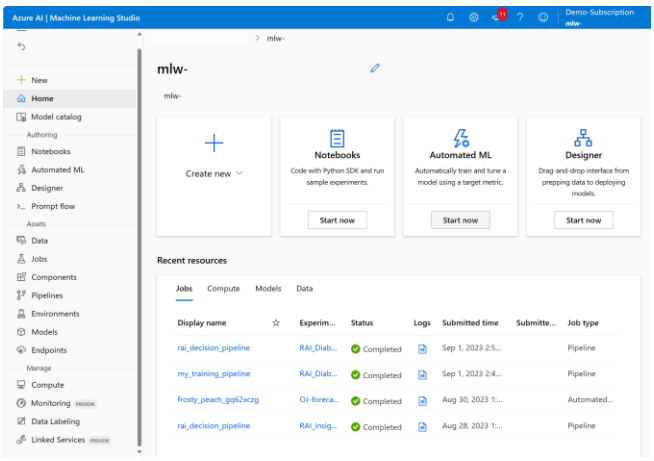
Explore the Azure Machine Learning workspace

Azure Machine Learning provides a platform for data scientists to train, deploy, and manage their machine learning models on the Microsoft Azure platform.

It provides a comprehensive set of **resources** and **assets** to train and deploy effective machine learning models.



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Make data available in Azure Machine Learning

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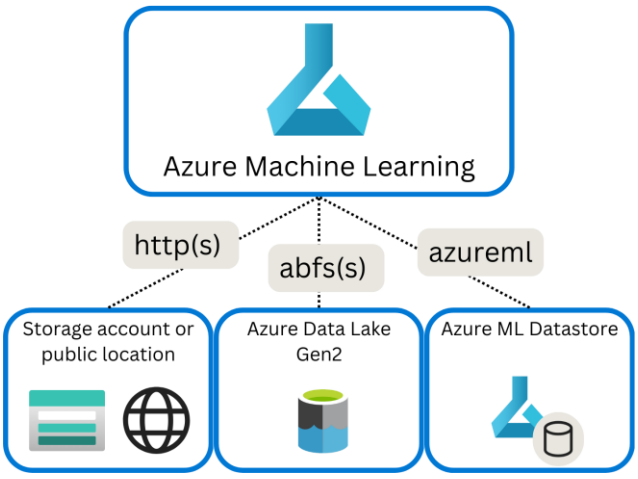
Understand URIs

A URI references the **location of your data.**

For Azure Machine Learning to connect to your data directly, you need to prefix the URI with the appropriate protocol.



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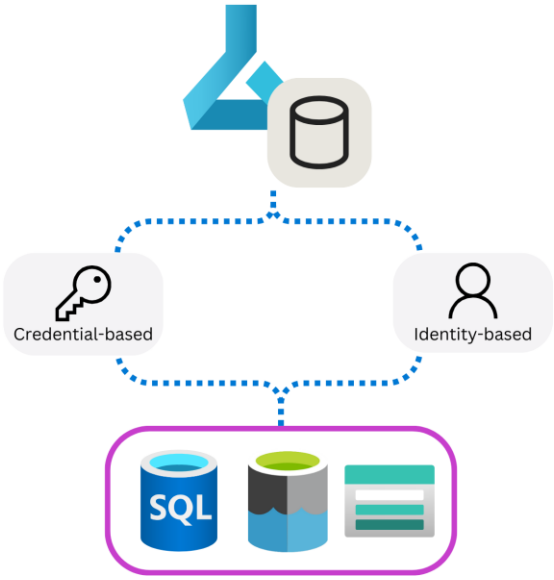
Understand datastores

Datastores are **abstractions** for cloud data sources, storing the **connection information**.

The benefits of datastores:

- Provide easy-to-use URIs to your data storage.
- Facilitates data discovery within Azure Machine Learning.
- Securely stores connection information, without exposing secrets and keys to data scientists.



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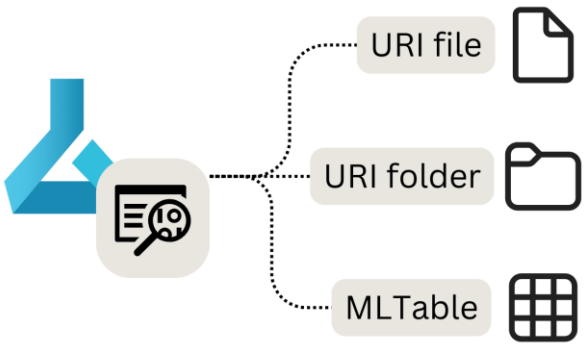
Understand data assets

Data assets are **references** to where the data is stored, how to get access, and any other relevant metadata.

The benefits of data assets:

- Share and reuse data with other members.
- Seamlessly access data during model training (on any supported compute type) without worrying about connection strings or data paths.
- Version the metadata of the data asset.



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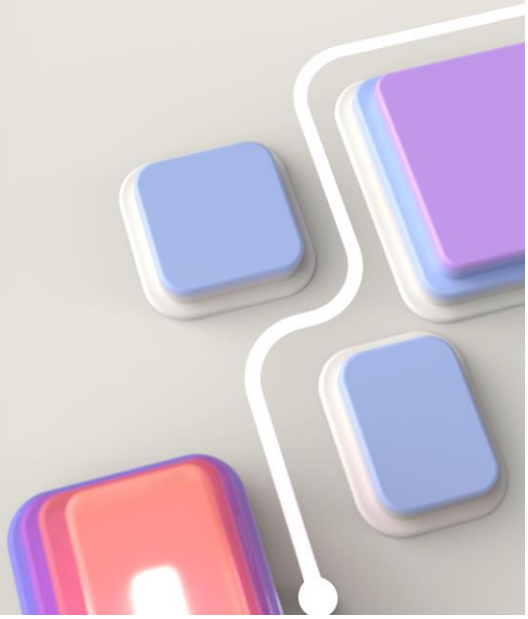
Work with compute resources in Azure Machine Learning



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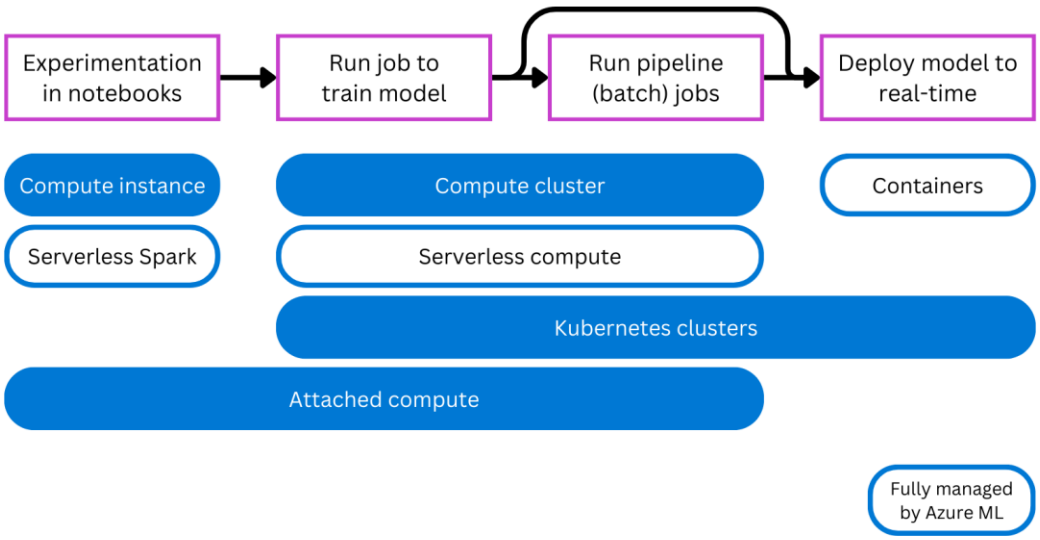
Choose the appropriate compute target



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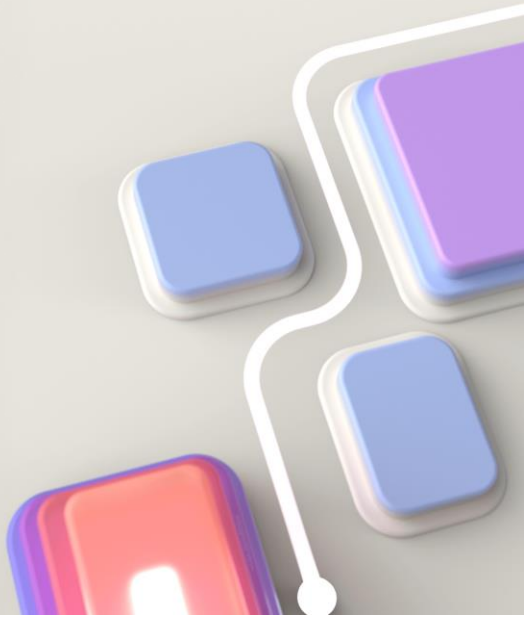
Work with environments in Azure Machine Learning



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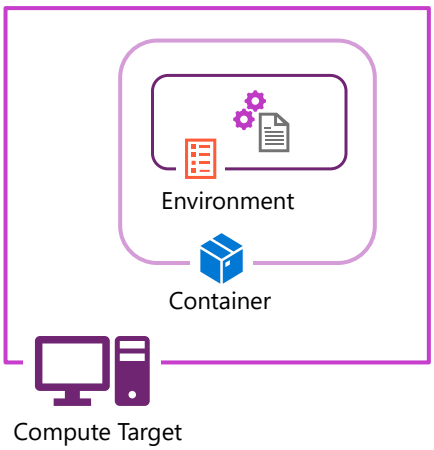
Understand environments

Environments define the context (runtime and packages) needed to run code on a compute target.

An environment is used to create the **Docker container** that your code runs in on the specified compute target.

Use a predefined **curated** environment or create your own **custom** environment.



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Create custom environments

Creating a custom environment within the Azure Machine Learning workspace from a:

- **Docker image**: choose an existing image from a (public) repository
- **Docker build context**: reference a path that includes a Dockerfile and requirements.txt
- **Conda specification**: reference an image and add a conda YAML file that includes additional dependencies

Dockerfile

```
#FROM mcr.microsoft.com/azureml/openmpi4.1.0-ubuntu20.04
FROM python:3.8

# python installs
COPY requirements.txt .
RUN pip install -r requirements.txt && rm requirements.txt

# set command
CMD ["bash"]
```

Conda YAML file

```
name: pydata-example
channels:
  - conda-forge
dependencies:
  - python=3.8
  - pip=21.2.4
  - pip:
    - numpy==1.22
    - scipy==1.7.1
    - pandas==1.3.0
    - scikit-learn==0.24.2
```


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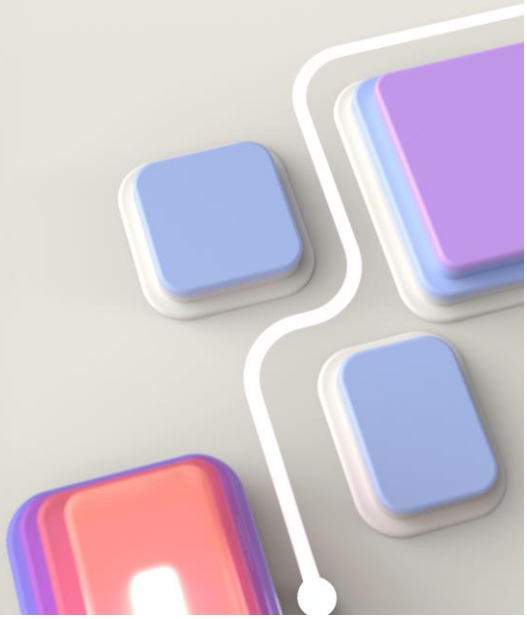
Train and track machine learning models in Azure Machine Learning



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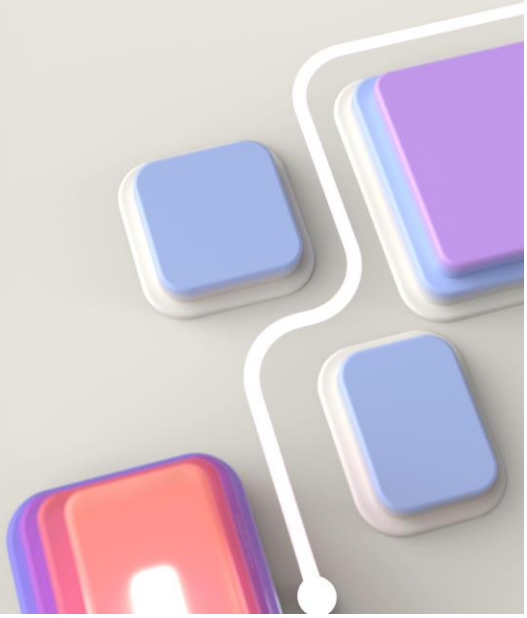
Run a training script as a command job in Azure Machine Learning



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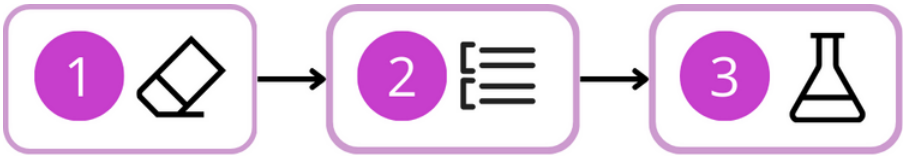
Convert a notebook to a script

Notebooks are ideal for exploration and development.
Scripts are ideal for testing and automation in your production environment.



To create a production-ready script, you need to:

1. Remove nonessential code.
2. Refactor your code into functions.
3. Test your script (in the terminal).

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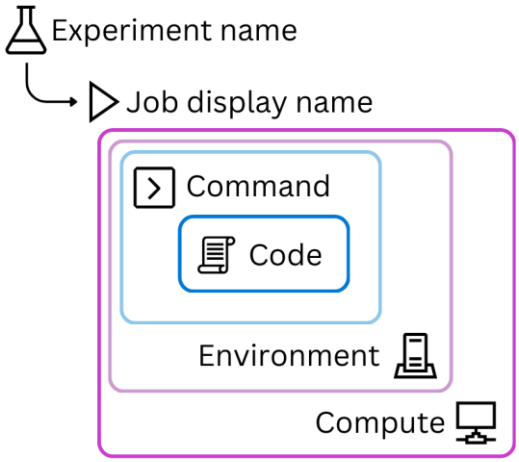
Configure a command job

When you have a **script** that you want to execute, you can run it as a **command job**.

Configure the command job by specifying the necessary job parameters and submit the job to the Azure Machine Learning workspace to run the script.



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Use parameters in a command job

To run one script with different inputs, use **parameters**:

1. Import the **argparse** library in the script.
2. Use the ArgumentParser() method to define arguments for parameters.
3. Specify the parameters in the script, include name, type, and default value.
4. When running the script, specify the value for the defined parameters you want the script to use for this specific run.

```
python train.py --training_data diabetes.csv --reg_rate 0.01“
```


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Knowledge check

1 **A data scientist wants to run a script as a command job to train a PyTorch model, setting the batch size and learning rate hyperparameters to specified values each time the job runs. What should be done by the data scientist?**

- ☐ Create multiple script files – one for each batch size and learning rate combination you want to use.
- ☐ Set the batch size and learning rate properties of the command job before submitting the job.
- ☑ Add arguments for batch size and learning rate to the script, and set them in the command property of the command job.

2 **A data scientist has trained a model in a notebook. The model should be retrained every week on new data. What should the data scientist do to make the code production-ready?**

- ☐ Copy and paste the code from each cell to a script.
- ☐ Convert the code to one function in a script that reads the data and trains the model.
- ☑ Convert the code to multiple functions in a script that read the data and train the model.

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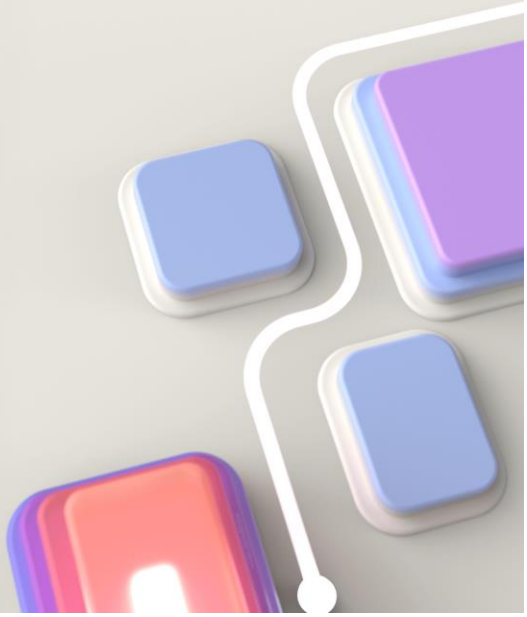
Track model training with MLflow in jobs



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Track metrics with MLflow

MLflow is an open-source platform, designed to manage the complete machine learning lifecycle.

There are two options to track machine learning jobs with MLflow:

- Enable autologging using **mlflow.autolog()**
- Use logging functions to track custom metrics using **mlflow.log_***

Include the **mlflow** and **azureml-mlflow** in the environment to ensure the pip packages are installed on the compute before running the script.

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Enable autologging

When working with one of the common libraries for machine learning, you can enable **autologging** in MLflow.

Autologging logs **parameters, metrics**, and model **artifacts** without anyone needing to specify what needs to be logged.

Python

```
import mlflow
mlflow.autolog()
```

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Log custom metrics with MLflow

Depending on the type of value you want to log, use the relevant MLflow method to store the parameter, metric, or artifact with the experiment run:

- **mlflow.log_param():** Log single key-value parameter. Use this function for an input parameter you want to log.
- **mlflow.log_metric():** Log single key-value metric. Value must be a number. Use this function for any output you want to store with the run.
- **mlflow.log_artifact():** Log a file. Use this function for any plot you want to log, save as image file first.

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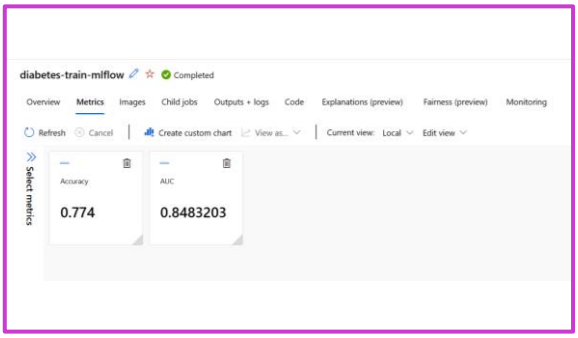
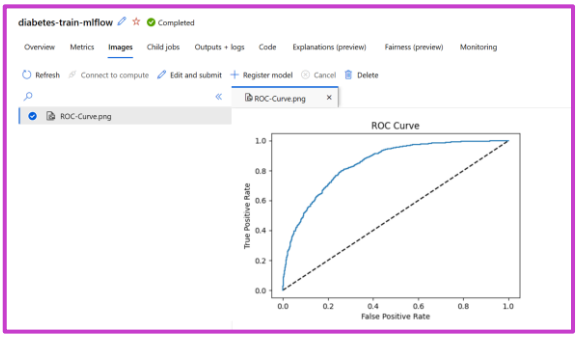
View the metrics in the Azure Machine Learning studio

- Logged metrics will show in **Overview** and **Metrics** tabs.
- Plots that are logged as artifacts are shown under **Images**.
- Find other artifacts like model files under **Outputs + logs**.





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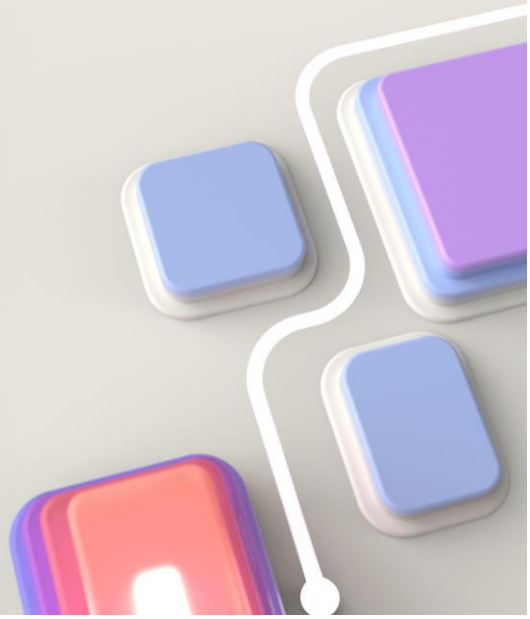
Deploy a model with Azure Machine Learning



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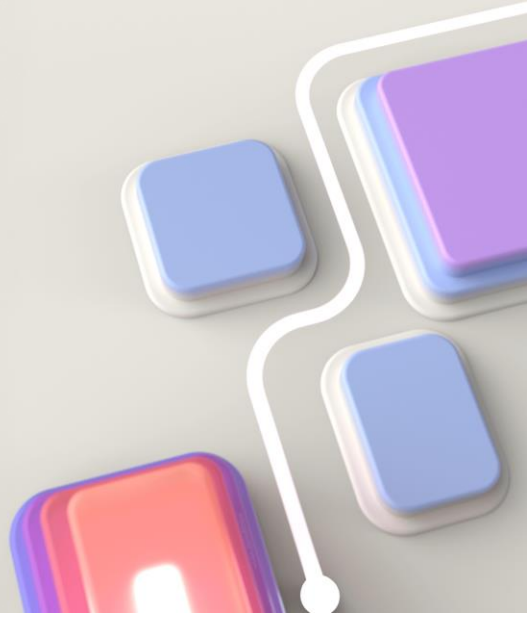
Register an MLflow model in Azure Machine Learning



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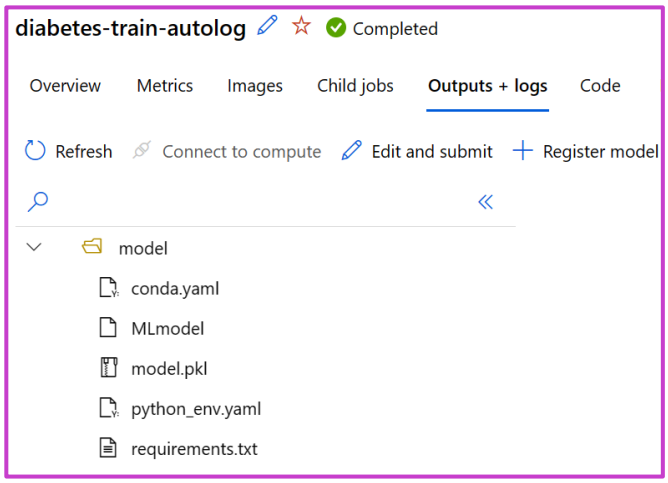
Log a model with MLflow

MLflow allows you to log a model as an **artifact**, or as a **model.**

- When you log a model as an artifact, the model is treated as a file.
- When you log a model as a model, you're adding information to the registered model that enables you to use the model directly in pipelines or deployments.

When you log as a model, an MLmodel file is created in the output directory. The MLmodel file contains the model's metadata, which allows for model traceability.



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Understand the MLmodel file format

The MLmodel file may include:

- **artifact_path:** During the training job, the model is logged to this path.
- **flavor:** The machine learning library with which the model was created.
- **model_uuid:** The unique identifier of the registered model.
- **run_id:** The unique identifier of job run during which the model was created.
- **signature:** Specifies the schema of the model's inputs and outputs:
  - **inputs:** Valid input to the model. For example, a subset of the training dataset.
  - **outputs:** Valid model output. For example, model predictions for the input dataset.

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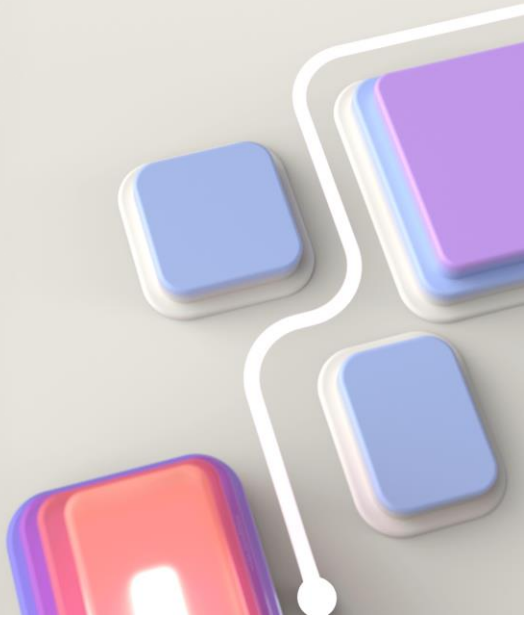
Deploy a model to a managed online endpoint



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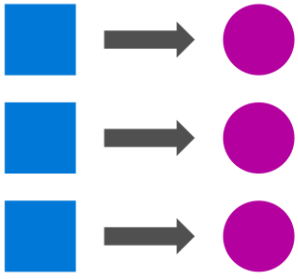
Explore managed online endpoints

An **endpoint** is an HTTPS endpoint to which you can send data, and which will return a response (almost) immediately.

Online endpoints are used to generate real-time predictions for individual data points.

With managed online endpoints, Azure Machine Learning manages all the underlying infrastructure.



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Deploy a model to a managed online endpoint

When you deploy a model to a managed online endpoint, you have two options:

Deploy a MLflow model:

1. Register a MLflow model with a MLModel file.
2. Create deployment.
3. Deploy model to endpoint.

Deploy a (custom) model:

1. Register a model with the necessary model files (subject to model type).
2. Create scoring script.
3. Define execution environment.
4. Create deployment.
5. Deploy model to endpoint.

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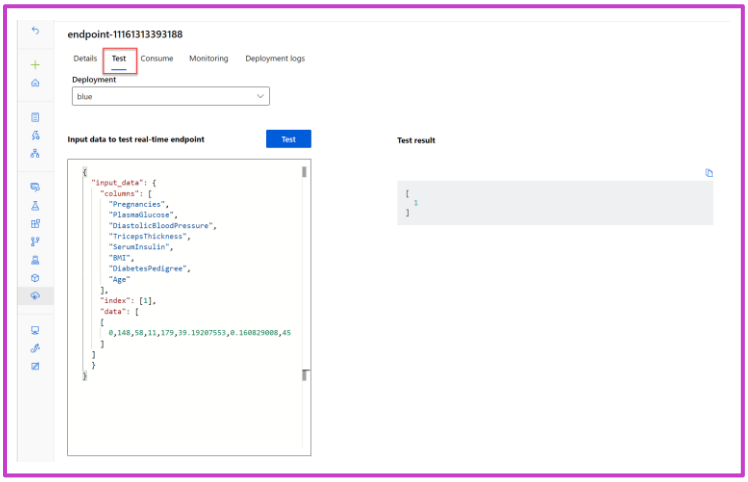
Test managed online endpoints

Use the Azure Machine Learning studio to:

- List all endpoints.
- View an endpoint's details and deployment logs.
- Test the endpoint.



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