Data Science

Artificial Inteligence

Machine Learning

Blockchain

Task 1 (AI & ML): Build and implement a Machine Learning model.

Your task is to create a Machine Learning model on MS Azure. Please make sure that you follow the instructions below:

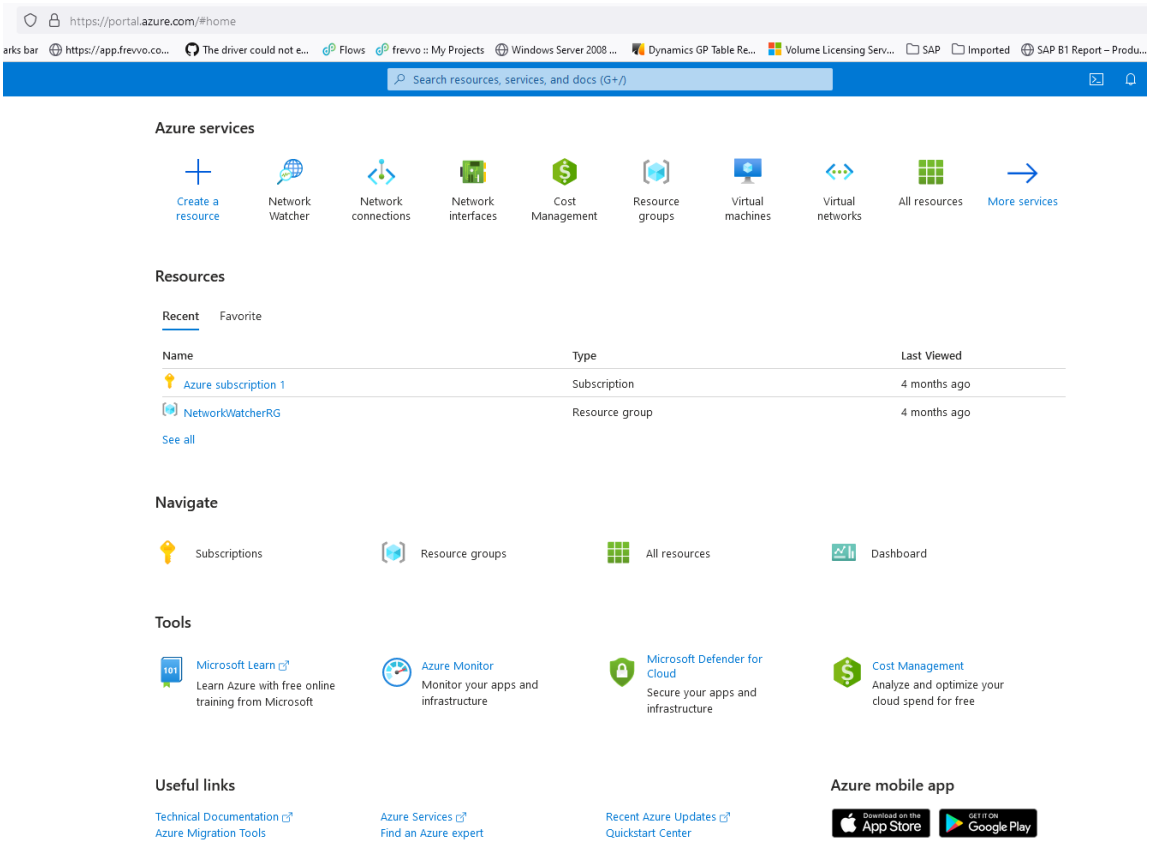
i. You may use any of the datasets available on Azure.
ii. Depending on the data, you must select the proper training method (Classification, NLP, Open CV).
iii. Your model should pass the validation stage without any mistakes.
iv. The acceptable accuracy percentage is 85%

Only supervised machine learning models with training data and predetermined labels are supported by Azure Machine Learning Studio. These models include time series forecasting, predicting future sales for a store for example, regression models that use numerical data to determine the best-fit equation, and classification models that predict categories.

Steps:

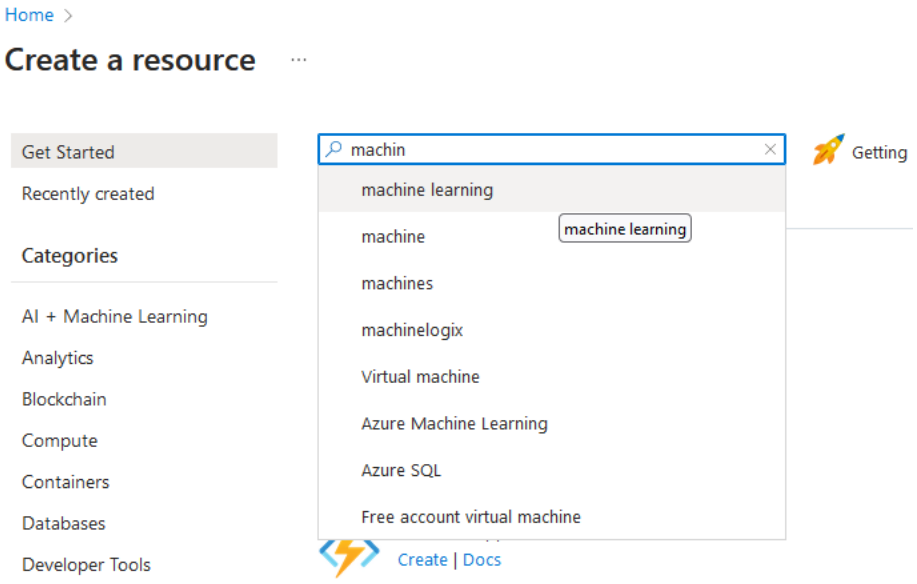
Login to Azure portal and creating a resource group.

Note: it is mandatory to have a subscription (Azure subscription 1) to continue below steps.

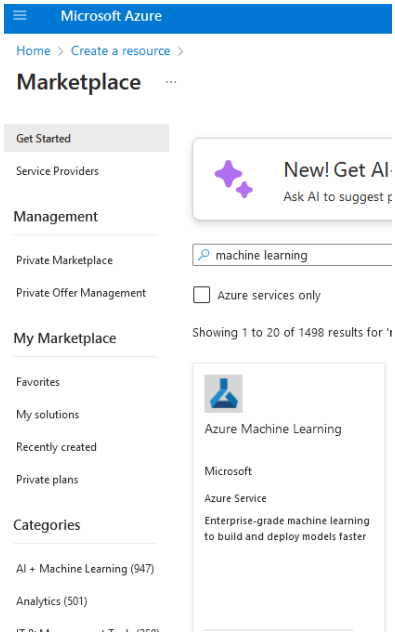


Creating a machine learning resource IN Azure portal.

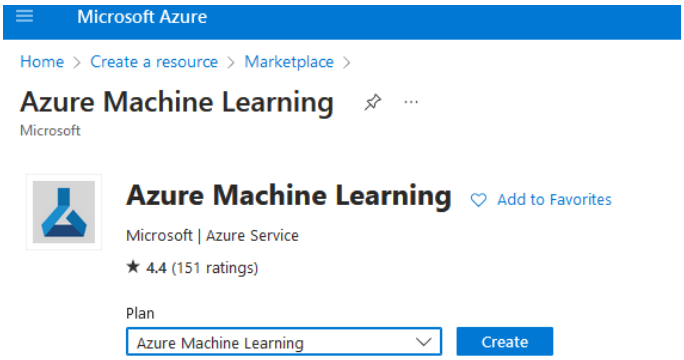
Selecting machine learning option from the drop down list.



Selecting Azure Machine Learning.

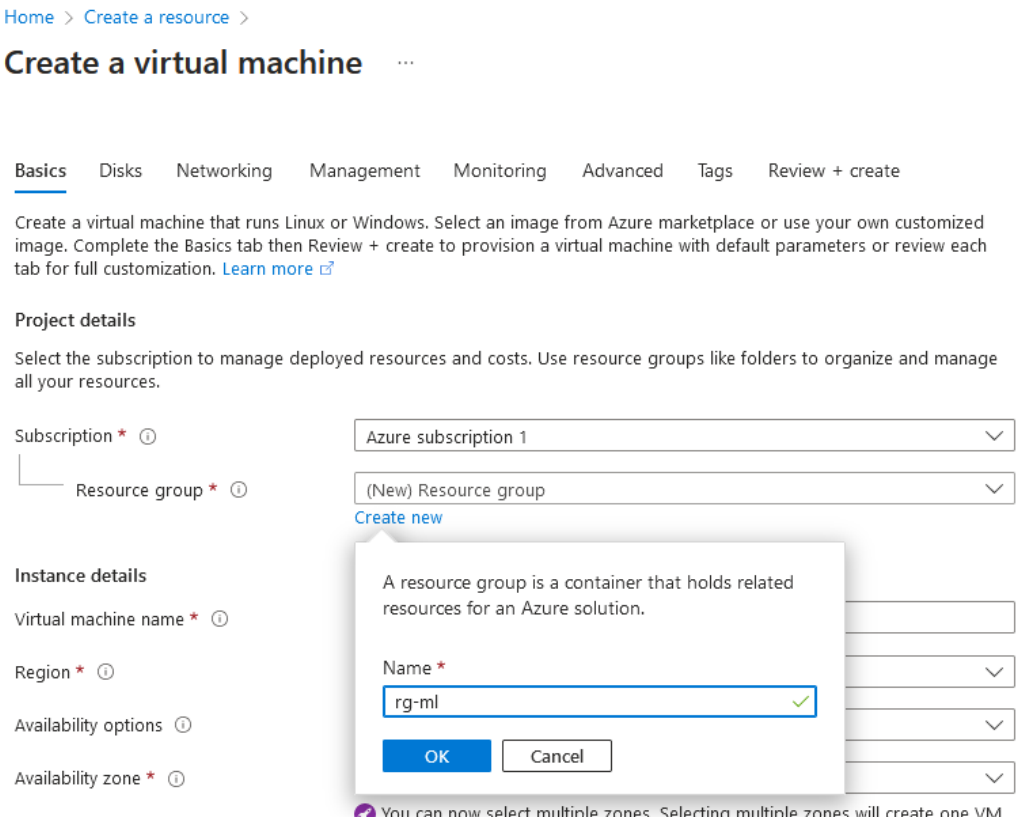


Creating an Azure Machine Learning plan.

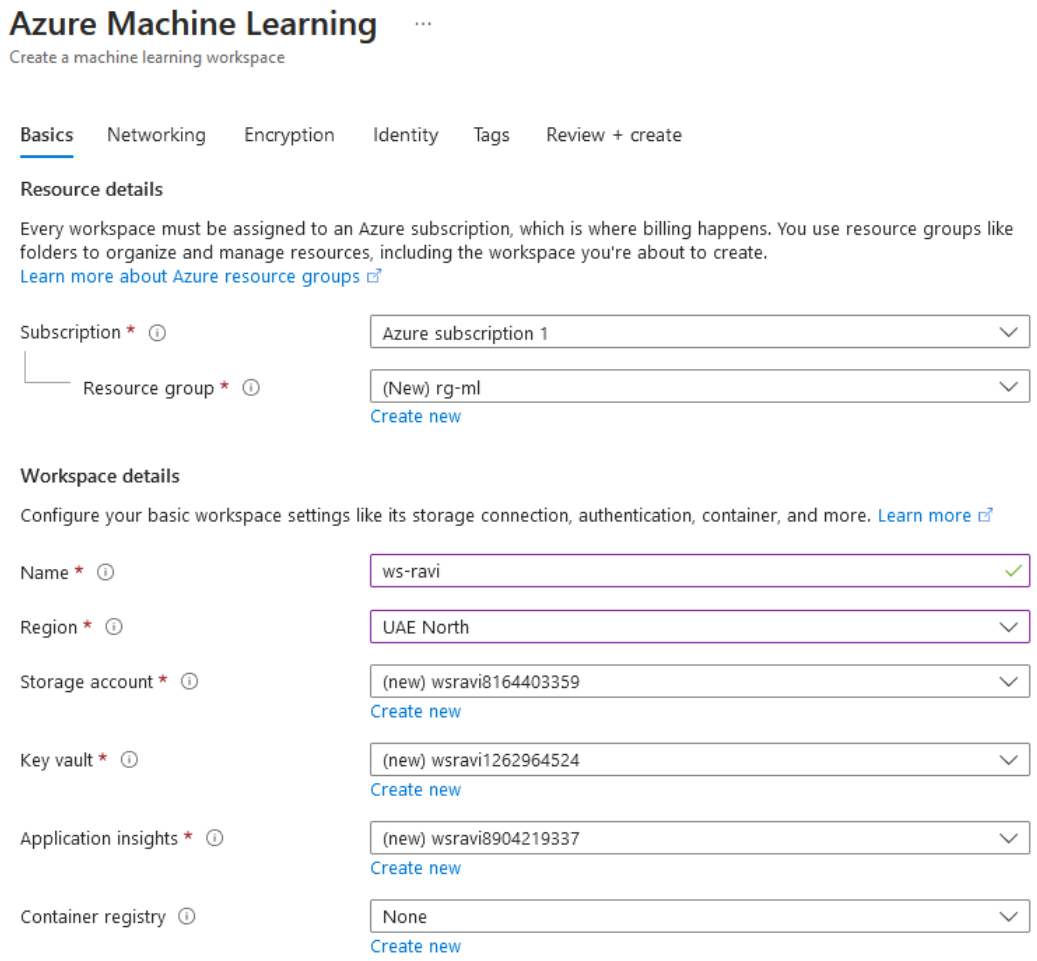


Creating a new resource group called ‘rg-ml’

Note: An Azure solution's resource group is a container that stores connected resources. All of the resources needed to solve the problem or just the ones wish to manage collectively can be included in the resource group.



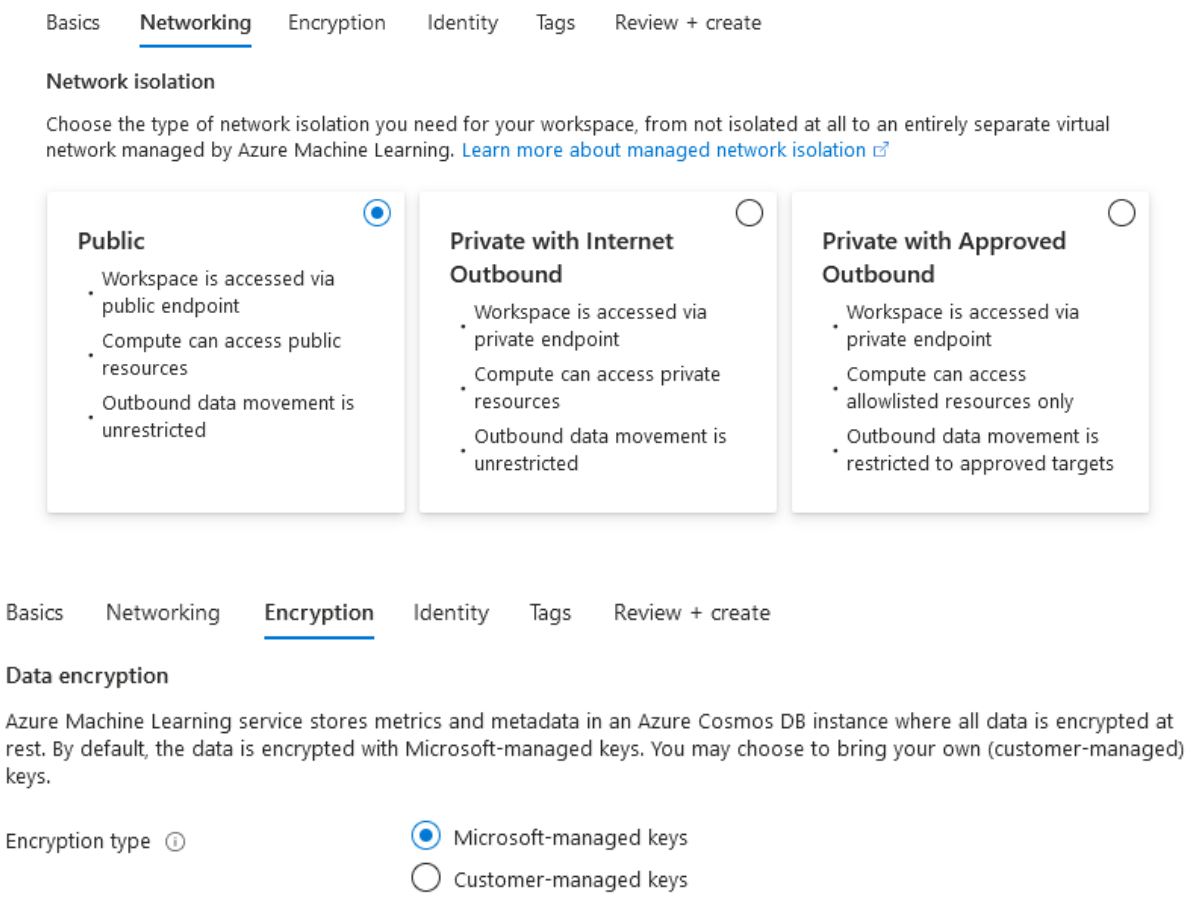
Selecting a nearby region so that the latency of data transmission will be lower.



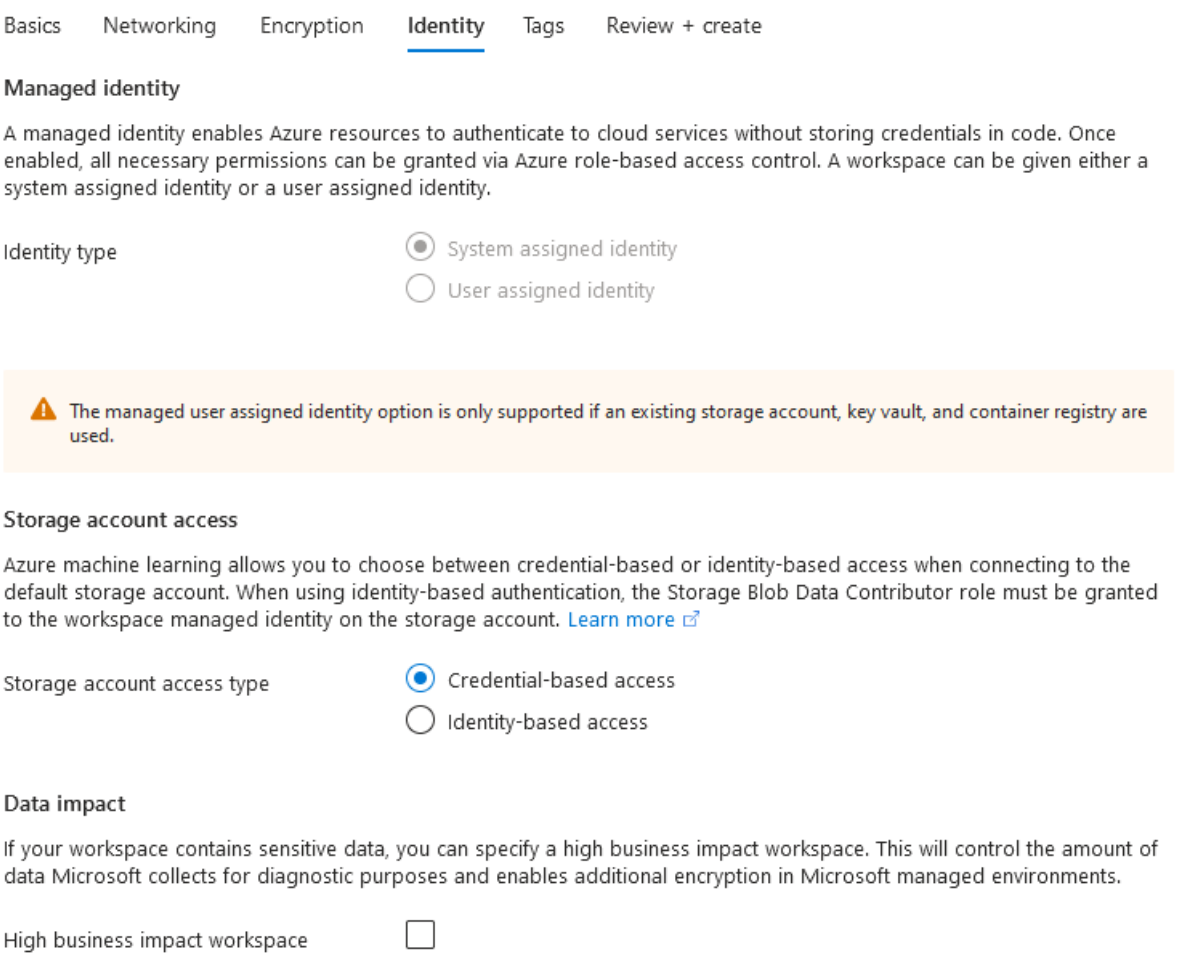
Selecting the default public workplace.

Note: It is advised to use the Private Network Isolation category while working with sensitive data in order to preserve data security.

The isolation of managed virtual networks, or managed VNets, is supported by Azure Machine Learning. Managed VNet isolation uses an integrated workspace-level Azure Machine Learning managed VNet to automate and streamline network isolation settings.

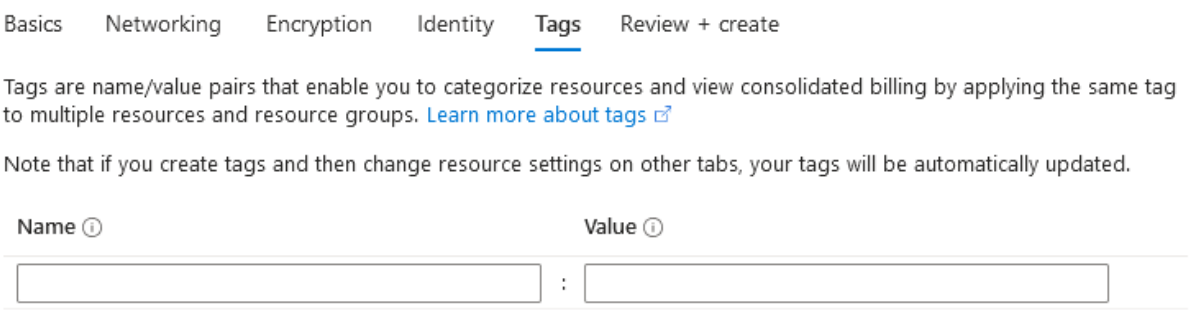


Keeping the default settings for Managed Identity.

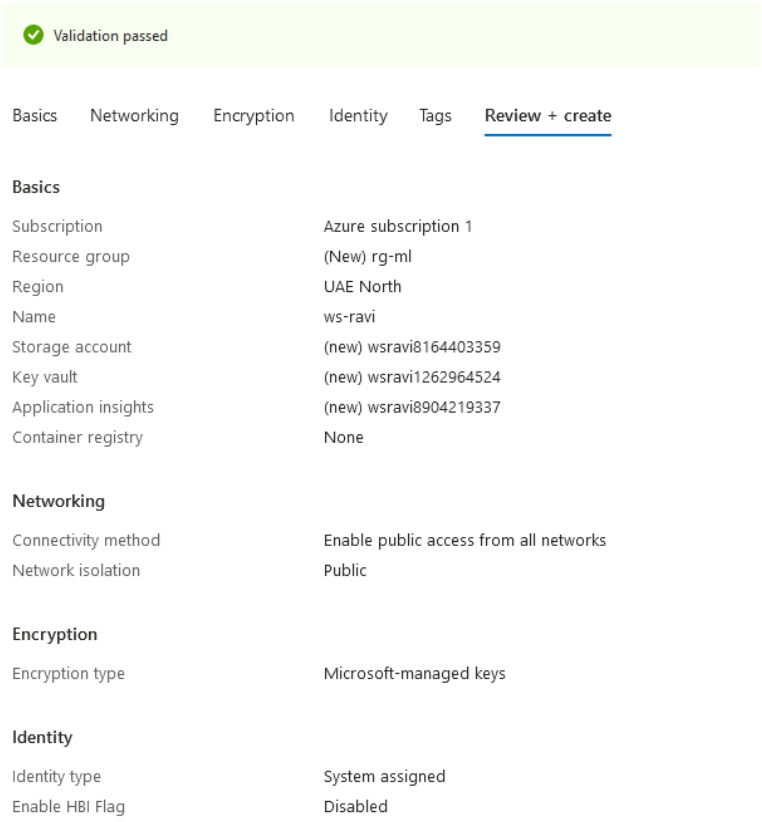


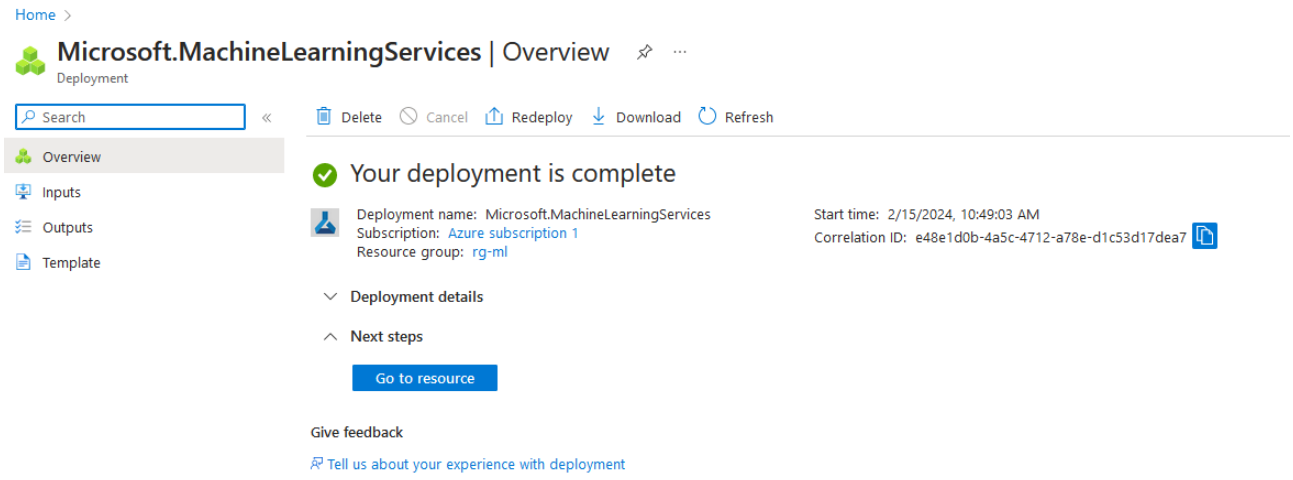
Keeping the default settings for Tags.

Metadata items can be added to the Azure resources called tags. These are key-value pairs that assist the user in finding resources according to parameters that are pertinent to the company.

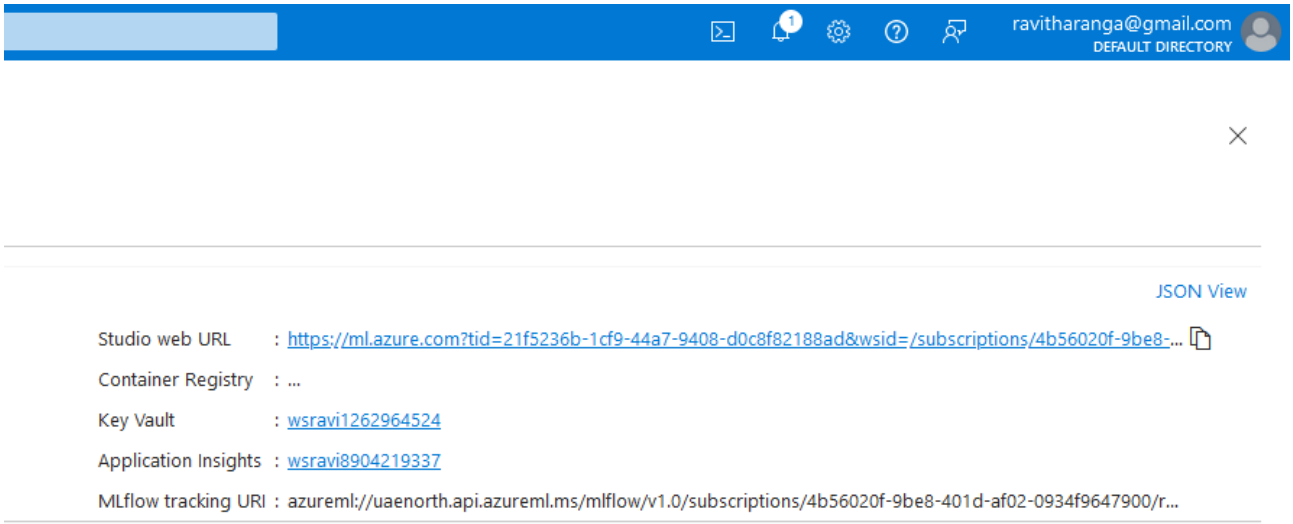


Microsoft Machine Learning Service is created successfully.





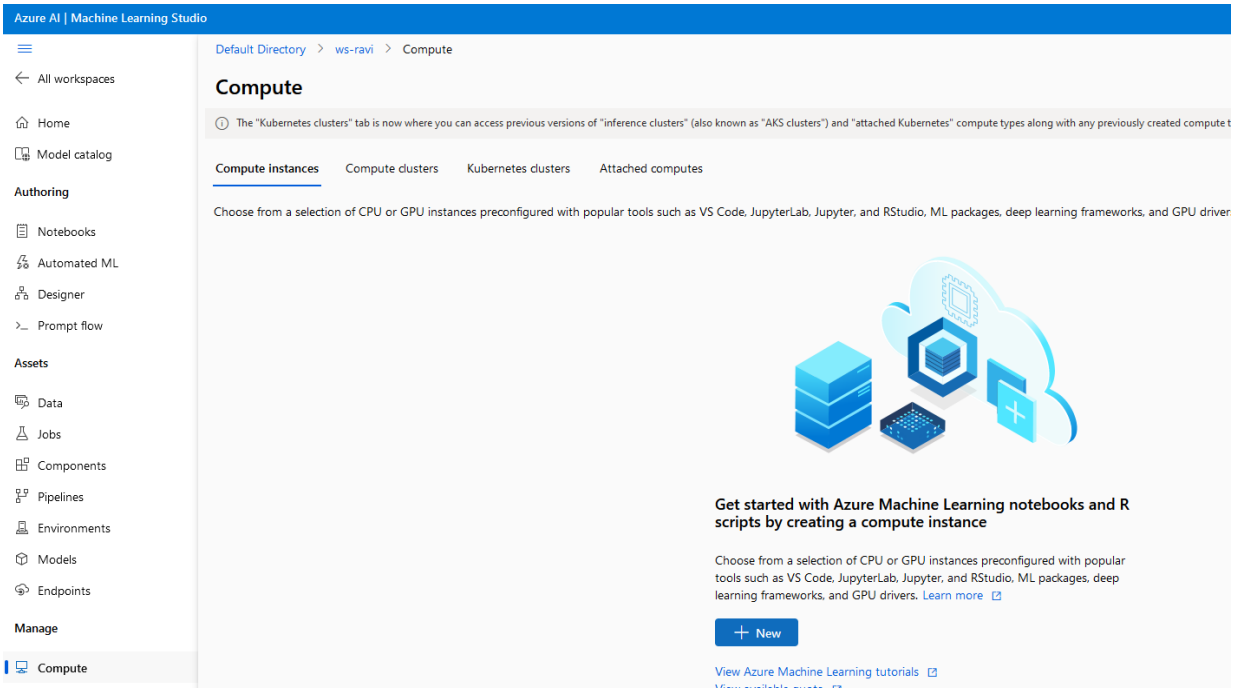
Opening the Azure Machine Learning Studio web portal.



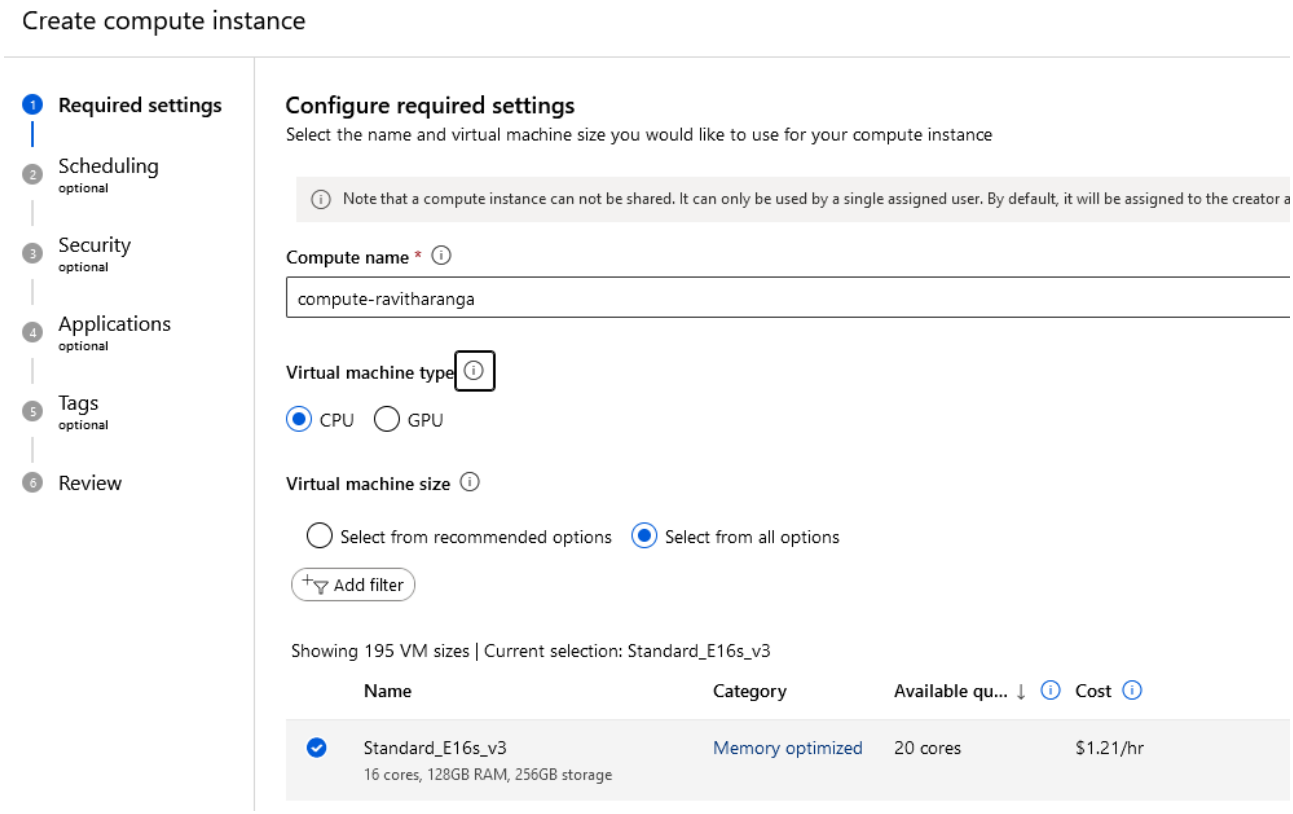
Building the machine learning model using Azure machine learning studio.

Creating a compute instance.

A managed cloud workstation is called an Azure Machine Learning compute instance. Compute instances offer administrative and business readiness features, as well as making it simple to begin developing with Azure Machine Learning. Additionally, compute instances can be utilized as a target for inferencing and training in development and testing scenarios.

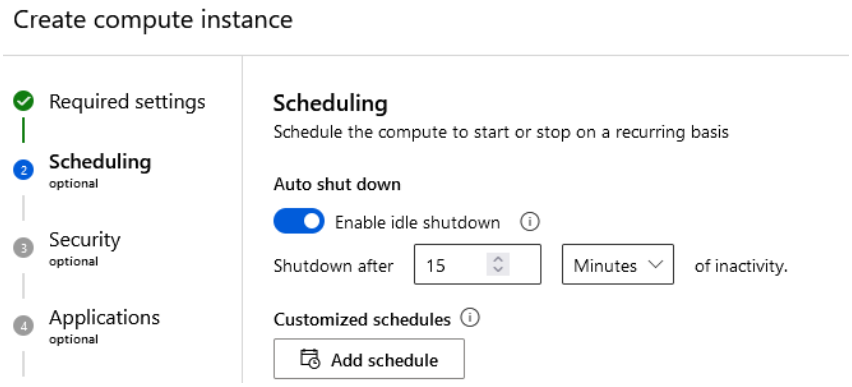


Selecting an appropriate CPU and naming the new compute instance.

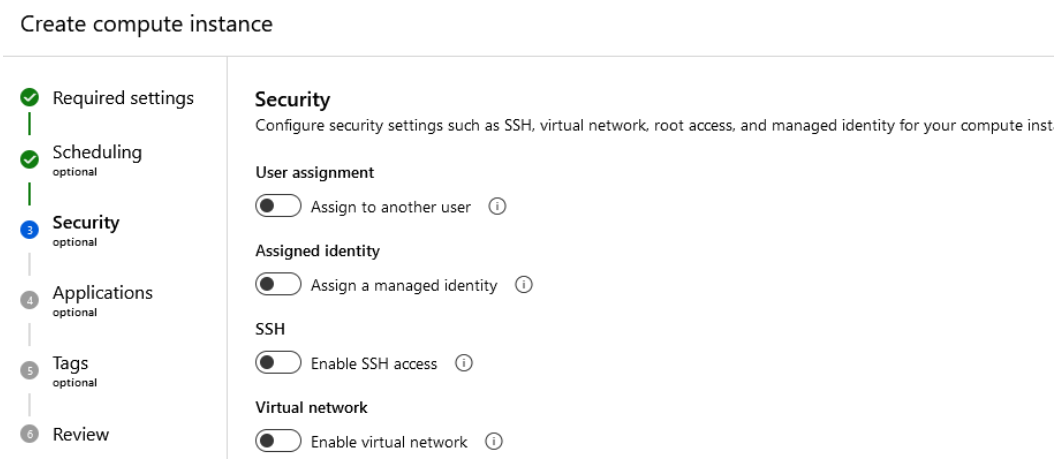


Defining the idle time for shutdown the compute instance.

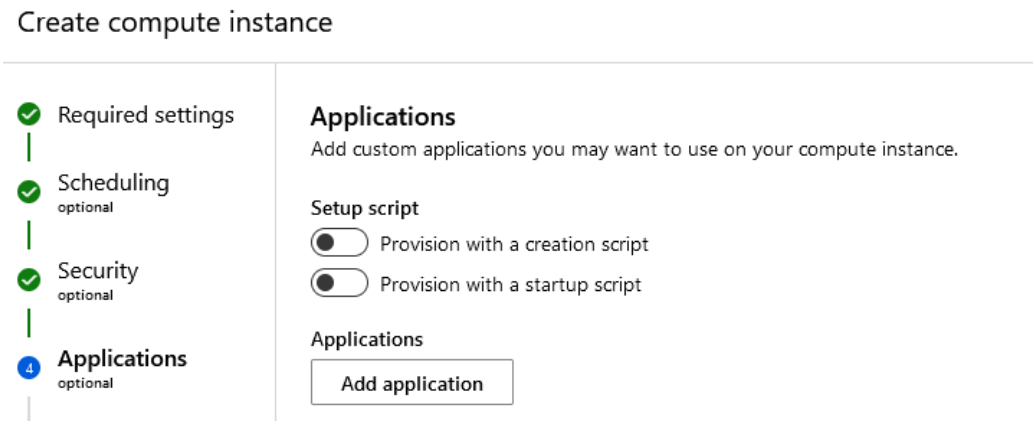
Note: it is possible to schedule the instance's active hours using the 'Add Schedule' option.



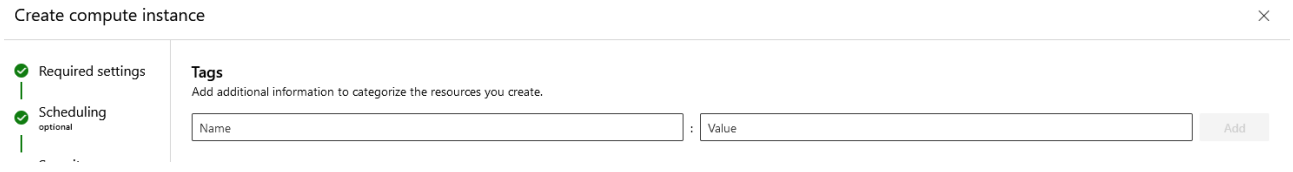
Keeping the default settings for Security section.



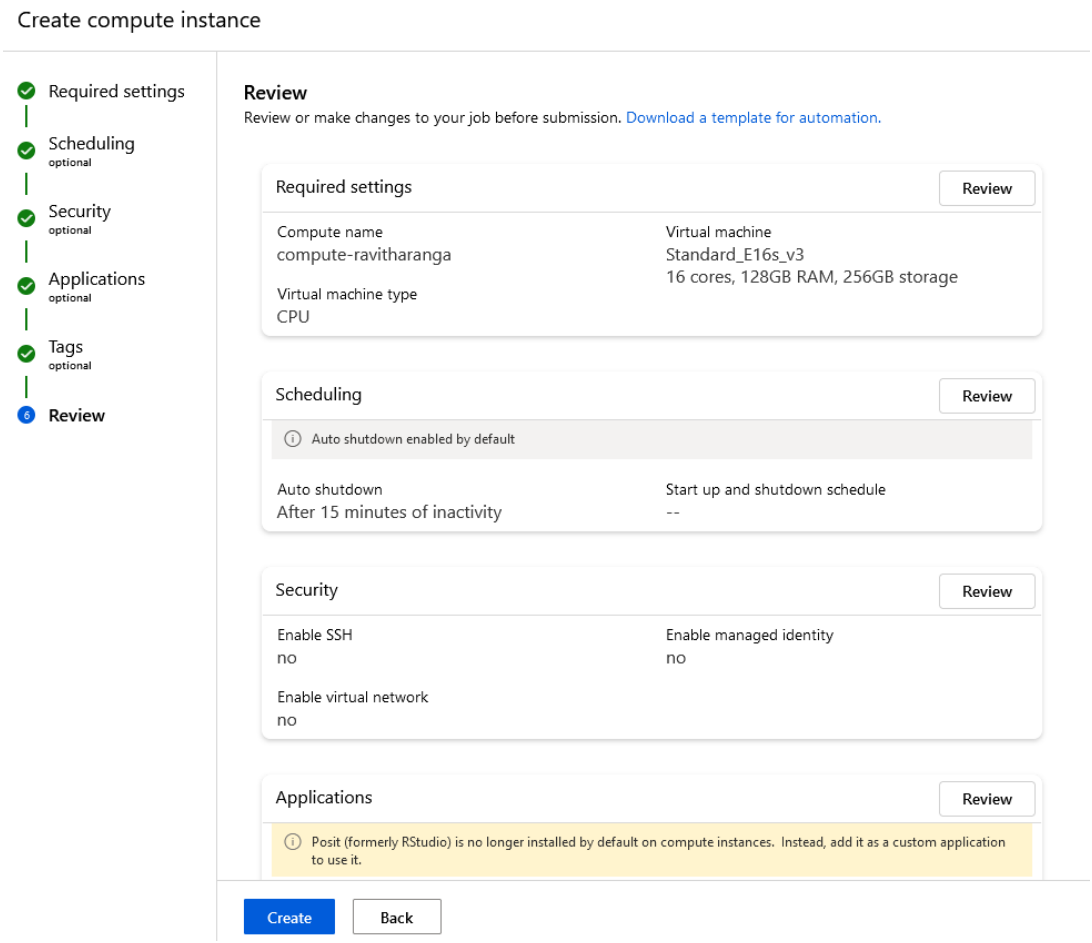
Keeping the default settings for Applications section.



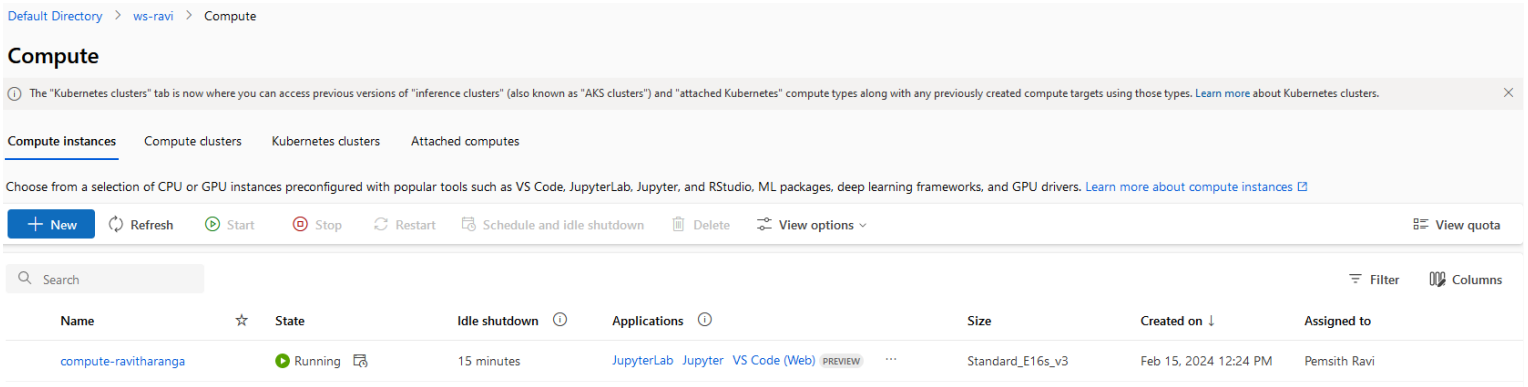
Keeping the default settings for Tags section.

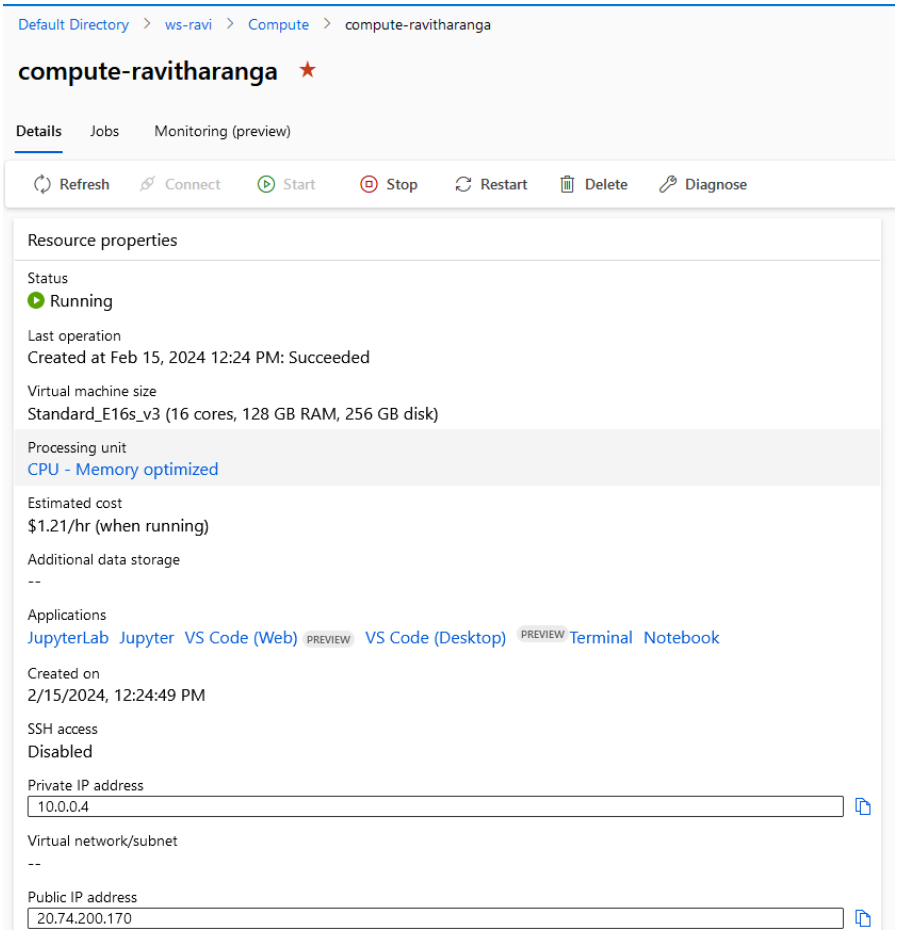


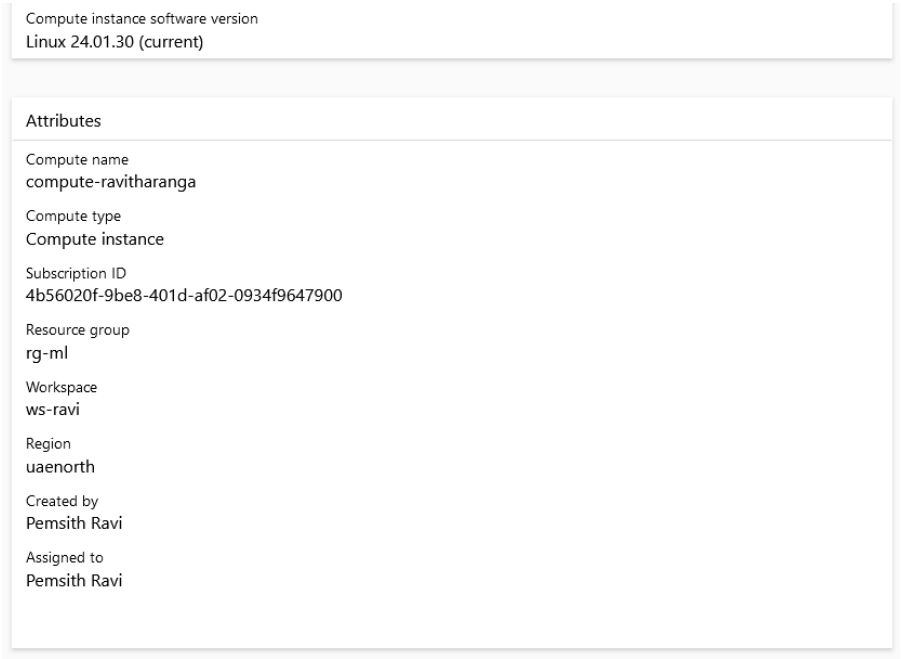
Creating the new compute instance.



Compute instance is started successfully.

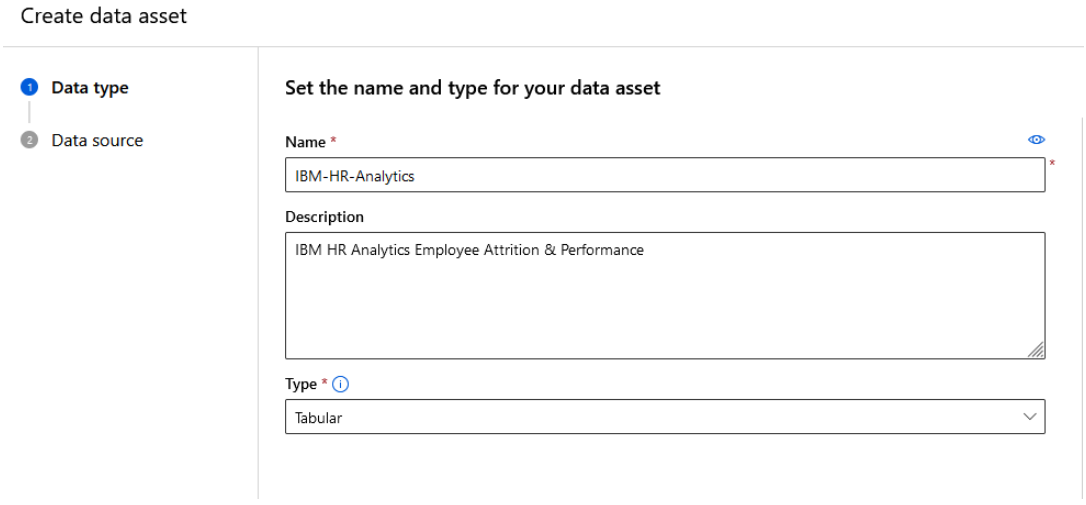

Default Directory > ws-ravi > Compute
Compute
The "Kubernetes clusters" tab is now where you can access previous versions of "inference clusters" (also known as "AKS clusters") and "attached Kubernetes" compute types along with any previously created compute targets using those types. Learn more about Kubernetes clusters.
Compute instances
Compute clusters
Kubernetes clusters
Attached computes
Choose from a selection of CPU or GPU instances preconfigured with popular tools such as VS Code, JupyterLab, Jupyter, and RStudio, ML packages, deep learning frameworks, and GPU drivers. Learn more about compute instances
New
Refresh
Start
Stop
Restart
Schedule and idle shutdown
Delete
View options
View quota
Search
Filter
Columns
Name
State
Idle shutdown
Applications
Size
Created on
Assigned to
compute-ravitharanga
Running
15 minutes
JupyterLab
Jupyter
VS Code (Web)
PREVIEW
Standard_E16s_v3
Feb 15, 2024 12:24 PM
Pemsith Ravi


Default Directory > ws-ravi > Compute > compute-ravitharanga
compute-ravitharanga
Details
Jobs
Monitoring (preview)
Refresh
Connect
Start
Stop
Restart
Delete
Diagnose
Resource properties
Status
Running
Last operation
Created at Feb 15, 2024 12:24 PM: Succeeded
Virtual machine size
Standard_E16s_v3 (16 cores, 128 GB RAM, 256 GB disk)
Processing unit
CPU - Memory optimized
Estimated cost
$1.21/hr (when running)
Additional data storage
--
Applications
JupyterLab
Jupyter
VS Code (Web)
PREVIEW
VS Code (Desktop)
PREVIEW
Terminal
Notebook
Created on
2/15/2024, 12:24:49 PM
SSH access
Disabled
Private IP address
10.0.0.4
Virtual network/subnet
--
Public IP address
20.74.200.170



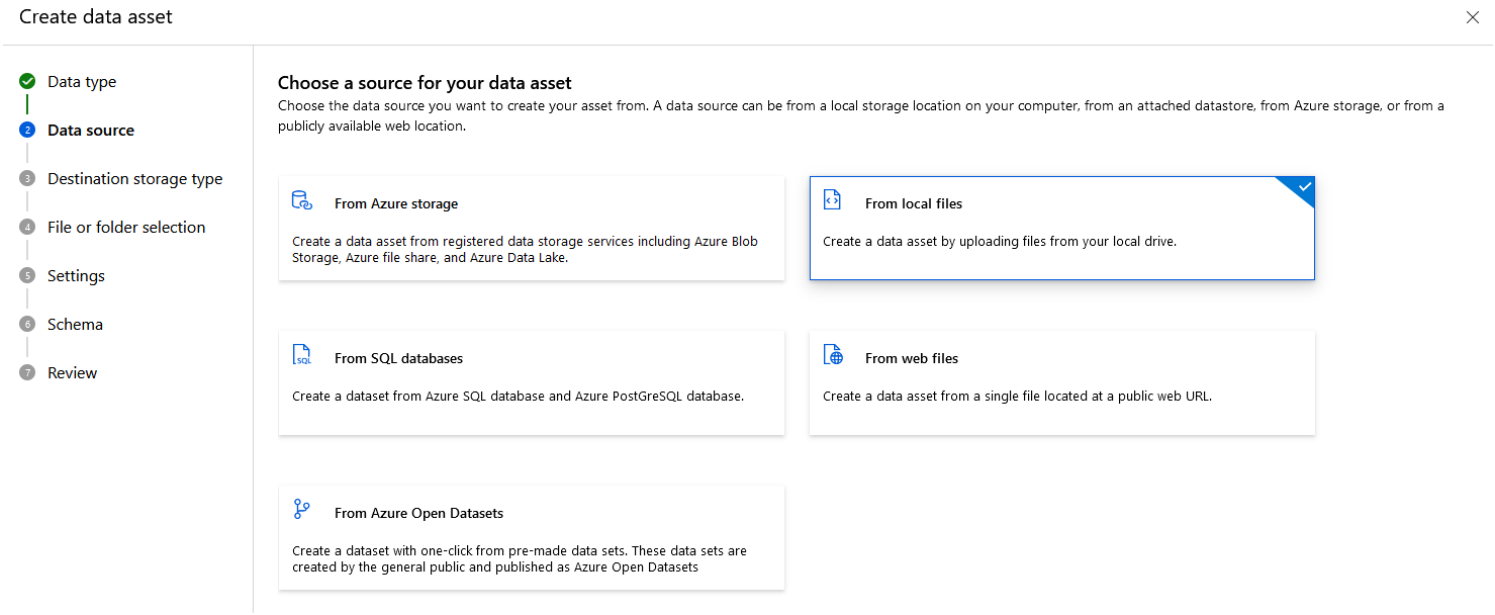
Capturing source data.

Note: Type of the dataset is Tabular (table type)

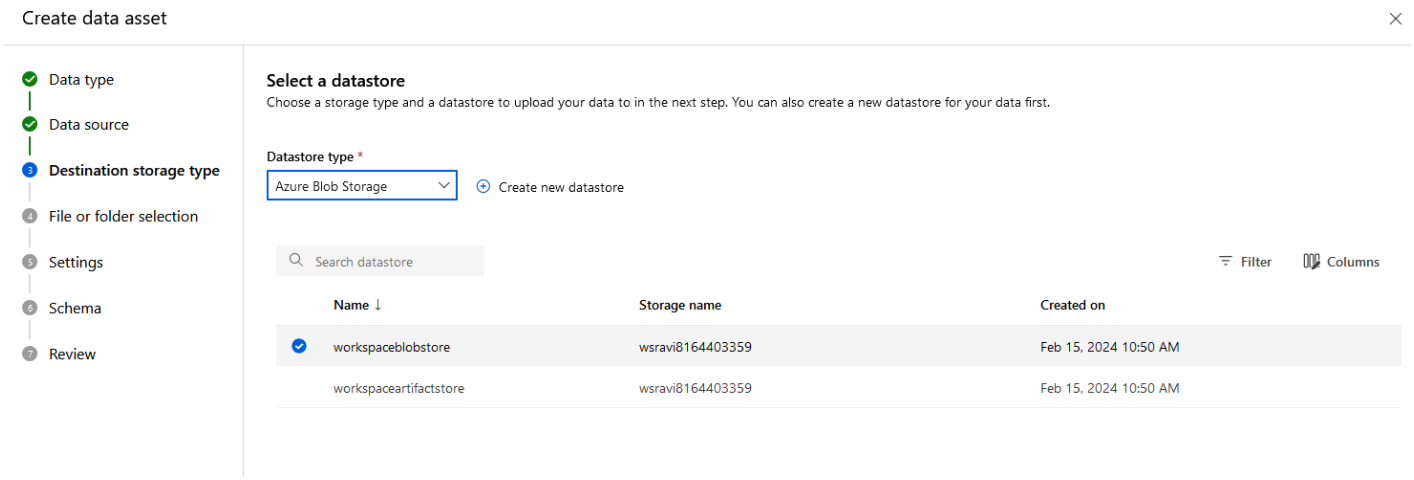


Selecting the location of the source file.

Note: The data source file can be chosen from pre-existing datasets in the Azure open datasets, web URLs, SQL servers, and Azure storage.



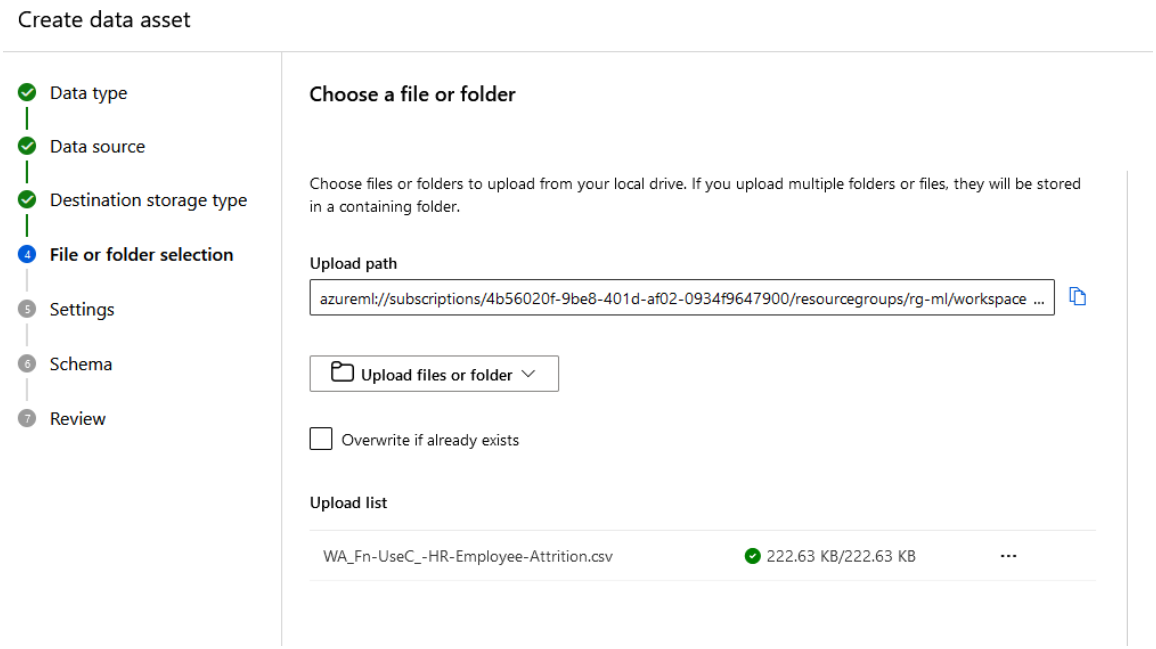
Selecting the default datastore.



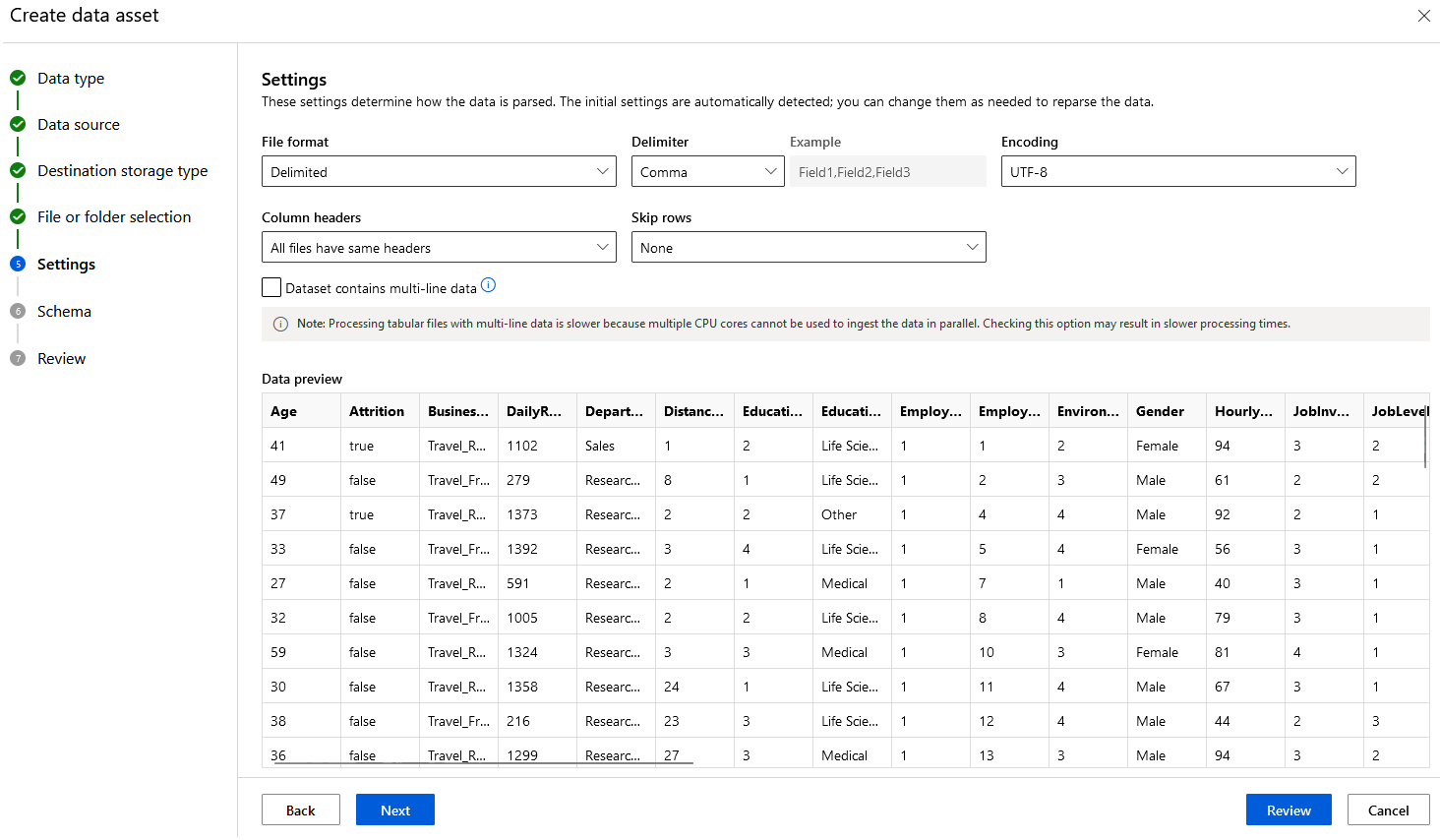
Choosing the data source file.

Data source: https://www.kaggle.com/datasets/pavansubhasht/ibm-hr-analytics-attrition-dataset

File name: WA_Fn-UseC_-HR-Employee-Attrition.csv

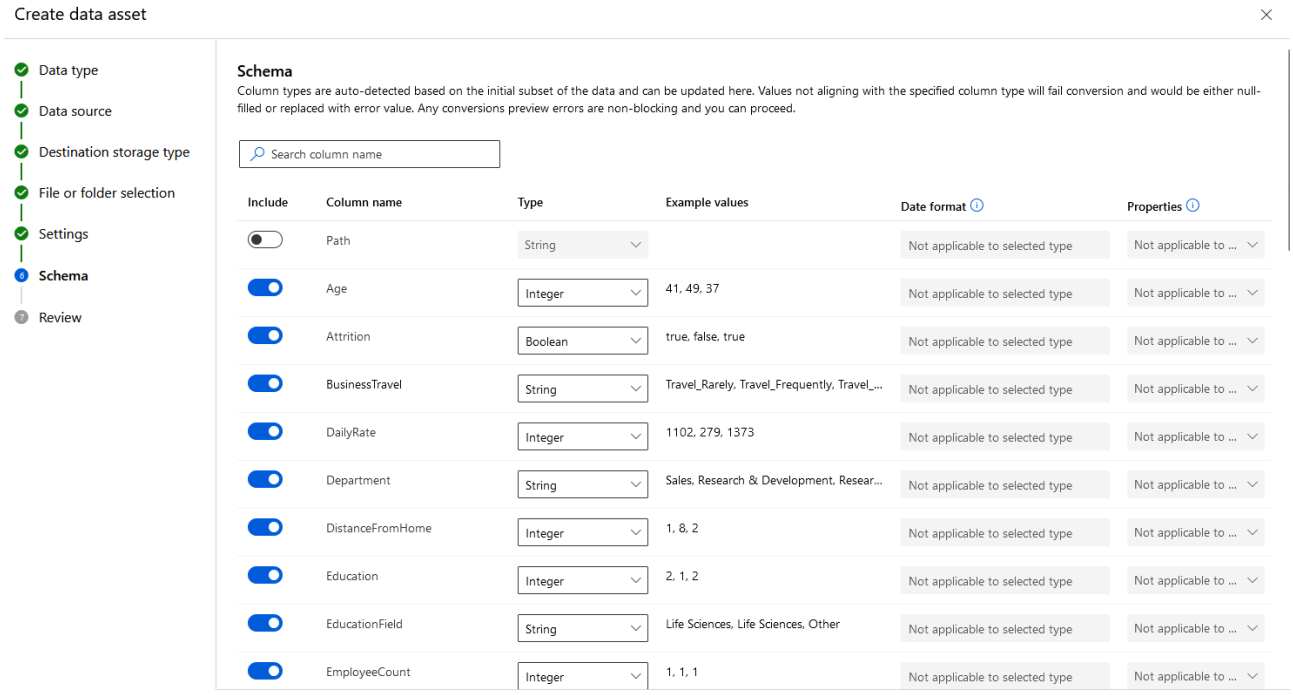


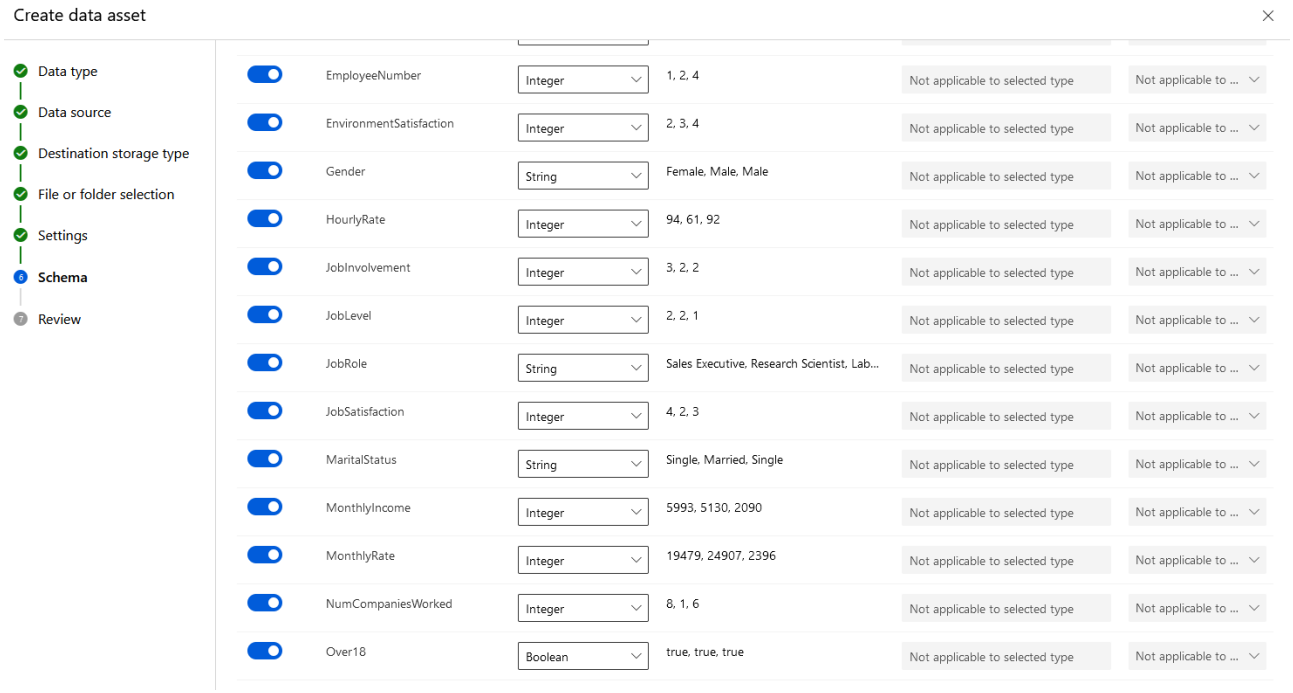
Previewing source data.

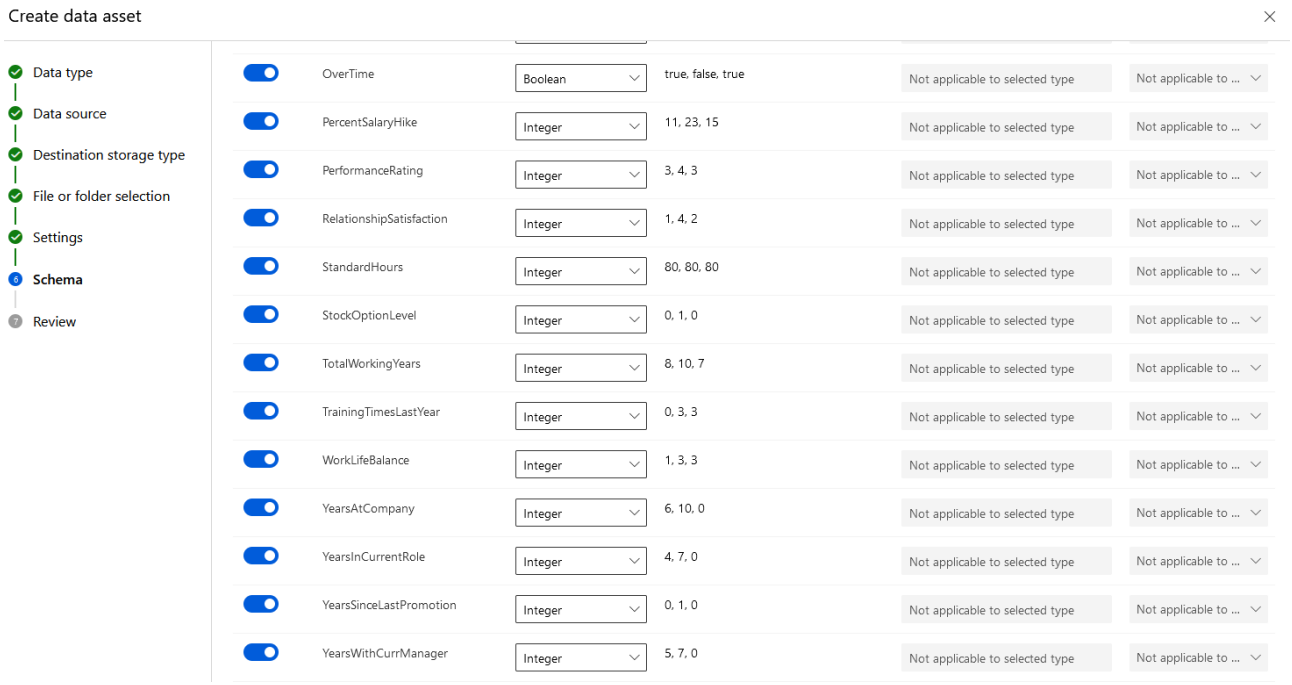


Viewing the schema data types.

Note: Azure automatically chooses the data types for each field based on the information that is available, but the user can also manually change the data types that are chosen or conceal columns that aren't needed.


Create data asset
Data type
Data source
Destination storage type
File or folder selection
Settings
Schema
Review
Schema
Column types are auto-detected based on the initial subset of the data and can be updated here. Values not aligning with the specified column type will fail conversion and would be either null-filled or replaced with error value. Any conversions preview errors are non-blocking and you can proceed.
Search column name
Include
Column name
Type
Example values
Date format
Properties
Path
String
Age
Integer
41, 49, 37
Attrition
Boolean
true, false, true
BusinessTravel
String
Travel_Rarely, Travel_Frequently, Travel_...
DailyRate
Integer
1102, 279, 1373
Department
String
Sales, Research & Development, Resear...
DistanceFromHome
Integer
1, 8, 2
Education
Integer
2, 1, 2
EducationField
String
Life Sciences, Life Sciences, Other
EmployeeCount
Integer
1, 1, 1
Not applicable to selected type
Not applicable to ...


Create data asset
Data type
Data source
Destination storage type
File or folder selection
Settings
Schema
Review
EmployeeNumber
Integer
1, 2, 4
EnvironmentSatisfaction
Integer
2, 3, 4
Gender
String
Female, Male, Male
HourlyRate
Integer
94, 61, 92
JobInvolvement
Integer
3, 2, 2
JobLevel
Integer
2, 2, 1
JobRole
String
Sales Executive, Research Scientist, Lab...
JobSatisfaction
Integer
4, 2, 3
MaritalStatus
String
Single, Married, Single
MonthlyIncome
Integer
5993, 5130, 2090
MonthlyRate
Integer
19479, 24907, 2396
NumCompaniesWorked
Integer
8, 1, 6
Over18
Boolean
true, true, true
Not applicable to selected type
Not applicable to ...



Reviewing all settings and creating the data asset.

Review

Review the settings for your data asset and make any changes as needed.

Data type

Name
IBM-HR-Analytics

Description
IBM HR Analytics Employee Attrition & Performance

Type
tabular

Data source

Type
Local

File selection

Upload path
azureml://subscriptions/4b56020f-9be8-401d-af02-0934f9647900/resourcegroups/rg-ml/workspaces/ws-ravi/datastores/workspaceblobstore/paths/UI/2024-02-15_145332_UTC/WA_Fn-UseC_-HR-Employee-Attrition.csv

Files uploaded
WA_Fn-UseC_-HR-Employee-Attrition.csv

Storage

Datastore type
AzureBlob

Datastore name
workspaceblobstore

Schema

Age	*Integer*
Attrition	*Boolean*
BusinessTravel	*String*
DailyRate	*Integer*
Department	*String*

(showing 5 of 36 columns)

Settings

Delimiter
Comma

Encoding
UTF-8

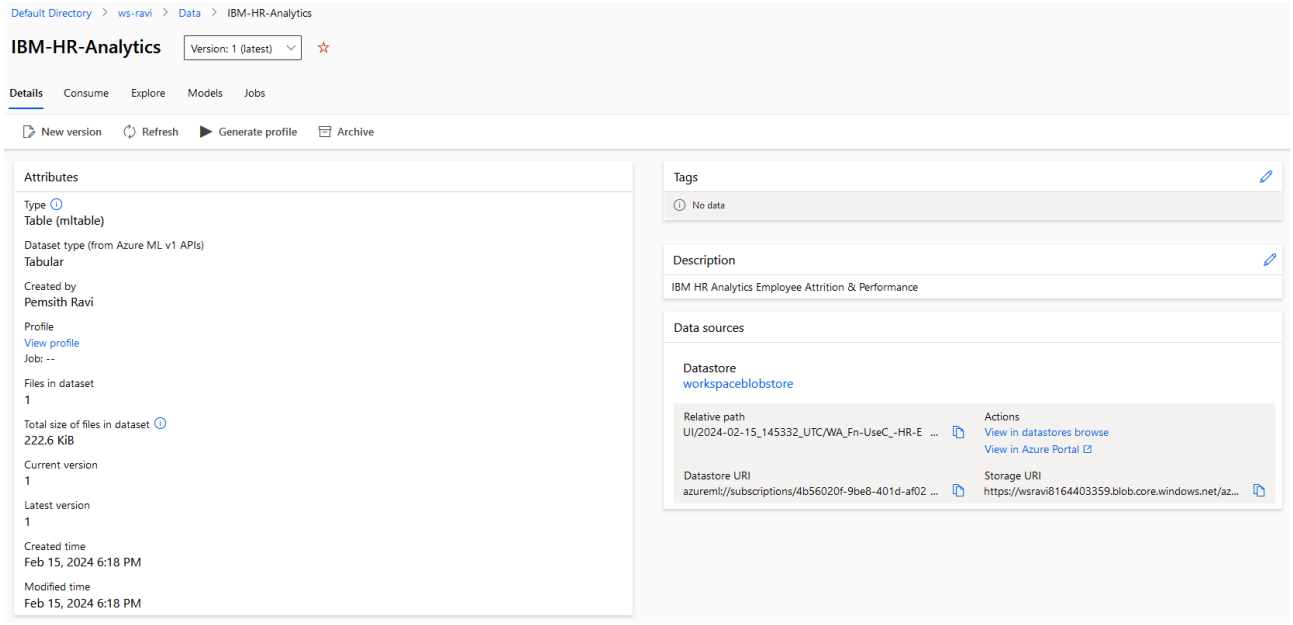
File format
Delimited

Column headers
All files have same headers

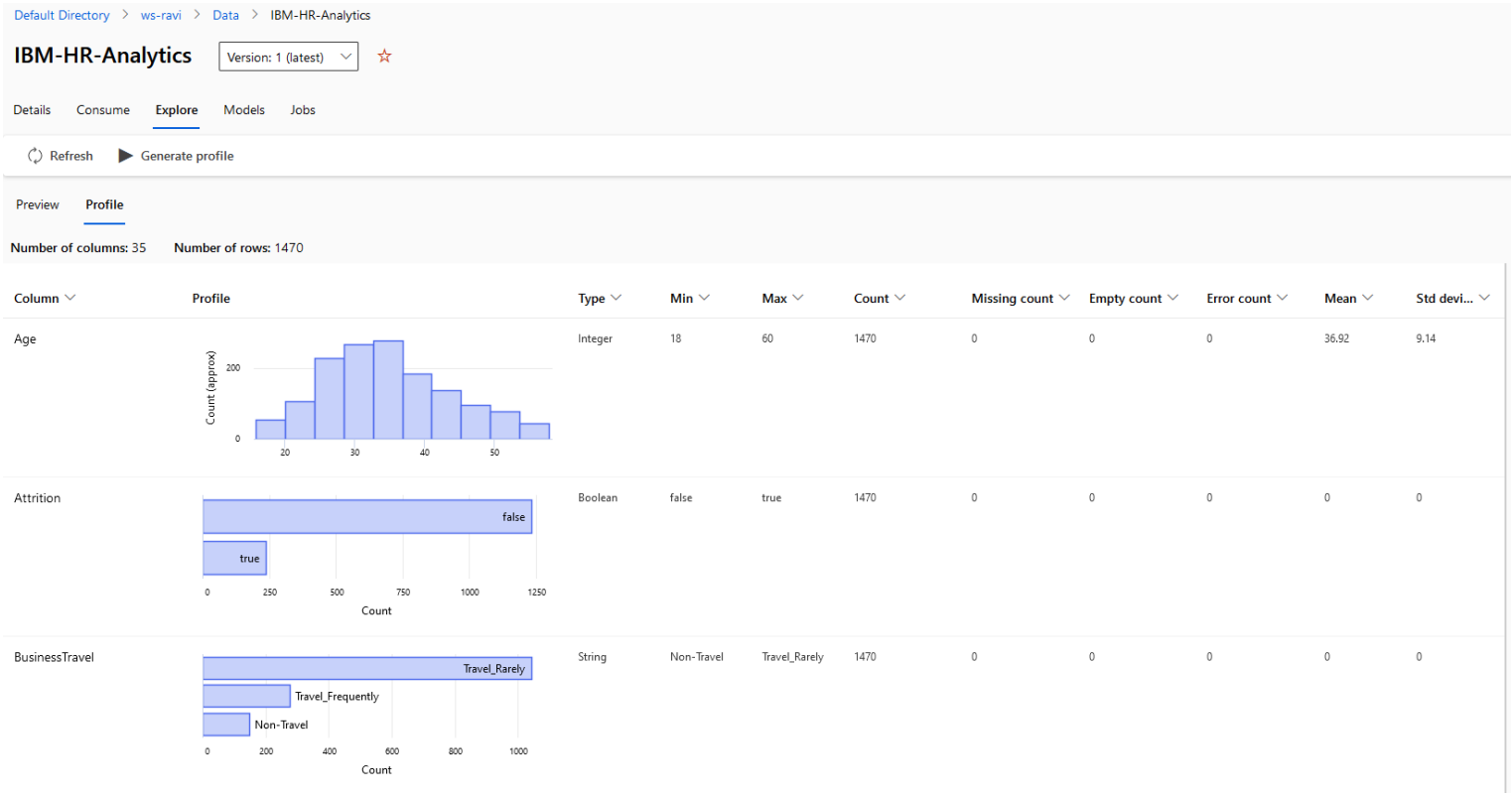
Number of rows to skip
None

Dataset contains multi-line data
false

The data asset.



Exploring auto generated data analytics such as Min, Max, Count, Mean, Standard deviation etc.



Designer: Azure Machine Learning Workspaces' UI interface creates machine learning pipelines. Building the ML model should take place here.

Creating a new pipeline.

Steps: Capture data.

Normalizing data.

Split data into training and testing (70% 30%).

Identifying the dependant and independent variables.

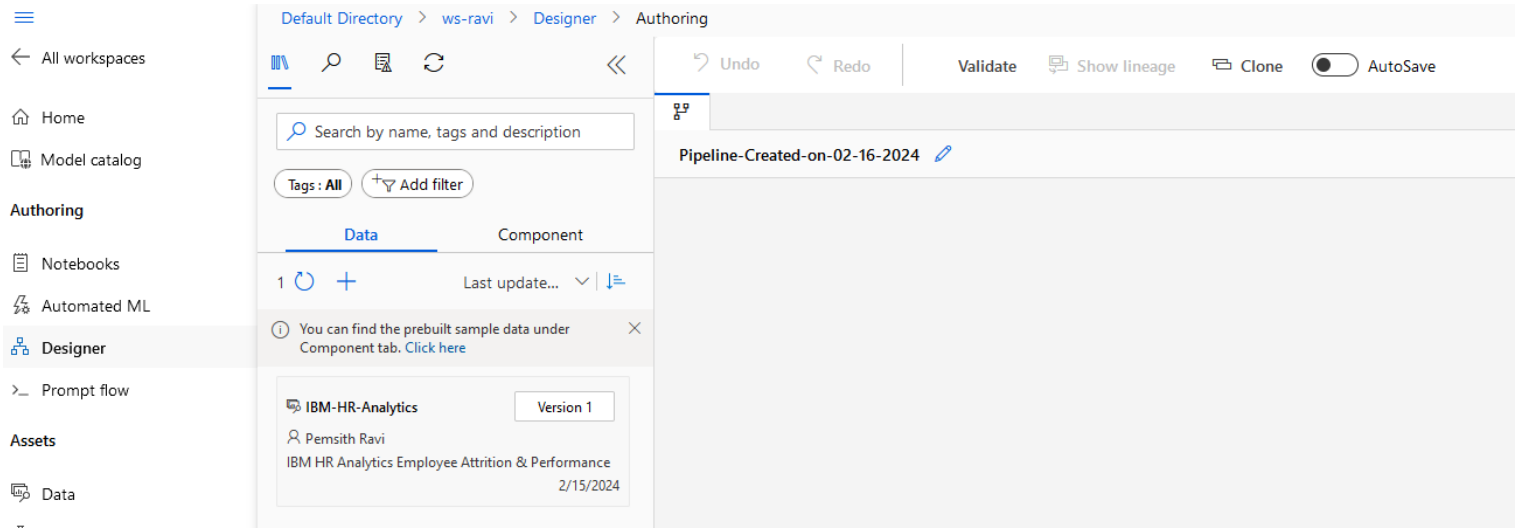
Measure the number of steps.

Training the model using 70%.

Testing the model (comparing) using 30%.

Building the confusion matrix.

Calculating the accuracy of the model.



Normalizing numerical columns.

Note: normalization applies to both training and testing datasets.

Reducing the variance and skewness of the data, which can impact the accuracy and stability of some ML algorithms, is one benefit that normalizing data can offer for ML models. Additionally, it can enhance the correlation and comparability of various features or variables, enabling determining which are most important or pertinent for the machine learning problem and stay clear of multicollinearity problems. Additionally, normalizing the information makes data analysis and visualization easier, enabling users to see patterns and trends in their data and more effectively convey findings.

Min-max normalization sensitive to outliers and extreme values, but scales the values of each feature or variable to a range between 0 and 1.

$$z = \frac{\mathrm{x} - min(x)}{[\max(x) - min(x)]}$$

Image source: https://learn.microsoft.com/en-us/azure/machine-learning/component-reference/normalize-data?view=azureml-api-2

Z-score normalization minimalizes the impact of outliers and extreme values by transforming the values into a conventional normal distribution with a mean of 0 and a standard deviation of 1.

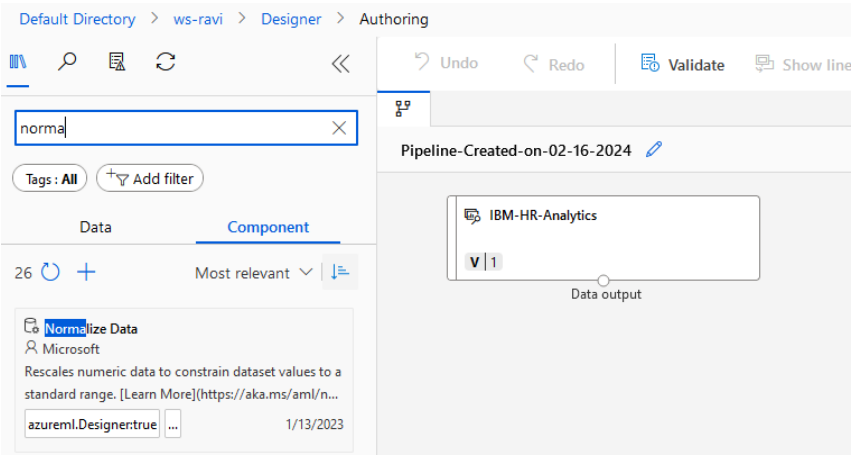
$$z = \frac{x - mean(x)}{stdev(x)}$$

Image source: https://learn.microsoft.com/en-us/azure/machine-learning/component-reference/normalize-data?view=azureml-api-2

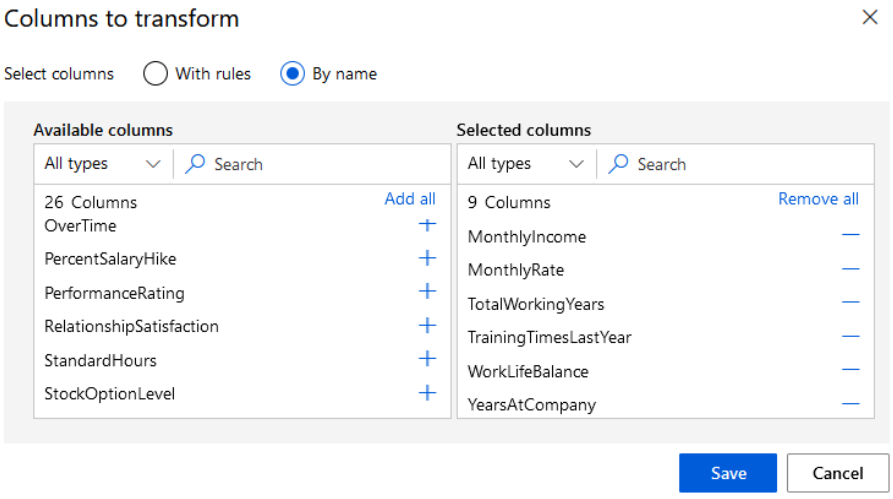
Logistic: The values in the column are transformed using the following formula.

$$z = \frac{1}{1 + \exp(-x)}$$

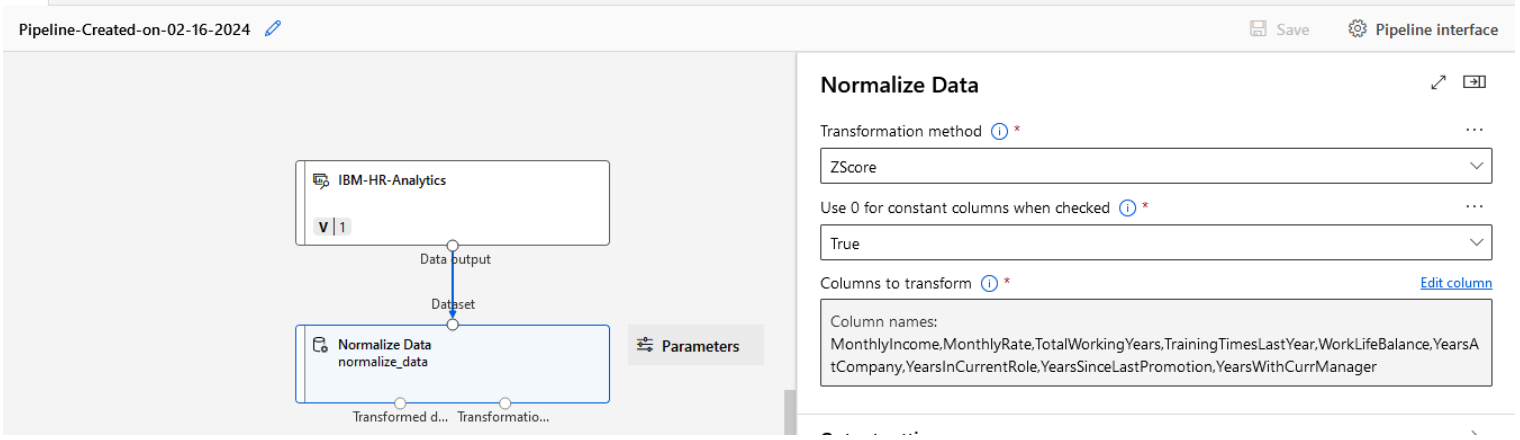
Image source: https://learn.microsoft.com/en-us/azure/machine-learning/component-reference/normalize-data?view=azureml-api-2



Adding necessary columns to normalize.

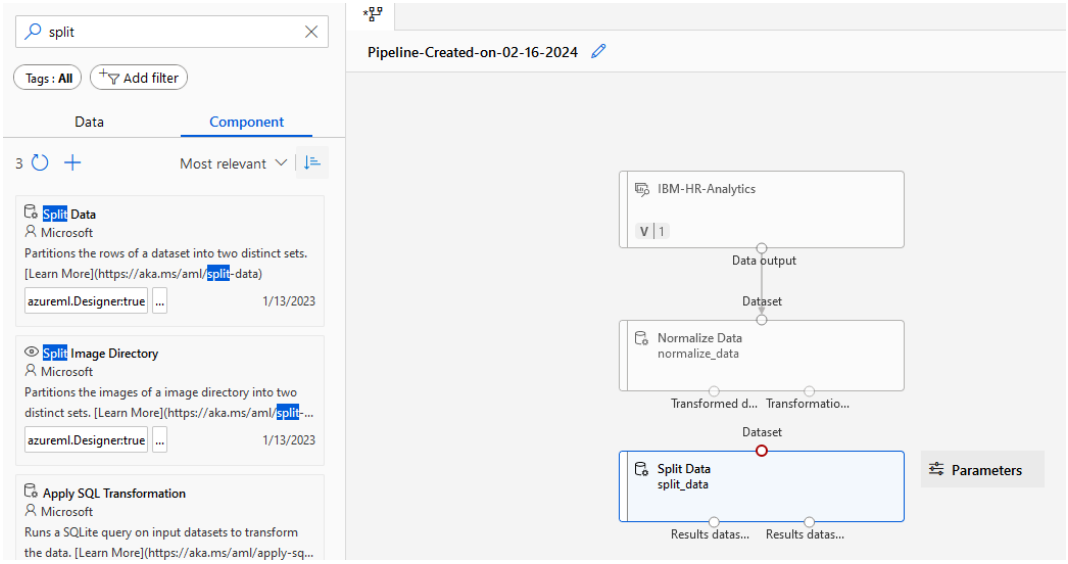


Note: in this model, the Z score has been selected as the transformation method.

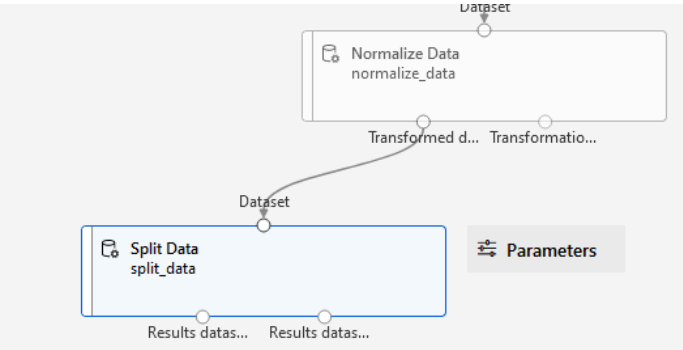


Split data.

Adding split component.



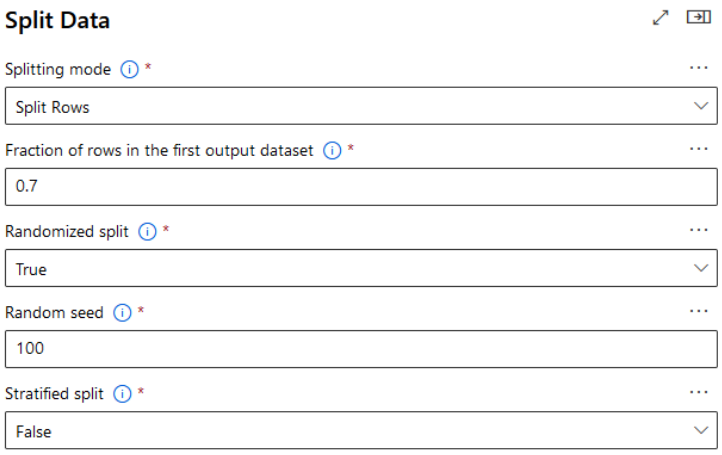
Connecting Transformed Data point with the Split Data component.



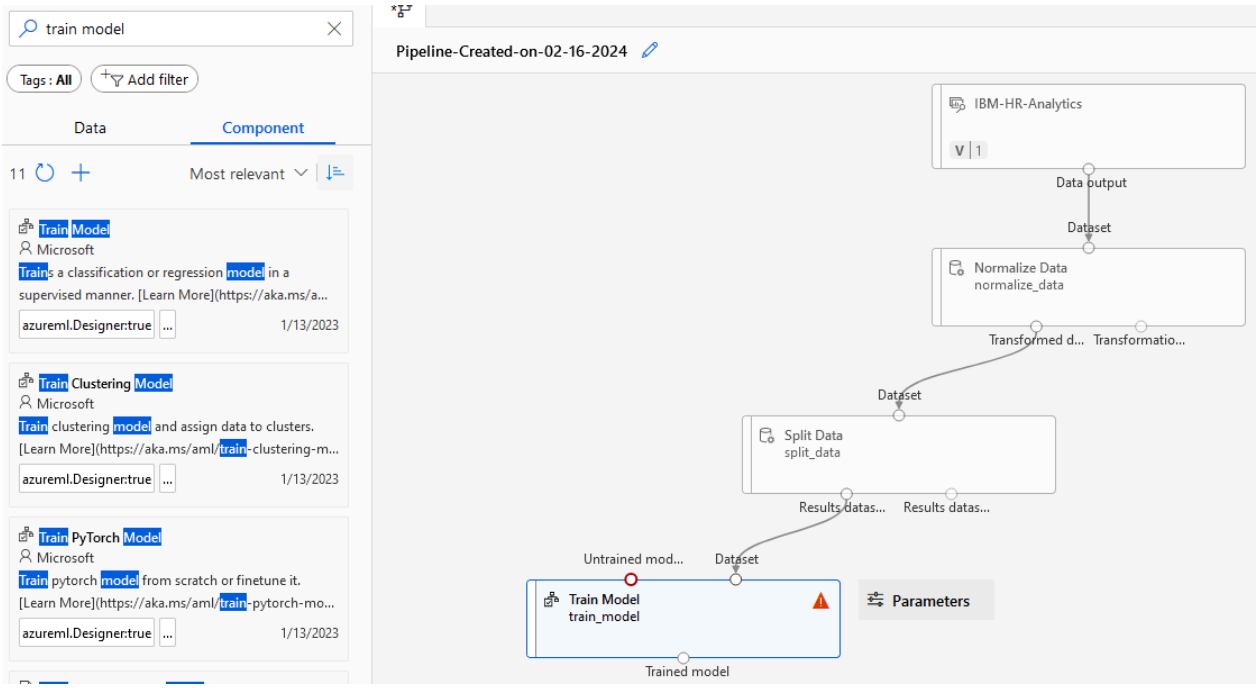
Settings for Split Data.

Note: 70% of data has been selected for training.

Random seed set to 100.



Adding the Trained Model component and feeding the training set with the Trained Model component.



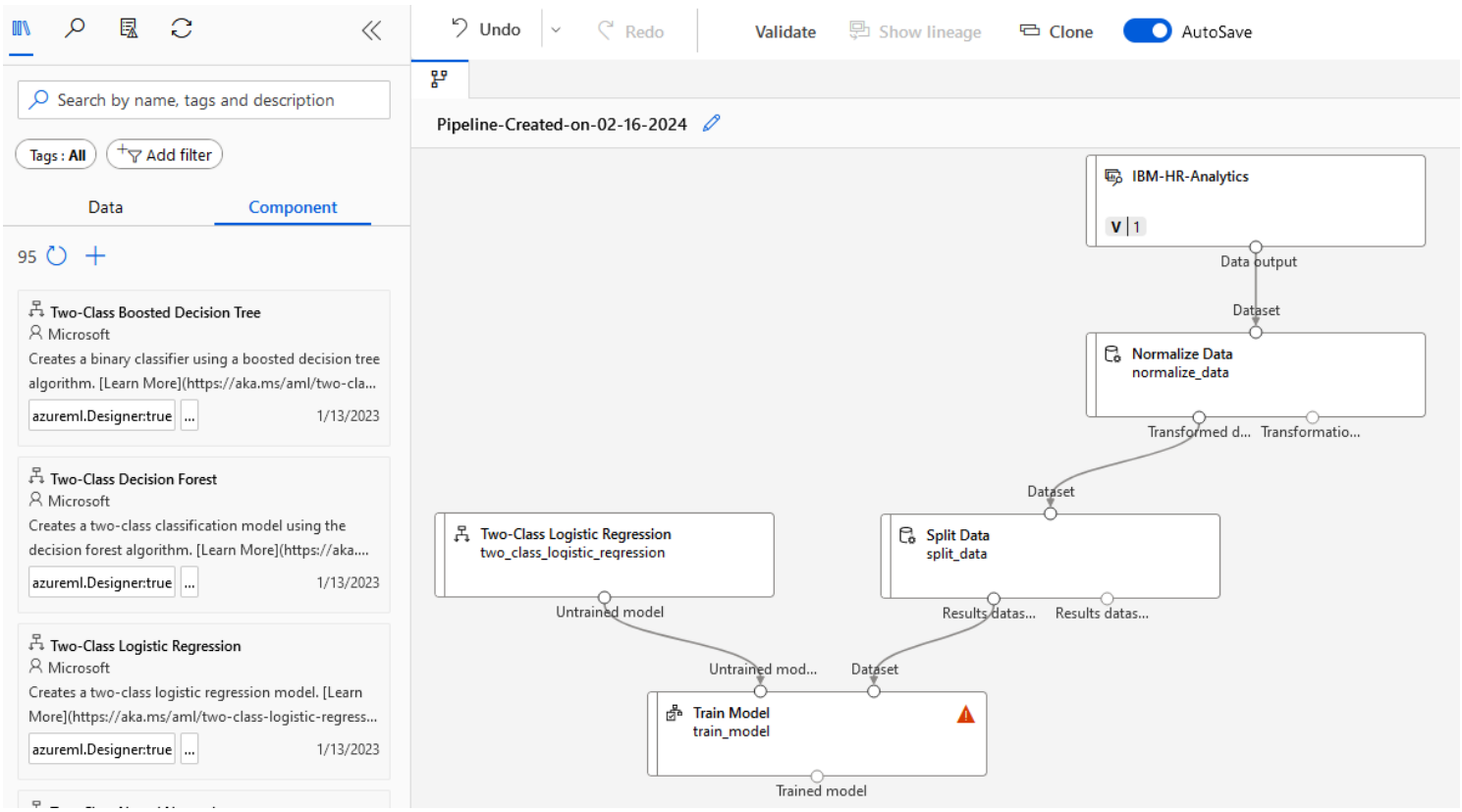
Choosing the algorithm to train the dataset.

Adding “Two-Class Logistic Regression” algorithm and linking with the untrained point of the “Trained Model” component.

Two-Class Logistic Regression component:

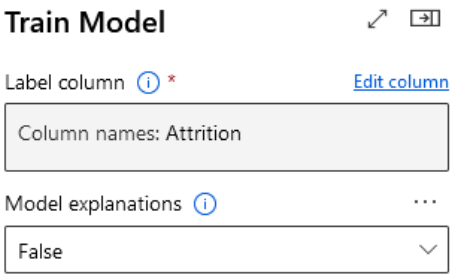
With this component, it is possible to build a logistic regression model with two (and only two) outcomes predicted. Since this strategy uses supervised learning, the dataset containing the model's training results is required.

A well-known statistical technique for estimating the likelihood of an occurrence is logistic regression, which is particularly well-liked for classification problems. The technique fits data to a logistic function in order to estimate the likelihood that an event will occur.



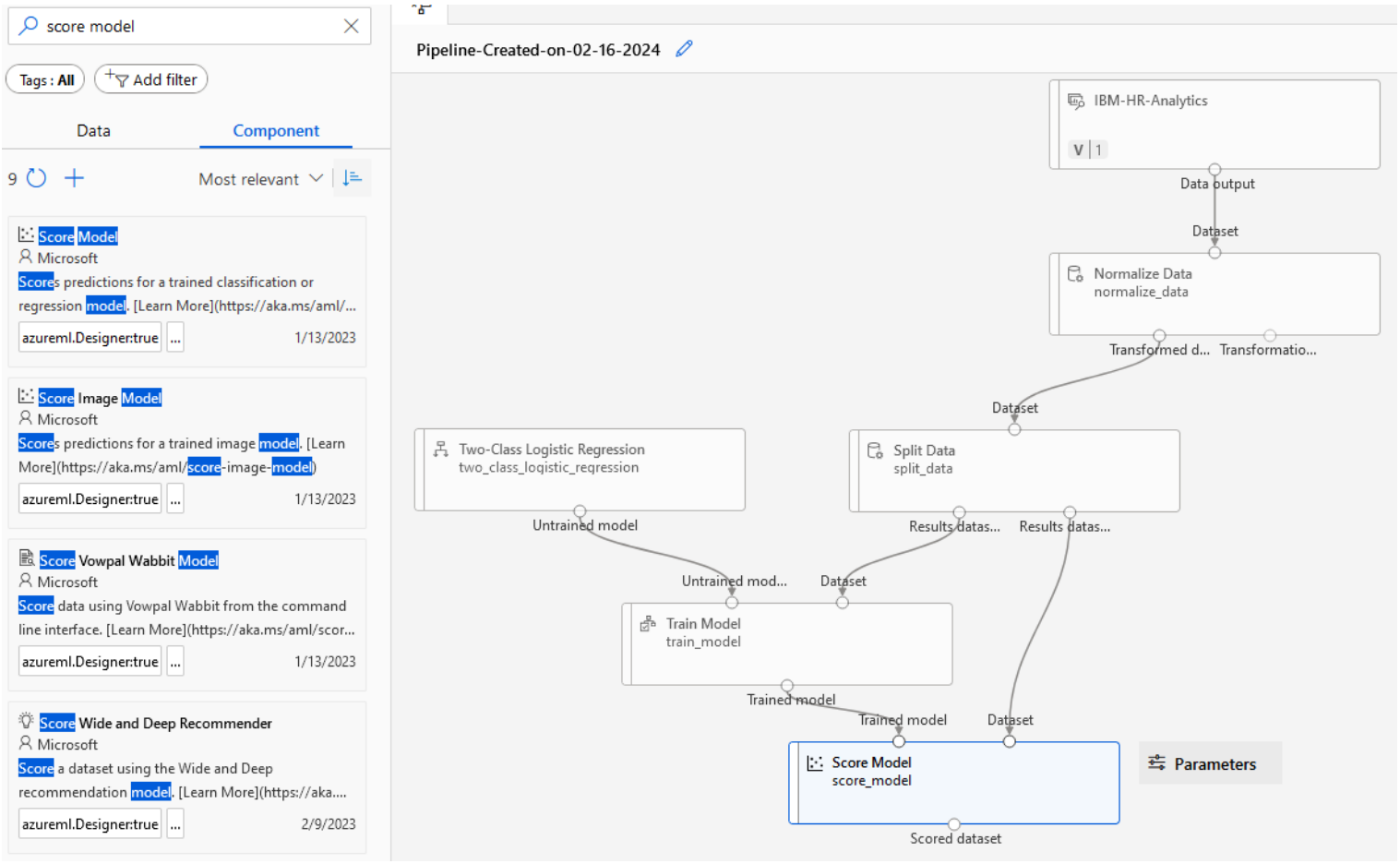
In the Train Model component, adding the target variable / dependent variable / the variable that needs to be trained.

Note: 70% of random data has been assigned to predict the outcome using the Two-class regression algorithm.



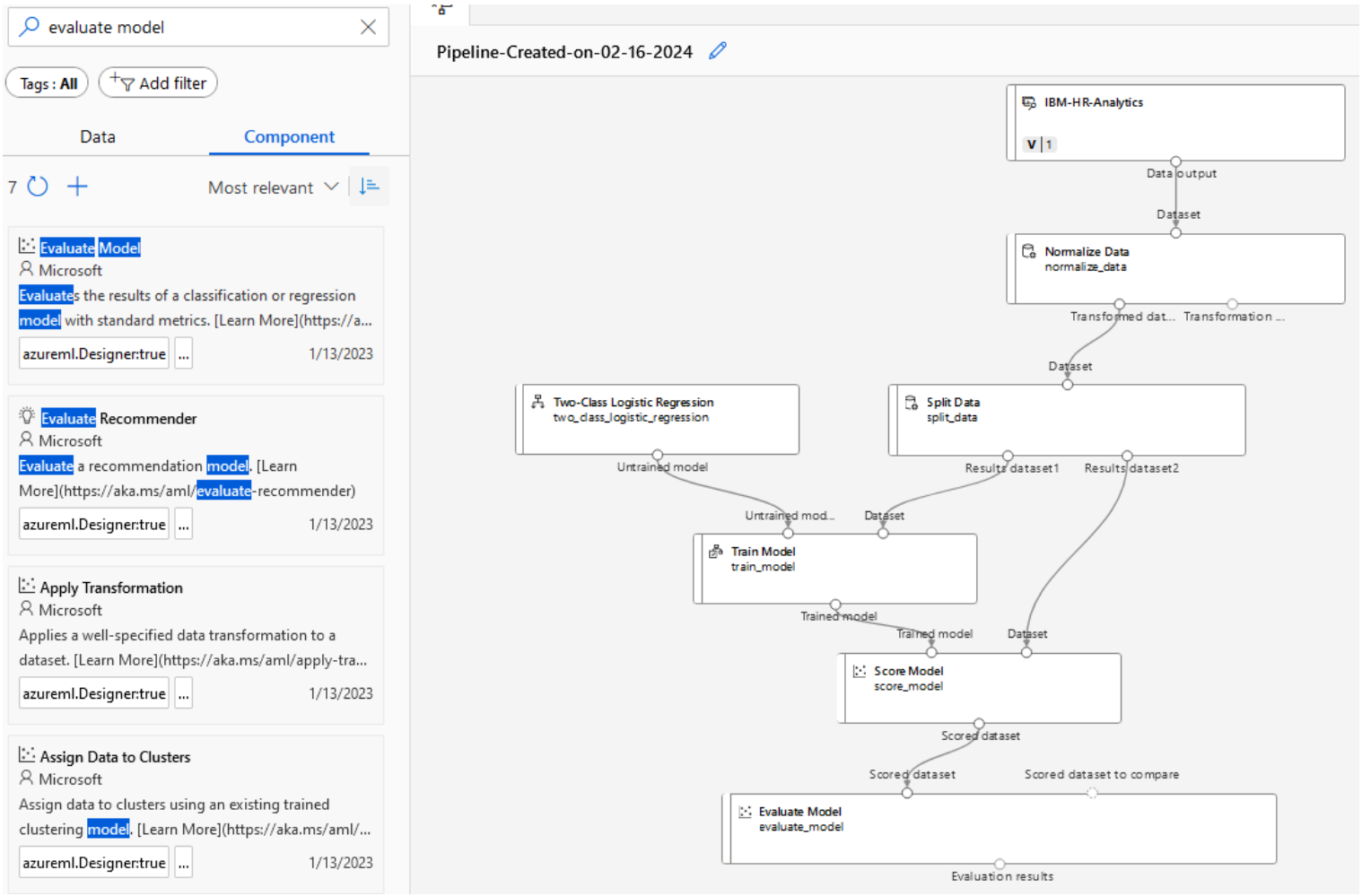
Comparing the result of the train model with the 30% test data that already exists in the source dataset.

Adding the Score Model and linking Trained model data (70%) and the 30% test data.

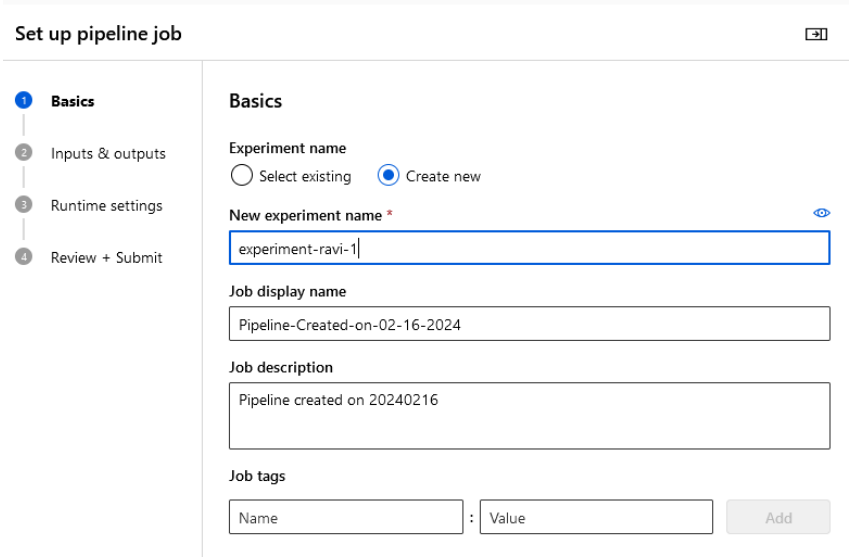


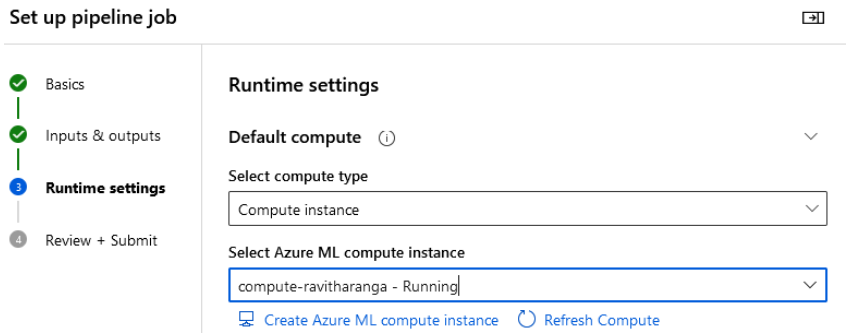
Adding the Evaluate Model and connecting with the Scored dataset.

Note: The Evaluate Model maintains the confusion matrix. This element is to assess a trained model's correctness. The Evaluate Model component computes a set of industry-standard evaluation metrics given a dataset containing scores produced by a model.

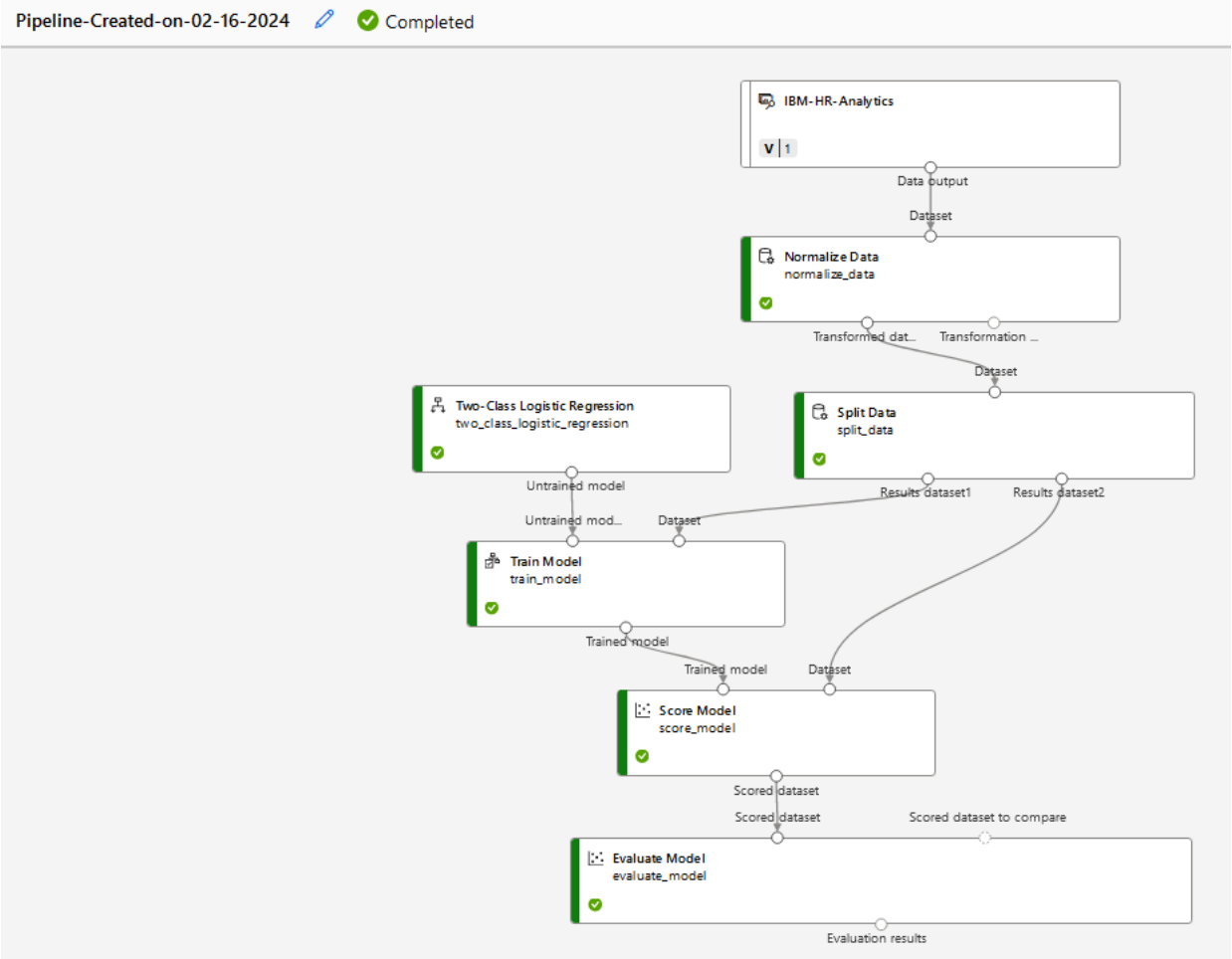


Creating a new experiment.



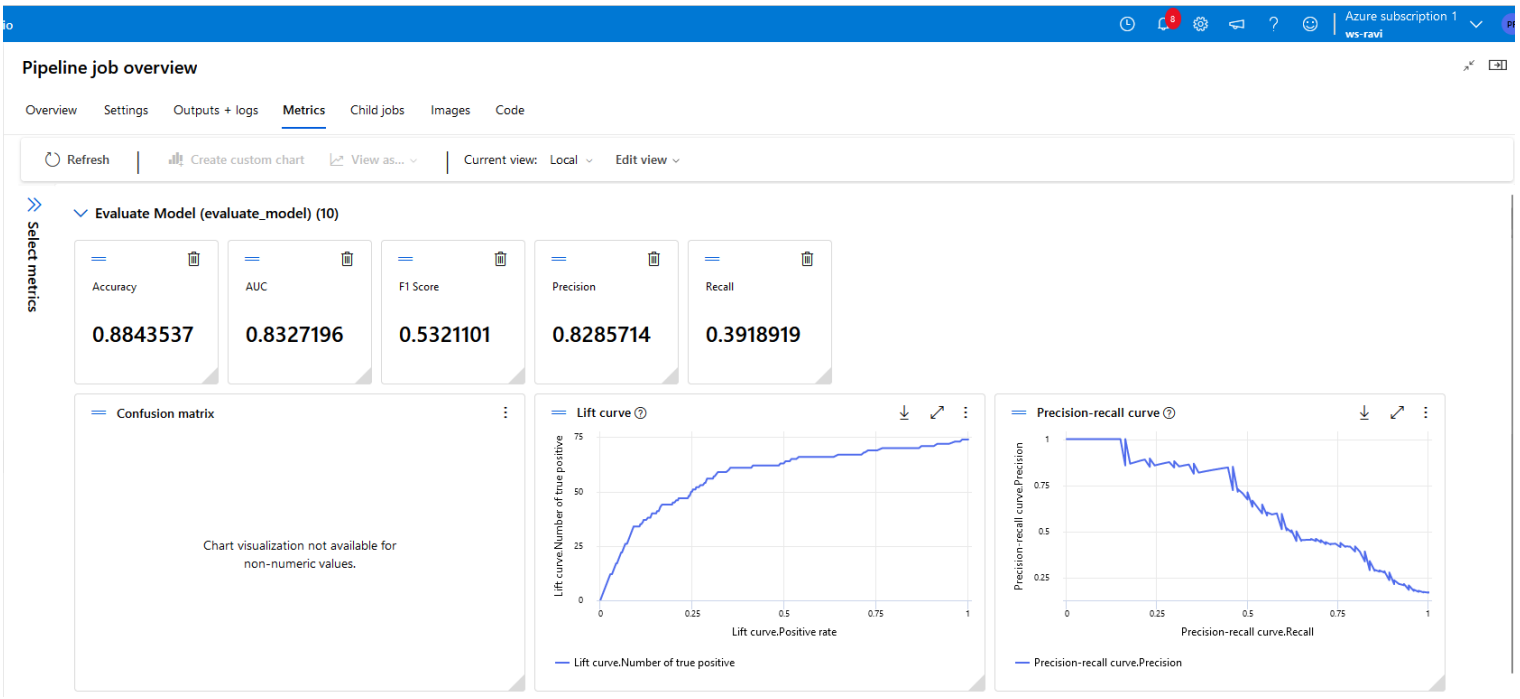


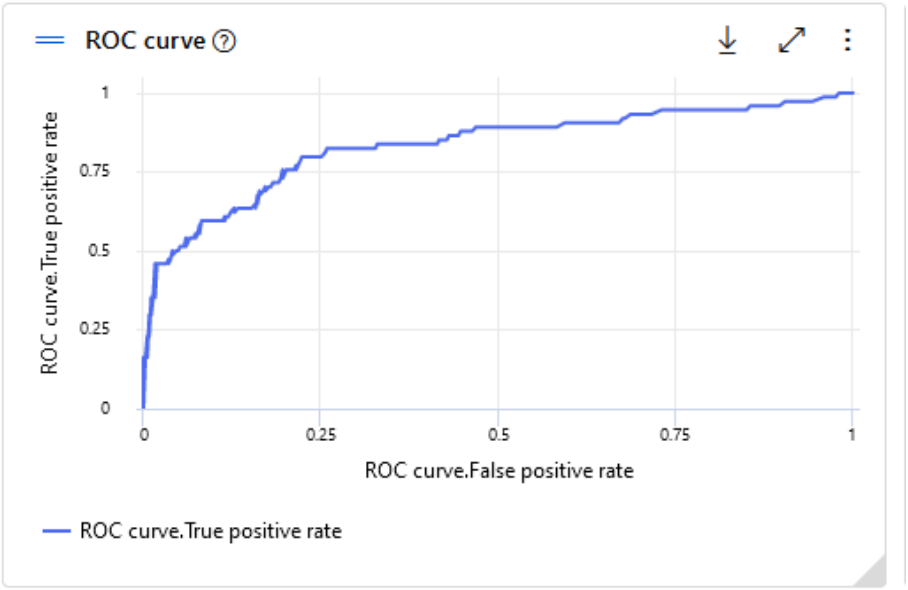
Running the new experiment and viewing final statistics.



Overview of the new experiment / model.

Note: the target variable (Attrition) is a non-numerical column hence the confusion matrix is not generated.


Azure subscription 1
ws-ravi
Pipeline job overview
Overview
Settings
Outputs + logs
Metrics
Child jobs
Images
Code
Refresh
Create custom chart
View as...
Current view: Local
Edit view
Select metrics
Evaluate Model (evaluate_model) (10)
Accuracy
0.8843537
AUC
0.8327196
F1 Score
0.5321101
Precision
0.8285714
Recall
0.3918919
Confusion matrix
Chart visualization not available for non-numeric values.
Lift curve
Lift curve.Number of true positive
Lift curve.Positive rate
Lift curve.Number of true positive
Precision-recall curve
Precision-recall curve.Precision
Precision-recall curve.Recall
Precision-recall curve.Precision


ROC curve
ROC curve.True positive rate
ROC curve.False positive rate
ROC curve.True positive rate

Observations:

Model has an accuracy (correctness) of 0.88 (88%)., meaning that the model can generate high accurate results on new data feeds.

AUC, Area Under the ROC Curve is 0.83 (value is closer to 1 / higher number shows better classification performance)., meaning the model performs well.

Recall value (the model's thoroughness) of this model is closer to zero (0.39) hence the model's ability to find all the relevant cases is low.

Recall Mathematic equation:

$$\text{Recall} = \frac{\text{number of true positives}}{\text{number of true positives} + \text{number of false negatives}}$$

True positives are data points that the model correctly classifies as positive but are genuinely positive.
False negatives are data points that the model incorrectly classifies as negative but are actually positive.

With a precision value of 0.82, which is closer to 1, the relevance of the classification model is high, indicating that it can effectively identify only the pertinent data points. However, as the precision value grows as the recall value drops, it is possible to view the model as being good.

Precision Mathematic equation:

$$\text{Precision} = \frac{\text{number of true positives}}{\text{number of true positives} + \text{number of false positives.}}$$

False positives are data points that are genuinely negative but are identified as negative by the model.

		Actual	
		Positive	Negative
Predicted	Positive	True Positive	False Positive
	Negative	False Negative	True Negative

Going from the confusion matrix to the precision and recall requires finding the respective values in the matrix and applying the equations:

$$recall = \frac{true\ positives}{true\ positives\ +\ false\ negatives} \qquad precision = \frac{true\ positives}{true\ positives + false\ positives}$$

Image source: https://builtin.com/data-science/precision-and-recall

F1 score: Precision and recall's harmonic mean is the F1 score.

F1 score Mathematical equation:

$$F1 = \frac{2 * Precision * Recall}{Precision + Recall}$$

By using the harmonic mean rather of a conventional average, extreme values are eliminated.

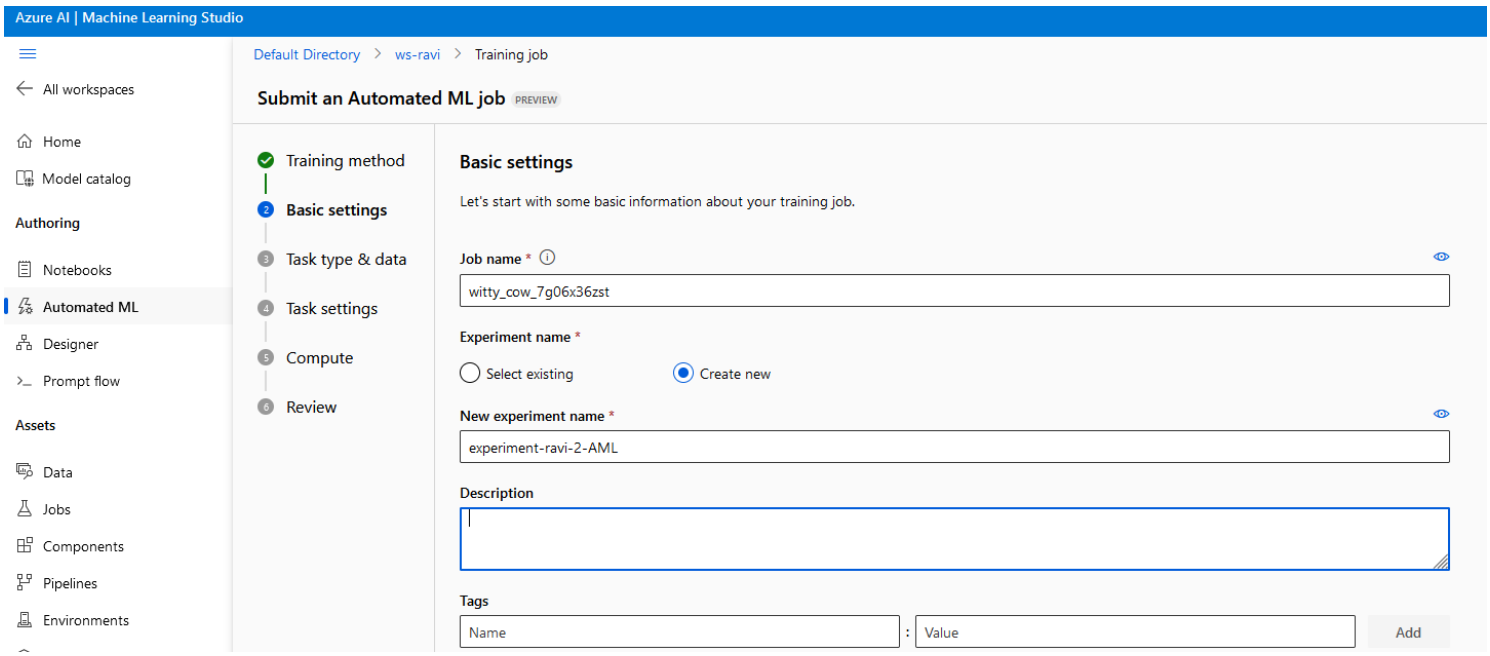
The F1 score is 0.53, as indicated by the pipeline assignment summary above. This may be explained by the fact that the recall is closer to 0.0 and the precision is closer to 1.0, so the F1 score has a simple average of 0.5.

Note: A maximum F1 score indicates that the classification model has an ideal ratio of recall to precision.

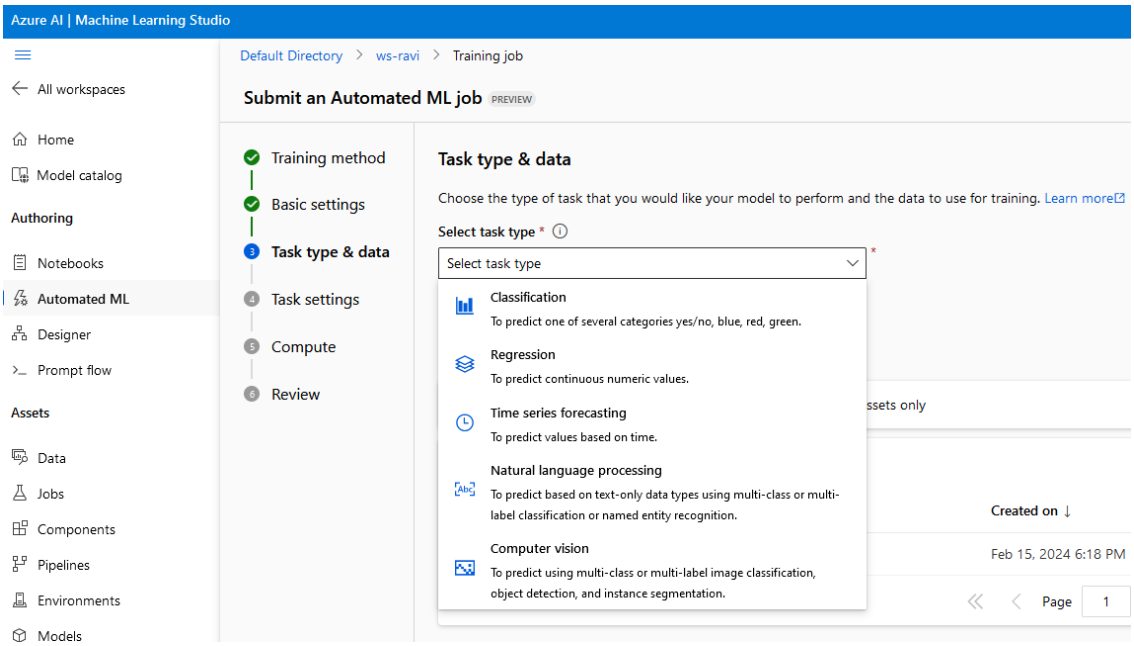
Automated ML: It is feasible to automate time-consuming processes with automated machine learning. Automated machine learning swiftly loop through numerous combinations of algorithms and hyperparameters to identify the optimal model depending on preferred success metric.

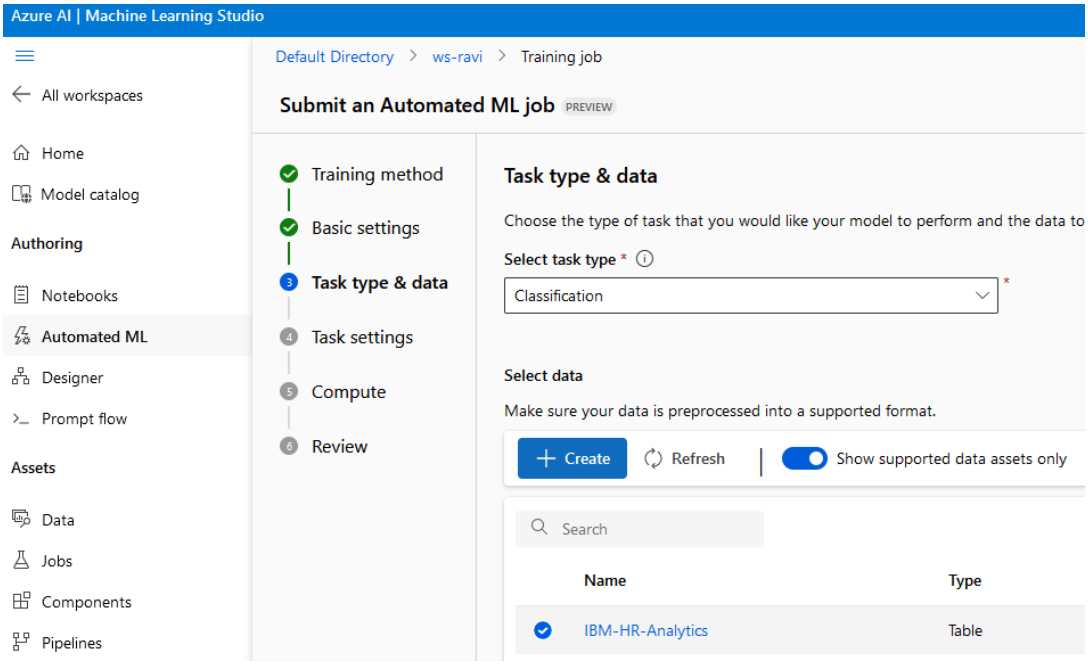
Azure Machine Learning builds several parallel pipelines during training that experiment with various settings and algorithms. The service creates a model with a training score after each iteration using ML techniques along with feature selections. The model is said to "fit" the data better if it has a higher score for the metric that wish to optimize for. Once it reaches the experiment's specified exit criterion, it will cease.

Building a new Automated ML job and creating a new experiment.

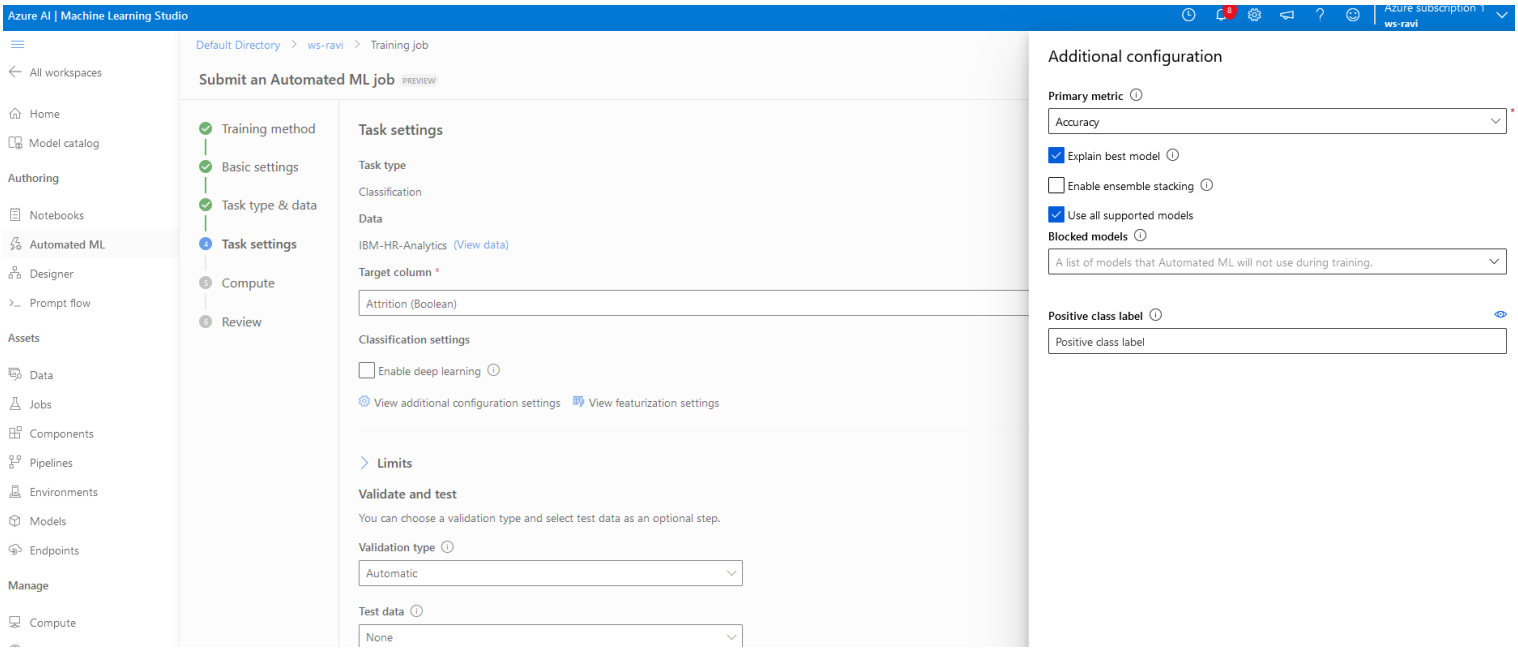


Selecting the Classification task type and selecting the existing data set.

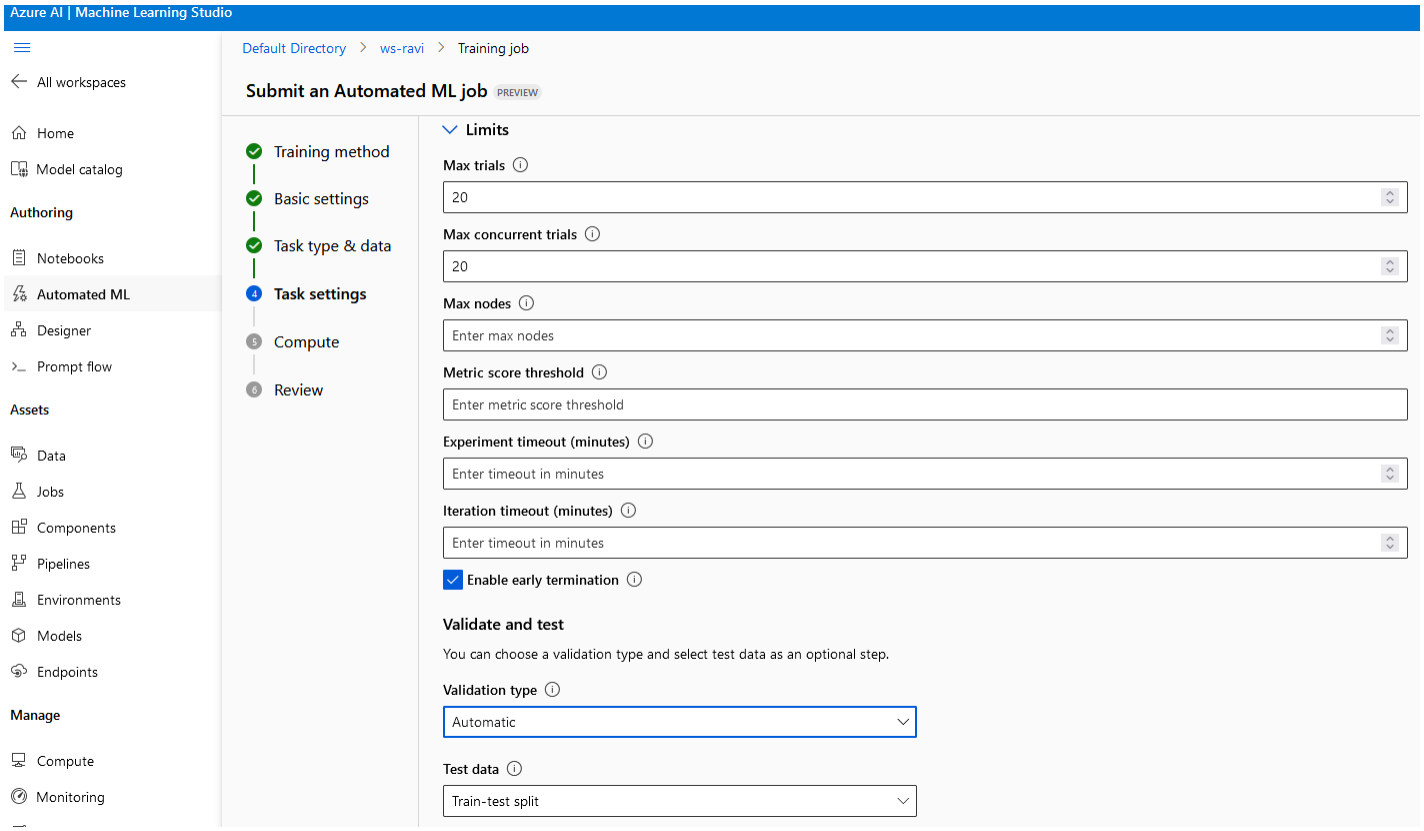




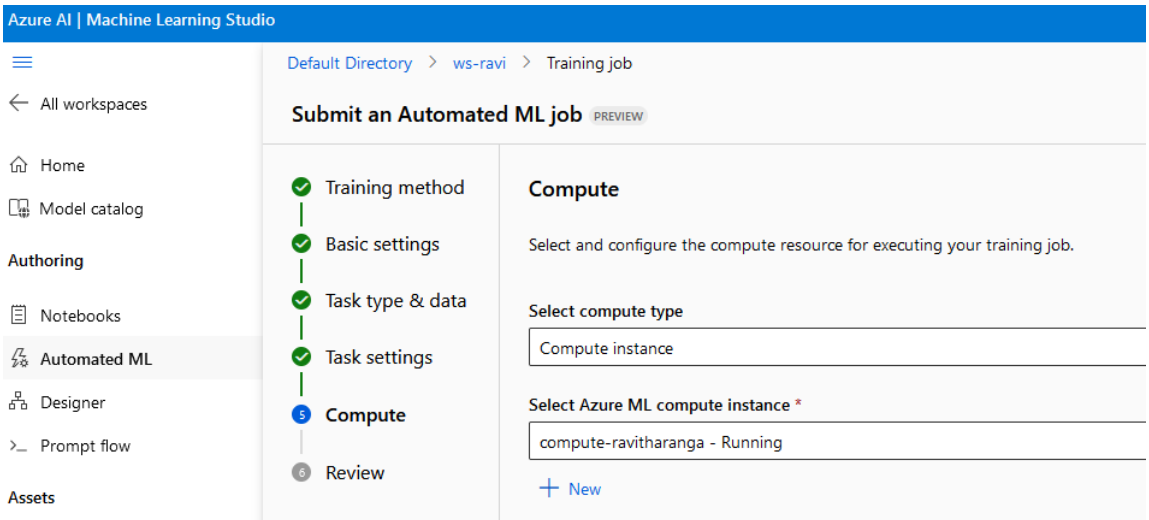
Set the primary metric as Accuracy.



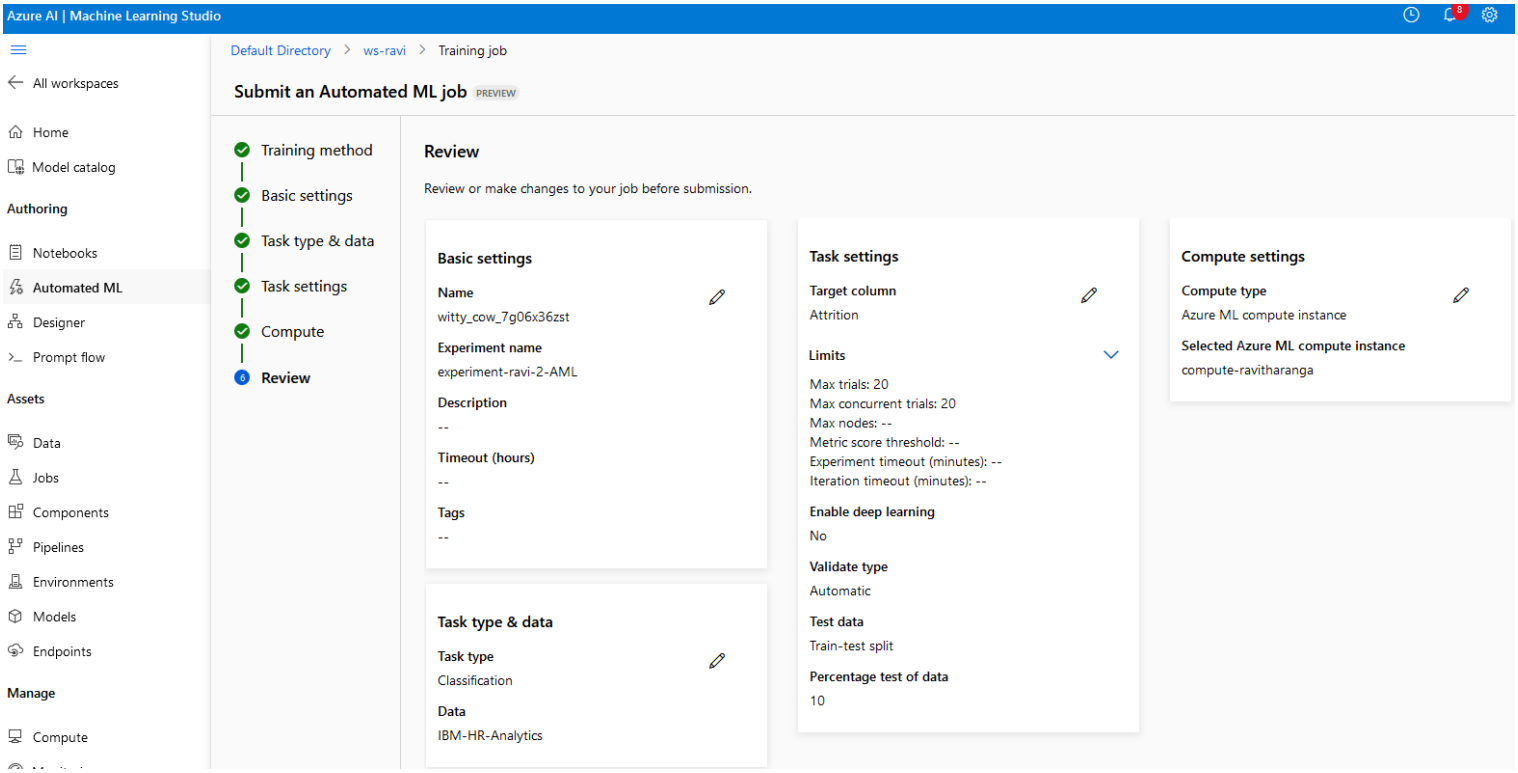
Set limits for maximum number of trials and maximum number of concurrent trials.



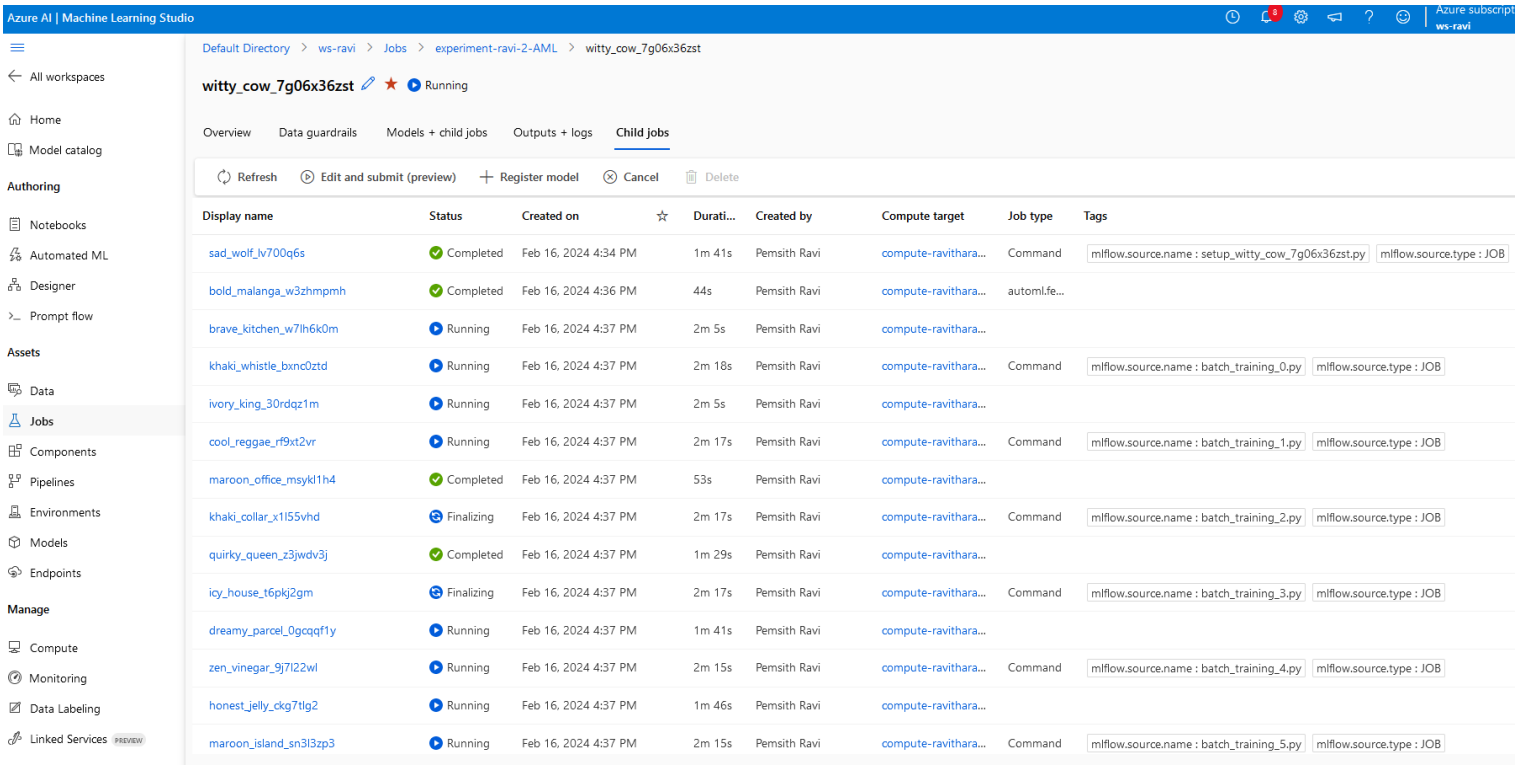
Selecting the compute type and compute instance.



Reviewing settings and submitting.

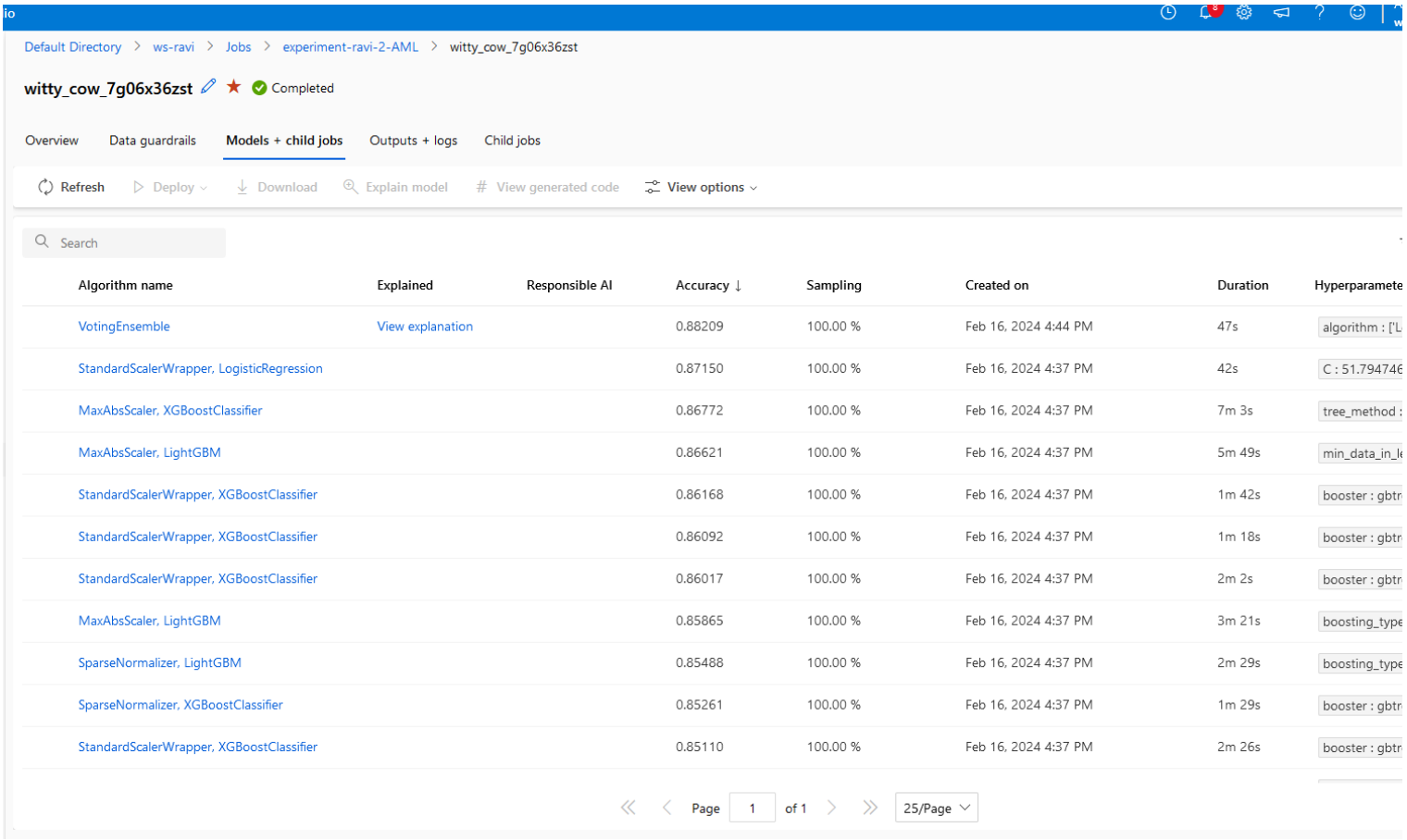


It is observed that how the Automated ML process executes potential experiments that can be utilized as pipelines with highest accuracy level.

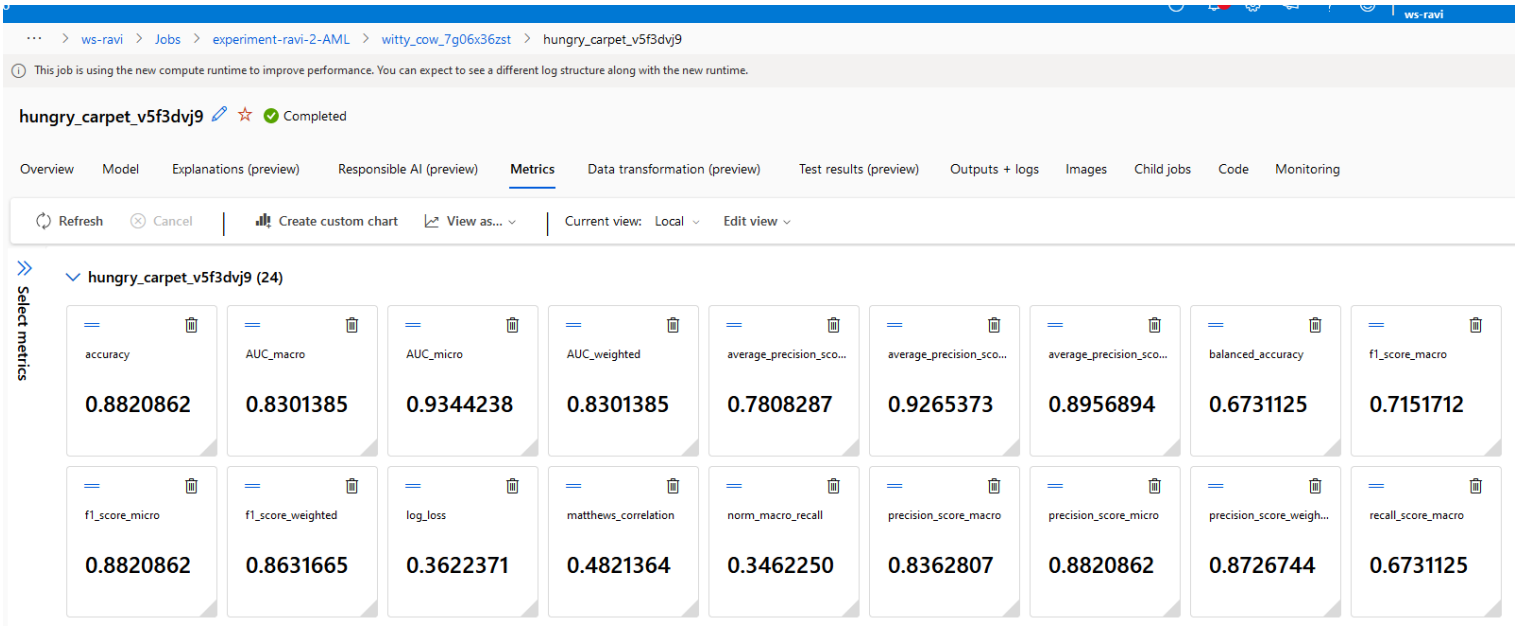


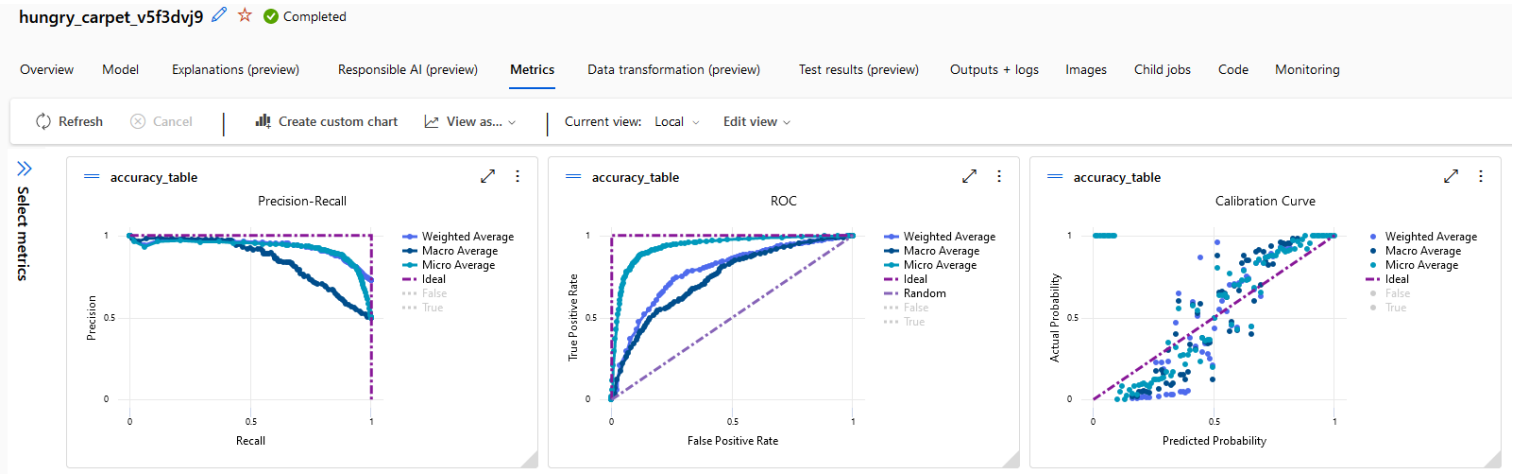
Once all the possible executions (as per the above settings) are complete, the best model with highest accuracy score can be seen as below.

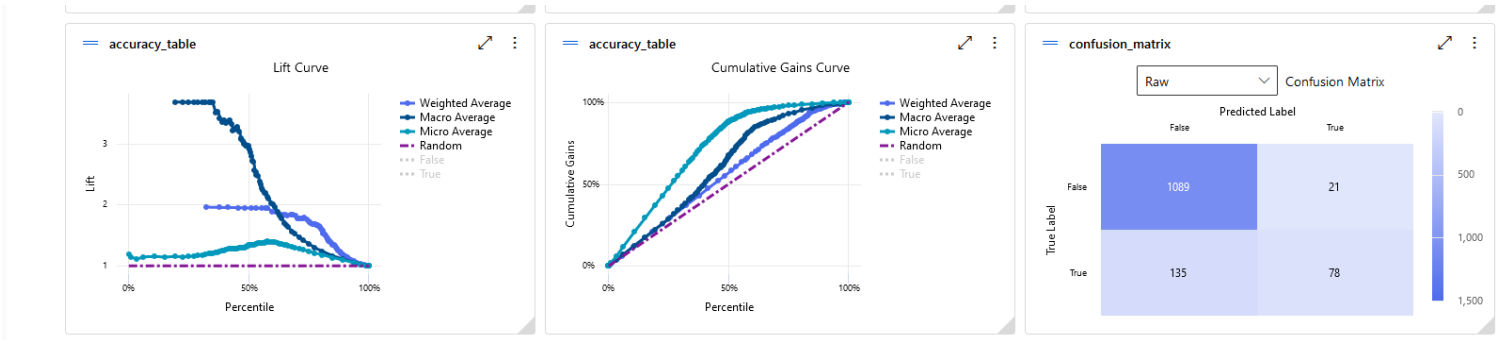
The Automated ML process has selected an algorithm with the highest accuracy score of 88% as the best model.



Observing most wanted explanations of the above best model as a dashboard.


ws-ravi > Jobs > experiment-ravi-2-AML > witty_cow_7g06x36zst > hungry_carpet_v5f3dvj9
This job is using the new compute runtime to improve performance. You can expect to see a different log structure along with the new runtime.
hungry_carpet_v5f3dvj9
Completed
Overview
Model
Explanations (preview)
Responsible AI (preview)
Metrics
Data transformation (preview)
Test results (preview)
Outputs + logs
Images
Child jobs
Code
Monitoring
Refresh
Cancel
Create custom chart
View as...
Current view: Local
Edit view
Select metrics
hungry_carpet_v5f3dvj9 (24)
accuracy 0.8820862
AUC_macro 0.8301385
AUC_micro 0.9344238
AUC_weighted 0.8301385
average_precision_sco... 0.7808287
average_precision_sco... 0.9265373
average_precision_sco... 0.8956894
balanced_accuracy 0.6731125
f1_score_macro 0.7151712
f1_score_micro 0.8820862
f1_score_weighted 0.8631665
log_loss 0.3622371
matthews_correlation 0.4821364
norm_macro_recall 0.3462250
precision_score_macro 0.8362807
precision_score_micro 0.8820862
precision_score_weigh... 0.8726744
recall_score_macro 0.6731125


hungry_carpet_v5f3dvj9
Completed
Overview
Model
Explanations (preview)
Responsible AI (preview)
Metrics
Data transformation (preview)
Test results (preview)
Outputs + logs
Images
Child jobs
Code
Monitoring
Refresh
Cancel
Create custom chart
View as...
Current view: Local
Edit view
Select metrics
accuracy_table
Precision-Recall
Precision
Recall
Weighted Average
Macro Average
Micro Average
Ideal
False
True
accuracy_table
ROC
True Positive Rate
False Positive Rate
Weighted Average
Macro Average
Micro Average
Ideal
Random
False
True
accuracy_table
Calibration Curve
Actual Probability
Predicted Probability
Weighted Average
Macro Average
Micro Average
Ideal
False
True



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