

Data Science

Artificial Intelligence

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:

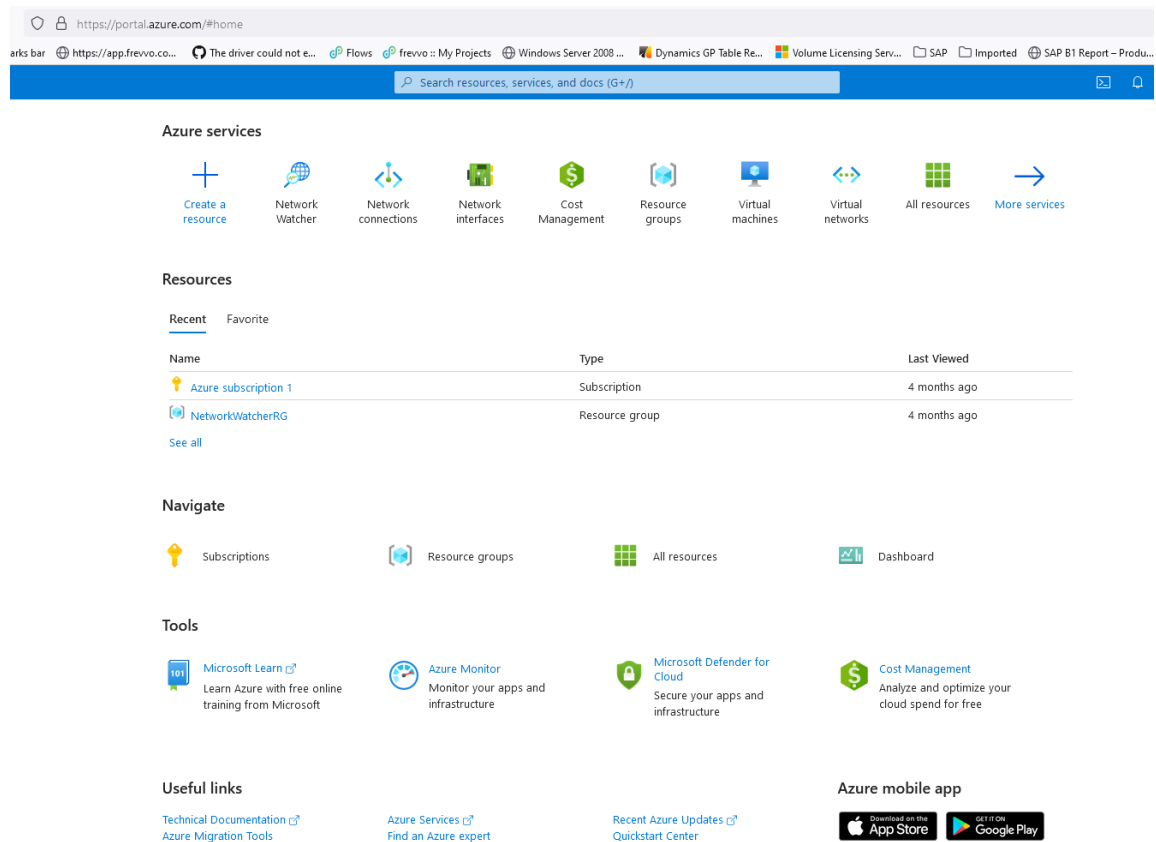
- i.** You may use any of the datasets available on Azure.
- ii.** Depending on the data, you must select the proper training method (Classification, NLP, Open CV).
- iii.** Your model should pass the validation stage without any mistakes.
- iv.** The acceptable accuracy percentage is 85%

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.

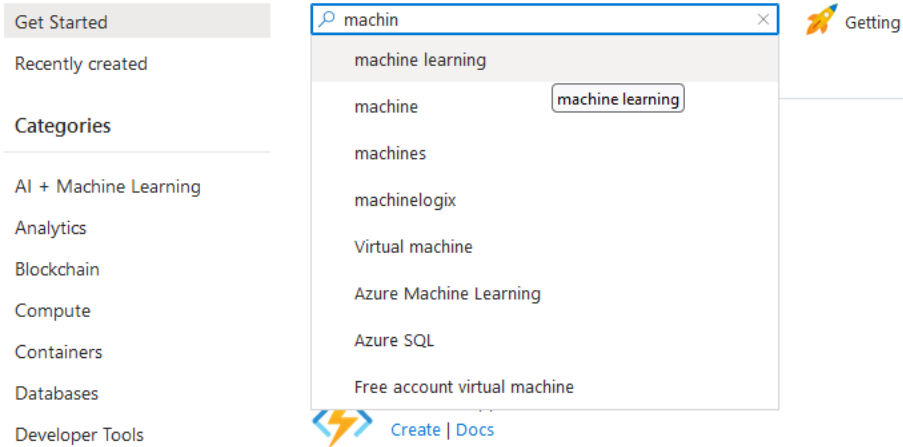
Note: it is mandatory to have a subscription (Azure subscription 1) to continue below steps.



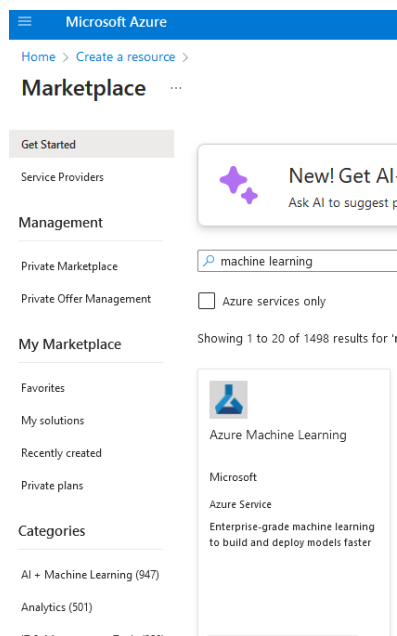
Creating a machine learning resource IN Azure portal.
Selecting machine learning option from the drop down list.

[Home](#) >

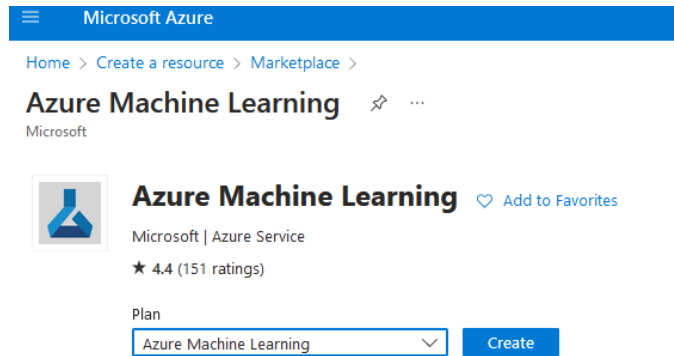
Create a resource ...



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.

[Home](#) > [Create a resource](#) >

Create a virtual machine ...

[Basics](#) [Disks](#) [Networking](#) [Management](#) [Monitoring](#) [Advanced](#) [Tags](#) [Review + create](#)

Create a virtual machine that runs Linux or Windows. Select an image from Azure marketplace or use your own customized image. Complete the Basics tab then Review + create to provision a virtual machine with default parameters or review each tab for full customization. [Learn more](#)

Project details

Select the subscription to manage deployed resources and costs. Use resource groups like folders to organize and manage all your resources.

Subscription * ⓘ

Resource group * ⓘ

[Create new](#)

Instance details

Virtual machine name * ⓘ

Region * ⓘ

Availability options ⓘ

Availability zone * ⓘ

A resource group is a container that holds related resources for an Azure solution.

Name *

You can now select multiple zones. Selecting multiple zones will create one VM

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

Azure Machine Learning

Create a machine learning workspace

[Basics](#)[Networking](#)[Encryption](#)[Identity](#)[Tags](#)[Review + create](#)

Resource details

Every workspace must be assigned to an Azure subscription, which is where billing happens. You use resource groups like folders to organize and manage resources, including the workspace you're about to create. [Learn more about Azure resource groups](#)

Subscription *

Azure subscription 1

Resource group *

(New) rg-ml

[Create new](#)

Workspace details

Configure your basic workspace settings like its storage connection, authentication, container, and more. [Learn more](#)

Name *

ws-ravi

Region *

UAE North

Storage account *

(new) wsravi8164403359

[Create new](#)

Key vault *

(new) wsravi1262964524

[Create new](#)

Application insights *

(new) wsravi8904219337

[Create new](#)

Container registry

None

[Create new](#)

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.

Network isolation

Choose the type of network isolation you need for your workspace, from not isolated at all to an entirely separate virtual network managed by Azure Machine Learning. [Learn more about managed network isolation](#)

<input checked="" type="radio"/> Public <ul style="list-style-type: none">Workspace is accessed via public endpointCompute can access public resourcesOutbound data movement is unrestricted	<input type="radio"/> Private with Internet Outbound <ul style="list-style-type: none">Workspace is accessed via private endpointCompute can access private resourcesOutbound data movement is unrestricted	<input type="radio"/> Private with Approved Outbound <ul style="list-style-type: none">Workspace is accessed via private endpointCompute can access allowlisted resources onlyOutbound data movement is restricted to approved targets
--	---	--

Data encryption

Azure Machine Learning service stores metrics and metadata in an Azure Cosmos DB instance where all data is encrypted at rest. By default, the data is encrypted with Microsoft-managed keys. You may choose to bring your own (customer-managed) keys.

Encryption type ⓘ

☒ Microsoft-managed keys


☐ Customer-managed keys

Keeping the default settings for Managed Identity.

Managed identity

A managed identity enables Azure resources to authenticate to cloud services without storing credentials in code. Once enabled, all necessary permissions can be granted via Azure role-based access control. A workspace can be given either a system assigned identity or a user assigned identity.

Identity type ☒ System assigned identity
☐ User assigned identity

 The managed user assigned identity option is only supported if an existing storage account, key vault, and container registry are used.

Storage account access

Azure machine learning allows you to choose between credential-based or identity-based access when connecting to the default storage account. When using identity-based authentication, the Storage Blob Data Contributor role must be granted to the workspace managed identity on the storage account. [Learn more](#)

Storage account access type ☒ Credential-based access
☐ Identity-based access

Data impact

If your workspace contains sensitive data, you can specify a high business impact workspace. This will control the amount of data Microsoft collects for diagnostic purposes and enables additional encryption in Microsoft managed environments.

High business impact workspace ☐

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.

Basics Networking Encryption Identity Tags Review + create

Tags are name/value pairs that enable you to categorize resources and view consolidated billing by applying the same tag to multiple resources and resource groups. [Learn more about tags](#)

Note that if you create tags and then change resource settings on other tabs, your tags will be automatically updated.

Name ⓘ	Value ⓘ
<input type="text"/>	<input type="text"/>

Microsoft Machine Learning Service is created successfully.

✔ Validation passed

Basics Networking Encryption Identity Tags Review + create

Basics

Subscription	Azure subscription 1
Resource group	(New) rg-ml
Region	UAE North
Name	ws-ravi
Storage account	(new) wsravi8164403359
Key vault	(new) wsravi1262964524
Application insights	(new) wsravi8904219337
Container registry	None

Networking

Connectivity method	Enable public access from all networks
Network isolation	Public

Encryption

Encryption type	Microsoft-managed keys
-----------------	------------------------

Identity

Identity type	System assigned
Enable HBI Flag	Disabled

Home >

Microsoft.MachineLearningServices | Overview ⚙️ ...

Deployment

Search << Delete Cancel Redeploy Download Refresh

Overview
Inputs
Outputs
Template

✓ **Your deployment is complete**

Deployment name: Microsoft.MachineLearningServices
Subscription: [Azure subscription 1](#)
Resource group: [rg-ml](#)

Start time: 2/15/2024, 10:49:03 AM
Correlation ID: e48e1d0b-4a5c-4712-a78e-d1c53d17dea7

Deployment details
Next steps

[Go to resource](#)

Give feedback
[Tell us about your experience with deployment](#)

Opening the Azure Machine Learning Studio web portal.

⌵ 1 ⚙️ ? 🗨️ ravitharanga@gmail.com
DEFAULT DIRECTORY

×

JSON View

Studio web URL : <https://ml.azure.com?tid=21f5236b-1cf9-44a7-9408-d0c8f82188ad&wsid=/subscriptions/4b56020f-9be8-401d-af02-0934f9647900/r...>

Container Registry : ...

Key Vault : [wsravi1262964524](#)

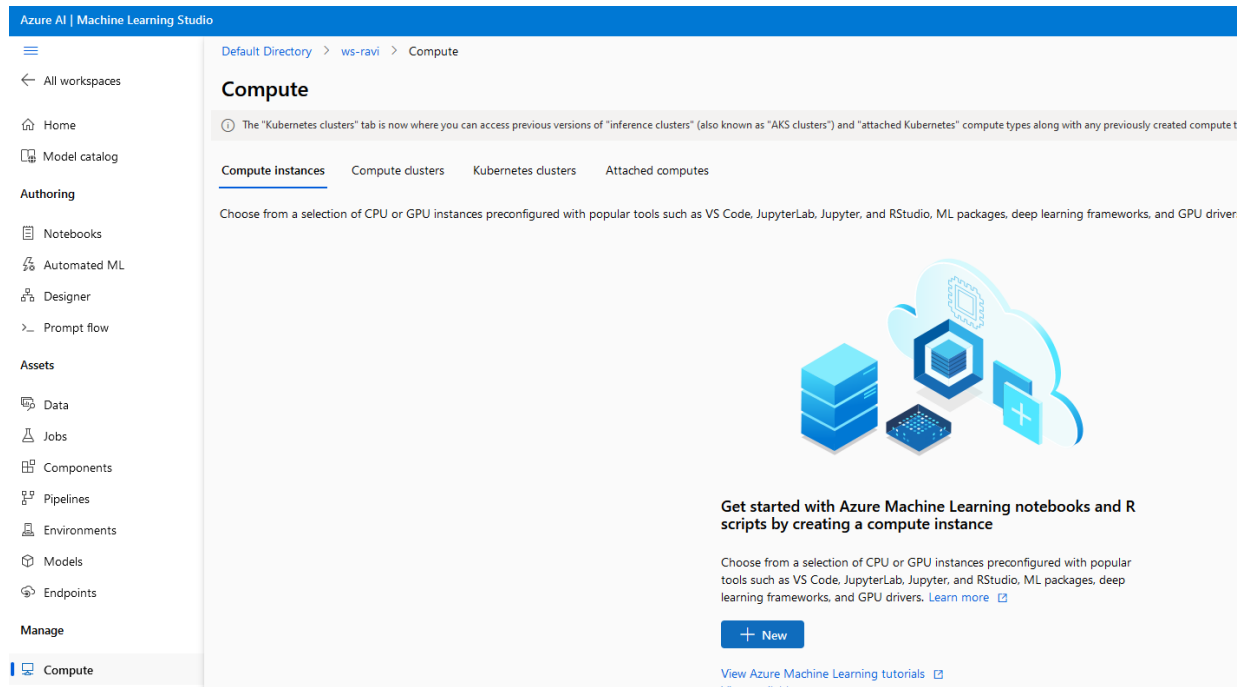
Application Insights : [wsravi8904219337](#)

MLflow tracking URI : [azureml://uaenorth.api.azureml.ms/mlflow/v1.0/subscriptions/4b56020f-9be8-401d-af02-0934f9647900/r...](#)

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.

Create compute instance

1 Required settings

2 Scheduling optional

3 Security optional

4 Applications optional

5 Tags optional

6 Review

Configure required settings

Select the name and virtual machine size you would like to use for your compute instance

Note that a compute instance can not be shared. It can only be used by a single assigned user. By default, it will be assigned to the creator a

Compute name * ⓘ

compute-ravitharanga

Virtual machine type ⓘ

☒ CPU ☐ GPU

Virtual machine size ⓘ

☐ Select from recommended options ☒ Select from all options

+ Add filter

Showing 195 VM sizes | Current selection: Standard_E16s_v3

Name	Category	Available qu... ↓ ⓘ	Cost ⓘ
<input checked="" type="checkbox"/> Standard_E16s_v3 16 cores, 128GB RAM, 256GB storage	Memory optimized	20 cores	\$1.21/hr

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.

Create compute instance

✓ Required settings

2 Scheduling optional

3 Security optional

4 Applications optional

Scheduling

Schedule the compute to start or stop on a recurring basis

Auto shut down

☒ Enable idle shutdown ⓘ

Shutdown after 15 Minutes of inactivity.

Customized schedules ⓘ

+ Add schedule

Keeping the default settings for Security section.

Create compute instance

✓ Required settings

✓ Scheduling
optional

3 Security
optional

4 Applications
optional

5 Tags
optional

6 Review

Security

Configure security settings such as SSH, virtual network, root access, and managed identity for your compute inst

User assignment

☐ Assign to another user ⓘ

Assigned identity

☐ Assign a managed identity ⓘ

SSH

☐ Enable SSH access ⓘ

Virtual network

☐ Enable virtual network ⓘ

Keeping the default settings for Applications section.

Create compute instance

✓ Required settings

✓ Scheduling
optional

✓ Security
optional

4 Applications
optional

Applications

Add custom applications you may want to use on your compute instance.

Setup script

☐ Provision with a creation script

☐ Provision with a startup script

Applications

Add application

Keeping the default settings for Tags section.

Create compute instance

✓ Required settings

✓ Scheduling
optional

Tags

Add additional information to categorize the resources you create.

Name

:

Value

Add

Creating the new compute instance.

Create compute instance

✓ Required settings

✓ Scheduling
optional

✓ Security
optional

✓ Applications
optional

✓ Tags
optional

6 Review

Review

Review or make changes to your job before submission. [Download a template for automation.](#)

Required settings

Review

Compute name
compute-ravitharanga

Virtual machine
Standard_E16s_v3
16 cores, 128GB RAM, 256GB storage

Virtual machine type
CPU

Scheduling

Review

① Auto shutdown enabled by default

Auto shutdown
After 15 minutes of inactivity

Start up and shutdown schedule
--

Security

Review

Enable SSH
no

Enable managed identity
no

Enable virtual network
no

Applications

Review

① Posit (formerly RStudio) is no longer installed by default on compute instances. Instead, add it as a custom application to use it.

Create

Back

Compute instance is started successfully.

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

Name	☆	State	Idle shutdown ⓘ	Applications ⓘ	Size	Created on ↓	Assigned to
compute-ravitharanga		Running	15 minutes	JupyterLab Jupyter VS Code (Web) <small>PREVIEW</small> ...	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

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

Create data asset×

✓ Data type

1 Data source

2 Destination storage type

3 File or folder selection


4 Settings

5 Schema


6 Review

Choose a source for your data asset


Choose the data source you want to create your asset from. A data source can be from a local storage location on your computer, from an attached datastore, from Azure storage, or from a publicly available web location.

 **From Azure storage**


Create a data asset from registered data storage services including Azure Blob Storage, Azure file share, and Azure Data Lake.

 **From local files**


Create a data asset by uploading files from your local drive.

 **From SQL databases**

Create a dataset from Azure SQL database and Azure PostgreSQL database.

 **From web files**

Create a data asset from a single file located at a public web URL.

 **From Azure Open Datasets**

Create a dataset with one-click from pre-made data sets. These data sets are created by the general public and published as Azure Open Datasets

Selecting the default datastore.

Create data asset×

✓ Data type

✓ Data source

1 Destination storage type

2 File or folder selection

3 Settings

4 Schema

5 Review


Select a datastore


Choose a storage type and a datastore to upload your data to in the next step. You can also create a new datastore for your data first.


Datastore type *


Azure Blob Storage


⌵

 Create new datastore

 Search datastore

 Filter

 Columns

Name ↓	Storage name	Created on
<div> workspaceblobstore</div>	wsravi8164403359	Feb 15, 2024 10:50 AM
workspaceartifactstore	wsravi8164403359	Feb 15, 2024 10:50 AM

17 | Page

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

Create data asset

✓ Data type

✓ Data source

✓ Destination storage type

4 File or folder selection

5 Settings

6 Schema

7 Review

Choose a file or folder

Choose files or folders to upload from your local drive. If you upload multiple folders or files, they will be stored in a containing folder.

Upload path

azureml://subscriptions/4b56020f-9be8-401d-af02-0934f9647900/resourcegroups/rg-ml/workspace ...

Upload files or folder

☐ Overwrite if already exists

Upload list

WA_Fn-UseC_-HR-Employee-Attrition.csv	✓ 222.63 KB/222.63 KB	...
---------------------------------------	-----------------------	-----

Previewing source data.

- ✓ Data type
- ✓ Data source
- ✓ Destination storage type
- ✓ File or folder selection
- 4 Settings**
- 5 Schema
- 6 Review

Settings

These settings determine how the data is parsed. The initial settings are automatically detected; you can change them as needed to reparse the data.

File format

Delimiter

Example

Encoding

Delimited

Comma

Field1,Field2,Field3

UTF-8

Column headers

Skip rows

All files have same headers

None

☐ Dataset contains multi-line data ⓘ

ⓘ Note: Processing tabular files with multi-line data is slower because multiple CPU cores cannot be used to ingest the data in parallel. Checking this option may result in slower processing times.

Data preview

Age	Attrition	Busines...	DailyR...	Depart...	Distanc...	Educati...	Educati...	Employ...	Employ...	Environ...	Gender	Hourly...	JobInv...	JobLevel
41	true	Travel_R...	1102	Sales	1	2	Life Scie...	1	1	2	Female	94	3	2
49	false	Travel_Fr...	279	Researc...	8	1	Life Scie...	1	2	3	Male	61	2	2
37	true	Travel_R...	1373	Researc...	2	2	Other	1	4	4	Male	92	2	1
33	false	Travel_Fr...	1392	Researc...	3	4	Life Scie...	1	5	4	Female	56	3	1
27	false	Travel_R...	591	Researc...	2	1	Medical	1	7	1	Male	40	3	1
32	false	Travel_Fr...	1005	Researc...	2	2	Life Scie...	1	8	4	Male	79	3	1
59	false	Travel_R...	1324	Researc...	3	3	Medical	1	10	3	Female	81	4	1
30	false	Travel_R...	1358	Researc...	24	1	Life Scie...	1	11	4	Male	67	3	1
38	false	Travel_Fr...	216	Researc...	23	3	Life Scie...	1	12	4	Male	44	2	3
36	false	Travel_R...	1299	Researc...	27	3	Medical	1	13	3	Male	94	3	2

Back

Next

Review

Cancel

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
- 6 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 ⓘ
<input type="checkbox"/>	Path	String		Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	Age	Integer	41, 49, 37	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	Attrition	Boolean	true, false, true	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	BusinessTravel	String	Travel_Rarely, Travel_Frequently, Travel_...	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	DailyRate	Integer	1102, 279, 1373	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	Department	String	Sales, Research & Development, Resear...	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	DistanceFromHome	Integer	1, 8, 2	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	Education	Integer	2, 1, 2	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	EducationField	String	Life Sciences, Life Sciences, Other	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	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
- 6 Schema**
- Review

<input checked="" type="checkbox"/>	EmployeeNumber	Integer	1, 2, 4	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	EnvironmentSatisfaction	Integer	2, 3, 4	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	Gender	String	Female, Male, Male	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	HourlyRate	Integer	94, 61, 92	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	JobInvolvement	Integer	3, 2, 2	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	JobLevel	Integer	2, 2, 1	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	JobRole	String	Sales Executive, Research Scientist, Lab...	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	JobSatisfaction	Integer	4, 2, 3	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	MaritalStatus	String	Single, Married, Single	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	MonthlyIncome	Integer	5993, 5130, 2090	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	MonthlyRate	Integer	19479, 24907, 2396	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	NumCompaniesWorked	Integer	8, 1, 6	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	Over18	Boolean	true, true, true	Not applicable to selected type	Not applicable to ...

✔ Data type

✔ Data source

✔ Destination storage type

✔ File or folder selection

✔ Settings

6 Schema

7 Review

<input checked="" type="checkbox"/>	OverTime	Boolean	true, false, true	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	PercentSalaryHike	Integer	11, 23, 15	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	PerformanceRating	Integer	3, 4, 3	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	RelationshipSatisfaction	Integer	1, 4, 2	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	StandardHours	Integer	80, 80, 80	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	StockOptionLevel	Integer	0, 1, 0	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	TotalWorkingYears	Integer	8, 10, 7	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	TrainingTimesLastYear	Integer	0, 3, 3	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	WorkLifeBalance	Integer	1, 3, 3	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	YearsAtCompany	Integer	6, 10, 0	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	YearsInCurrentRole	Integer	4, 7, 0	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	YearsSinceLastPromotion	Integer	0, 1, 0	Not applicable to selected type	Not applicable to ...
<input checked="" type="checkbox"/>	YearsWithCurrManager	Integer	5, 7, 0	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.

Default Directory > ws-ravi > Data > IBM-HR-Analytics

IBM-HR-Analytics

Version: 1 (latest) ☆

Details

Consume

Explore

Models

Jobs

New version

Refresh

Generate profile

Archive

Attributes

Type ⓘ

Table (mitable)

Dataset type (from Azure ML v1 APIs)

Tabular

Created by

Pemsith Ravi

Profile

[View profile](#)

Job: --

Files in dataset

1

Total size of files in dataset ⓘ

222.6 KiB

Current version

1

Latest version

1

Created time

Feb 15, 2024 6:18 PM

Modified time

Feb 15, 2024 6:18 PM

Tags

ⓘ No data

Description

IBM HR Analytics Employee Attrition & Performance

Data sources

Dataset

[workspaceblobstore](#)

Relative path

UI/2024-02-15_145332.UTC/WA_Fn-UseC_-HR-E ...

Actions

[View in datastores browse](#)

[View in Azure Portal](#)

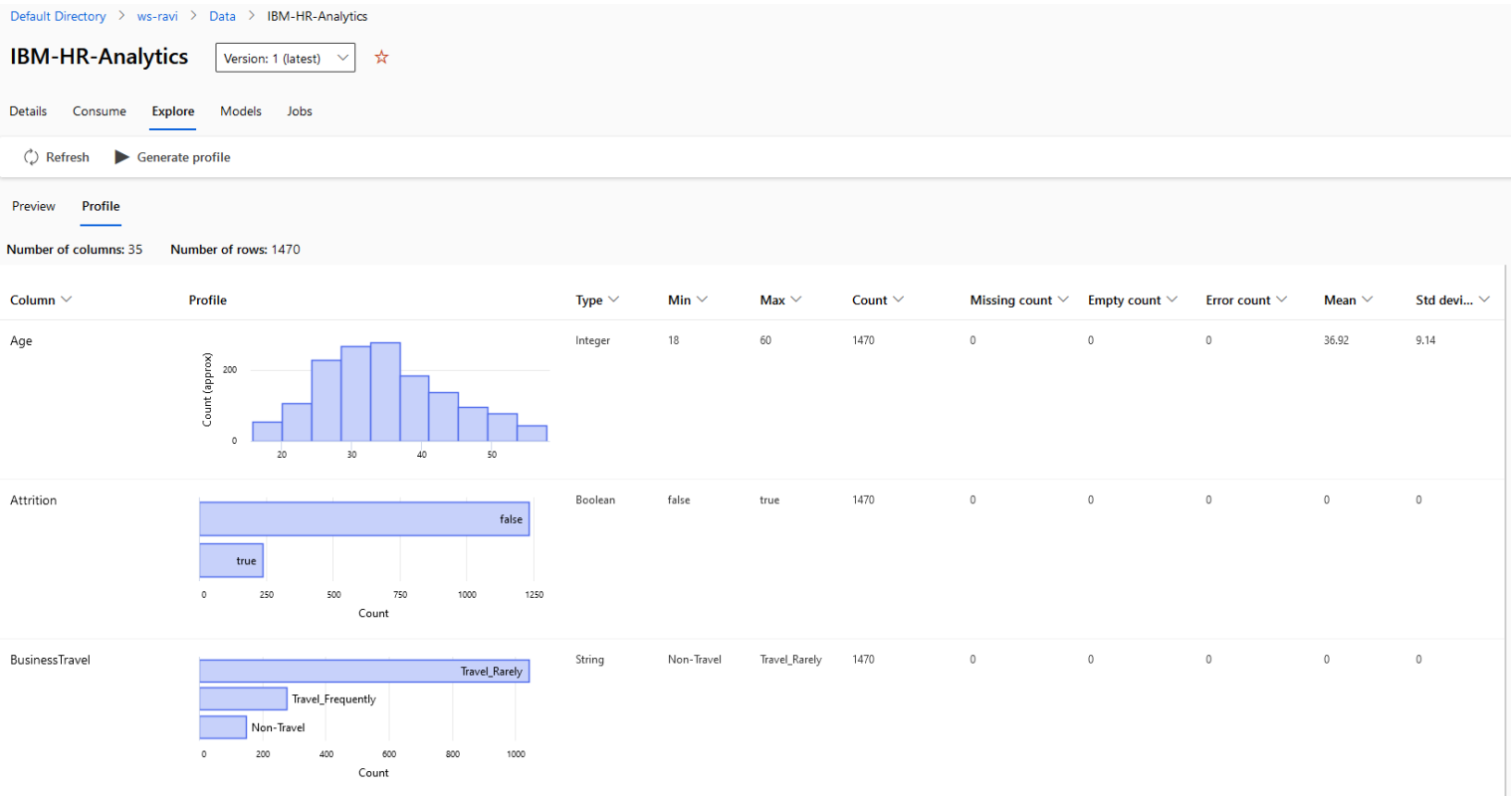
Dataset URI

azureml:/subscriptions/4b56020f-9be8-401d-af02 ...

Storage URI

[https://wsravi8164403359.blob.core.windows.net/az...](#)

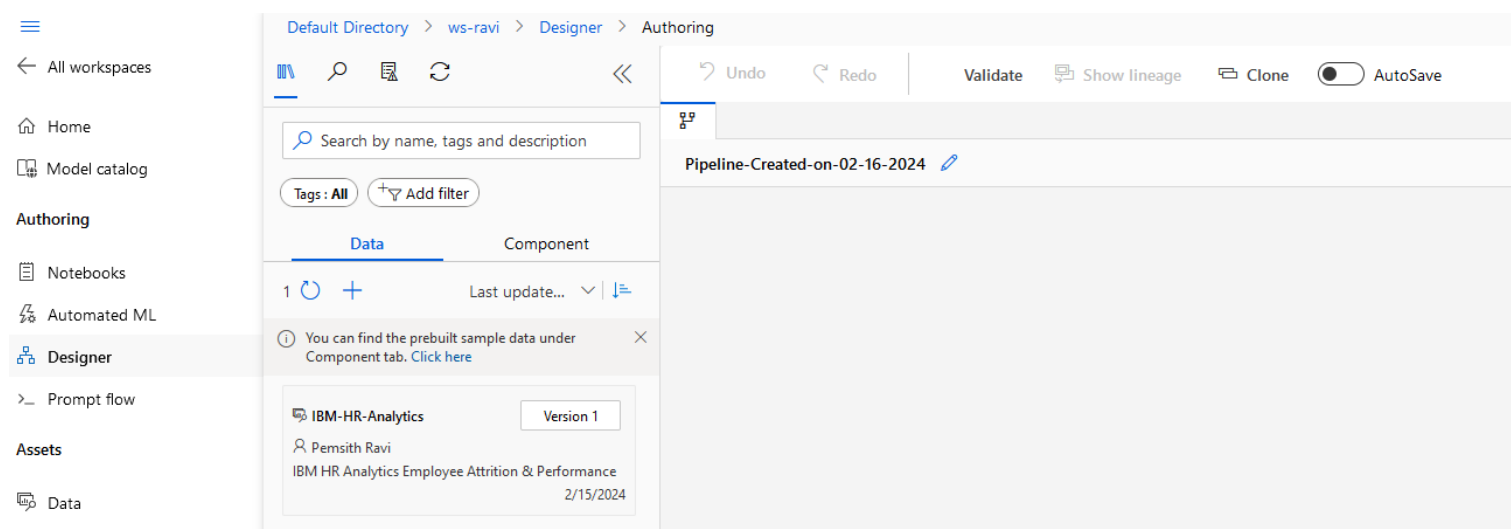
Exploring auto generated data analytics such as Min, Max, Count, Mean, Standard deviation etc.



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.

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

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.

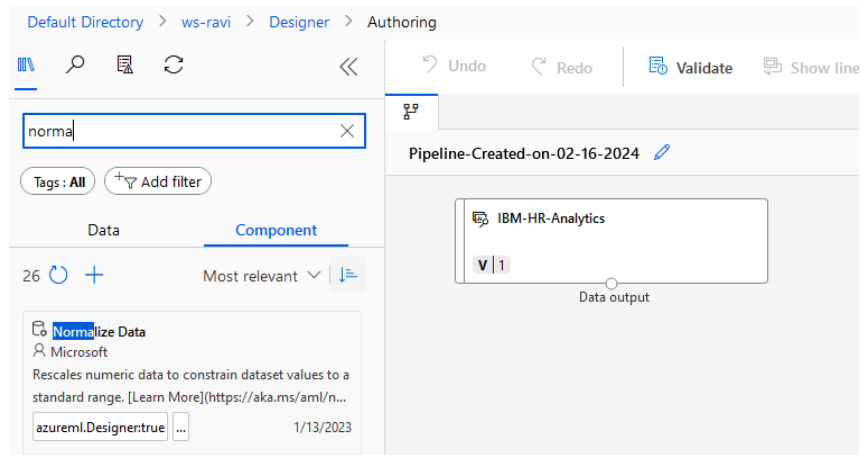
$$z = \frac{x - \text{mean}(x)}{\text{stdev}(x)}$$

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

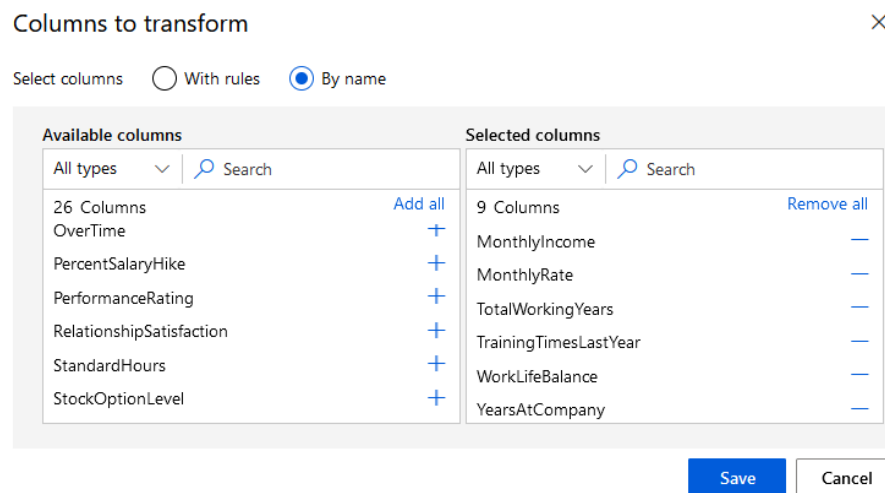
Logistic: The values in the column are transformed using the following formula.

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

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.

Pipeline-Created-on-02-16-2024

Save
Pipeline interface

IBM-HR-Analytics

V | 1

Data output

Dataset

Normalize Data

normalize_data

Transformed d... Transformation...

Parameters

Normalize Data

Transformation method ⓘ *

ZScore

Use 0 for constant columns when checked ⓘ *

True

Columns to transform ⓘ *

[Edit column](#)

Column names:

MonthlyIncome,MonthlyRate,TotalWorkingYears,TrainingTimesLastYear,WorkLifeBalance,YearsAtCompany,YearsInCurrentRole,YearsSinceLastPromotion,YearsWithCurrManager

Split data.

Adding split component.

split

Tags: All
Add filter

Data
Component

3
+
Most relevant

Split Data
Microsoft
Partitions the rows of a dataset into two distinct sets. [Learn More](https://aka.ms/aml/split-data)
azureml.Design:true
1/13/2023

Split Image Directory
Microsoft
Partitions the images of a image directory into two distinct sets. [Learn More](https://aka.ms/aml/split-...)
azureml.Design:true
1/13/2023

Apply SQL Transformation
Microsoft
Runs a SQLite query on input datasets to transform the data. [Learn More](https://aka.ms/aml/apply-sq...)

Pipeline-Created-on-02-16-2024

IBM-HR-Analytics

V | 1

Data output

Dataset

Normalize Data

normalize_data

Transformed d... Transformation...

Dataset

Split Data

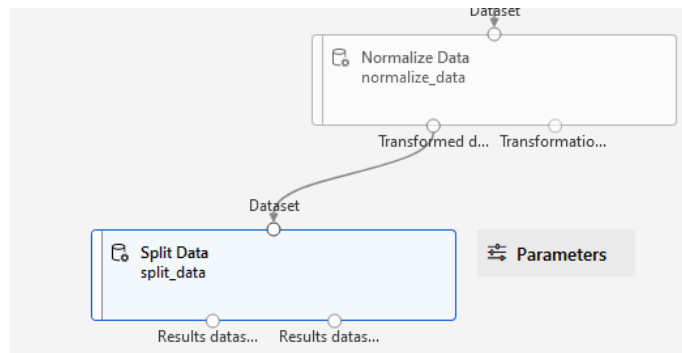
split_data

Results datas... Results datas...

Parameters

Connecting Transformed Data point with the Split Data component.

28 | Page



Settings for Split Data.

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

Random seed set to 100.

Split Data

Splitting mode ⓘ *

Split Rows

Fraction of rows in the first output dataset ⓘ *

0.7

Randomized split ⓘ *

True

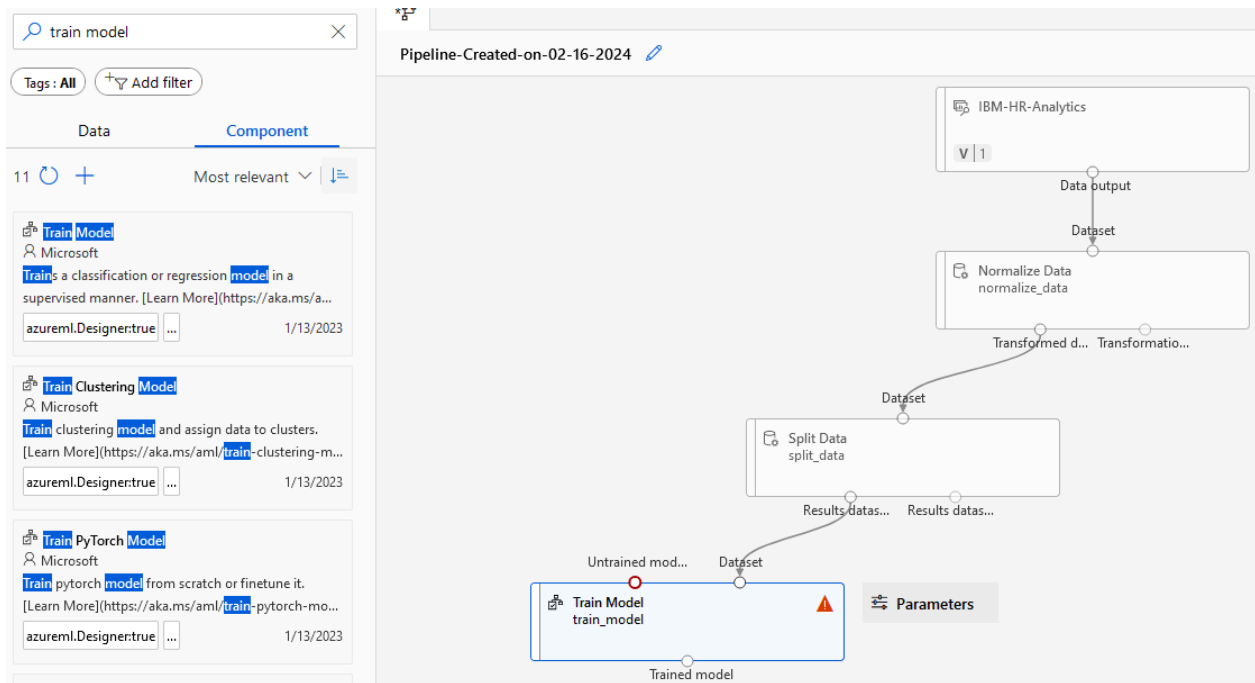
Random seed ⓘ *

100

Stratified split ⓘ *

False

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



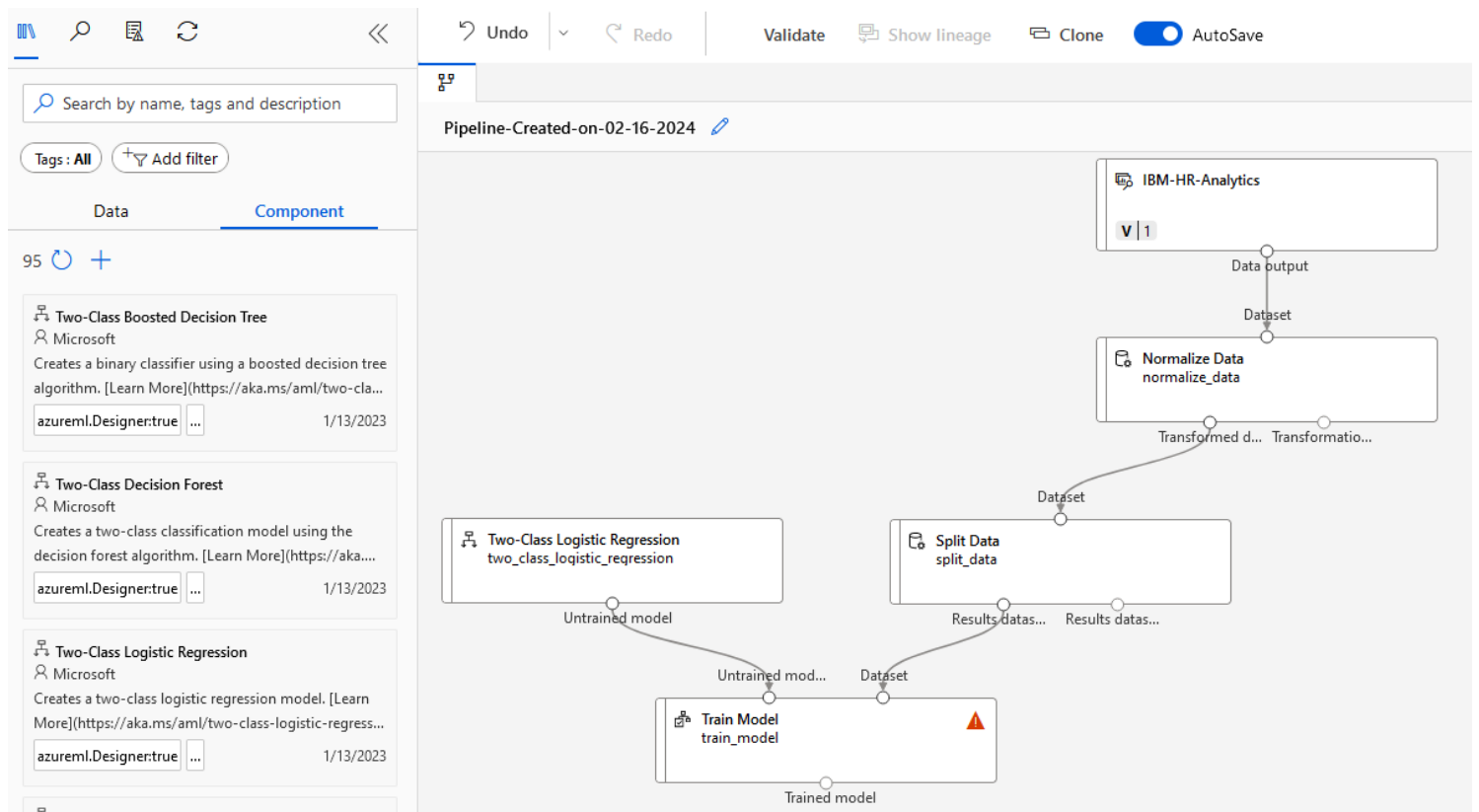
Choosing the algorithm to train the dataset.

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.

Train Model

Label column ⓘ *

[Edit column](#)

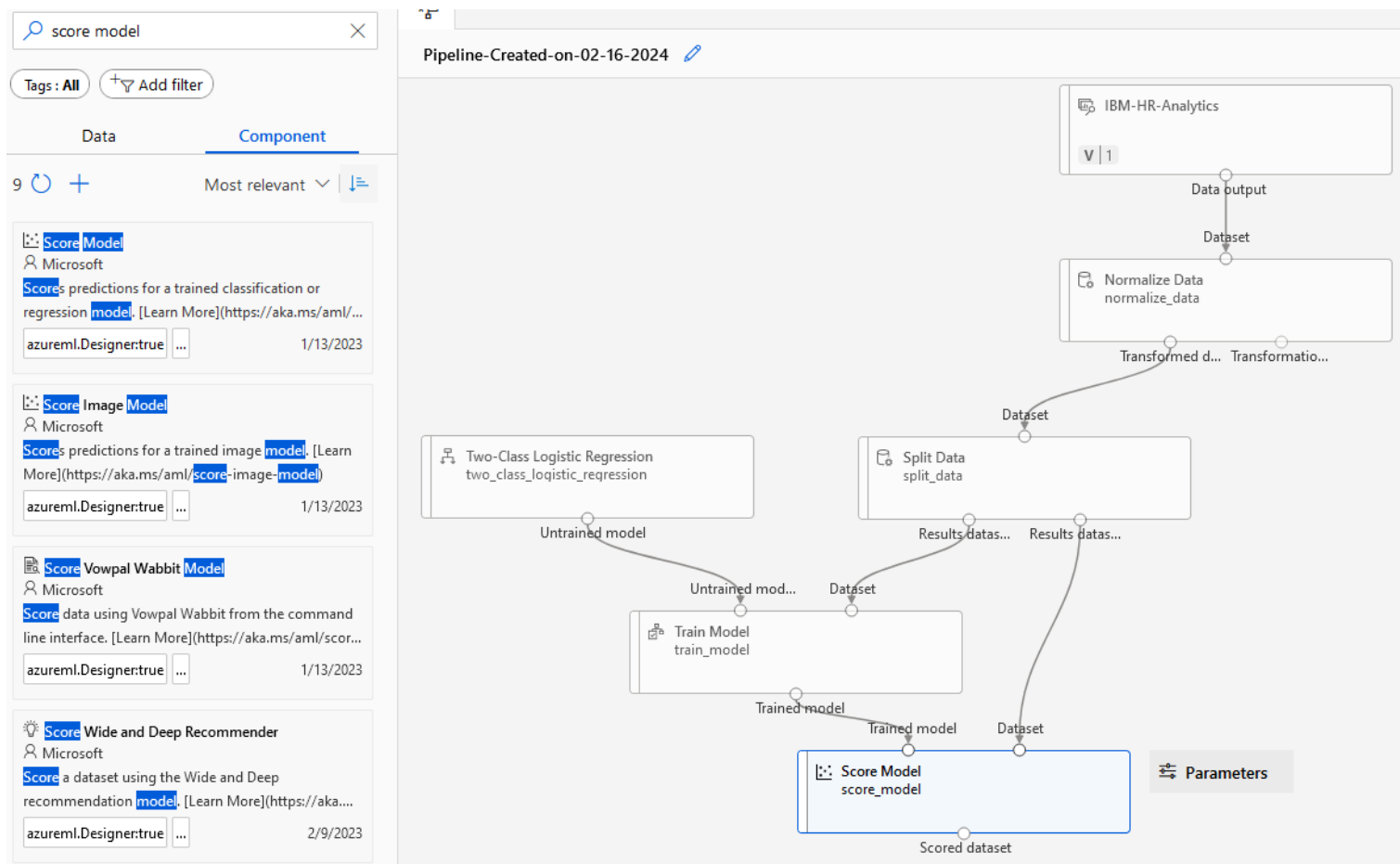
Column names: Attrition

Model explanations ⓘ ...

False

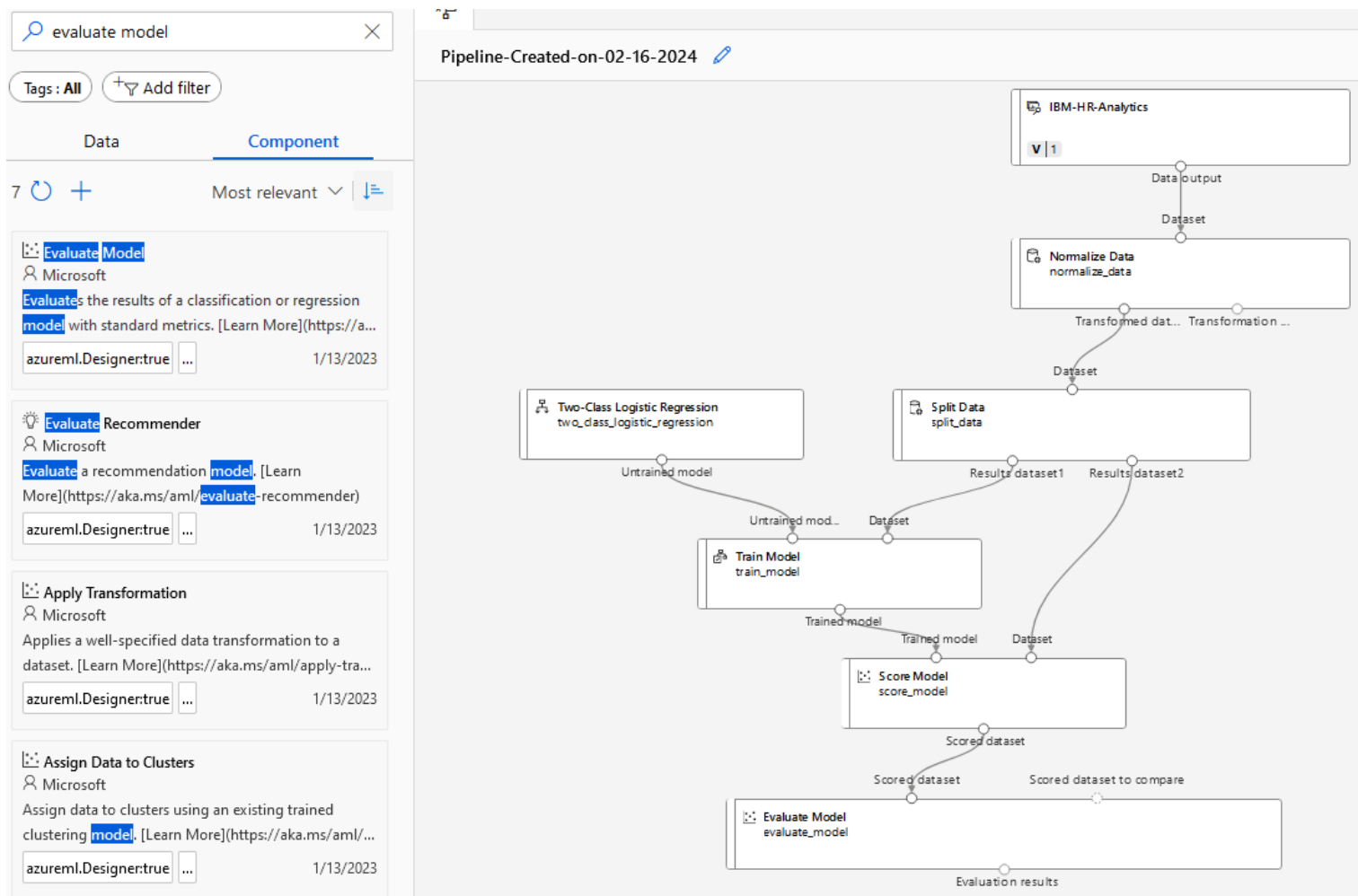
Comparing the result of the train model with the 30% test data that already exists in the source dataset.

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.

Set up pipeline job

1 Basics

2 Inputs & outputs

3 Runtime settings

4 Review + Submit

Basics

Experiment name

Select existing

Create new

New experiment name *

experiment-ravi-1

Job display name

Pipeline-Created-on-02-16-2024

Job description

Pipeline created on 20240216

Job tags

Name

:

Value

Add

Set up pipeline job

✓ Basics

✓ Inputs & outputs

3 Runtime settings

4 Review + Submit

Runtime settings

Default compute ⓘ

Select compute type

Compute instance

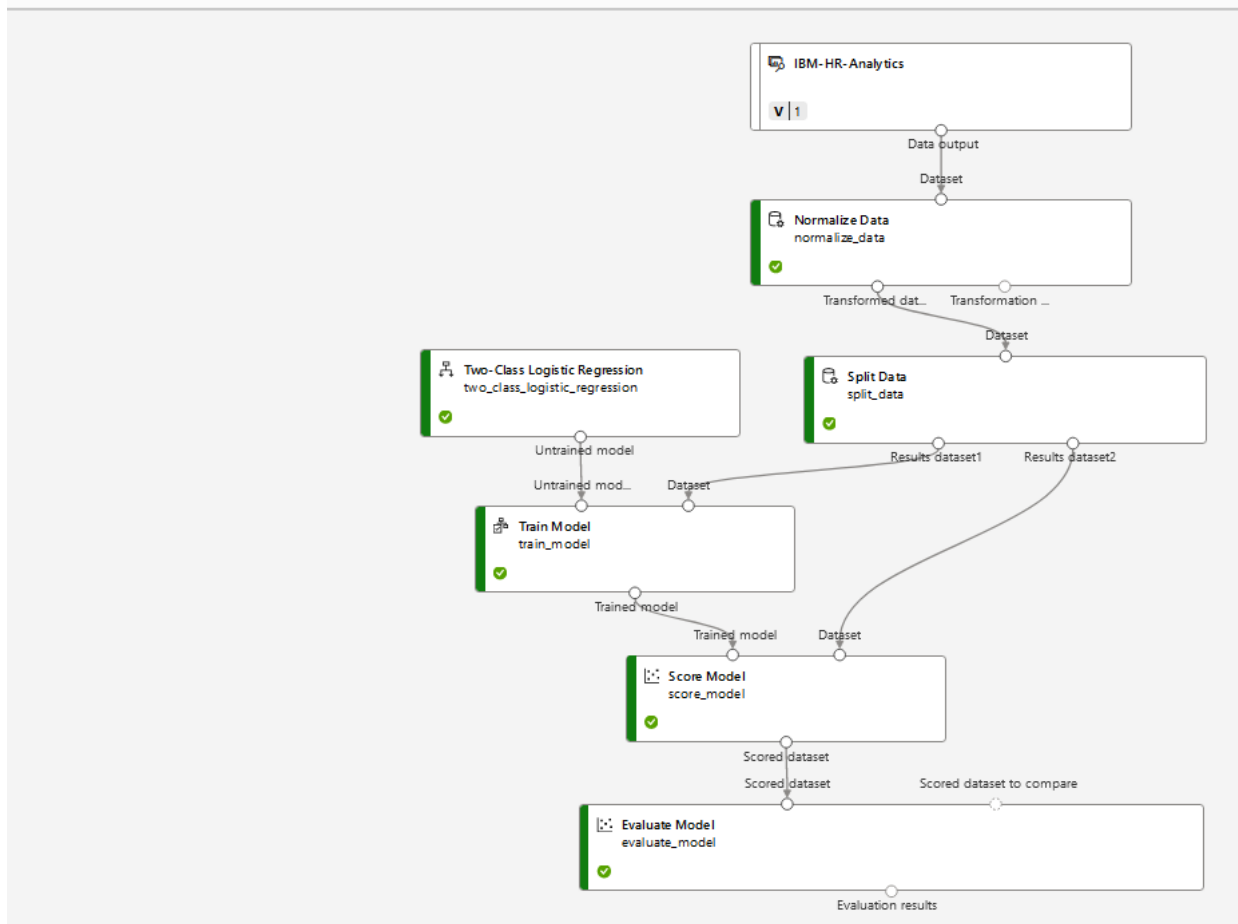
Select Azure ML compute instance

compute-ravitharanga - Running

Create Azure ML compute instance Refresh Compute

Running the new experiment and viewing final statistics.

34 | Page



Overview of the new experiment / model.

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

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:

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

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.

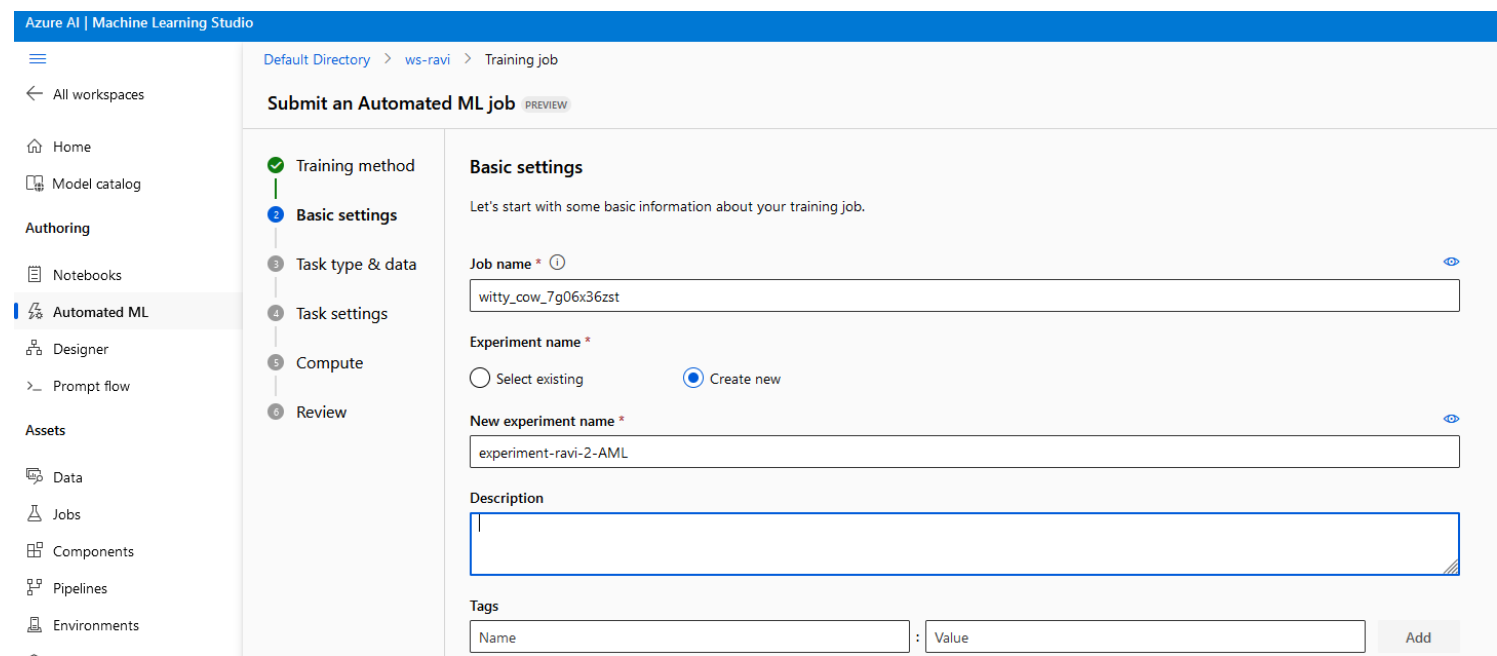
The F1 score is 0.53, as indicated by the pipeline assignment summary above. This may be explained by the fact that the recall is closer to 0.0 and the precision is closer to 1.0, so the F1 score has a simple average of 0.5.

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.

Azure AI | Machine Learning Studio

All workspaces

Home

Model catalog

Authoring

Notebooks

Automated ML

Designer

Prompt flow

Assets

Data

Jobs

Components

Pipelines

Environments

Models

Default Directory > ws-ravi > Training job

Submit an Automated ML job PREVIEW

Training method

Basic settings

Task type & data

Task settings

Compute

Review

Task type & data

Choose the type of task that you would like your model to perform and the data to use for training. [Learn more](#)

Select task type * ⓘ

Select task type

Classification

To predict one of several categories yes/no, blue, red, green.

Regression

To predict continuous numeric values.

Time series forecasting

To predict values based on time.

Natural language processing

To predict based on text-only data types using multi-class or multi-label classification or named entity recognition.

Computer vision

To predict using multi-class or multi-label image classification, object detection, and instance segmentation.

Created on ↓

Feb 15, 2024 6:18 PM

<<

<

Page

1

Azure AI | Machine Learning Studio

All workspaces

Home

Model catalog

Authoring

Notebooks

Automated ML

Designer

Prompt flow

Assets

Data

Jobs

Components

Pipelines

Default Directory > ws-ravi > Training job

Submit an Automated ML job PREVIEW

Training method

Basic settings

Task type & data

Task settings

Compute

Review

Task type & data

Choose the type of task that you would like your model to perform and the data to

Select task type * ⓘ

Classification

Select data

Make sure your data is preprocessed into a supported format.

+ Create

Refresh

Show supported data assets only

Search

Name

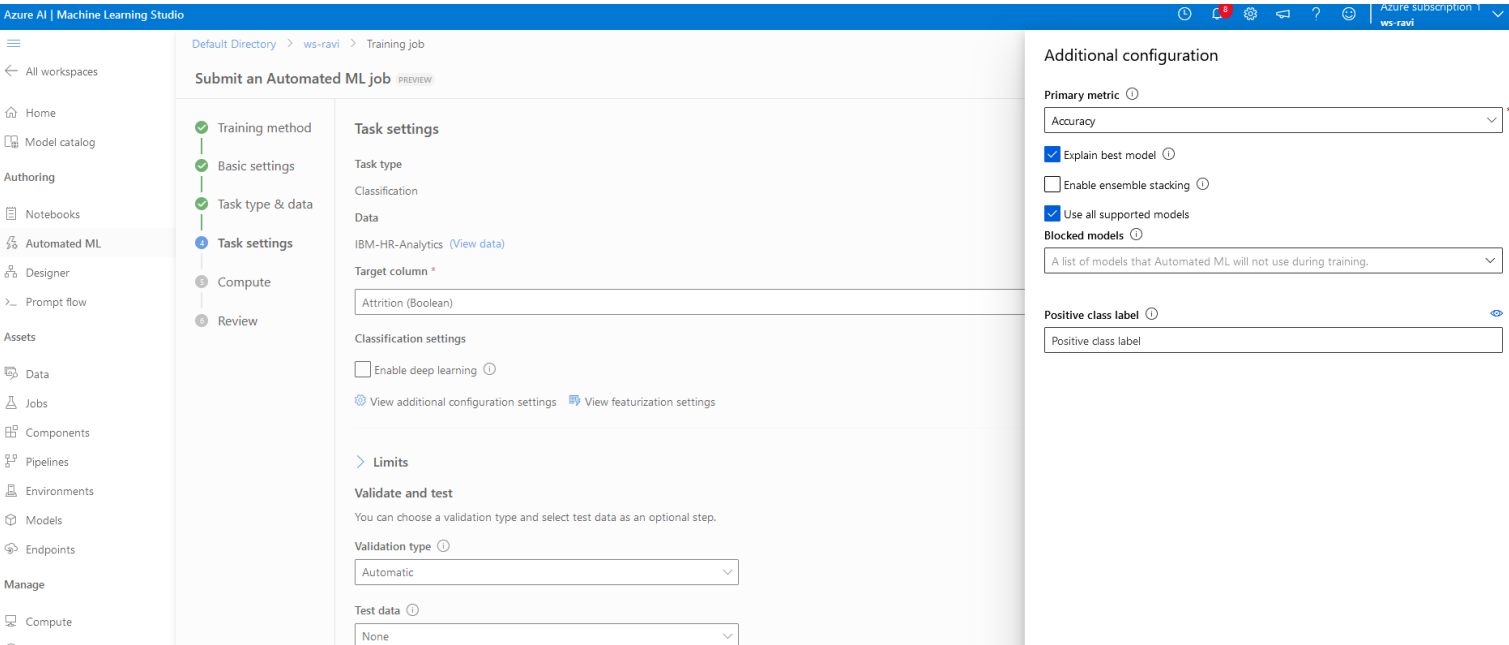
Type

IBM-HR-Analytics

Table

Set the primary metric as Accuracy.

40 | Page



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

Azure AI | Machine Learning Studio

Default Directory > ws-ravi > Training job

Submit an Automated ML job PREVIEW

- Training method
- Basic settings
- Task type & data
- Task settings**
- Compute
- Review

Limits

Max trials ⓘ

Max concurrent trials ⓘ

Max nodes ⓘ

Metric score threshold ⓘ

Experiment timeout (minutes) ⓘ

Iteration timeout (minutes) ⓘ

☒ **Enable early termination** ⓘ

Validate and test

You can choose a validation type and select test data as an optional step.

Validation type ⓘ

Test data ⓘ

Selecting the compute type and compute instance.

Azure AI | Machine Learning Studio

Default Directory > ws-ravi > Training job

Submit an Automated ML job PREVIEW

- Training method
- Basic settings
- Task type & data
- Task settings
- Compute**
- Review

Compute

Select and configure the compute resource for executing your training job.

Select compute type

Select Azure ML compute instance *

[+ New](#)

Reviewing settings and submitting.

Azure AI | Machine Learning Studio

Default Directory > ws-ravi > Training job

Submit an Automated ML job PREVIEW

Training method

Basic settings

Task type & data

Task settings

Compute

Review

Review

Review or make changes to your job before submission.

Basic settings

Name
witty_cow_7g06x36zst

Experiment name
experiment-ravi-2-AML

Description
--

Timeout (hours)
--

Tags
--

Task type & data

Task type
Classification

Data
IBM-HR-Analytics

Task settings

Target column
Attrition

Limits
Max trials: 20
Max concurrent trials: 20
Max nodes: --
Metric score threshold: --
Experiment timeout (minutes): --
Iteration timeout (minutes): --

Enable deep learning
No

Validate type
Automatic

Test data
Train-test split

Percentage test of data
10

Compute settings

Compute type
Azure ML compute instance

Selected Azure ML compute instance
compute-ravitharanga

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




Azure AI Machine Learning Studio									
Default Directory > ws-ravi > Jobs > experiment-ravi-2-AML > witty_cow_7g06x36zst									
witty_cow_7g06x36zst Running									
Overview Data guardrails Models + child jobs Outputs + logs Child jobs									
Refresh Edit and submit (preview) Register model Cancel Delete									
Display name	Status	Created on	☆	Durati...	Created by	Compute target	Job type	Tags	
sad_wolf_lv700q6s	Completed	Feb 16, 2024 4:34 PM		1m 41s	Pemsith Ravi	compute-ravithara...	Command	mlflow.source.name : setup_witty_cow_7g06x36zst.py mlflow.source.type : JOB	
bold_malanga_w3zhmpmh	Completed	Feb 16, 2024 4:36 PM		44s	Pemsith Ravi	compute-ravithara...	automl.fe...		
brave_kitchen_w7lh6k0m	Running	Feb 16, 2024 4:37 PM		2m 5s	Pemsith Ravi	compute-ravithara...			
khaki_whistle_bxnc0ztd	Running	Feb 16, 2024 4:37 PM		2m 18s	Pemsith Ravi	compute-ravithara...	Command	mlflow.source.name : batch_training_0.py mlflow.source.type : JOB	
ivory_king_30rdqz1m	Running	Feb 16, 2024 4:37 PM		2m 5s	Pemsith Ravi	compute-ravithara...			
cool_reggae_r9xt2vr	Running	Feb 16, 2024 4:37 PM		2m 17s	Pemsith Ravi	compute-ravithara...	Command	mlflow.source.name : batch_training_1.py mlflow.source.type : JOB	
maroon_office_msykl1h4	Completed	Feb 16, 2024 4:37 PM		53s	Pemsith Ravi	compute-ravithara...			
khaki_collar_x1l55vhd	Finalizing	Feb 16, 2024 4:37 PM		2m 17s	Pemsith Ravi	compute-ravithara...	Command	mlflow.source.name : batch_training_2.py mlflow.source.type : JOB	
quirky_queen_z3jwv3j	Completed	Feb 16, 2024 4:37 PM		1m 29s	Pemsith Ravi	compute-ravithara...			
icy_house_t6pkj2gm	Finalizing	Feb 16, 2024 4:37 PM		2m 17s	Pemsith Ravi	compute-ravithara...	Command	mlflow.source.name : batch_training_3.py mlflow.source.type : JOB	
dreamy_parcel_0gcqf1y	Running	Feb 16, 2024 4:37 PM		1m 41s	Pemsith Ravi	compute-ravithara...			
zen_vinegar_9j7l22wl	Running	Feb 16, 2024 4:37 PM		2m 15s	Pemsith Ravi	compute-ravithara...	Command	mlflow.source.name : batch_training_4.py mlflow.source.type : JOB	
honest_jelly_ckg7tlg2	Running	Feb 16, 2024 4:37 PM		1m 46s	Pemsith Ravi	compute-ravithara...			
maroon_island_sn3l3zp3	Running	Feb 16, 2024 4:37 PM		2m 15s	Pemsith Ravi	compute-ravithara...	Command	mlflow.source.name : batch_training_5.py mlflow.source.type : JOB	

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.

io

Default Directory > ws-ravi > Jobs > experiment-ravi-2-AML > witty_cow_7g06x36zst

witty_cow_7g06x36zst    Completed


Overview


Data guardrails


Models + child jobs


Outputs + logs


Child jobs


 Refresh


 Deploy ▾

 Download

 Explain model

 View generated code

 View options ▾

 Search

Algorithm name	Explained	Responsible AI	Accuracy ↓	Sampling	Created on	Duration	Hyperparameter
VotingEnsemble	View explanation		0.88209	100.00 %	Feb 16, 2024 4:44 PM	47s	<div>algorithm : [L</div>
StandardScalerWrapper, LogisticRegression			0.87150	100.00 %	Feb 16, 2024 4:37 PM	42s	<div>C : 51.794746</div>
MaxAbsScaler, XGBoostClassifier			0.86772	100.00 %	Feb 16, 2024 4:37 PM	7m 3s	<div>tree_method :</div>
MaxAbsScaler, LightGBM			0.86621	100.00 %	Feb 16, 2024 4:37 PM	5m 49s	<div>min_data_in_k</div>
StandardScalerWrapper, XGBoostClassifier			0.86168	100.00 %	Feb 16, 2024 4:37 PM	1m 42s	<div>booster : gbtr</div>
StandardScalerWrapper, XGBoostClassifier			0.86092	100.00 %	Feb 16, 2024 4:37 PM	1m 18s	<div>booster : gbtr</div>
StandardScalerWrapper, XGBoostClassifier			0.86017	100.00 %	Feb 16, 2024 4:37 PM	2m 2s	<div>booster : gbtr</div>
MaxAbsScaler, LightGBM			0.85865	100.00 %	Feb 16, 2024 4:37 PM	3m 21s	<div>boosting_type</div>
SparseNormalizer, LightGBM			0.85488	100.00 %	Feb 16, 2024 4:37 PM	2m 29s	<div>boosting_type</div>
SparseNormalizer, XGBoostClassifier			0.85261	100.00 %	Feb 16, 2024 4:37 PM	1m 29s	<div>booster : gbtr</div>
StandardScalerWrapper, XGBoostClassifier			0.85110	100.00 %	Feb 16, 2024 4:37 PM	2m 26s	<div>booster : gbtr</div>

⏪ <

Page 1 of 1

> ⏩

25/Page ▾

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

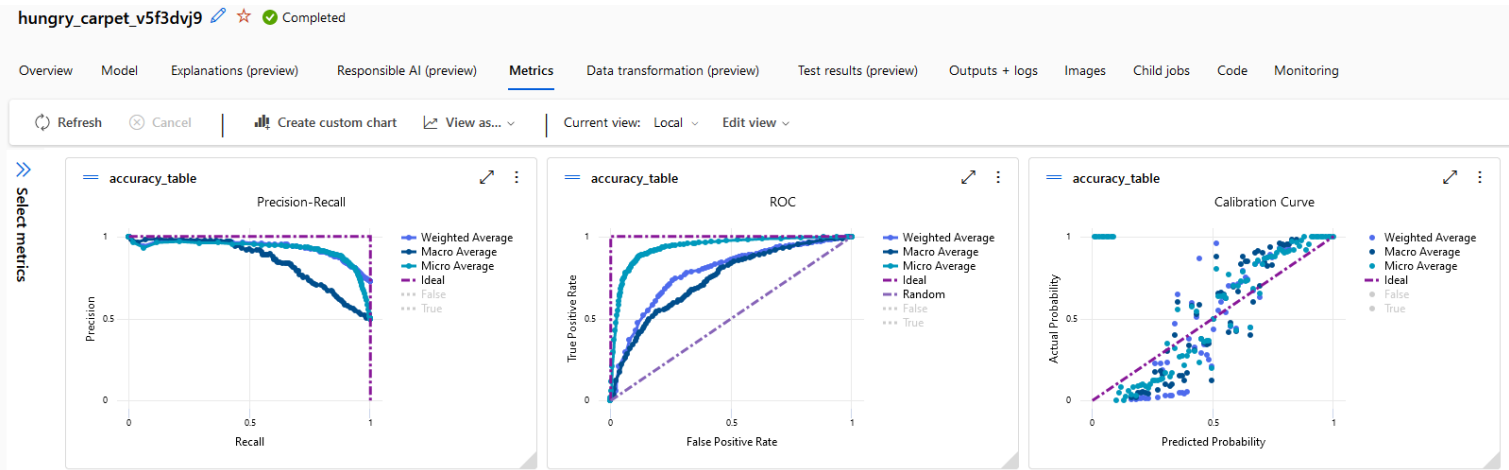
Completed

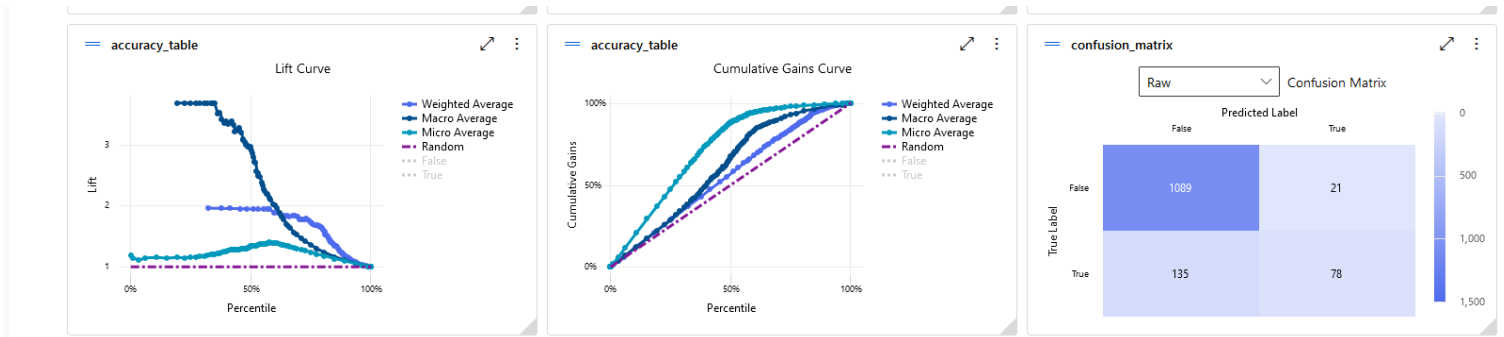
OverviewModelExplanations (preview)Responsible AI (preview)MetricsData transformation (preview)Test results (preview)Outputs + logsImagesChild jobsCodeMonitoring

RefreshCancelCreate custom chartView as...Current view: LocalEdit view

Select metrics

accuracy	AUC_macro	AUC_micro	AUC_weighted	average_precision_sco...	average_precision_sco...	average_precision_sco...	balanced_accuracy	f1_score_macro
0.8820862	0.8301385	0.9344238	0.8301385	0.7808287	0.9265373	0.8956894	0.6731125	0.7151712
f1_score_micro	f1_score_weighted	log_loss	matthews_correlation	norm_macro_recall	precision_score_macro	precision_score_micro	precision_score_weigh...	recall_score_macro
0.8820862	0.8631665	0.3622371	0.4821364	0.3462250	0.8362807	0.8820862	0.8726744	0.6731125





References

- 5 Basic Components of A Blockchain Networ. (n.d.). Retrieved from vietnamblockchain.asia: <https://vietnamblockchain.asia/post/5666316/5-basic-components-of-blockchain>
- Afshine Amidi and Shervine Amidi. (n.d.). *Recurrent Neural Networks cheatsheet* . Retrieved from stanford.edu: <https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-recurrent-neural-networks>
- Agit Çelik. (2018). *Revenue Prediction using Random Forest Regressor*. Retrieved from www.kaggle.com: <https://www.kaggle.com/code/celikagit/revenue-prediction-using-random-forest-regressor>
- Akansha Khandelwal. (2024, Feb 22). *Azure Machine Learning: A Step-by-Step Guide*. Retrieved from www.analyticsvidhya.com: <https://www.analyticsvidhya.com/blog/2021/09/a-comprehensive-guide-on-using-azure-machine-learning/>
- Ali, T. (n.d.). *Comparative Analysis of Blockchain Architecture and Its Application*. IEEEAccess.
- Allie Grace Garnett. (n.d.). *How smart contracts work with blockchain: A step-by-step guide*. Retrieved from www.britannica.com: <https://www.britannica.com/money/how-smart-contracts-work>
- amazon. (n.d.). *What is a Neural Network?* Retrieved from aws.amazon.com: <https://aws.amazon.com/what-is/neural-network/>
- amazon. (n.d.). *What is Deep Learning?* Retrieved from aws.amazon.com: <https://aws.amazon.com/what-is/deep-learning/>
- amazon. (n.d.). *What Is RNN?* Retrieved from aws.amazon.com: <https://aws.amazon.com/what-is/recurrent-neural-network/>
- Asaph Azaria; Ariel Ekblaw; Thiago Vieira; Andrew Lippman. (2016, Aug 22). *MedRec: Using Blockchain for Medical Data Access and Permission Management*. Retrieved from ieeexplore.ieee.org: <https://ieeexplore.ieee.org/document/7573685>
- Bioplav Kant . (2022). *How to Detect and Remove Outliers*. Retrieved from www.kaggle.com: <https://www.kaggle.com/code/bioplavkant/how-to-detect-and-remove-outliers>
- Components of Blockchain Network*. (2022, Oct 02). Retrieved from www.geeksforgeeks.org: <https://www.geeksforgeeks.org/components-of-blockchain-network/>
- Ella Creamer. (2023, Jul 05). *Authors file a lawsuit against OpenAI for unlawfully ‘ingesting’ their books*. Retrieved from www.theguardian.com: <https://www.theguardian.com/books/2023/jul/05/authors-file-a-lawsuit-against-openai-for-unlawfully-ingesting-their-books>

- Harnessing the Power of GenAI*. (2024, Jan 18). Retrieved from [www.wsj.com: https://www.wsj.com/video/sponsored/harnessing-the-power-of-genai/4C47317C-0018-4DE2-AE4D-DA6B6B571ADD.html?utm_medium=content_discovery&utm_source=google-search&gad_source=1&gclid=CjwKCAiA2pyuBhBKEiwApLaIOzOxSOQlPCMX6m5Nj27Cq36Ipez5qN_T6s3FFLH4U6EcqynPjO](https://www.wsj.com/video/sponsored/harnessing-the-power-of-genai/4C47317C-0018-4DE2-AE4D-DA6B6B571ADD.html?utm_medium=content_discovery&utm_source=google-search&gad_source=1&gclid=CjwKCAiA2pyuBhBKEiwApLaIOzOxSOQlPCMX6m5Nj27Cq36Ipez5qN_T6s3FFLH4U6EcqynPjO)
- ibm. (n.d.). *IBM Food Trust* . Retrieved from [www.ibm.com: https://www.ibm.com/products/supply-chain-intelligence-suite/food-trust](https://www.ibm.com/products/supply-chain-intelligence-suite/food-trust)
- James Vincent. (2023, Feb 08). *Google's AI chatbot Bard makes factual error in first demo*. Retrieved from [www.theverge.com: https://www.theverge.com/2023/2/8/23590864/google-ai-chatbot-bard-mistake-error-exoplanet-demo](https://www.theverge.com/2023/2/8/23590864/google-ai-chatbot-bard-mistake-error-exoplanet-demo)
- Jessica Groopman. (2019, Oct 30). *AI, blockchain and IoT convergence improves daily applications*. Retrieved from [www.techtarget.com: https://www.techtarget.com/iotagenda/tip/AI-blockchain-and-IoT-convergence-improves-daily-applications](https://www.techtarget.com/iotagenda/tip/AI-blockchain-and-IoT-convergence-improves-daily-applications)
- linkedin. (n.d.). *How can you normalize data in ML models during data cleaning?* Retrieved from [www.linkedin.com: https://www.linkedin.com/advice/0/how-can-you-normalize-data-ml-models-during-cleaning-edo4e](https://www.linkedin.com/advice/0/how-can-you-normalize-data-ml-models-during-cleaning-edo4e)
- Marcel Isler. (2023, Oct 13). *DLT ADVANTAGES AND BENEFITS OF DISTRIBUTED LEDGER TECHNOLOGY*. Retrieved from [imiblockchain.com: https://imiblockchain.com/dlt-advantages-and-benefits/](https://imiblockchain.com/dlt-advantages-and-benefits/)
- Mark Purdy and A. Mark Williams . (2023, Oct 26). *How AI Can Help Leaders Make Better Decisions Under Pressure* . Retrieved from [hbr.org: https://hbr.org/2023/10/how-ai-can-help-leaders-make-better-decisions-under-pressure](https://hbr.org/2023/10/how-ai-can-help-leaders-make-better-decisions-under-pressure)
- Matt G. Southern . (2023, Feb 22). *Microsoft's AI-Powered Bing Search Now On Mobile* . Retrieved from [www.searchenginejournal.com: https://www.searchenginejournal.com/microsofts-ai-powered-bing-search-now-on-mobile/480762/](https://www.searchenginejournal.com/microsofts-ai-powered-bing-search-now-on-mobile/480762/)
- Matthew Urwin. (2023, Mar 08). *Precision and Recall: How to Evaluate Your Classification Model*. Retrieved from [builtin.com: https://builtin.com/data-science/precision-and-recall](https://builtin.com/data-science/precision-and-recall)
- Michael M. Grynbaum and Ryan Mac. (2023, Dec 27). *The Times Sues OpenAI and Microsoft Over A.I. Use of Copyrighted Work*. Retrieved from [www.nytimes.com: https://www.nytimes.com/2023/12/27/business/media/new-york-times-open-ai-microsoft-lawsuit.html](https://www.nytimes.com/2023/12/27/business/media/new-york-times-open-ai-microsoft-lawsuit.html)
- Microsoft. (2017, May 22). *Power BI Convert numbers to month*. Retrieved from [community.fabric.microsoft.com: https://community.fabric.microsoft.com/t5/Desktop/Convert-numbers-to-month/m-p/179838](https://community.fabric.microsoft.com/t5/Desktop/Convert-numbers-to-month/m-p/179838)
- Microsoft. (2021, Nov 10). *Evaluate Model component*. Retrieved from [learn.microsoft.com: https://learn.microsoft.com/en-us/azure/machine-learning/component-reference/evaluate-model?view=azureml-api-2](https://learn.microsoft.com/en-us/azure/machine-learning/component-reference/evaluate-model?view=azureml-api-2)
- Microsoft. (2021, Nov 04). *Normalize Data component*. Retrieved from [learn.microsoft.com: https://learn.microsoft.com/en-us/azure/machine-learning/component-reference/normalize-data?view=azureml-api-2](https://learn.microsoft.com/en-us/azure/machine-learning/component-reference/normalize-data?view=azureml-api-2)
- Microsoft. (2021, Nov 04). *Two-Class Logistic Regression component*. Retrieved from [learn.microsoft.com: https://learn.microsoft.com/en-us/azure/machine-learning/component-reference/two-class-logistic-regression?view=azureml-api-2](https://learn.microsoft.com/en-us/azure/machine-learning/component-reference/two-class-logistic-regression?view=azureml-api-2)
- Microsoft. (2023, Oct 20). *Data Analysis Expressions (DAX) GROUPBY*. Retrieved from [learn.microsoft.com: https://learn.microsoft.com/en-us/dax/groupby-function-dax](https://learn.microsoft.com/en-us/dax/groupby-function-dax)
- Microsoft. (2023, Aug 16). *Manage Azure resource groups by using the Azure portal*. Retrieved from [learn.microsoft.com: https://learn.microsoft.com/en-us/azure/azure-resource-manager/management/manage-resource-groups-portal](https://learn.microsoft.com/en-us/azure/azure-resource-manager/management/manage-resource-groups-portal)

- Microsoft. (2023, Aug 09). *Tutorial: Train a classification model with no-code AutoML in the Azure Machine Learning studio*. Retrieved from learn.microsoft.com: <https://learn.microsoft.com/en-us/azure/machine-learning/tutorial-first-experiment-automated-ml?view=azureml-api-2>
- Microsoft. (2023, Jun 07). *What is automated machine learning (AutoML)?* Retrieved from learn.microsoft.com: <https://learn.microsoft.com/en-us/azure/machine-learning/concept-automated-ml?view=azureml-api-2>
- Microsoft. (2024, Jan 05). *Use tags to organize your Azure resources and management hierarchy*. Retrieved from learn.microsoft.com: https://learn.microsoft.com/en-us/azure/azure-resource-manager/management/tag-resources?wt.mc_id=azuremachinelearning_inproduct_portal_utilities-tags-tab
- Microsoft. (2024, Jan 17). *What is an Azure Machine Learning compute instance?* Retrieved from learn.microsoft.com: <https://learn.microsoft.com/en-us/azure/machine-learning/concept-compute-instance?view=azureml-api-2>
- Microsoft. (2024, Feb 01). *Workspace Managed Virtual Network Isolation*. Retrieved from learn.microsoft.com: https://learn.microsoft.com/en-us/azure/machine-learning/how-to-managed-network?view=azureml-api-2&WT.mc_id=Portal-Microsoft_Azure_MLTeamAccounts&tabs=azure-cli
- Microsoft. (n.d.). *Azure Machine Learning documentation*. Retrieved from learn.microsoft.com: <https://learn.microsoft.com/en-us/azure/machine-learning/?view=azureml-api-2>
- Mohamed Sohail, Waseem Mohammad Fayed, Fidel Kaldas. (2018). *IOT AND BLOCKCHAIN - A WALLET*. Retrieved from education.dell.com: https://education.dell.com/content/dam/dell-emc/documents/en-us/2018KS_Sohail-IoT_and_Blockchain-a_wallet_of_secrets.pdf
- Olivia Barber. (2023, Oct 19). *How artificial intelligence will change decision making*. Retrieved from indatalabs.com: <https://indatalabs.com/blog/artificial-intelligence-decision-making>
- oracle. (n.d.). *What Is Natural Language Processing (NLP)?* Retrieved from www.oracle.com: <https://www.oracle.com/sa/artificial-intelligence/what-is-natural-language-processing/>
- Prateek Majumder. (2023, Sep 25). *Guide to Create Interactive Plots with Plotly Python*. Retrieved from www.analyticsvidhya.com: <https://www.analyticsvidhya.com/blog/2021/10/interactive-plots-in-python-with-plotly-a-complete-guide/>
- Ripple: how it works, and why it is different than other crypto*. (n.d.). Retrieved from www.bots.io: <https://www.bots.io/botspedia/ripple-how-it-works-and-why-it-is-different-than-other-crypto#:~:text=and%20finally%2c%20ripple%20is%20an,also%20a%20form%20of%20dlt.>
- SaiKumar Kalla. (n.d.). *Components of Blockchain*. Retrieved from mindmajix.com: <https://mindmajix.com/components-of-blockchain>
- Smart Contract Challenges*. (n.d.). Retrieved from hedera.com: <https://hedera.com/learning/smart-contracts/smart-contract-challenges>
- Welcome Hyperledger Fabric 2.0: Enterprise DLT for Production*. (2020, Jan 30). Retrieved from www.hyperledger.org: <https://www.hyperledger.org/blog/2020/01/30/welcome-hyperledger-fabric-2-0-enterprise-dlt-for-production>
- What are smart contracts on blockchain?* . (n.d.). Retrieved from www.ibm.com: <https://www.ibm.com/topics/smart-contracts>
- What is IoT?* (n.d.). Retrieved from www.oracle.com: <https://www.oracle.com/sa/internet-of-things/what-is-iot/>
- What is the Internet of Things?* (2022, Aug 17). Retrieved from www.mckinsey.com: <https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-the-internet-of-things>
- xolo. (n.d.). *What is Estonian e-Residency and how to take advantage of it?* Retrieved from www.xolo.io: <https://www.xolo.io/zz-en/e-residency>

Yusuf Mehdi. (2023, Feb 07). *Reinventing search with a new AI-powered Microsoft Bing and Edge, your copilot for the web*. Retrieved from blogs.microsoft.com: <https://blogs.microsoft.com/blog/2023/02/07/reinventing-search-with-a-new-ai-powered-microsoft-bing-and-edge-your-copilot-for-the-web/>