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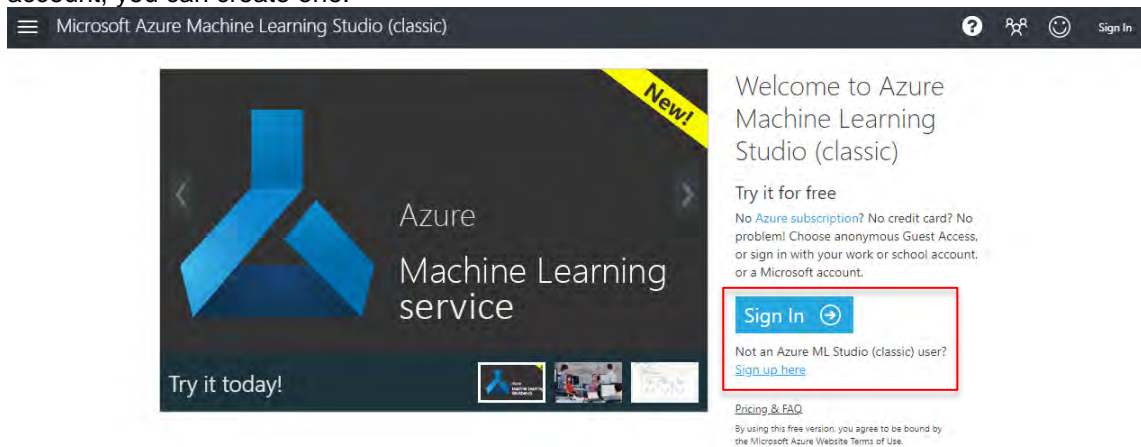
## Activity 1 – First Machine Learning with Azure

### In this activity, we will:

- ☐ Create a new experiment in Azure Machine Learning Studio (Classic)
- ☐ Use various dataset modules
- ☐ Perform data filtering
- ☐ Clean missing data
- ☐ Define features for training
- ☐ Apply a learning algorithm
- ☐ Score a training model
- ☐ Evaluate a training model

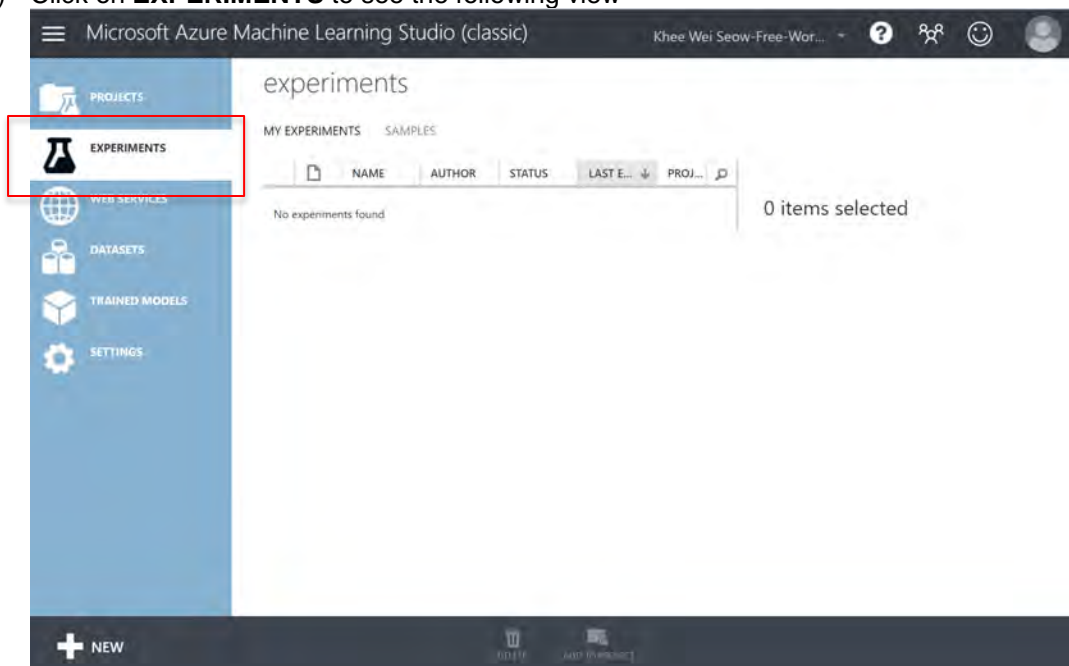
### 1) Setup account on Azure

- 1) Launch your web browser, navigate to <https://studio.azureml.net/> and sign in. If you have not created an account, you can create one.

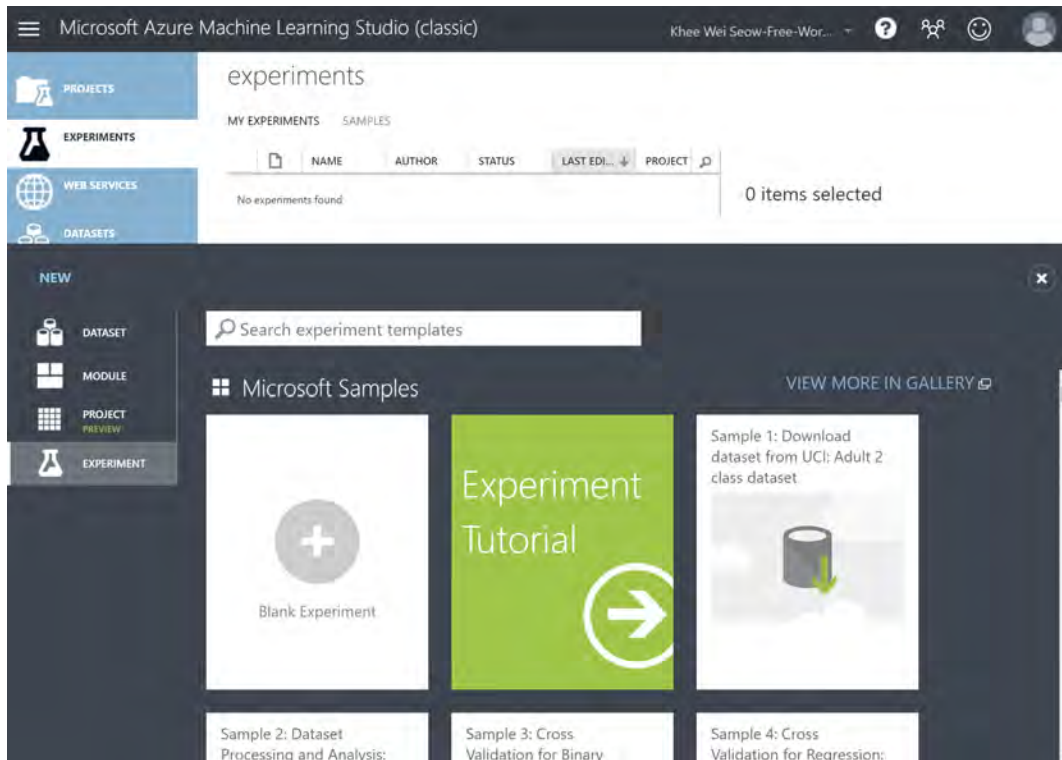


### 2) Create a new Experiment

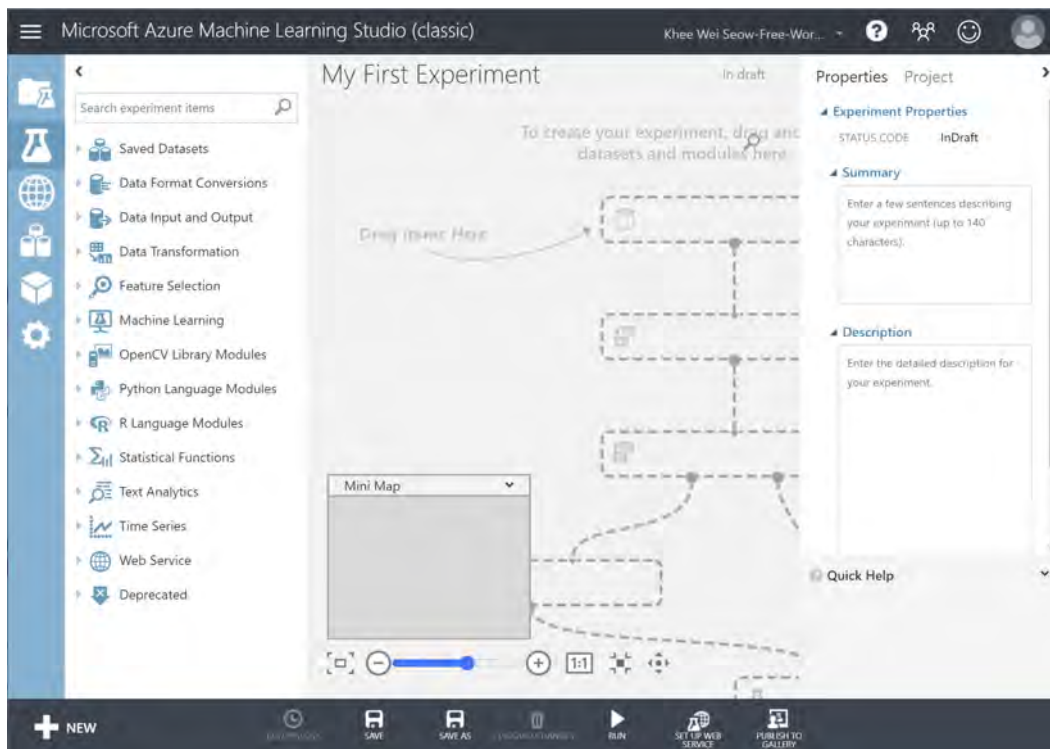
- 1) Click on **EXPERIMENTS** to see the following view



- 2) Click on **+New** at the bottom left of the view and click on **Blank Experiment**.

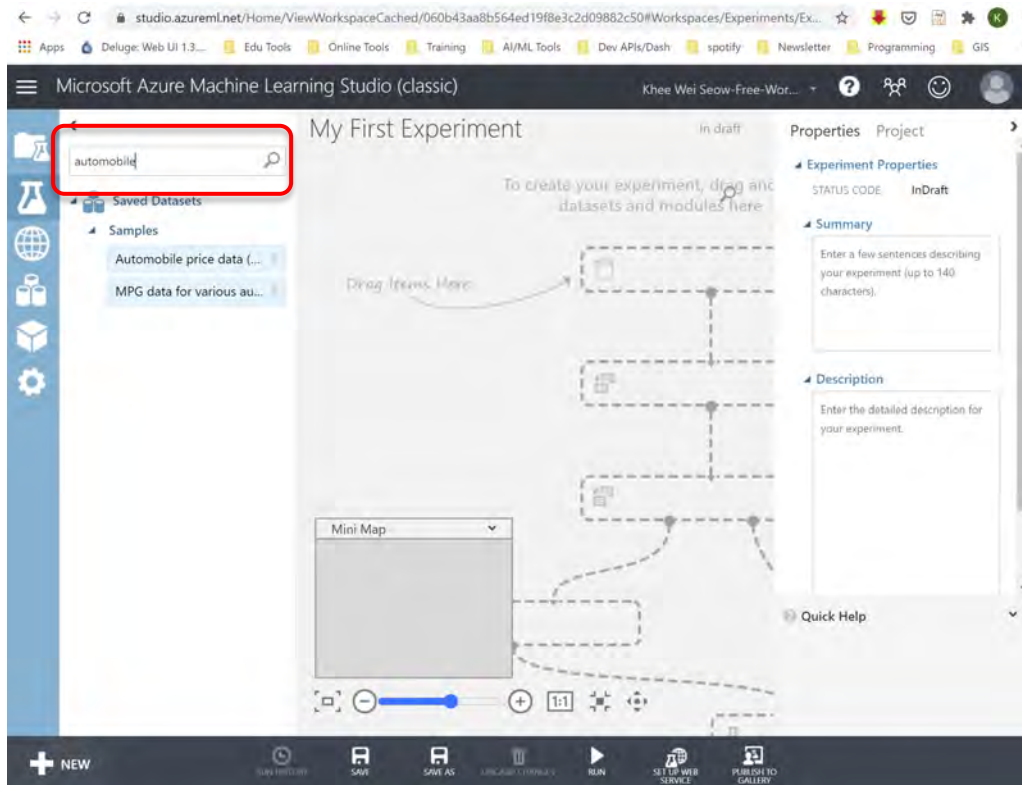


- 3) Name it **"My First Experiment"**. A screen similar to the follow will be presented.

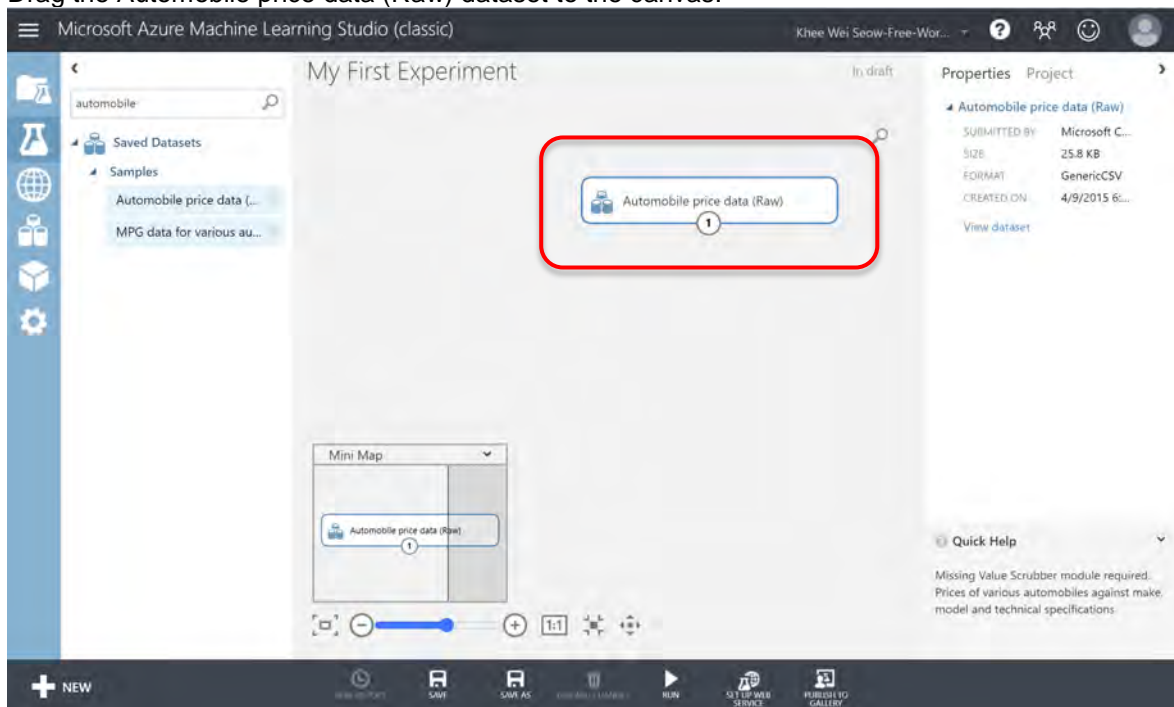


### 3) Setting up your data

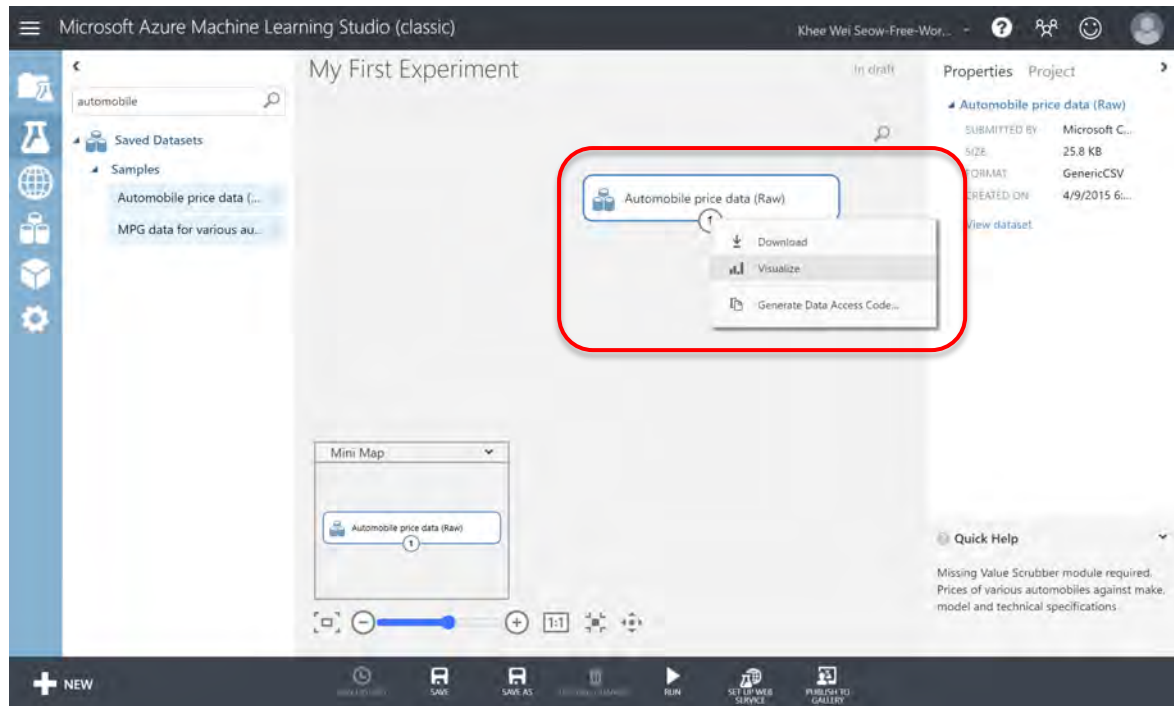
- 1) In the left search box, type Automobile.



- 2) Drag the Automobile price data (Raw) dataset to the canvas.



- 3) Right-click on the output port and click **Visualize**



- 4) You should see the content of the dataset as shown below. Every column in the dataset is also known as a feature. Notice that some data (rows) have missing values.

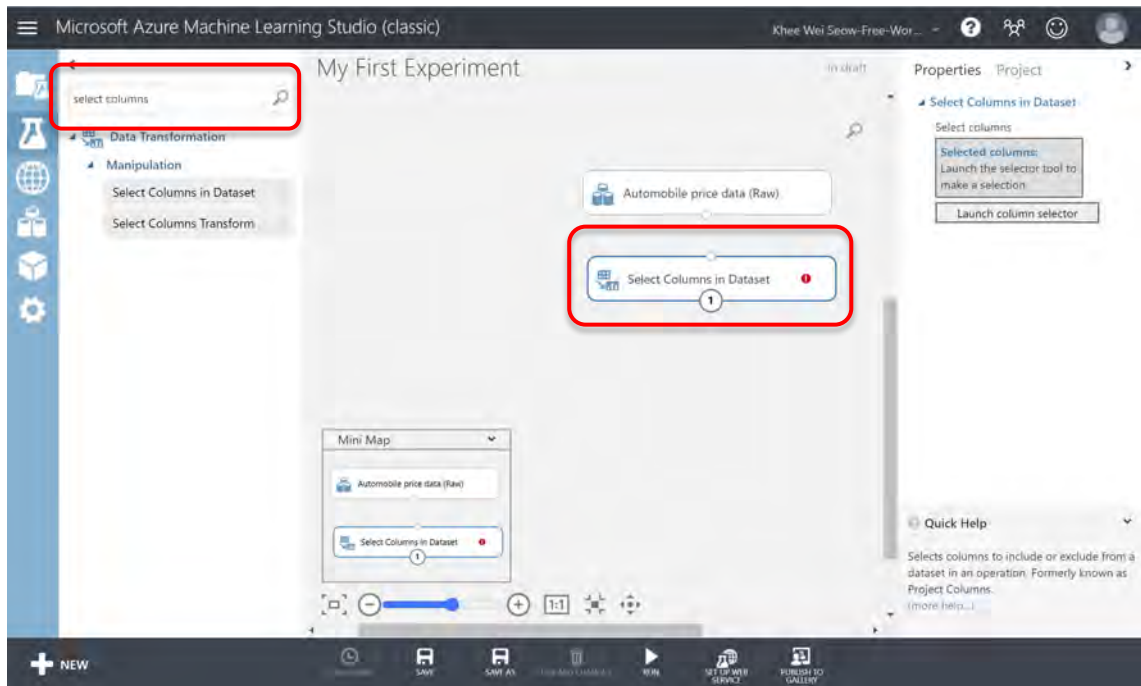
My First Experiment > Automobile price data (Raw) > dataset

| rows | columns | symboling | normalized-<br>losses | make        | fuel-<br>type | aspiration | num-<br>of-<br>doors |
|------|---------|-----------|-----------------------|-------------|---------------|------------|----------------------|
| 205  | 26      |           |                       |             |               |            |                      |
|      |         | view as   |                       |             |               |            |                      |
|      |         | 3         |                       | alfa-romero | gas           | std        | two                  |
|      |         | 1         |                       | alfa-romero | gas           | std        | two                  |
|      |         | 2         | 164                   | audi        | gas           | std        | four                 |
|      |         | 2         | 164                   | audi        | gas           | std        | four                 |
|      |         | 1         | 158                   | audi        | gas           | std        | four                 |
|      |         | 1         | 158                   | audi        | gas           | std        | four                 |
|      |         | 1         | 158                   | audi        | gas           | turbo      | four                 |
|      |         | 0         |                       | audi        | gas           | turbo      | two                  |

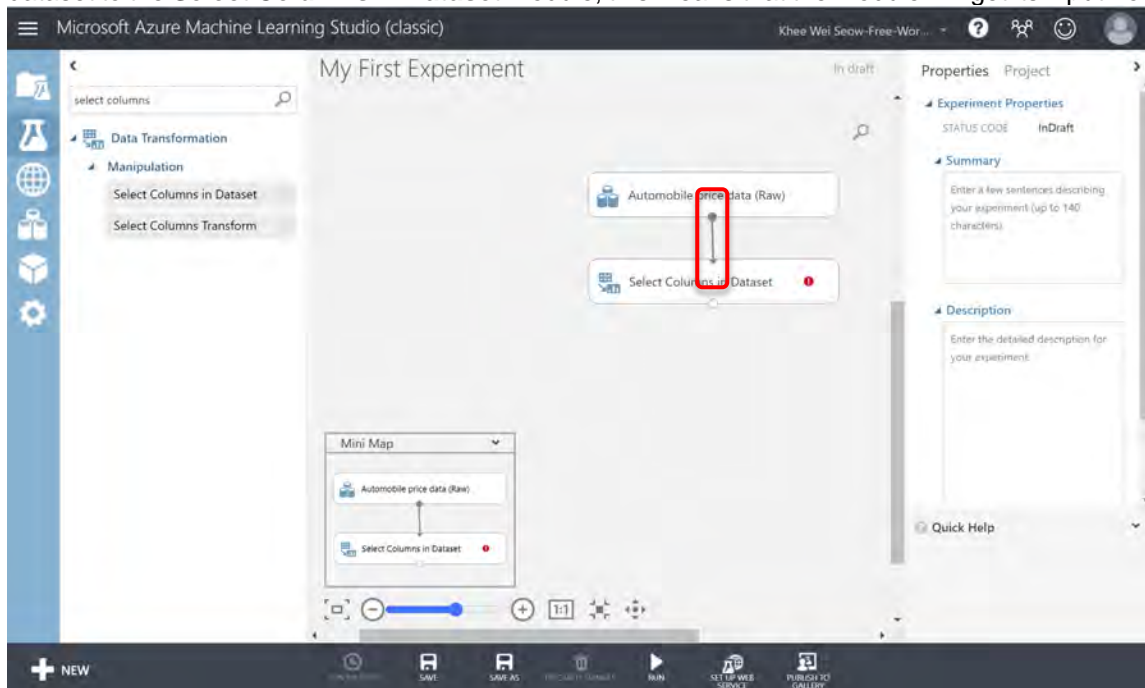
#### 4) Preparing your Dataset

- 1) **Filter data.** In the search box, type **select column** and drag and drop the **Select Columns in Dataset** module onto the canvas. The **Select Columns in Dataset** module allows you to filter the dataset based on the specified column names.

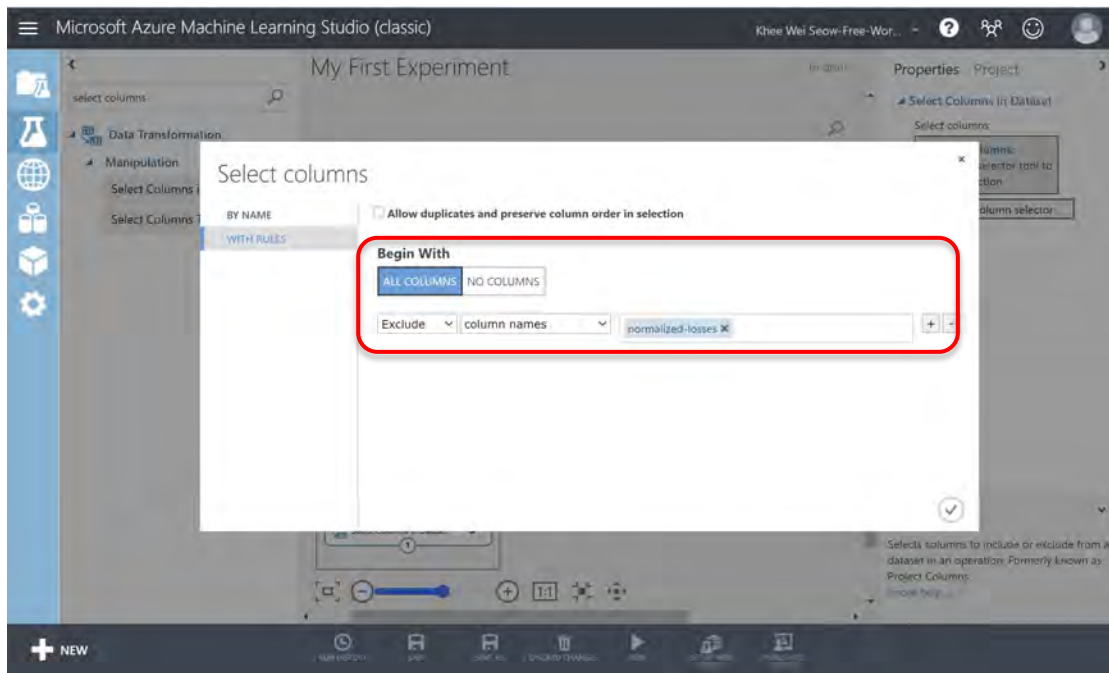




- 2) Connect the output port of the dataset to the input port of the module as shown below. By connecting the dataset to the **Select Columns in Dataset** module, this means that the module will get its input from the dataset.

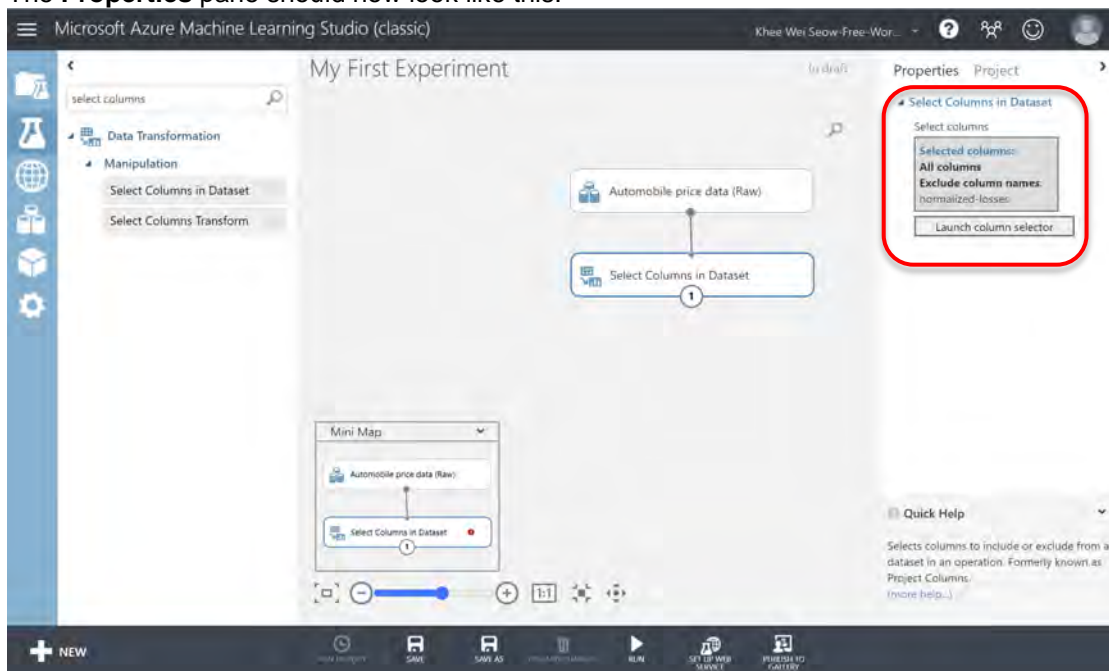


- 3) Select the **Select Columns in Dataset** module and on the Properties pane on the right, click the **Launch column selector** button.
- 4) Set the values as shown below. Click the check mark button when done.

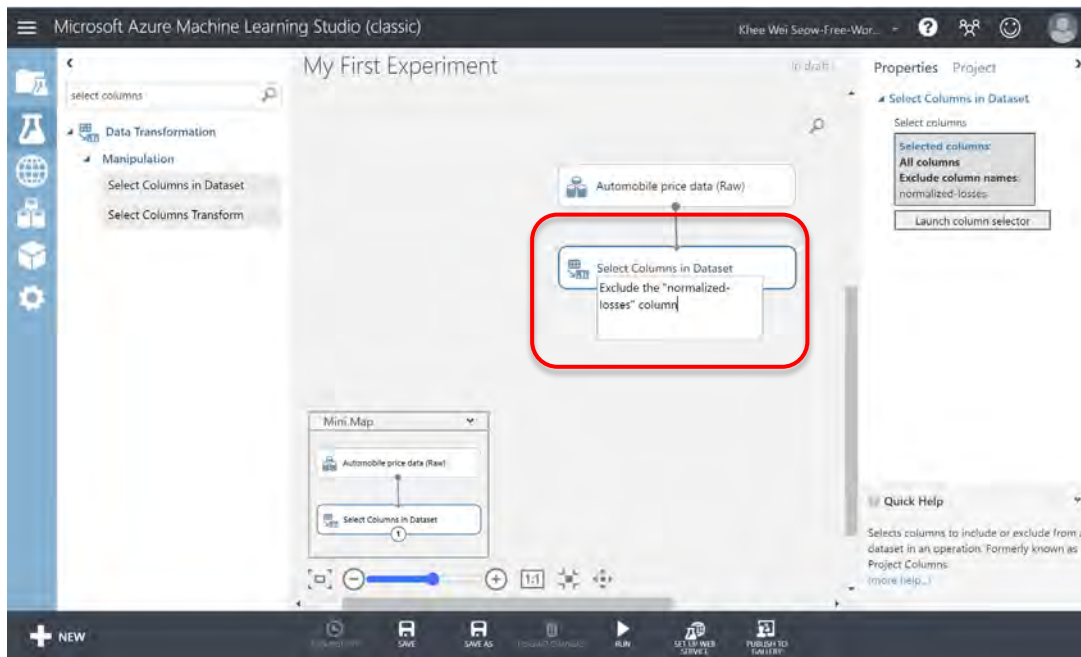


- This rule specifies that you want to exclude the **normalised-losses** column from the dataset.

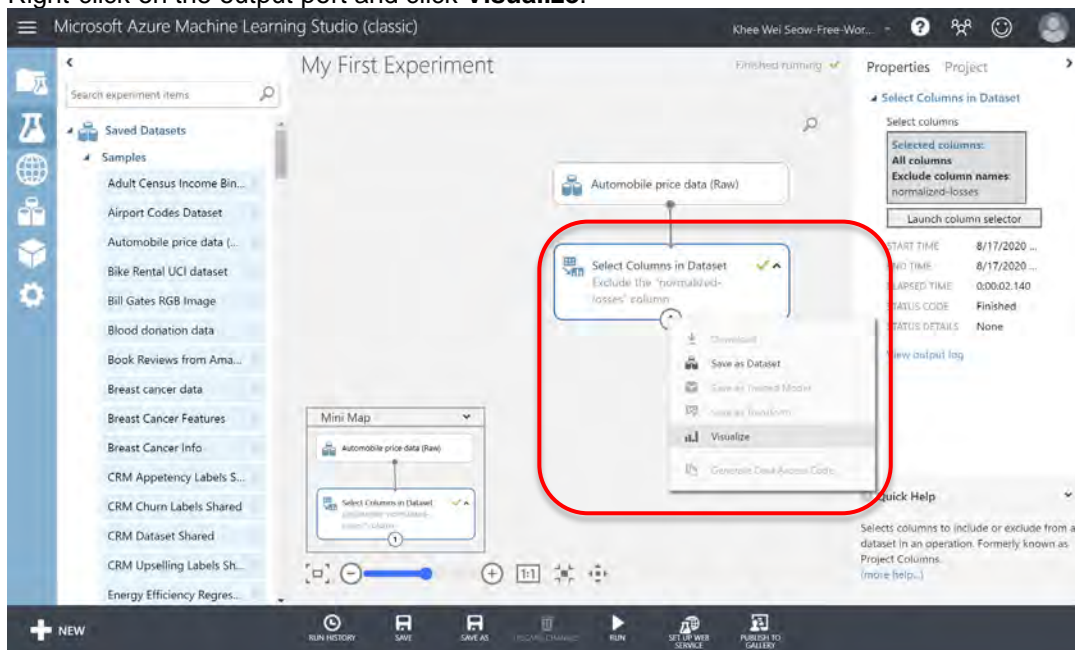
5) The **Properties** pane should now look like this:



6) Double click on the **Select Columns in Dataset** module to add a comment.

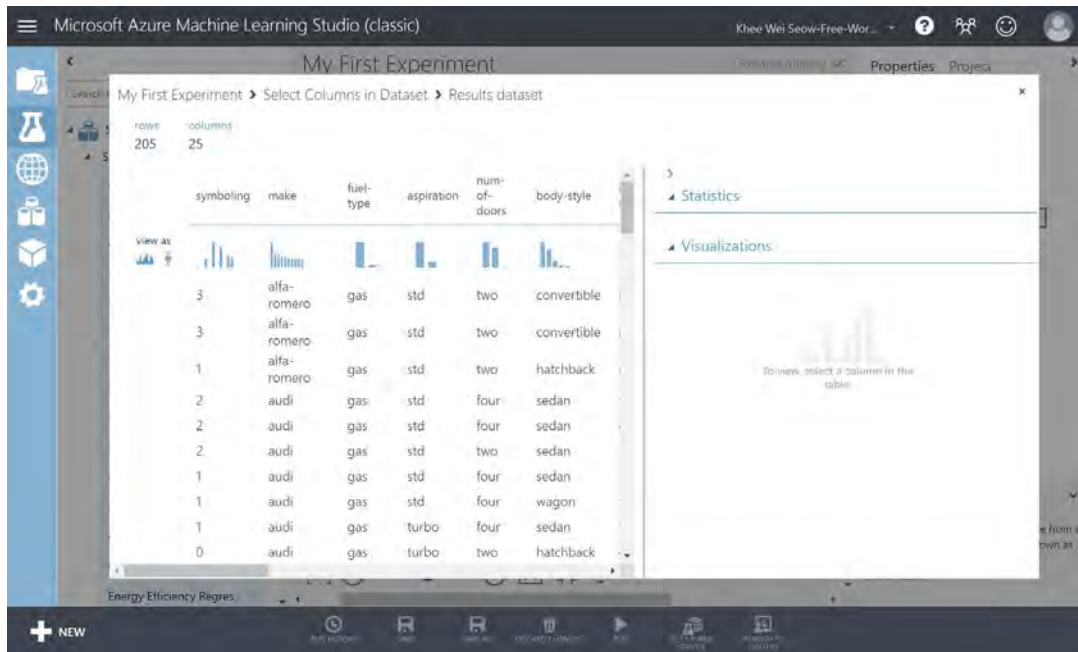


- 7) Click **Run** button located at the bottom of the screen. You will now see a green mark displayed in the **Select Columns in Dataset** module.
- 8) Right-click on the output port and click **Visualize**.

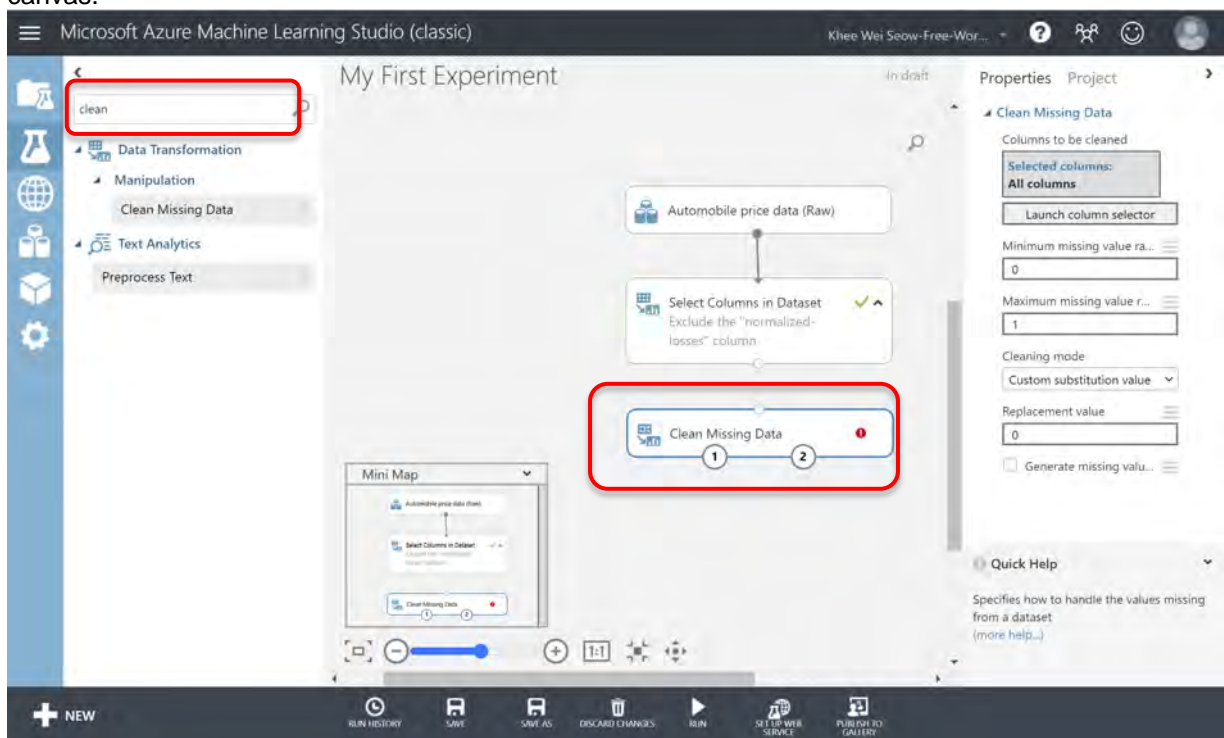


- 9) You should now see that the normalized-losses column is no longer in the dataset.





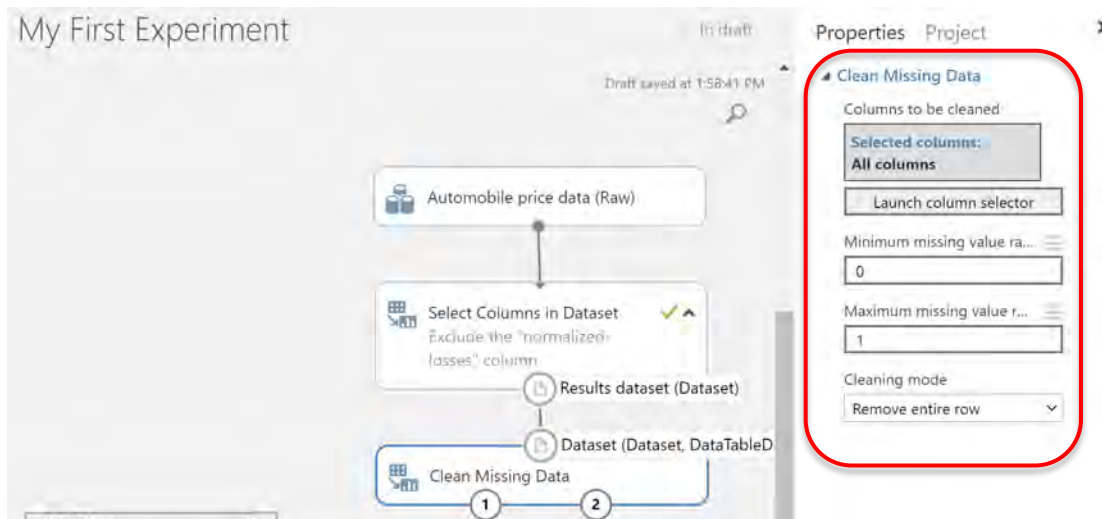
- 10) **Cleaning Data** – In the search box, type Clean missing and Drag the **Clean Missing Data** module to the canvas.



- 11) Connect the **Select Columns in Dataset** module to the **Clean Missing Data** module.

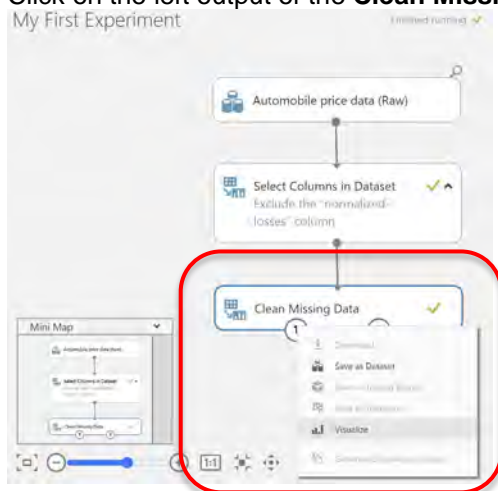


- 12) Select the **Clean Missing Data** module and set its **properties** as follows:

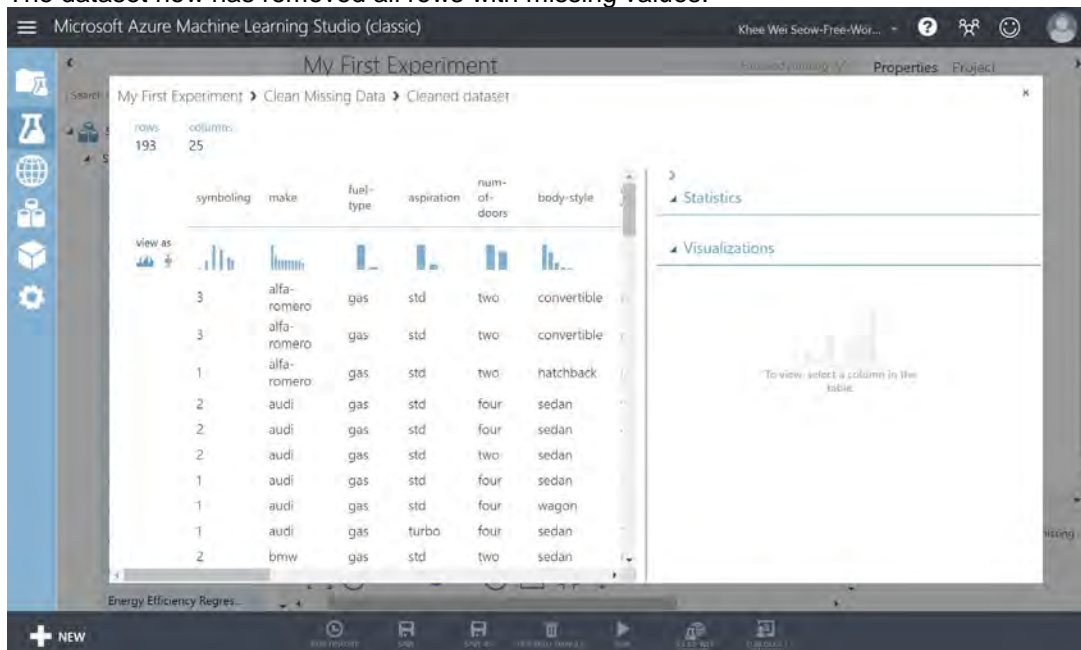


This property removes all rows with missing values. For other options available, you may want to refer to <https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/clean-missing-data>

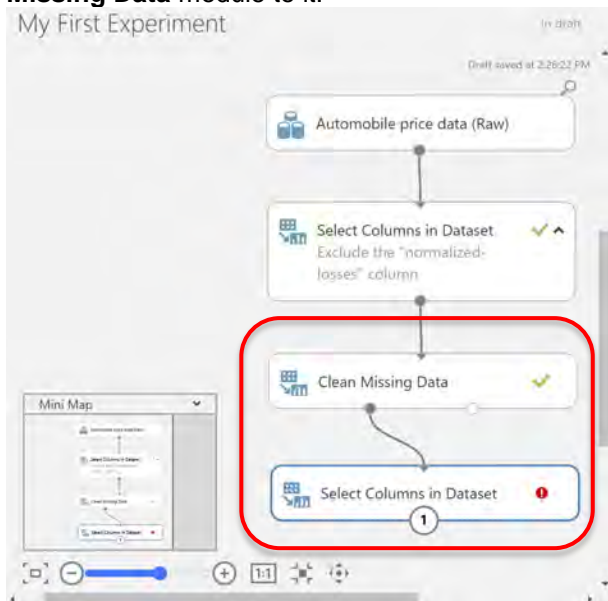
- 13) Click **Run**. Wait for a couple of seconds and you should see a green tick.
- 14) Click on the left output of the **Clean Missing Data** module and click **Visualize**.



- 15) The dataset now has removed all rows with missing values:



- 16) **Defining Features** – Add another **Select Columns in Dataset** module to the canvas and connect the **Clean Missing Data** module to it.



- 17) Double-click on the module and type **Select features for prediction**. (For comment purpose)
- 18) Select the module and in the **Properties** pane, click **Launch column selector**.
- 19) Set the values as shown below. Click on the check mark button when done.

Select columns

BY NAME  
WITH RULES

☐ Allow duplicates and preserve column order in selection

Begin With  
ALL COLUMNS NO COLUMNS

Include column names

make body-style wheel-base engine-size  
horsepower peak-rpm highway-mpg  
price

- We are effectively including the following columns: **make, body-style, wheel-base, engine-size, horsepower, peak-rpm, highway-mpg, price**

- 20) The **Properties** pane should now look like this.

Properties Project

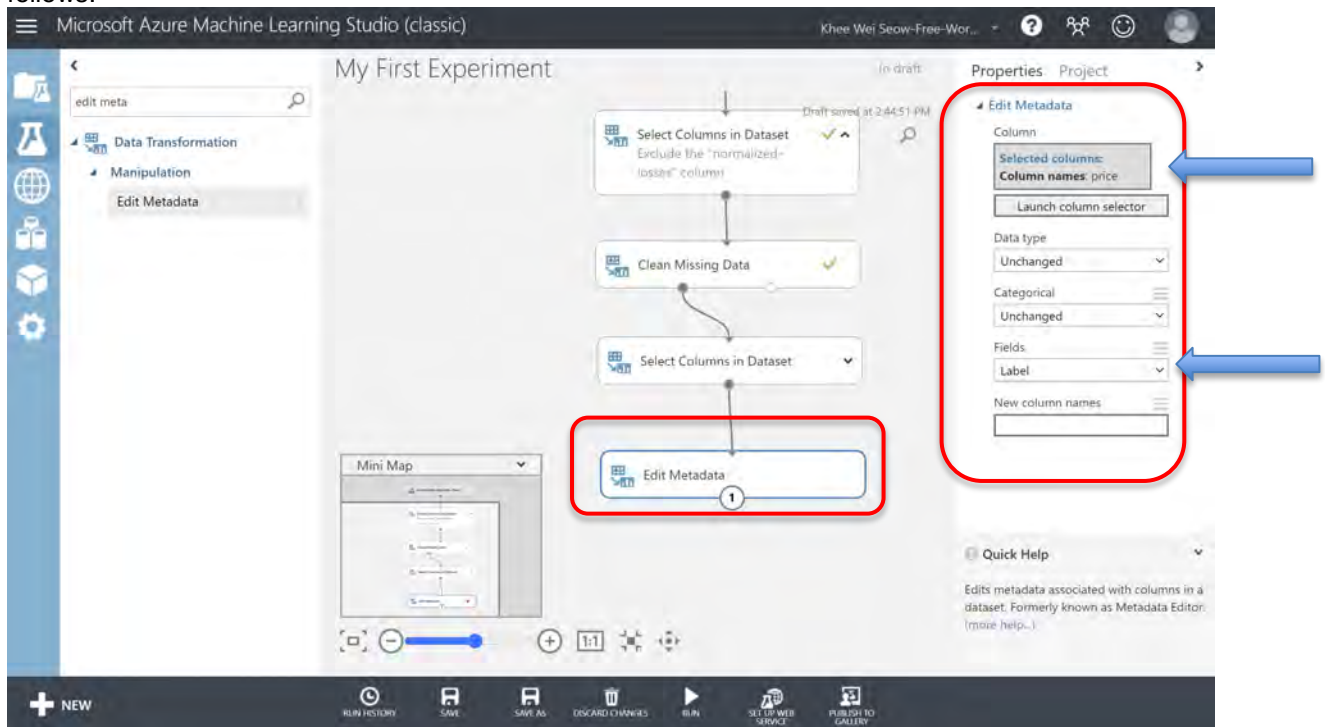
Select Columns in Dataset

Select columns

Selected columns:  
Column names:  
make,body-style,wheel-base,engine-size,horsepower,peak-rpm,highway-mpg,price

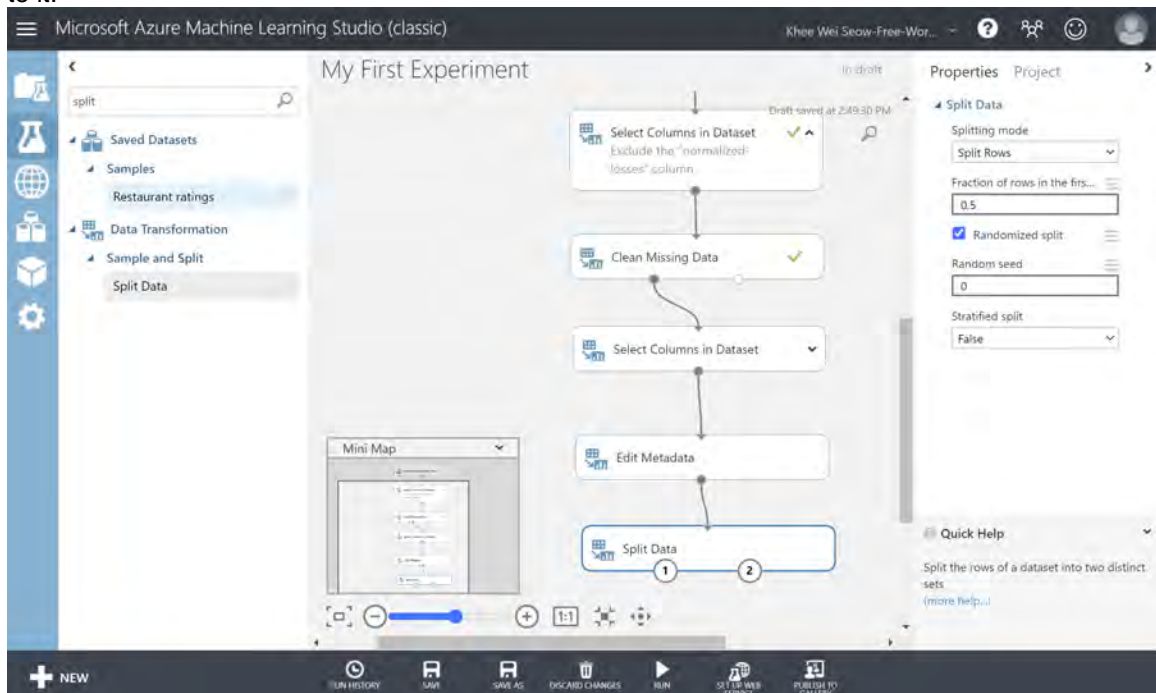
Launch column selector

- 21) **Labelling a Feature** – Add the **Edit Metadata** module to the canvas and then connect and configure it as follows:



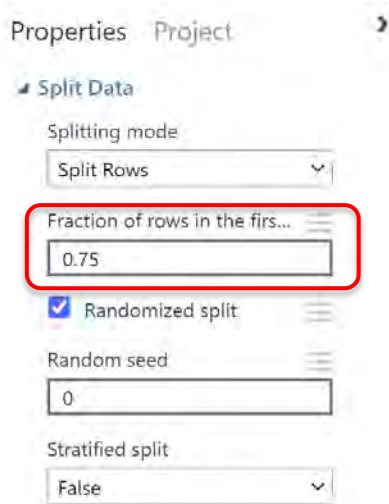
In this case, we are specifying the **price** column as the label. **A label defines the output of your learning model.** I.e. What we are going to predict.

- 22) **Splitting the dataset** – Add the **split data** module to the canvas and then connect the **Edit Metadata** module to it:



The **Split Data** module allows you to split the dataset into 2 groups – one for training the model and the other to use for testing the accuracies/performance of the prediction.

- 23) Select the **Split Data** module and set its properties as follows:



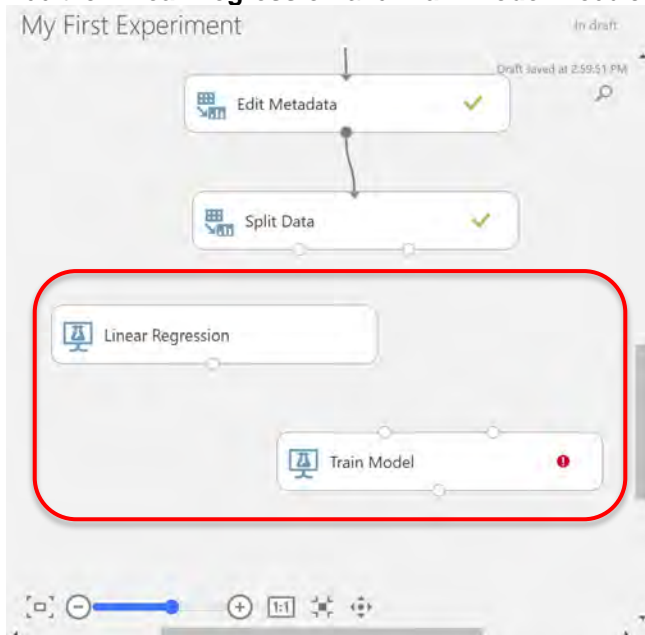
Ref: <https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/split-data>

The above setting splits the dataset into 2 parts – 75% of it for training the model and the rest, 25%, for testing.

24) Click **Run**.

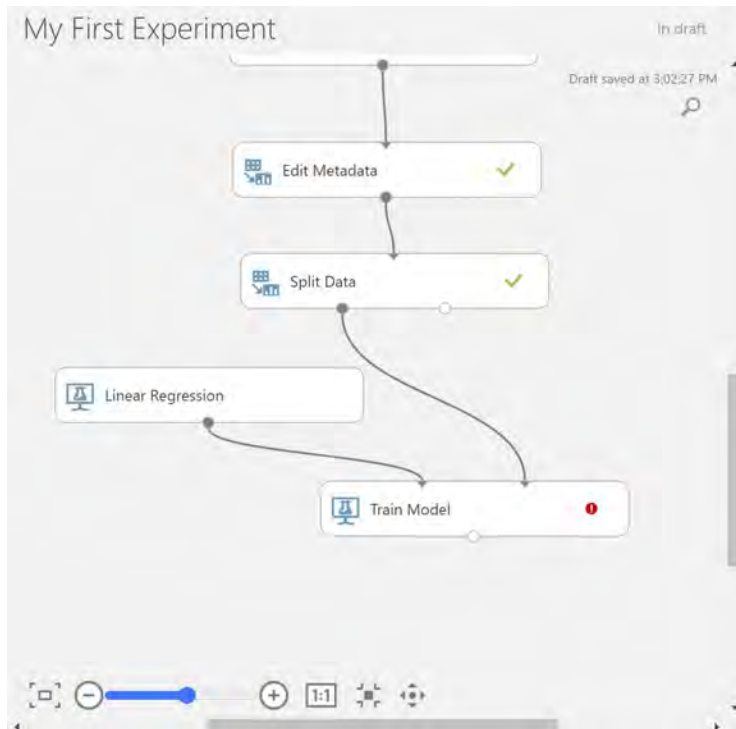
## 5) Select and score a model (or learning algorithm)

- 1) Add the **Linear Regression** and **Train Model** modules to the canvas.

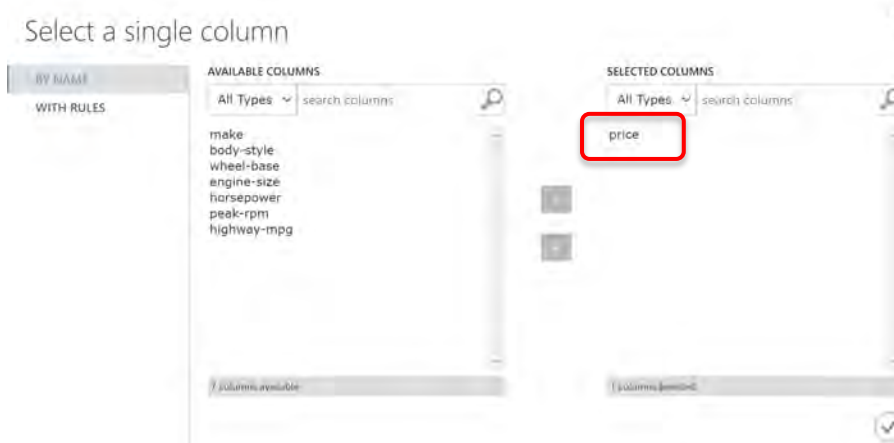


- 2) Connect the **Linear Regression** module to the left input port of the **Train Model** module and the left output port of the **Split Data** module to the right input port of the **Train Model** module.



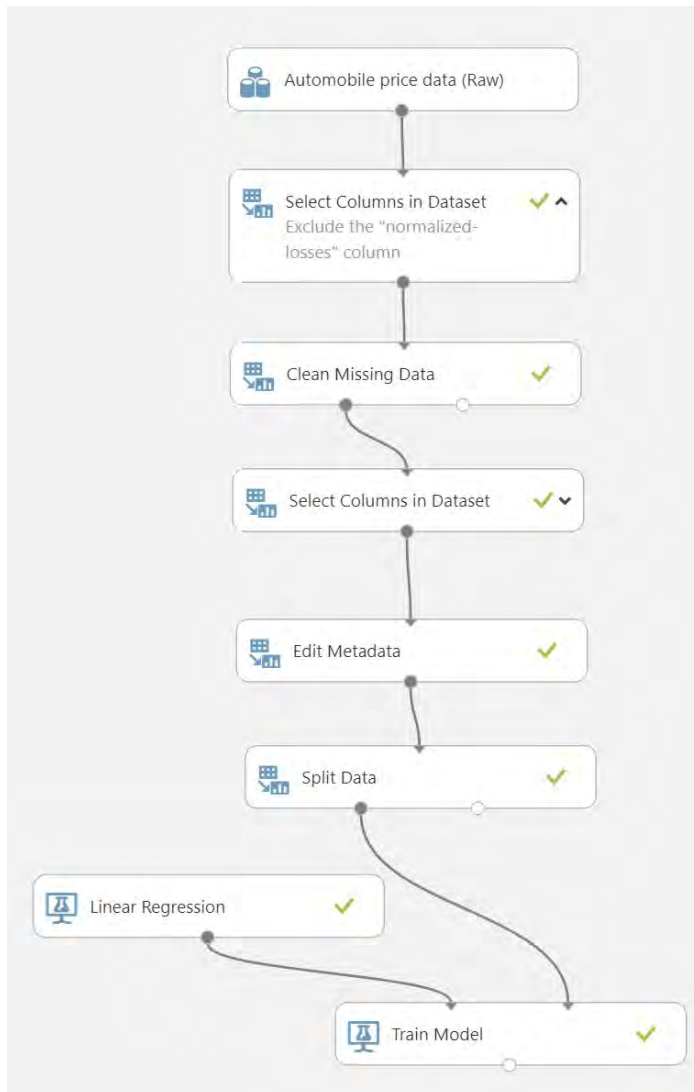


- 3) Select the **Train Model** module and in the **Properties** pane, click the **Launch column** selector button. Select **price** in the AVAILABLE COLUMNS pane and click on the > button to move it to the SELECTED COLUMNS pane. Click on the tick button to finish this step.

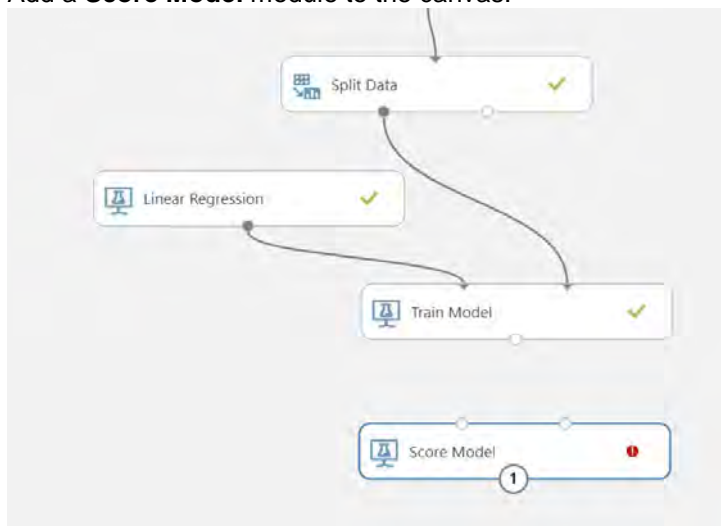


The above step indicates that you want the training model to predict the prices of vehicles.

- 4) Click **Run**. The canvas should now look like this:

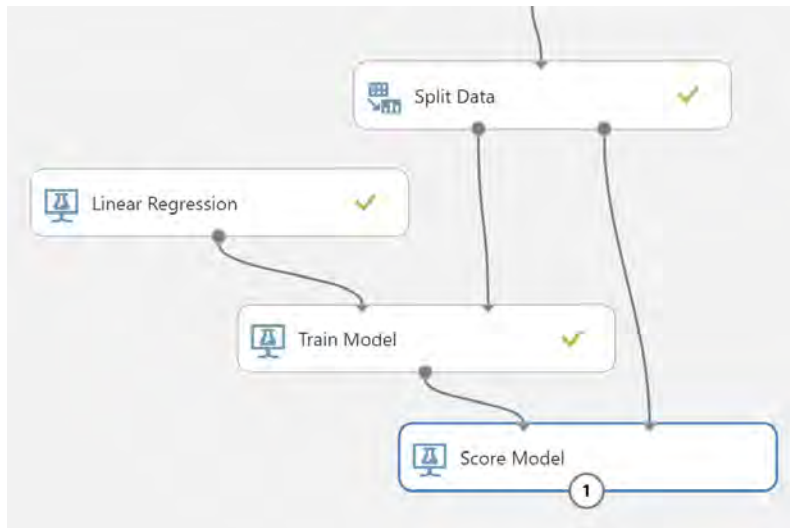


- 5) Add a **Score Model** module to the canvas:



Ref: <https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/score-model>

- 6) Connect the output port of the **Train Model** to the left input port of the **Score Model** module and the right output port of the **Split Data** module to the right input port of the **Score Model** module:



- 7) Click **RUN**. When it is completed, click on the output port of the **Score Model** and click **Visualize**:



- 8) You should see the following output.

My First Experiment > Score Model > Scored dataset

| rows    | columns     |             |            |             |            |          |             |       |               |
|---------|-------------|-------------|------------|-------------|------------|----------|-------------|-------|---------------|
| 48      | 9           |             |            |             |            |          |             |       |               |
|         | make        | body-style  | wheel-base | engine-size | horsepower | peak-rpm | highway-mpg | price | Scored Labels |
| view as |             |             |            |             |            |          |             |       |               |
|         | subaru      | sedan       | 97         | 108         | 111        | 4800     | 29          | 11259 | 10286.204819  |
|         | mitsubishi  | hatchback   | 93.7       | 92          | 68         | 5500     | 38          | 6669  | 5446.847864   |
|         | dodge       | hatchback   | 93.7       | 90          | 68         | 5500     | 38          | 6229  | 6344.800711   |
|         | honda       | hatchback   | 86.6       | 92          | 76         | 6000     | 38          | 6855  | 5528.302953   |
|         | alfa-romero | convertible | 88.6       | 130         | 111        | 5000     | 27          | 16500 | 13498.476233  |
|         | volvo       | wagon       | 104.3      | 141         | 114        | 5400     | 28          | 16515 | 16097.608038  |
|         | isuzu       | hatchback   | 96         | 119         | 90         | 5000     | 29          | 11048 | 8315.257218   |
|         | dodge       | hatchback   | 93.7       | 90          | 68         | 5500     | 41          | 5572  | 6630.154608   |
|         | bmw         | sedan       | 101.2      | 108         | 101        | 5800     | 29          | 16430 | 19913.408695  |
|         | mitsubishi  | hatchback   | 93.7       | 92          | 68         | 5500     | 41          | 5389  | 5732.201761   |
|         | bmw         | sedan       | 103.5      | 209         | 182        | 5400     | 22          | 41315 | 30548.819502  |
|         | jaguar      | sedan       | 113        | 258         | 176        | 4750     | 19          | 35550 | 30863.486076  |
|         | plymouth    | hatchback   | 93.7       | 90          | 68         | 5500     | 38          | 6229  | 5806.676601   |
|         | toyota      | hatchback   | 102.9      | 171         | 161        | 5200     | 24          | 16558 | 17388.014192  |
|         | mitsubishi  | hatchback   | 95.9       | 156         | 145        | 5000     | 24          | 14489 | 13094.447938  |
|         | plymouth    | hatchback   | 93.7       | 90          | 68         | 5500     | 41          | 5572  | 6092.030497   |

**The price column shows the actual values and the Scored Labels column shows the predicted values.**

## 6) Evaluating the model

- 1) Add a **Evaluate Model** module to the canvas.



- 2) Click **RUN**. Click on the **Evaluate Model** module output port and click **Visualize**:



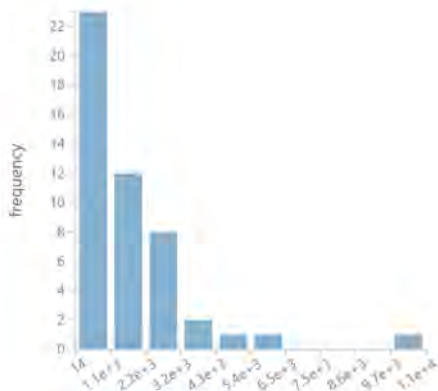
- 3) You should see the following:

My First Experiment > Evaluate Model > Evaluation results

### Metrics

|                              |             |
|------------------------------|-------------|
| Mean Absolute Error          | 1656.147651 |
| Root Mean Squared Error      | 2456.983209 |
| Relative Absolute Error      | 0.276606    |
| Relative Squared Error       | 0.089608    |
| Coefficient of Determination | 0.910392    |

### Error Histogram



The following statistics are shown for our model:

**Mean Absolute Error (MAE):** The average of absolute errors (an error is the difference between the predicted value and the actual value).

**Root Mean Squared Error (RMSE):** The square root of the average of squared errors of predictions made on the test dataset.

**Relative Absolute Error:** The average of absolute errors relative to the absolute difference between actual values and the average of all actual values.

**Relative Squared Error:** The average of squared errors relative to the squared difference between the actual values and the average of all actual values.

**Coefficient of Determination:** Also known as the R squared value, this is a statistical metric indicating how well a model fits the data.



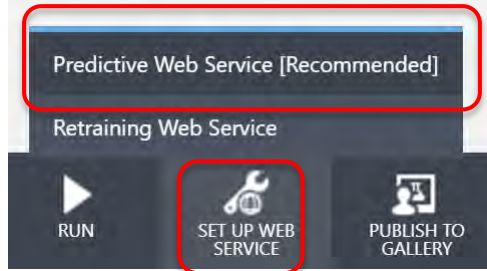
## Activity 2 – Deploying your experiment as a Web Service

In this activity, we will learn:

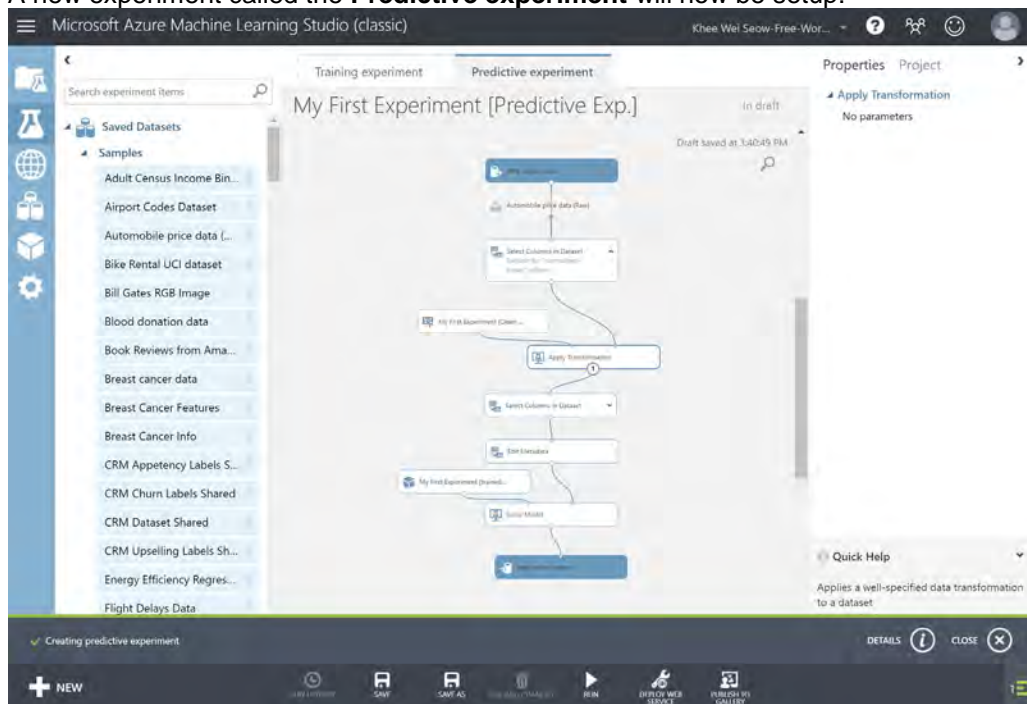
- ☐ Deploy a training model as a Web Service
- ☐ Test the webservice
- ☐ [Optional] access the web service using Python 3
- ☐ Use the web services via Excel

### 1) Prediction using a web Service

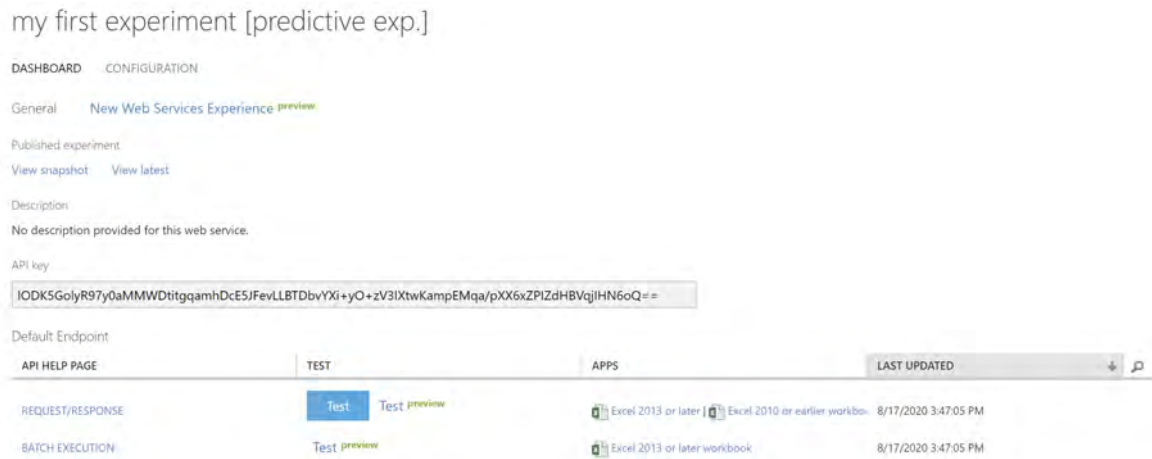
- 1) Using the same experiment, click on **SETUP WEB SERVICE, Predictive Web Service**



- 2) A new experiment called the **Predictive experiment** will now be setup:

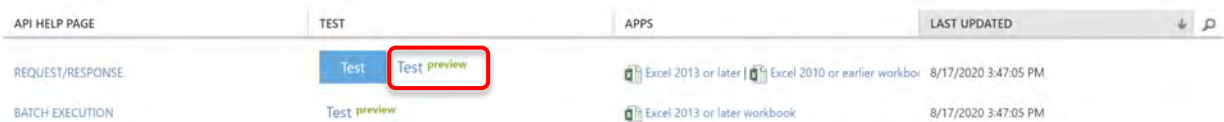


- 3) Click **RUN**. Then click **DEPLOY WEB SERVICE**.
- 4) You should see the following after a few seconds.

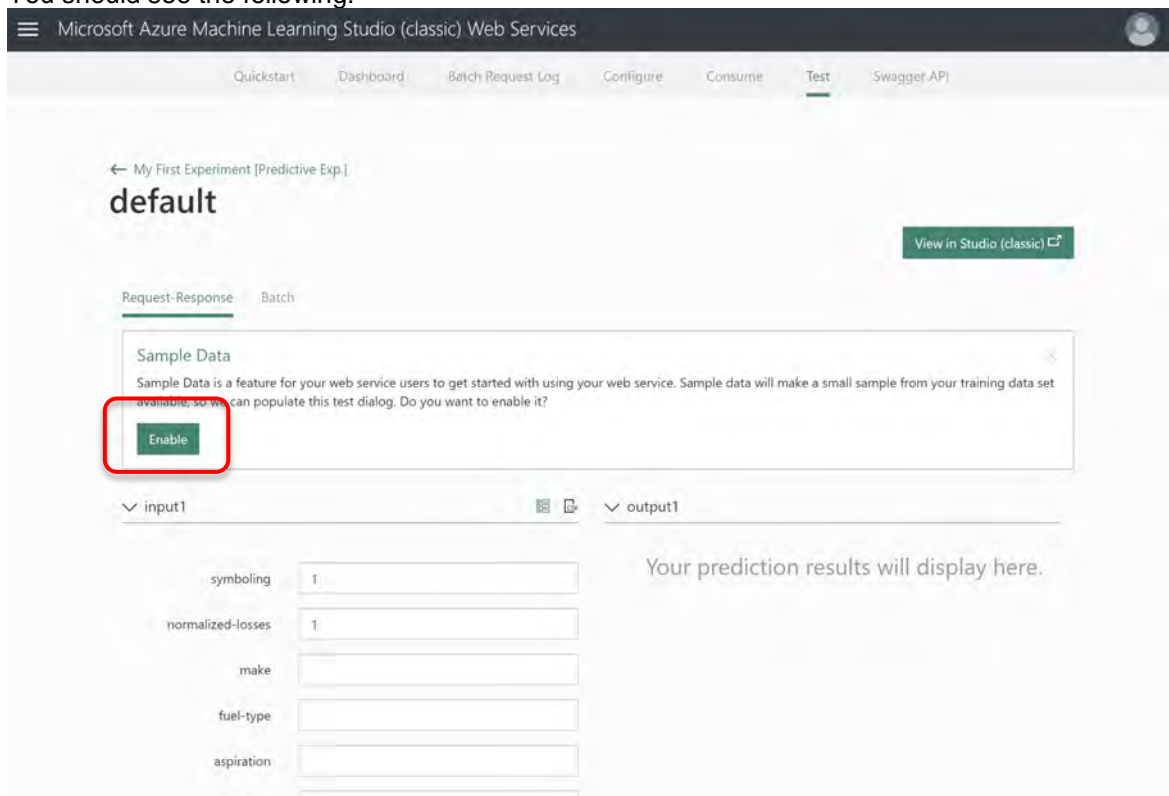


## 2) Testing the Web Service

1) Click on the **Test** hyperlink.



2) You should see the following:



3) Click the **Enable** button to populate the various fields with sample data from your dataset.

4) At the bottom of the page, click the **Test Request-Response** button to test the web service.

Microsoft Azure Machine Learning Studio (classic) Web Services

Quickstart Dashboard Batch Request Log Configure Consume **Test** Swagger API

engine-type dohc

num-of-cylinders four

engine-size 130

fuel-system mpfi

bore 3.47

stroke 2.68

compression-ratio 9

horsepower 111

peak-rpm 5000

city-mpg 21

highway-mpg 27

price 13495

**Test Request-Response**

Microsoft

5) The prediction will now be shown.

Microsoft Azure Machine Learning Studio (classic) Web Services

Quickstart Dashboard Batch Request Log Configure Consume **Test** Swagger API

make alfa-romero

fuel-type gas

aspiration std

num-of-doors two

body-style convertible

drive-wheels rwd

engine-location front

wheel-base 88.6

engine-size 130

horsepower 111

peak-rpm 5000

highway-mpg 27

price 13495

**Scored Labels 13498.4762334354**

### 3) [Optional] Consuming the web service programmatically

1) Click the **Consume** tap at the top of the page:

Microsoft Azure Machine Learning Studio (classic) Web Services

Quickstart Dashboard Batch Request Log Configure **Consume** Test Swagger API

← My First Experiment [Predictive Exp.]

**default**

View in Studio (classic)

Web service consumption options:

Excel 2013 or later

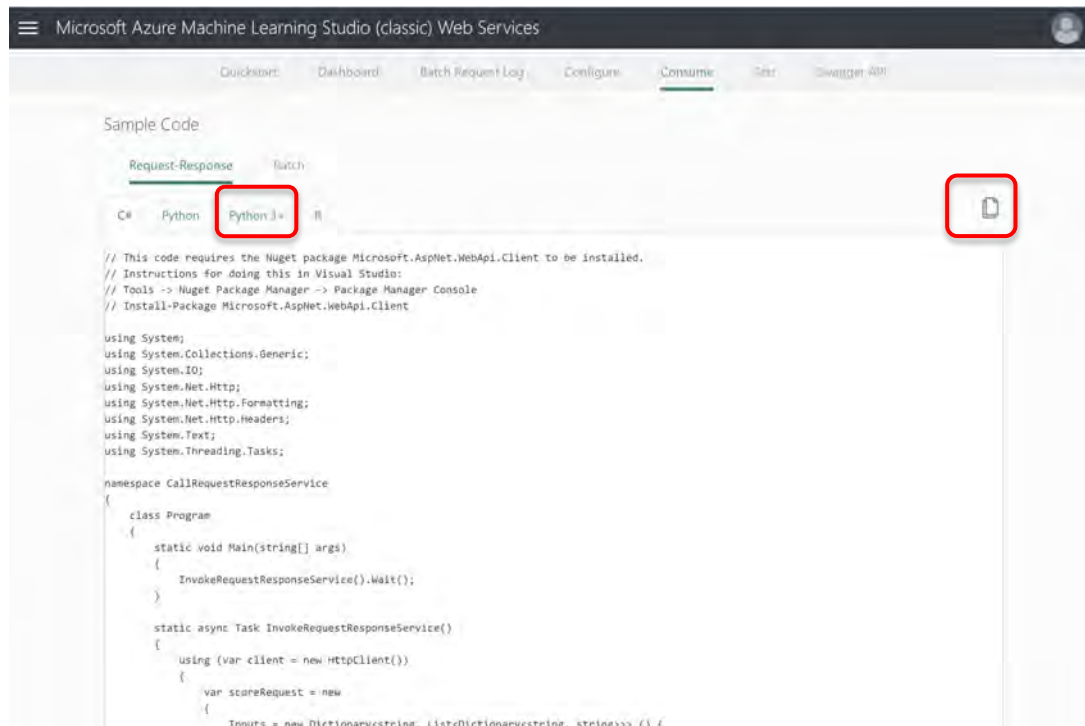
Excel 2010 or earlier

Request-Response Web App Template

Basic consumption info

Want to see how to consume this information? Check out this easy tutorial!

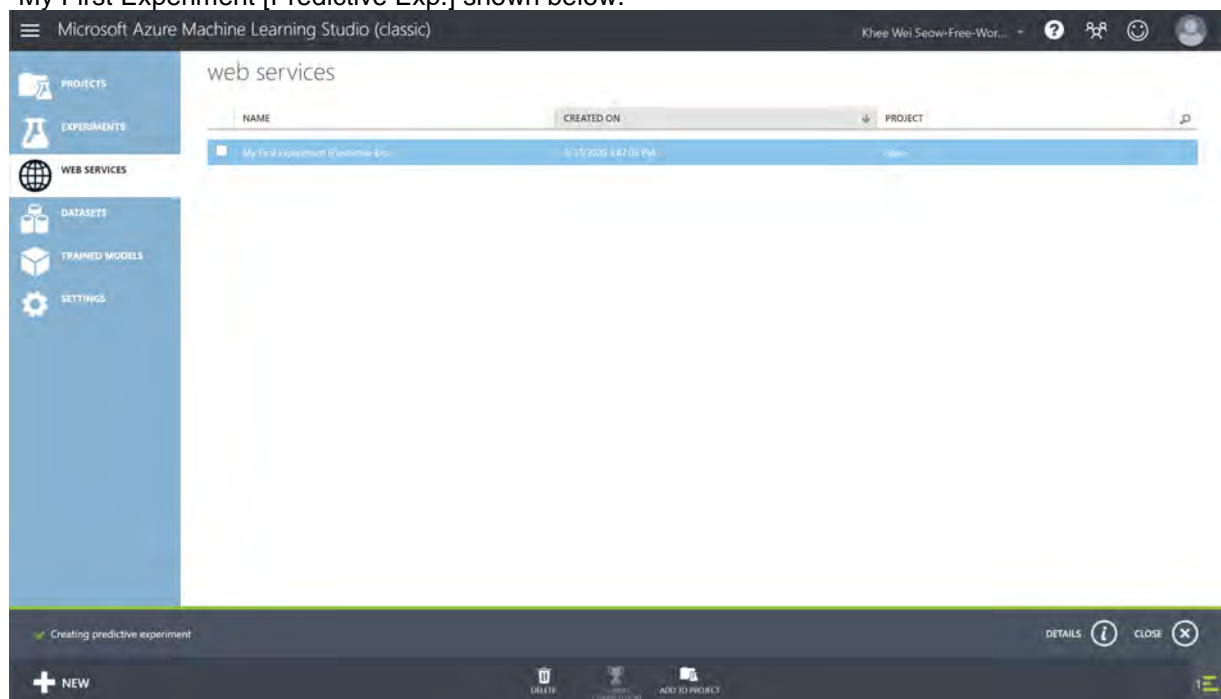
2) Scroll down the page and you should see the following:



3) Click on **Python 3+** tab and copy the code.

#### 4) Make Prediction using Excel (2010 or earlier)

- 1) Azure Machine Learning Studio (classic) makes it easy to call web services directly from Excel without the need to write any code. If you are using Excel 2013 (or later) or Excel Online, then we recommend that you use the Excel add-in (next section).
- 2) In Microsoft Azure Machine Learning Studio (classic), click on **WEB SERVICES** on the left pane. Then click on "My First Experiment [Predictive Exp.] shown below.

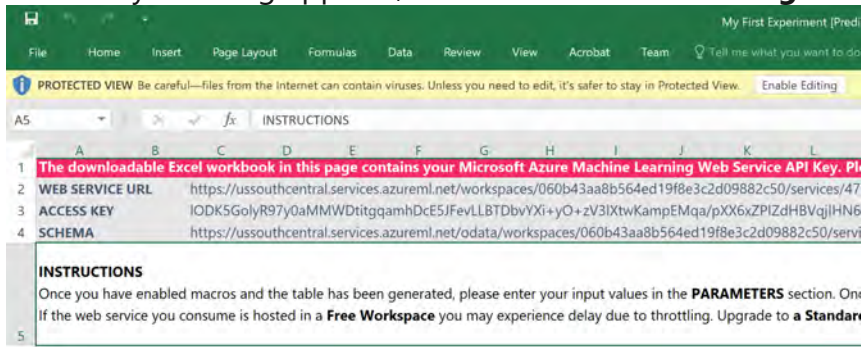


- 3) On the DASHBOARD tab for the web service is a row for the REQUEST/RESPONSE service. Click on **Excel 2010 or earlier workbook** the hyperlink to download the workbook in that row.

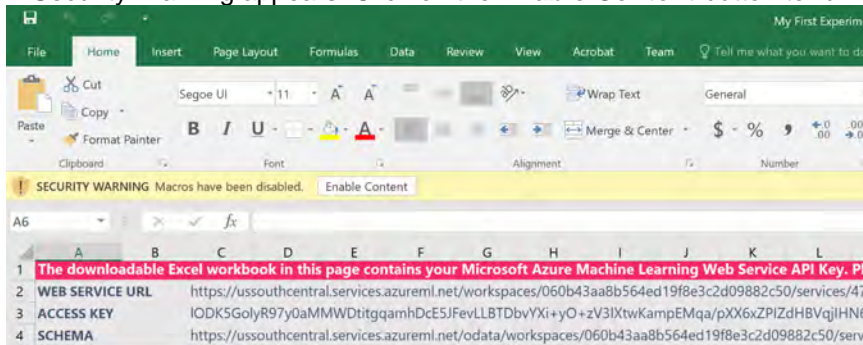
| API HELP PAGE    | TEST                              | APPS                                                                               | LAST UPDATED         |
|------------------|-----------------------------------|------------------------------------------------------------------------------------|----------------------|
| REQUEST/RESPONSE | Test <a href="#">Test preview</a> | <a href="#">Excel 2013 or later</a> <a href="#">Excel 2010 or earlier workbook</a> | 8/17/2020 3:47:05 PM |
| BATCH EXECUTION  | Test <a href="#">Test preview</a> | <a href="#">Excel 2013 or later workbook</a>                                       | 8/17/2020 3:47:05 PM |



- 4) Open the workbook.
- 5) A Security Warning appears; click on the **Enable Editing** button.



- 6) A Security Warning appears. Click on the **Enable Content** button to run macros on your spreadsheet.



- 7) Once macros are enabled, a table is generated. Columns in blue are required as input into the RRS web service, or PARAMETERS. Note the output of the service, PREDICTED VALUES in green. When all columns for a given row are filled, the workbook automatically calls the scoring API, and displays the scored results

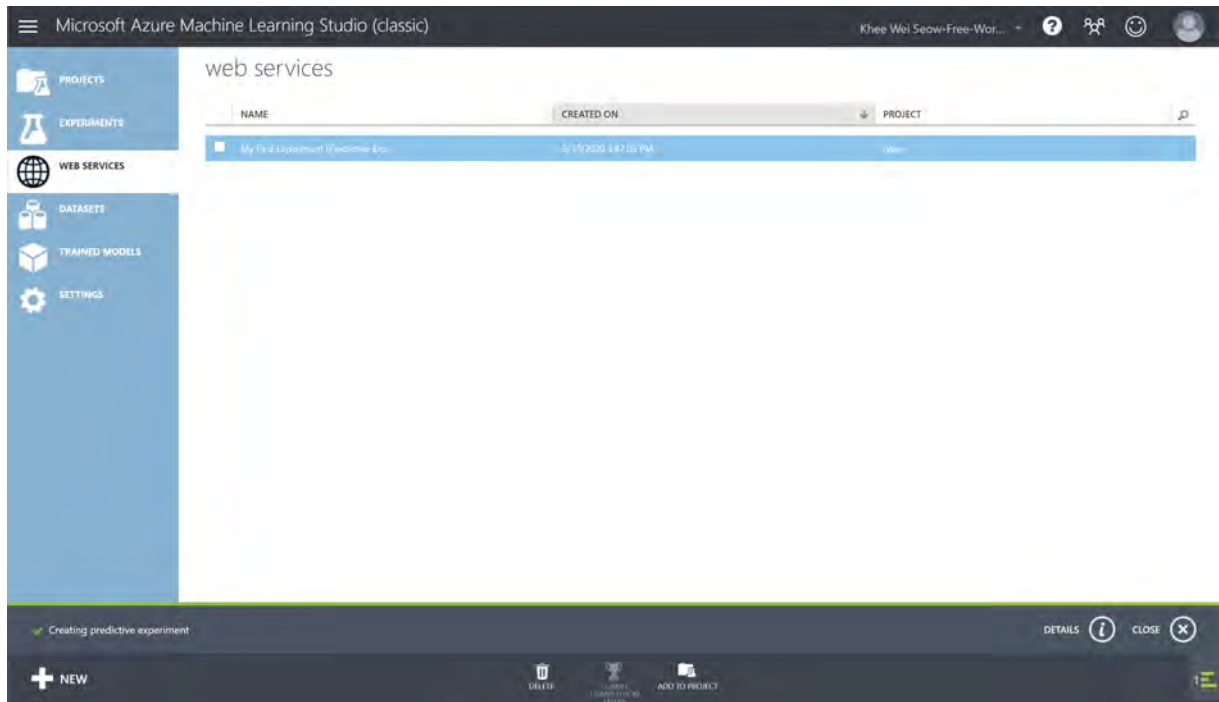
| PARAMETERS |                   |            |           |            |              |            |              |                 |            |        |       |        |             |                              |
|------------|-------------------|------------|-----------|------------|--------------|------------|--------------|-----------------|------------|--------|-------|--------|-------------|------------------------------|
| symboling  | normalized-losses | make       | fuel-type | aspiration | num-of-doors | body-style | drive-wheels | engine-location | wheel-base | length | width | height | curb-weight | engine-type num-of-cylinders |
| 3          | 1                 | alfa-romeo | std       | two        | convertible  | rwd        | front        |                 | 88.6       | 168.8  | 64.1  | 48.8   | 2548        | dohc four                    |

| PREDICTED VALUES |             |             |      |        |                   |            |          |          |             |       |            |             |            |             |
|------------------|-------------|-------------|------|--------|-------------------|------------|----------|----------|-------------|-------|------------|-------------|------------|-------------|
| num-of-cylinders | engine-size | fuel-system | bore | stroke | compression-ratio | horsepower | peak-rpm | city-mpg | highway-mpg | price | make       | body-style  | wheel-base | engine-size |
| four             | 130         | mpfi        | 3.47 | 2.68   | 9                 | 111        | 5000     | 21       | 27          | 13495 | alfa-romeo | convertible | 88.6       | 130         |

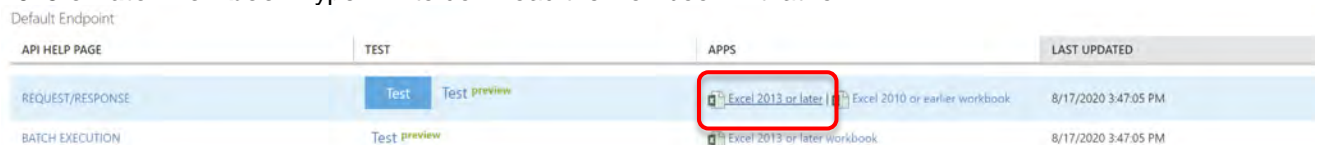
## 5) Make Prediction using Excel (after 2013)

- 1) In Microsoft Azure Machine Learning Studio (classic), click on **WEB SERVICES** on the left pane. Then click on "My First Experiment [Predictive Exp.] shown below.

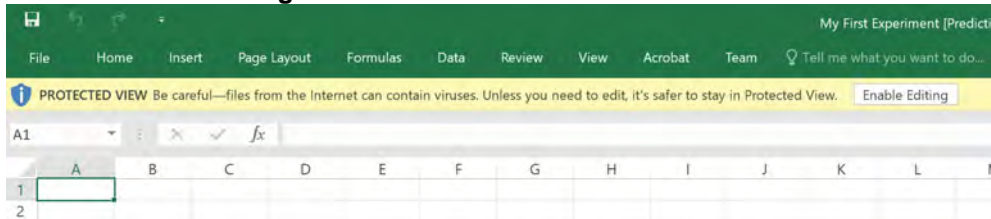




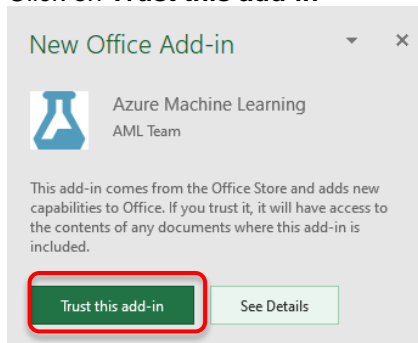
- 2) On the DASHBOARD tab for the web service is a row for the REQUEST/RESPONSE service. Click on **Excel 2013 or later workbook** hyperlink to download the workbook in that row.



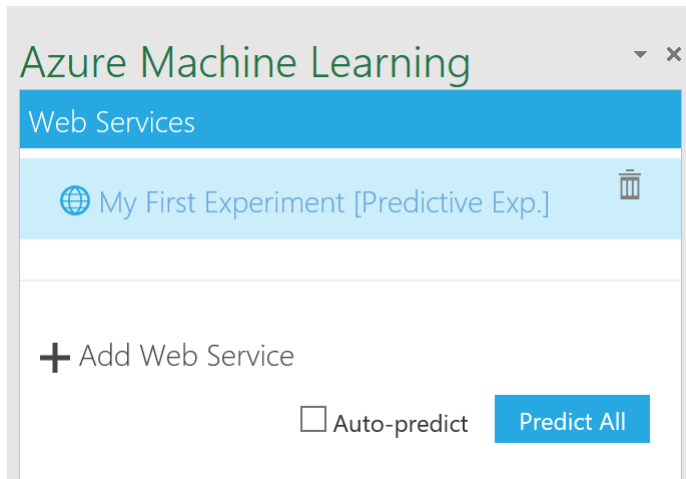
- 3) Open the sample Excel file, which contains the Excel add-in.
- 4) Click on **Enable Editing**.



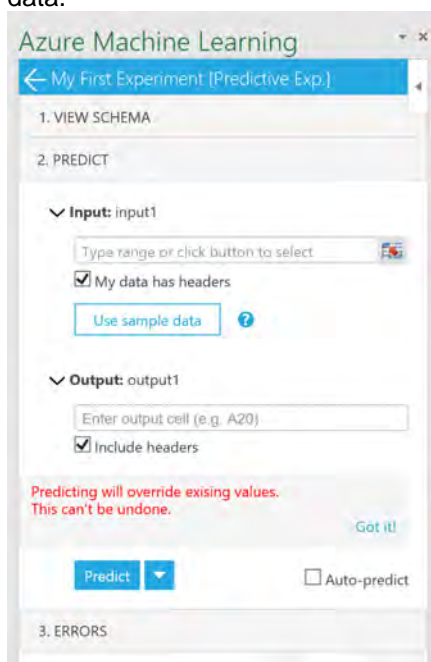
- 5) Click on **Trust this add-in**



- 6) Choose the web service by clicking it – “My First Experiment [Predictive Exp.]” in this activity.



- 7) This takes you to the **Predict** section. For a blank workbook you can select a cell in Excel and click **Use sample data**.



- 8) Select the data with headers and click the input data range icon. Make sure the "My data has headers" box is checked.
- 9) Under Output, enter the cell number where you want the output to be, for example "A10".

10) Click **Predict**. If you select the "auto-predict" checkbox any change on the selected areas (the ones specified as input) will trigger a request and an update of the output cells without the need for you to press the predict button.

11) You will see the predicted values as follow:

| 1  | symboling   | normalized  | make        | fuel-type   | aspiration | num-of-do | body-style  | drive-whe | engine-loce   | wheel-base | length |
|----|-------------|-------------|-------------|-------------|------------|-----------|-------------|-----------|---------------|------------|--------|
| 2  | 3           | 1           | alfa-romero | gas         | std        | two       | convertible | rwd       | front         | 88.6       |        |
| 3  | 3           | 1           | alfa-romero | gas         | std        | two       | convertible | rwd       | front         | 88.6       |        |
| 4  | 1           | 1           | alfa-romero | gas         | std        | two       | hatchback   | rwd       | front         | 94.5       |        |
| 5  | 2           | 164         | audi        | gas         | std        | four      | sedan       | fwd       | front         | 99.8       |        |
| 6  | 2           | 164         | audi        | gas         | std        | four      | sedan       | 4wd       | front         | 99.4       |        |
| 7  |             |             |             |             |            |           |             |           |               |            |        |
| 8  |             |             |             |             |            |           |             |           |               |            |        |
| 9  |             |             |             |             |            |           |             |           |               |            |        |
| 10 | make        | body-style  | wheel-base  | engine-size | horsepower | peak-rpm  | highway-mp  | price     | Scored Labels |            |        |
| 11 | alfa-romero | convertible | 88.6        | 130         | 111        | 5000      | 27          | 13495     | 13498.476     |            |        |
| 12 | alfa-romero | convertible | 88.6        | 130         | 111        | 5000      | 27          | 16500     | 13498.476     |            |        |
| 13 | alfa-romero | hatchback   | 94.5        | 152         | 154        | 5000      | 26          | 16500     | 14329.816     |            |        |
| 14 | audi        | sedan       | 99.8        | 109         | 102        | 5500      | 30          | 13950     | 15696.502     |            |        |
| 15 | audi        | sedan       | 99.4        | 136         | 115        | 5500      | 22          | 17450     | 17161.153     |            |        |
| 16 |             |             |             |             |            |           |             |           |               |            |        |

## Activity 3 – Car Damage Assessment Classification

In this activity, we will learn:

- Save training time and create well-performing models with small datasets using transfer learning

Ref: A Comprehensive Hands-on Guide to Transfer Learning with Real-World Applications in Deep Learning.  
<https://towardsdatascience.com/a-comprehensive-hands-on-guide-to-transfer-learning-with-real-world-applications-in-deep-learning-212bf3b2f27a>

### 1) The Problem

In this activity, you will use a pretrained snippet in a classification model designed to detect different types of car damage. The number of images in the input data is small relative to the number of classes and has a significant amount of variation. This makes it challenging to create a well-performing model based on this dataset alone.

### 2) The Data

The dataset that we will use in this activity contains approximately 1,500 unique RGB images with the dimensions 224 x 224 pixels, and is split into a training- and a validation subset.

#### Unbalanced dataset

The underrepresented classes in the training subset have been upsampled in the pre-processing stage in order to reduce **bias**. This means that the index file (index.csv) has duplicate entries that are linking to the same image file. The total number of entries in the index file is approximately 3,800.

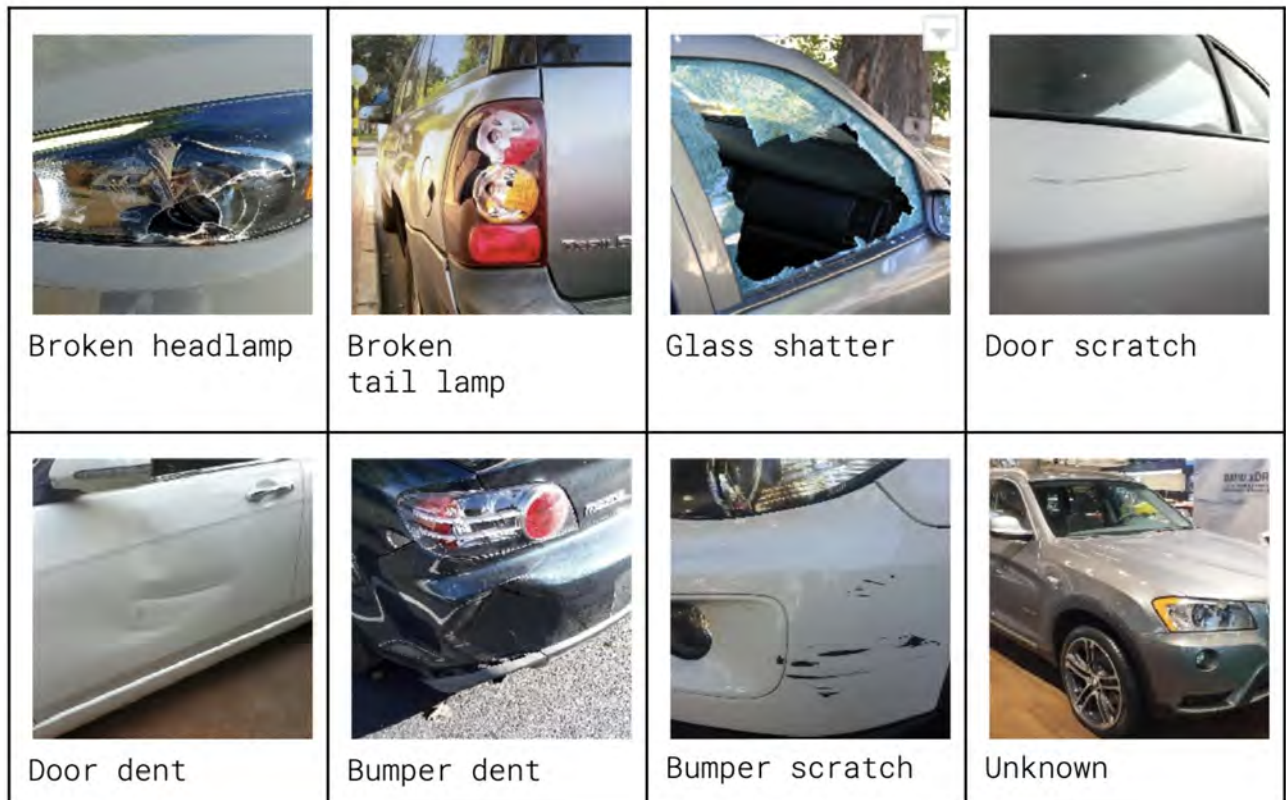
#### Classes

Each image belongs to one of the following classes:

- Broken headlamp
- Broken tail lamp
- Glass shatter
- Door scratch
- Door dent
- Bumper dent
- Bumper scratch
- Unknown

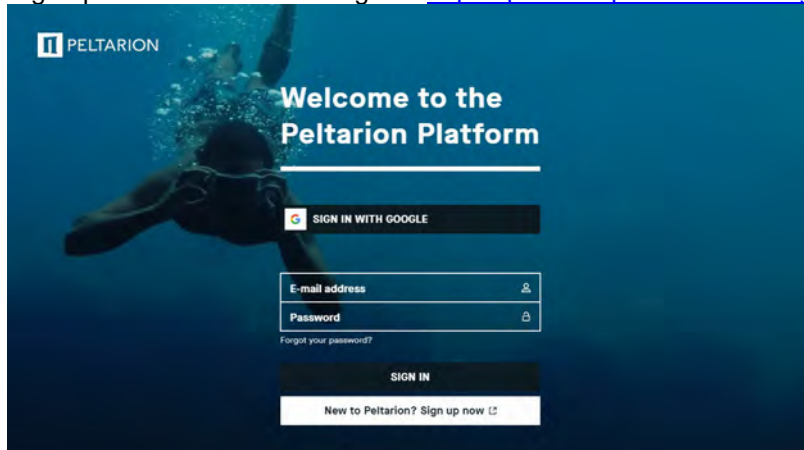
Below are sample images from the various classes in the dataset. Note that the unknown class contains images of cars that are in either a pristine or wrecked condition.

Each collected image represents one car with one specific type of damage. This means that the dataset can be used to solve a single-label classification problem.

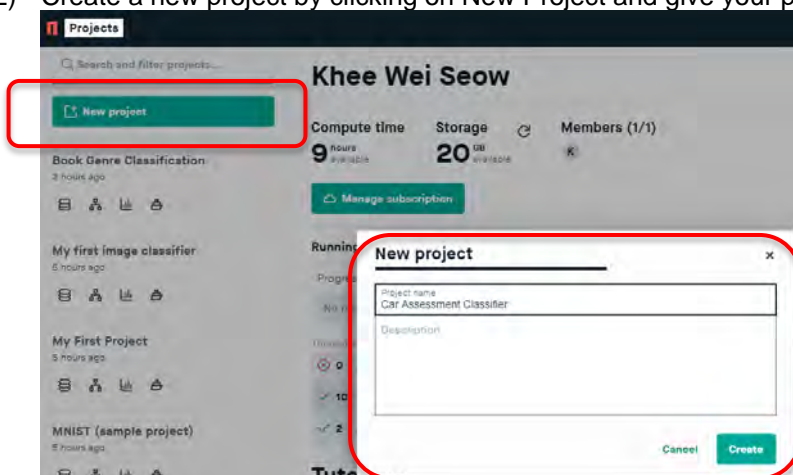


### 3) Create new Project

- 1) Sign up for an account and login at <https://platform.peltarion.com/login>

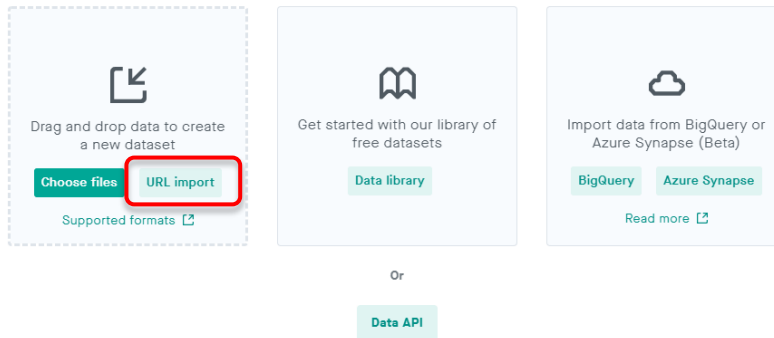


- 2) Create a new project by clicking on New Project and give your project a new. Click **Create** when done.

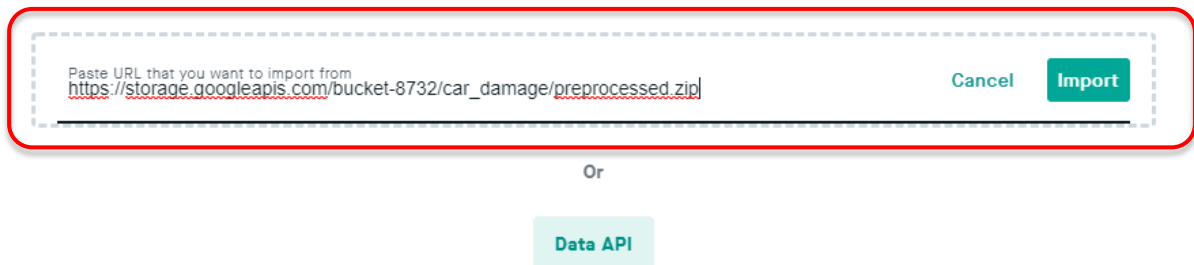




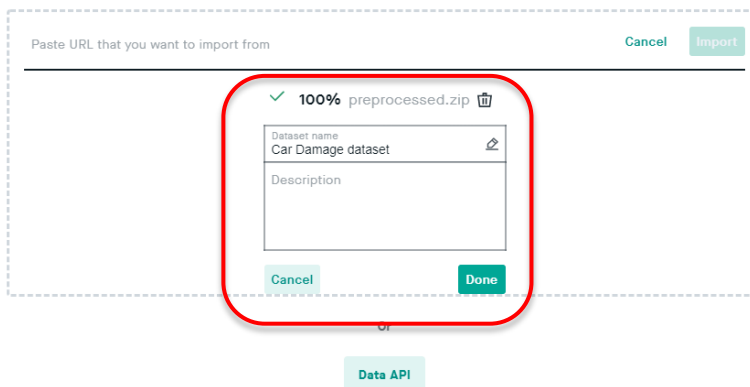
- 3) Navigate to the **Datasets** canvas if you are not automatically brought there. Click on **URL import**.



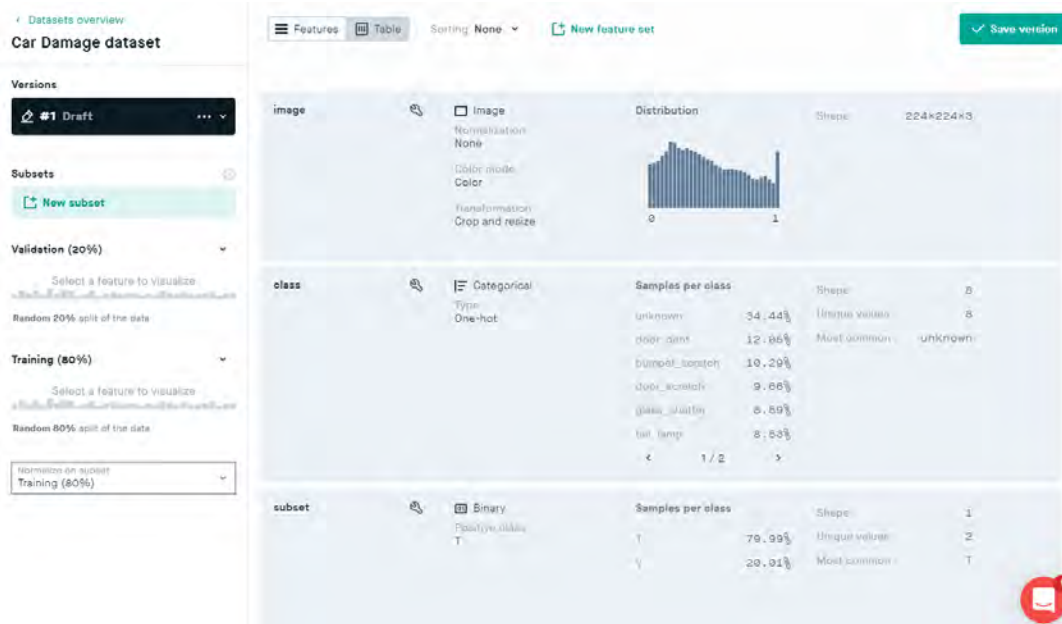
- 4) Copy the link and paste the link [https://storage.googleapis.com/bucket-8732/car\\_damage/preprocessed.zip](https://storage.googleapis.com/bucket-8732/car_damage/preprocessed.zip) to the **Import data from URL** box. The zip includes the whole dataset.



- 5) Click on **Import**.
- 6) When done, name the dataset **Car damage dataset** and click **Done**.



- 7) You will see the summaries of the dataset displayed as shown below.

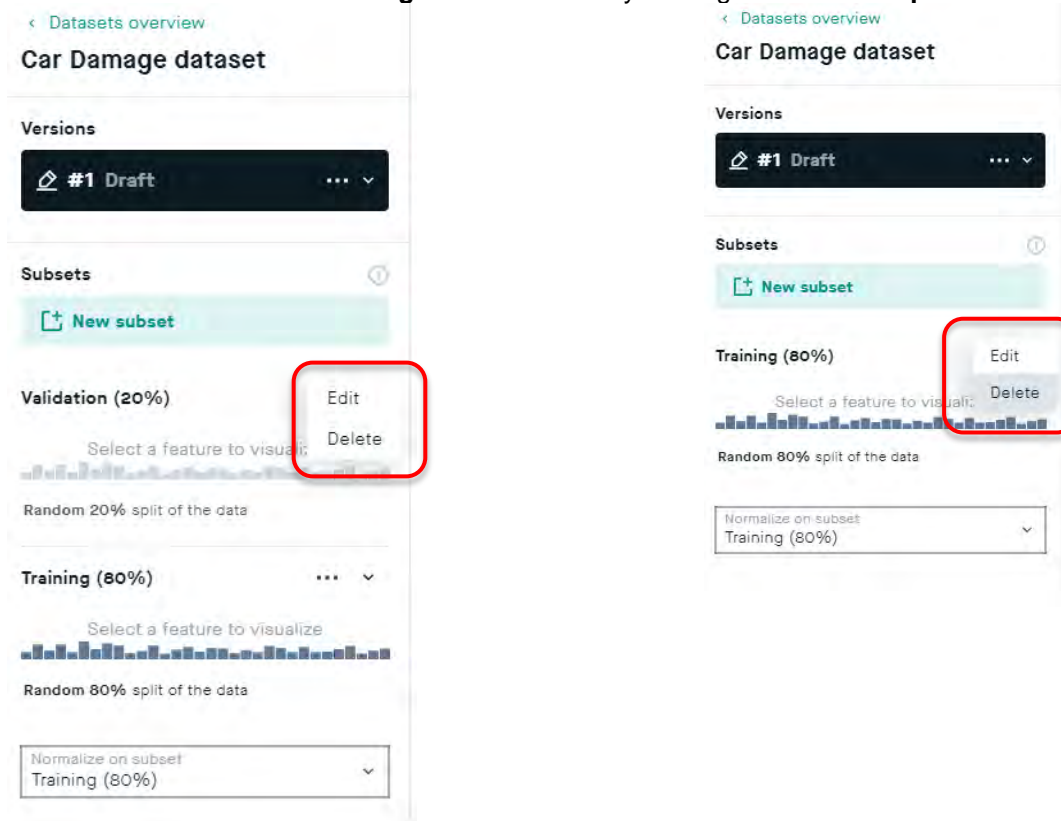


#### 4) Create subsets of the car damage dataset

The subset column, containing a T or a V, indicates if the row should be used for training or validation. The split between training and validation data is approximately 80% and 20%. This column was created during the pre-processing of the raw data.

Even though it is possible to use the default subsets created by the platform when you upload the data, it is more advantageous to create a conditional split based on the subset column. For this dataset, there is no separate labelled test subset, in case you want to analyse the performance of the deployed model outside the platform. Instead, you can compare the model predictions with the ground truth provided with the predefined validation subset.

- 1) Delete the default subsets **Training** and **Validation** by clicking the **Subsets options menu (...)** then **Delete**.



- 2) Click **New subset** and name the training subset **Training**. Then click **Add conditional filter** and set **Feature** to **subset**, **Operator** to **is equal to**, and **Value** to **T**. The details are shown below. Click **Create** to create this subset.

**Create a subset**

A subset enables you to define a set of examples in the dataset to be used for training and validation of your experiments.

Read more about how to create subsets [here](#).

Training

**Filter(s)**

1. Feature subset Operator is equal to Value T

+ Add random % filter + Add conditional filter

Create

- 3) Repeat the procedure for a new **Validation** subset and set **Feature** to **subset**, **Operator** to **is equal to**, and **Value** to **V**. The details are shown below.

**Create a subset**

A subset enables you to define a set of examples in the dataset to be used for training and validation of your experiments.

Read more about how to create subsets [here](#).

Validation

**Filter(s)**

1. Feature subset Operator is equal to Value V

+ Add random % filter + Add conditional filter

Create

- 4) Select the Training subset that you have created in **Normalize on subset**.

< Datasets overview

**Car Damage dataset**

**Versions**

#1 Draft

**Subsets**

+ New subset

**Training**

Select a feature to visualize

subset is equal to T

**Validation**

Select a feature to visualize

subset is equal to V

Normalize on subset  
Training

5) We have now created a dataset ready to be used in the platform. Click **Save version**.

## 5) Create a new experiment

- 1) Click on **Use in new experiment** to create a new experiment using this dataset.
- 2) Name the experiment in the **Experiment wizard**.
- 3) Make sure that the **Car damage dataset** is selected in the **Define dataset** tab. Click **Next** to continue.

- 4) In the Input(s) / target tab, check that the following inputs are pre-populated. Click **Next** to move to the next step.

**Experiment wizard** x

Experiment name  
Experiment 1

1. Dataset    **2. Input(s) / target**    3. Snippet    4. Weights

Select the input(s) and target features you want to use.

**Input(s)**

☐ Search feature

☒ image (224×224×3)

☐ class (8)

☐ subset (1)

**Target**

☐ image (224×224×3)

☒ class (8)

☐ subset (1)

[Previous](#)    [Create custom experiment](#)    [Next](#)

- 5) On the **Snippet** tab and select the **EfficientNet B0** snippet. Click **Next** to continue.

**Experiment wizard** x

Experiment name  
Experiment 1

1. Dataset    2. Input(s) / target    **3. Snippet**    4. Weights

Select problem type and snippet.

Problem type  
Single-label image classification

Recommended snippets

**EfficientNet B0**    MobileNetV2 1.0    ResNetV2 large 101

Other snippets

[Previous](#)    [Create custom experiment](#)    [Next](#)

- 6) On the **Weights** tab. Select **ImageNet** for pretrained data. Click **Create** to continue.

**Experiment wizard** x

Experiment name  
Experiment 1

1. Dataset    2. Input(s) / target    3. Snippet    **4. Weights**

Choose how you want to initialize the weights.

Weights  
ImageNet

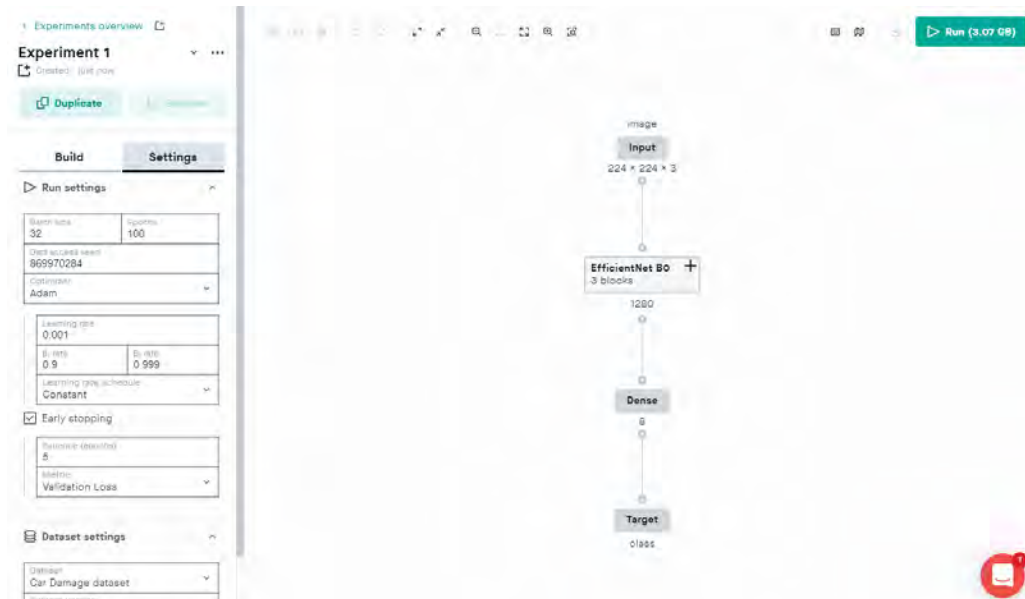
☒ Weights trainable (all blocks)

Trained on the ImageNet classification dataset, with 1.2 million images from 1000 classes.  
 Browse the dataset at [image-net.org](https://image-net.org)  
[Third-party terms apply](#)

[Previous](#)    [Create custom experiment](#)    [Create](#)

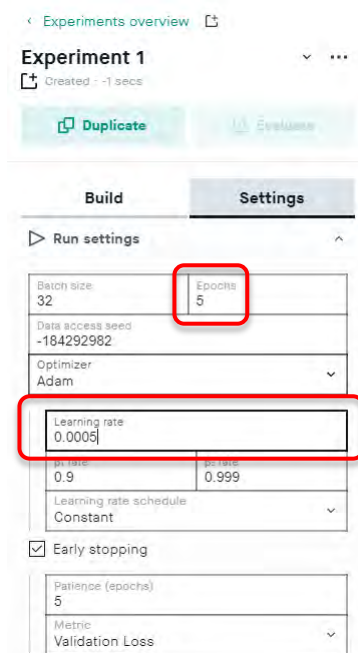
The EfficientNet B0 blocks will be added to the Modeling canvas. You can expand and collapse the EfficientNet B0 group at any time by clicking + or -.





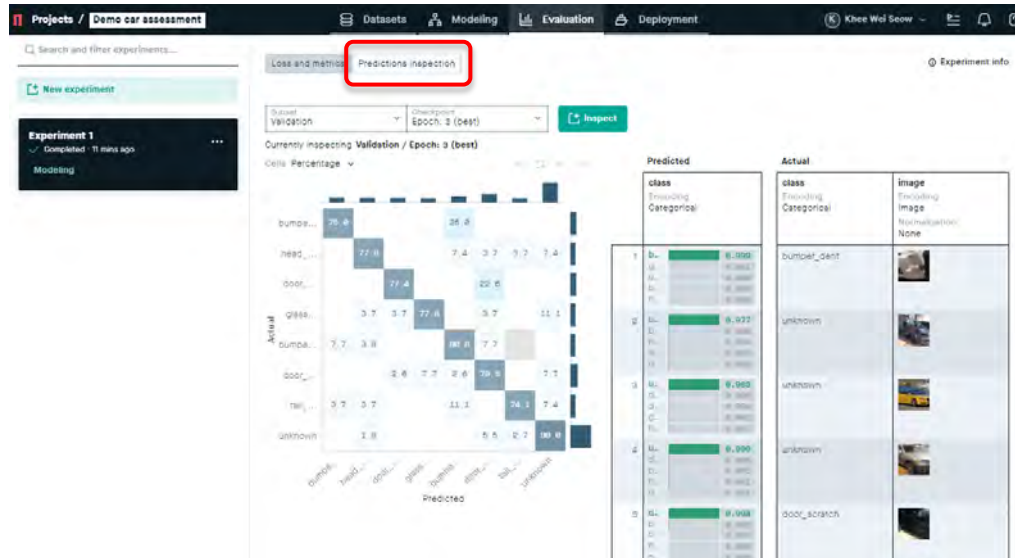
## 6) Run the experiment

- 1) Click the **Settings** tab and change the **Learning rate** to 0.0005 and **Epoch** to 5. Click **Run** to start the training. The training may take a long time depending on complexity and the number of epochs. You can grab a coffee or tea at this point in time. For this case, we should take around 8 mins.

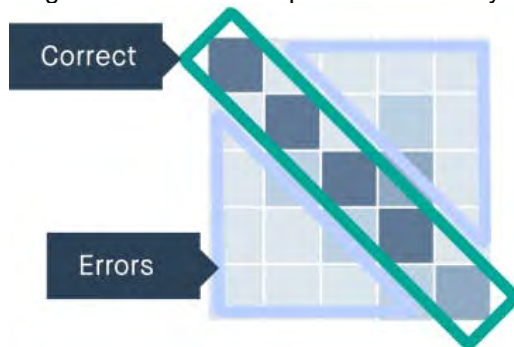


## 7) Analyse the experiment

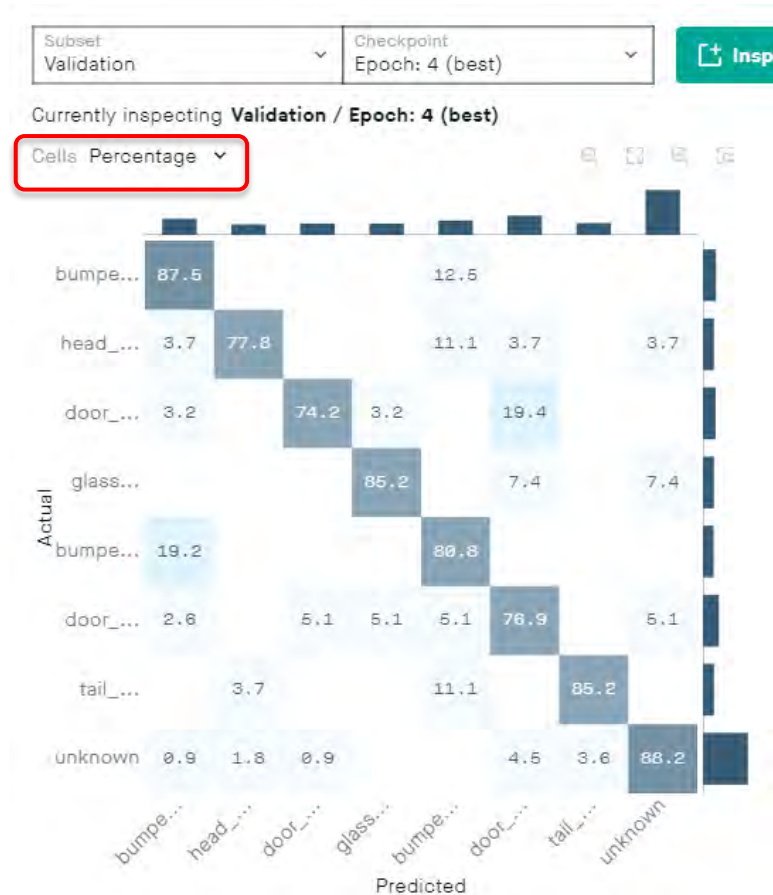
- 1) Go to the **Evaluation** view. Click on **Predictions inspection**.



- 2) Since the model solves a classification problem, a confusion matrix is displayed. The top-left to bottom-right diagonal shows correct predictions. Everything outside this diagonal are errors.



- 3) Note that metrics are based on the validation subset which only consists of 20% of the original dataset.
- 4) Click the dropdown next to **Cells** and select **Percentage**. The normalized values that are now displayed correspond to the recall for each class.



The recall values clearly indicate that the model has learned the features in the images.

Ref: <https://peltarion.com/knowledge-center/documentation/glossary#R>

## 8) Deploy the trained model

- 1) In the **Deployment** view click **New deployment** as shown below.



- 2) In the **Create deployment** window, select the experiment, **Checkpoint** model and set a **name** for this deployment. Click **Create** to continue.

Create deployment

Experiment

Experiment 1

Checkpoint

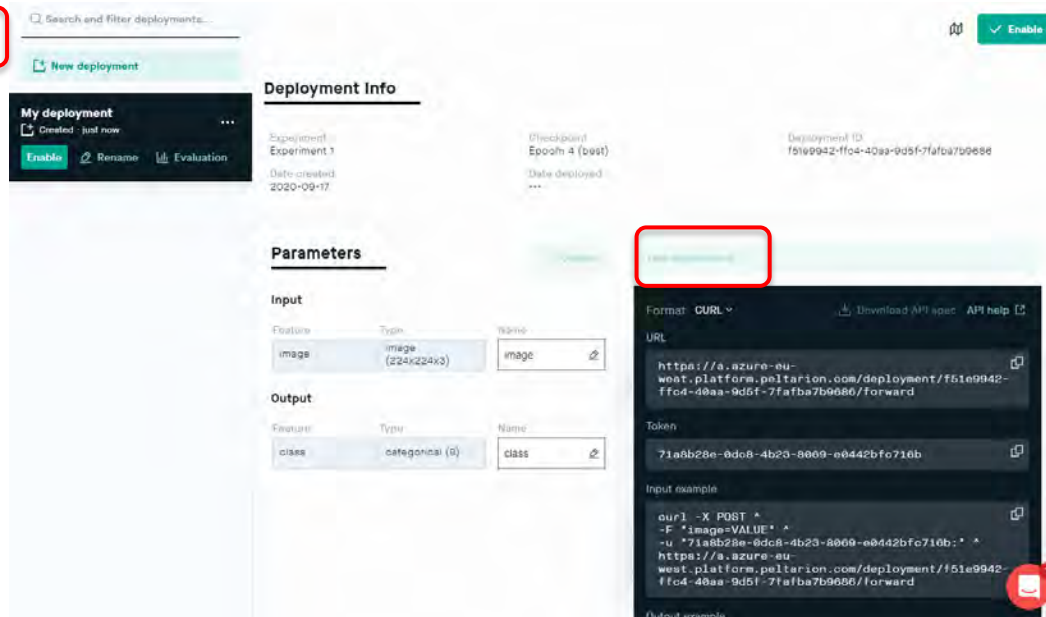
Epoch: 4 (best)

Name

My deployment

Create

- 3) Once the deployment is ready, you will see a summary as follow.



4) Click the **Enable** switch to deploy the experiment.

## 9) Test the classifier in a browser

1) Let's test your model. Click the **Test deployment** button, and you'll open the **Image & Text classifier API tester** with all relevant data copied from your deployment.



2) Drag a test image onto the image box on the left and click **on Play** to get a prediction.



#### 10) Next Steps

The next steps could be to try to run the project using different models to see if that improves the result or maybe change the learning rate or training epochs.



## Activity 4 – Creating a Sentiment Analyser

In this activity, we will learn:

- ❑ We will solve a text classification problem using BERT (Bidirectional Encoder Representations from Transformers). The input is an IMDB dataset consisting of movie reviews, tagged with either positive or negative sentiment – i.e., how a user or customer feels about the movie.

Ref:

- 1) Deploy an operational AI model (<https://peltarion.com/knowledge-center/documentation/tutorials/deploy-an-operational-ai-model>)
  - 2) Embeddings - If you want it could be a good idea to read about word embeddings, which is an important concept in NLP (Natural Language Processing). For an introduction and overview of different types of word embeddings, check out the links below:
  - 3) Get Busy with Word Embeddings — An Introduction (<https://www.shanelynn.ie/get-busy-with-word-embeddings-introduction>)
  - 4) Introduction to Embedding in Natural Language Processing (<https://www.datascience.com/blog/embedding-in-natural-language-processing>)
- Text embedding block (<https://peltarion.com/knowledge>)

### 1) The Problem

Text classification aims to assign text, e.g., tweets, messages, or reviews, to one or multiple categories. Such categories can be the author's mood: is a review positive or negative?

We will learn how to build and deploy a model based on BERT.

BERT pushed the state of the art in Natural Language Processing (NLP) by combining two powerful technologies:

- a. It is based on a deep Transformer network. A type of network that can process efficiently long texts by using attention.
- b. It is bidirectional. Meaning that it takes into account the whole text passage to understand the meaning of each word.

### 2) Dataset – The Large Movie Review Dataset v1.0

The raw dataset contains movie reviews along with their associated binary category: positive or negative. The dataset is intended to serve as a benchmark for sentiment classification

The core dataset contains 50,000 reviews split evenly into a training and test subset. The overall distribution of labels is balanced, i.e., there are 25,000 positive and 25,000 negative reviews.

The raw dataset also includes 50,000 unlabelled reviews for unsupervised learning, these will not be used in this tutorial.

In the entire collection, no more than 30 reviews are allowed for any given movie because reviews for the same movie tend to have correlated ratings.

In the labelled train/test sets, a negative review has a score that is less or equal to 4 out of 10, and a positive review has a score that is higher than 7. Reviews with more neutral ratings are not included in the dataset.

Each review is stored in a separate text file, located in a folder named either “positive” or “negative.”

Note: For more information about the raw dataset, see the ACL 2011 paper "Learning Word Vectors for Sentiment Analysis".

Written by Maas, A., Daly, R., Pham, P., Huang, D., Ng, A. and Potts, C. (2011). Learning Word Vectors for Sentiment Analysis: Proceedings of the 49th Annual Meeting of the Association for Computational Linguistics: Human Language Technologies. [online] Portland, Oregon, USA: Association for Computational Linguistics, pp.142–150. Available at: <http://www.aclweb.org/anthology/P11-1015>.

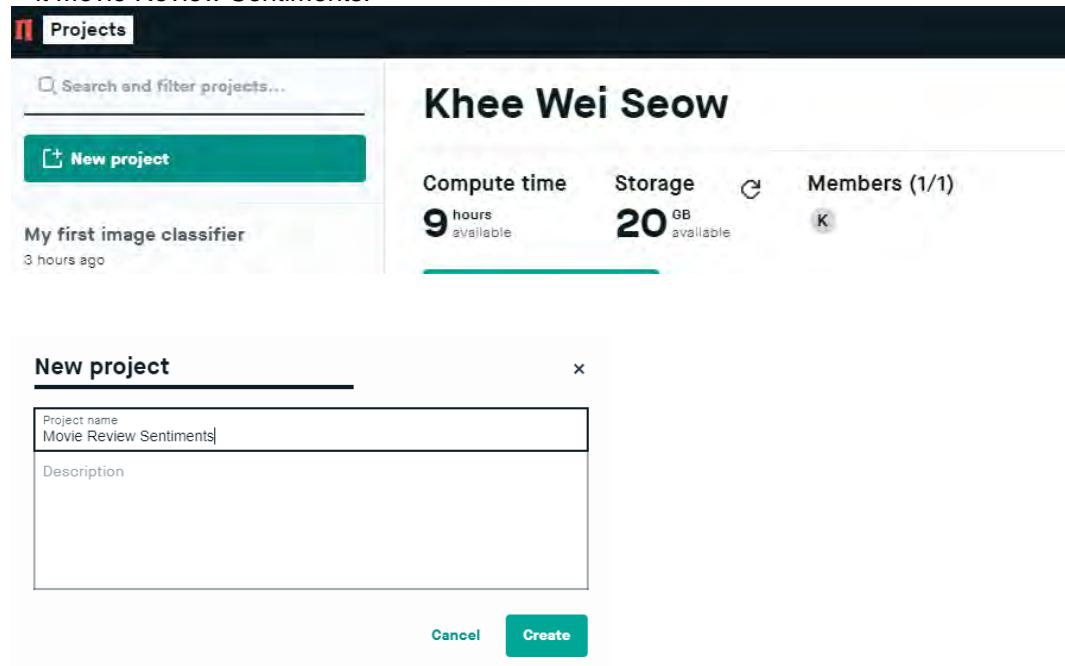
**For this activity**, the dataset that we will upload in this activity has been preprocessed so that all the reviews and their respective sentiments are stored in a single CSV file with two fields, “review” and “sentiment.”

The review text may include commas, which will be interpreted as a field delimiter on the platform. To escape these commas, the text is surrounded by double-quotes.

The processed dataset only includes the training data.

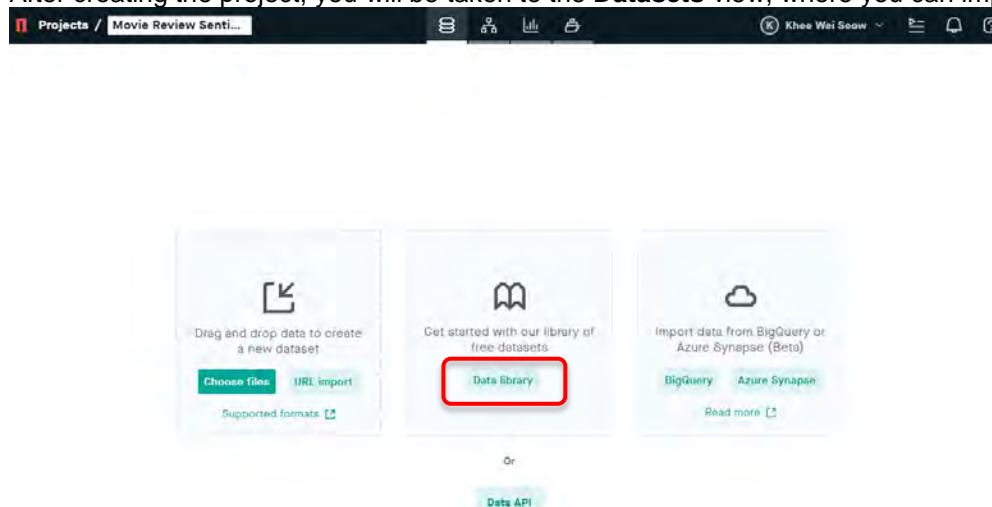
### 3) Create a new project

- 1) Sign up for an account and login at <https://platform.peltarion.com/login>
- 2) Create a new project by clicking on New Experiment and give your project a name. In this case, we can name it Movie Review Sentiments.

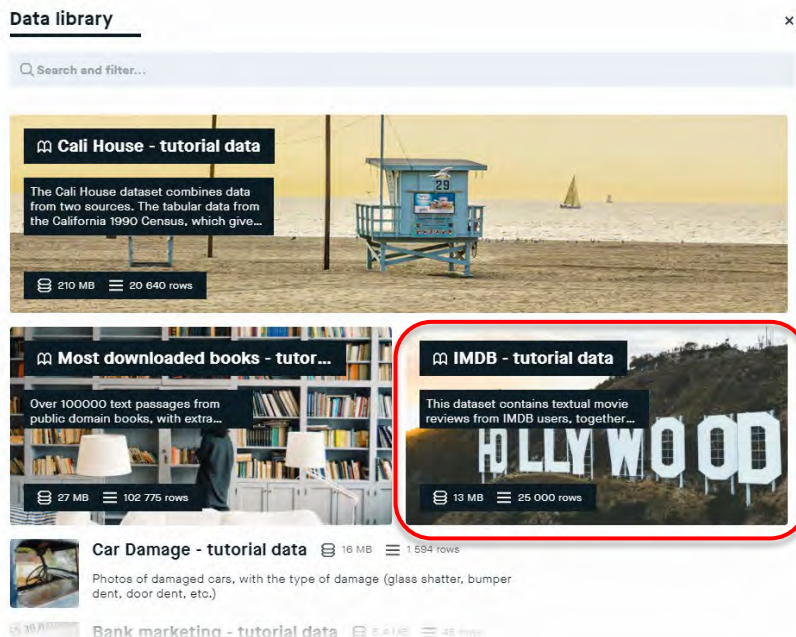


### 4) Add a new dataset

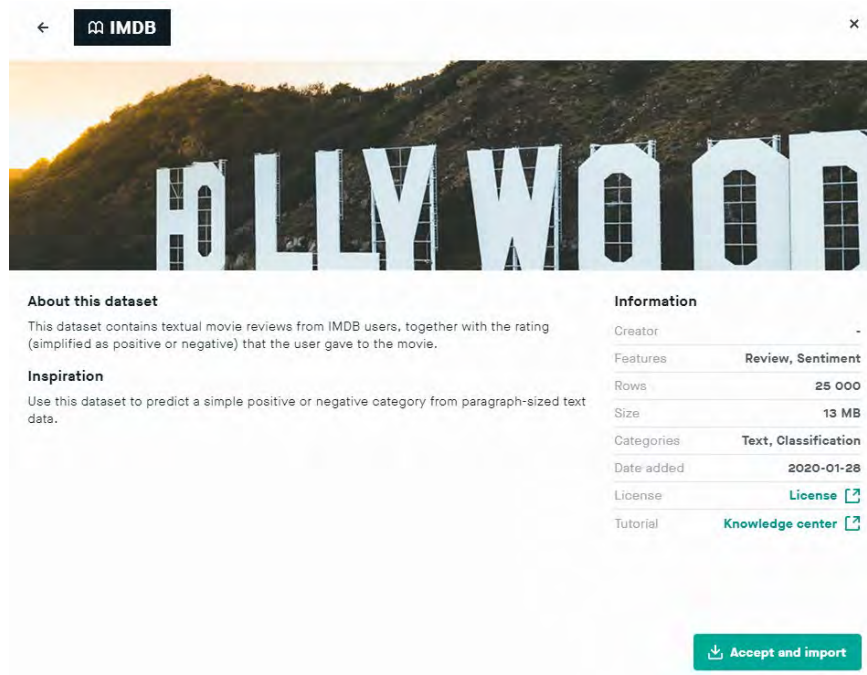
- 1) After creating the project, you will be taken to the **Datasets** view, where you can import data.



- 2) Click the **Data library** button and look for the **IMDB - tutorial data** dataset in the list. Click on it to get more information.

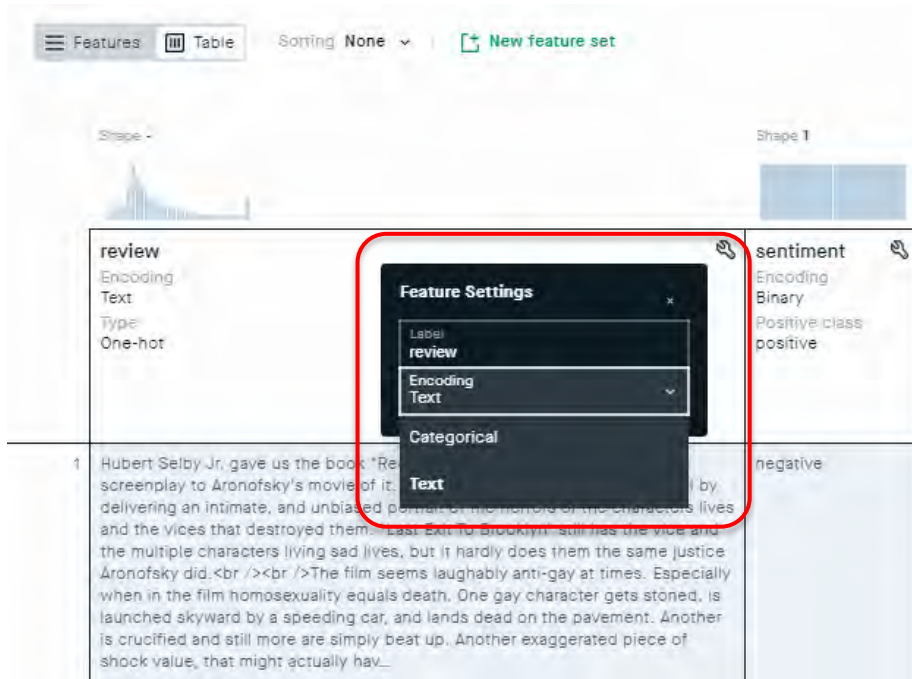


- 1) If you agree with the license, click **Accept and import**. This will import the dataset in your project, and you will be taken to the dataset's details where you can edit features and subsets.



## 5) Text Encoding

- 1) Click on the **Table** button, click the **Review** column and set the following in the **Feature Settings**.
  - a. Encoding to Text

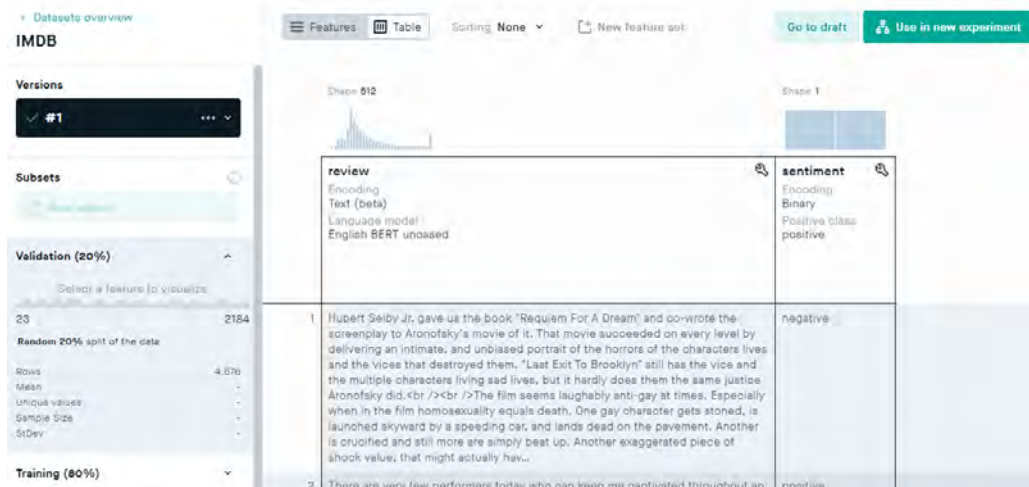


Note:

#### Subsets of the dataset

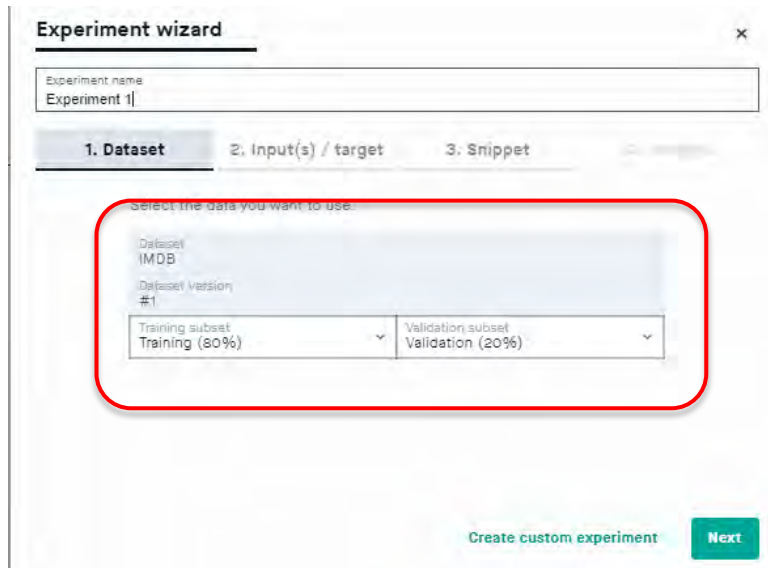
On the left, you will see the subsets. All samples in the dataset are by default split into 20% validation and 80% training subsets. Keep these default values in this project.

- 2) Save the dataset by clicking on **Save Version**. The view will then change to **Use in new experiment**.



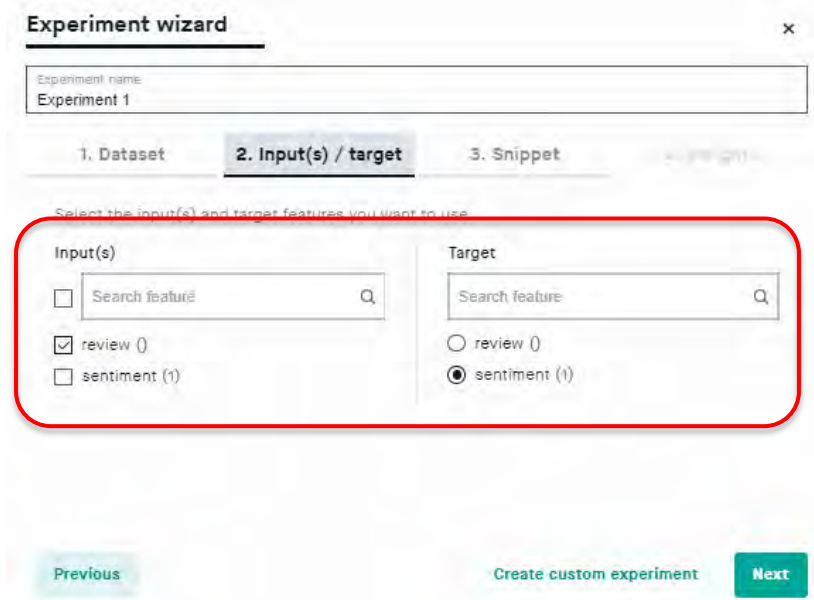
## 6) Design a text classification model with the BERT model

- 1) Make sure that the **IMDB** dataset is selected in the **Experiment wizard**. Click **Next**.



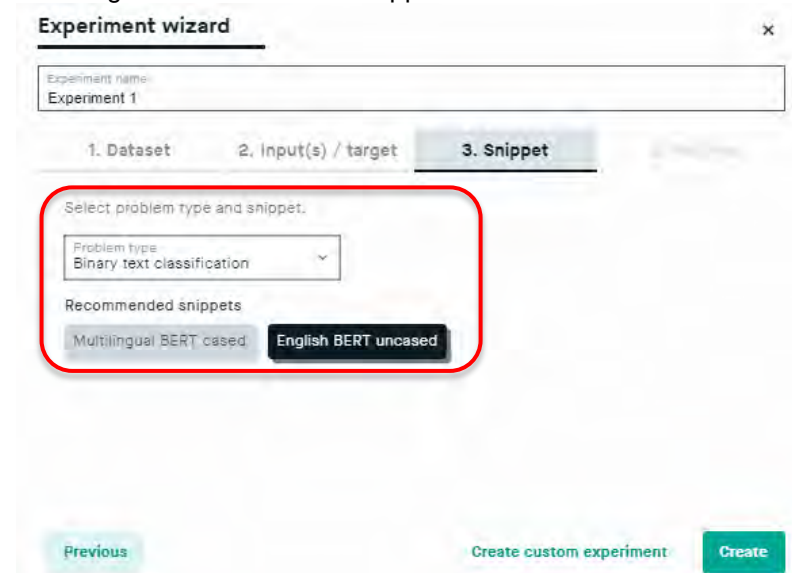
The screenshot shows the 'Experiment wizard' dialog box with the '1. Dataset' tab selected. The 'Experiment name' field contains 'Experiment 1'. Below the tabs, a red box highlights the 'Select the data you want to use' section. This section includes a 'Dataset' dropdown set to 'IMDB', a 'Dataset version' dropdown set to '#1', and two subset selection dropdowns: 'Training subset' set to 'Training (80%)' and 'Validation subset' set to 'Validation (20%)'. At the bottom, there are buttons for 'Create custom experiment' and 'Next'.

- 2) In the **Inputs(s) / target** tab, check that the **Input(s)** and **Target** are set as follows:



The screenshot shows the 'Experiment wizard' dialog box with the '2. Input(s) / target' tab selected. The 'Experiment name' field contains 'Experiment 1'. Below the tabs, a red box highlights the 'Select the input(s) and target features you want to use' section. This section is divided into two columns: 'Input(s)' and 'Target'. In the 'Input(s)' column, there is a search bar, a checkbox for 'Search feature', a checked checkbox for 'review ()', and an unchecked checkbox for 'sentiment (1)'. In the 'Target' column, there is a search bar, an unchecked radio button for 'review ()', and a checked radio button for 'sentiment (1)'. At the bottom, there are buttons for 'Previous', 'Create custom experiment', and 'Next'.

- 3) In the Snippet tab, set the Problem type to Binary text classification since we are predicting Science fiction or not. Use English BERT uncased snippet.



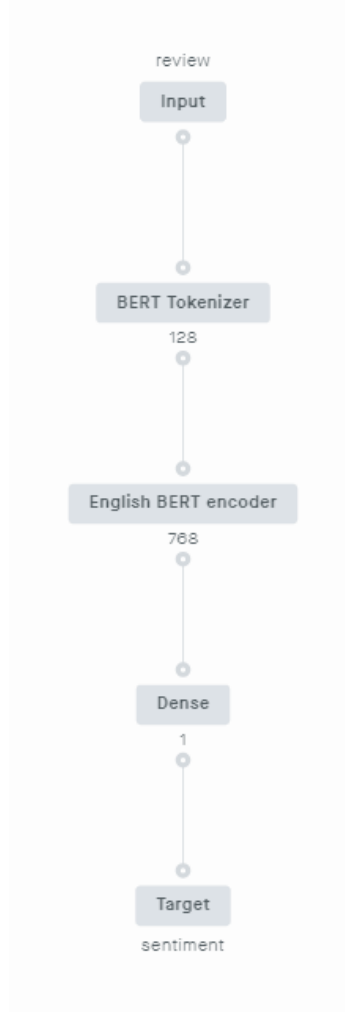
The screenshot shows the 'Experiment wizard' dialog box with the '3. Snippet' tab selected. The 'Experiment name' field contains 'Experiment 1'. Below the tabs, a red box highlights the 'Select problem type and snippet' section. This section includes a 'Problem type' dropdown set to 'Binary text classification'. Below this, under 'Recommended snippets', there are two buttons: 'Multilingual BERT cased' and 'English BERT uncased'. At the bottom, there are buttons for 'Previous', 'Create custom experiment', and 'Create'.



The BERT English uncased snippet includes the whole BERT network. The BERT block implements the base version of the BERT network. It is composed of 12 encoding layers from a Transformer network, each layer having 12 attention heads. The total number of parameters is 110 million. The snippet allows you to use this massive network with weights pre-trained to understand the text.

The BERT snippet includes:

- a. An Input block.
  - b. A BERT Encoder block with pre-trained weights which gives BERT a general understanding of English. The BERT encoder block looks at the input sequence as a whole, producing an output that contains an understanding of the sentence. The block outputs a single vector of 768 size.
  - c. A label block with pre-trained weights.
  - d. A Dense block that is untrained.
  - e. A Target block.
- 4) Click **Create** to create the experiment and the prepopulated BERT model will appear in the **Modeling** canvas.



- 5) Click the Settings tab and check that:
- a. **Batch Size** is 2. If you set a larger batch size you will run out of memory.
  - b. **Epochs** is 2. Training takes a long time, so don't train for too long the first time when you check if your model is good.
  - c. **Learning rate** is 0.00001 (4 zeros). To avoid catastrophic forgetting.

Experiments overview

Experiment 2

Created - 1 sec

Duplicate

Build Settings

Run settings

Batch size: 2 Epochs: 2

Data access seed: 1180914220

Optimizer: Adam

Learning rate: 0.00001

Warm-up epochs: 0.5

Decrement per epoch: 0.000008

Early stopping

- 6) Click **Run** to start training the model. **Note: This experiment will take 2 hours to complete.**

## 7) Evaluation

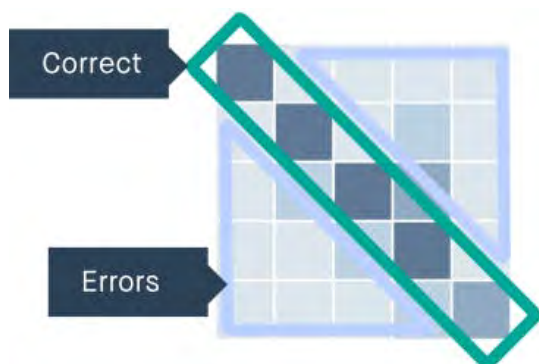
- 1) Navigate to the **Evaluation** view and watch the model train. The training will take quite a long time since BERT is a very large and complex model.

### Accuracy

To evaluate the performance of the model, you can look at overall accuracy, which is displayed in the Experiment info section to the right. It should be approximately 85-90%. For comparison, a classifier that would predict the class randomly would have a 50% accuracy, since 50% of reviews in the dataset are positive and 50% are negative.

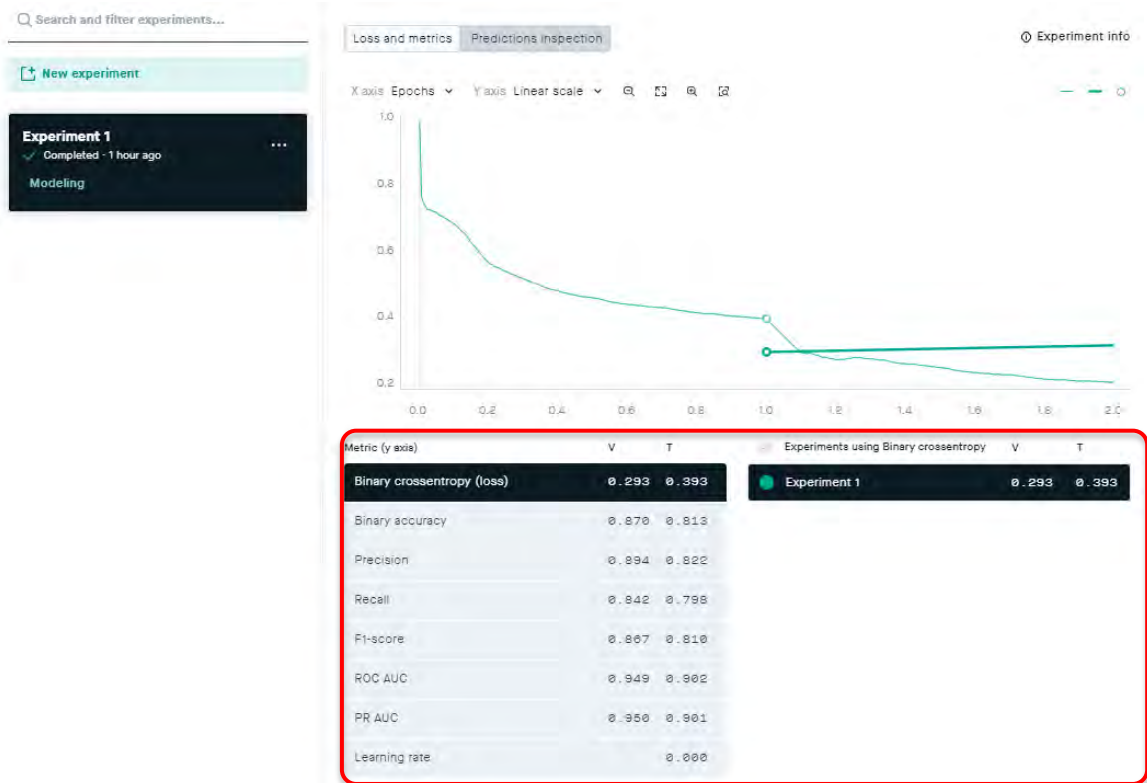
### Confusion matrix

Since the model solves a classification problem, a confusion matrix is displayed. The top-left to bottom-right diagonal shows correct predictions. Everything outside this diagonal are errors.

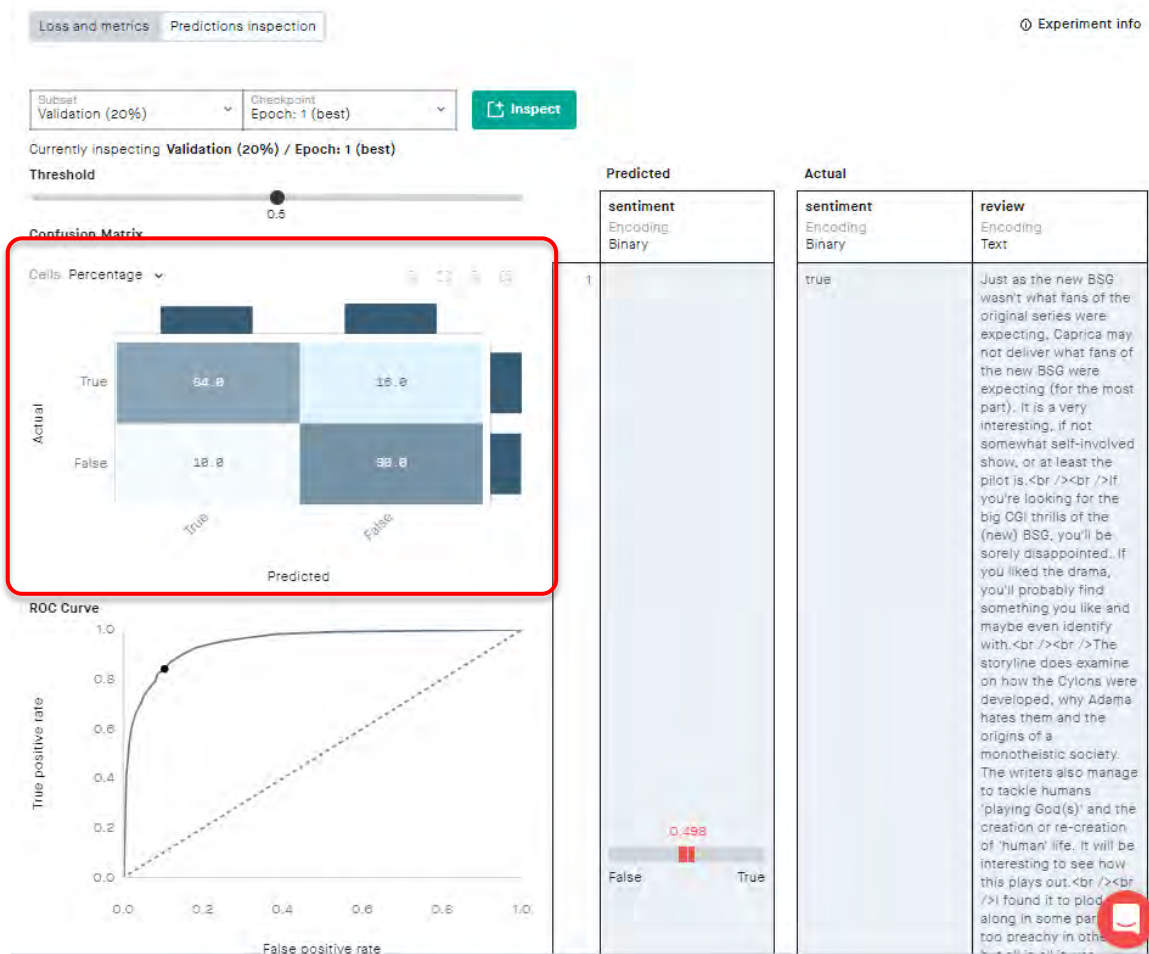


### Recall

The recall (<https://peltarion.com/knowledge-center/documentation/glossary>) per class corresponds to the percentage values in the confusion matrix diagonal. You can display the same metric by hovering over the horizontal bars to the right of the confusion matrix. You can also view the precision per class by hovering over the vertical bars on top of the confusion matrix.

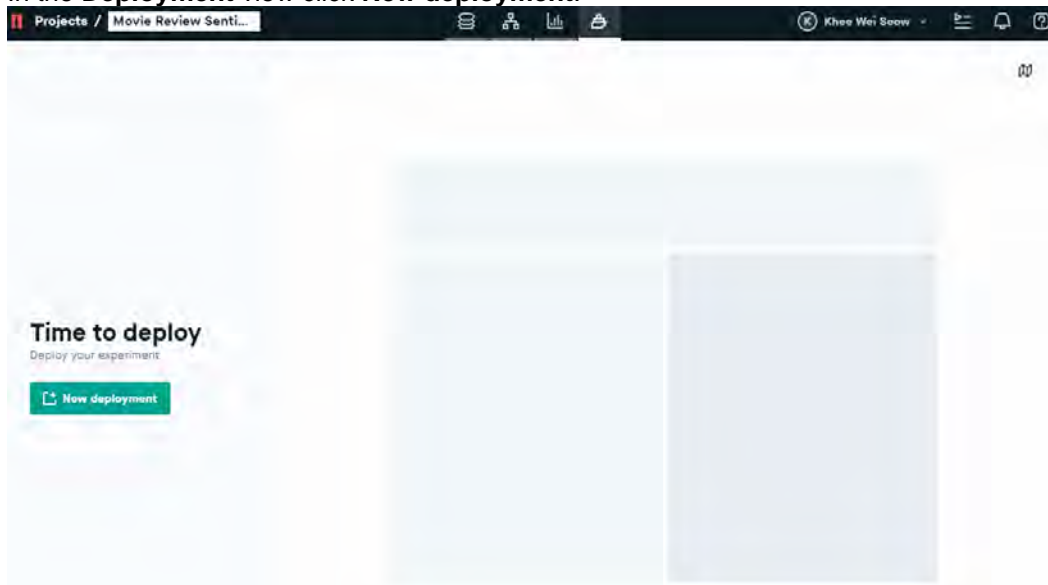


- 2) Navigate to the **Predictions Inspection** view. It will take awhile to create the confusion matrix. When all the examples were processed, you should see the following:



## 8) Create new deployment

- 1) In the **Deployment** view click **New deployment**.



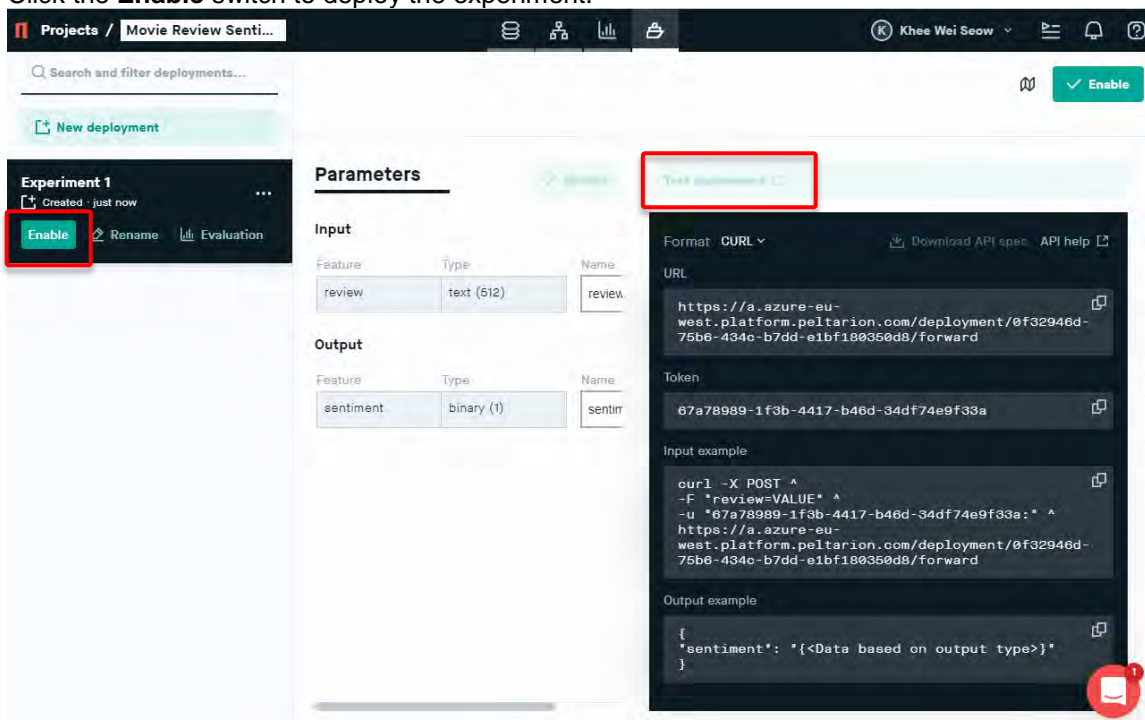
- 2) Select experiment and checkpoint of your trained model to test it for predictions, or enable for business product calls. Both best epoch and last epoch for each trained experiment are available for deployment. Click **Create** to continue.

**Create deployment** ×

|                 |   |
|-----------------|---|
| Experiment      | ▼ |
| Experiment 1    |   |
| Checkpoint      | ▼ |
| Epoch: 1 (best) |   |
| Name            |   |
| Experiment 1    |   |

Create

- 3) Click the **Enable** switch to deploy the experiment.



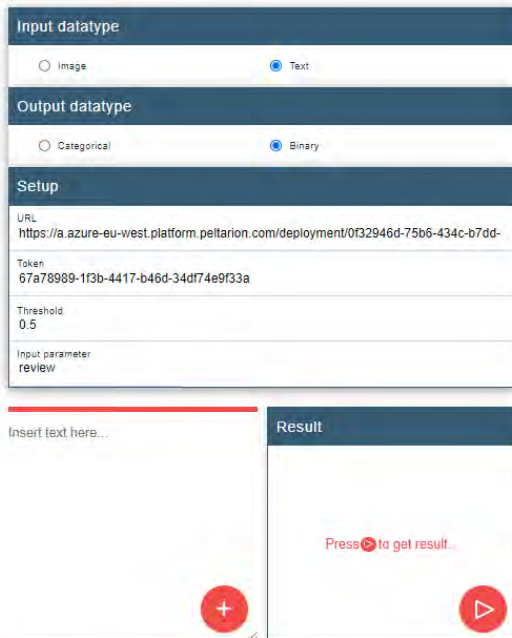
## 9) Test the text classifier in a browser

- 1) Let's test your model. Click the **Test deployment** button, and you'll open the **Text classifier API tester** with all relevant data copied from your deployment.



### Image & Text Classifier

#### API tester



The screenshot shows the 'Image & Text Classifier API tester' interface. It has a 'Setup' section with the following fields:

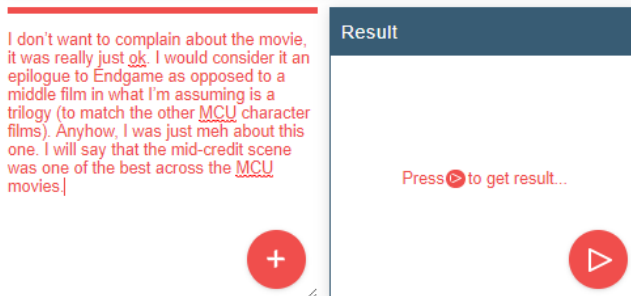
- Input datatype:** Radio buttons for 'Image' and 'Text' (selected).
- Output datatype:** Radio buttons for 'Categorical' and 'Binary' (selected).
- URL:** `https://a.azure-eu-west.platform.peltarion.com/deployment/0f32946d-75b6-434c-b7dd-`
- Token:** `67a78989-1f3b-4417-b46d-34df74e9f33a`
- Threshold:** `0.5`
- Input parameter:** `review`

Below the setup section is a text input area with a placeholder 'Insert text here...' and a red '+' button. To the right is a 'Result' section with a red play button and the text 'Press ▶ to get result...'.

- 2) Now, write your own review, copy the example below or simply copy a recent review from, e.g., IMDB.

#### Example:

I don't want to complain about the movie, it was really just ok. I would consider it an epilogue to Endgame as opposed to a middle film in what I'm assuming is a trilogy (to match the other MCU character films). Anyhow, I was just meh about this one. I will say that the mid-credit scene was one of the best across the MCU movies.



The screenshot shows the 'Text classifier API tester' interface with the example review text pasted into the input field. The text is: 'I don't want to complain about the movie, it was really just ok. I would consider it an epilogue to Endgame as opposed to a middle film in what I'm assuming is a trilogy (to match the other MCU character films). Anyhow, I was just meh about this one. I will say that the mid-credit scene was one of the best across the MCU movies.' The 'Result' section is still empty with the text 'Press ▶ to get result...'.

- 3) Click **Play**.
- 4) [Optional] To see what an actual request from the application and the response from the model may look like, you can run the example CURL command that is provided in the Code examples section of the Deployment view. Replace the VALUE parameter with review text and run the command in a terminal.



The screenshot displays the Peltarion API interface. On the left, under the 'Parameters' tab, the 'Input' section shows a feature named 'review' of type 'text (512)'. The 'Output' section shows a feature named 'sentiment' of type 'binary (1)'. On the right, the 'Test deployment' tab is active, showing the API URL, a token, and example curl commands for input and output. A red chat bubble icon is visible in the bottom right corner.

**Parameters**

**Input**

| Feature | Type       | Name   |
|---------|------------|--------|
| review  | text (512) | review |

**Output**

| Feature   | Type       | Name   |
|-----------|------------|--------|
| sentiment | binary (1) | sentir |

**Test deployment**

Format: **CURL** [Download API spec](#) [API help](#)

**URL**

`https://a.azure-eu-west.platform.peltarion.com/deployment/0f32946d-75b6-434c-b7dd-e1bf180350d8/forward`

**Token**

`67a78989-1f3b-4417-b46d-34df74e9f33a`

**Input example**

```
curl -X POST ^
-F "review=VALUE" ^
-u "https://a.azure-eu-west.platform.peltarion.com/deployment/0f32946d-75b6-434c-b7dd-e1bf180350d8/forward"
```

**Output example**

```
{
  "sentiment": "{<Data based on output type>}"
}
```

In a cmd windows:

```
C:\Users\seow_khee_wei>curl -X POST ^
More? -F "review=A fun brain candy movie...good action...fun dialog. A genuinely good day" ^
More? -u "https://a.azure-eu-west.platform.peltarion.com/deployment/0f32946d-75b6-434c-b7dd-e1bf180350d8/forward" ^
More? {"sentiment":0.95231044}
C:\Users\seow_khee_wei>
```

## 10) Next Step

The next steps could be to try to run the experiment with increased epochs and see if that improves the result or maybe change the learning rate.

## Activity 5 – [Bonus] Book Genre Classifier

In this activity, we will learn:

- ☐ In this activity, we will use the Peltarion Platform to build a model to classify books.

Ref:

- Deploy an operational AI model (<https://peltarion.com/knowledge-center/documentation/tutorials/deploy-an-operational-ai-model>)
- Embeddings - If you want it could be a good idea to read about word embeddings, which is an important concept in NLP (Natural Language Processing). For an introduction and overview of different types of word embeddings, check out the links below:
  - Get Busy with Word Embeddings — An Introduction (<https://www.shanelynn.ie/get-busy-with-word-embeddings-introduction>)
  - Introduction to Embedding in Natural Language Processing (<https://www.datascience.com/blog/embedding-in-natural-language-processing>)
  - Text embedding block (<https://peltarion.com/knowledge-center/documentation/modeling-view/build-an-ai-model/blocks/text-embedding>)

### 1) The Problem

Text classification aims to assign text, e.g., tweets, messages, or reviews, to one or multiple categories. Such categories can be whether or not a book is considered as science fiction.

We will learn how to build and deploy a model based on BERT.

BERT pushed the state of the art in Natural Language Processing (NLP) by combining two powerful technologies:

- It is based on a deep Transformer network. A type of network that can process efficiently long texts by using attention.
- It is bidirectional. Meaning that it takes into account the whole text passage to understand the meaning of each word.

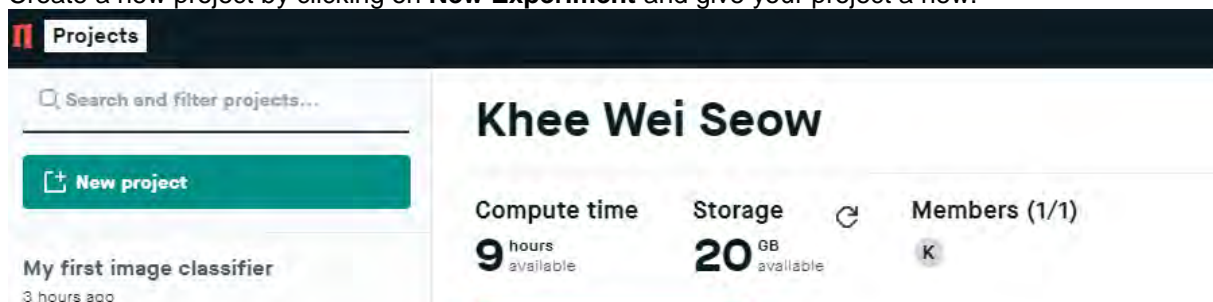
### 2) Dataset - CMU book summary dataset

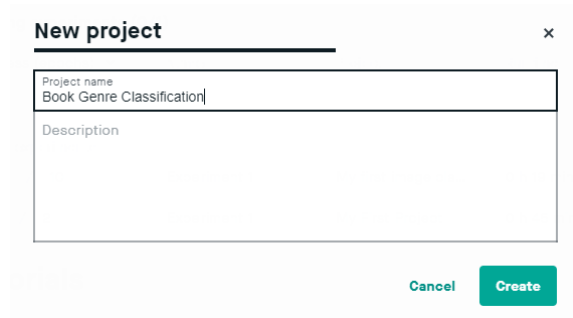
The data comes from the CMU Book Summary Dataset (<http://www.cs.cmu.edu/~dbamman/booksummaries.html>), a dataset of over 16 000 book summaries. For this activity, we wanted a dataset with science fiction book summaries, so we chose to preprocess the data to our task, so it contains book summaries along with their associated binary category: Science Fiction or not.

The dataset is intended to serve as a benchmark for sentiment classification. The overall distribution of labels is balanced, i.e., there are approximately 2 500 science fiction and 2 500 non-science fiction book summaries. Each summary is stored in a column, with a science fiction classification of either "yes" or "no".

### 3) Create a new Project

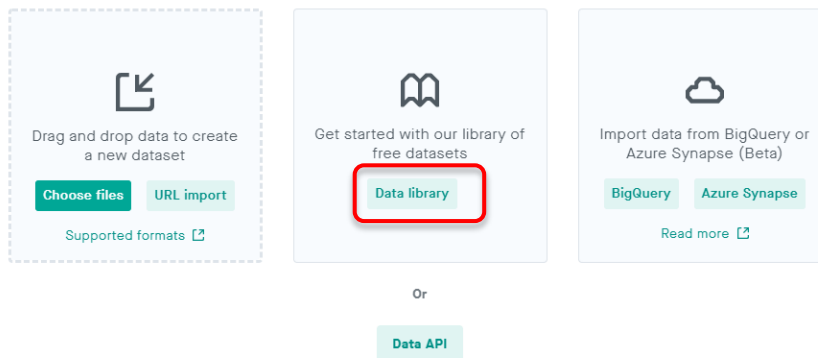
- Sign up for an account and login at <https://platform.peltarion.com/login>
- Create a new project by clicking on **New Experiment** and give your project a new.



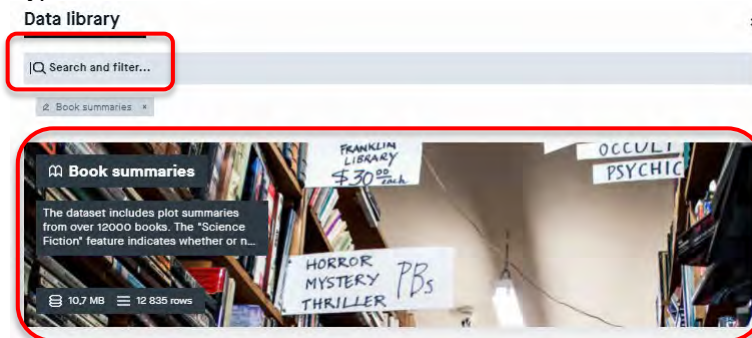


A dialog box titled "New project" with a close button (x) in the top right corner. It contains two input fields: "Project name" with the text "Book Genre Classification" and "Description" which is empty. At the bottom, there are two buttons: "Cancel" and "Create".

- 3) Navigate to the Datasets if you are not automatically brought there. Click on **Data Library**.



- 4) Type **Book Summaries** in the search box and select the Book Summaries dataset



- 5) Click on **Accept and import**

**About this dataset**

The dataset includes plot summaries from over 12000 books. The "Science Fiction" feature indicates whether or not the book is classified as sci-fi (1) or not(0)

**Inspiration**

Build your sci-fi/not sci-fi classifier, based on the plot summary.

**Information**

|            |                         |
|------------|-------------------------|
| Creator    | David Bamman            |
| Features   | 1 Text, 1 Categorical   |
| Rows       | 12 835                  |
| Size       | 10,7 MB                 |
| Categories | Text, Classification    |
| Date added | 2020-01-28              |
| License    | <a href="#">License</a> |

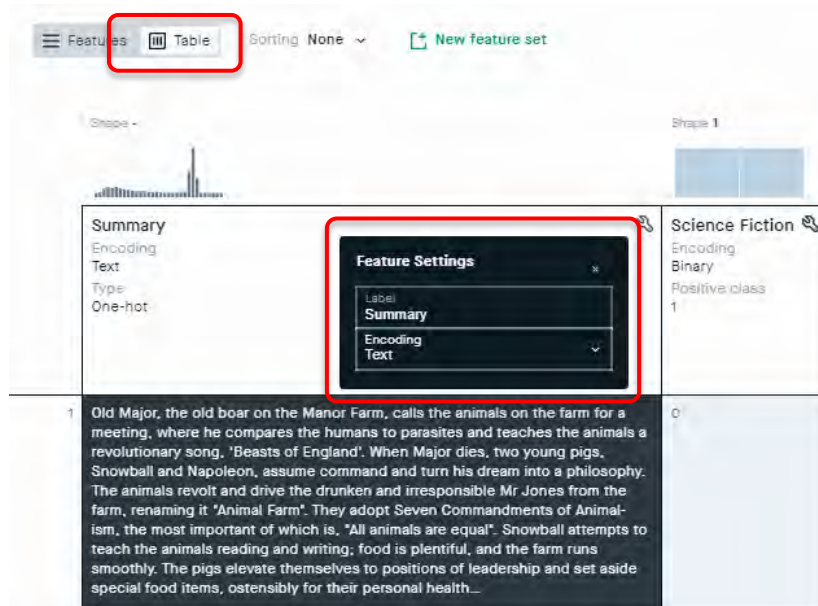
[Accept and import](#)

6) You will see the summaries of the dataset displayed as shown below.

The dataset is labelled binary, that is, 1 indicates that the book is classified as a science fiction book and 0 is not.

#### 4) Text encoding

- 1) Click on the **Table** button, click the **Summary** column and check the following in the **Feature Settings**.
  - Encoding to Text

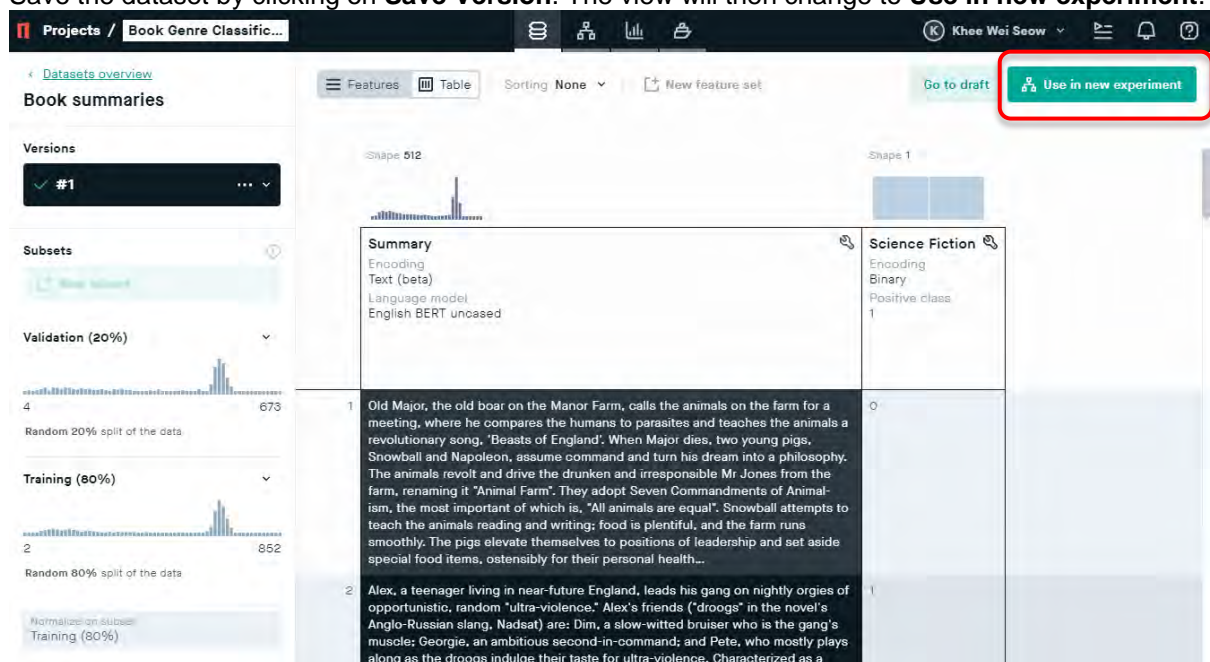


**Note:**

**Subsets of the dataset**

On the left, you will see the subsets. All samples in the dataset are by default split into 20% validation and 80% training subsets. Keep these default values in this project.

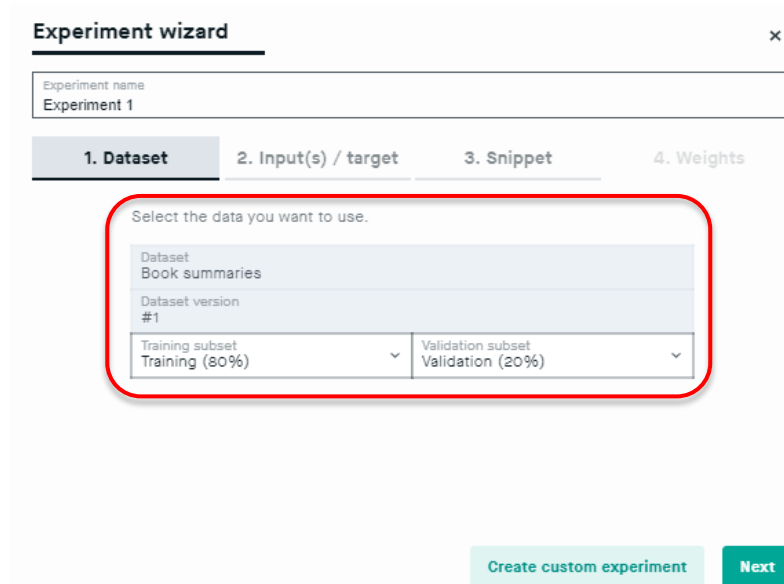
- 2) Save the dataset by clicking on **Save Version**. The view will then change to **Use in new experiment**.



**5) Design a text classification model**

- 1) Make sure that the **Book Summaries** dataset is selected in the Experiment wizard.

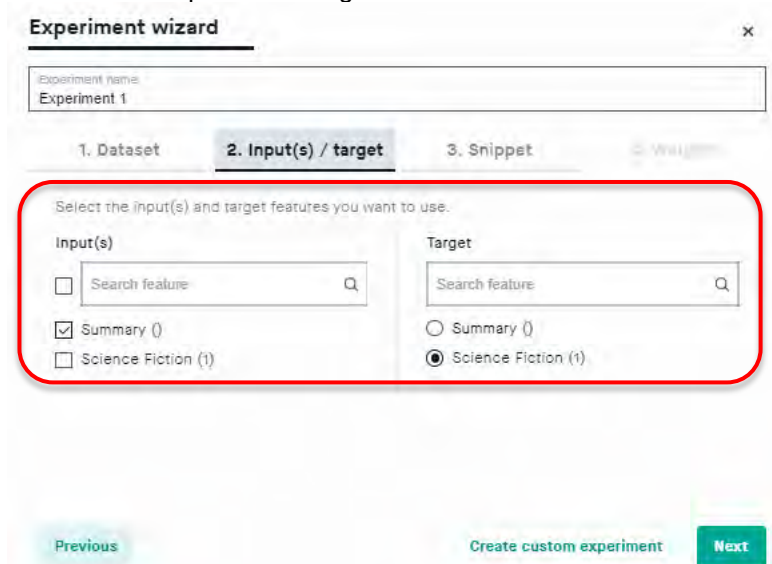




The screenshot shows the 'Experiment wizard' interface with the '1. Dataset' tab selected. The 'Experiment name' field contains 'Experiment 1'. Below the tabs, a red box highlights the dataset selection area. It includes a dropdown for 'Dataset' with 'Book summaries' selected, a dropdown for 'Dataset version' with '#1' selected, and two dropdowns for 'Training subset' (set to 'Training (80%)') and 'Validation subset' (set to 'Validation (20%)'). At the bottom right, there are two buttons: 'Create custom experiment' and 'Next'.

2) Click **Next** to continue.

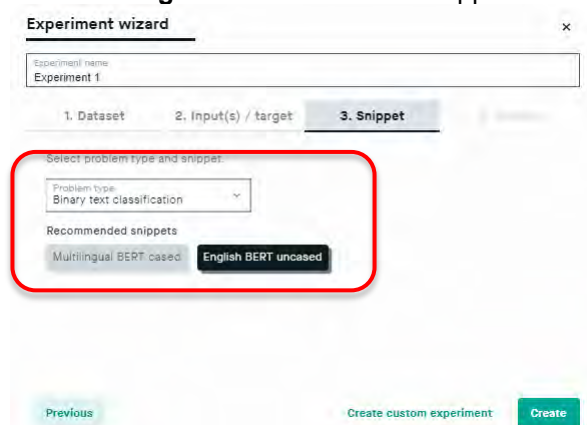
3) Check that the Inputs and Target are set as follows:



The screenshot shows the 'Experiment wizard' interface with the '2. Input(s) / target' tab selected. The 'Experiment name' field contains 'Experiment 1'. Below the tabs, a red box highlights the input and target selection area. It is divided into two sections: 'Input(s)' and 'Target'. In the 'Input(s)' section, there are three options: 'Search feature' (unchecked), 'Summary ()' (checked), and 'Science Fiction (t)' (unchecked). In the 'Target' section, there are three options: 'Search feature' (unchecked), 'Summary ()' (unchecked), and 'Science Fiction (t)' (checked). At the bottom, there are three buttons: 'Previous', 'Create custom experiment', and 'Next'.

Click **Next** to continue.

4) In the **Snippet** tab, set the Problem type to **Binary text classification** since we are predicting Science fiction or not. Use **English BERT uncased** snippet.



The screenshot shows the 'Experiment wizard' interface with the '3. Snippet' tab selected. The 'Experiment name' field contains 'Experiment 1'. Below the tabs, a red box highlights the snippet selection area. It includes a dropdown for 'Problem type' with 'Binary text classification' selected. Below this, there are two buttons for 'Recommended snippets': 'Multilingual BERT cased' and 'English BERT uncased'. At the bottom, there are three buttons: 'Previous', 'Create custom experiment', and 'Create'.

The BERT English uncased snippet includes the whole BERT network. The BERT block implements the base version of the BERT network. It is composed of 12 encoding layers from a Transformer network, each layer having



12 attention heads. The total number of parameters is 110 million. The snippet allows you to use this massive network with weights pre-trained to understand the text.

The BERT snippet includes:

- An Input block.
- A BERT Encoder block with pre-trained weights which gives BERT a general understanding of English. The BERT encoder block looks at the input sequence as a whole, producing an output that contains an understanding of the sentence. The block outputs a single vector of 768 size.
- A label block with pre-trained weights.
- A Dense block that is untrained.
- A Target block.

5) Click **Create** to create the experiment and the prepopulated BERT model will appear in the **Modeling** canvas.

The screenshot displays the Google Cloud AI Platform interface for an experiment titled "Book Genre Classification". The left sidebar shows the "Build" tab with "Run settings" and "Dataset settings". The "Run settings" section includes fields for Batch size (6), Epochs (2), Data access (1110274247), Optimizer (Adam), Learning rate (0.00002), p1 rate (0.9), p2 rate (0.999), Learning rate schedule (Triangle schedule), Warm-up epochs (0.5), and Decrement per epoch (0.000008). The "Dataset settings" section shows the Dataset as "Book summaries". The main canvas shows a flow diagram with the following blocks: Input (512), BERT Encoder (768), Dense (768), Dense (1), and Target (Science Fiction). A "Run (417.70 MB)" button is located in the top right corner of the canvas.

6) Click the **Settings** tab and check that:

- **Batch Size** is 2. If you set a larger batch size you may run out of memory.
- **Epochs** is 2. Training takes a long time, so don't train for too long the first time when you check if your model is good.
- **Learning rate** is 0.00001 (4 zeros). To avoid catastrophic forgetting.

**Experiment 1**  
 Created · -1 secs

[Duplicate](#) [Evaluate](#)

**Build** **Settings**

Run settings

|            |        |
|------------|--------|
| Batch size | Epochs |
| 2          | 2      |

1478377733

Optimizer  
Adam

|               |
|---------------|
| Learning rate |
| 0.00001       |

0.9 0.999

Learning rate schedule  
Triangle schedule

Warm-up epochs  
0.5

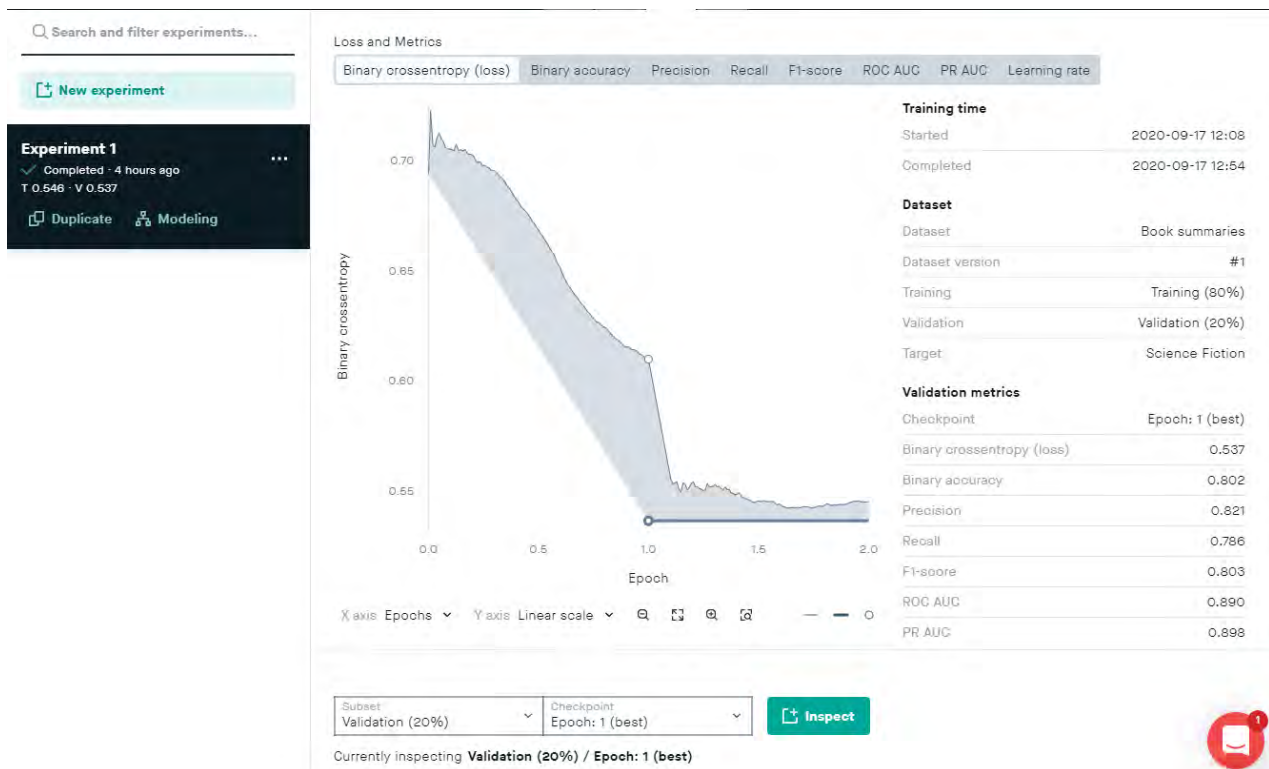
Decrement per epoch  
0.000008

☐ Early stopping

5) Click **Run** to start training the model. With our settings, it took about

## 6) Evaluation

Navigate to the **Evaluation** view and watch the model train. The training will take quite a long time since BERT is a very large and complex model.



The training loss will decrease for each epoch, but the evaluation loss may start to increase. This means that the model is starting to overfit to the training data.

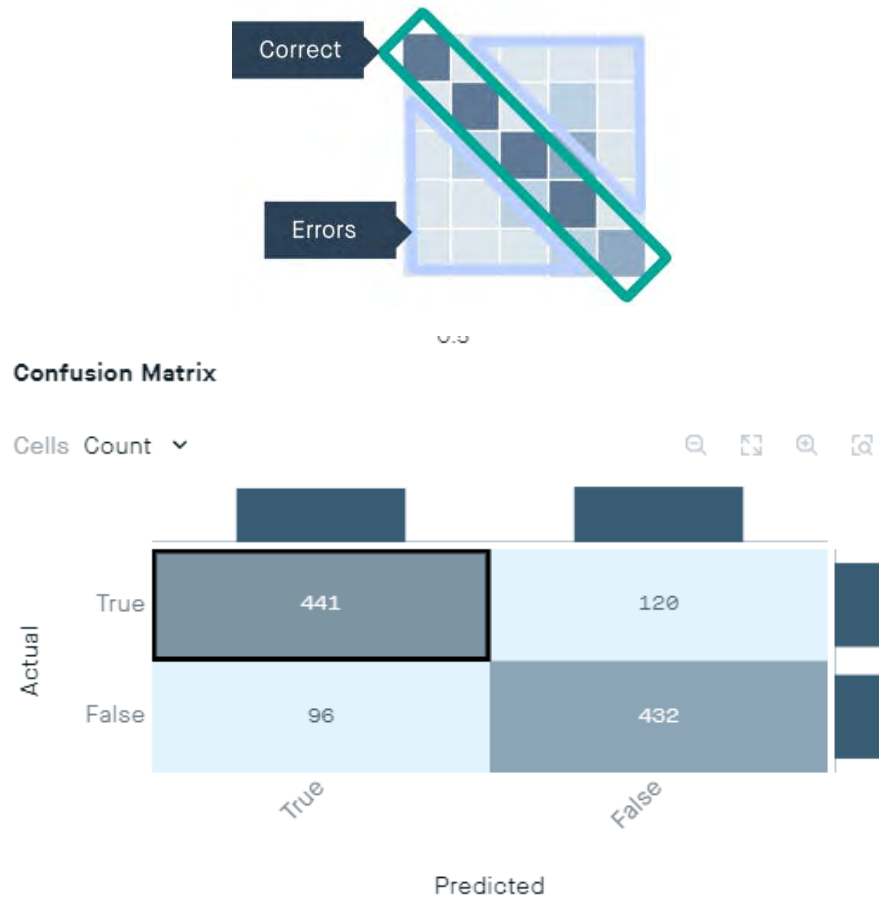
You can read more about the loss metrics here: <https://peltarion.com/knowledge-center/documentation/evaluation-view/classification-loss-metrics>

### Accuracy

To evaluate the performance of the model, you can look at overall accuracy, which is displayed in the Experiment info section to the right. It should be approximately 85-90%.

### Confusion matrix

Since the model solves a classification problem, a confusion matrix is displayed. The top-left to bottom-right diagonal shows correct predictions. Everything outside this diagonal are errors.



## 7) Create new deployment

- 1) In the **Deployment** view click **New deployment**.

The screenshot displays the Azure ML Studio 'My First Project' page. On the left, a sidebar shows 'Experiment 1' with an 'Enable' button. The main area is divided into 'Deployment Info' and 'Parameters' sections. 'Deployment Info' shows 'Experiment: Experiment 1', 'Checkpoint: Epoch: 1 (best)', 'Date created: 2020-09-17', and 'Date deployed: 2020-09-17'. 'Parameters' has an 'Input' table with 'Summary' (text, 512) and an 'Output' table with 'Science Fiction' (binary, 1). On the right, a 'Text classifier API tester' overlay is visible, showing the deployment URL, a token input field, and a cURL command for testing the model.

- 2) Select experiment and checkpoint of your trained model to test it for predictions, or enable for business product calls. Both best epoch and last epoch for each trained experiment are available for deployment.
- 3) Click the **Enable** switch to deploy the experiment.

## 8) Test the text classifier in a browser

- 1) Let's test your model. Click the **Test deployment** button, and you'll open the **Text classifier API tester** with all relevant data copied from your deployment.



## Image & Text Classifier

### API tester

- 2) Now, write your own summary, copy the example below or simply copy a recent summary from:

#### Example:

Harry Potter has never been the star of a Quidditch team, scoringpoints while riding a broom far above the ground. He knows no spells, has never helped to hatch a dragon, and has never worn a cloak of invisibility.

All he knows is a miserable life with the Dursleys, his horrible aunt and uncle, and their abominable son, Dudley -- a great big swollen spoiled bully. Harry's room is a tiny closet at the foot of the stairs, and he hasn't had a birthday party in eleven years.

But all that is about to change when a mysterious letter arrives by owl messenger: a letter with an invitation to an incredible place that Harry — and anyone who reads about him — will find unforgettable.



Now, write your own summary, copy the example below or simply copy a recent summary from: Now, write your own summary, copy the example below or simply copy a recent summary from:

All he knows is a miserable life with the Dursleys, his horrible aunt and uncle, and their abominable son, Dudley -- a great big swollen spoiled bully. Harry's room is a tiny closet at the foot of the stairs, and he hasn't had a birthday party in eleven years.

But all that is about to change when a mysterious letter arrives by owl messenger: a letter with an invitation to an incredible place that Harry -- and anyone who reads about him -- will find unforgettable.

Result

Press ▶ to get result...

3) Click **Play** to get a result.

All he knows is a miserable life with the Dursleys, his horrible aunt and uncle, and their abominable son, Dudley -- a great big swollen spoiled bully. Harry's room is a tiny closet at the foot of the stairs, and he hasn't had a birthday party in eleven years.

But all that is about to change when a mysterious letter arrives by owl messenger: a letter with an invitation to an incredible place that Harry -- and anyone who reads about him -- will find unforgettable.

Result

Science Fiction true

## 9) Next Steps

The next steps could be to try to run the project for more epochs and see if that improves the result or maybe change the learning rate

## Activity 6 – [Bonus] Importing data

In this activity, we will learn:

- ☐ How to upload CSV file into Azure Machine Learning Studio (Classic)
- ☐ How to import a CSV file from the web

- 1) To use your own data in Machine Learning Studio (classic) to develop and train a predictive analytics solution, you can use data from:

**Local file** - Load local data ahead of time from your hard drive to create a dataset module in your experiment.

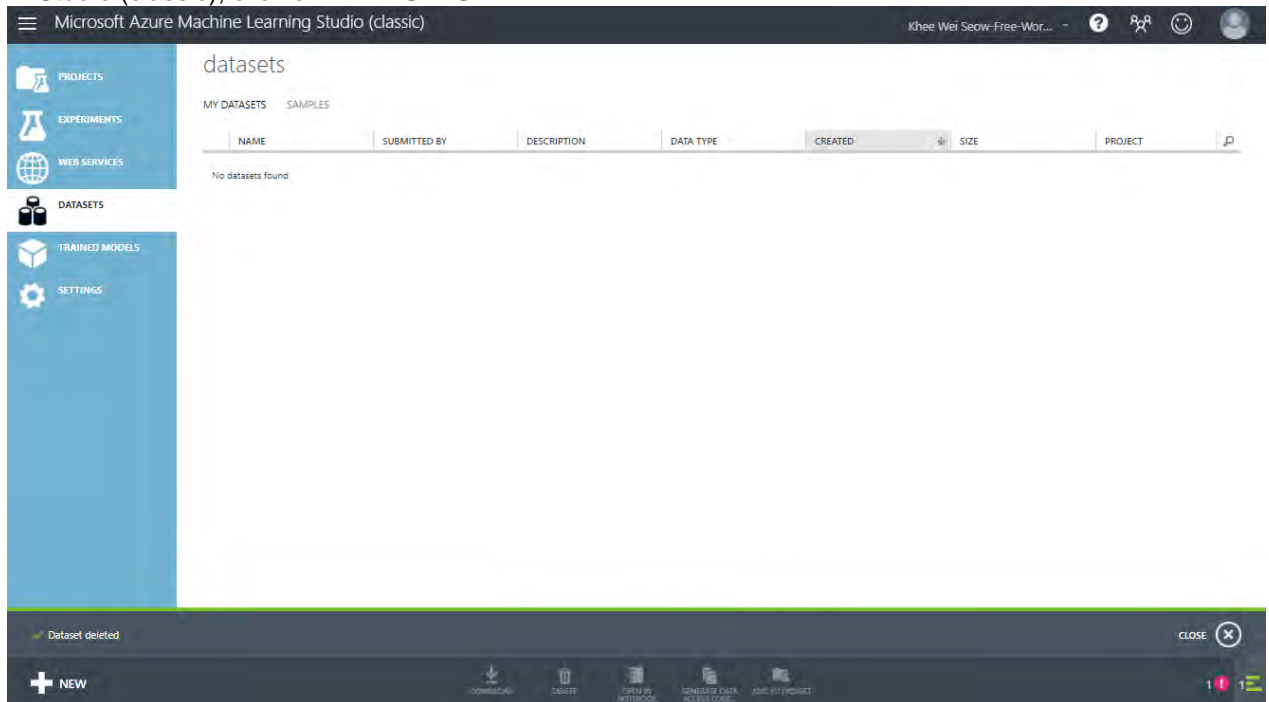
**Online data sources** - Use the Import Data module to access data from one of several online sources while your experiment is running

**Machine Learning Studio (classic) experiment** - Use data that was saved as a dataset in Machine Learning Studio (classic). For a list of datasets available in Studio (classic), you may want to refer to <https://docs.microsoft.com/en-us/azure/machine-learning/studio/use-sample-datasets>

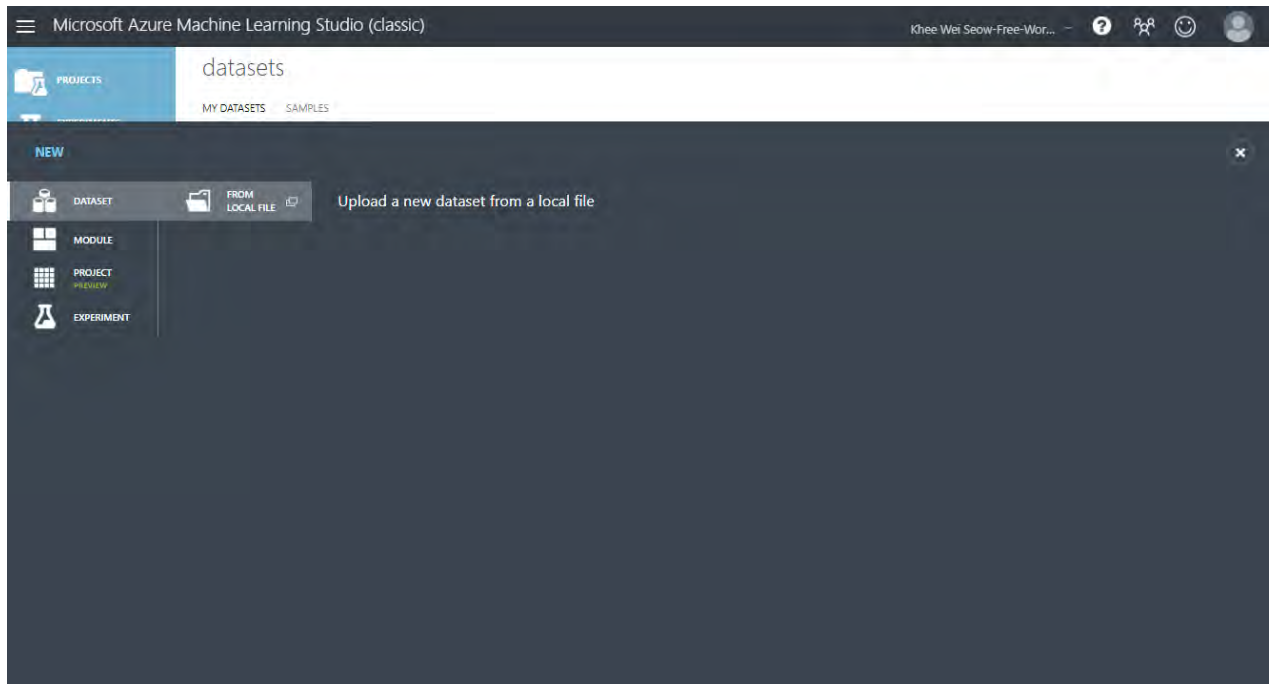
**SQL Server database** - Use data from a SQL Server database without having to copy data manually

### 2) Import from a local file

- 1) In Studio (classic), click on **DATASETS**.



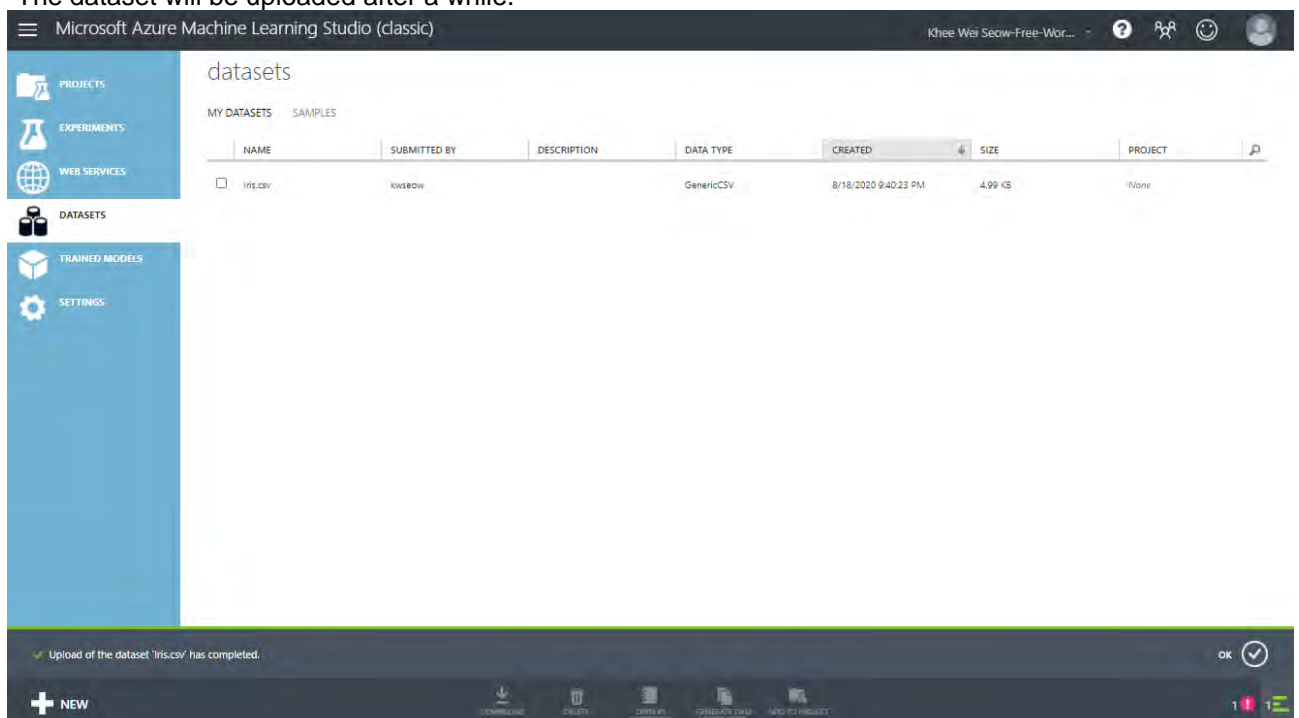
- 2) Click **+NEW** and then **FROM LOCAL FILE**.



- 3) In the Upload a new dataset dialog, click **Choose File** button and locate the iris.csv file provided. Click the tick button.

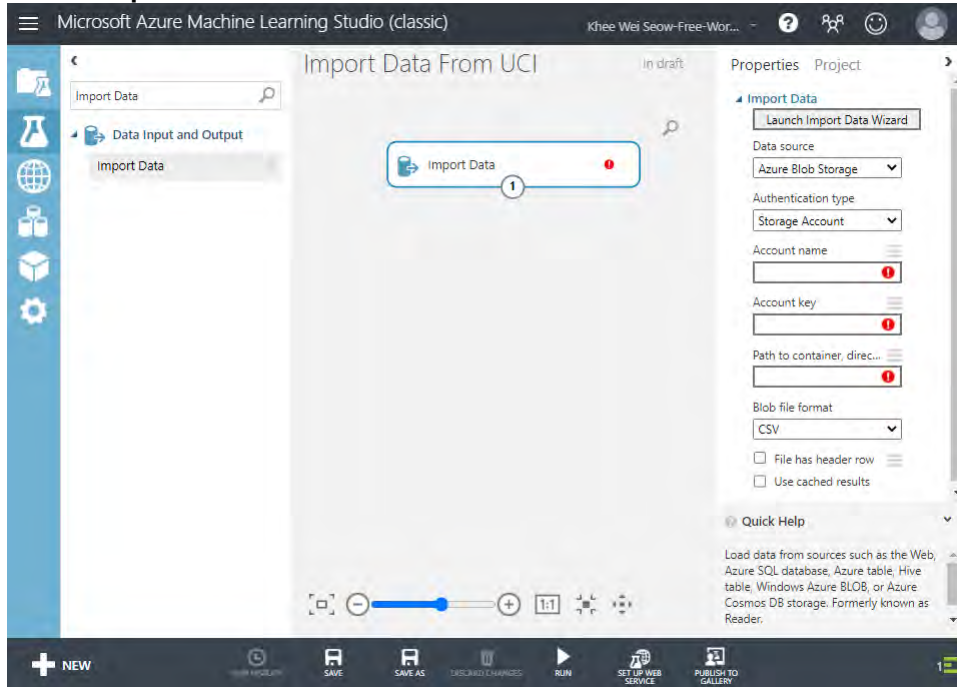
The screenshot shows the 'Upload a new dataset' dialog box. It has a title bar with a close button. Below the title, it says 'SELECT THE DATA TO UPLOAD:' and has a 'Choose File' button. The file 'Iris.csv' is listed. There is a checkbox 'This is the new version of an existing dataset' which is unchecked. Below that, it says 'ENTER A NAME FOR THE NEW DATASET:' and has a text box containing 'Iris.csv'. Then it says 'SELECT A TYPE FOR THE NEW DATASET:' and has a dropdown menu showing 'Generic CSV File with a header (.csv)'. At the bottom, it says 'PROVIDE AN OPTIONAL DESCRIPTION:' and has a text box. A green checkmark icon is visible at the bottom right.

- 4) The dataset will be uploaded after a while.

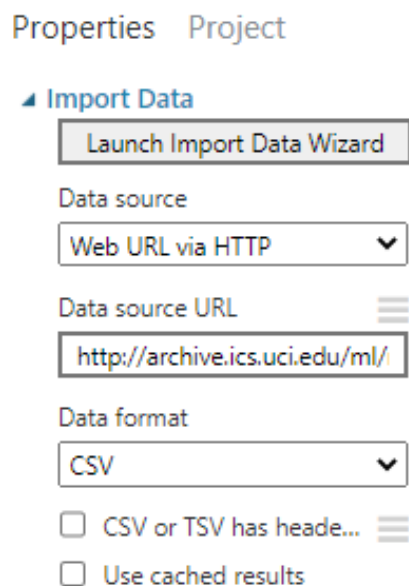


### 3) Import directly from the web

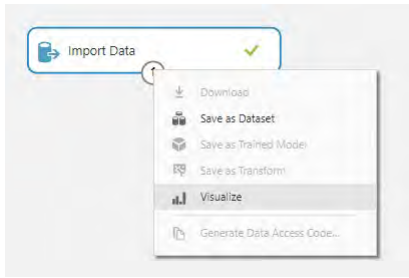
- 1) Create a new **Black Experiment** and name it Import dataset from UCI.
- 2) Add an **Import Data** module to the Canvas



- 3) Set the properties of the Import Data module as follows (Data Source URL: <http://archive.ics.uci.edu/ml/index.php>) :



- 4) Click **RUN**. Wait for the green tick to appear before proceeding to the next step.
- 5) Right click the output port of the Import Data module and select Visualise.



6) You should see the following:

Import Data From UCI > Import Data > Results dataset

rows 32562 columns 15

|         | Col1             | Col2   | Col3      | Col4 | Col5               | Col6              | Col7          | Col8  | Col9   | Col10 | Col11 |
|---------|------------------|--------|-----------|------|--------------------|-------------------|---------------|-------|--------|-------|-------|
| view as |                  |        |           |      |                    |                   |               |       |        |       |       |
| 39      | State-gov        | 77516  | Bachelors | 13   | Never-married      | Adm-clerical      | Not-in-family | White | Male   | 2174  |       |
| 50      | Self-emp-not-inc | 83311  | Bachelors | 13   | Married-civ-spouse | Exec-managerial   | Husband       | White | Male   | 0     |       |
| 38      | Private          | 215646 | HS-grad   | 9    | Divorced           | Handlers-cleaners | Not-in-family | White | Male   | 0     |       |
| 53      | Private          | 234721 | 11th      | 7    | Married-civ-spouse | Handlers-cleaners | Husband       | Black | Male   | 0     |       |
| 28      | Private          | 338409 | Bachelors | 13   | Married-civ-spouse | Prof-specialty    | Wife          | Black | Female | 0     |       |
| 37      | Private          | 284582 | Masters   | 14   | Married-civ-spouse | Exec-managerial   | Wife          | White | Female | 0     |       |
| 49      | Private          | 160187 | 9th       | 5    | Married-spouse-    | Other-service     | Not-in-family | Black | Female | 0     |       |

Statistics and Visualizations



## Activity 7 – [Bonus] Cleaning and Structuring Data

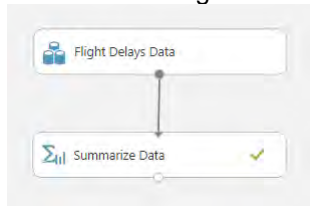
In this activity, we will learn:

- ☐ How to summarise data
- ☐ How to remove missing values
- ☐ How to remove duplicate records
- ☐ How to remove outliers
- ☐ How to read a boxplot

In Studio (classic), create a new Blank Experiment using **+ New** and call it **Data Cleaning**.

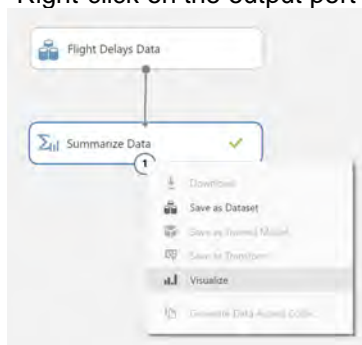
### 1) Summarizing Data

- 1) Add the following dataset and module onto the canvas.

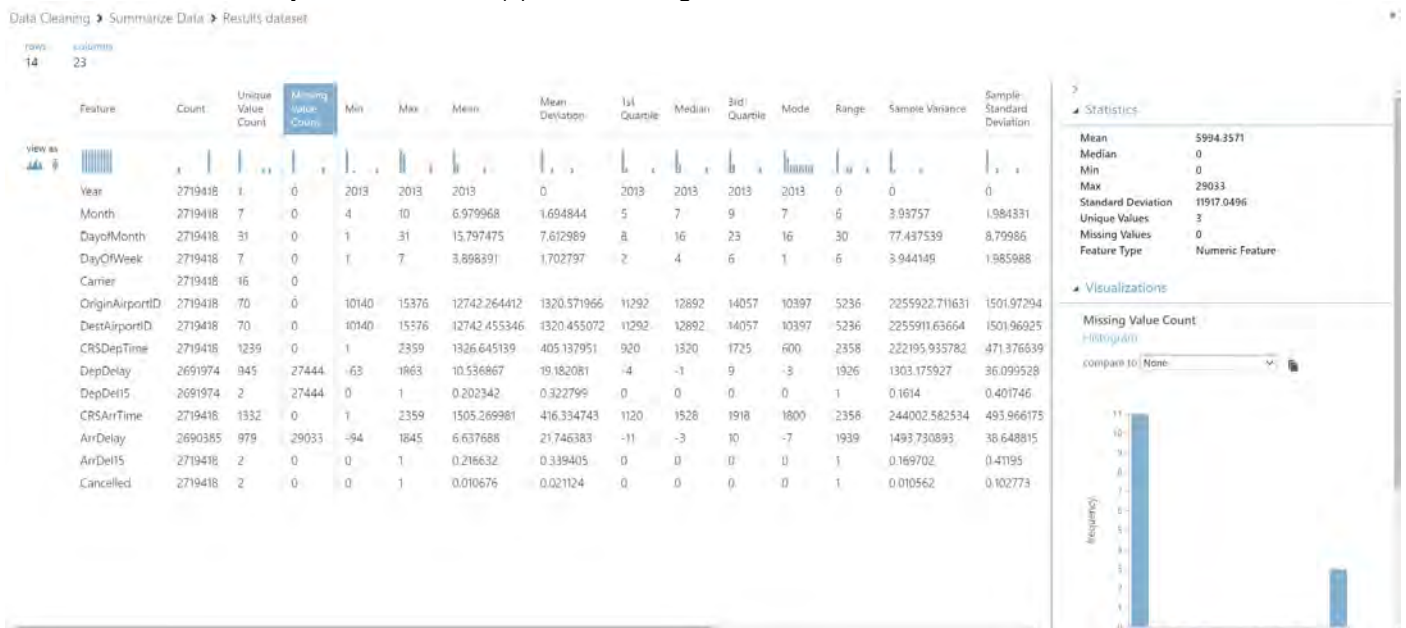


- 2) Click **Run**,

- 3) Right-click on the output port of the **Summarize Data** module and select **Visualize**:



- 4) You should see a similar screen (below) that shows a summary of the dataset. The column **"Missing Value Count"** will tell you which feature(s) have missing data.



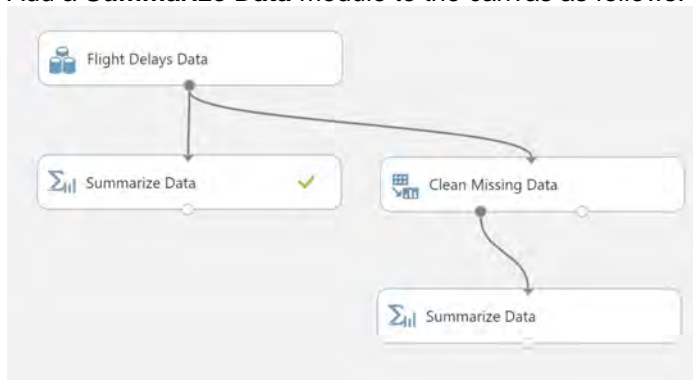
### 2) Missing Value

- 1) Add a **Clean Missing Data** module to the canvas, connect and configure it as follows.

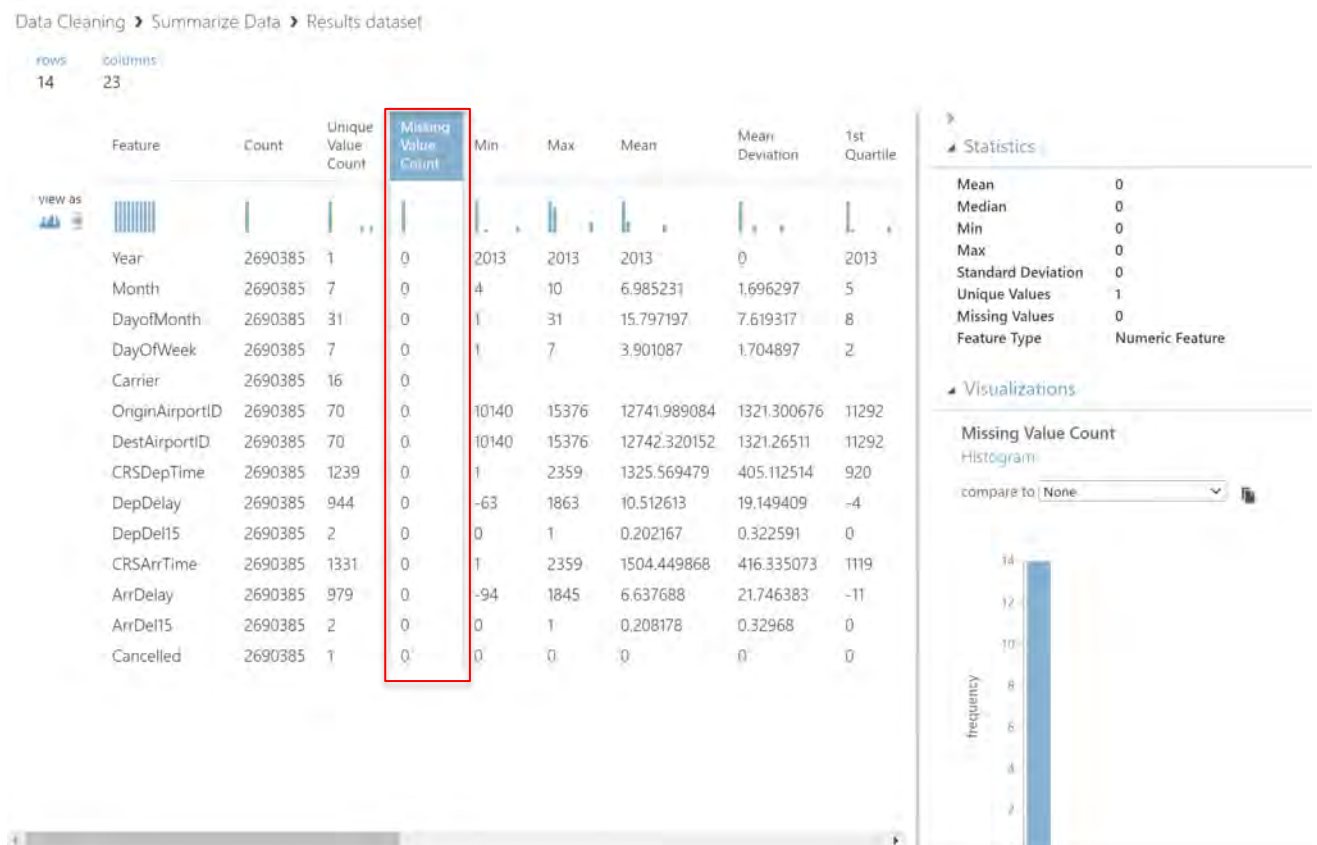
The screenshot shows the 'Data Cleaning' canvas with the 'Clean Missing Data' module connected to the 'Summarize Data' module. The 'Clean Missing Data' module is configured with the following settings:

- Columns to be cleaned:**
  - Selected columns: All columns
  - Column names: DepDelay, DepDel15, ArrDelay
- Minimum missing value ratio:** 0
- Maximum missing value ratio:** 1
- Cleaning mode:** Remove entire row

- 2) Add a **Summarize Data** module to the canvas as follows:

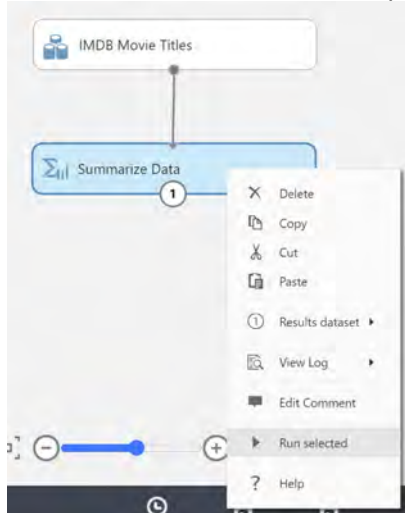


- 3) Click on **Run**
- 4) Visualise the output of the newly added **Summarize Data** module. There should be no missing values in the dataset now.

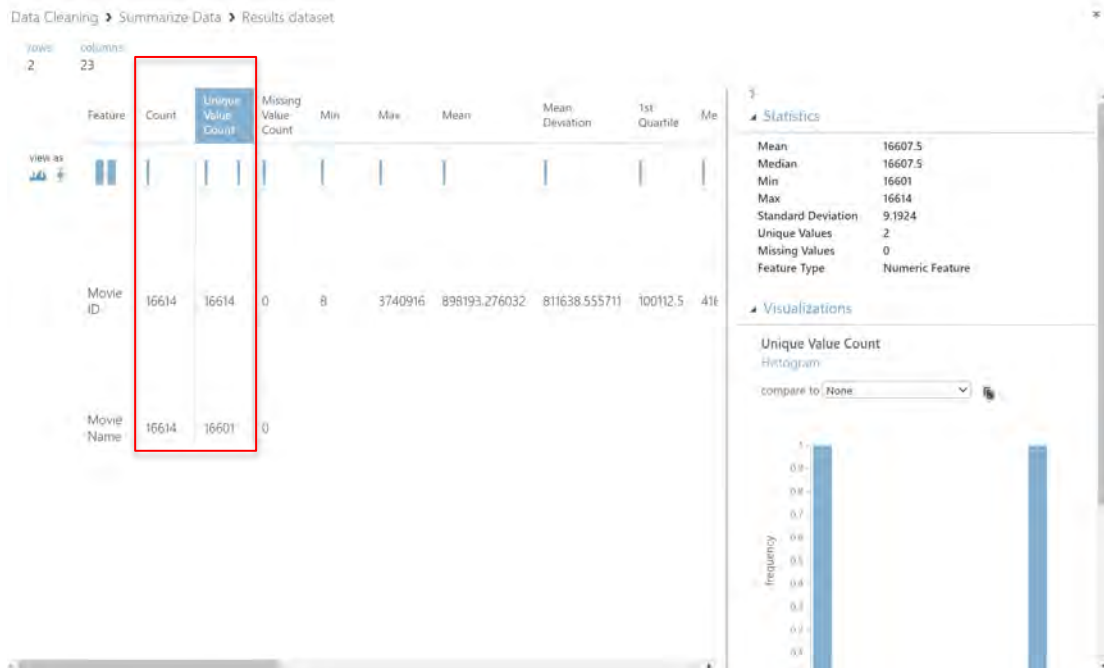


### 3) Duplicate Records

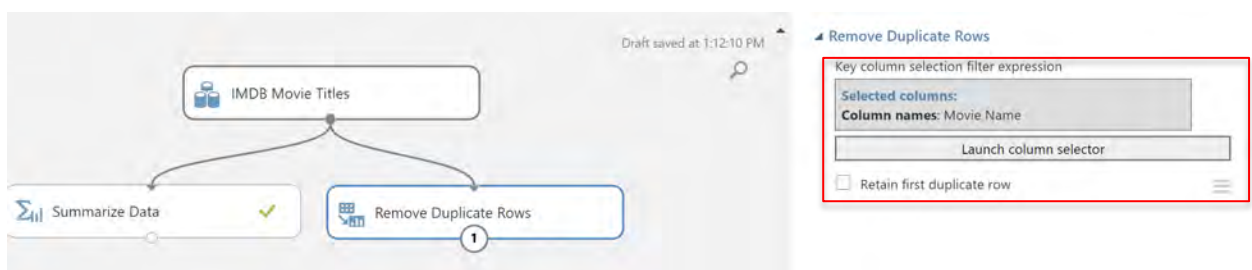
- 1) Add the **IMDB Movie Titles** and **Summarize Data** module to the canvas.
- 2) Right-click on the **Summarize Data** module and select **Run selected**. This action will only run the selected module rather than the whole experiment saving some time.



- 3) Visualize the dataset. There should be a total of 16614 rows but only 16601 are unique.

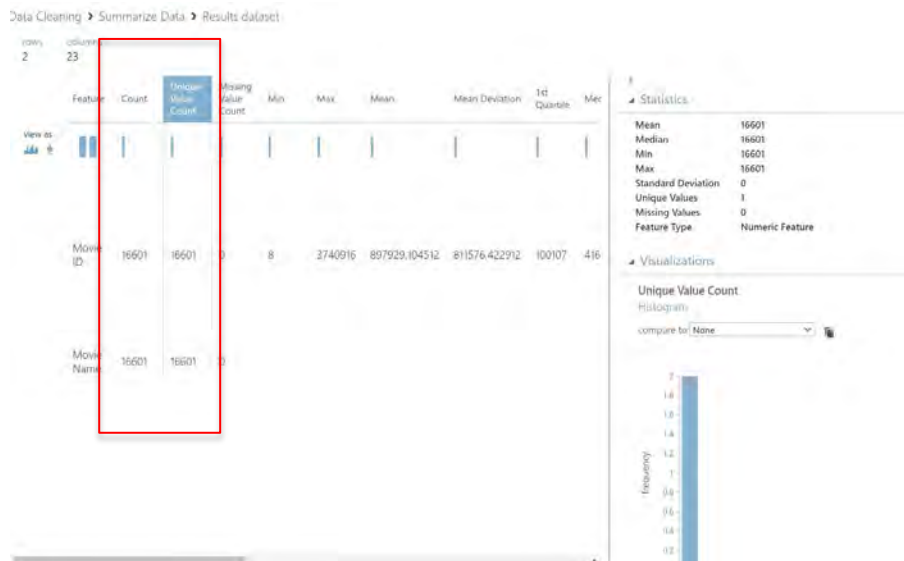


- 4) Add a **Remove Duplicate Rows** module to the canvas, connect and configure it as follows:



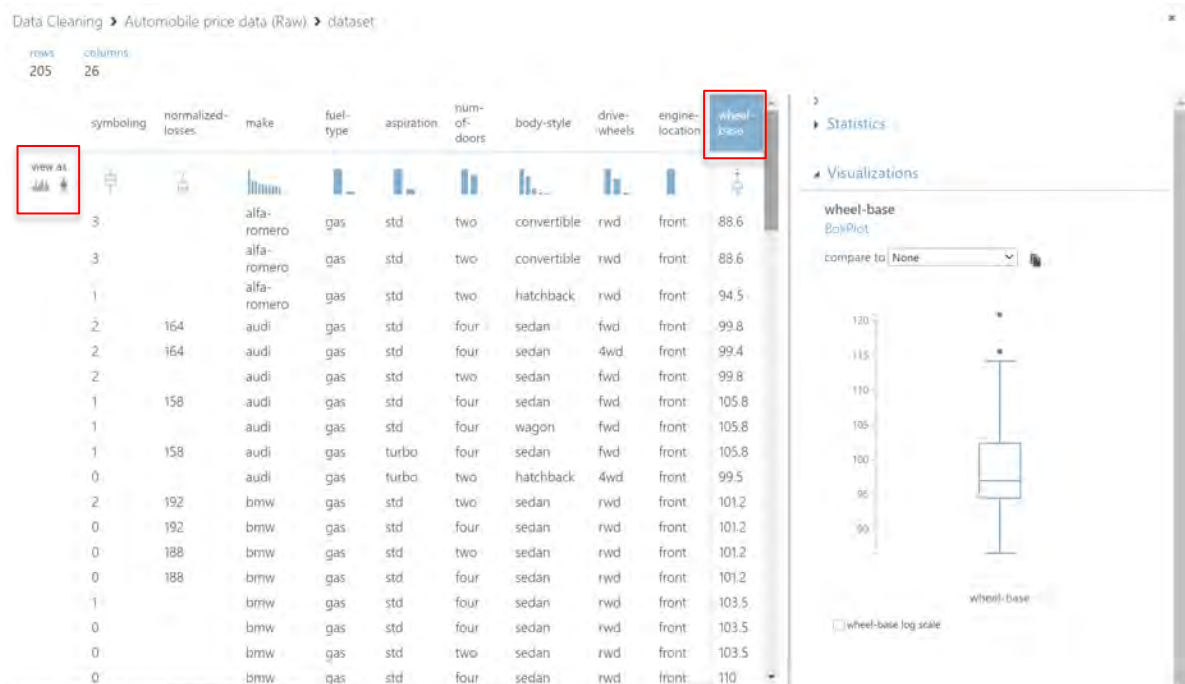
Note: Use the Retain first duplicate row checkbox to indicate which row to return when duplicates are found: If selected, the first row is returned and others discarded. If you uncheck this option, the last duplicate row is kept in the results, and others are discarded.

- 5) Add a **Summarize Data** module and **Visualize** the output. There should be a total of 16601 rows and the same number of unique rows.



#### 4) Removing Outliers

- 1) Add the **Automobile price data (Raw)** to the canvas.
- 2) **Visualize** and view as **Box-Plot** the wheel-base feature.



Note: The dots outside the boxplot are the outliers, and they should be removed from the dataset as they may affect the accuracy of the prediction.

- 3) Add a **Clip-Values** module to the canvas, connect and configure it as follows:

Ref: <https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/clip-values>

In draft  
Draft saved at 1:31:29 PM

Automobile price data (Raw)

Clip Values 1

Properties Project

Clip Values

Set of thresholds  
ClipPeaks

Upper threshold  
Percentile

Percentile number for upper threshold  
98

Upper substitute value  
Threshold

List of columns  
Selected columns:  
All columns  
Column names: wheel-base  
Launch column selector

☒ Overwrite flag

☐ Add indicator columns

4) Right-Click on the **Clip-Values** and select **Run selected**.

Data Cleaning > Clip Values > Results dataset

rows 205 columns 26

| symboling | normalized-losses | make        | fuel-type | aspiration | num-of-doors | body-style  | drive-wheels | engine-location | wheel-base |
|-----------|-------------------|-------------|-----------|------------|--------------|-------------|--------------|-----------------|------------|
| 3         |                   | alfa-romero | gas       | std        | two          | convertible | rwd          | front           | 88.6       |
| 3         |                   | alfa-romero | gas       | std        | two          | convertible | rwd          | front           | 88.6       |
| 1         |                   | alfa-romero | gas       | std        | two          | hatchback   | rwd          | front           | 94.5       |
| 2         | 164               | audi        | gas       | std        | four         | sedan       | fwd          | front           | 99.8       |
| 2         | 164               | audi        | gas       | std        | four         | sedan       | 4wd          | front           | 99.4       |
|           |                   | audi        | gas       | std        | two          | sedan       | fwd          | front           | 99.8       |
| 1         | 158               | audi        | gas       | std        | four         | sedan       | fwd          | front           | 105.8      |
| 1         |                   | audi        | gas       | std        | four         | wagon       | fwd          | front           | 105.8      |
| 1         | 158               | audi        | gas       | turbo      | four         | sedan       | fwd          | front           | 105.8      |
| 0         |                   | audi        | gas       | turbo      | two          | hatchback   | 4wd          | front           | 99.5       |
| 2         | 192               | bmw         | gas       | std        | two          | sedan       | rwd          | front           | 101.2      |
| 0         | 192               | bmw         | gas       | std        | four         | sedan       | rwd          | front           | 101.2      |
| 0         | 188               | bmw         | gas       | std        | two          | sedan       | rwd          | front           | 101.2      |
| 0         | 188               | bmw         | gas       | std        | four         | sedan       | rwd          | front           | 101.2      |
| 1         |                   | bmw         | gas       | std        | four         | sedan       | rwd          | front           | 103.5      |
| 0         |                   | bmw         | gas       | std        | four         | sedan       | rwd          | front           | 103.5      |
| 0         |                   | bmw         | gas       | std        | two          | sedan       | rwd          | front           | 103.5      |
| 0         |                   | bmw         | gas       | std        | four         | sedan       | rwd          | front           | 110        |

Min 88.6  
Max 114.2  
Standard Deviation 5.8806  
Unique Values 51  
Missing Values 0  
Feature Type Numeric Feature

Visualizations

wheel-base  
BoxPlot  
compare to: None

wheel-base

☐ wheel-base log scale

Note: If the outliers are still present, adjust the **Percentile number for upper threshold** property of the **clip-values** module



## Activity 8 – [Bonus] Using Binary Classification Algorithms

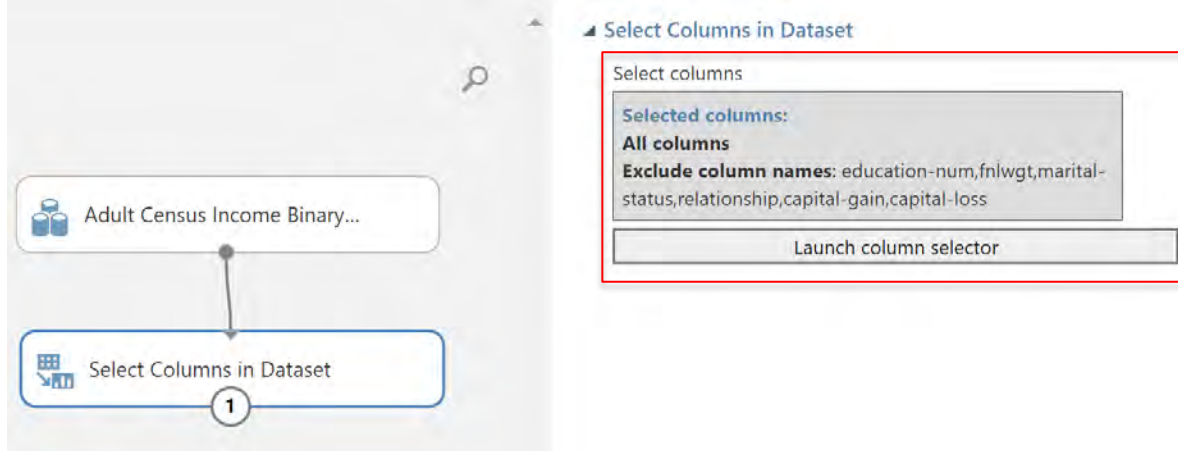
In this activity, we will learn:

- ☐ How to use the Two-Class Logistic Regression algorithm for training
- ☐ How to use the Two-Class Boosted Decision Tree algorithm for training
- ☐ How to evaluate two learning algorithms
- ☐ How to save a trained model

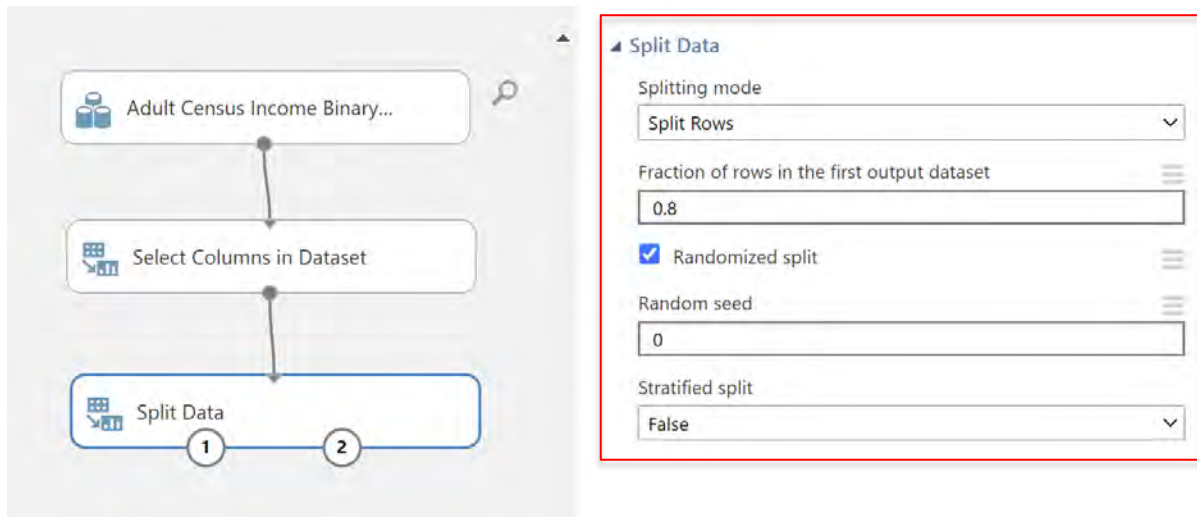
- 1) Create a new experiment and name it as **Binary Classification – Income**.
- 2) Add the **Adult Census Income Binary Classification** dataset to the canvas.
- 3) Right-click on the output port of the dataset and select Visualize. You should see the following:



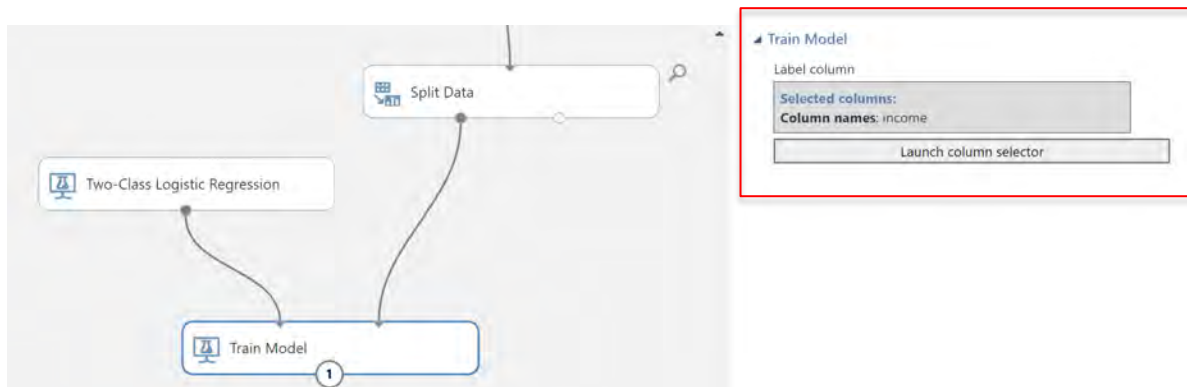
- 4) Add the **Select Columns in Dataset** module to the canvas and connect and configure it as follows:



- 5) Add **Split Data** module to the canvas, connect and configure it as follows:  
 Ref: <https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/split-data>



- 6) Add a **Two-Class Logistic Regression** and **Train Model** modules to the canvas, connect and configure them as follows:

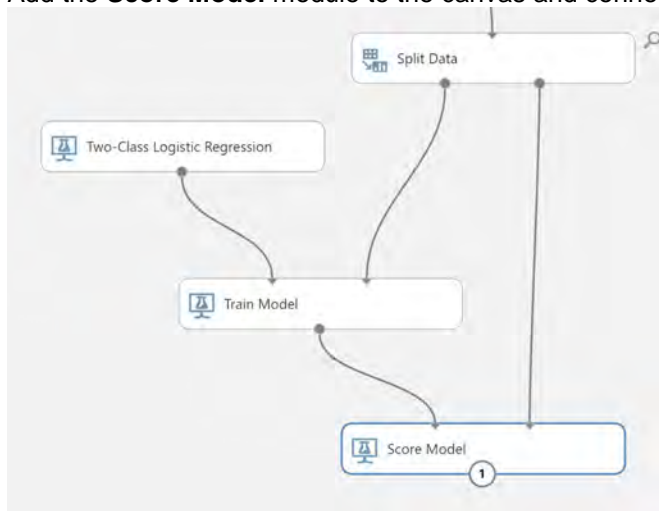


Ref:

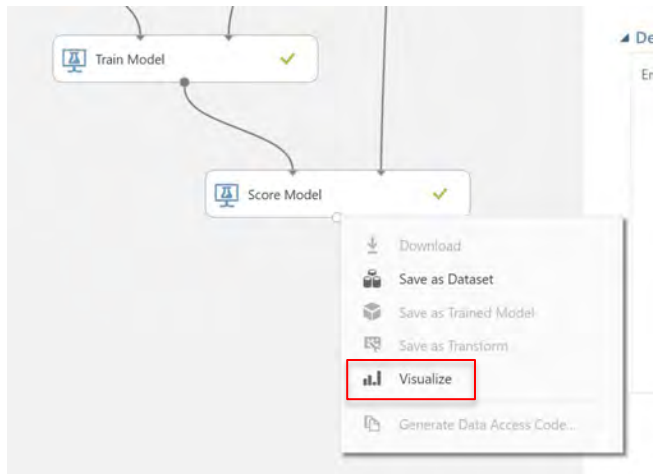
<https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/two-class-logistic-regression>  
<https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/train-model>

Note: You use the **Two-Class Logistic Regression** module to create a logistic regression model that can be used to predict one of two states/classes of the target variable (label).

- 7) Add the **Score Model** module to the canvas and connect it as follows:



- 8) Click **Run**. When it is completed, right-click on the output port and select **Visualize**:



9) You should see the following:

Binary Classification - Income > Score Model > Scored dataset

rows: 6512 columns: 11

|          | age | workclass        | education    | occupation        | race  | sex    | hours-per-week | native-country | income | Scored Labels | Scored Probabilities |
|----------|-----|------------------|--------------|-------------------|-------|--------|----------------|----------------|--------|---------------|----------------------|
| view all |     |                  |              |                   |       |        |                |                |        |               |                      |
|          | 34  | Private          | Some-college | Machine-op-inspct | White | Male   | 35             | United-States  | <=50K  | <=50K         | 0.140938             |
|          | 17  | Private          | 11th         | Other-service     | White | Male   | 15             | United-States  | <=50K  | <=50K         | 0.006722             |
|          | 29  | Private          | Some-college | Prof-specialty    | White | Male   | 15             | United-States  | <=50K  | <=50K         | 0.130627             |
|          | 36  | Private          | Assoc-voc    | Handlers-cleaners | White | Male   | 38             | United-States  | <=50K  | <=50K         | 0.119357             |
|          | 21  | Private          | HS-grad      | Farming-fishing   | White | Male   | 53             | United-States  | <=50K  | <=50K         | 0.054273             |
|          | 51  | Self-emp-not-inc | HS-grad      | Farming-fishing   | White | Male   | 45             | United-States  | <=50K  | <=50K         | 0.103781             |
|          | 37  | Private          | HS-grad      | Other-service     | Black | Female | 40             | United-States  | <=50K  | <=50K         | 0.103781             |
|          | 53  | Private          | HS-grad      | Craft-repair      | White | Male   | 46             | United-States  | >50K   | <=50K         | 0.370918             |
|          | 36  | Private          | Assoc-voc    | Craft-repair      | White | Male   | 40             | United-States  | <=50K  | <=50K         | 0.282886             |
|          | 45  | Private          | Assoc-voc    | Adm-clerical      | White | Female | 40             | United-States  | <=50K  | <=50K         | 0.135465             |
|          | 36  | Private          | Assoc-voc    | Craft-repair      | White | Male   | 40             | United-States  | <=50K  | <=50K         | 0.282886             |
|          | 24  | Private          | HS-grad      | Sales             | White | Female | 30             | United-States  | <=50K  | <=50K         | 0.034528             |
|          | 45  | Local-gov        | Masters      | Prof-specialty    | Black | Male   | 10             | United-States  | >50K   | <=50K         | 0.325163             |
|          | 33  | Private          | Bachelors    | Exec-managerial   | White | Male   | 40             | United-States  | >50K   | >50K          | 0.517066             |

**Note:**

The **Scored Labels** column shows the predicted income group.

The **Scored Probabilities** column shows the confidence levels of the scored labels

If your test dataset is missing the dependent values, your **Scored Labels** may be empty.

10) Add the **Two-Class Boosted Decision Tree** and the **Train Model** modules to the canvas and connect and configure them as follows:



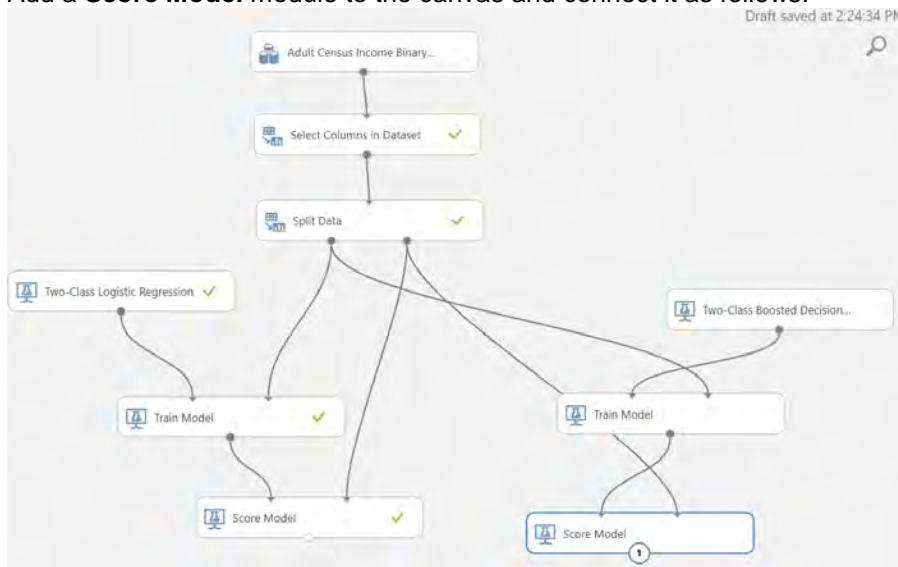
Ref:

<https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/two-class-boosted-decision-tree>

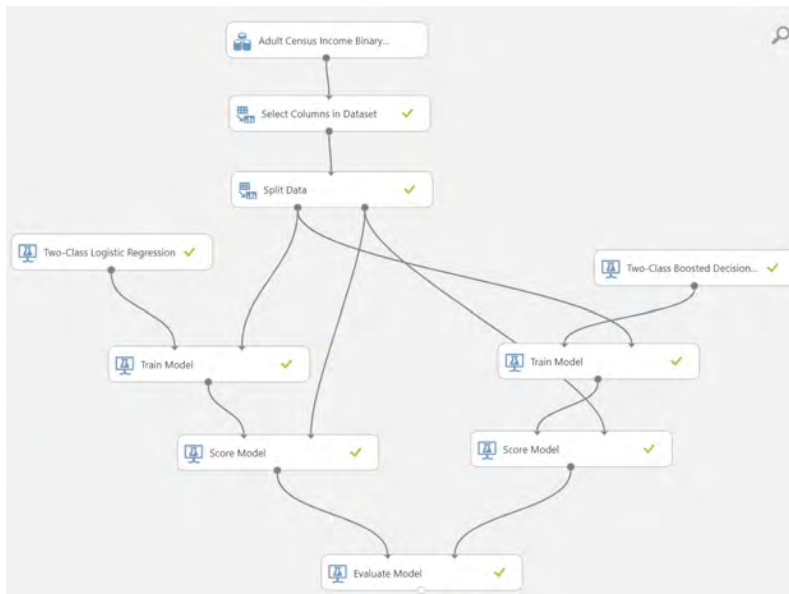
**Note:**

You use the **Two-Class Boosted Decision Tree** module to create a machine learning model that is based on the boosted decision trees algorithm. A boosted decision tree is an ensemble learning method in which the second tree corrects for the errors of the first tree, the third tree corrects for the errors of the first and second tree, and so forth. Predictions are based on the entire ensemble of trees together that makes the prediction.

- 11) Add a **Score Model** module to the canvas and connect it as follows:



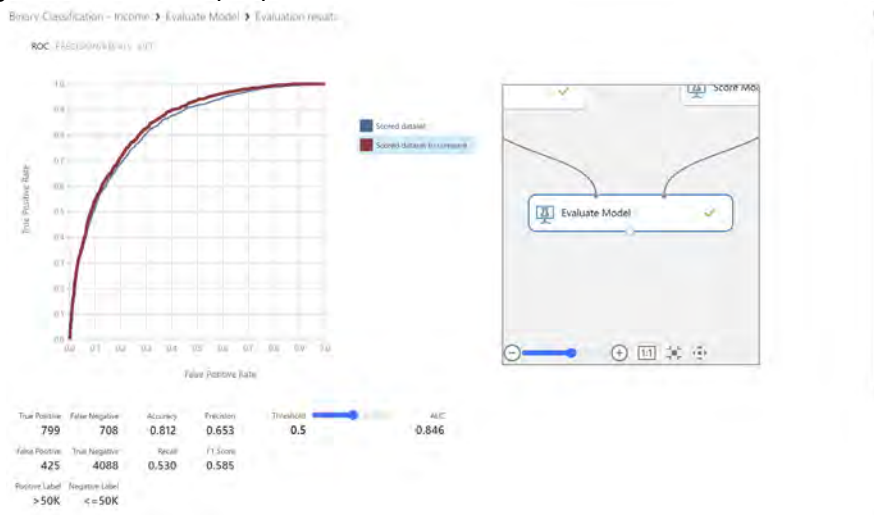
- 12) Add the **Evaluate Model** module to the canvas and connect it as follows:



Ref: <https://docs.microsoft.com/en-us/azure/machine-learning/studio-module-reference/evaluate-model>

13) Click **Run**

14) Right-click on the output port of the **Evaluate Model** module and select **Visualize**:



You should see two curves on the output. Click on either the blue or red box. The curve that is closer to the vertical axis is the better one.

### Evaluation metrics

|                                |                                                                                                                                 |
|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| Mean Absolute Error (MAE)      | The average of absolute errors (an error is the difference between the value and the actual value)                              |
| Root Mean Squared Error (RMSE) | The square root of the average of squared errors of predictions made on the test dataset                                        |
| Relative Absolute Error        | The average of absolute errors relative to the absolute difference between actual values and the average of all actual values   |
| Relative Squared Error         | The average of squared errors relative to the squared difference between the actual values and the average of all actual values |
| Coefficient of Determination   | Also known as the R squared value, this is a statistical metric indicating how well a model fits the data                       |

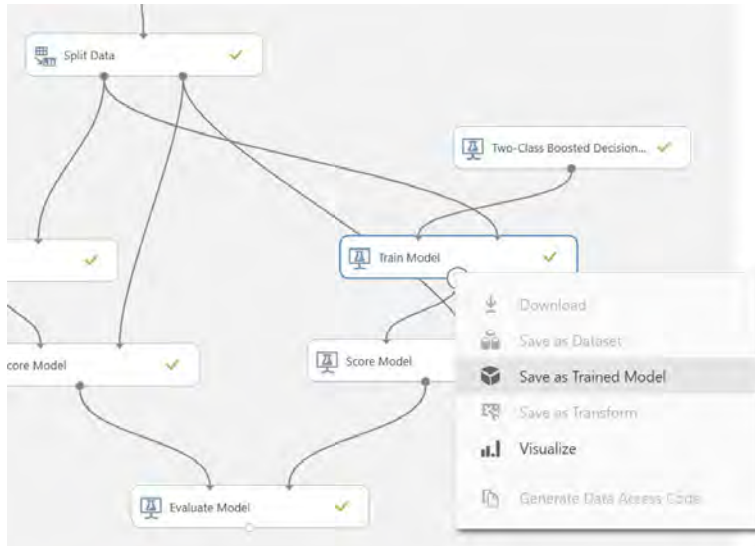
For each of the metrics, smaller is better.

A smaller value indicates that the predictions more closely match the actual values.

For Coefficient of Determination, the closer its value to one (1.0), the better the predictions.

### 15) Saved a train model

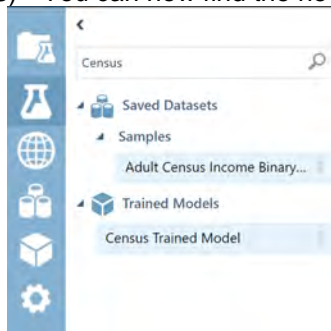
- 1) Right-click on the output port of the **Train Model** module (on the right of the canvas) and select **Save as Trained Model**:



Note: Once a **Train Model** is trained, you can save it as a trained model so that you can later use it on the canvas without specifying the algorithm.

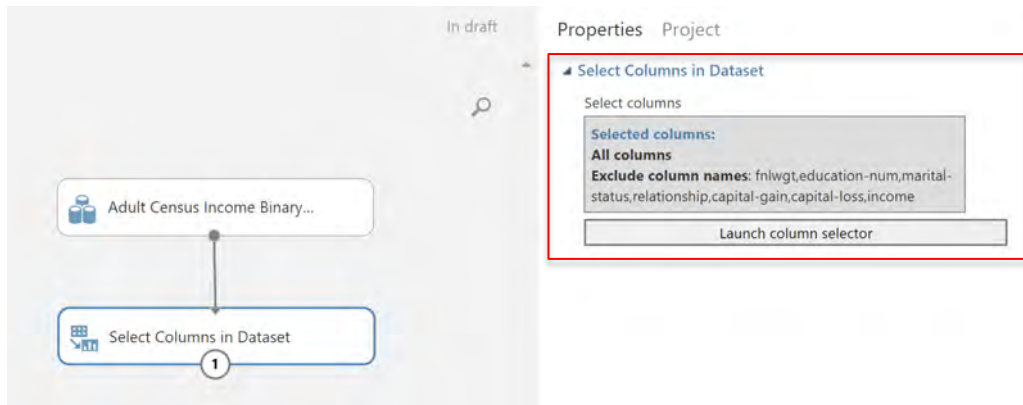
- 2) Name the trained model as **Census Trained model**:

- 3) You can now find the newly saved trained model in the left panel.



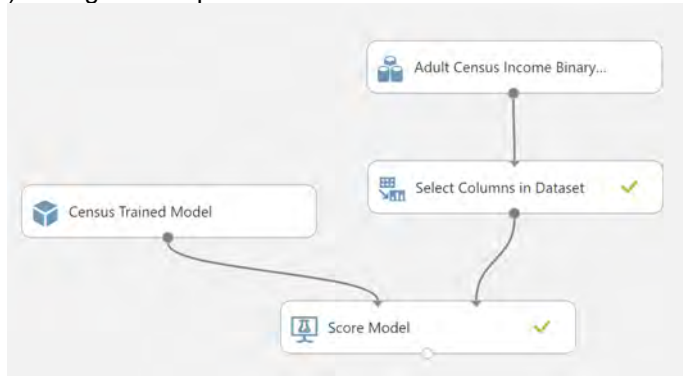
- 4) Create a new experiment and name it as **Income Prediction**.
- 5) Add the **Adult Census Income Binary Classification** dataset to the canvas.
- 6) Add the **Select Columns in Dataset** module to the canvas and connect and configure it as follows:





Note: We have excluded **income** column in this case. Our model is going to predict income, so there is no need to have the income as part of the inputs.

- 7) Drag and drop the saved trained model onto the canvas, and a **Score Model** module and connect as follows:



- 8) Click **Run**.

- 9) Right-click on the output port of the **Score Model** module and select **Visualize**:

Income Prediction > Score Model > Scored dataset

rows: 32561, columns: 10

view as

|    | age              | workclass    | education         | occupation         | race   | sex | hours-per-week | native-country | Scored Labels | Scored Probabilities |
|----|------------------|--------------|-------------------|--------------------|--------|-----|----------------|----------------|---------------|----------------------|
| 39 | State-gov        | Bachelors    | Adm-clerical      | White              | Male   | 40  | United-States  | <=50K          | 0.37412       |                      |
| 50 | Self-emp-not-inc | Bachelors    | Exec-managerial   | White              | Male   | 13  | United-States  | >50K           | 0.744454      |                      |
| 38 | Private          | HS-grad      | Handlers-cleaners | White              | Male   | 40  | United-States  | <=50K          | 0.10904       |                      |
| 53 | Private          | 11th         | Handlers-cleaners | Black              | Male   | 40  | United-States  | <=50K          | 0.302544      |                      |
| 28 | Private          | Bachelors    | Prof-specialty    | Black              | Female | 40  | Cuba           | <=50K          | 0.08168       |                      |
| 37 | Private          | Masters      | Exec-managerial   | White              | Female | 40  | United-States  | <=50K          | 0.451775      |                      |
| 49 | Private          | 9th          | Other-service     | Black              | Female | 16  | Jamaica        | <=50K          | 0.012307      |                      |
| 52 | Self-emp-not-inc | HS-grad      | Exec-managerial   | White              | Male   | 45  | United-States  | <=50K          | 0.432165      |                      |
| 31 | Private          | Masters      | Prof-specialty    | White              | Female | 50  | United-States  | <=50K          | 0.428208      |                      |
| 42 | Private          | Bachelors    | Exec-managerial   | White              | Male   | 40  | United-States  | >50K           | 0.776759      |                      |
| 37 | Private          | Some-college | Exec-managerial   | Black              | Male   | 80  | United-States  | >50K           | 0.835646      |                      |
| 30 | State-gov        | Bachelors    | Prof-specialty    | Asian-Pac-Islander | Male   | 40  | India          | <=50K          | 0.246062      |                      |
| 23 | Private          | Bachelors    | Adm-clerical      | White              | Female | 30  | United-States  | <=50K          | 0.005884      |                      |
| 32 | Private          | Assoc-acdm   | Sales             | Black              | Male   | 50  | United-States  | <=50K          | 0.250539      |                      |
| 40 | Private          | Assoc-voc    | Craft-repair      | Asian-Pac-Islander | Male   | 40  |                |                |               |                      |
| 34 | Private          | 7th-8th      | Transport-moving  | Amer-Indian-Eskimo | Male   | 45  | Mexico         | <=50K          | 0.04403       |                      |
| 25 | Self-emp-not-inc | HS-grad      | Farming-fishing   | White              | Male   | 35  | United-States  | <=50K          | 0.018797      |                      |
| 32 | Private          | HS-grad      | Machine-op-inspct | White              | Male   | 40  | United-States  | <=50K          | 0.07359       |                      |
| 38 | Private          | 11th         | Sales             | White              | Male   | 50  | United-States  | <=50K          | 0.402333      |                      |
| 43 | Self-emp-not-inc | Masters      | Exec-managerial   | White              | Female | 45  | United-States  | <=50K          | 0.498074      |                      |
| 40 | Private          | Doctorate    | Prof-specialty    | White              | Male   | 60  | United-States  | >50K           | 0.92778       |                      |

Note:

Observe that **Income** column is no longer visible.

**Scored Labels** and **Scored Probabilities** have been added. Scored Labels is the predicted income.

**Exercise:** Use the **Select Columns in Data** after the score model to show only the predicted salary.

