Hands on tutorial
A Classification Model in Azure ML

Tutorial #2 Questions:

- What are we trying to accomplish?
  - Given these dynamometer card readings, can we classify the operations into failed or not??
- How can we use Azure Machine Learning to answer these questions?

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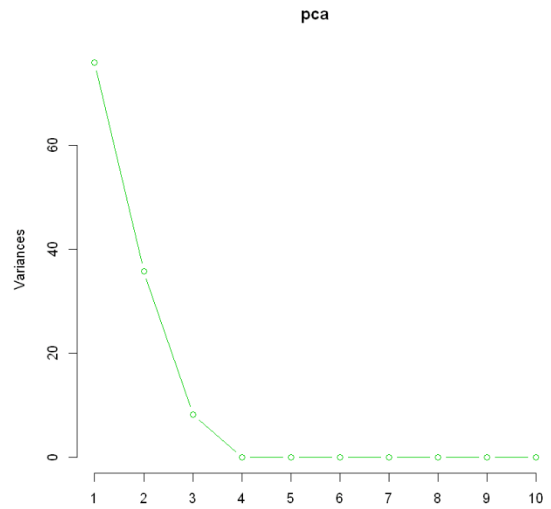
Scenario Data:

- After the PCA was performed we ended up with~57K rows of data with 3 Principal Components (PC1, PC2, PC3)
- 263 unique wells
- We merged the new dataset with the operation failure dataset. (Already done that for the purpose of this tutorial)
- Training data now comprises of the following:
  - Date-Time at which the readings were taken
  - PC1
  - PC2
  - PC3
  - Assignments



rows 57883 columns 51

view as

well	date	PC1	PC2	PC3	Assignments
Alabama	2013-08-16T01:55:22	-8.243341	2.918071	2.023029	35
Alabama	2013-08-16T23:49:23	-8.243341	2.918071	2.023029	35
Alabama	2013-09-03T00:17:00	-8.495328	2.311737	2.154067	35
Alabama	2013-09-06T09:38:47	-8.148383	2.731808	2.341957	35
Alabama	2013-09-06T16:13:14	-8.148383	2.731808	2.341957	35

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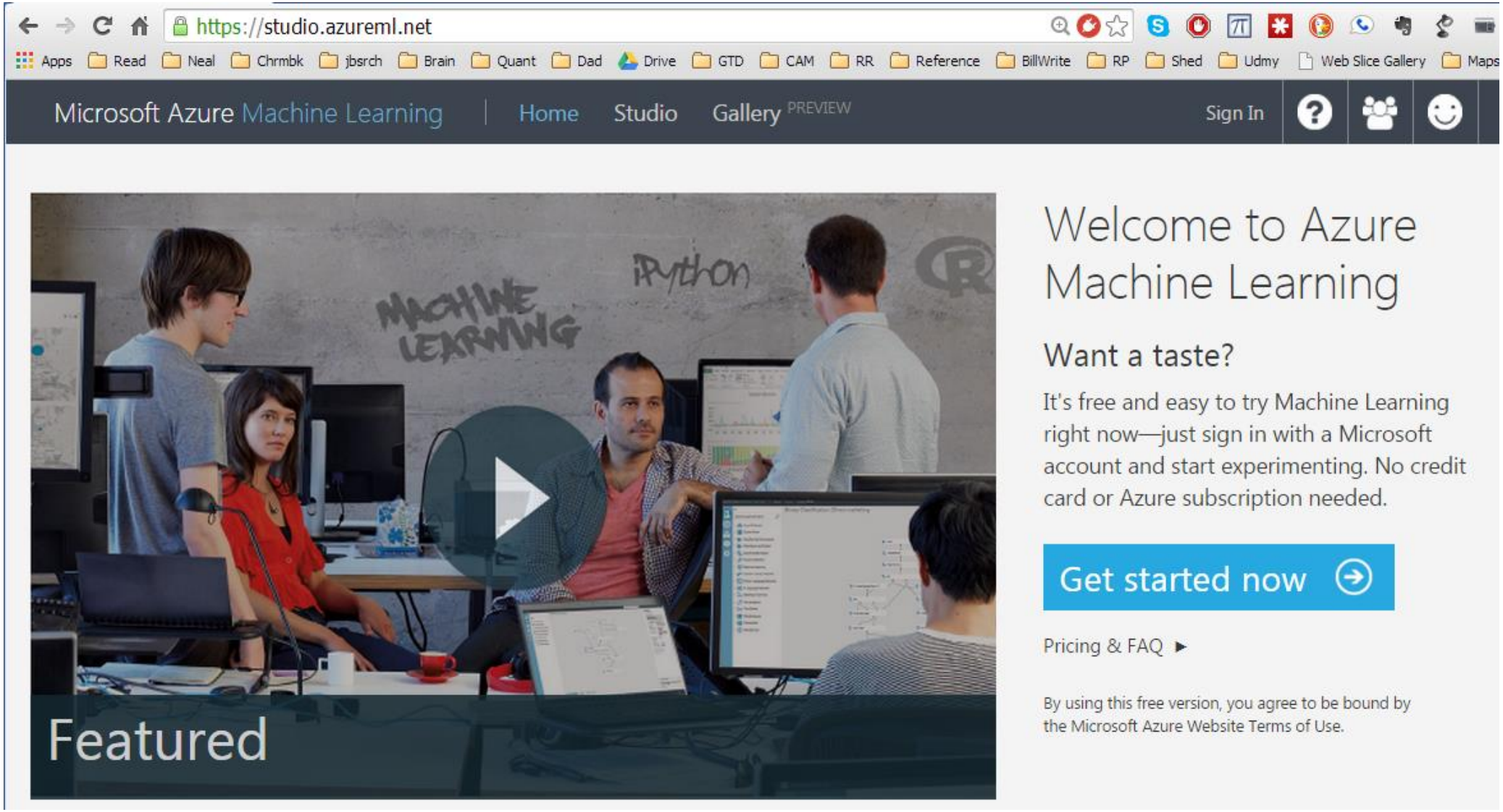
Step 1 : Go to https://studio.azureml.net/



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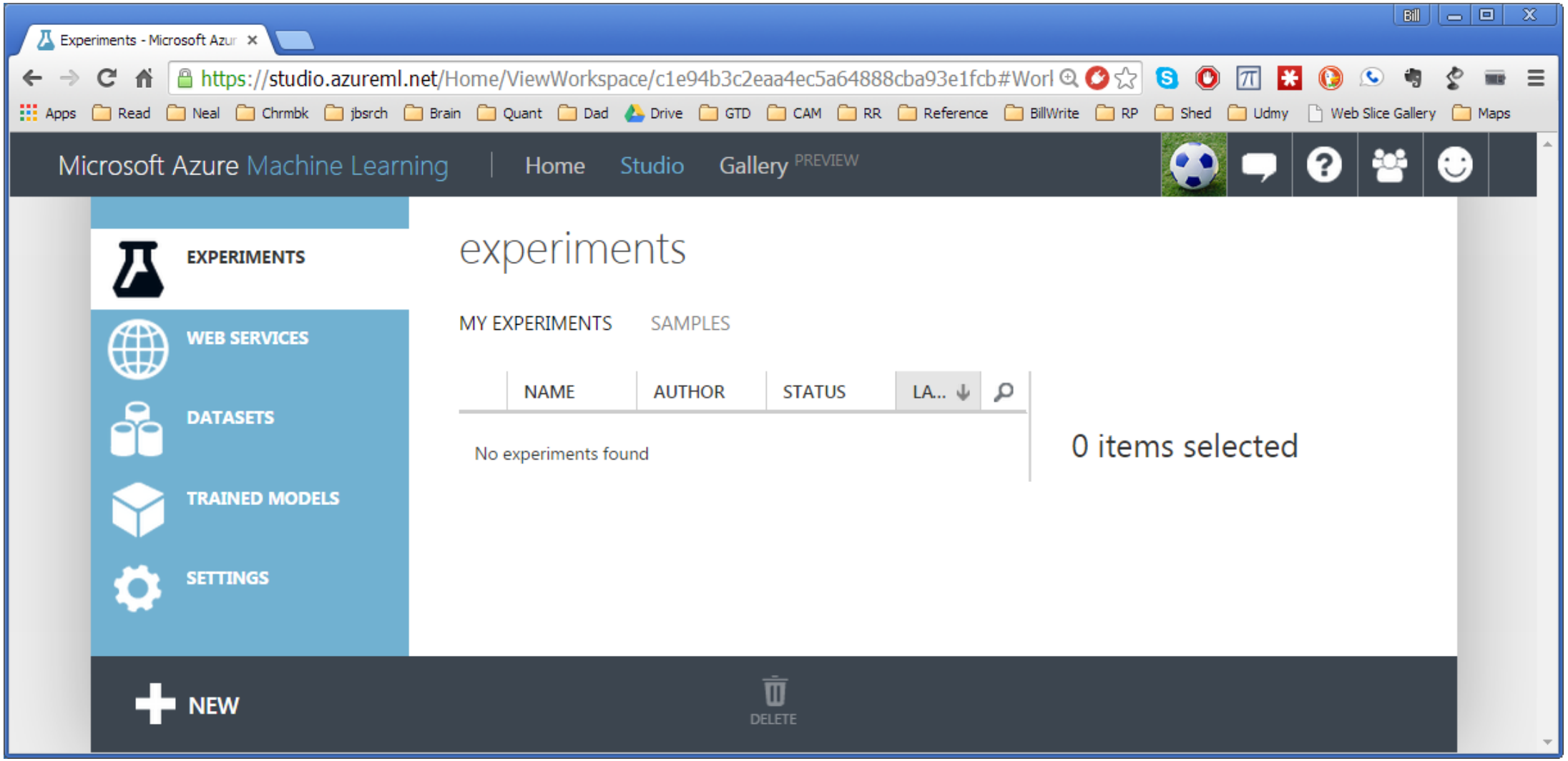
Step 2 : Log in to your account



Microsoft

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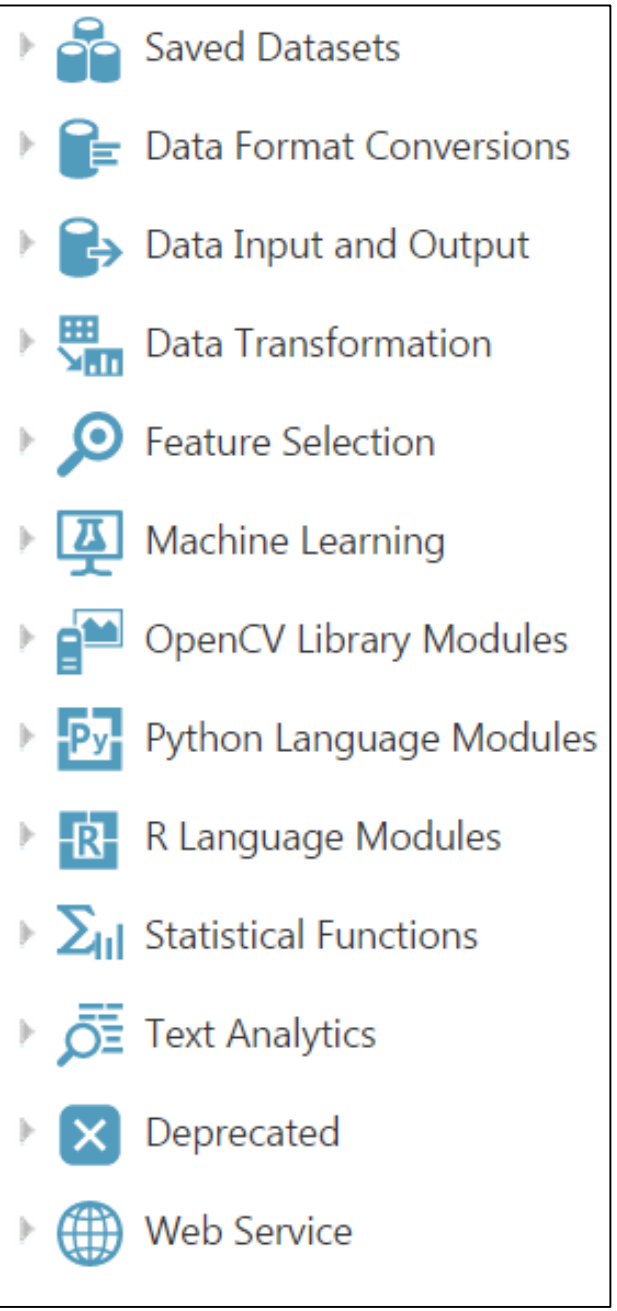

Step 3.1 : Create New Experiment

- AML modelling … a checklist approach
  - ❑ Create new experiment

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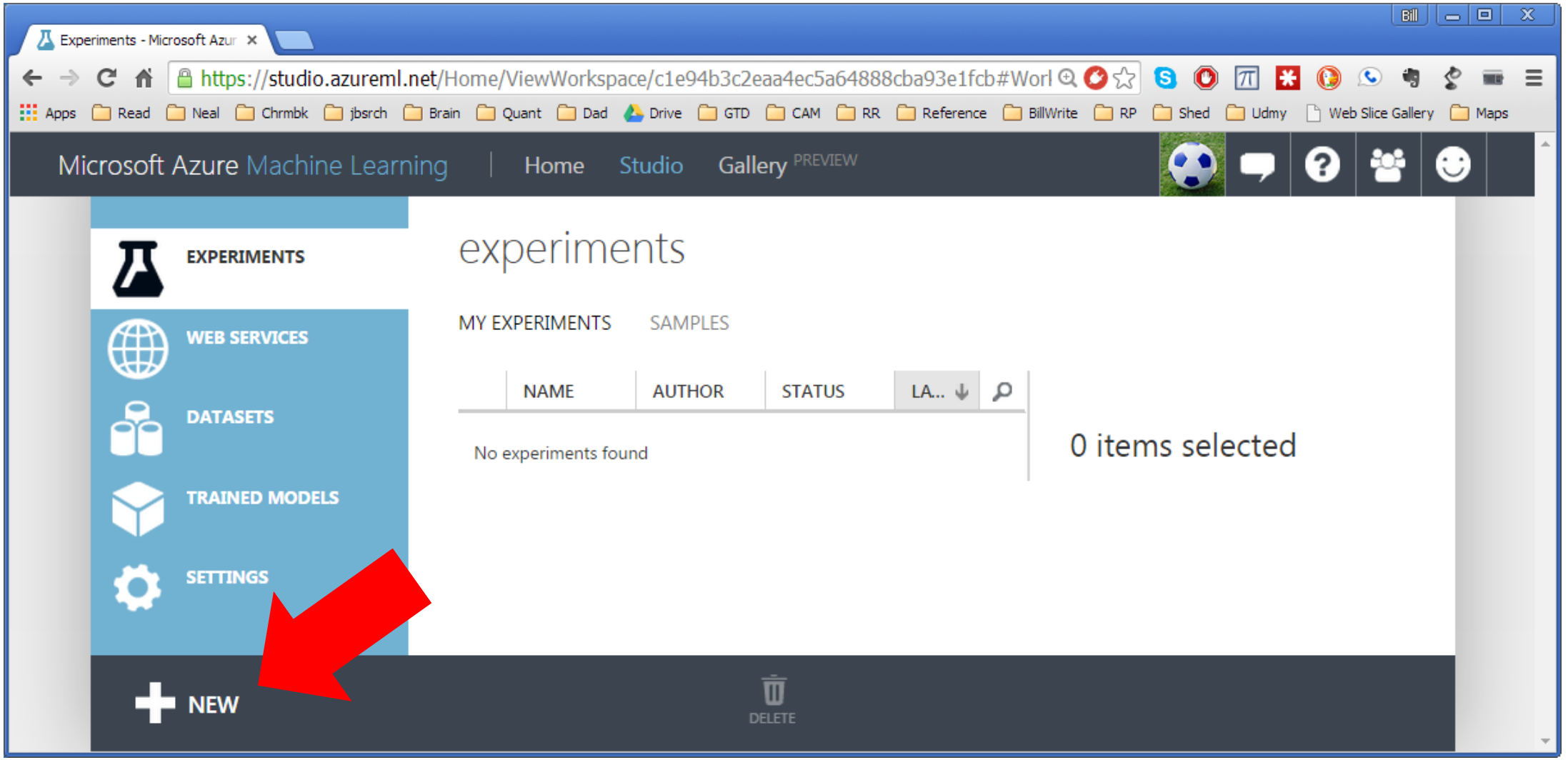
Step 3.2 : Create a new experiment



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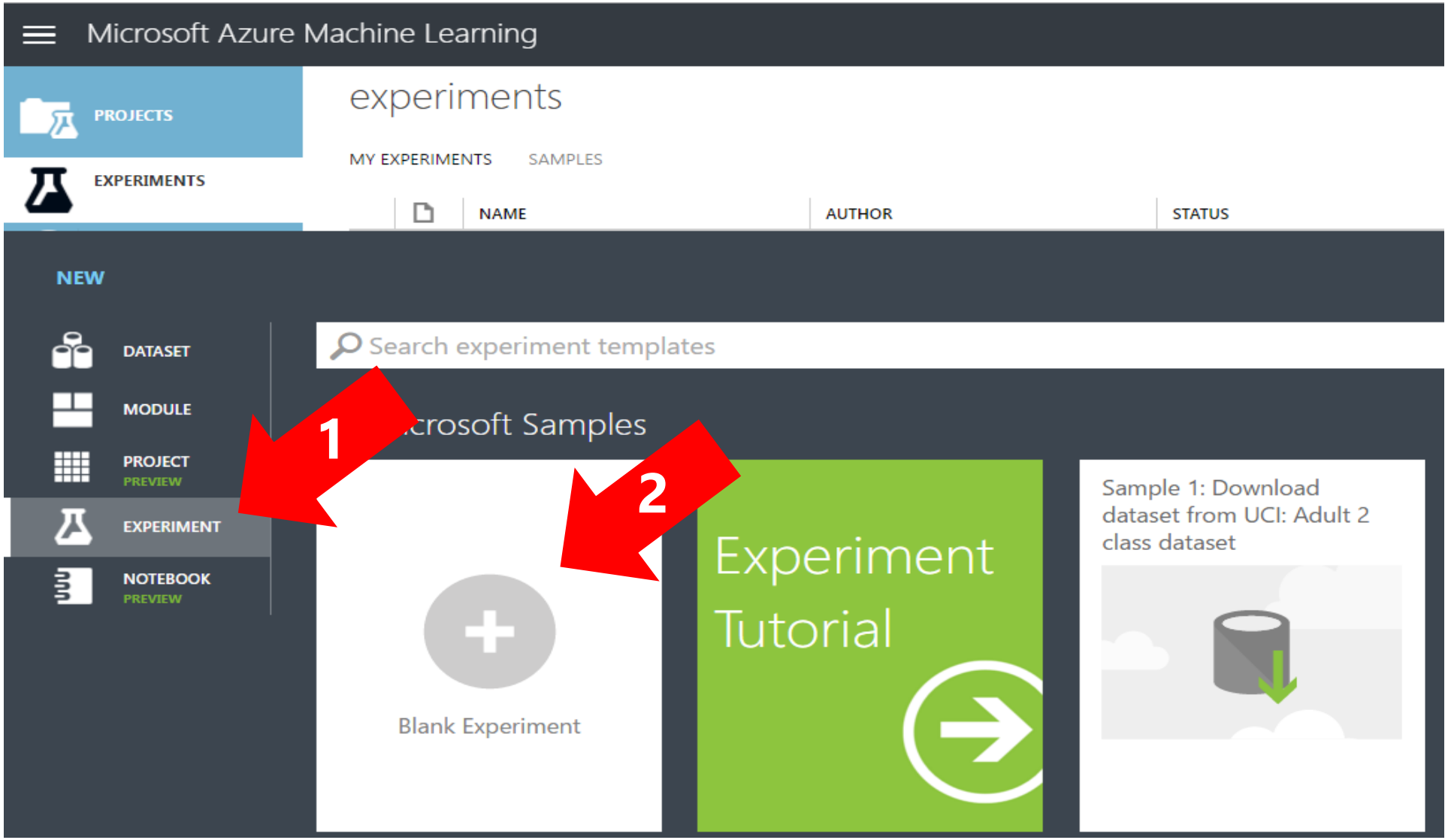
Step 3.3 : Create a new experiment



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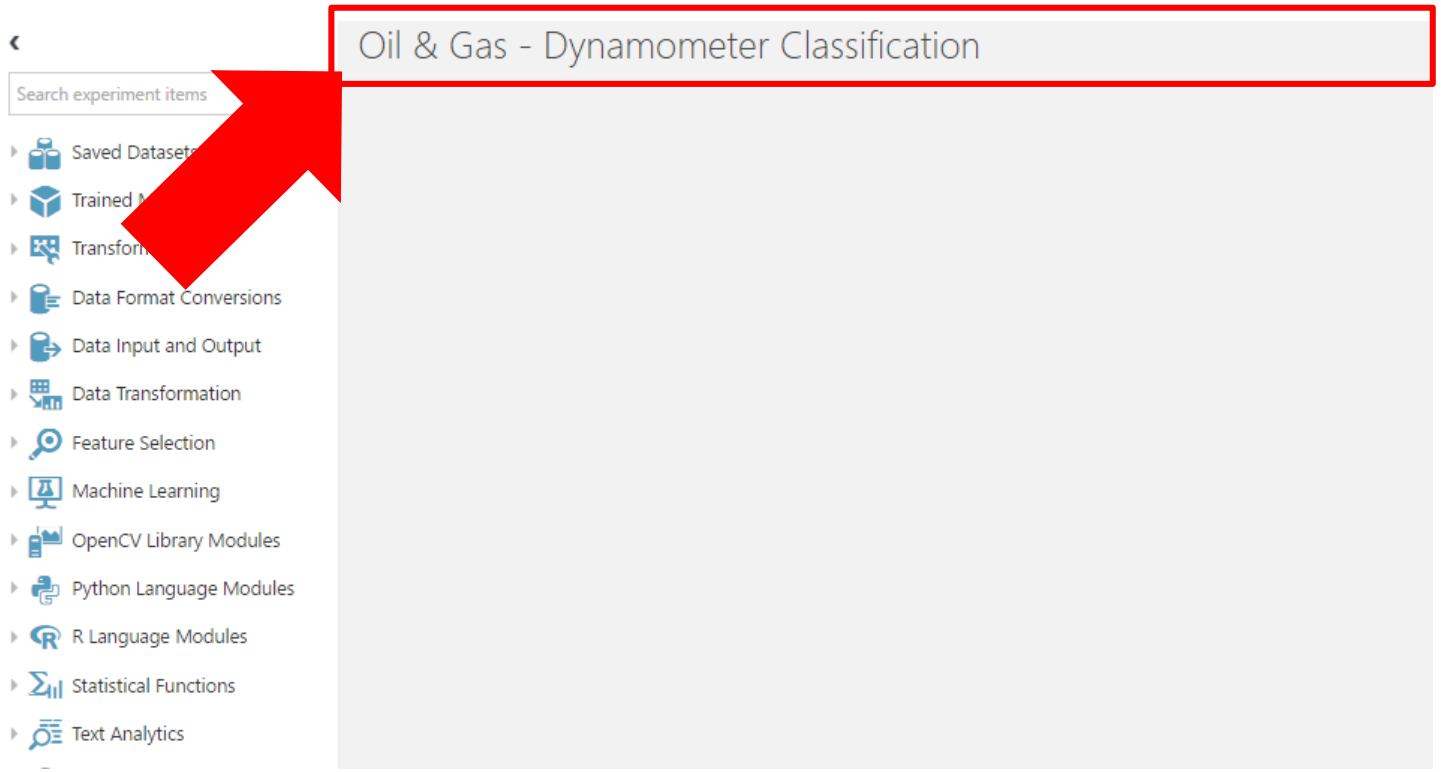
Step 3.4 : Name your experiment



- Click on the title box at the top that says "Experiment Created on …."
- Give the experiment the following title: "Oil & Gas – Dynamometer Classification"

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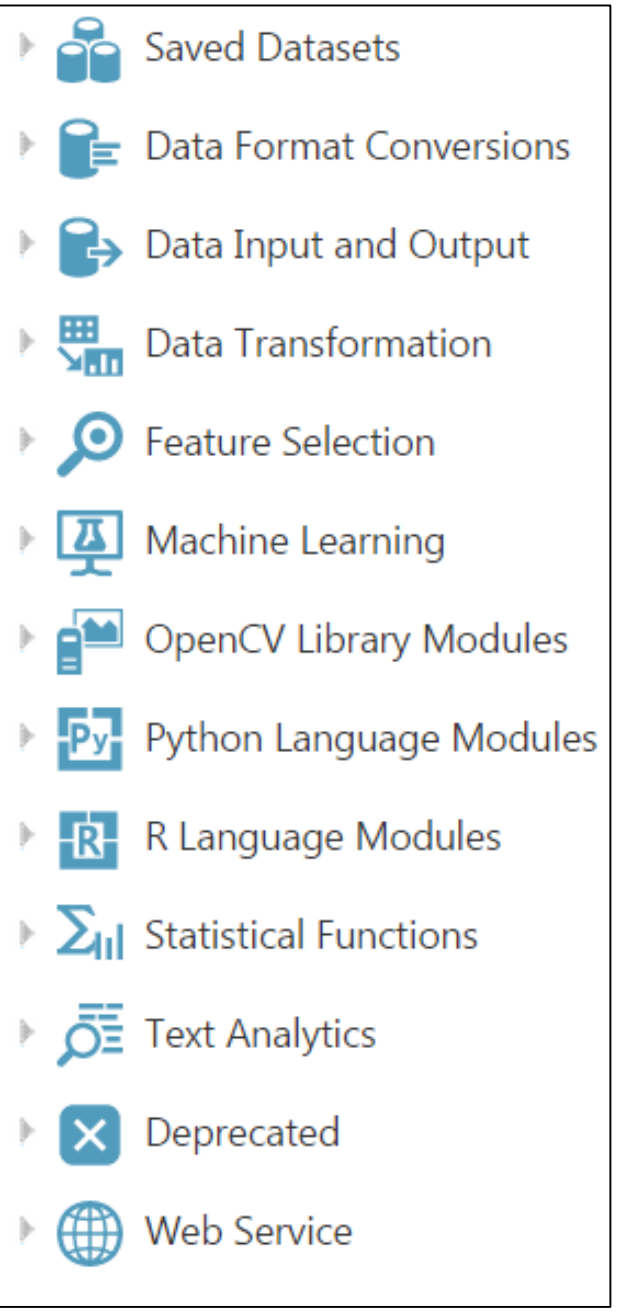

Step 4.1 : Import the dataset

- AML modelling … a checklist approach
  - ☑ ~~Create new experiment~~
  - ☐ Import data set

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Option 1 - Import the training dataset from the Azure Blob Storage. If option 1 did not work, skip to option 2.

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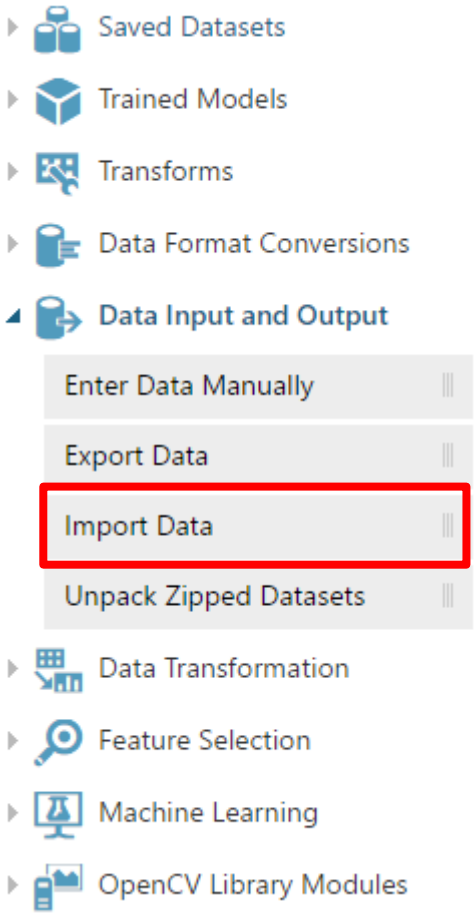
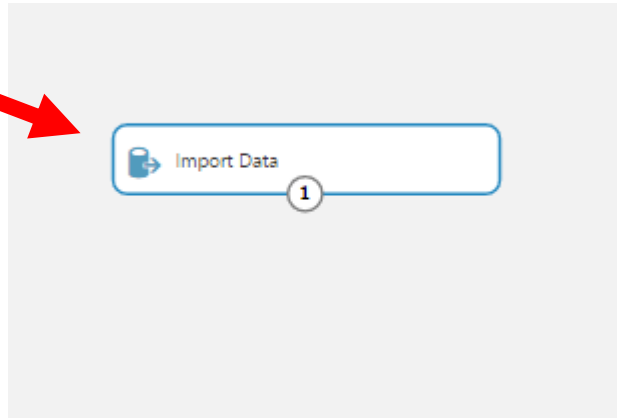
Step 4.2 : Q? How to import data from Azure Blob?

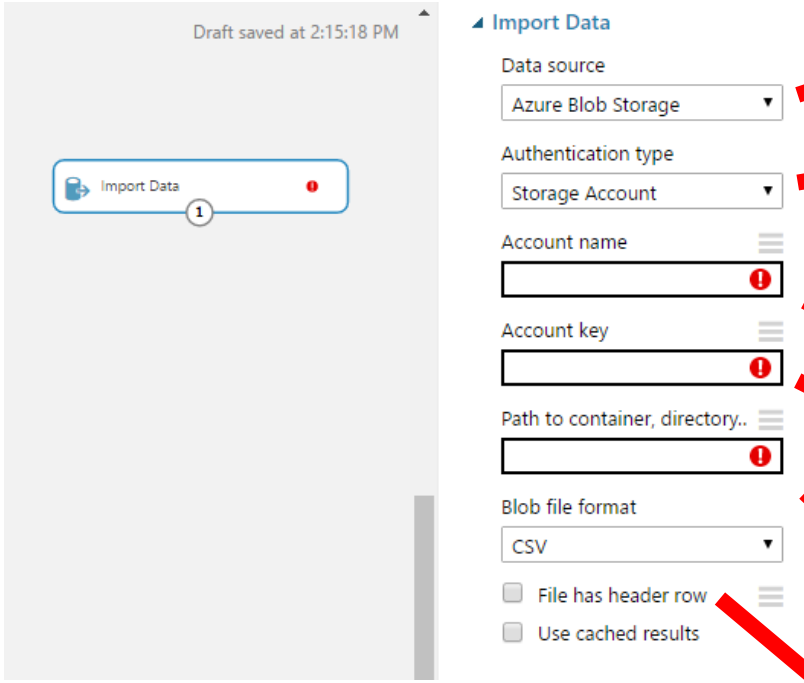


- Open “Data Input and Output” from the navigation pane at the left
- Drag “Import Data” to the canvas
  - “Import Data” loads data from sources such as the Web, Azure SQL, Windows Azure Blob storage, etc



Microsoft NEAL ANALYTICS

Step 4.3 : Q? How to import data from Azure Blob?



- Machine Learning
  - Click on Import Data
  - Chose “Azure Blob Storage” for Data source
  - Chose “Storage Account” for Authentication type
  - Copy and Paste the following information without the quotes in the Import Data module
    - Account Name – “**nealworkshop**”
    - Account key – “**RER9c7kfM1e67p7p7gI+TbkE5Y6aIzURg4PQc9lew+l8O+ZfU58gFjNgBW/WQm0u8N0YZQUG+wIaIzfWKxyIjA==**“
    - Path to container – **“/oilandgas/Dynamometer Clusters.csv**”
    - Check the File has header row check box

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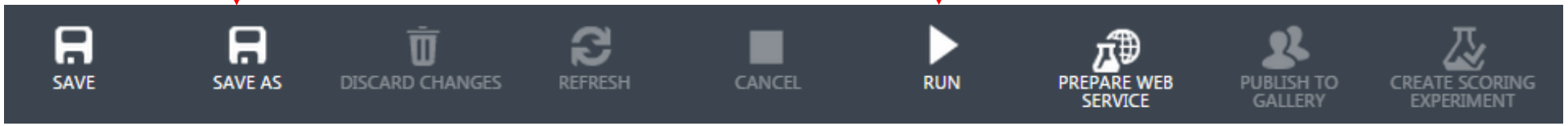
Step 4.4 : Q? How to import data from Azure Blob?

Step 1: Click "Save"

Step 2: Click "Run"



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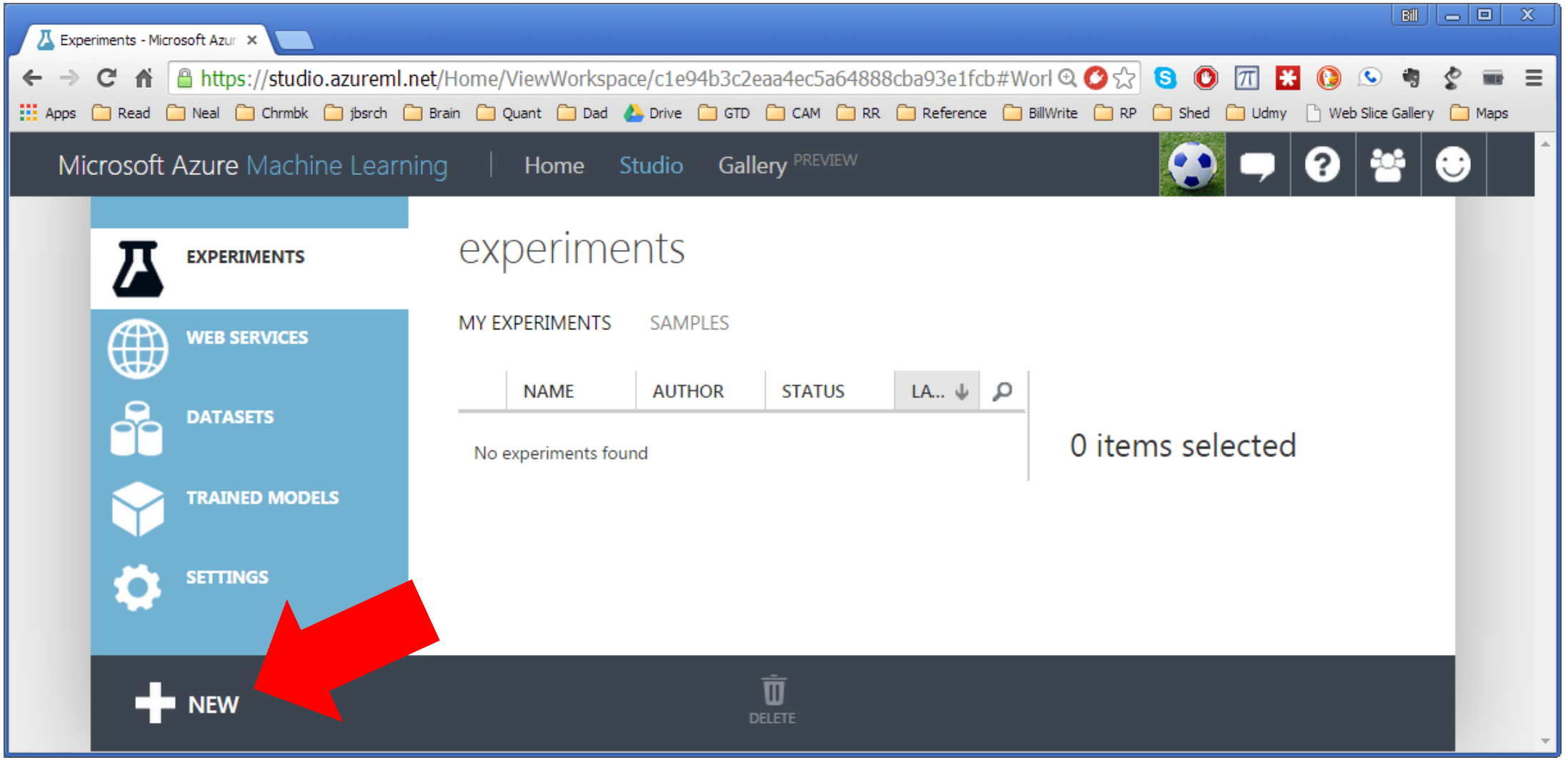
If Option 1 worked, move on to Step 4.13

Option 2 - Import the training dataset from the saved datasets.

Step 4.5 : Import this tutorial's training dataset



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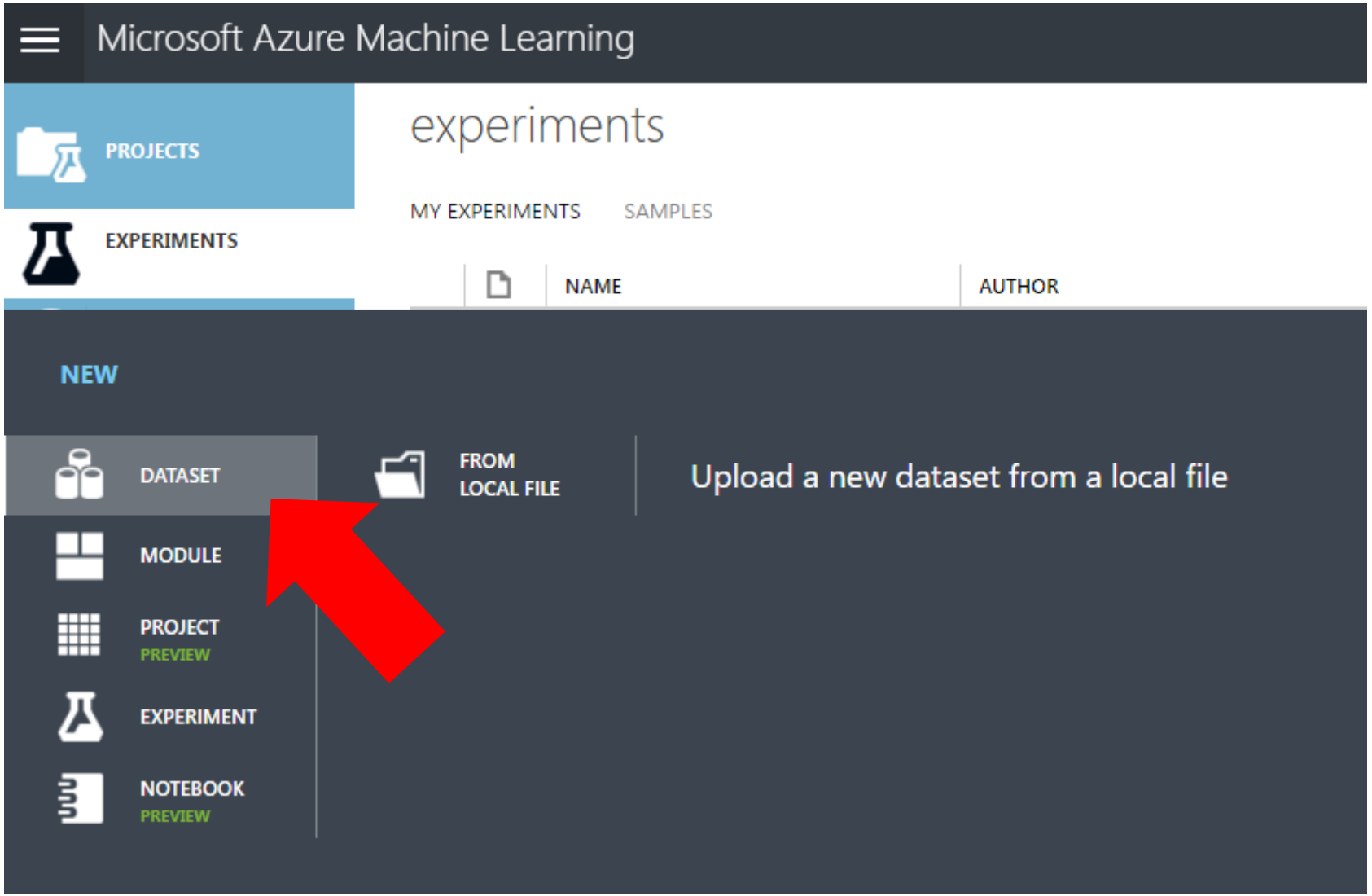
Step 4.6 : Import this tutorial's training dataset



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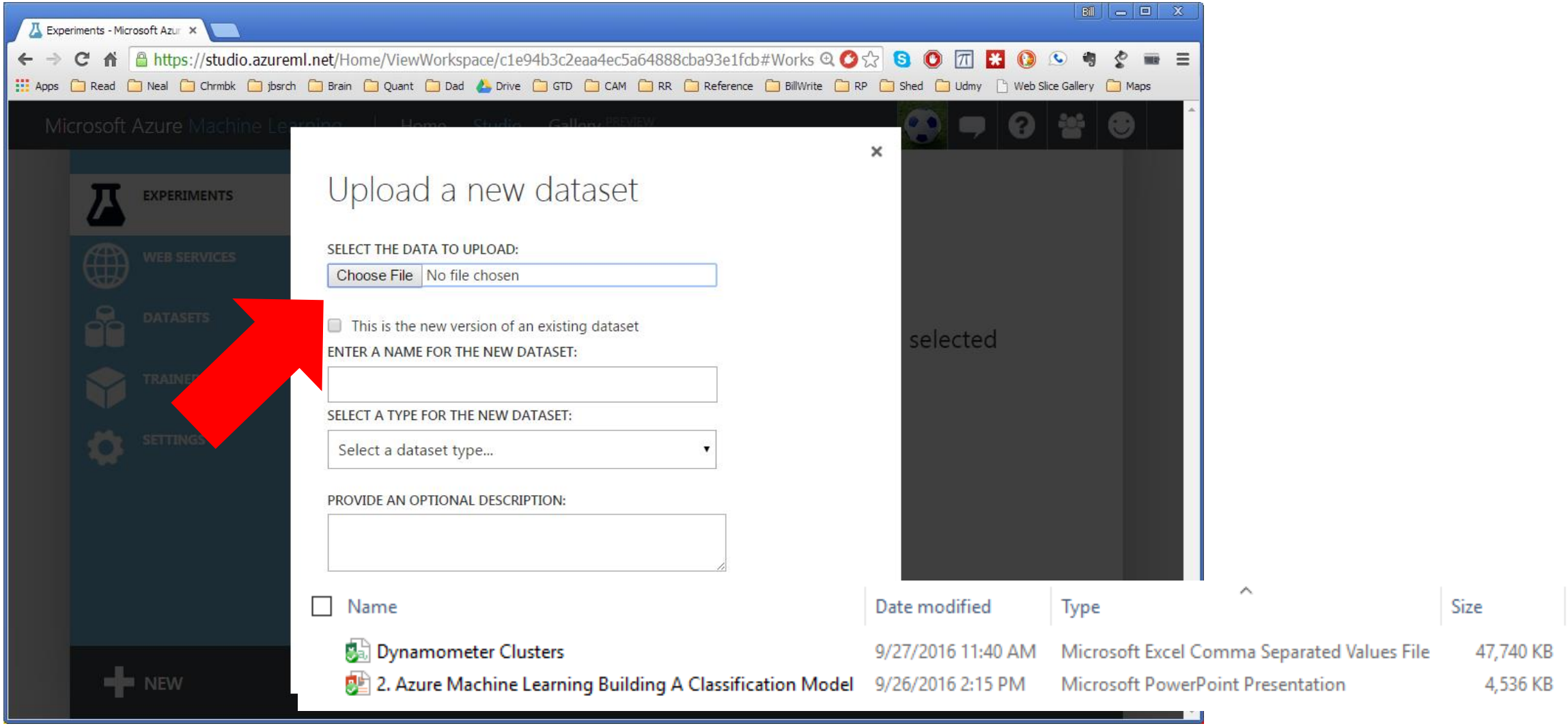
Step 4.7 : Import this tutorial's training dataset



Microsoft

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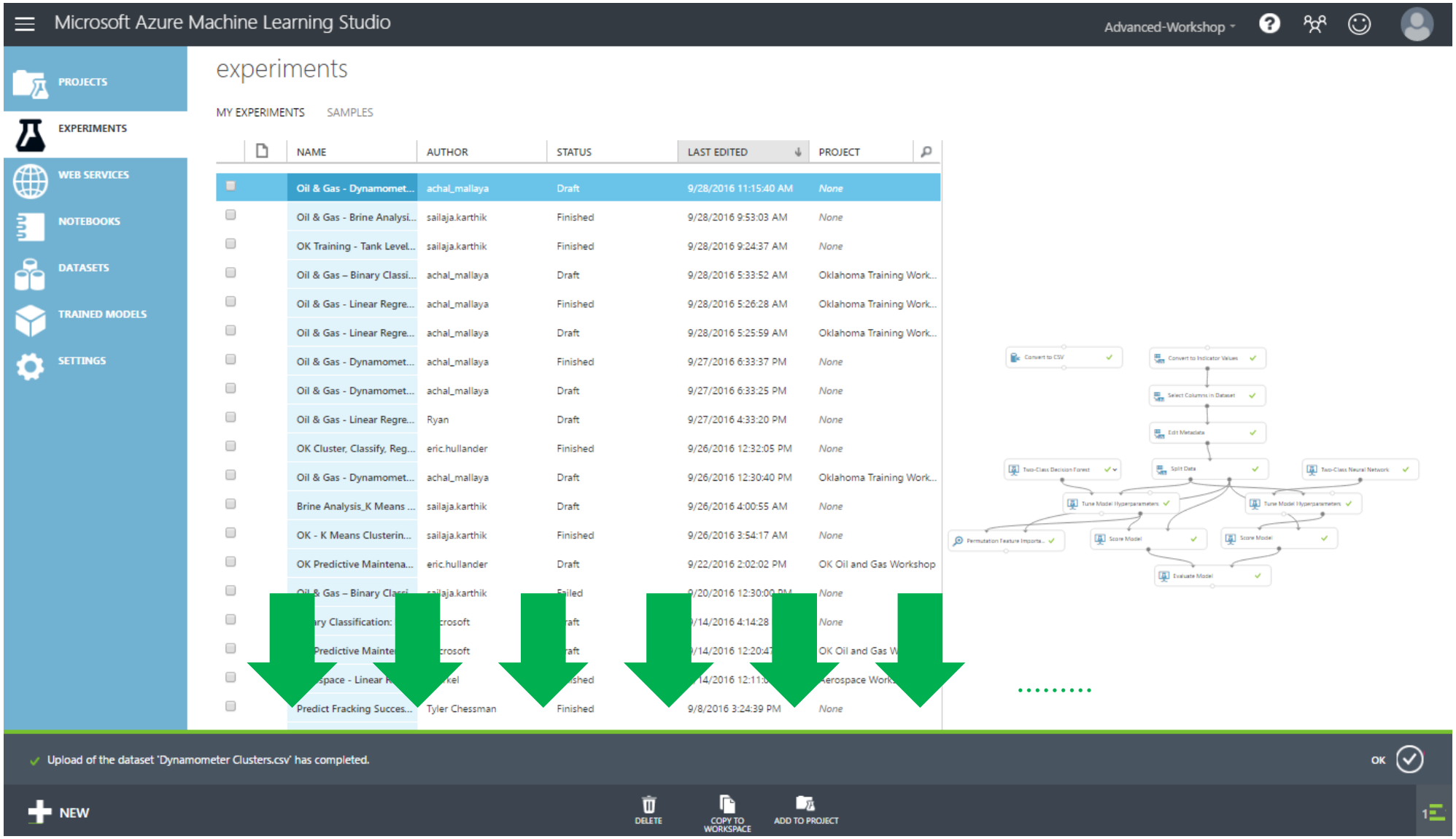
Step 4.8 : Import this tutorial's training dataset



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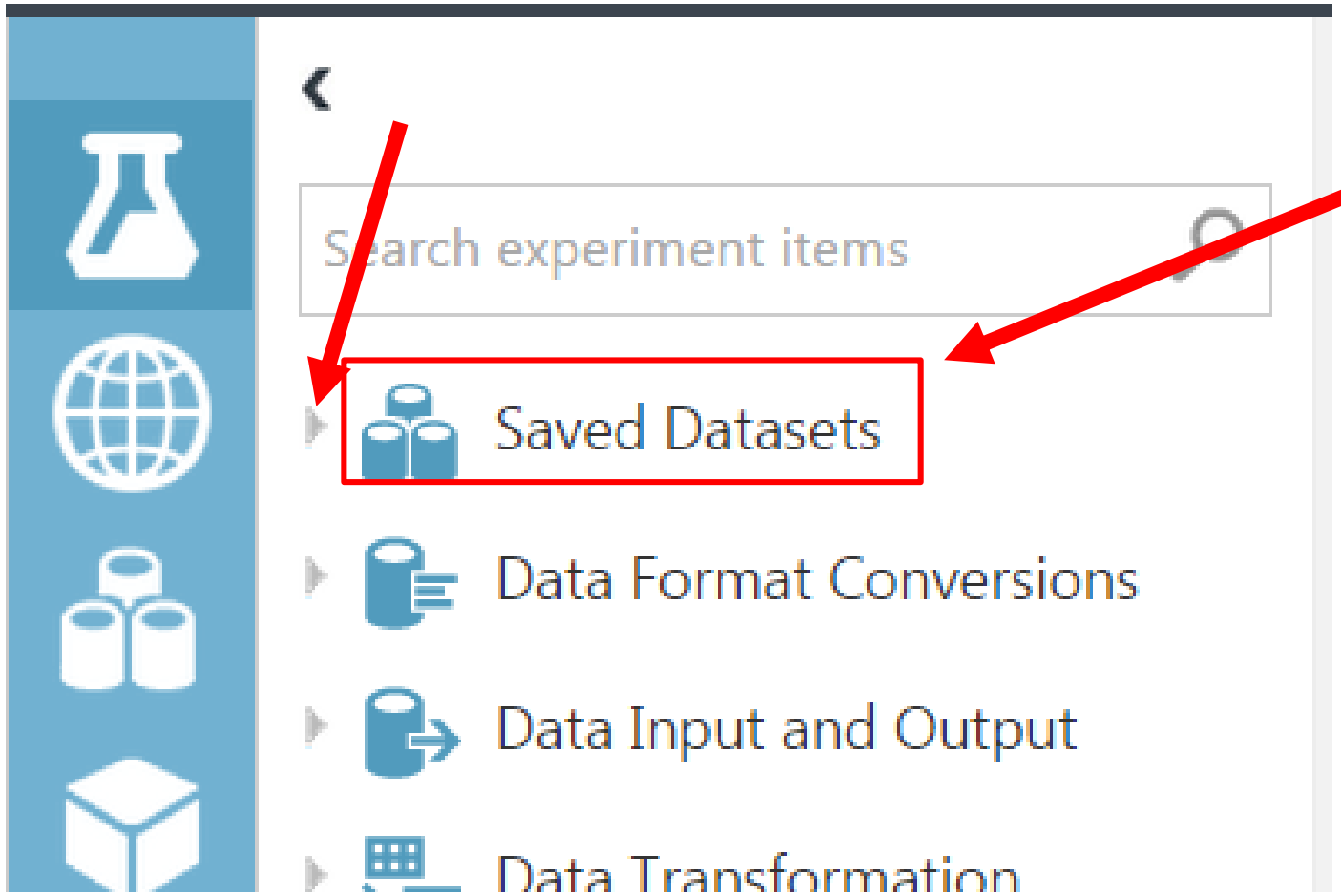
Step 4.9 : Open “Saved Datasets”



- By clicking on the triangle at the left
of “Saved Datasets”

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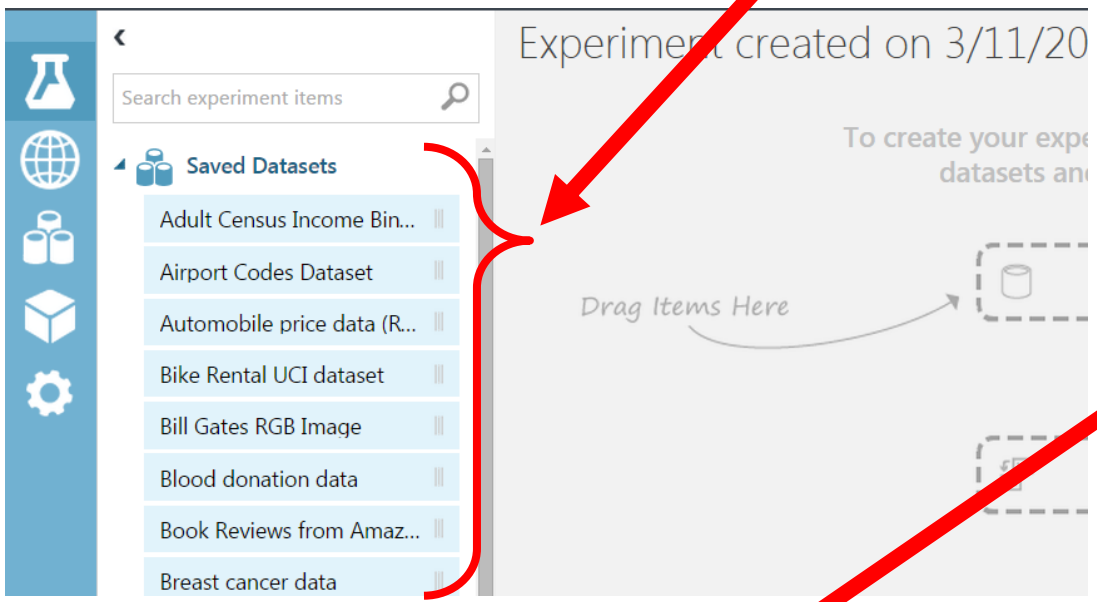
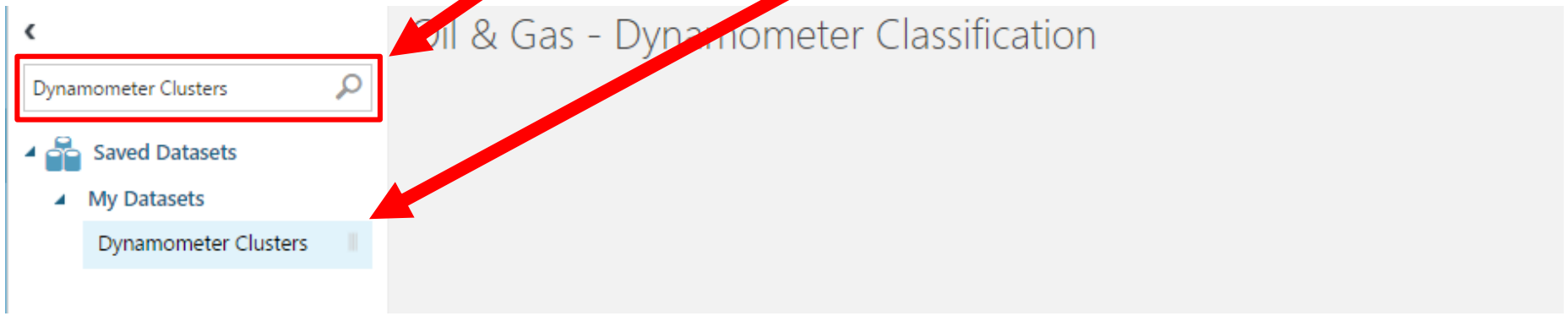
Step 4.10 : Take a second to notice the MANY datasets



- To filter to the data set for this tutorial …
- Type “Dynamometer Clusters” in the “Search experiment items” dialog box
- The data set list will reduce to our data set for this tutorial



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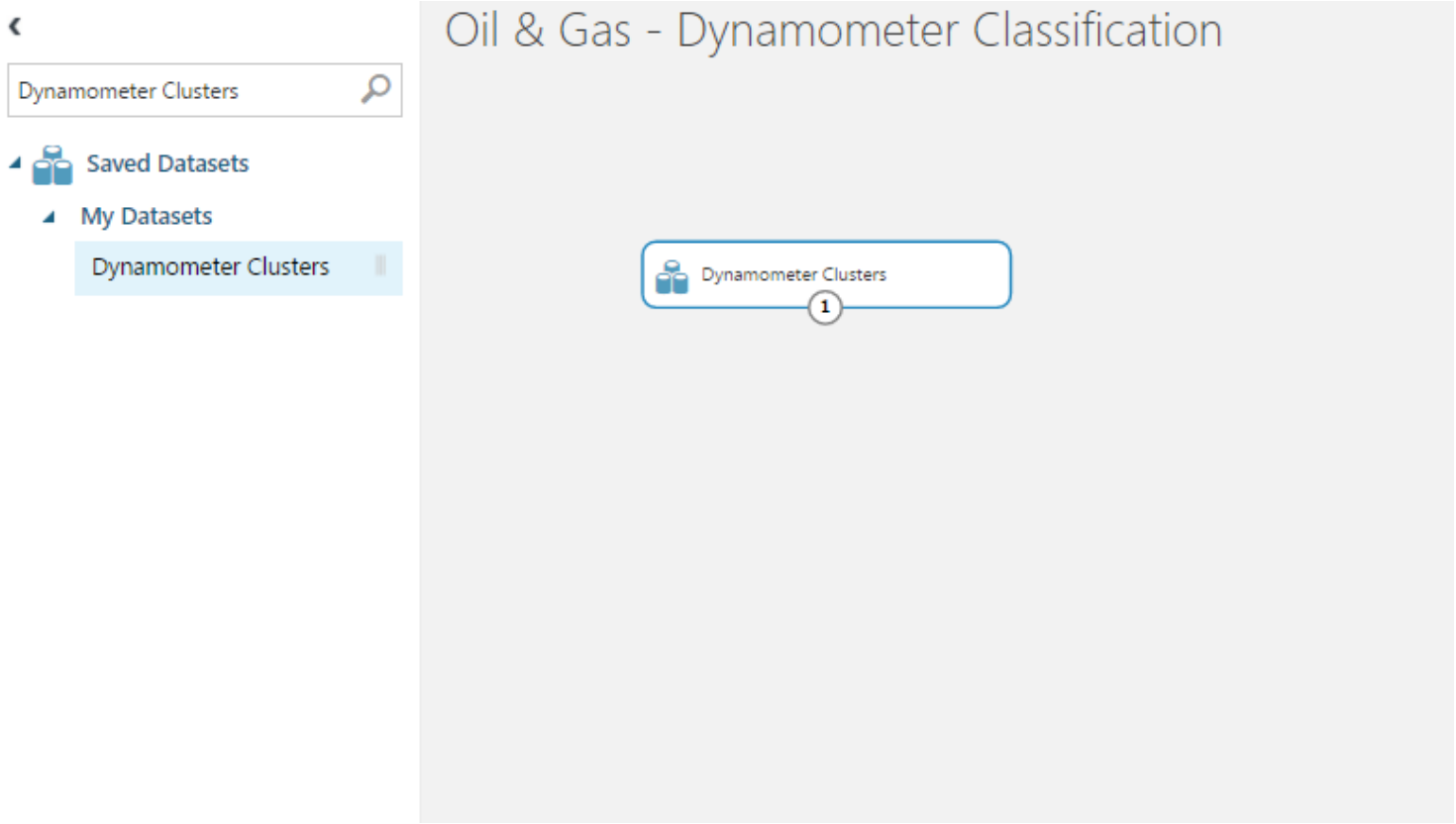
Step 4.11 : Drag the data set to the experiment



- *Note* when you drag the first element of your model to the canvas … all the guides disappear
- Now, where are all the tools that were at the left Azure Machine Learning?
- They are still there, … but we need to un-filter to see them

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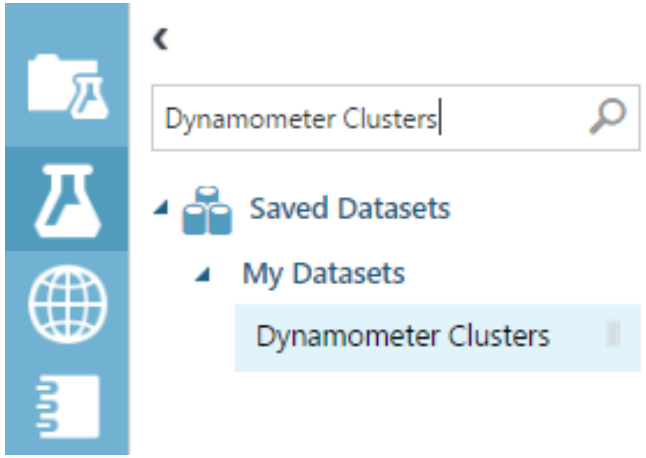
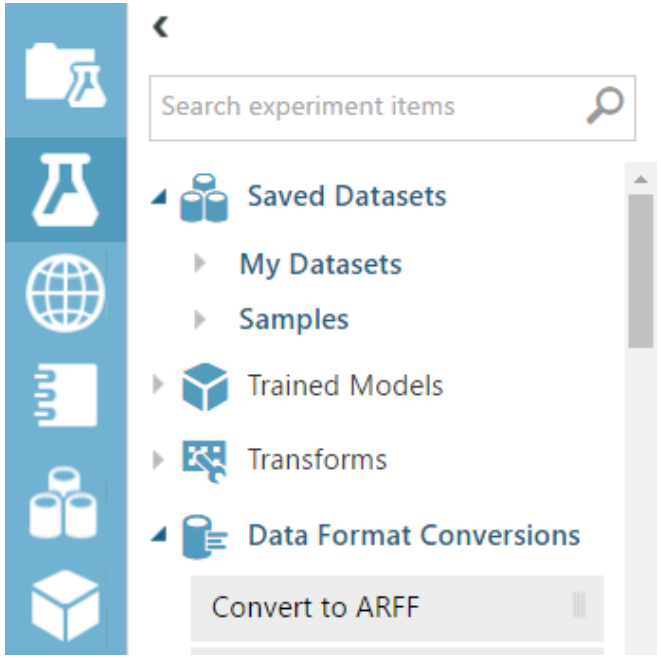
Step 4.12 : Backspace over “Dynamometer Clusters”



- Backspace to remove “Dynamometer Clusters” from the “Search experiment items” dialog



- Then click the triangle at left of “Saved Datasets” to close the dataset list

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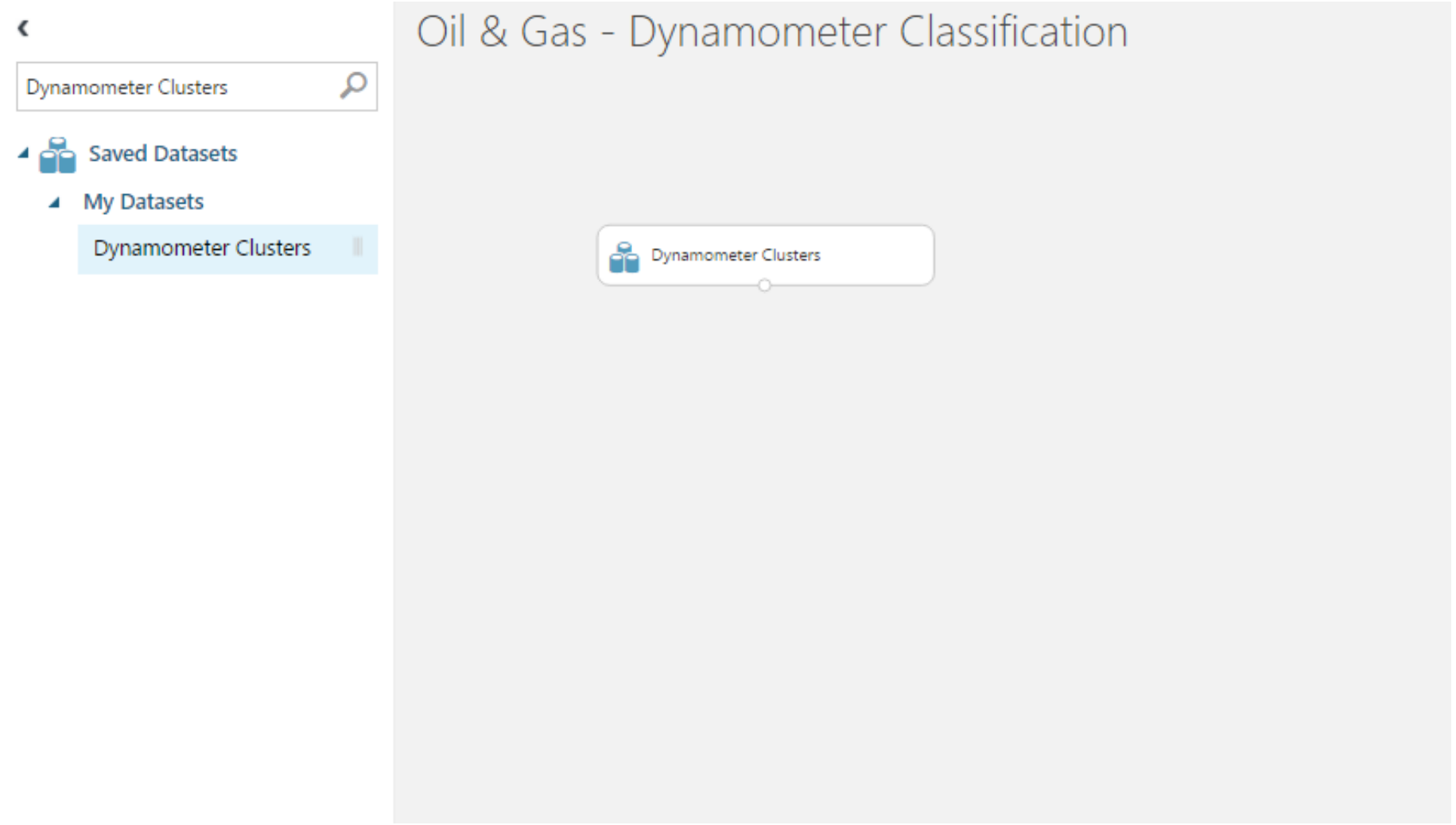
Step 4.13 : Admire your data set living in your experiment



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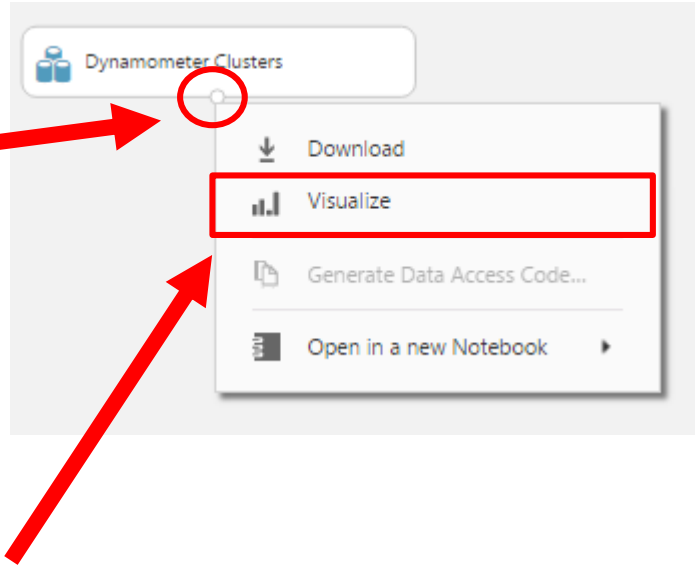
Step 4.14 : Visualize the data set

Right click on the bottom-middle circle of the module



Then click “Visualize”

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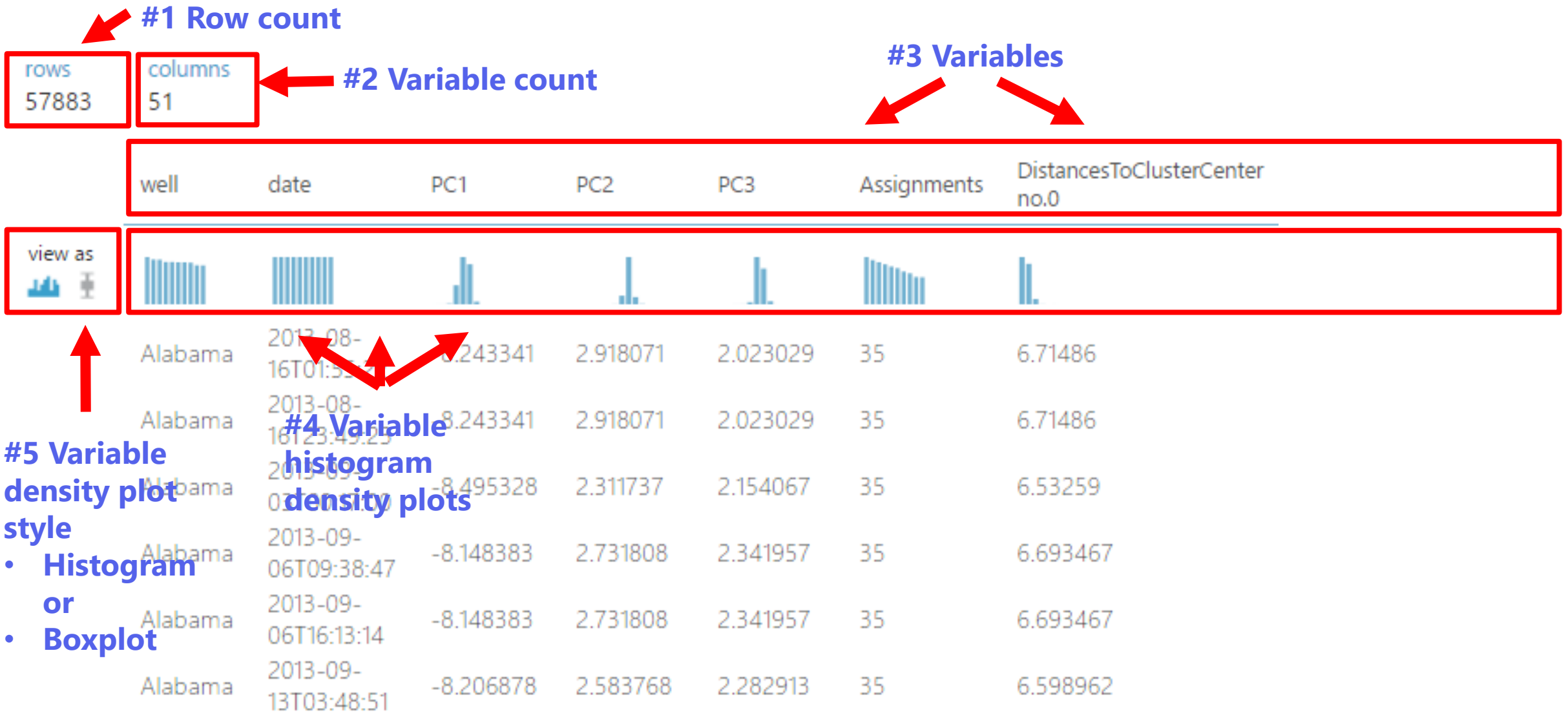
Step 4.15 : Now look at the data for 4 attributes



Microsoft

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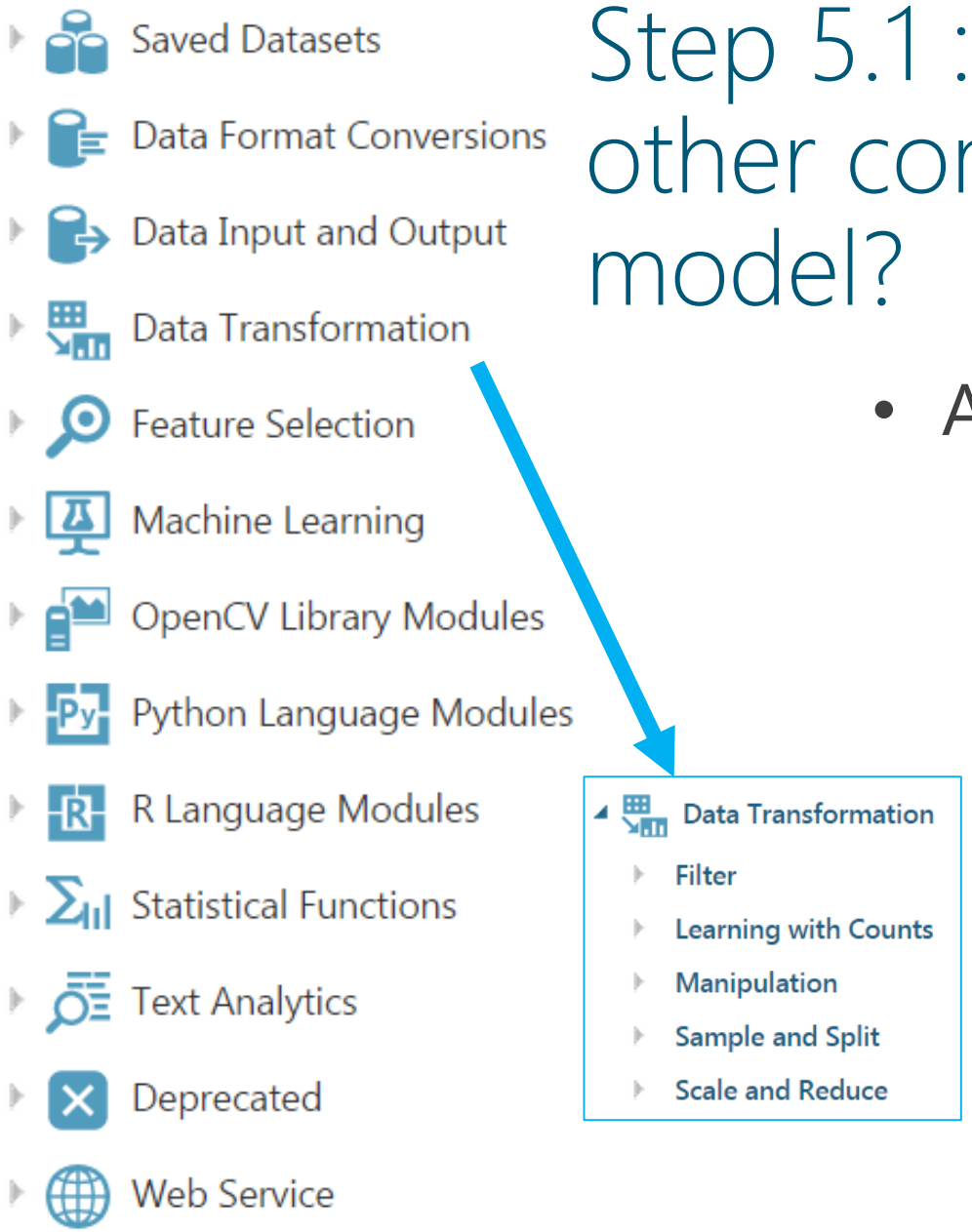
Step 5.1 : In addition to data what are the other components we need for an AML model?



- AML modelling … a checklist approach
  - ☑ ~~Create new experiment~~
  - ☑ ~~Import data set~~
  - ☐ Data transformation

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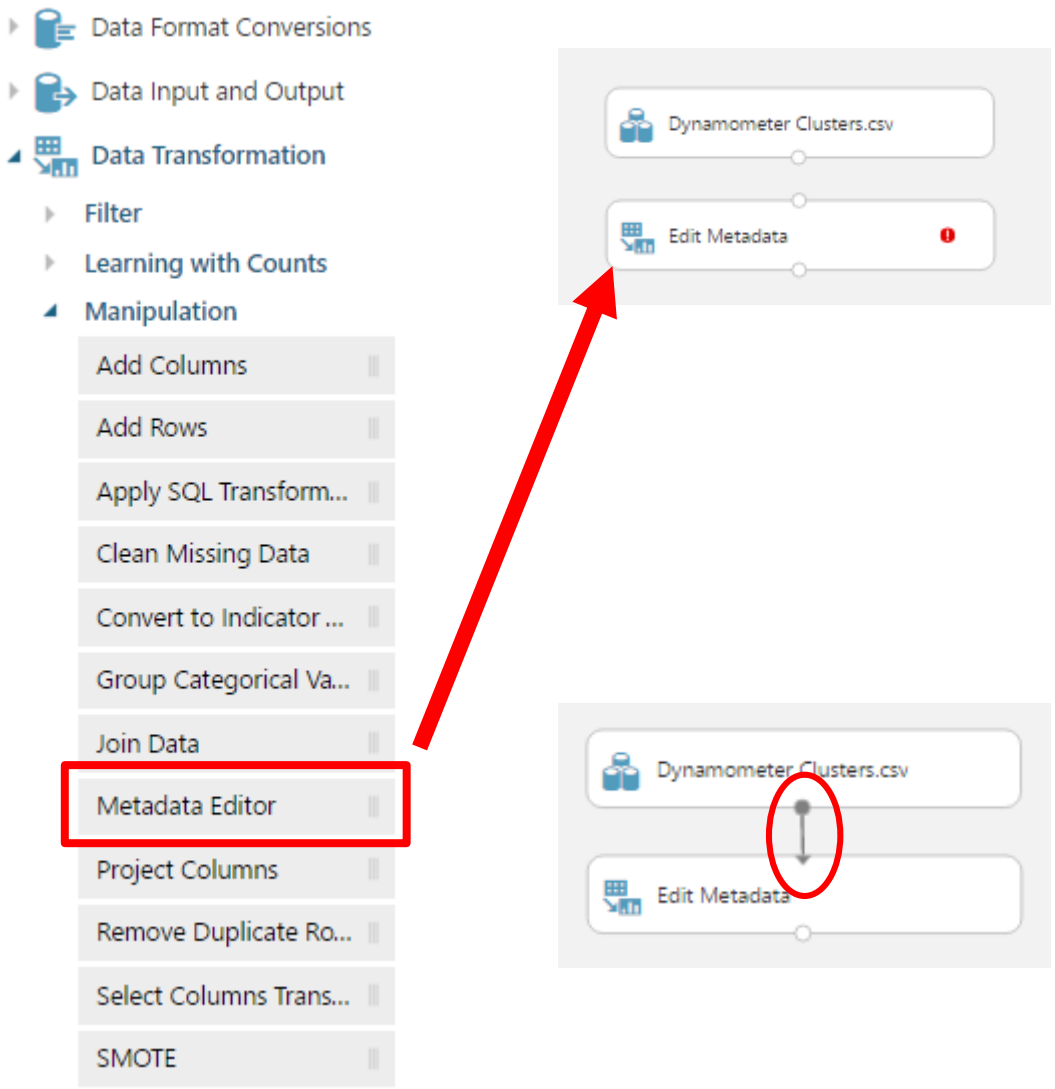
Step 5.2 : Q? Edit Metadata



- Open "Data Transformation" and then "Manipulation" from the navigation pane at the left
- Drag "Metadata Editor" to the canvas
  - "Metadata Editor" edits metadata associated with the columns in a dataset
- Next, click and hold on the bottom middle circle of your "Dataset" module
- While holding down the mouse button, drag the line to the top middle circle of "Metadata Editor" module

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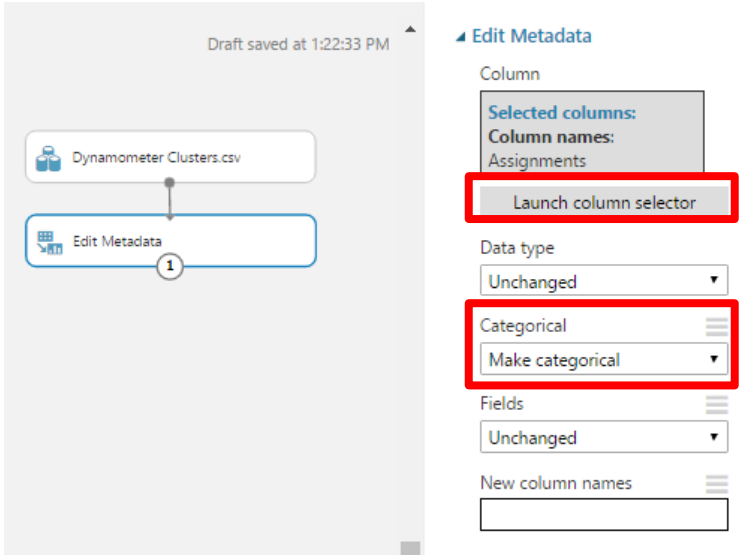
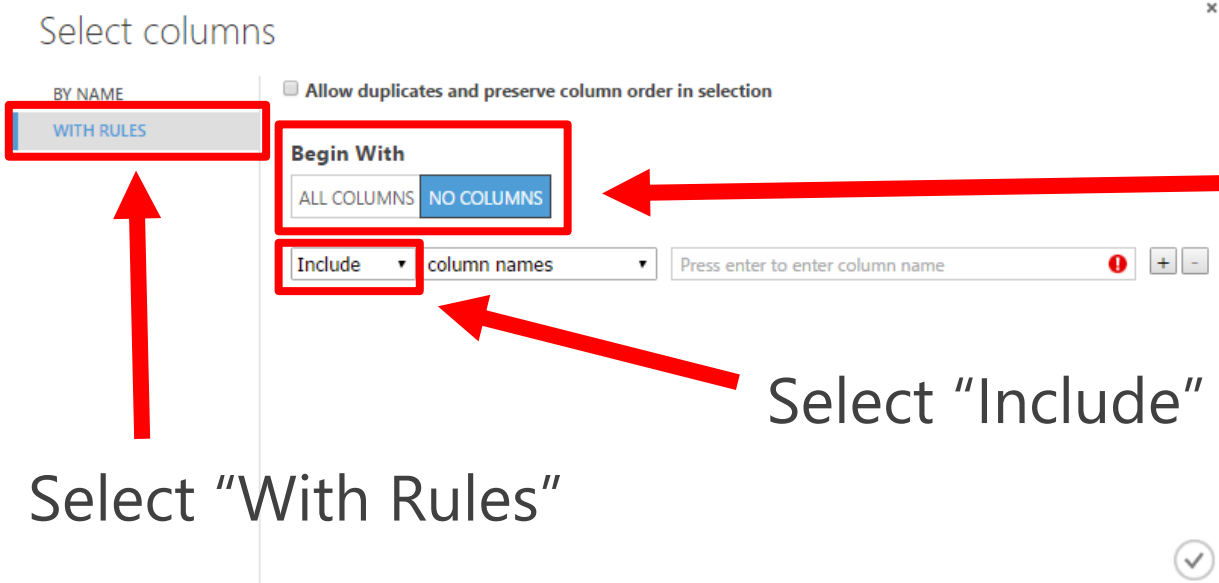
Step 5.3 : Q? Edit Metadata



- Machine Learning
  - Click on Metadata Editor
  - Chose “Make categorical” from the drop down menu under Categorical
  - Then click on “Launch column selector”



Select “No Columns”

Select “Include” from the drop down menu

Select “With Rules”

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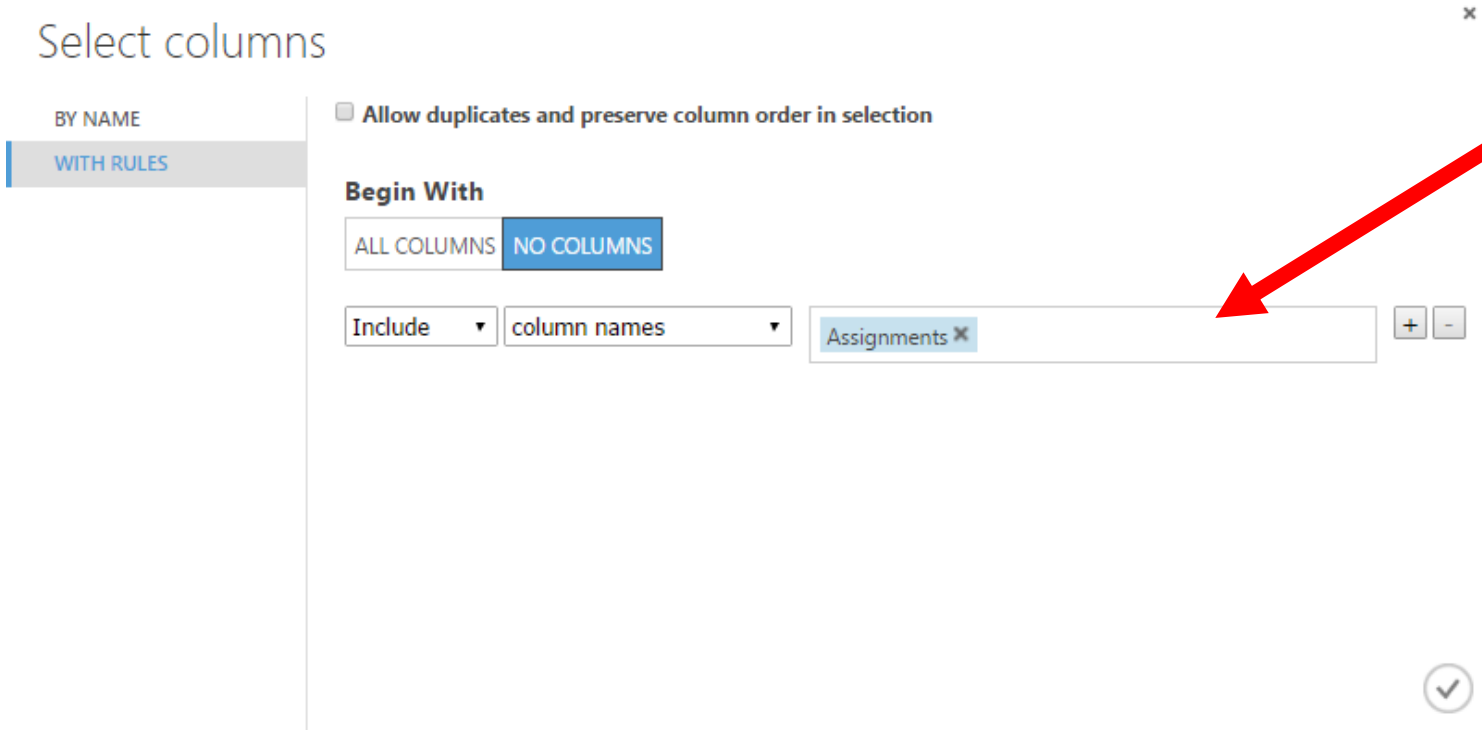
Step 5.4 : Q? Edit Metadata



- Click here and a drop down list appears
- Select one variable at a time
  - Assignments

Step 1: Next, click on the check circle

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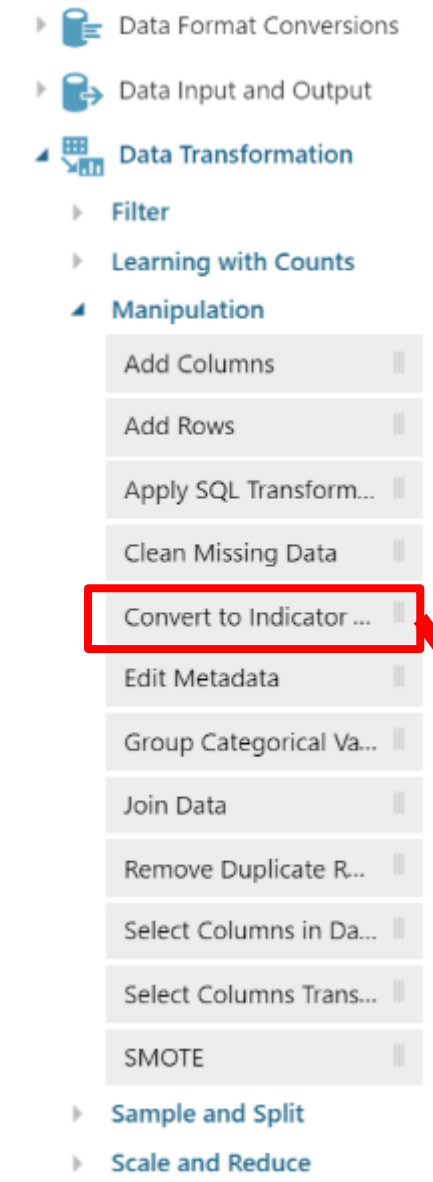
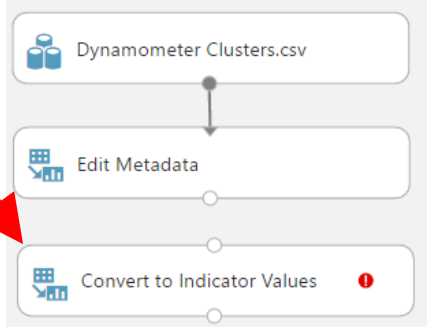
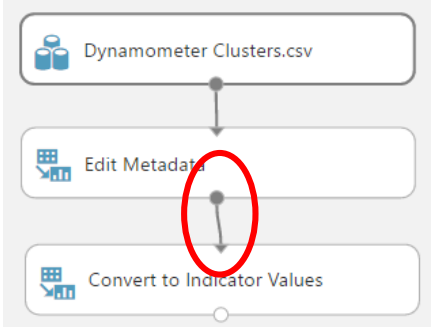
Step 5.5 : Q? How do we exclude variables?



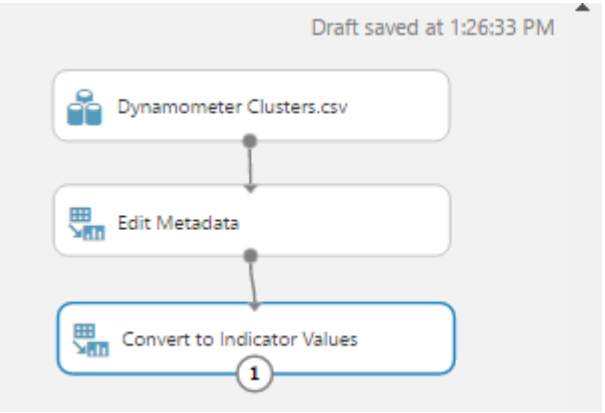
- Open “Data Transformation” and then “Manipulation” from the navigation pane at the left
- Drag “Convert to Indicator Values” to the canvas
  - “Convert to Indicator Values” converts categorical values in columns to indicator values
- Next, click and hold on the bottom middle circle of your “Edit Metadata” module
- While holding down the mouse button, drag the line to the top middle circle of “Convert to Indicator Values” module

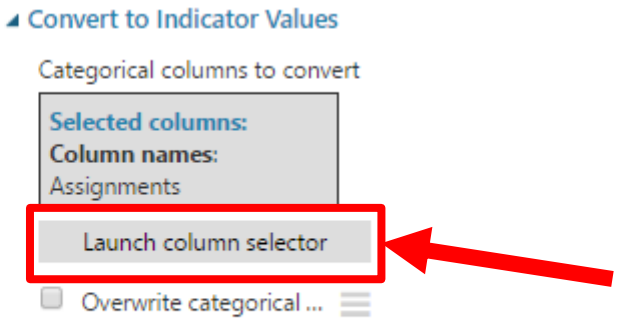




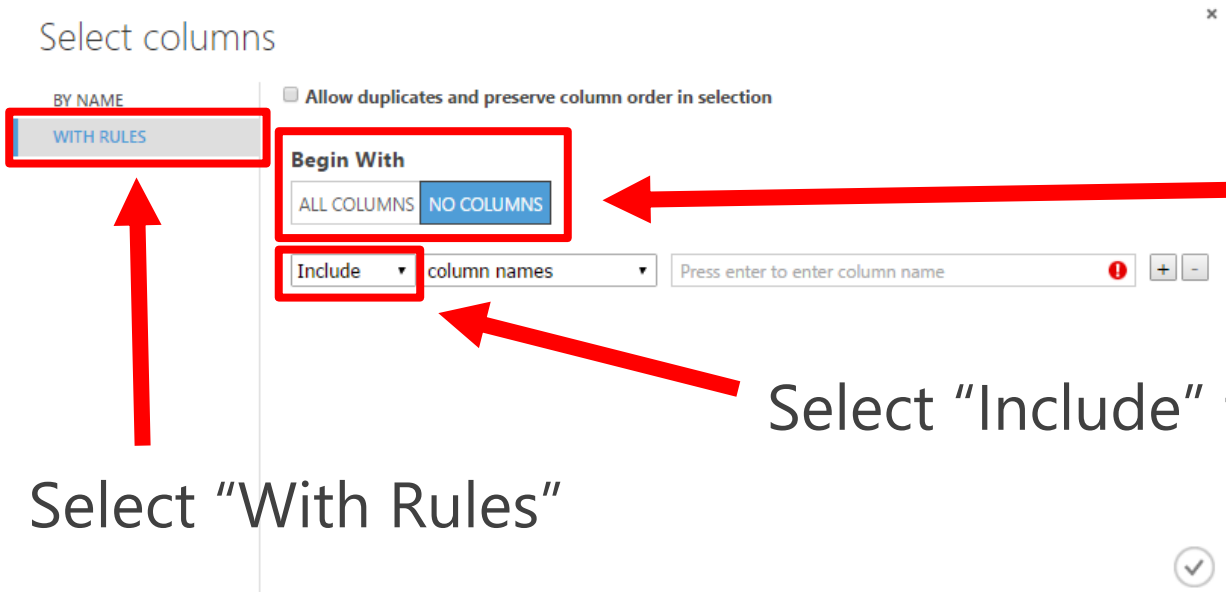
Microsoft NEAL ANALYTICS

Step 5.6 : Q? How do we exclude variables?





- Click on "Select Columns in Dataset" on your canvas, and make sure it has a blue outline
- Then click on "Launch column selector" in the menu at right



Select "No Columns"

Select "Include" from the drop down menu

Select "With Rules"

Microsoft

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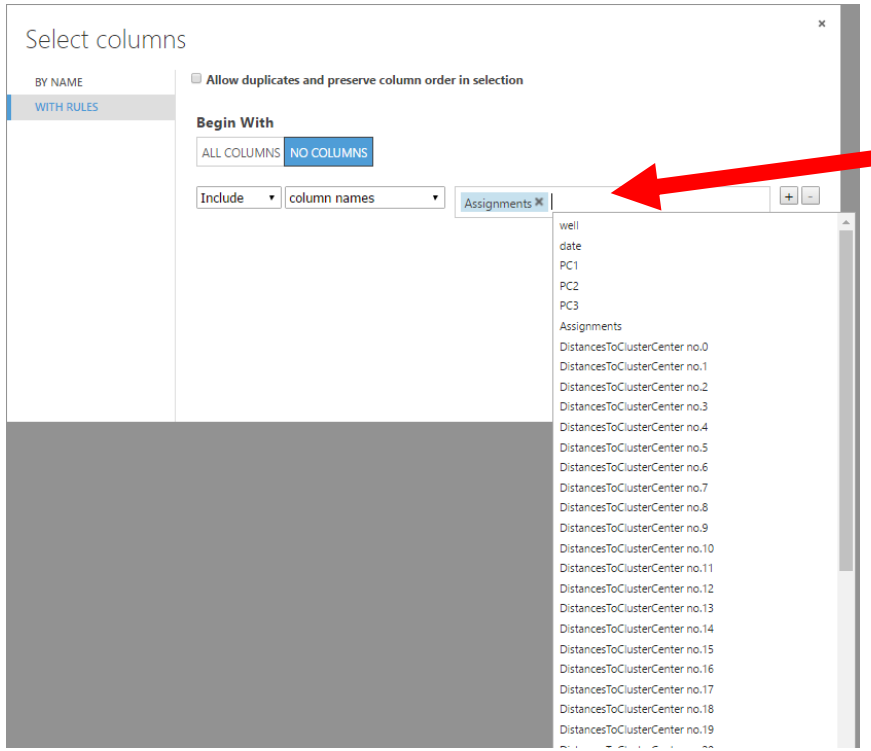
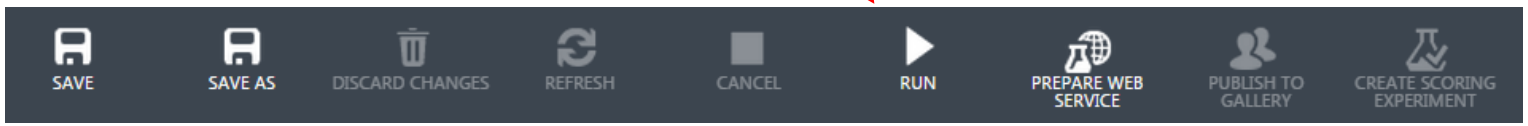
Step 5.7 : Q? How do we exclude variables?



- Click here and a drop down list appears
- Select one variable at a time
  - Assignments

Click “Run”



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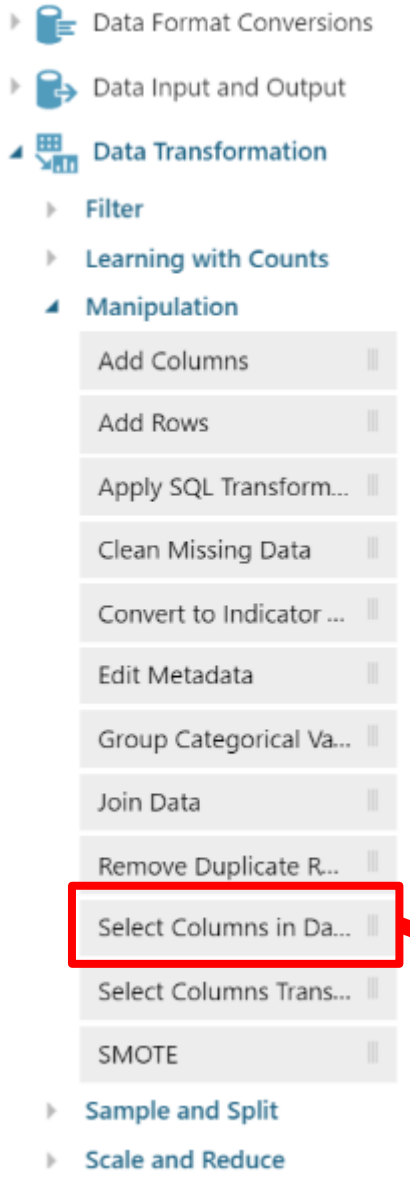
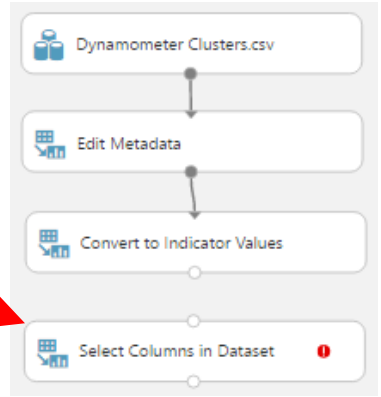
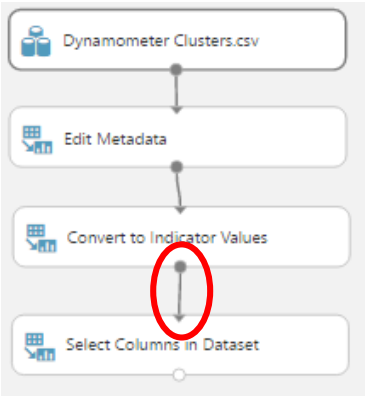
Step 5.8 : Q? How do we exclude variables?



- Open “Data Transformation” and then “Manipulation” from the navigation pane at the left
- Drag “Select Columns in Dataset” to the canvas
  - “Select Columns in Dataset” selects columns to include or exclude from a dataset in an operation
- Next, click and hold on the bottom middle circle of your “Convert to Indicator Values” module
- While holding down the mouse button, drag the line to the top middle circle of “Select Columns in Dataset” module





Microsoft

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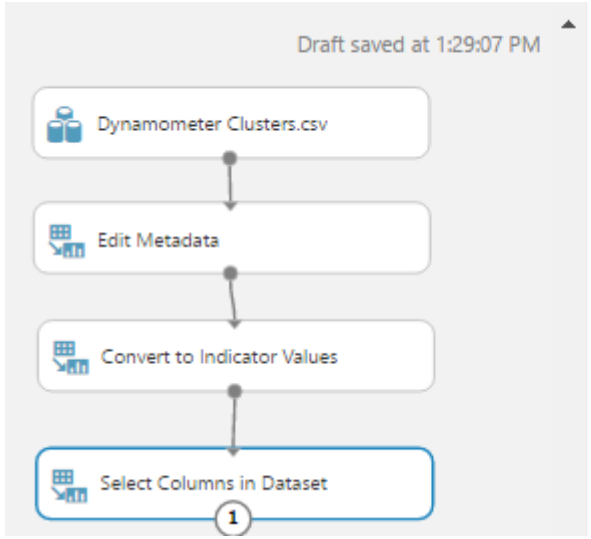
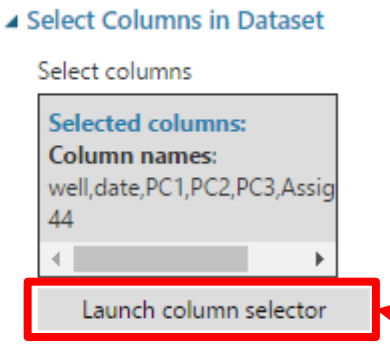
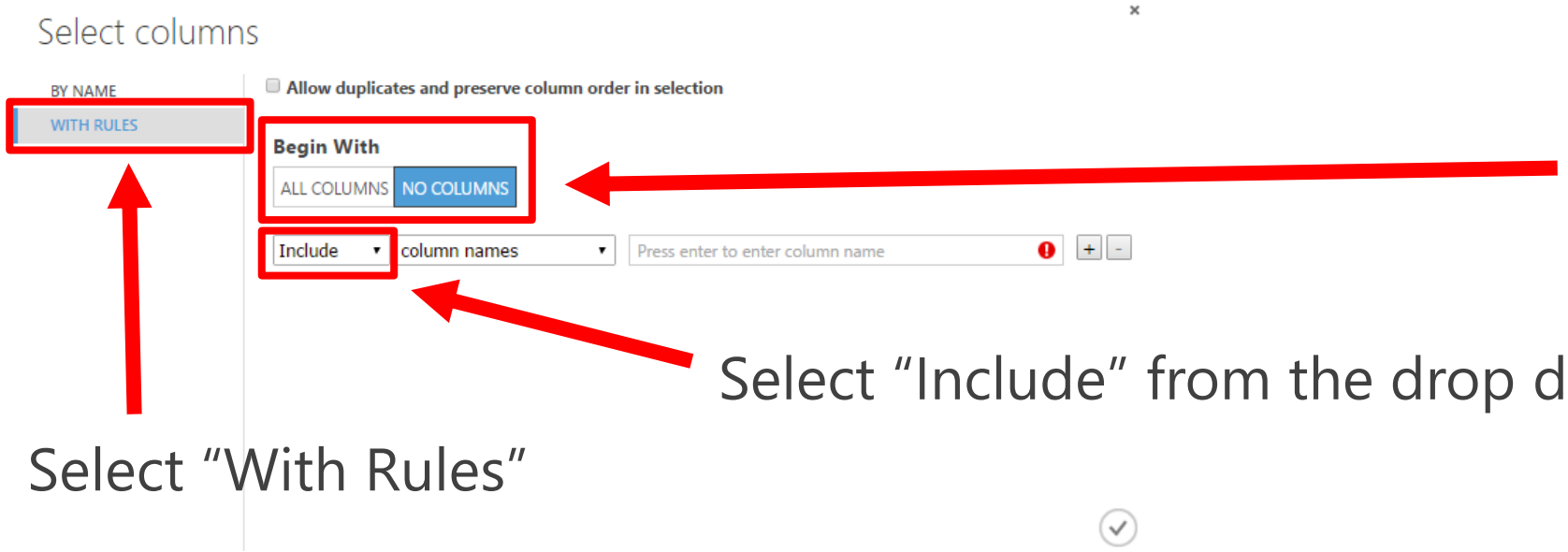
Step 5.9 : Q? How do we exclude variables?





- Click on "Select Columns in Dataset" on your canvas, and make sure it has a blue outline
- Then click on "Launch column selector" in the menu at right



Select "No Columns"

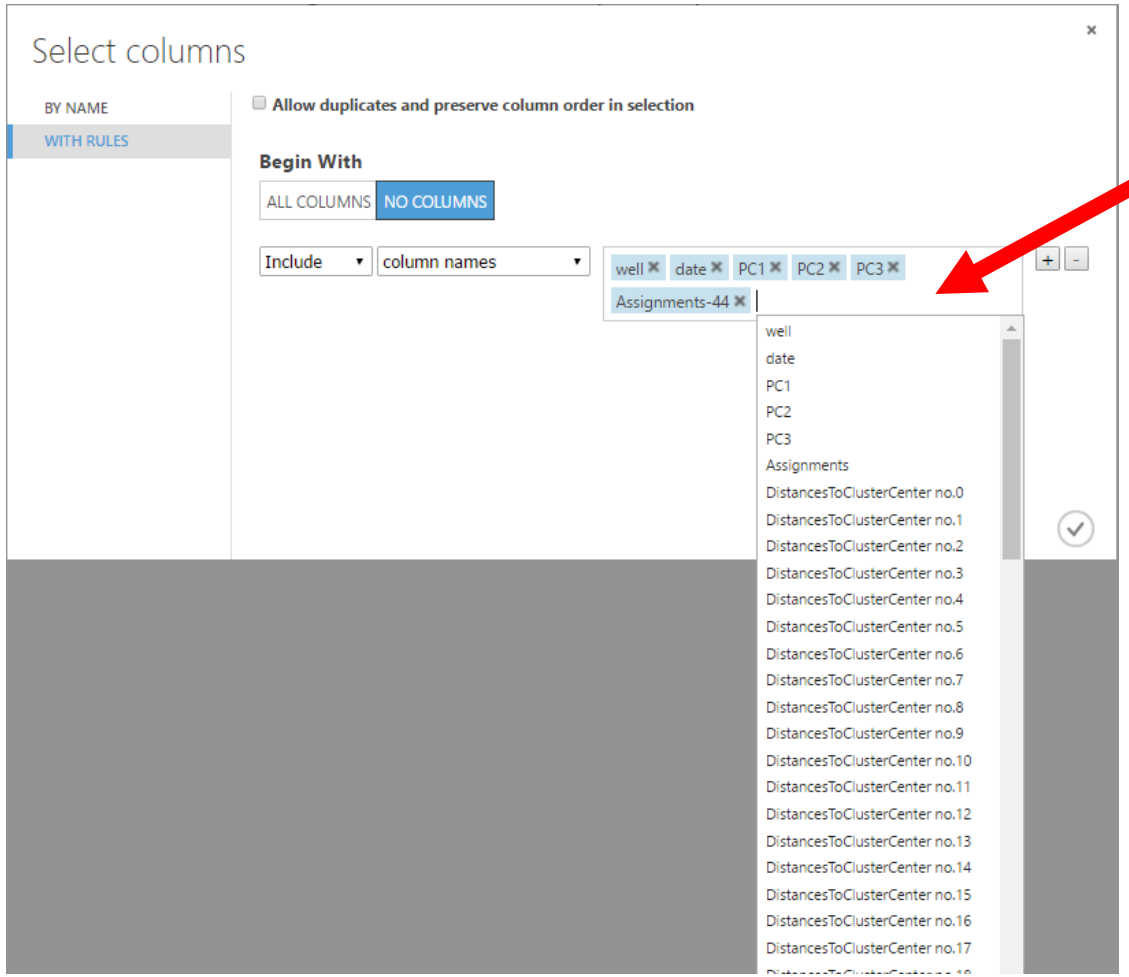
Select "Include" from the drop down menu

Select "With Rules"

Microsoft

NEAL ANALYTICS

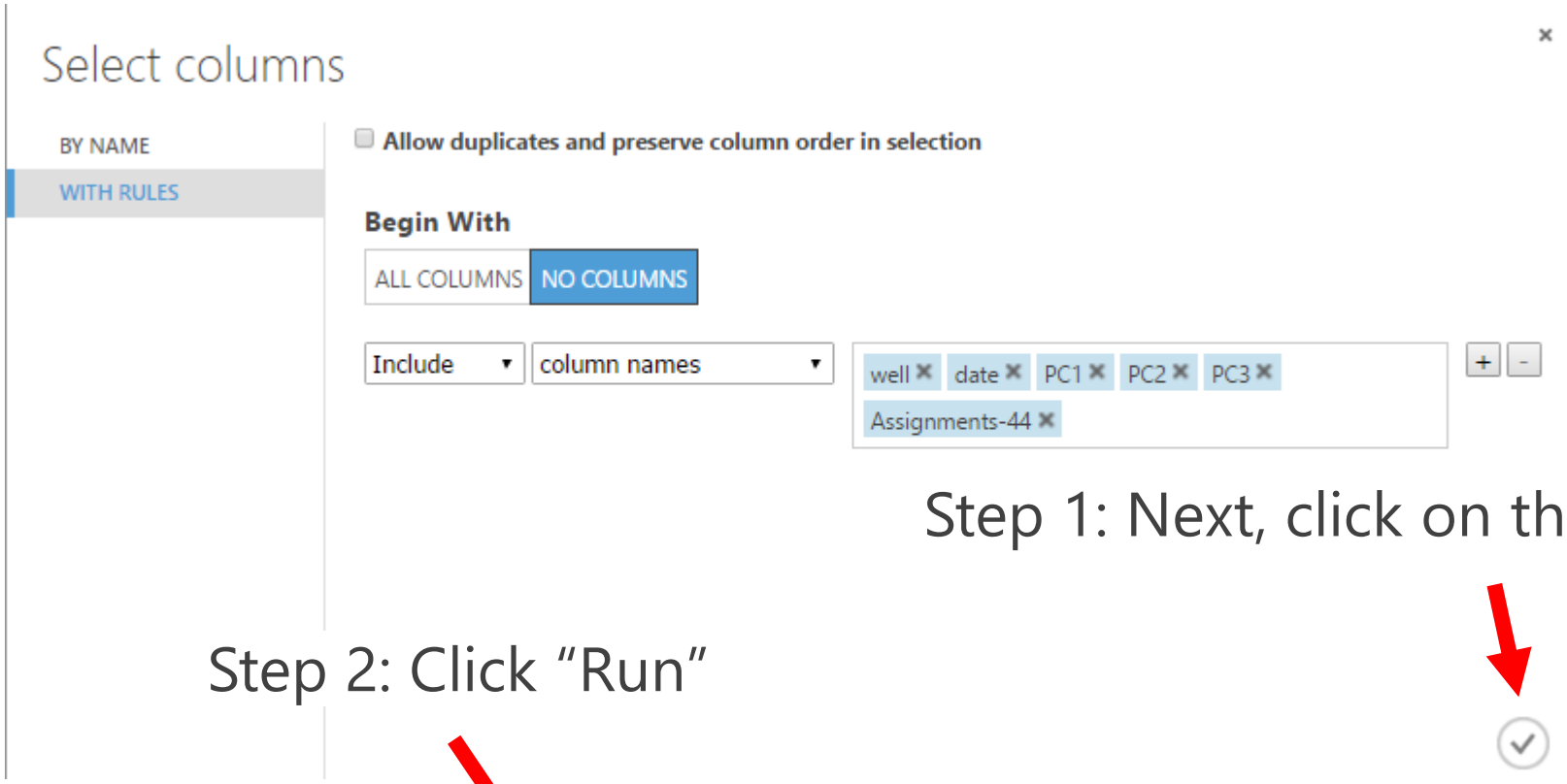
Step 5.10 : Q? How do we exclude variables?



- Click here and a drop down list appears
- Select one variable at a time
  - Well
  - Date
  - PC1
  - PC2
  - PC3
  - Assignments-44

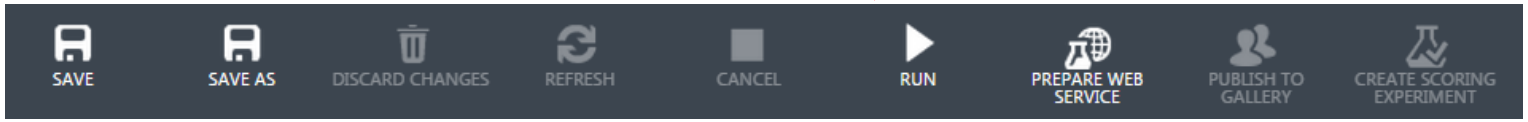
Microsoft NEAL ANALYTICS

Step 5.11 : Q? How do we exclude variables?



Step 1: Next, click on the check circle

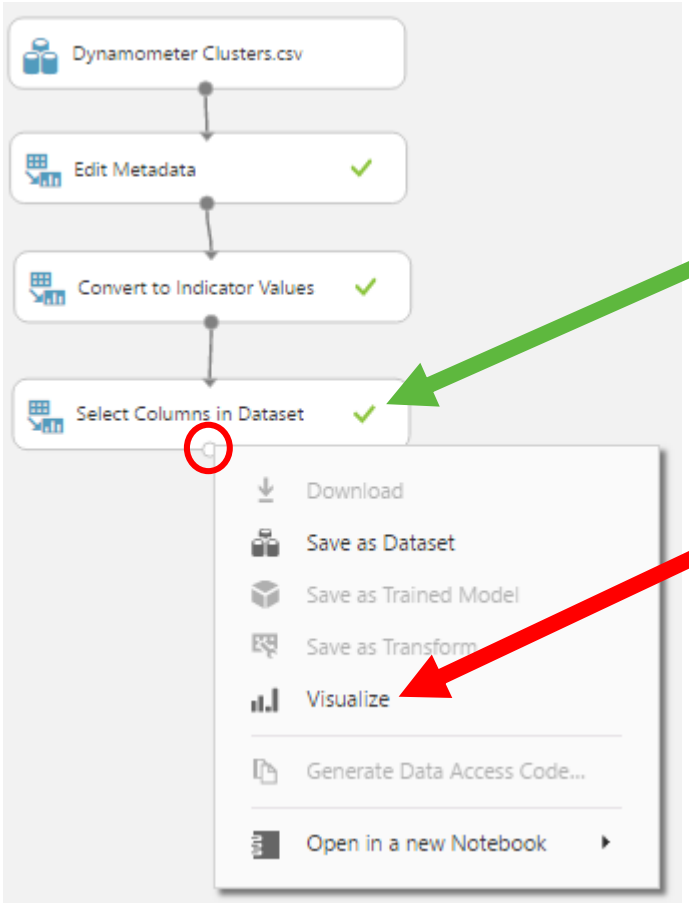
Step 2: Click “Run”



Microsoft

NEAL ANALYTICS

Step 5.12 : Q? How do we exclude variables?



- After Azure Machine Learning "runs" all the steps in your model, you will see a green check mark in the "Select Columns in Dataset" box
- Next right click on the bottom-middle circle in "Select Columns in Dataset" and select "Visualize"

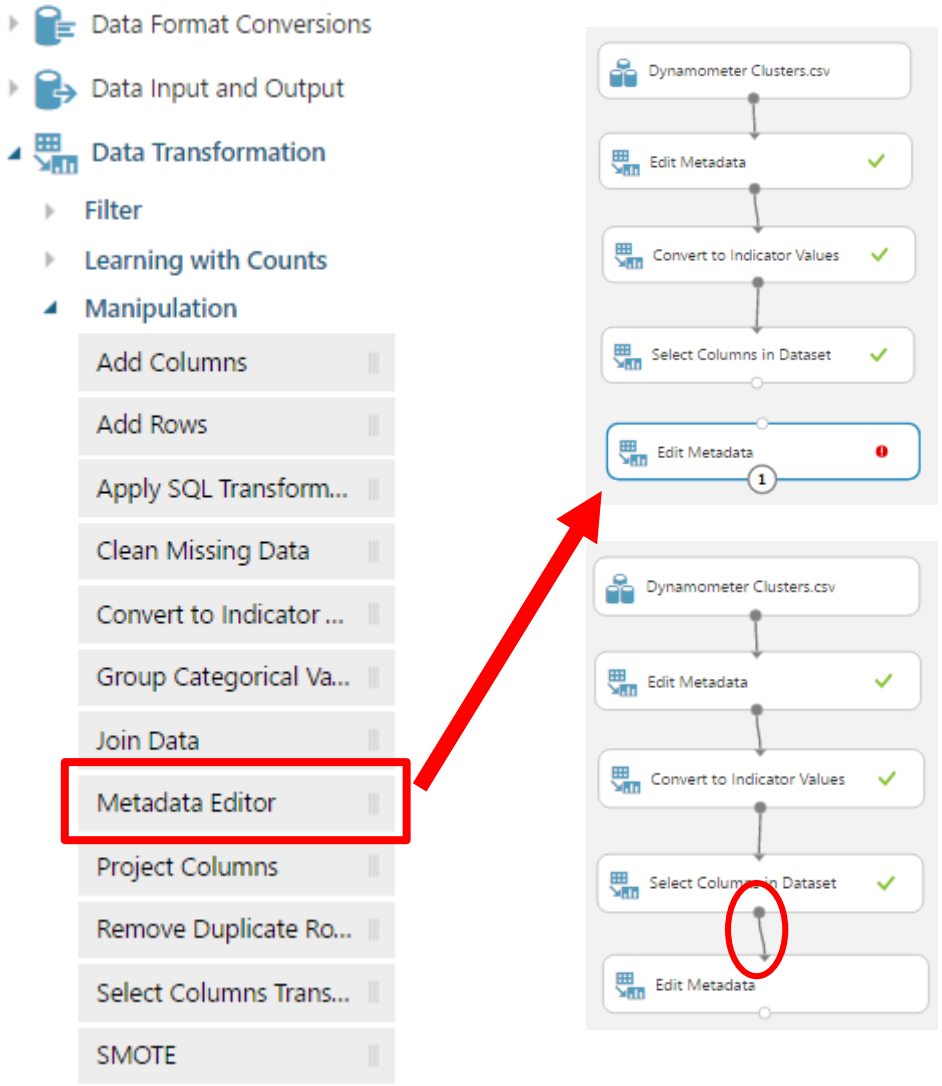
rows 57883 columns 6

view as

well	date	PC1	PC2	PC3	Assignments-44
Alabama	2013-08-16T01:55:22	-8.243341	2.918071	2.023029	0
Alabama	2013-08-16T23:49:23	-8.243341	2.918071	2.023029	0
Alabama	2013-09-03T00:17:00	-8.495328	2.311737	2.154067	0
Alabama	2013-09-06T09:38:47	-8.148383	2.731808	2.341957	0
Alabama	2013-09-06T16:13:14	-8.148383	2.731808	2.341957	0
Alabama	2013-09-13T03:48:51	-8.206878	2.583768	2.282913	0
Alabama	2013-09-13T20:28:44	-8.206878	2.583768	2.282913	0
Alabama	2013-11-05T13:17:14	-8.640142	2.146508	2.971267	0

Microsoft NEAL ANALYTICS

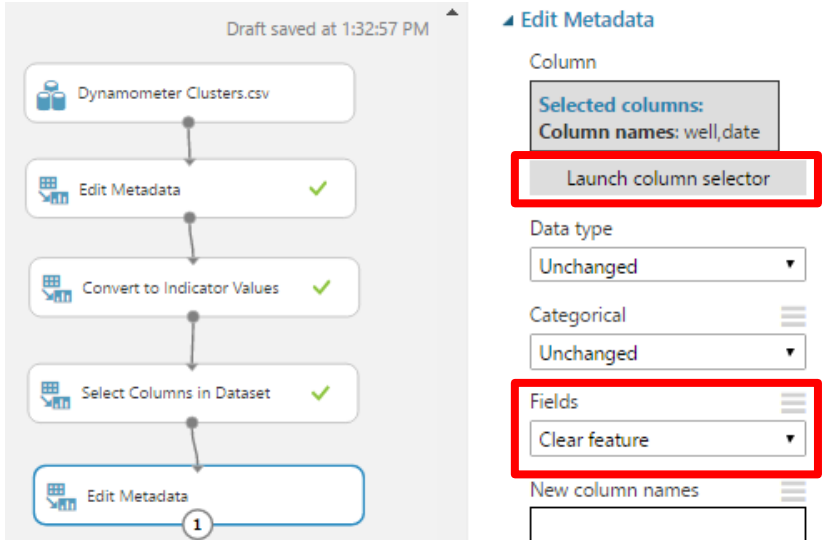
Step 5.13 : Q? Edit Metadata



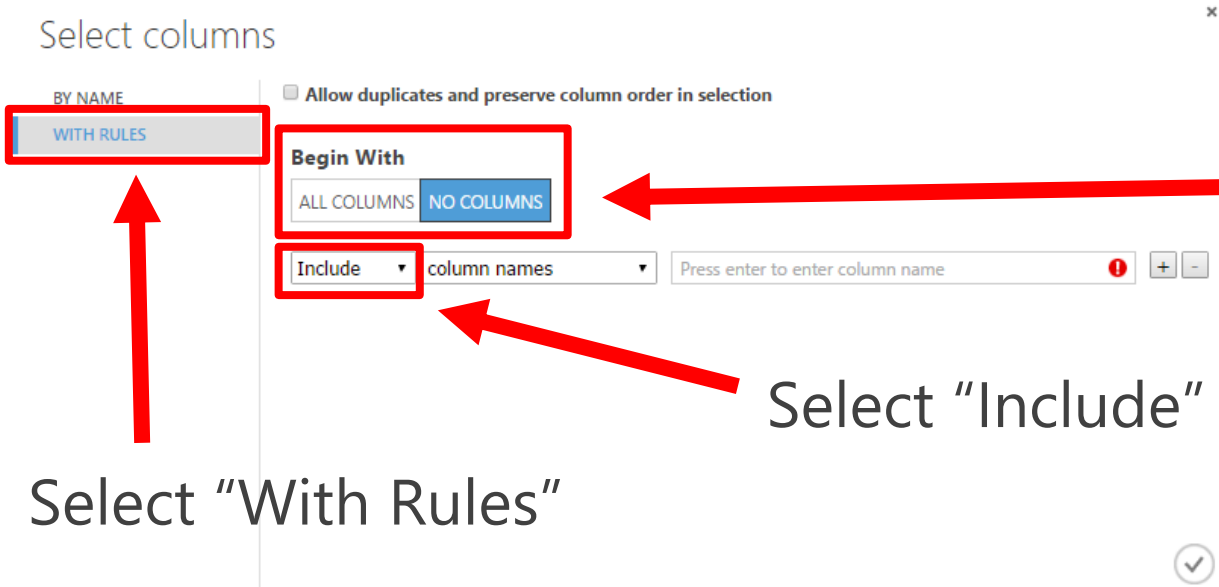
- Open “Data Transformation” and then “Manipulation” from the navigation pane at the left
- Drag “Metadata Editor” to the canvas
  - “Metadata Editor” edits metadata associated with the columns in a dataset
- Next, click and hold on the bottom middle circle of your “Select Columns in Dataset” module
- While holding down the mouse button, drag the line to the top middle circle of “Metadata Editor” module

Microsoft NEAL ANALYTICS

Step 5.14 : Q? Edit Metadata



- Machine Learning
  - Click on Metadata Editor
  - Chose “Clear feature” from the drop down menu under Fields
  - Then click on “Launch column selector”



Select “No Columns”

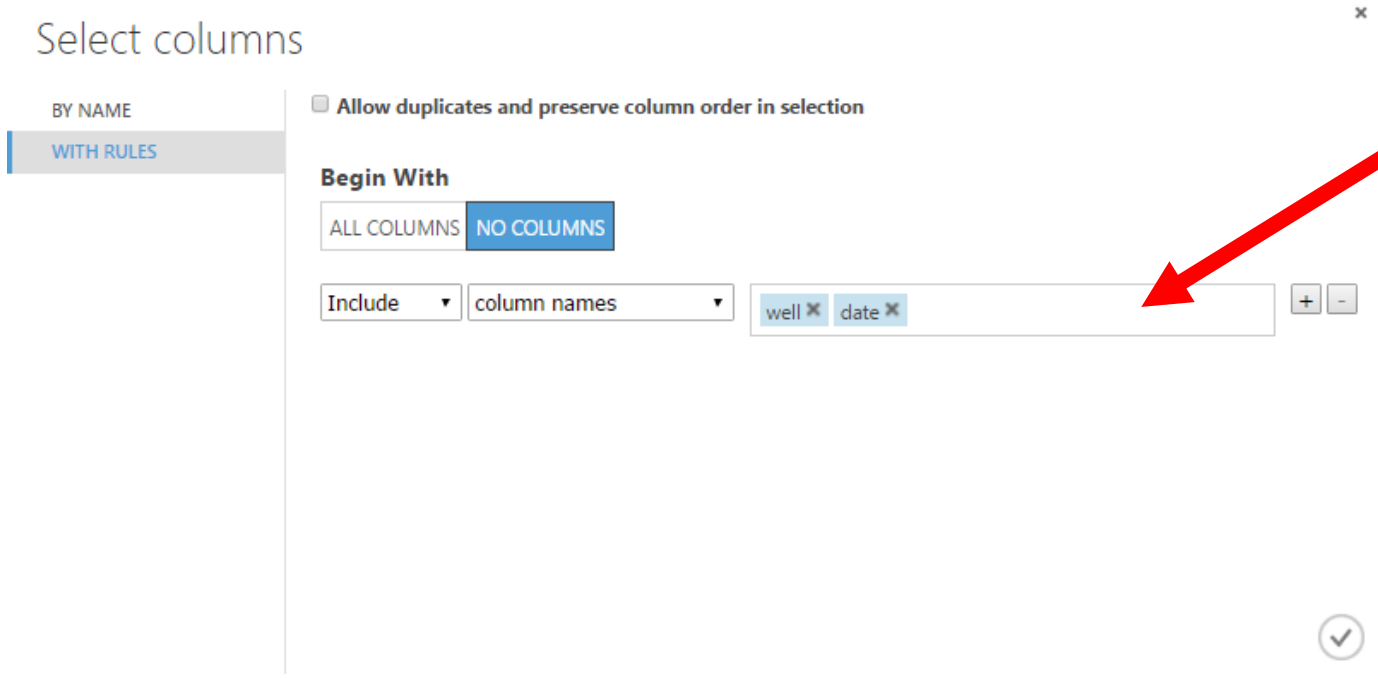
Select “Include” from the drop down menu

Select “With Rules”

Microsoft

NEAL ANALYTICS

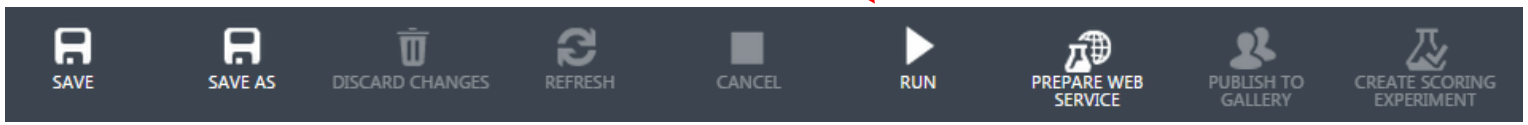
Step 5.15 : Q? Edit Metadata



- Click here and a drop down list appears
- Select one variable at a time
  - well
  - date

Step 1: Next, click on the check circle

Step 2: Click “Run”



Microsoft

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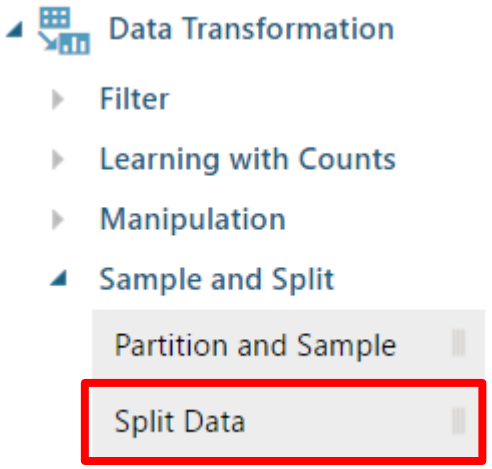
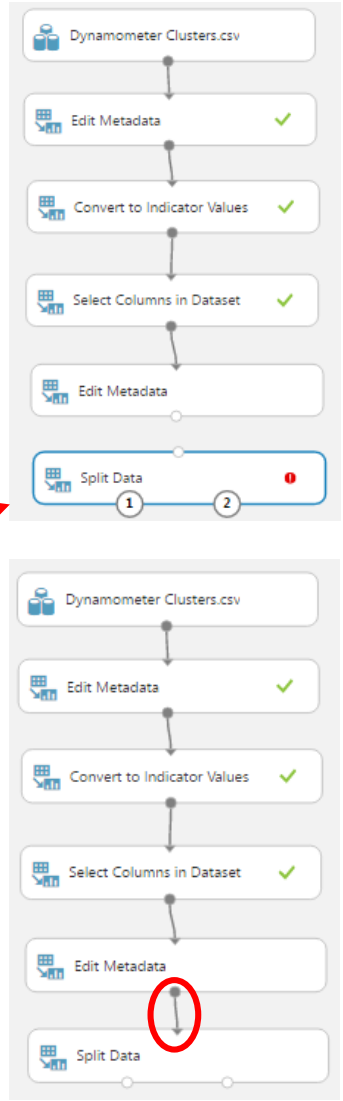
Step 5.16 : Q? How to split the dataset for training and scoring?

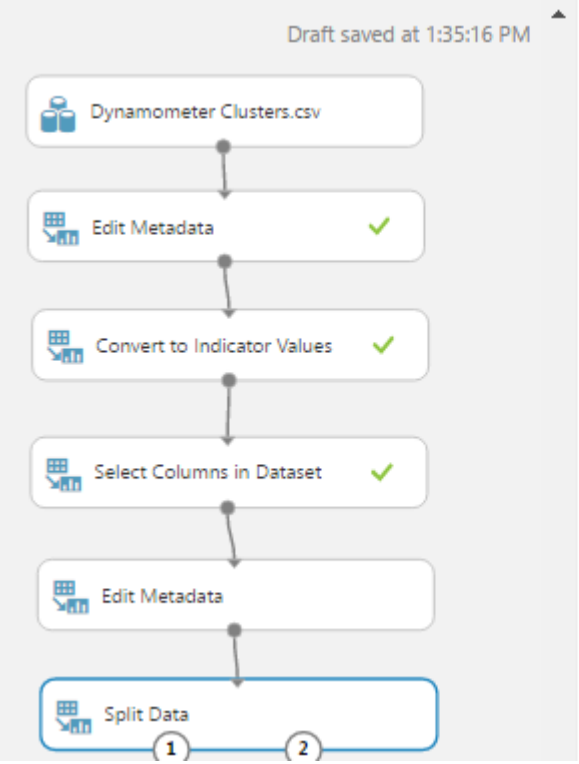


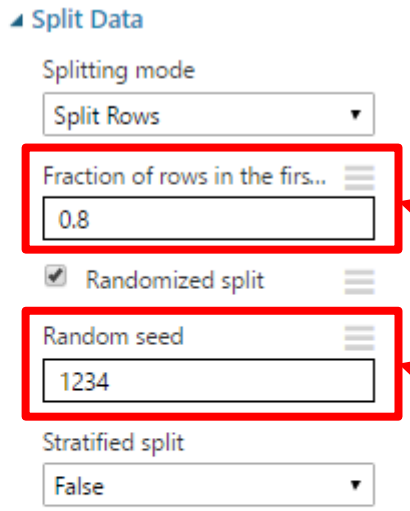


- Open “Data Transformation” and then “Sample and Split” from the navigation pane at the left
- Drag “Split Data” to the canvas
  - “Split Data” splits the rows of a dataset into two distinct sets
- Next, click and hold on the bottom middle circle of your “Metadata Editor” module
- While holding down the mouse button, drag the line to the top middle circle of “Split Data” module

Microsoft NEAL ANALYTICS

Step 5.17 : Q? How to split the dataset for training and scoring?





- Click on “Split Data” on your canvas, and make sure it has a blue outline
- Change the “Fraction of rows in the first output dataset” to 0.8
- Set the Random seed to 1234

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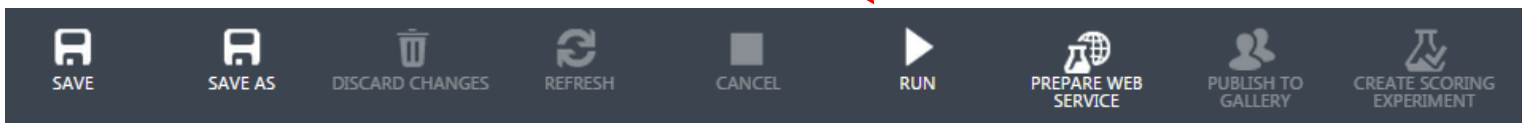
Step 5.18 : Run the Experiment

Finally, click "Run"



- All the data transformation needed for this tutorial is complete.
  - It was all
    - Drag and Drop
    - Every step preserved on the canvas
    - Data and programs are just simple shapes
- We are ready for the next component of our model

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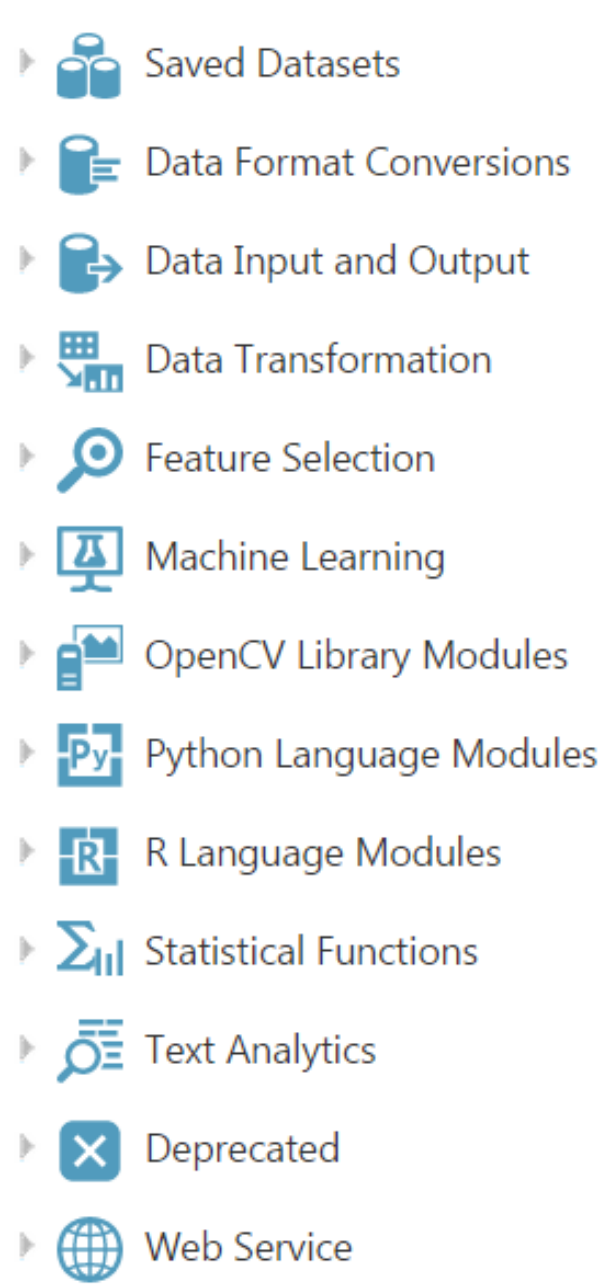
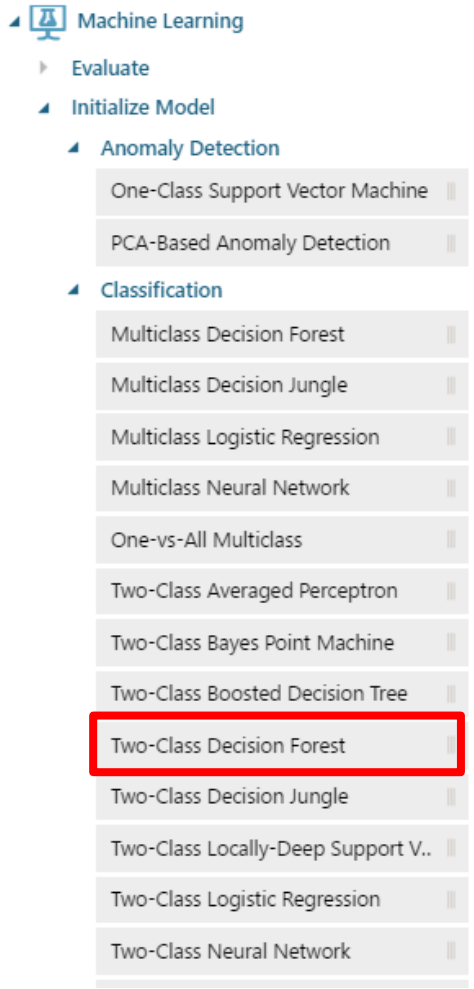


Step 6.1 : AML Modeling Components

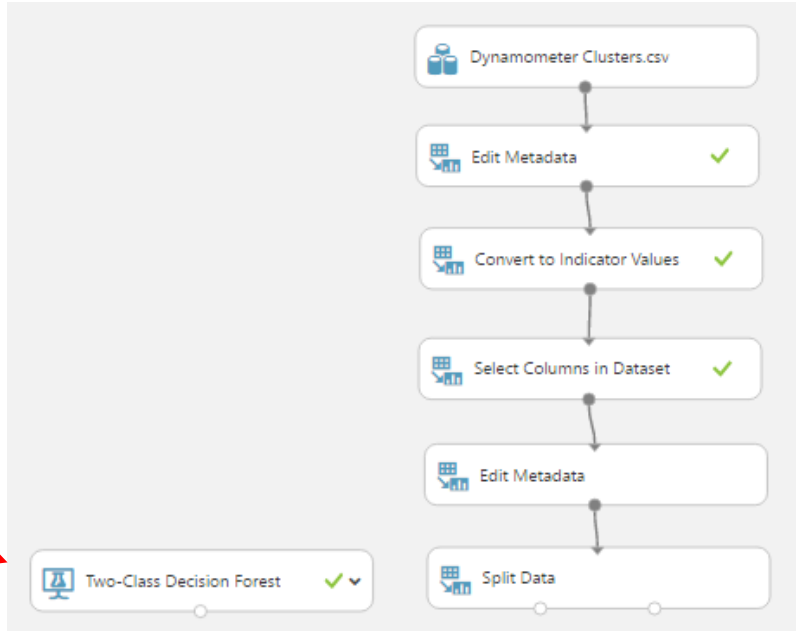
- AML modelling … a checklist approach
  - ☑ ~~Initial data set~~
  - ☑ ~~Create new experiment~~
  - ☑ ~~Import data set~~
  - ☑ ~~Data transformation~~
  - ☐ Machine Learning

Microsoft NEAL ANALYTICS

Step 6.2 : Q? How to develop the Machine Learning Algorithm?



- Open “Machine Learning” -> “Initialize Model” -> “Classification” from the navigation pane at the left
- Drag “Two-Class Decision Forest” to the canvas



Microsoft

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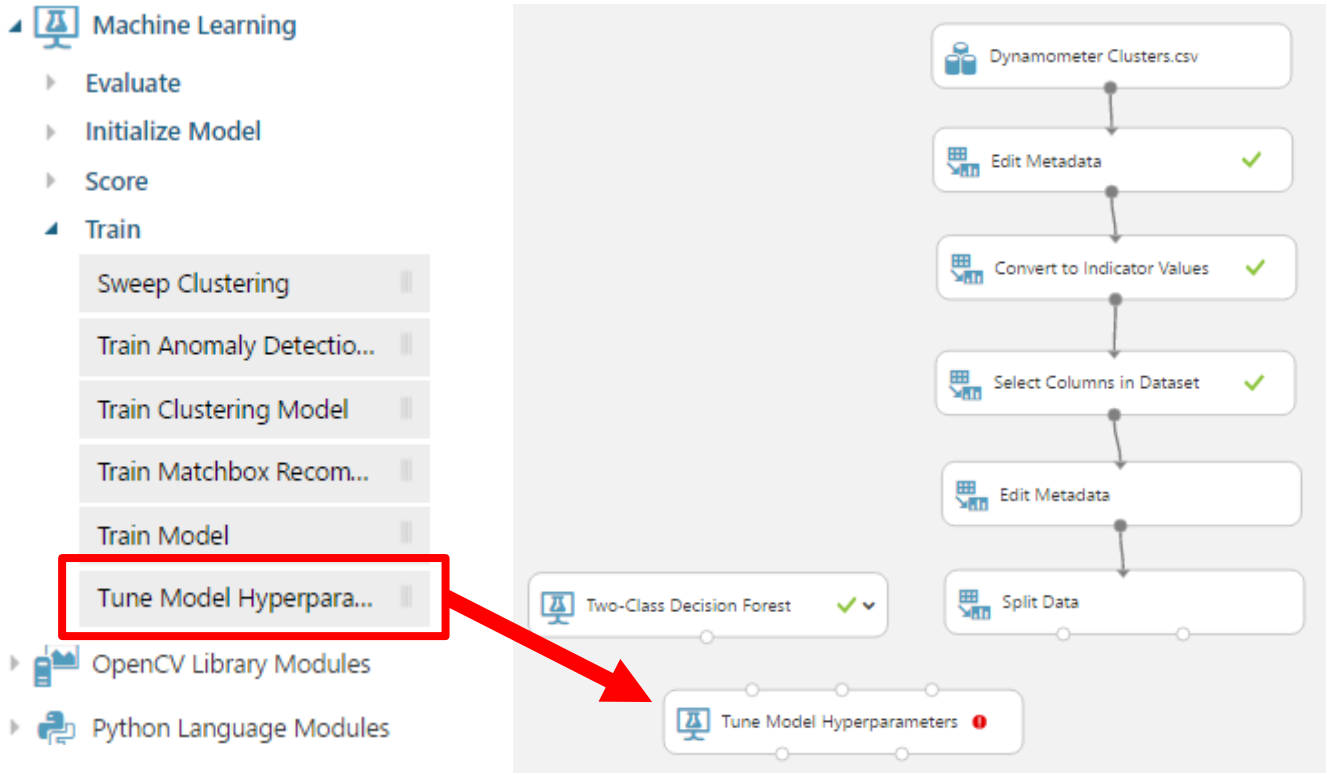
Step 6.3 : Q? How to develop the Machine Learning Algorithm?



- Open “Machine Learning” and then “Train” from the navigation pane at the left
- Drag “Tune Model Hyperparameters” module to the canvas
  - “Tune Model Hyperparameters” perform a parameter sweep on the model to determine the optimum parameter settings

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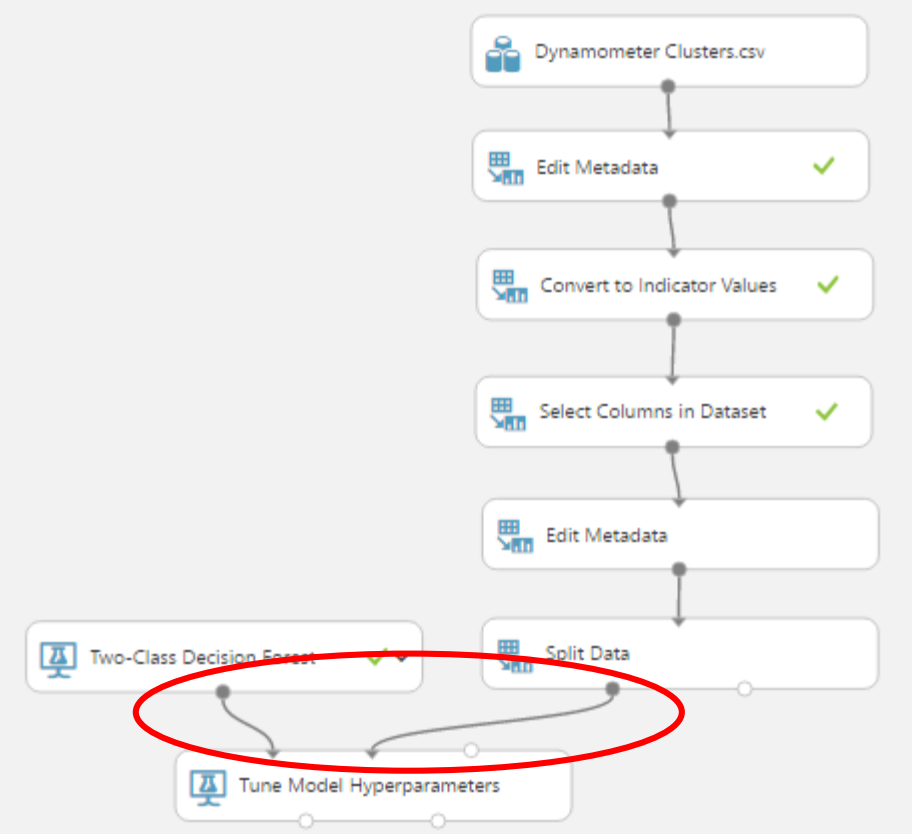
Step 6.4 : Q? How to develop the Machine Learning Algorithm?



- Next, click and hold on the bottom middle circle of your "Two-Class Decision Forest" module and drag the line to the top left circle of the "Tune Model Hyperparameters" module.
- Similarly, click and hold on the bottom left circle of your "Split Data" module and drag the line to the top right circle of the "Tune Model Hyperparameters" module.

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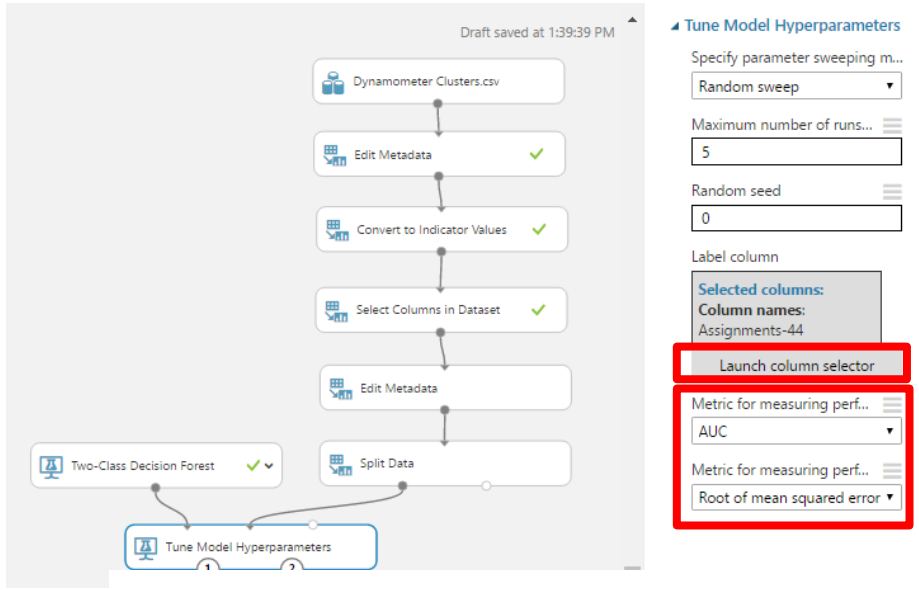
Step 6.5 : Q? How to develop the Machine Learning Algorithm



- Machine Learning
  - Click on "Tune Model Hyperparameters"
  - Set Metric for measuring performance for classification to "AUC"
  - Set Metric for measuring performance for regression to "Root of mean squared error"
  - Then click on "Launch column selector"

Select "Include" from the drop down menu

Select "With Rules"

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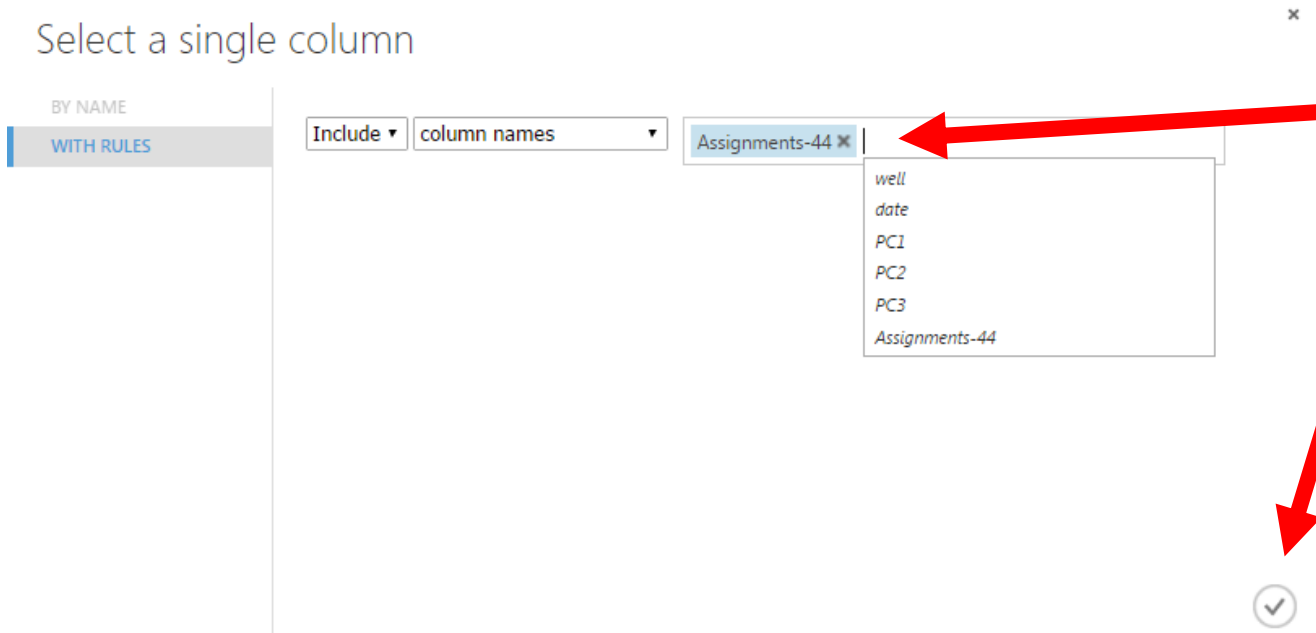
Step 6.6 : Q? How to develop the Machine Learning Algorithm?



- Click here and a drop down list appears
- Select one variable at a time
  - Assignments-44
- Next, click on the check circle

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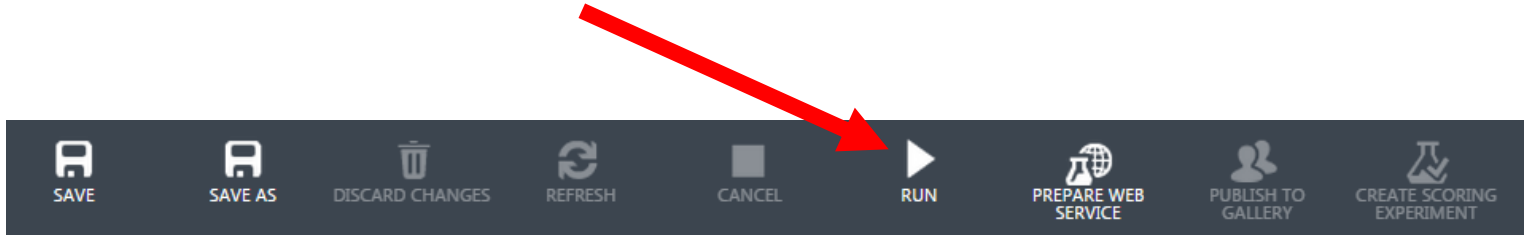
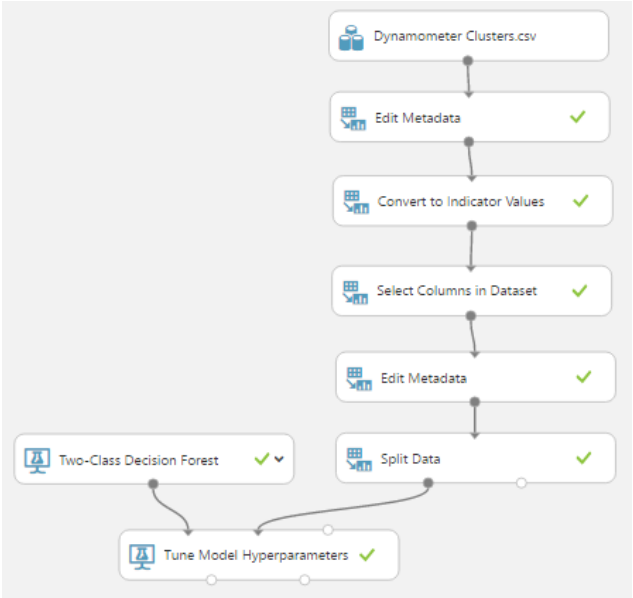
Step 6.7 : Run the Experiment

Click “Run”





- After Azure Machine Learning “runs”, you will see a green check mark in all the modules
- All it took to train a machine learning model was drag and drop

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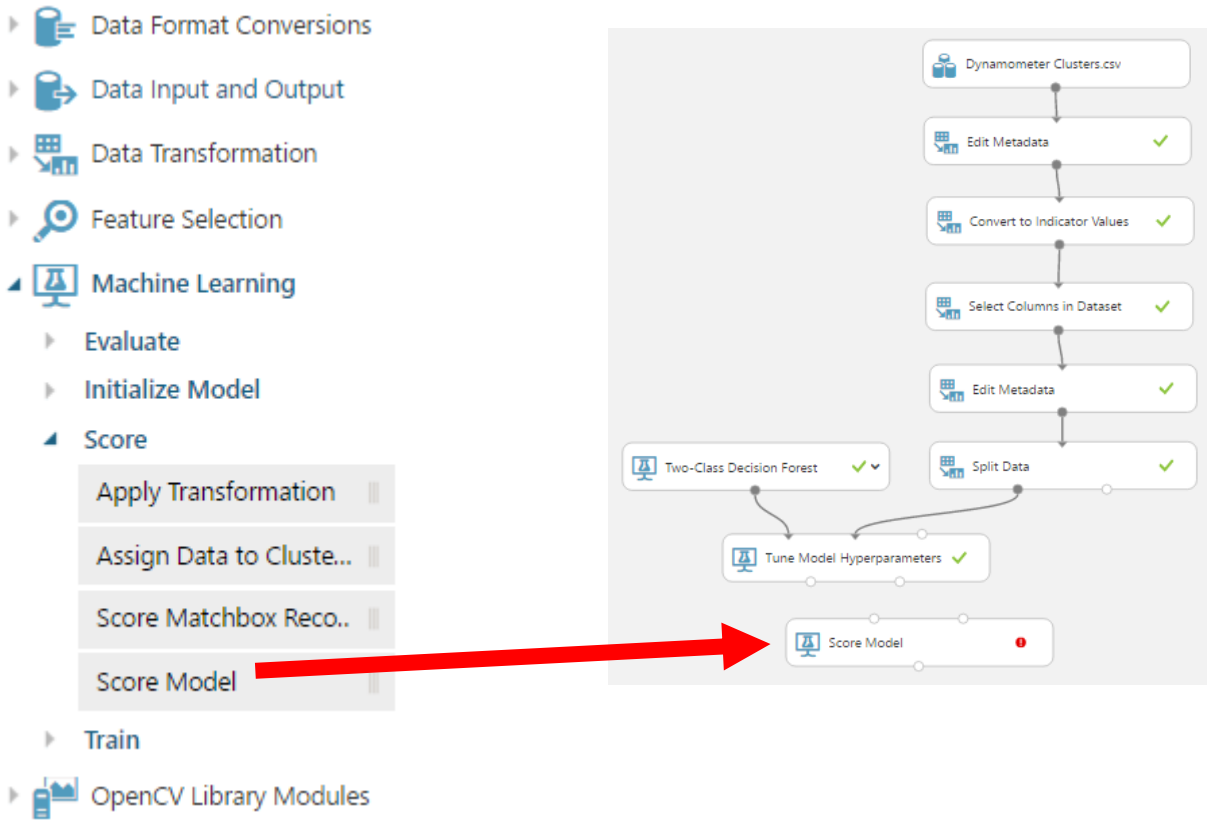
Step 6.8 : Add Score Model



- Open “Machine Learning” and then “Score” from the navigation pane at the left
- Drag two “Score Model” to the canvas
  - “Score Model” scores a trained classification or a regression model

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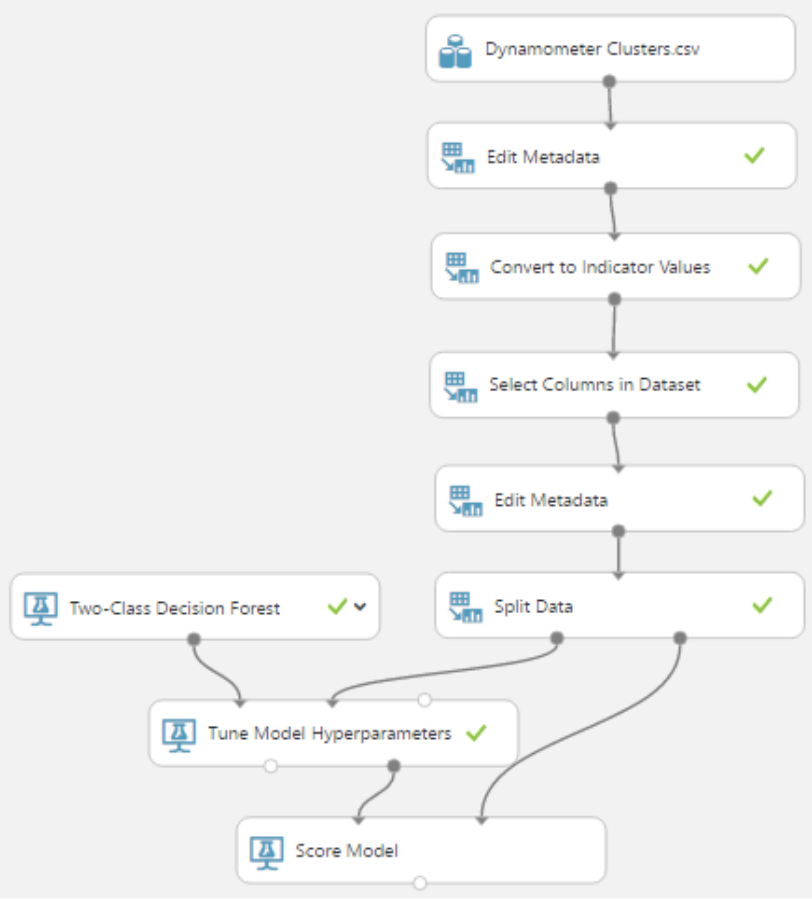
Step 6.9 : Q? How to develop the Machine Learning Algorithm?



- Next, click and hold on the bottom right circle of your “Tune Model Hyperparameters” module and drag the line to the top left circle of the “Score Model” module.
- Similarly, click and hold on the bottom right circle of your “Split Data” module and drag the line to the top right circle of the “Score Model” module.

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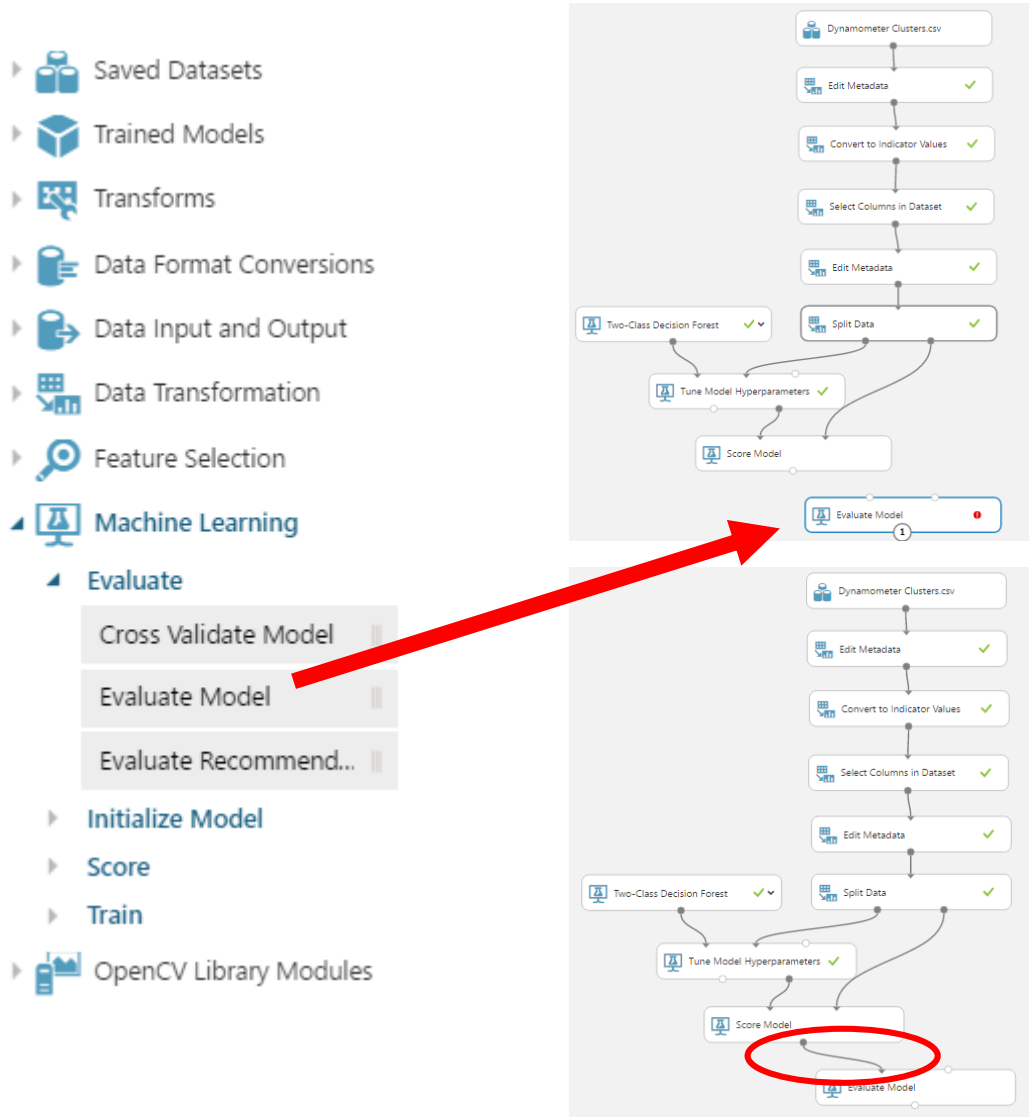
Step 6.10 : Add Evaluate Model



- Open “Machine Learning” and then “Evaluate” from the navigation pane at the left
- Drag “Evaluate Model” to the canvas
  - “Evaluate Model” evaluates the scored classification or regression model with standard metrics
- Next, click and hold on the bottom middle circle of your “Score Model” module
- While holding down the mouse button, drag the line to the top left circle of “Evaluate Model” module

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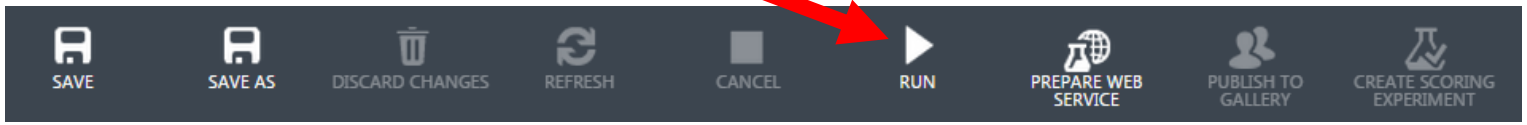
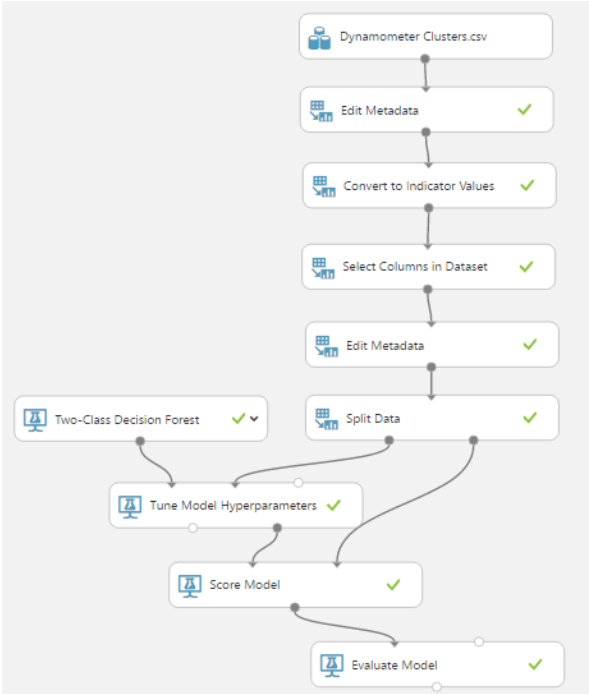
Step 6.11 : Run the Experiment

Click “Run”





- After Azure Machine Learning “runs”, you will see a green check mark in all the modules
- All it took to train a machine learning model was drag and drop

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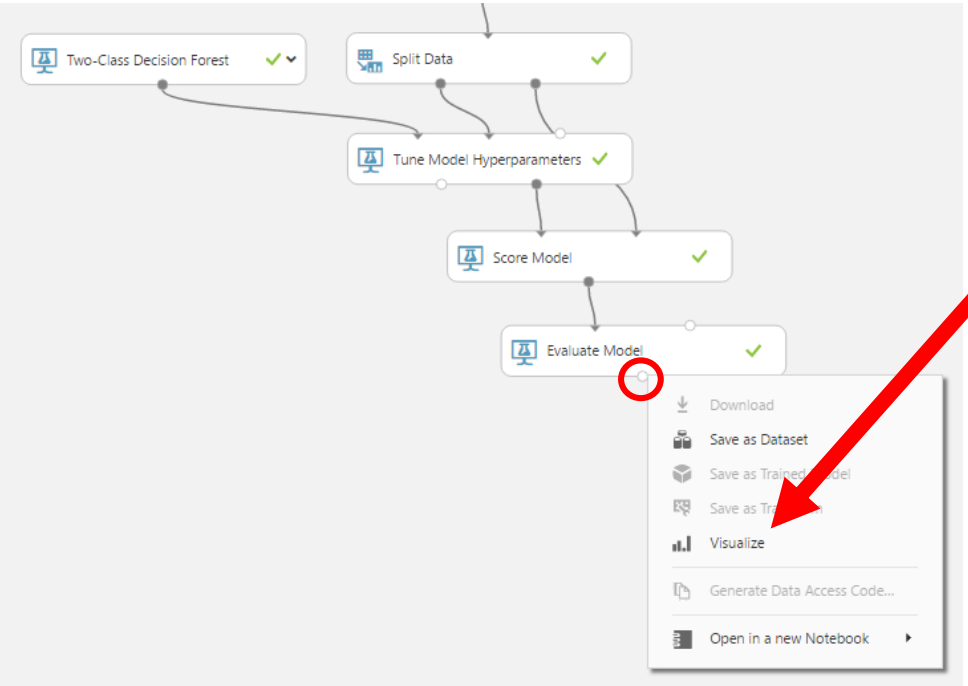
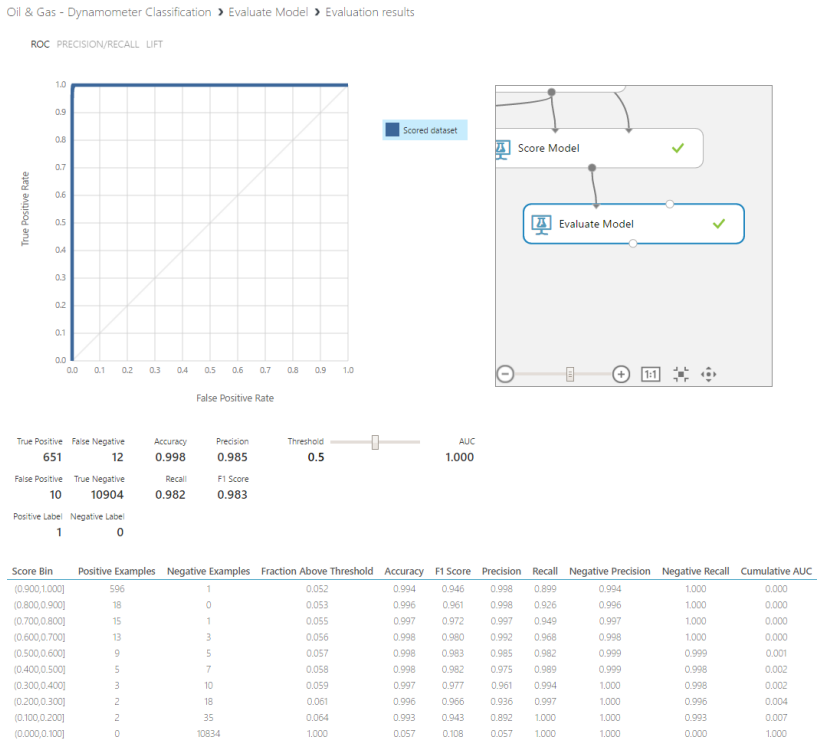
Step 6.12 : Visualize the Results



- Right click on the bottom-middle circle of “Evaluate Model” and select “Visualize”



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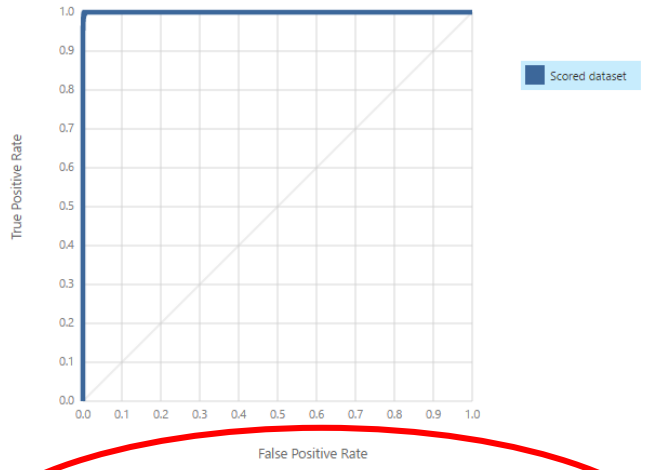
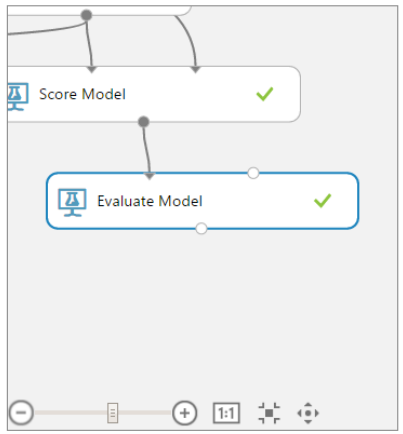
Step 6.13 : Interpret the Results

Oil & Gas - Dynamometer Classification › Evaluate Model › Evaluation results

ROC PRECISION/RECALL LIFT





True Positive	False Negative	Accuracy	Precision	Threshold	AUC
651	12	0.998	0.985	0.5	1.000

False Positive	True Negative	Recall	F1 Score
10	10904	0.982	0.983

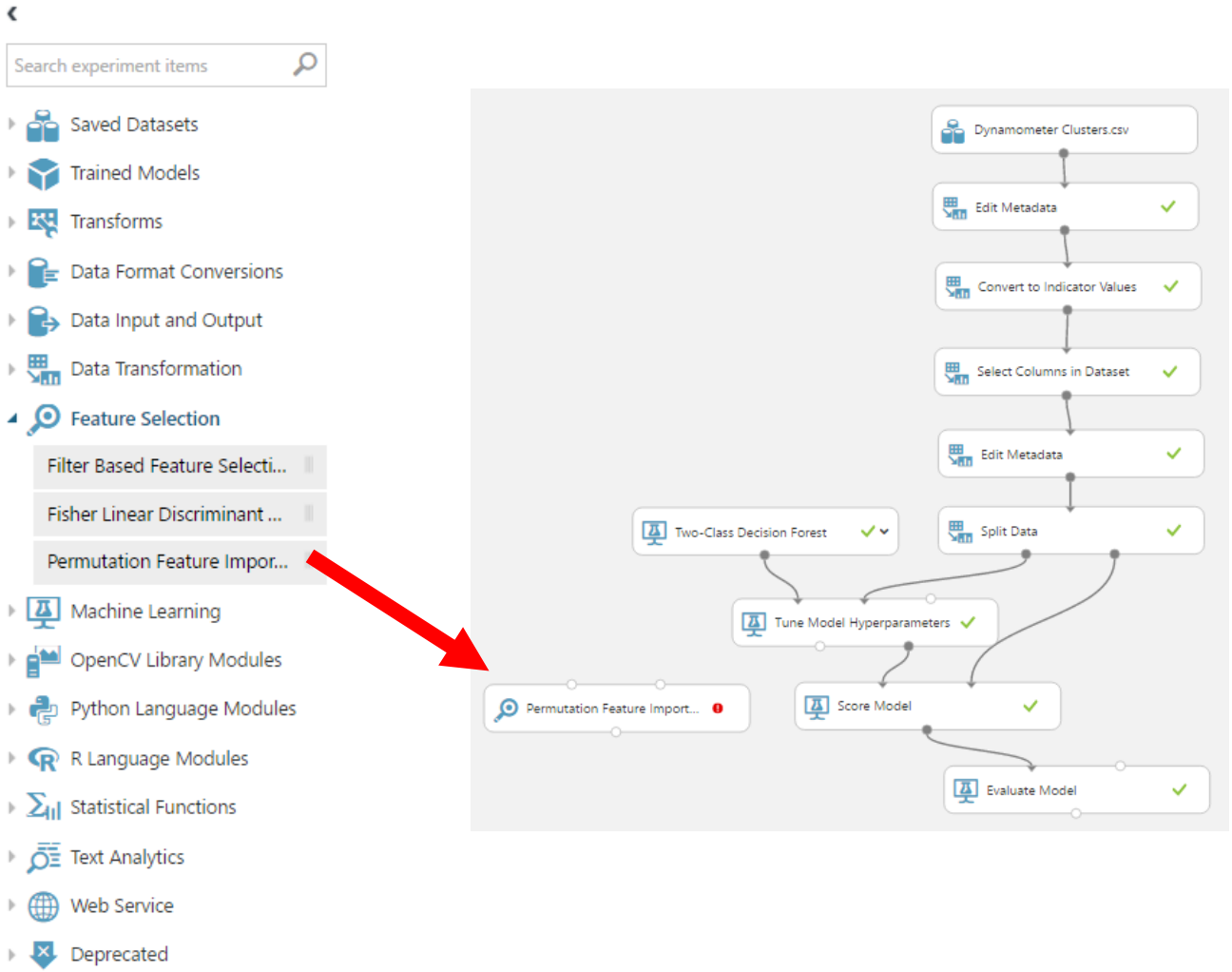
Positive Label	Negative Label
1	0

Score Bin	Positive Examples	Negative Examples	Fraction Above Threshold	Accuracy	F1 Score	Precision	Recall	Negative Precision	Negative Recall	Cumulative AUC
(0.900,1.000]	596	1	0.052	0.994	0.946	0.998	0.899	0.994	1.000	0.000
(0.800,0.900]	18	0	0.053	0.996	0.961	0.998	0.926	0.996	1.000	0.000
(0.700,0.800]	15	1	0.055	0.997	0.972	0.997	0.949	0.997	1.000	0.000
(0.600,0.700]	13	3	0.056	0.998	0.980	0.992	0.968	0.998	1.000	0.000
(0.500,0.600]	9	5	0.057	0.998	0.983	0.985	0.982	0.999	0.999	0.001
(0.400,0.500]	5	7	0.058	0.998	0.982	0.975	0.989	0.999	0.998	0.002
(0.300,0.400]	3	10	0.059	0.997	0.977	0.961	0.994	1.000	0.998	0.002
(0.200,0.300]	2	18	0.061	0.996	0.966	0.936	0.997	1.000	0.996	0.004
(0.100,0.200]	2	35	0.064	0.993	0.943	0.892	1.000	1.000	0.993	0.007
(0.000,0.100]	0	10834	1.000	0.057	0.108	0.057	1.000	1.000	0.000	1.000

- ROC - Accuracy is measured by the area under the ROC curve. An area of 1 represents a perfect test; an area of .5 represents a worthless test
  - .90-1 = excellent
  - .80-.90 = good
  - .70-.80 = fair
  - .60-.70 = poor
  - .50-.60 = fail
- Model performance metrics: "Accuracy", "Precision, "Recall", and "F-Score".

Microsoft NEAL ANALYTICS

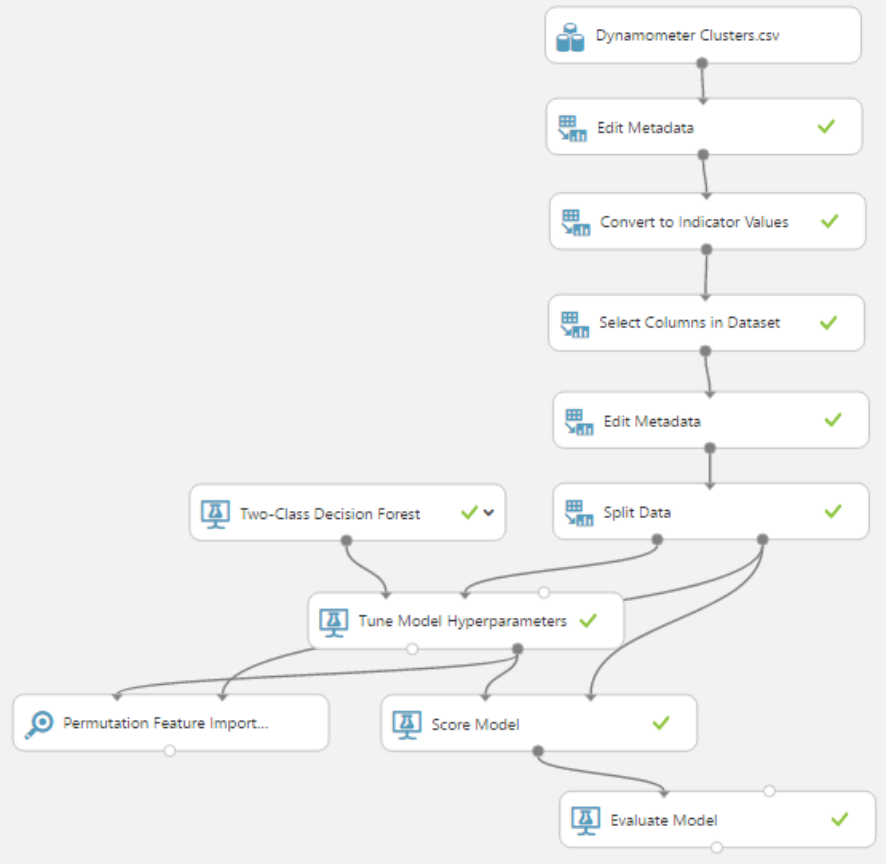
Step 6.14 : Add Permutation Feature Importance Module



- Open “Feature Selection” from the navigation pane at the left
- Drag “Permutation Feature Importance” to the canvas
  - “Permutation Feature Importance” computes the permutation feature importance of feature variables given a trained model and a test dataset

Microsoft NEAL ANALYTICS

Step 6.15 : Add Permutation Feature Importance Module



- Next, click and hold on the bottom right circle of your “Tune Model Hyperparameters” module
- While holding down the mouse button, drag the line to the top left circle of “Permutation Feature Importance” module
- Similarly, click and hold on the bottom right circle of your “Split Data” module and drag the line to the top right circle of the “Permutation Feature Importance” module.

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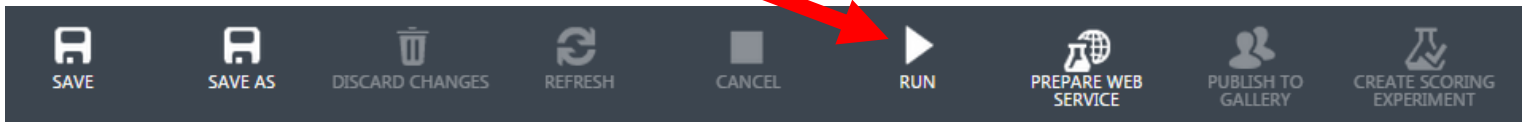
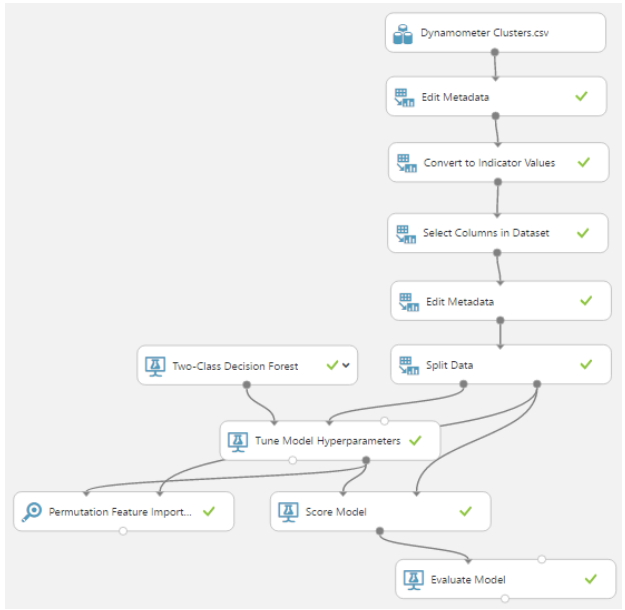
Step 6.16 : Run the Experiment

Click “Run”





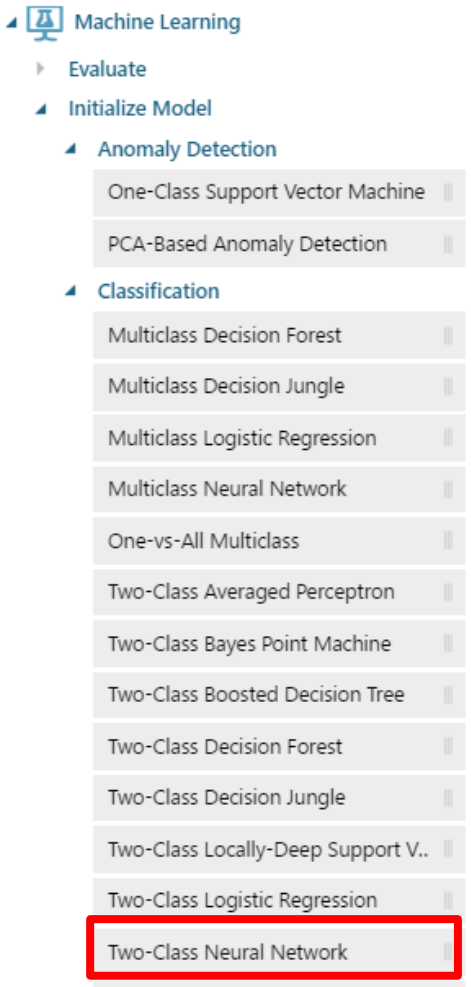
- After Azure Machine Learning “runs”, you will see a green check mark in all the modules
- All it took to train a machine learning model was drag and drop

Microsoft

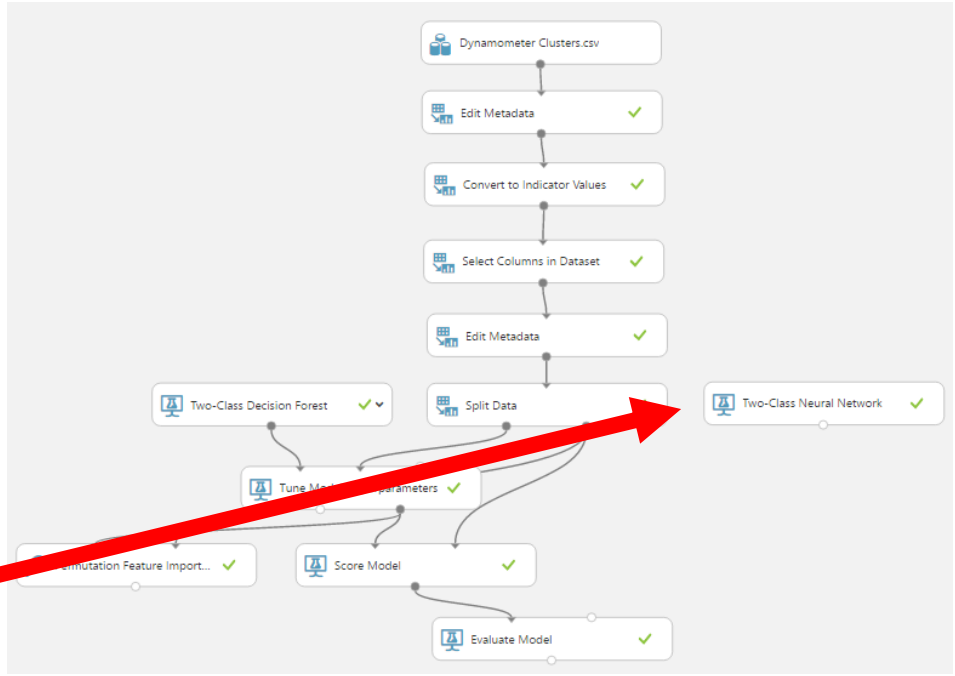
NEAL ANALYTICS

If you have time left then let's try a comparison between two classification algorithms

Step 7.1 : Adding the Two-Class Neural Network



- Open “Machine Learning” -> “Initialize Model” -> “Classification” from the navigation pane at the left
- Drag “Two-Class Neural Network” to the canvas



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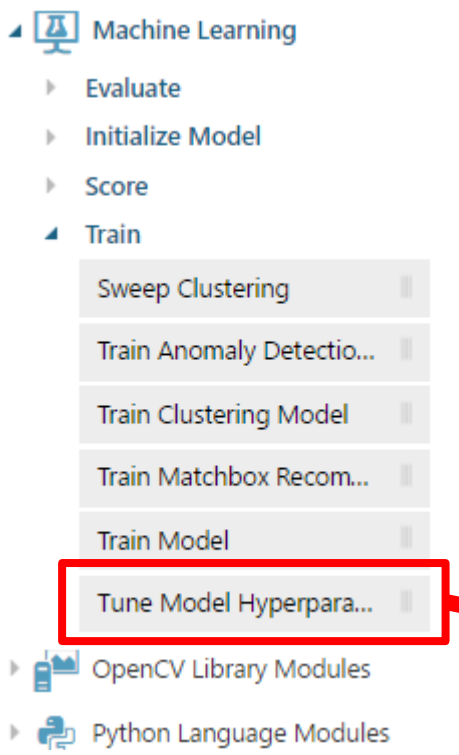
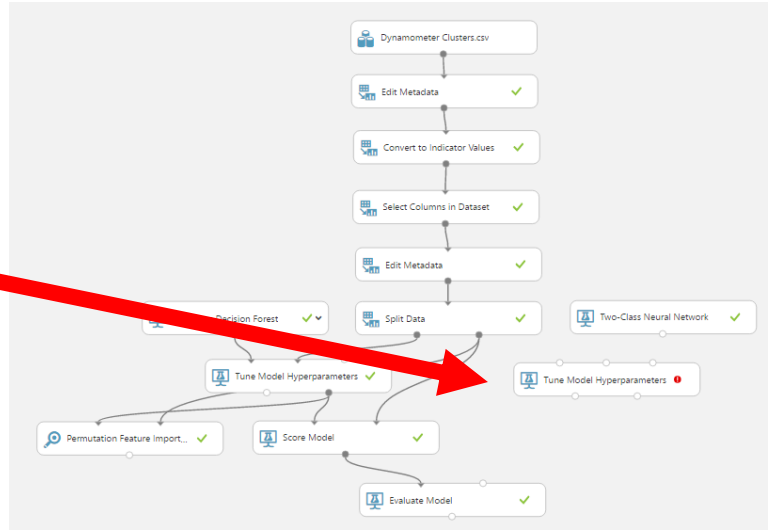
NEAL ANALYTICS

Step 7.2 : Q? Train the Model



- Open “Machine Learning” and then “Train” from the navigation pane at the left
- Drag “Tune Model Hyperparameters” module to the canvas
  - “Tune Model Hyperparameters” perform a parameter sweep on the model to determine the optimum parameter settings



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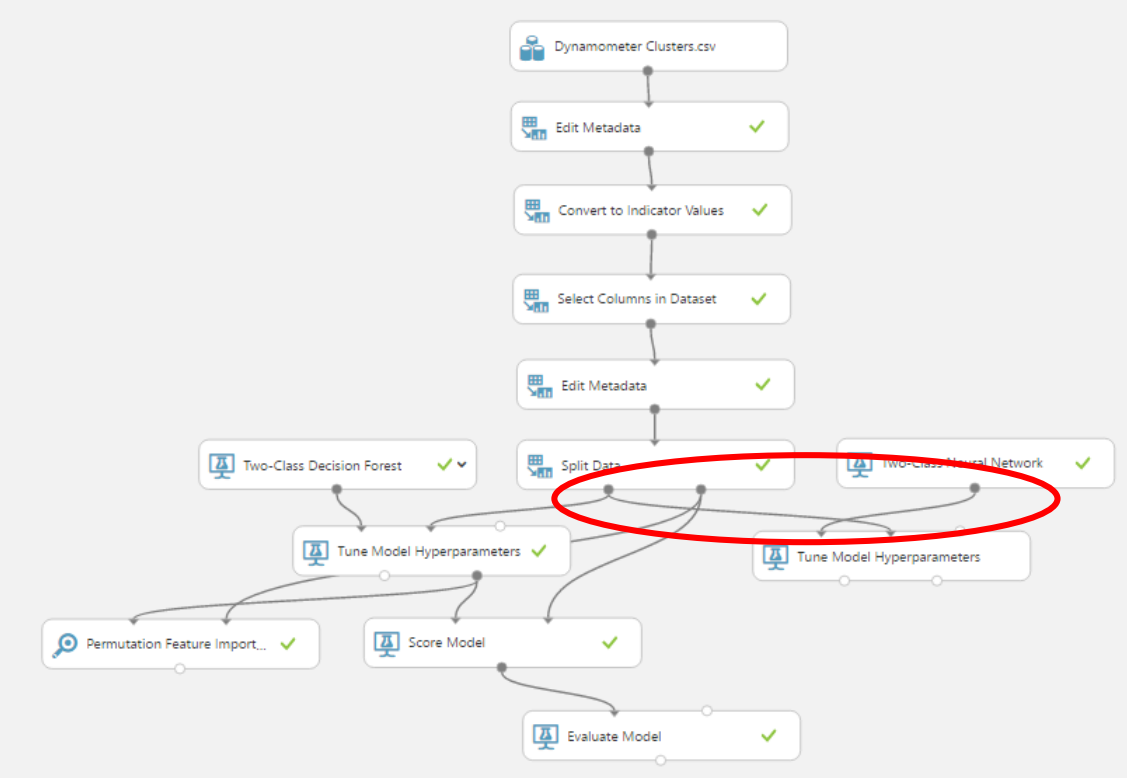
Step 7.3 : Q? Train the Model



- Next, click and hold on the bottom middle circle of your “Two-Class Neural Network” module and drag the line to the top left circle of the new “Tune Model Hyperparameters” module.
- Similarly, click and hold on the bottom left circle of your “Split Data” module and drag the line to the top right circle of the new “Tune Model Hyperparameters” module.

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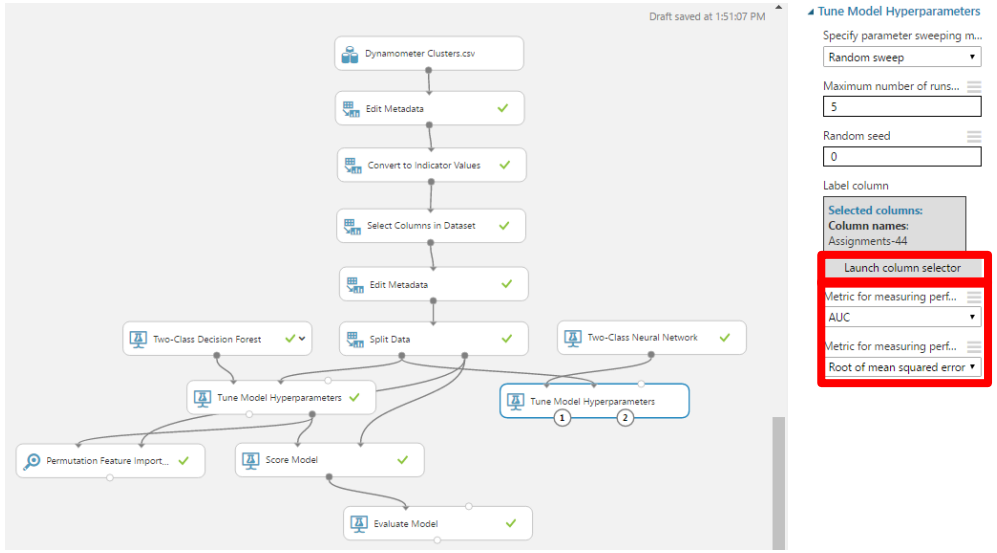
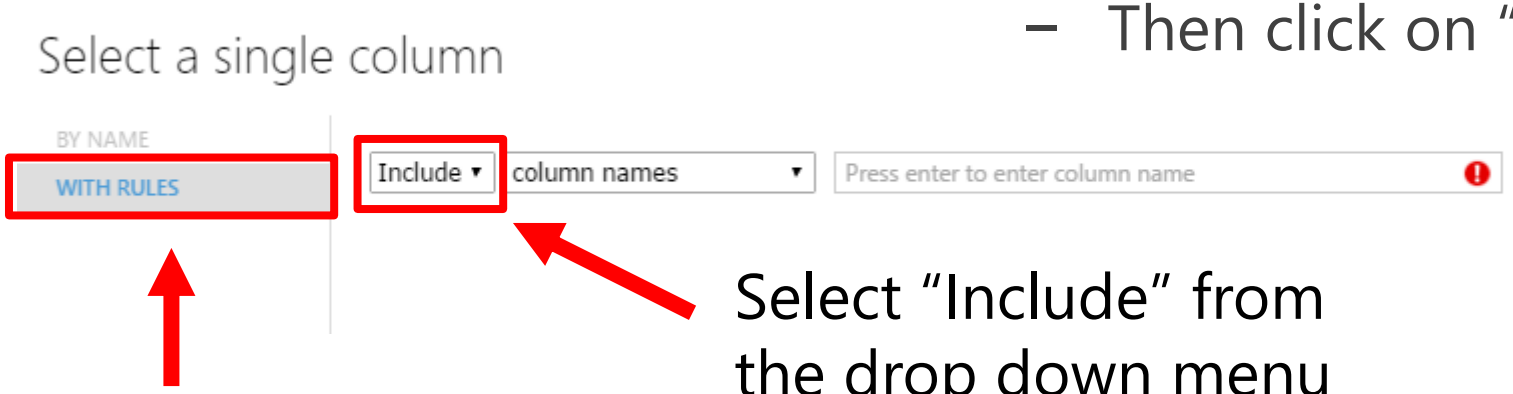
Step 7.4 : Q? Train the Model



- Machine Learning
  - Click on “Tune Model Hyperparameters”
  - Set Metric for measuring performance for classification to “AUC”
  - Set Metric for measuring performance for regression to “Root of mean squared error”
  - Then click on “Launch column selector”



Select “With Rules”

Select “Include” from the drop down menu

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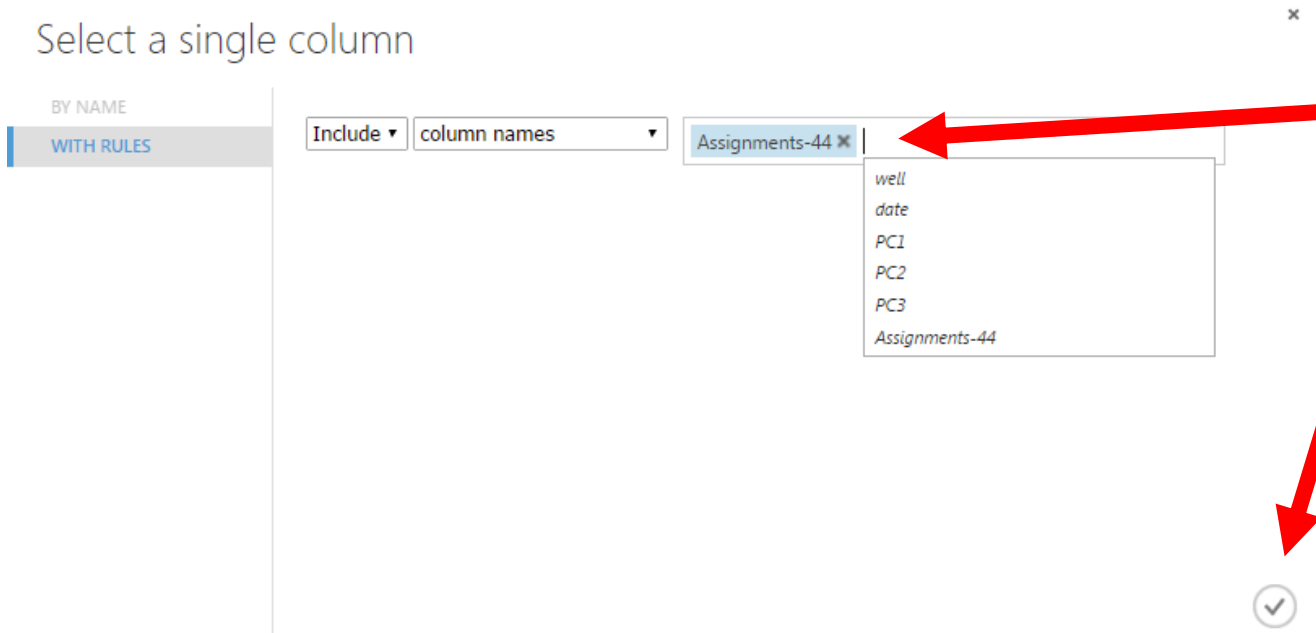
Step 7.5 : Q? Train the Model



- Click here and a drop down list appears
- Select one variable at a time
  - Assignments-44
- Next, click on the check circle

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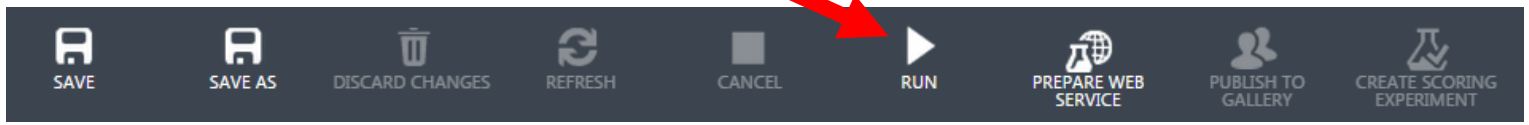
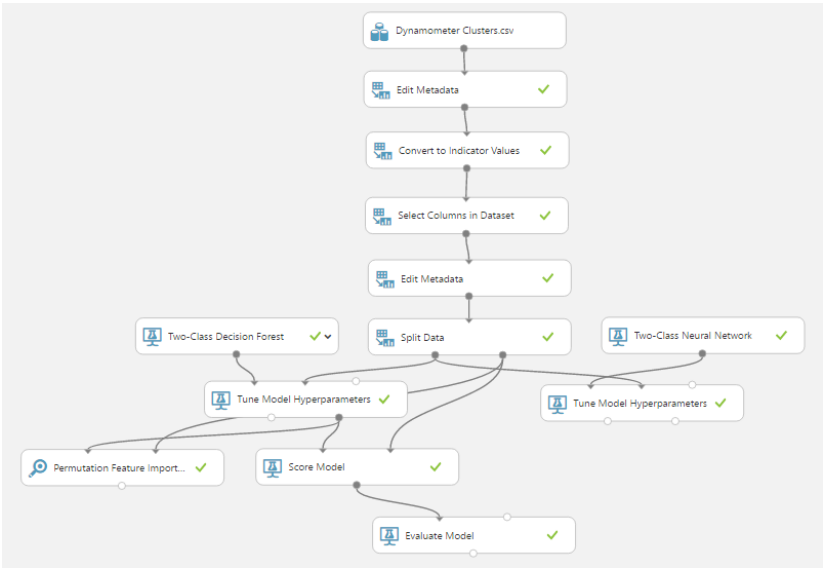
Step 7.6 : Run the Experiment

Click “Run”





- After Azure Machine Learning “runs”, you will see a green check mark in all the modules
- All it took to train a machine learning model was drag and drop

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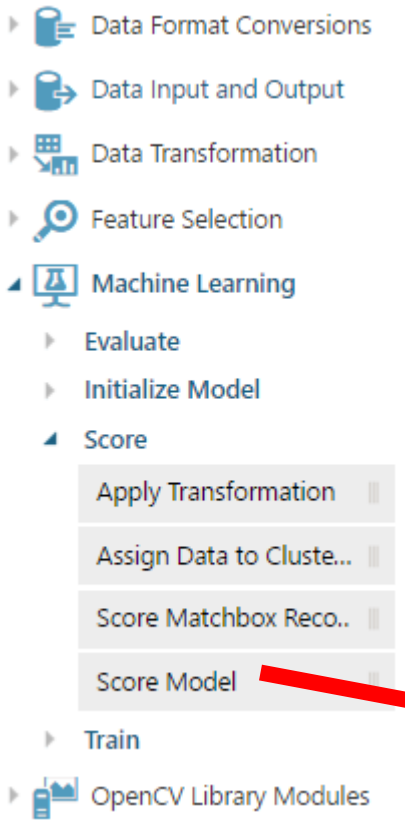
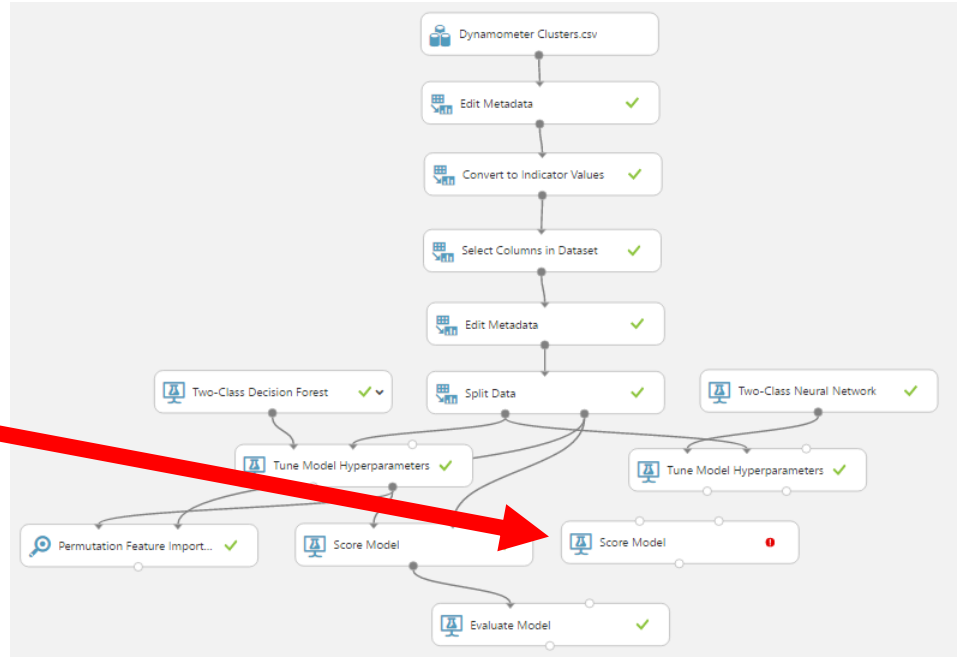
Step 7.7 : Adding the Score Model Module



- Open “Machine Learning” and then “Score” from the navigation pane at the left
- Drag “Score Model” module to the canvas
  - “Score Model” scores a trained classification or a regression model



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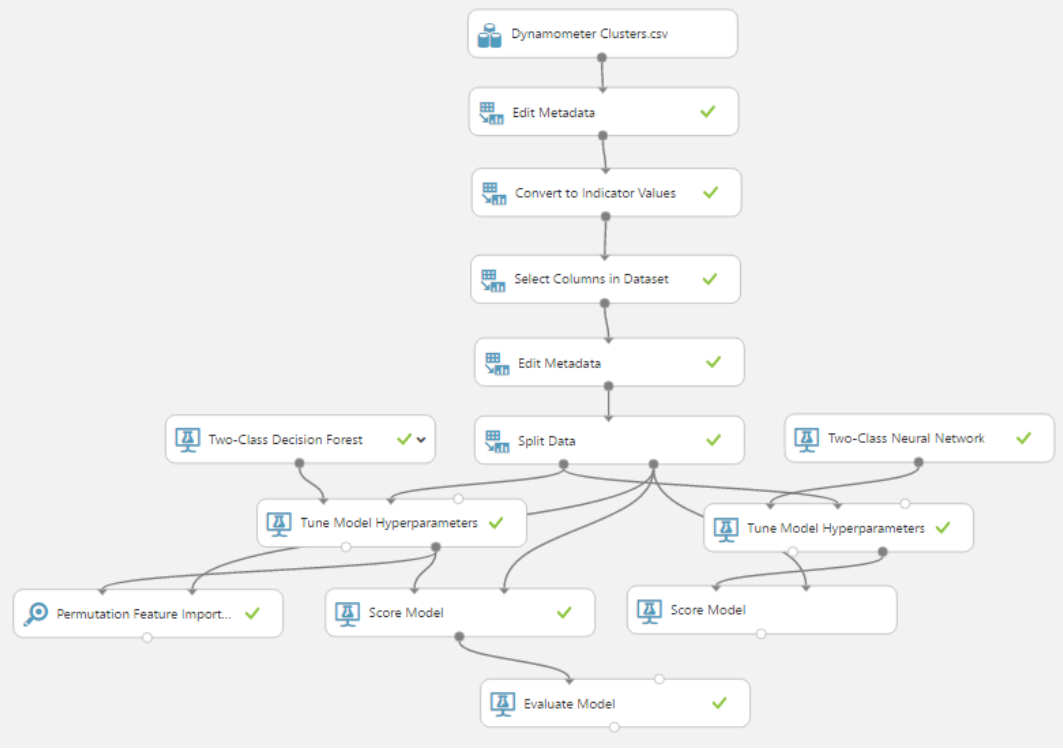
Step 7.8 : Adding the Score Model Module



- Next, click and hold on the bottom right circle of your new “Tune Model Hyperparameters” module and drag the line to the top left circle of the “Score Model” module.
- Similarly, click and hold on the bottom right circle of your “Split Data” module and drag the line to the top right circle of the “Score Model” module.

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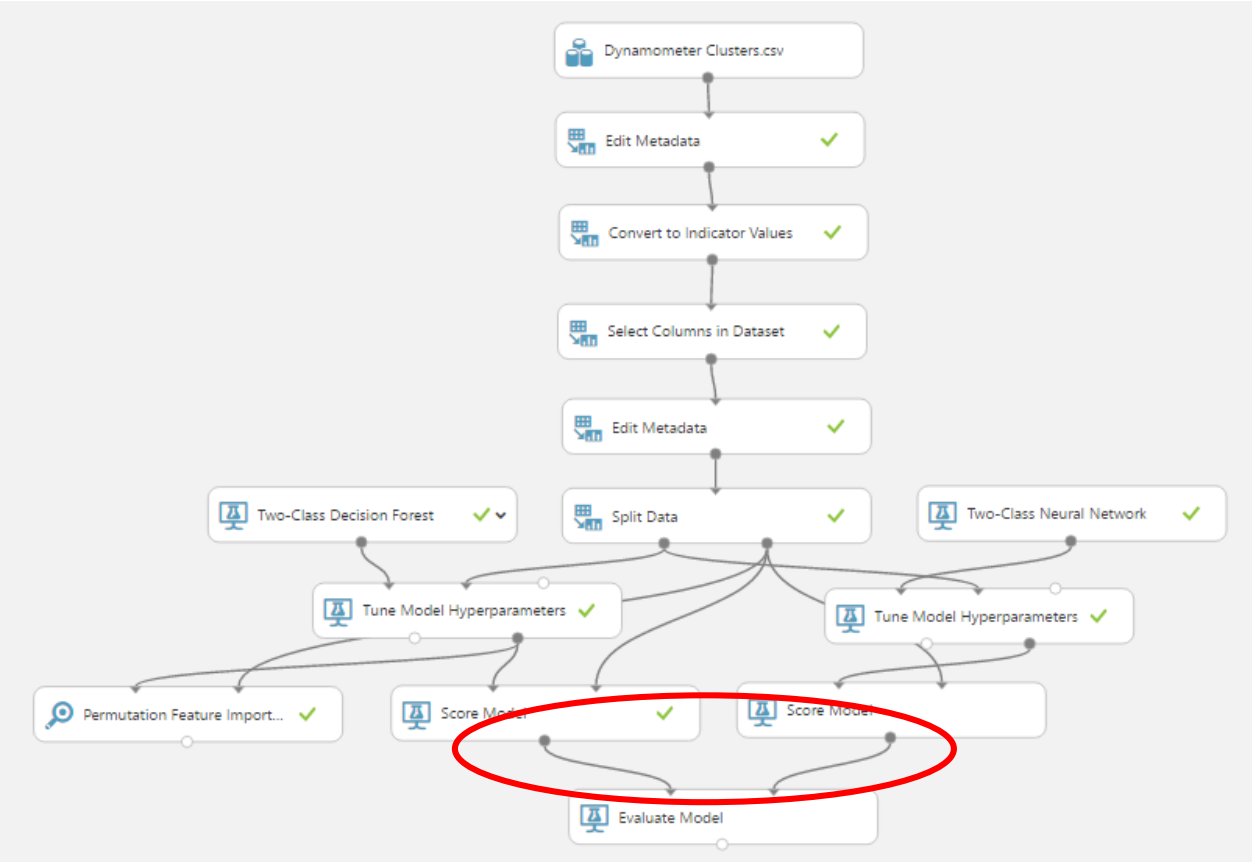
Step 7.9 : Connect the to to the Evaluate Model



- Click and hold on the bottom middle circle of your “Score Model” module on the right side
- While holding down the mouse button, drag the line to the top right circle of “Evaluate Model” module

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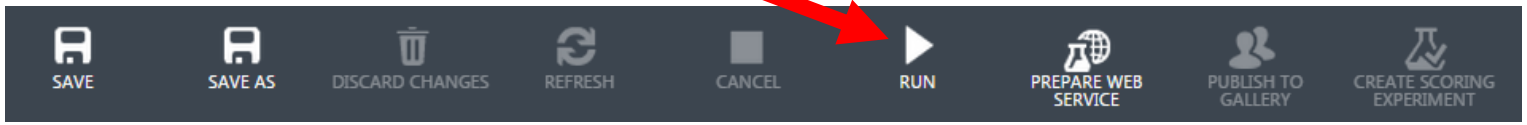
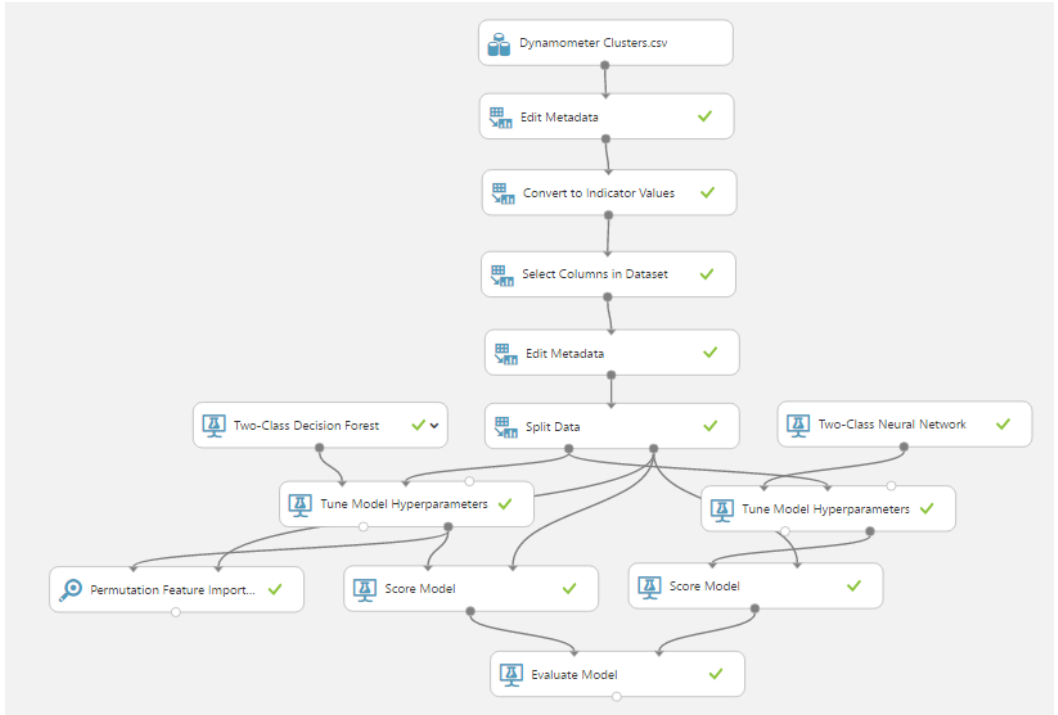
Step 7.10 : Run the Experiment

Click “Run”





- After Azure Machine Learning “runs”, you will see a green check mark in all the modules
- All it took to train a machine learning model was drag and drop

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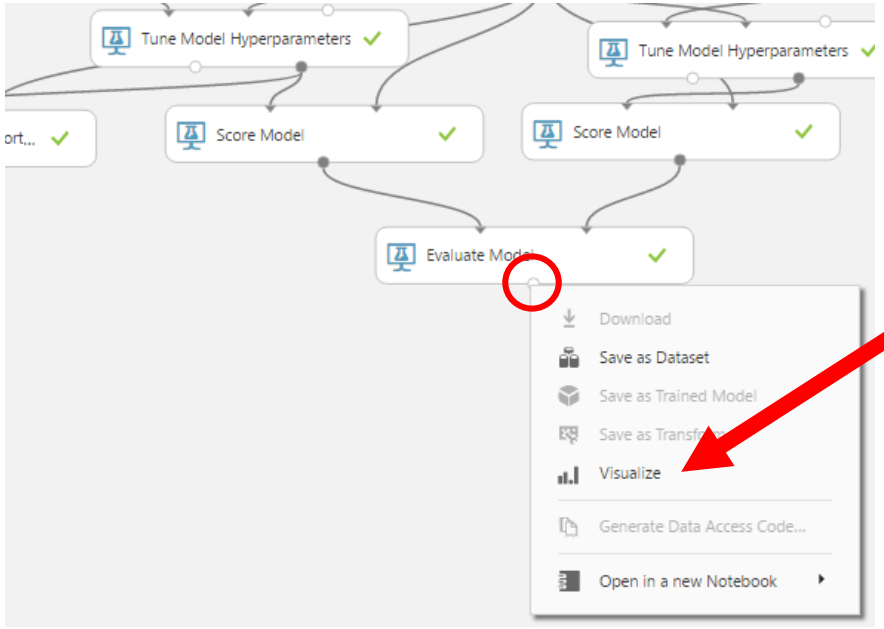
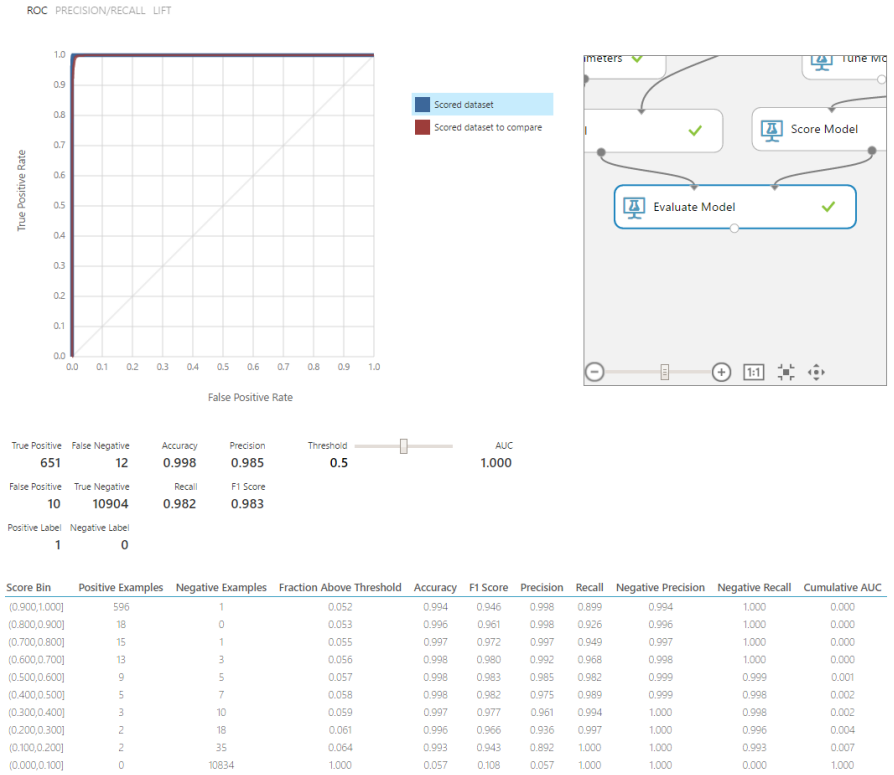
Step 7.11 : Visualize the Results



- Right click on the bottom-middle circle of “Evaluate Model” and select “Visualize”



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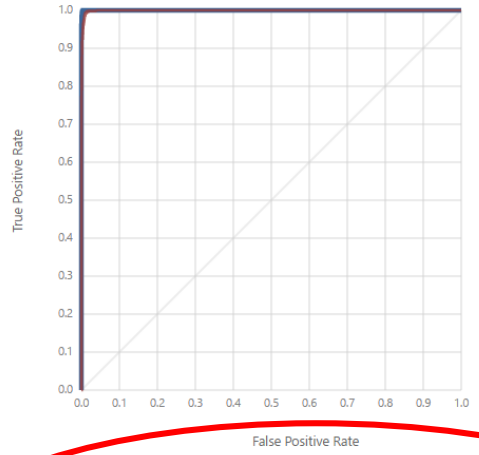
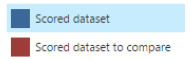
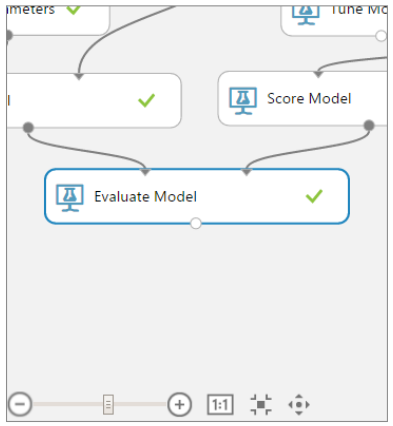
Step 7.12 : Interpret the Results

ROC PRECISION/RECALL LIFT







True Positive	False Negative	Accuracy	Precision	Threshold	AUC
651	12	0.998	0.985	0.5	1.000

False Positive	True Negative	Recall	F1 Score
10	10904	0.982	0.983

Positive Label	Negative Label
1	0

Score Bin	Positive Examples	Negative Examples	Fraction Above Threshold	Accuracy	F1 Score	Precision	Recall	Negative Precision	Negative Recall	Cumulative AUC
(0.900,1.000]	596	1	0.052	0.994	0.946	0.998	0.899	0.994	1.000	0.000
(0.800,0.900]	18	0	0.053	0.996	0.961	0.998	0.926	0.996	1.000	0.000
(0.700,0.800]	15	1	0.055	0.997	0.972	0.997	0.949	0.997	1.000	0.000
(0.600,0.700]	13	3	0.056	0.998	0.980	0.992	0.968	0.998	1.000	0.000
(0.500,0.600]	9	5	0.057	0.998	0.983	0.985	0.982	0.999	0.999	0.001
(0.400,0.500]	5	7	0.058	0.998	0.982	0.975	0.989	0.999	0.998	0.002
(0.300,0.400]	3	10	0.059	0.997	0.977	0.961	0.994	1.000	0.998	0.002
(0.200,0.300]	2	18	0.061	0.996	0.966	0.936	0.997	1.000	0.996	0.004
(0.100,0.200]	2	35	0.064	0.993	0.943	0.892	1.000	1.000	0.993	0.007
(0.000,0.100]	0	10834	1.000	0.057	0.108	0.057	1.000	1.000	0.000	1.000

- ROC - Accuracy is measured by the area under the ROC curve. An area of 1 represents a perfect test; an area of .5 represents a worthless test
  - .90-1 = excellent
  - .80-.90 = good
  - .70-.80 = fair
  - .60-.70 = poor
  - .50-.60 = fail
- The algorithm "Two-Class Decision Forest" performs best in terms of four metrics: "Accuracy", "Precision, "Recall", and "F-Score".

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