Hands on Tutorial
k-means Clustering Model

Tutorial #3 Questions:

- What are we trying to accomplish?
  - Build a clustering algorithm to classify wells based on dynamometer card data.
  - Which are similar?
  - Which are dissimilar?
- How can we use Azure Machine Learning to address this question?

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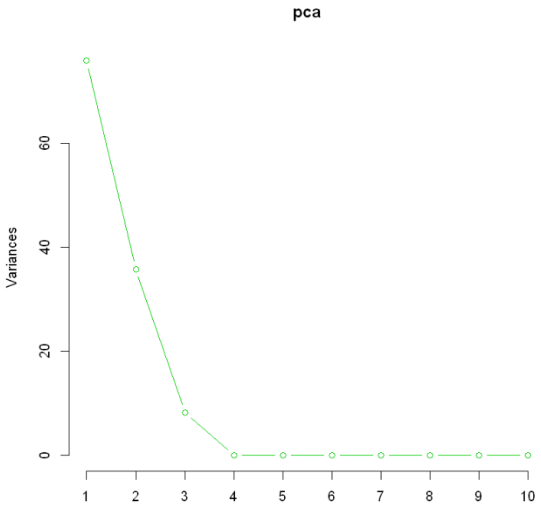
Scenario Data:

well	date	idx	x	y
Alabama	8/16/2013 1:55	1	0.00074002	-5327.23698
Alabama	8/16/2013 1:55	2	0.15595834	-4476.758361
Alabama	8/16/2013 1:55	3	1.536036006	-3475.778052
Alabama	8/16/2013 1:55	4	3.779102308	-2636.548613
Alabama	8/16/2013 1:55	5	6.817062356	-1999.545532
Alabama	8/16/2013 1:55	6	10.7311654	-1622.668567
Alabama	8/16/2013 1:55	7	15.5308829	-1432.091513
Alabama	8/16/2013 1:55	8	21.09257393	-1346.745211
Alabama	8/16/2013 1:55	9	27.24284435	-1325.808833

- ~3.4 million rows of data
- 263 unique wells
- The data comprises of the following:
  - Date-Time at which the readings were taken
  - Idx - Reading number (1-60): During every up and down motion of the Pump Jack, 60 sets of reading will be taken at various positions
  - X - Position of the Pump Jack
  - Y – Load on the Pump Jack
- We then perform the Principal Component Analysis over this data which was covered during your Exploratory Data Analysis lecture

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
- Training data comprises of the following:
  - Date-Time at which the readings were taken
  - PC1
  - PC2
  - PC3



well	date	PC1	PC2	PC3
Alabama	8/16/2013 1:55	-8.243340971	2.918070697	2.023029116
Alabama	8/16/2013 23:49	-8.243340971	2.918070697	2.023029116
Alabama	9/3/2013 0:17	-8.495327766	2.311736767	2.154066737
Alabama	9/6/2013 9:38	-8.148383208	2.731807776	2.341956526
Alabama	9/6/2013 16:13	-8.148383208	2.731807776	2.341956526
Alabama	9/13/2013 3:48	-8.206877815	2.58376763	2.282912974
Alabama	9/13/2013 20:28	-8.206877815	2.58376763	2.282912974
Alabama	11/5/2013 13:17	-8.640142409	2.146508336	2.971266786
Alabama	11/5/2013 17:26	-8.640142409	2.146508336	2.971266786
Alabama	12/12/2013 9:46	-3.139291754	7.206502009	-2.257469677
Alabama	12/12/2013 14:13	-3.139291754	7.206502009	-2.257469677

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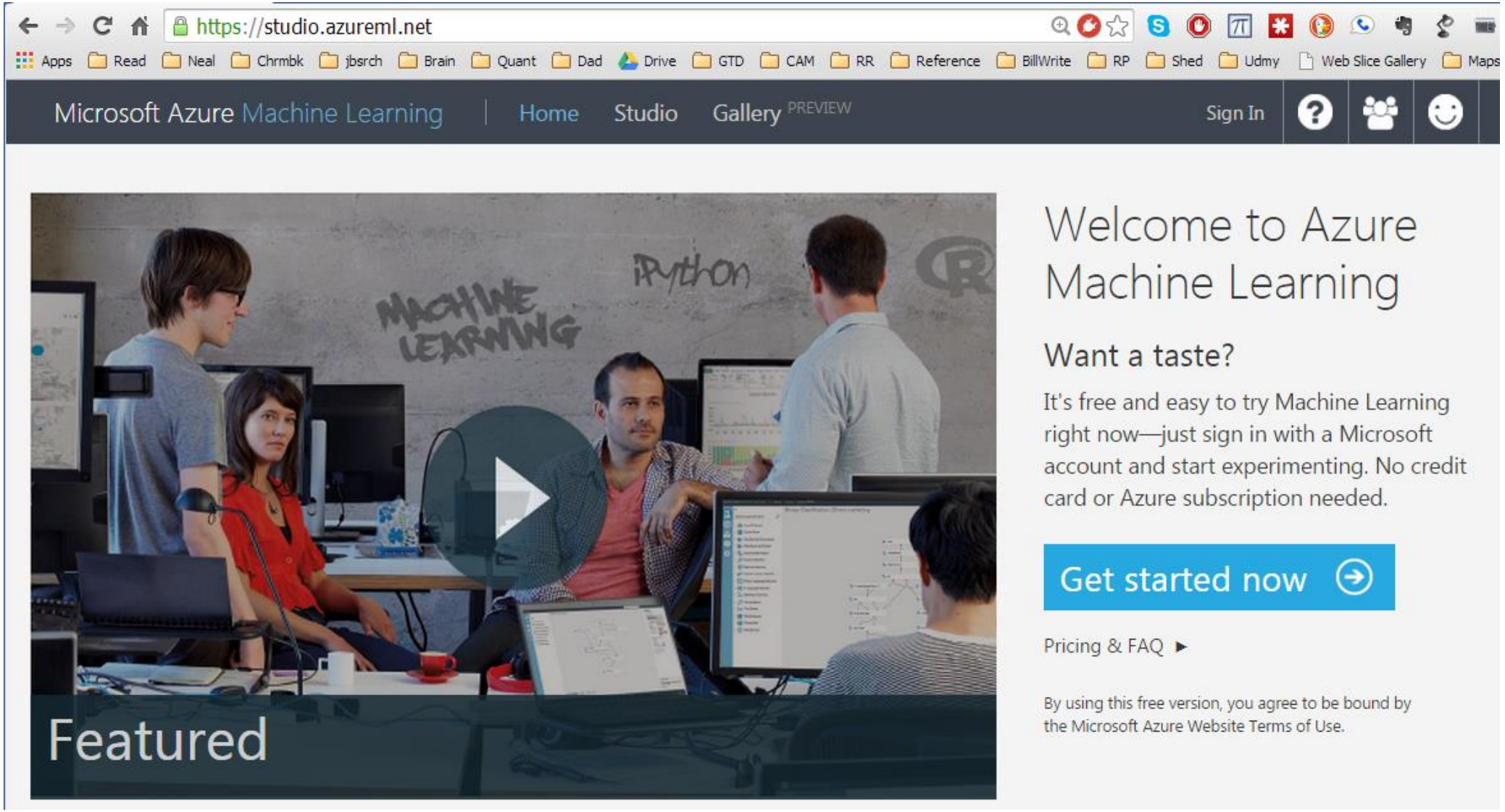
Step by Step Guide for Building a Clustering Model

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



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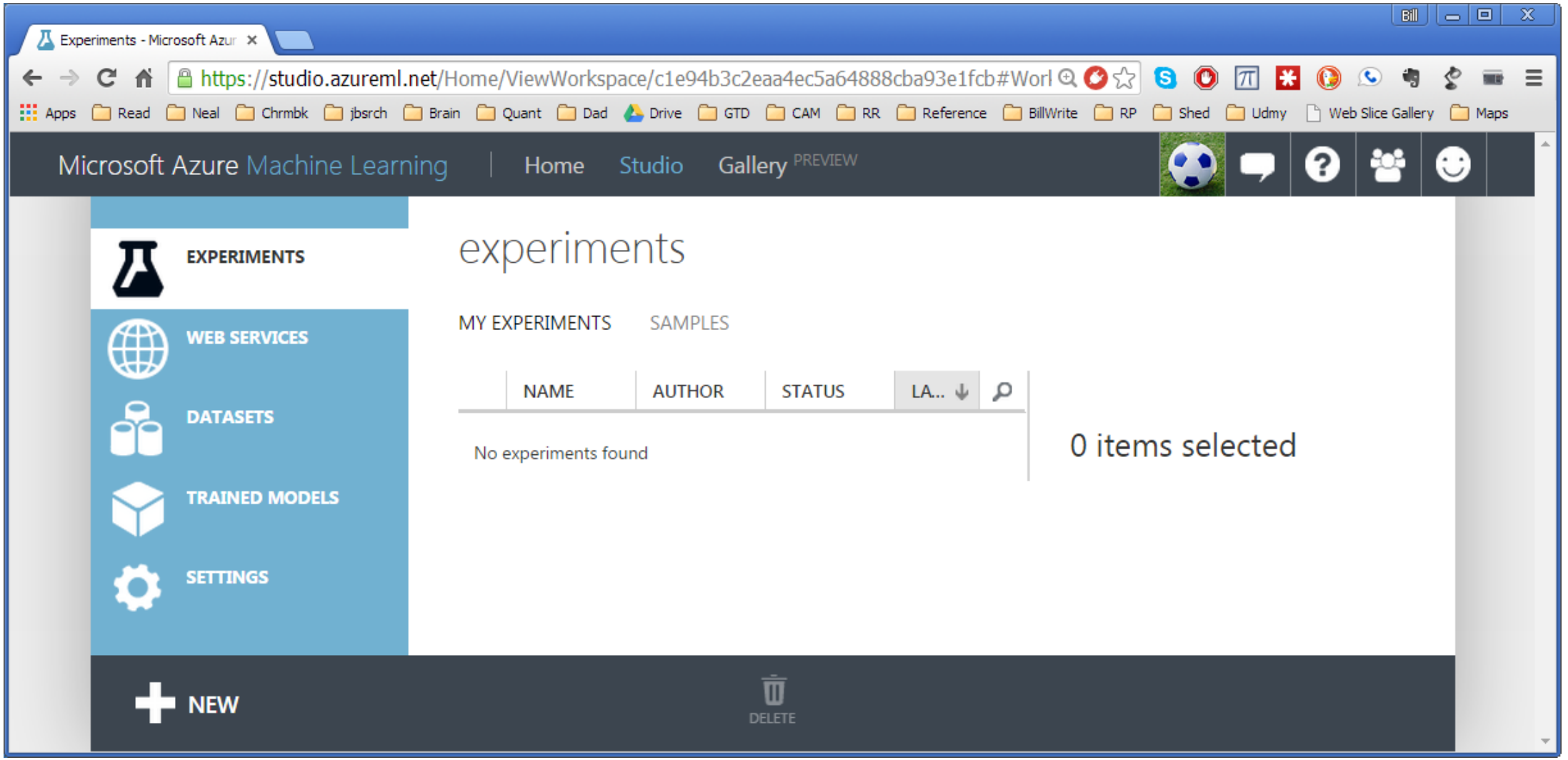
Step 2 : Log in to your account



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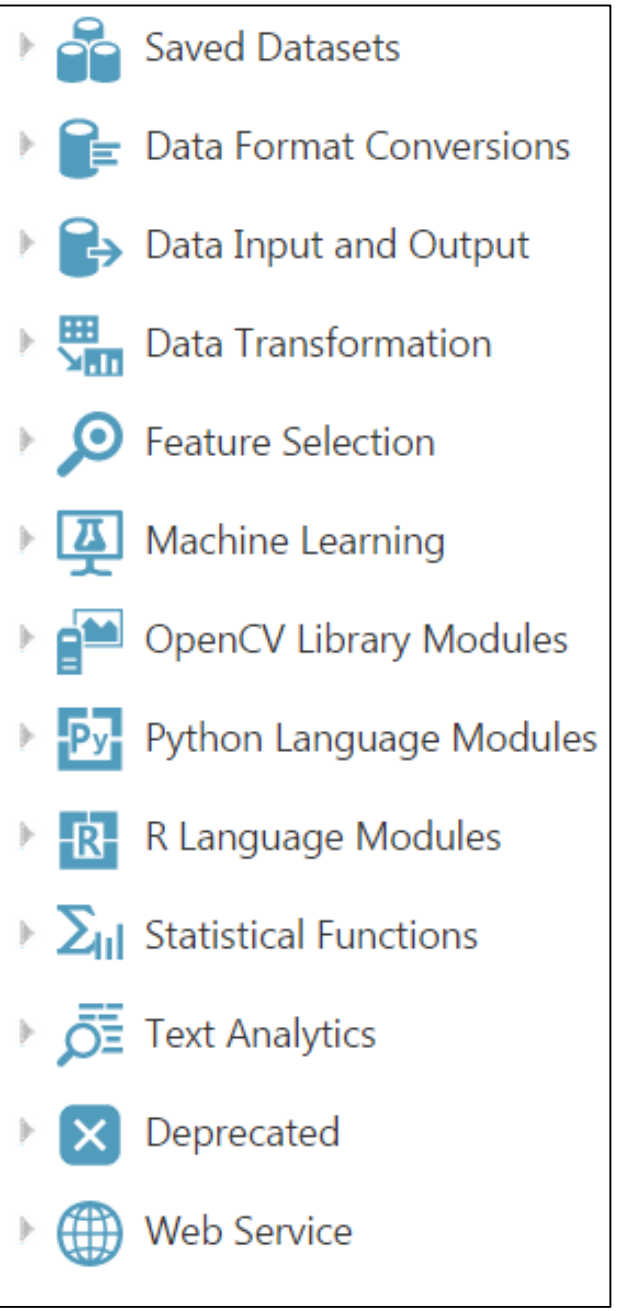

Step 3.1 : Create New Experiment

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

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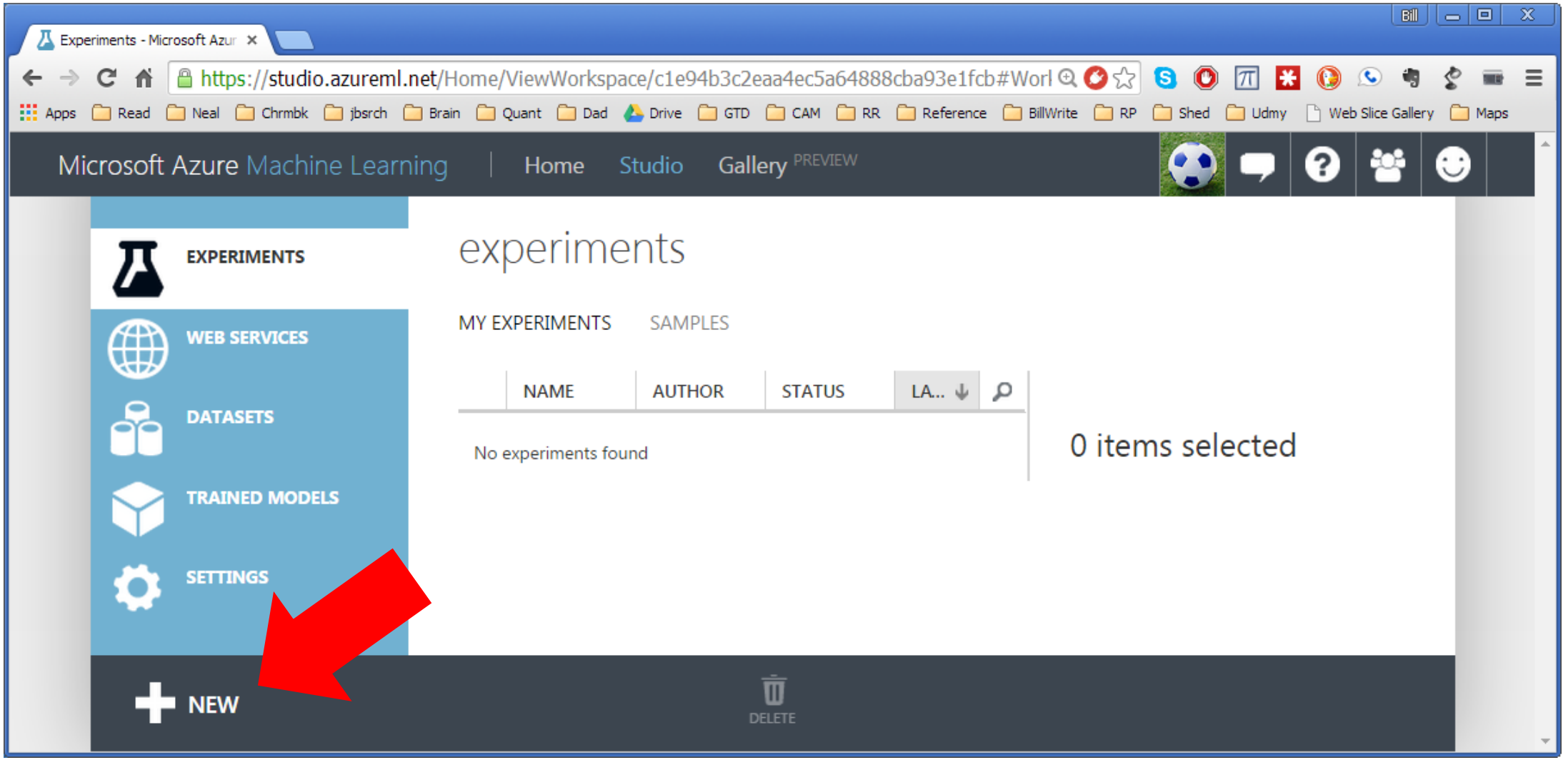
Step 3.2 : Create a new experiment



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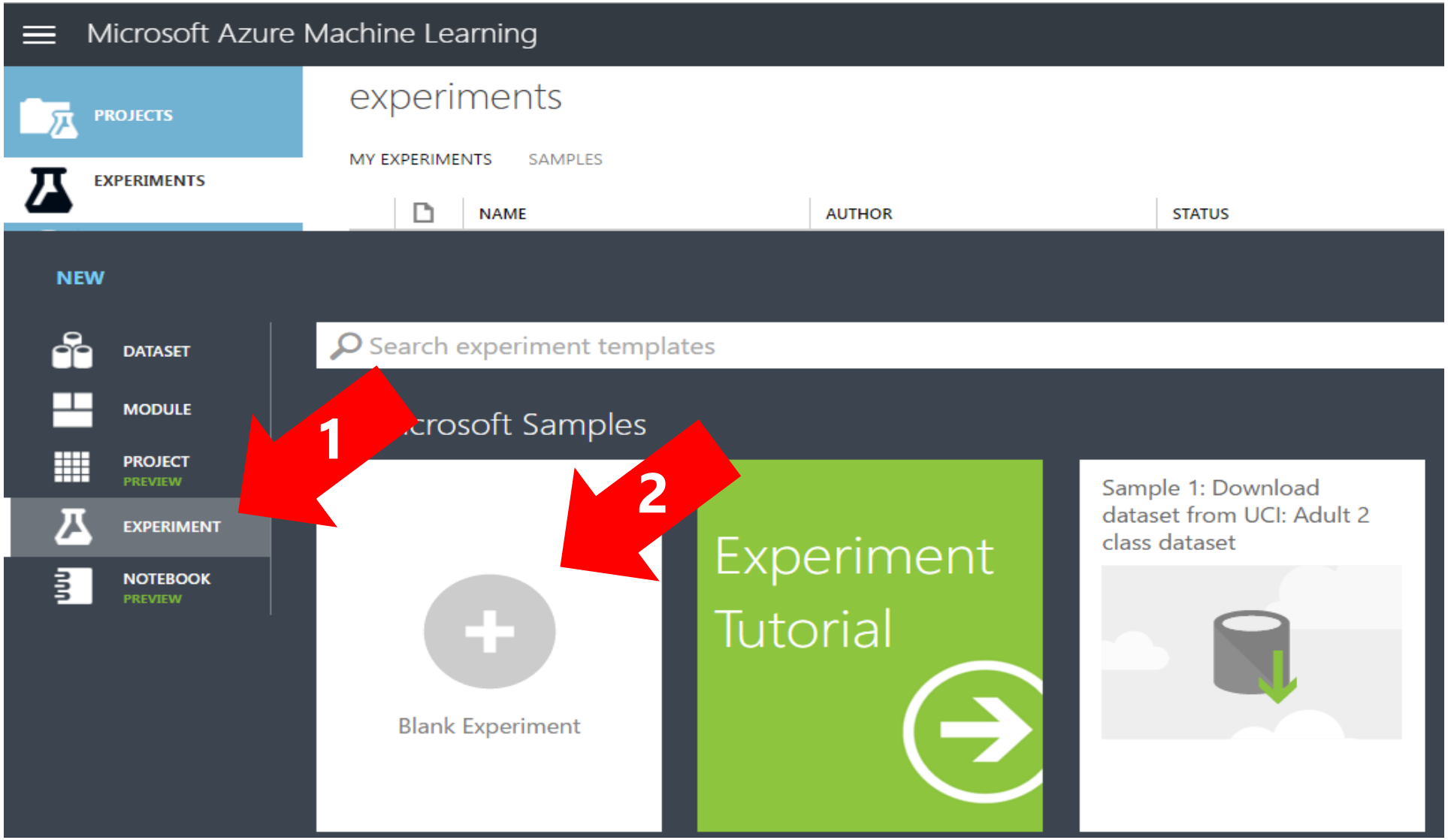
Step 3.3 : Create a new experiment



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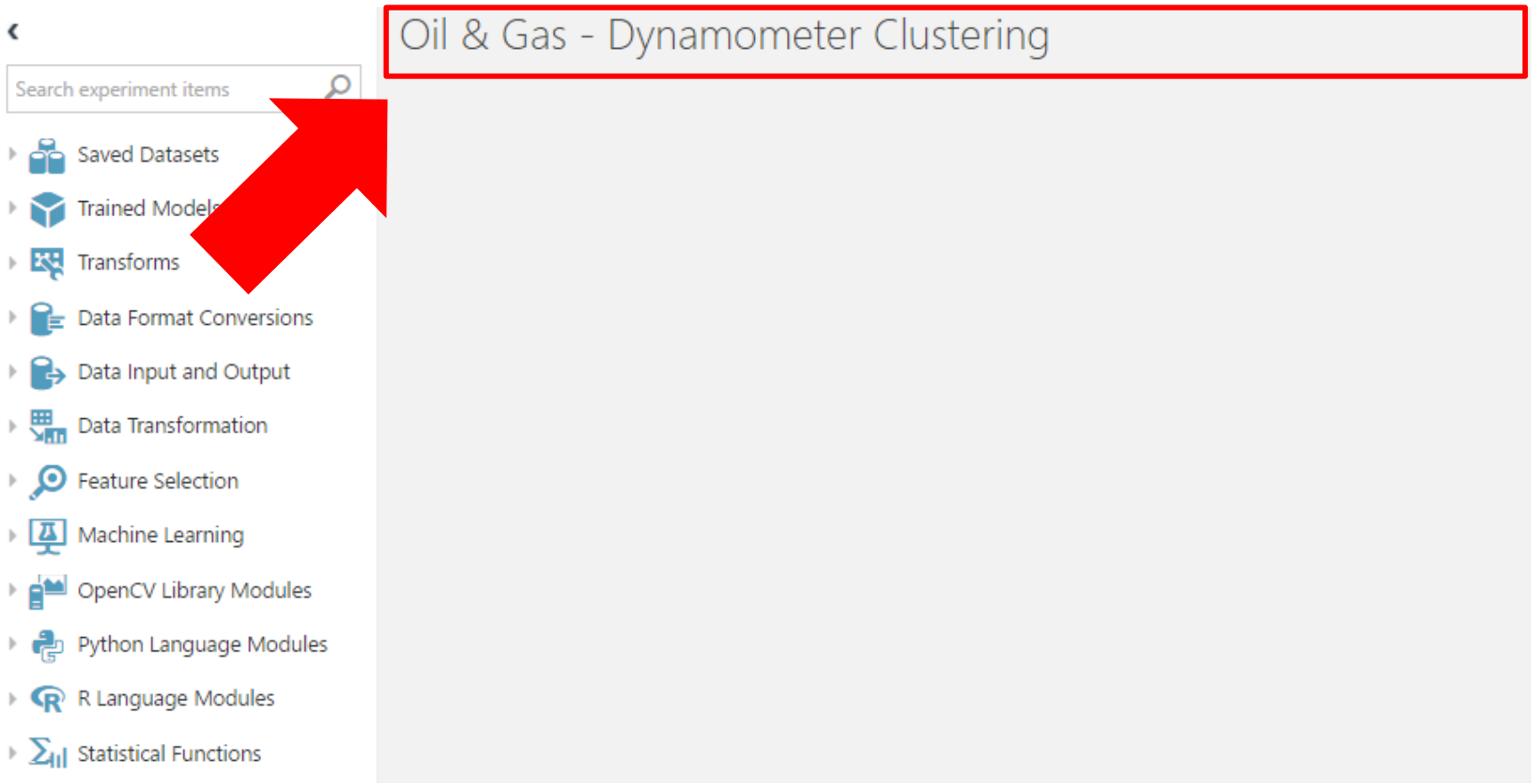
Step 3.4 : Name your experiment



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

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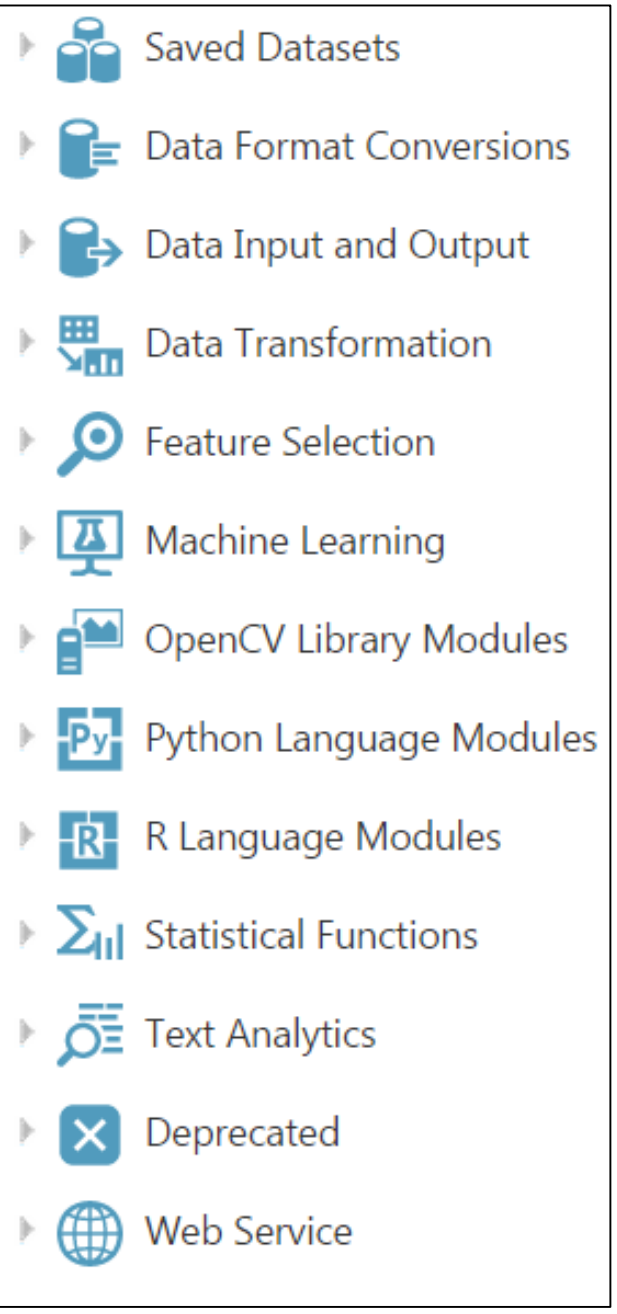

Step 4.1 : Import the dataset

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

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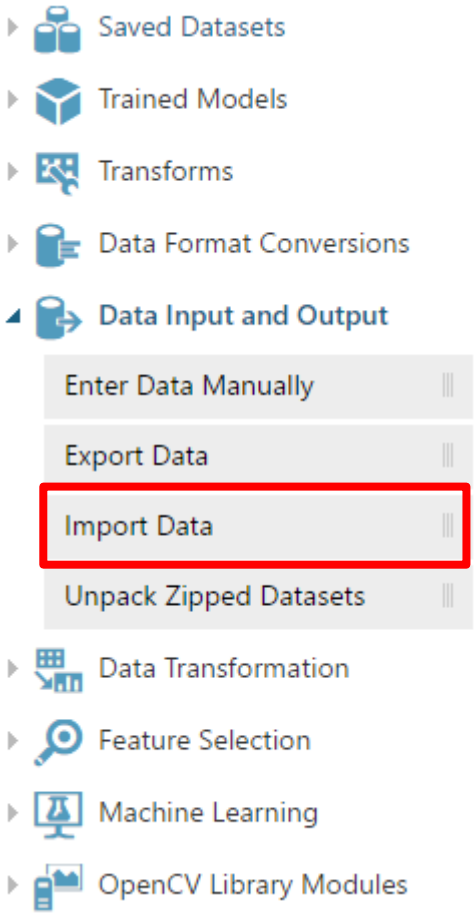
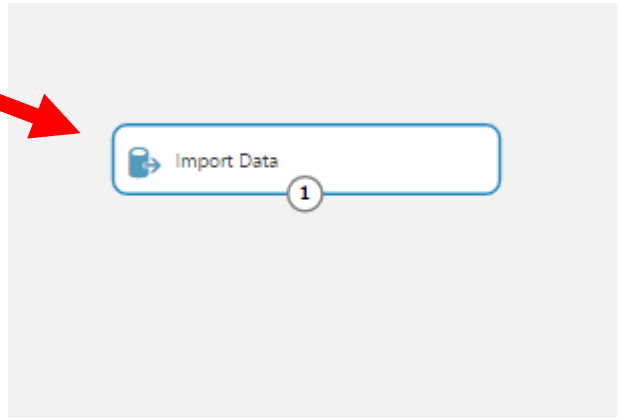
Option 1 - Import the training dataset from the Azure Blob Storage. If option 1 did not work, skip to option 2.

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



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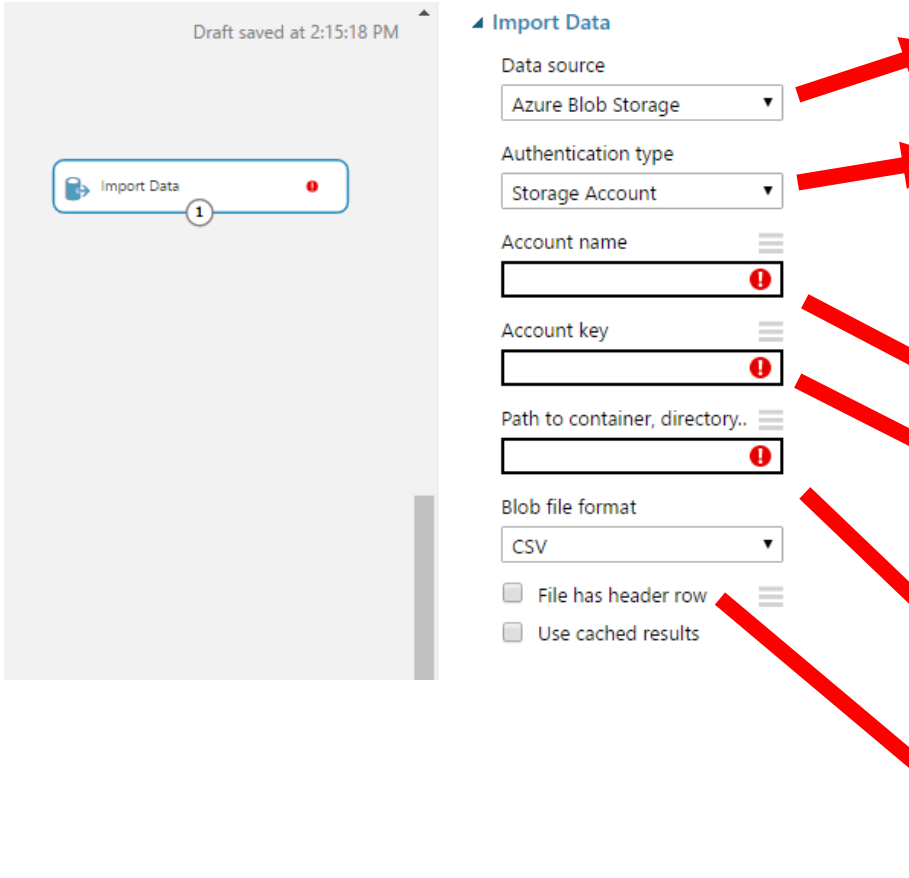
Step 4.3 : Q? How to import data from Azure Blob?



- 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 Card Reading Data PCA.csv**"
    - Check the File has header row check box

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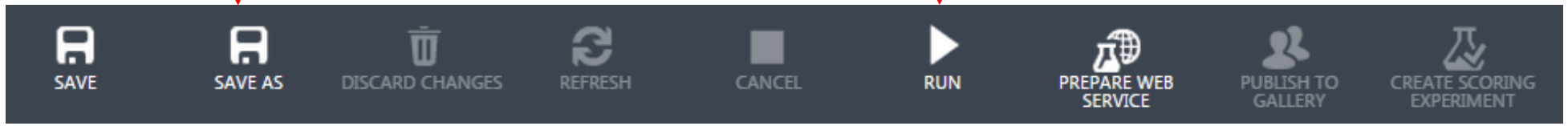
Step 4.4 : Q? How to import data from Azure Blob?

Step 1: Click "Save"

Step 2: Click "Run"



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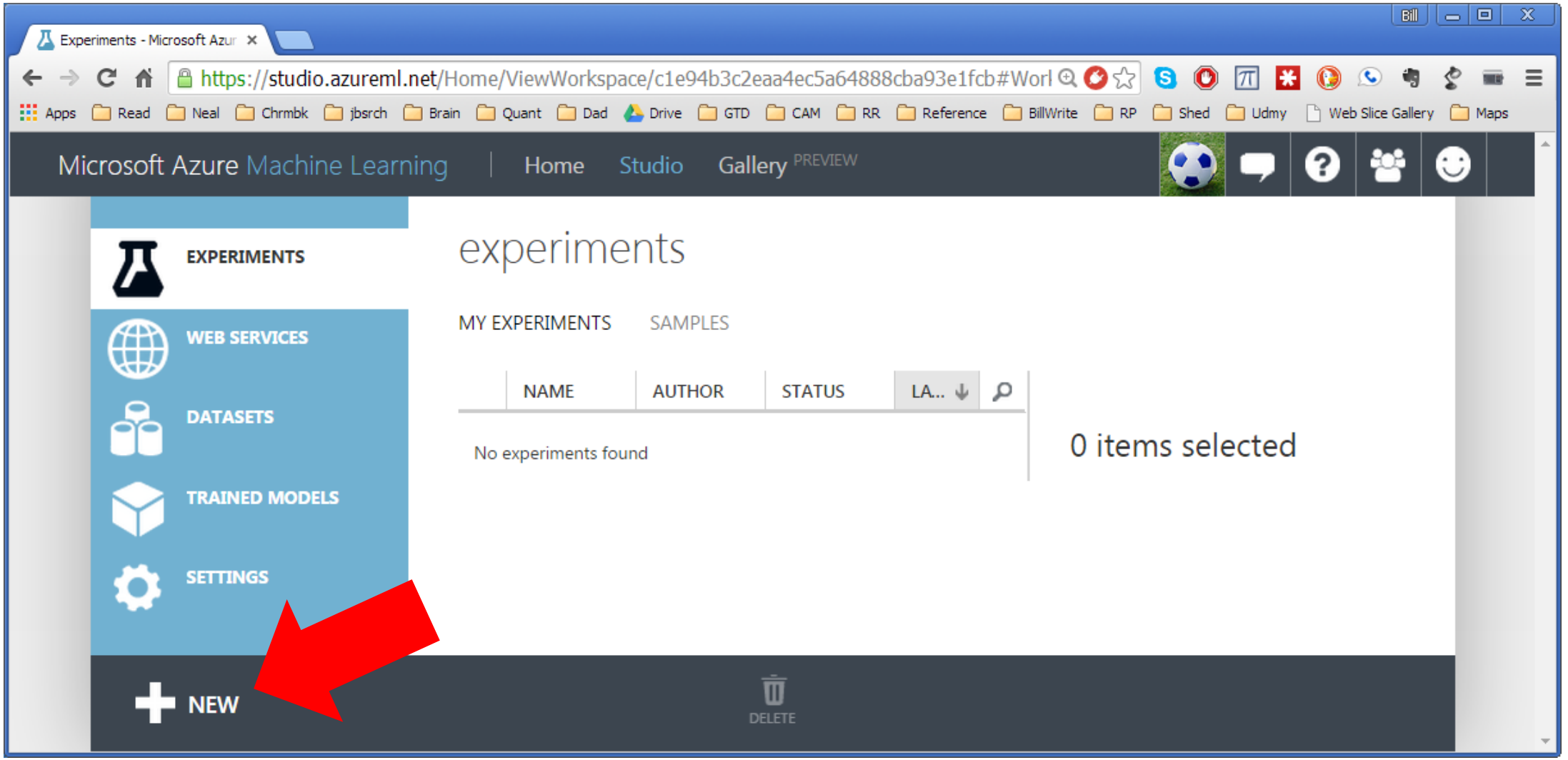
If Option 1 worked, move on to Step 4.12

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

Step 4.5 : Import this tutorial's training dataset



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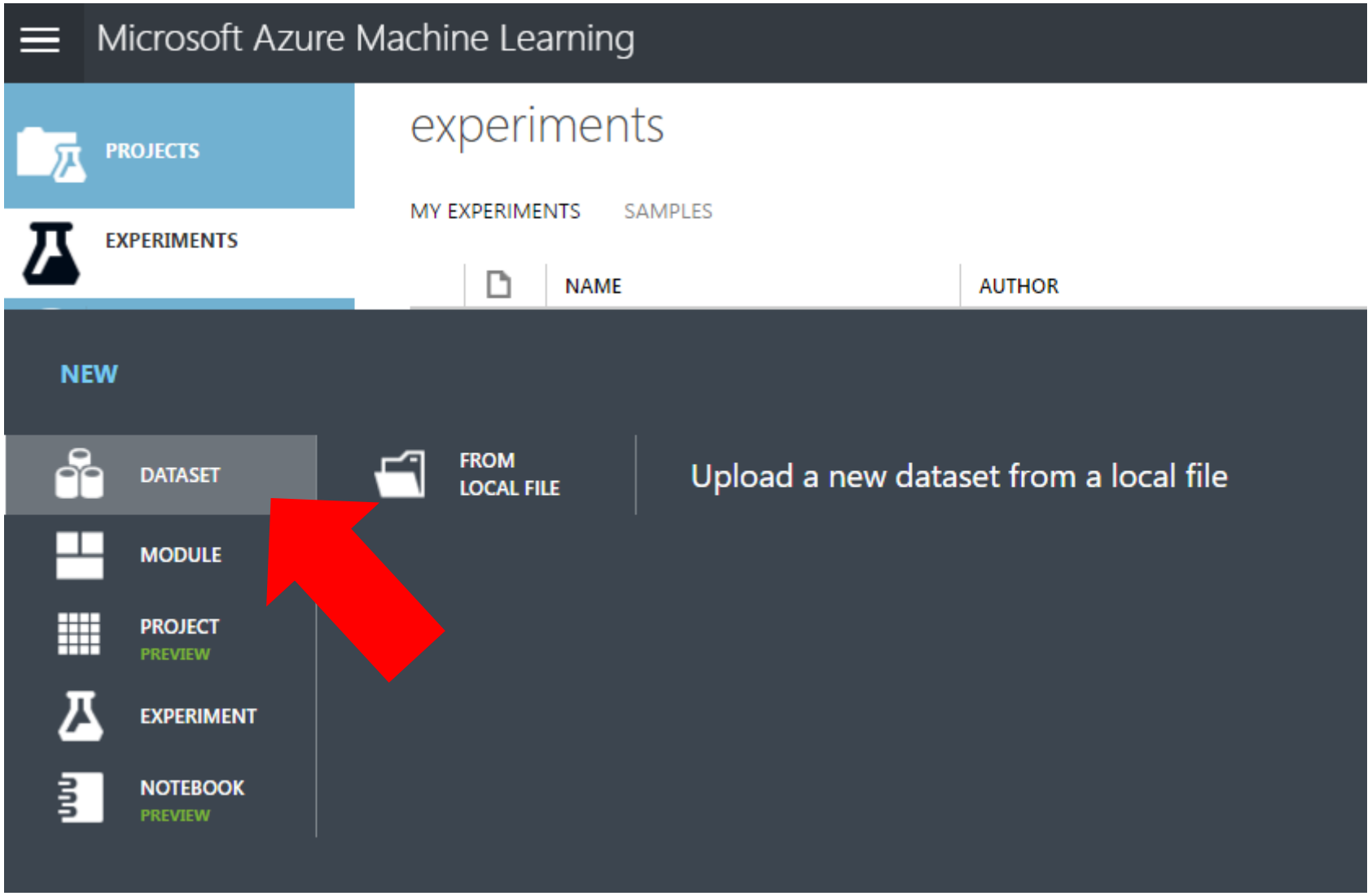
Step 4.6 : Import this tutorial's training dataset



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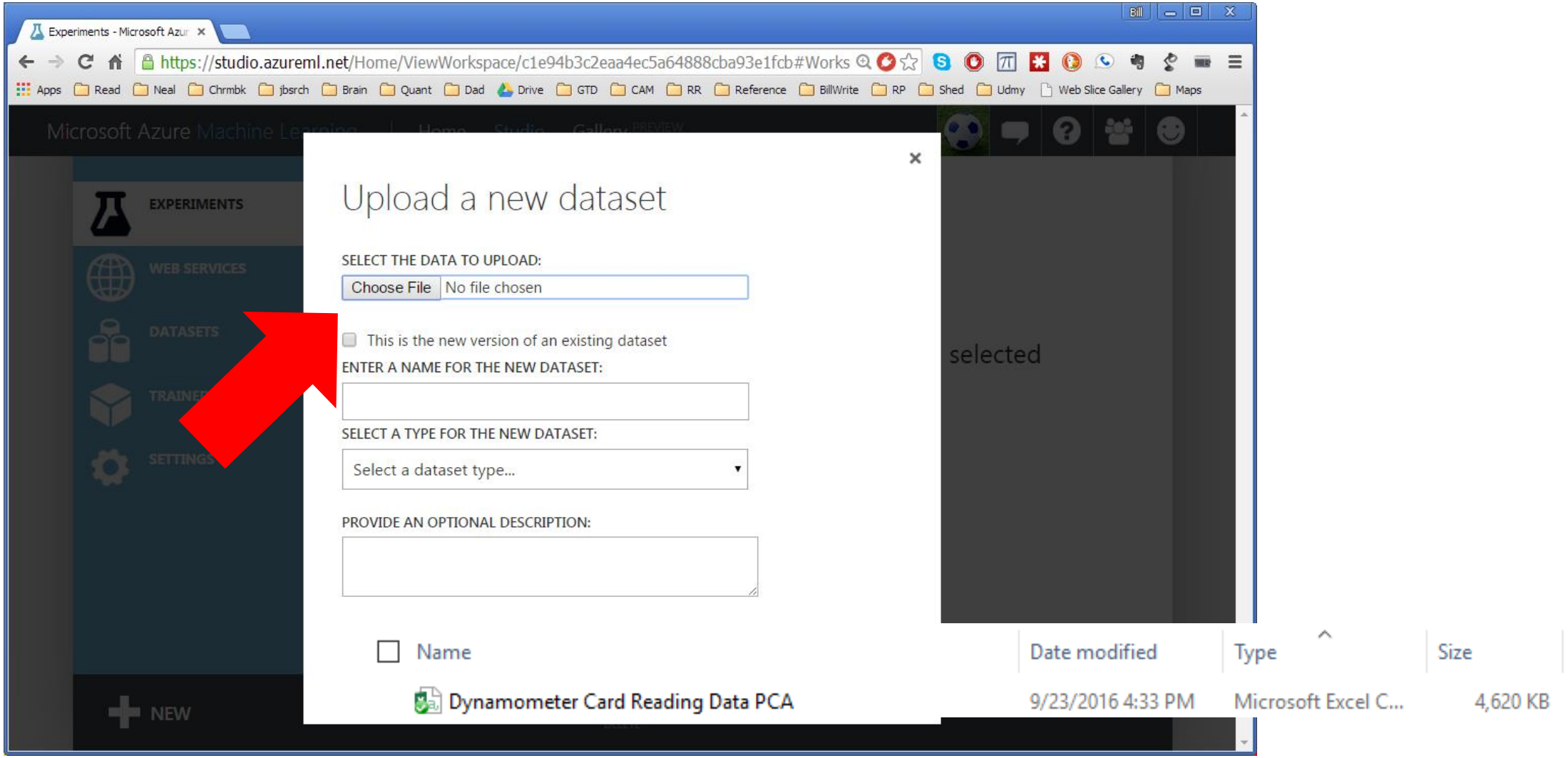
Step 4.7 : Import this tutorial's training dataset



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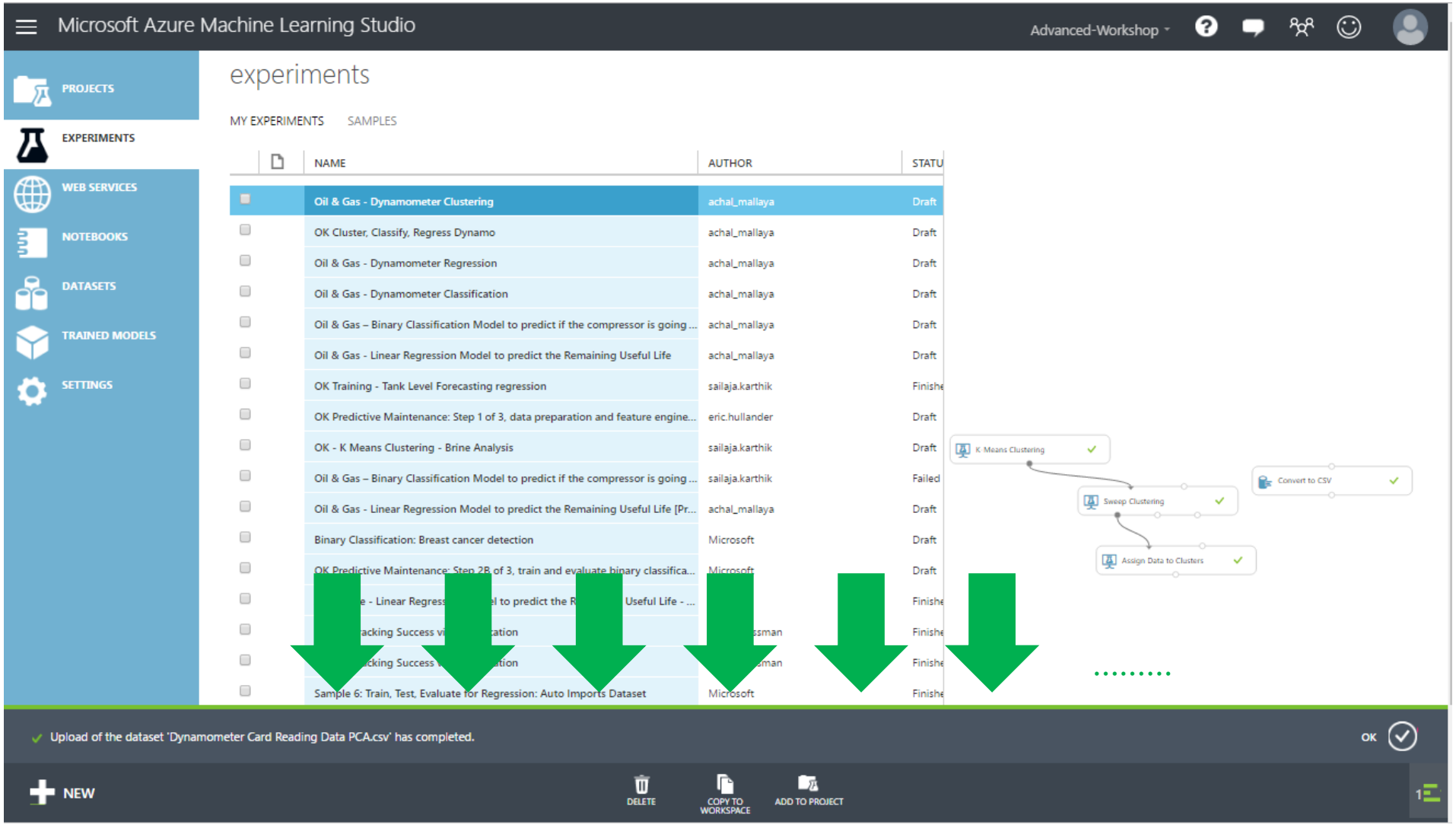
Step 4.8 : Import this tutorial's training dataset



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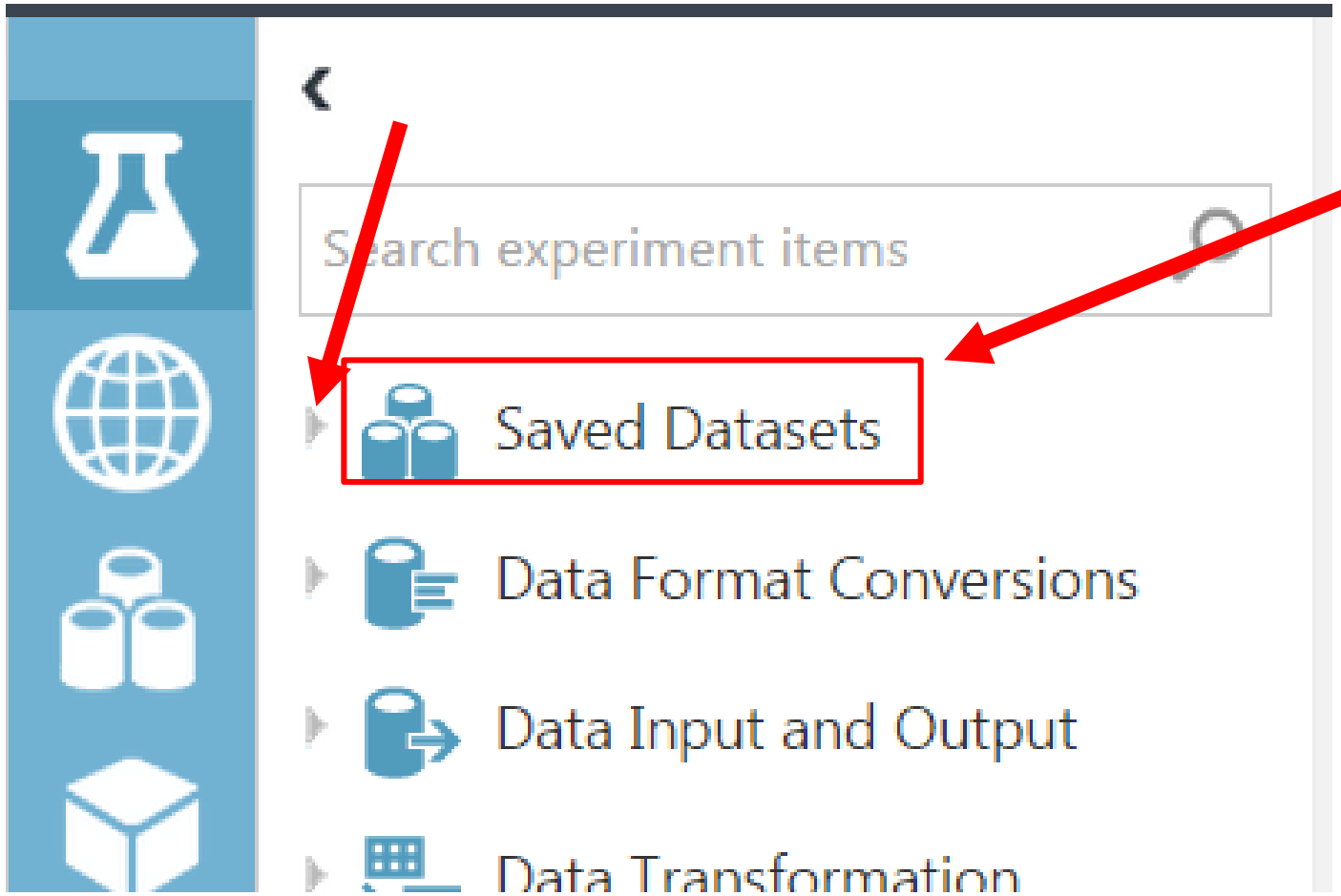
Step 4.9 : Open “Saved Datasets”



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

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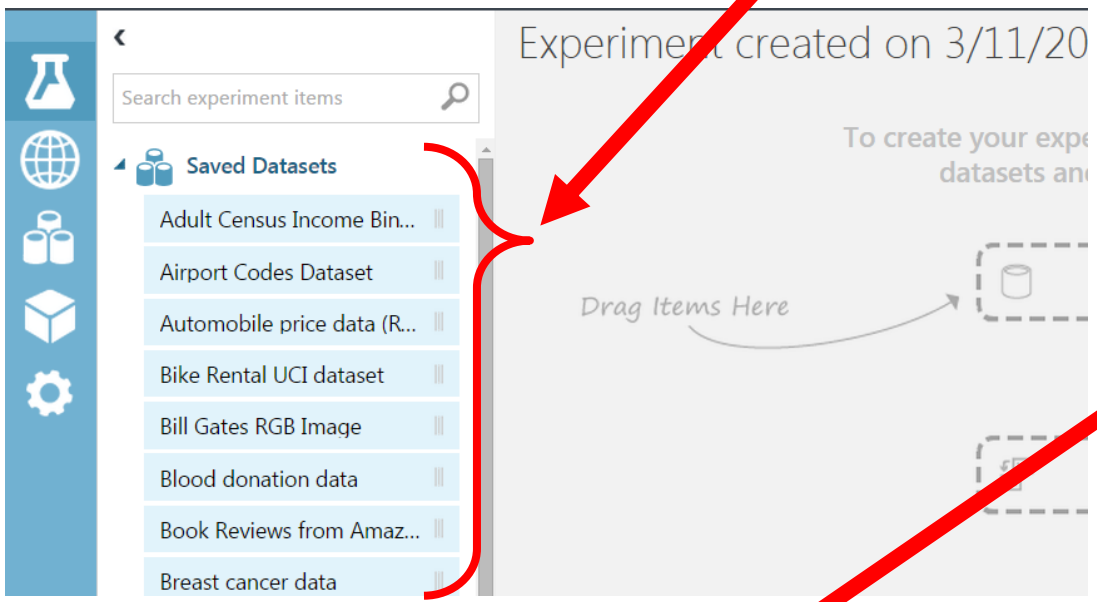
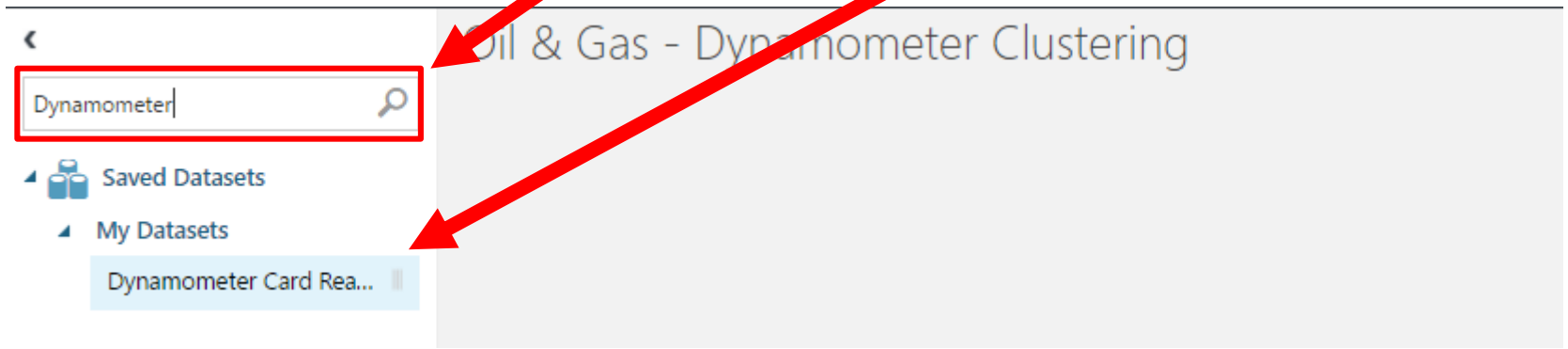
Step 4.10 : Take a second to notice the MANY datasets



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



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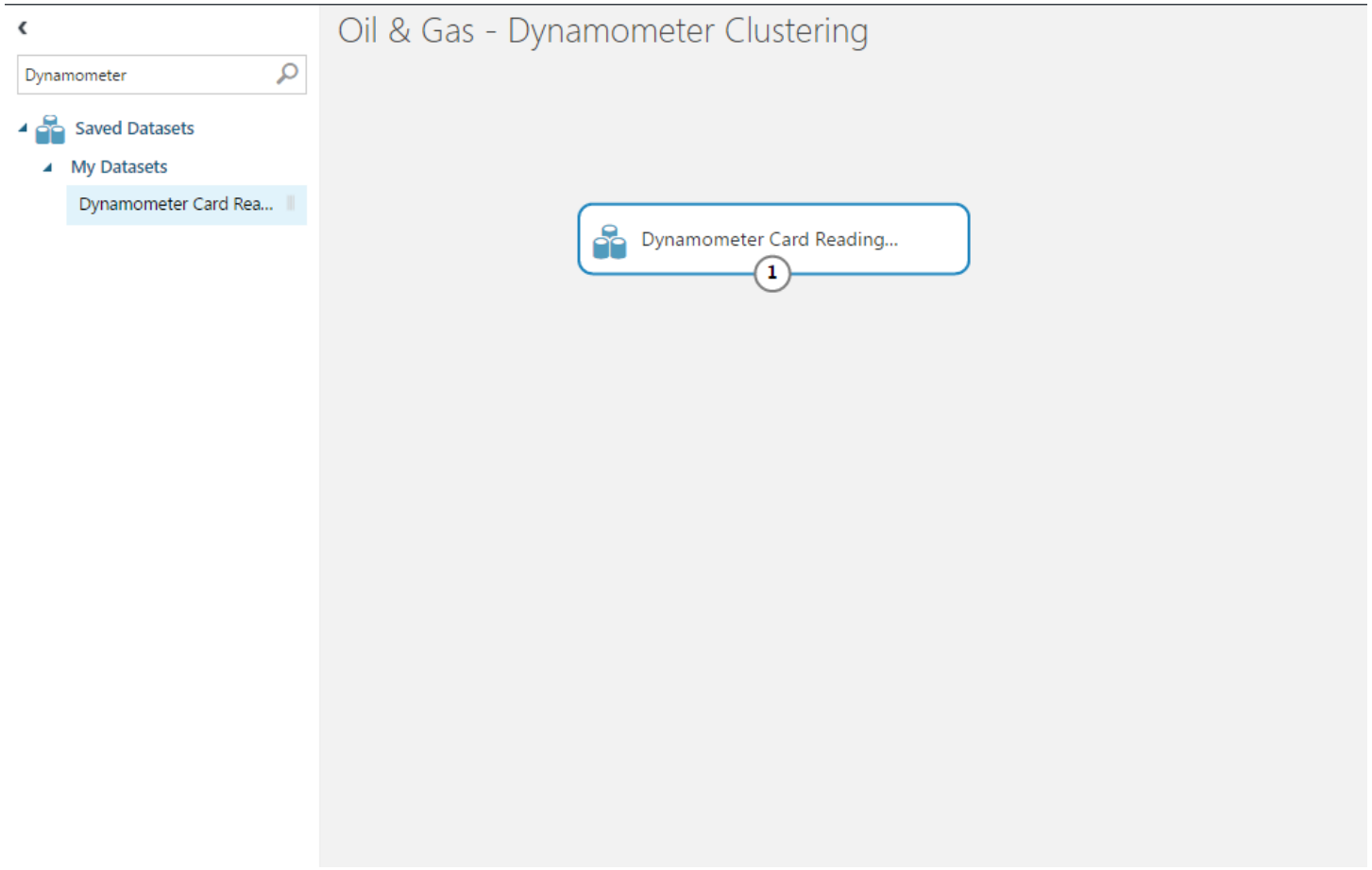
Step 4.11 : Drag the data set to the experiment



- *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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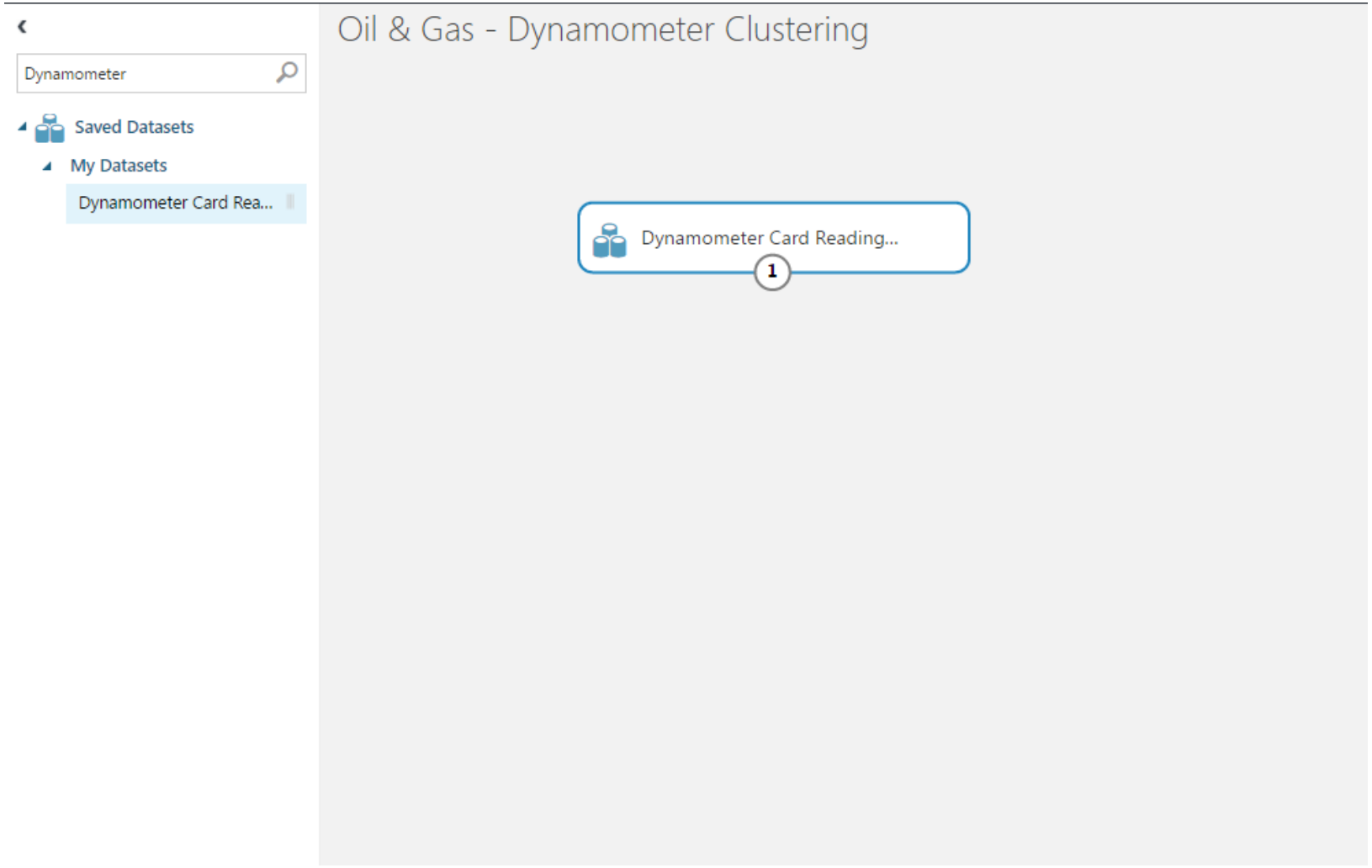
Step 4.12 : Admire your data set living in your experiment



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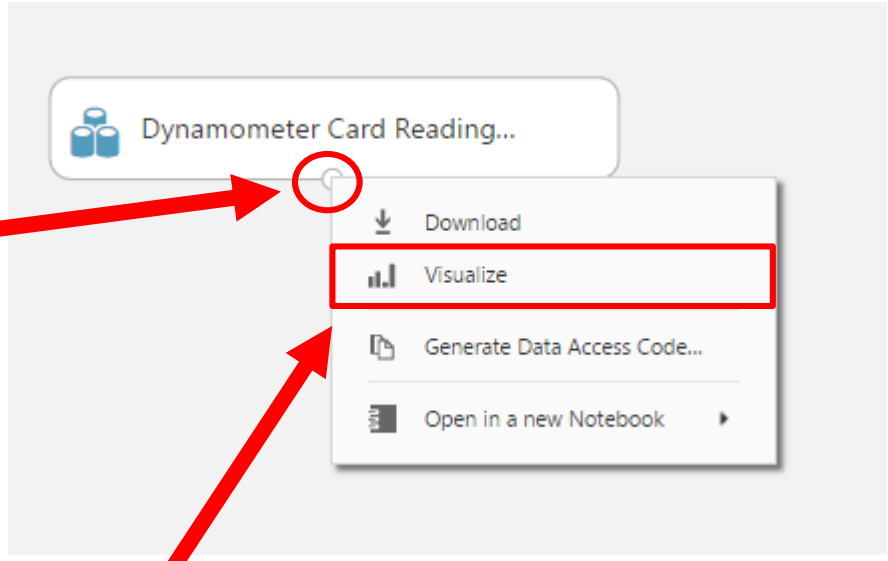
Step 4.13 : Visualize the data set

Right click on the bottom-middle circle of the module



Then click “Visualize”

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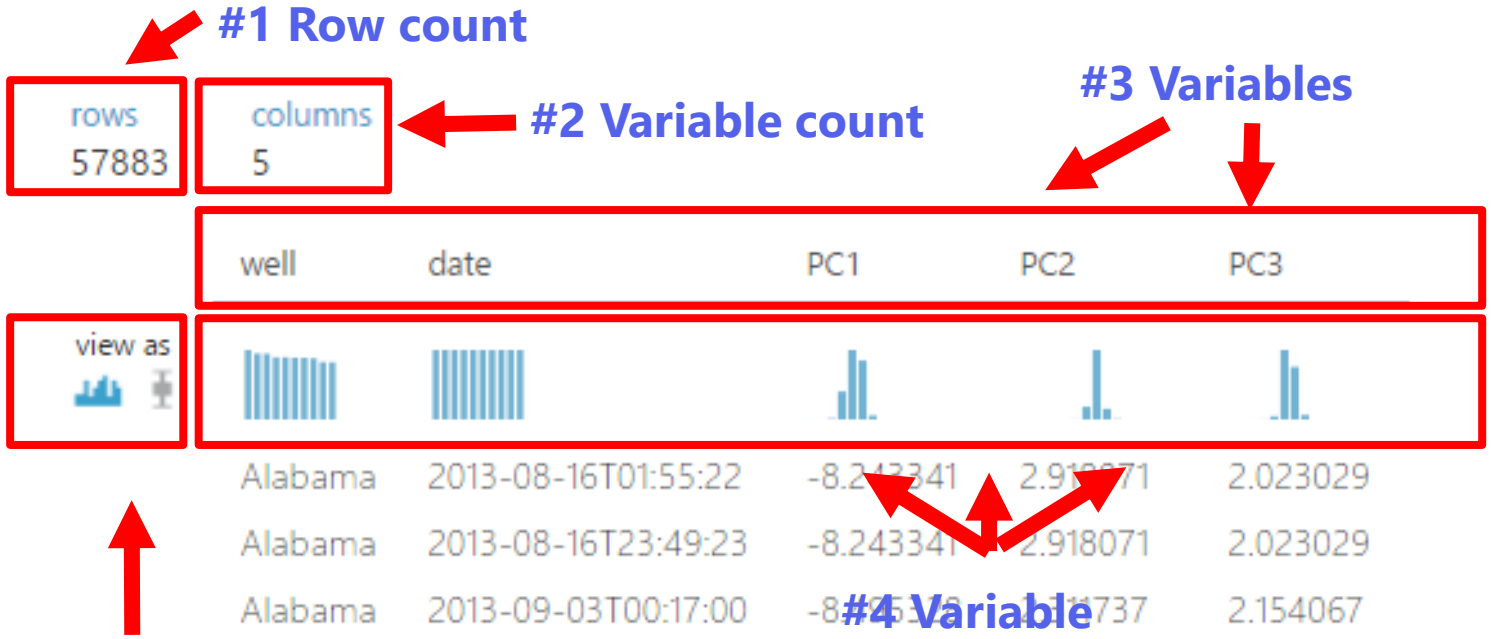
Step 4.14 : Now look at the data for 4 attributes



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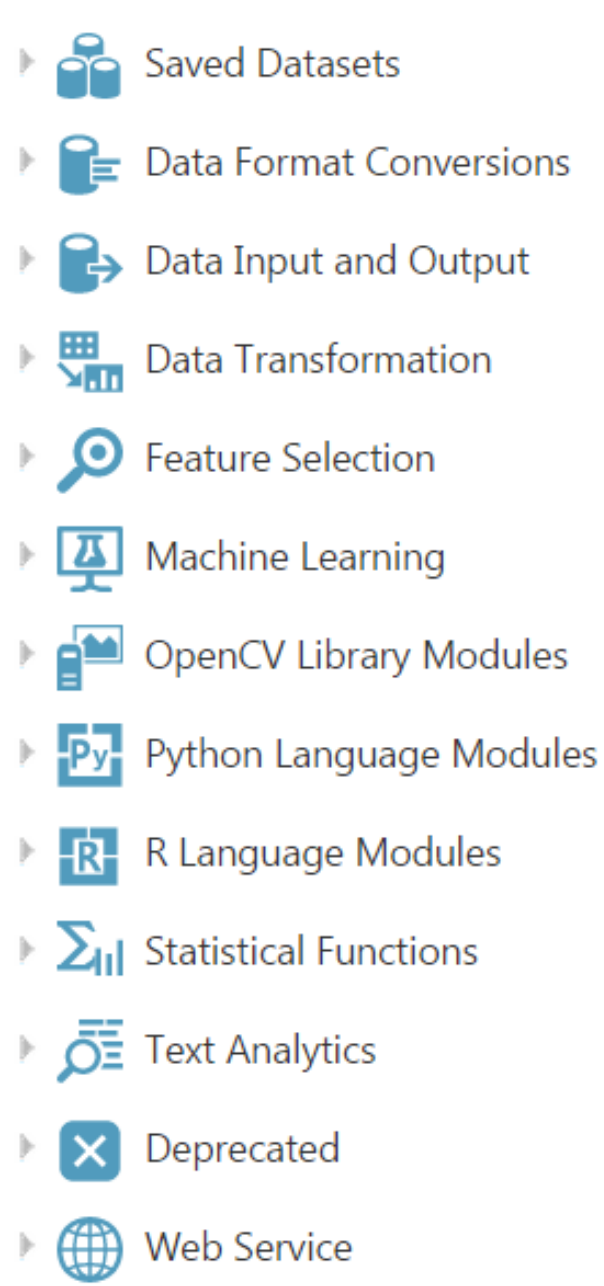
Step 5.1 : AML Modeling Components



- AML modelling … a checklist approach
  - ~~Initial data set~~
  - ~~Create new experiment~~
  - ~~Import data set~~
  - ❑ Machine Learning

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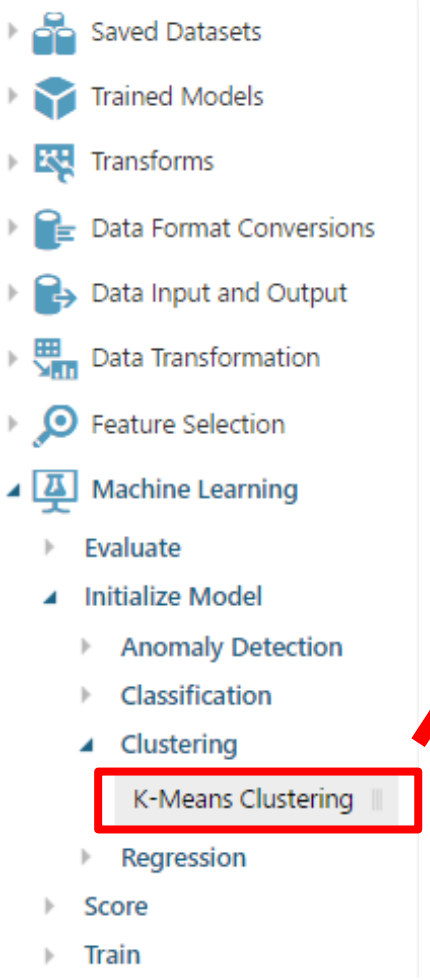
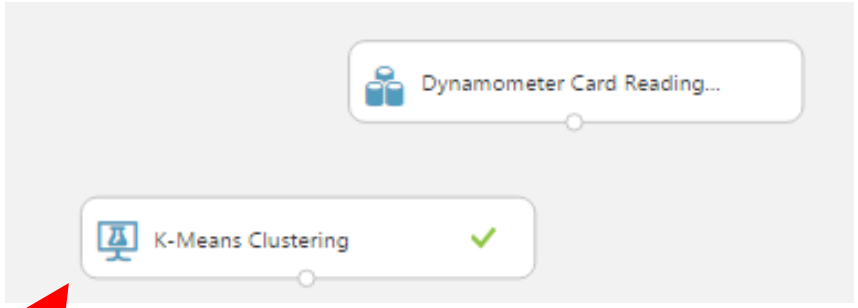
Step 5.2 : Q? How to develop the Machine Learning Algorithm?





- Open “Machine Learning” -> “Initialize Model” -> “Clustering” from the navigation pane at the left
- Drag “K-Means Clustering” to the canvas

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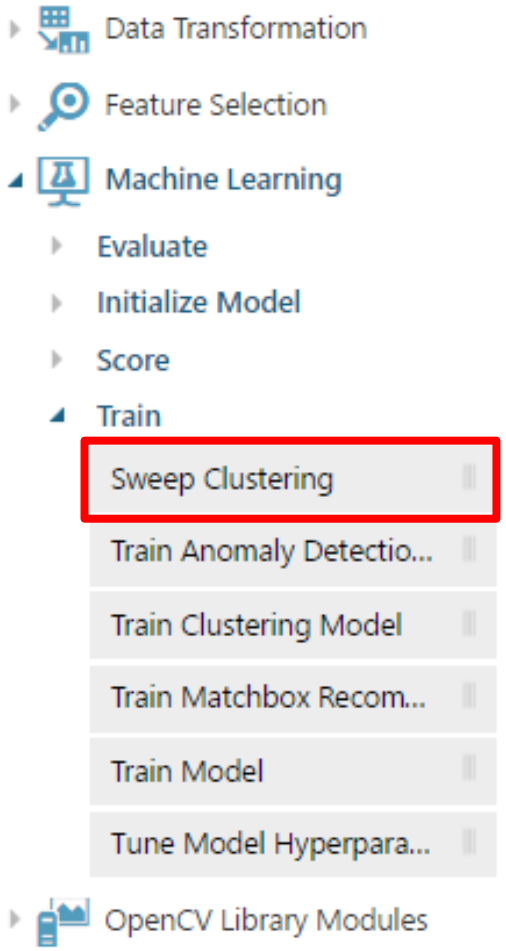
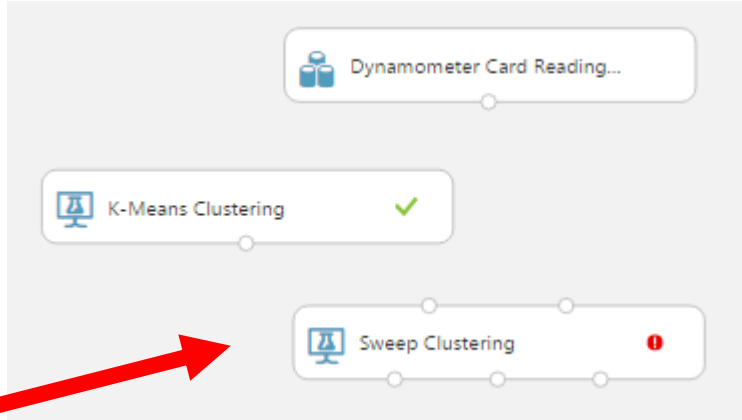
Step 5.3 : Q? How to develop the Machine Learning Algorithm?





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

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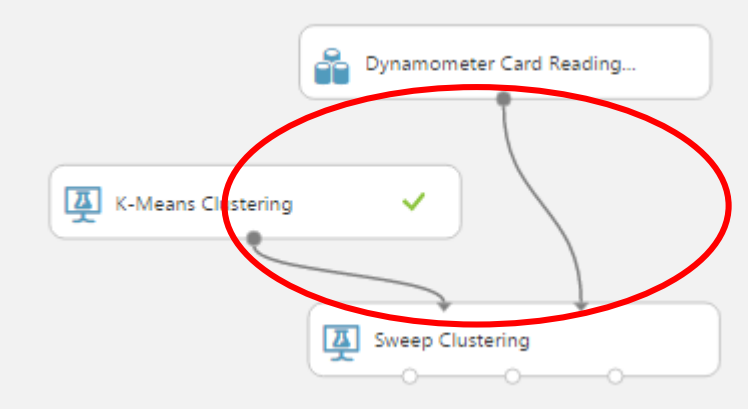
Step 5.4 : Q? How to develop the Machine Learning Algorithm?



- Next, click and hold on the bottom middle circle of your “K-Means Clustering” module and drag the line to the top left circle of the “Sweep Clustering” module.
- Similarly, click and hold on the bottom left circle of your “Dataset” module and drag the line to the top right circle of the “Sweep Clustering” module.

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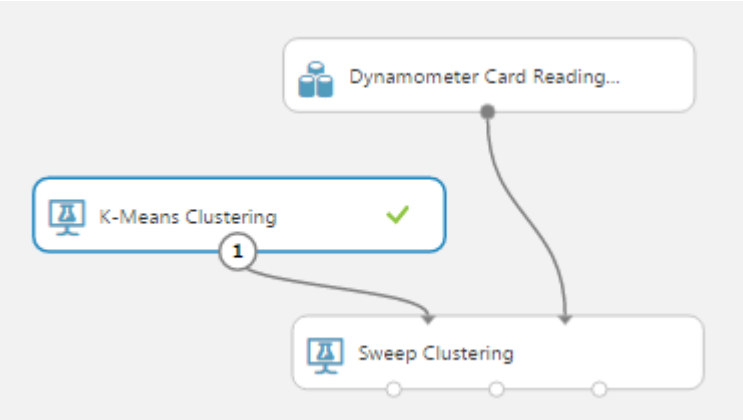
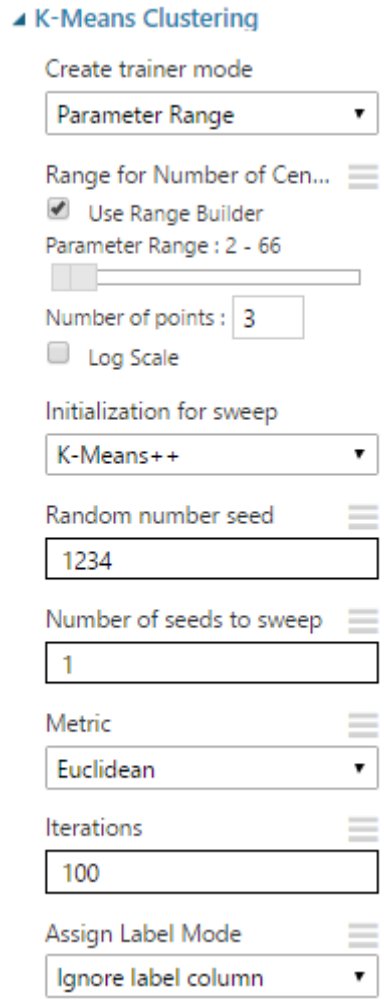
Step 5.5: Q? How to develop the Machine Learning Algorithm?



- Machine Learning
  - Initialize parameters for K-Means Clustering algorithm
  - Click on “K-Means Clustering” module on your canvas, and make sure it has a blue outline
  - A properties window will open on extreme right



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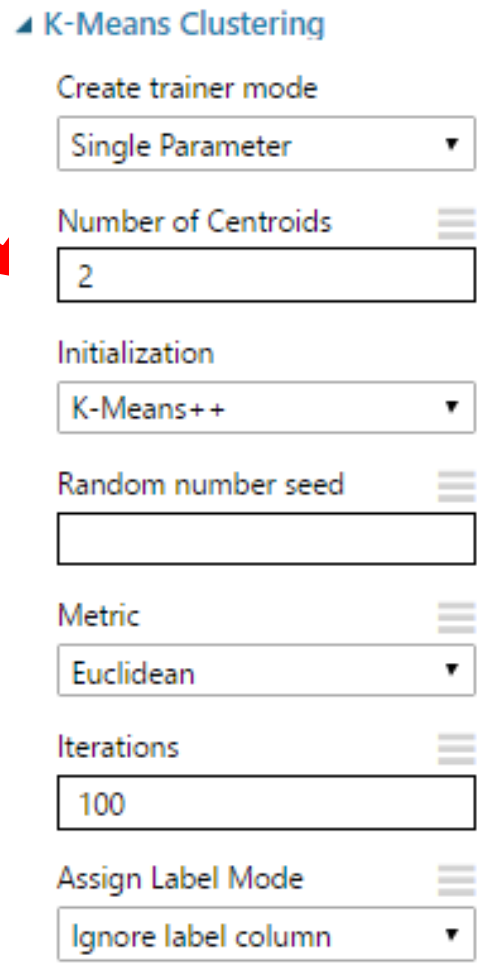
Step 5.6: Q? How to develop the Machine Learning Algorithm?

- Machine Learning
  - ~~Click on K-Means Module and a properties window will open on extreme right~~
  - Initialize parameters

Default Values



Number of Clusters needed

Initialization – Algorithm used for initial cluster configuration

Metric – Function used to measure distance between cluster vectors

Iterations – Number of times the allocation is retested

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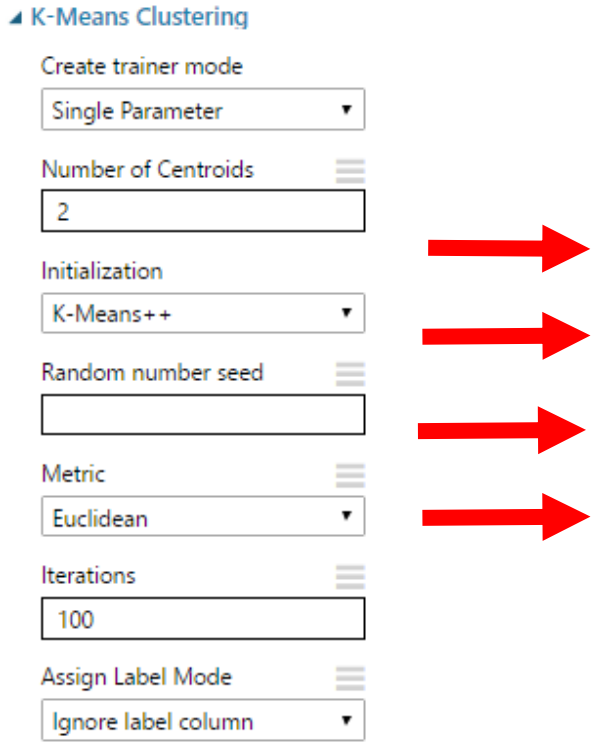
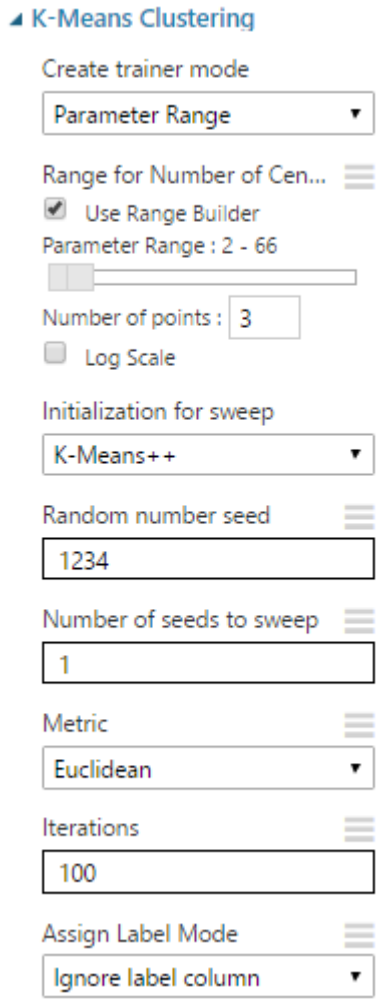
Step 5.7 : Q? How to develop the Machine Learning Algorithm



Assign Values



- Machine Learning
  - ~~Click on K-Means Module and a properties window will open on extreme right~~
  - Initialize parameters

Starting with 4 Clusters and rest as default options.

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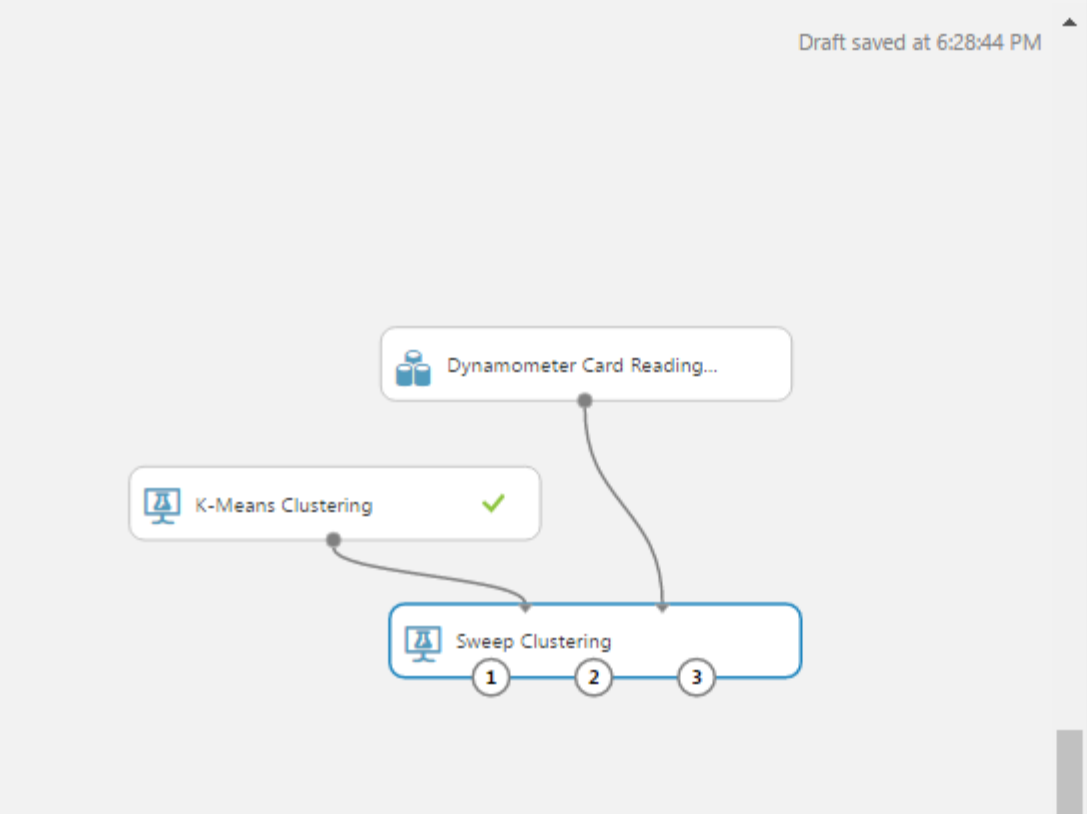
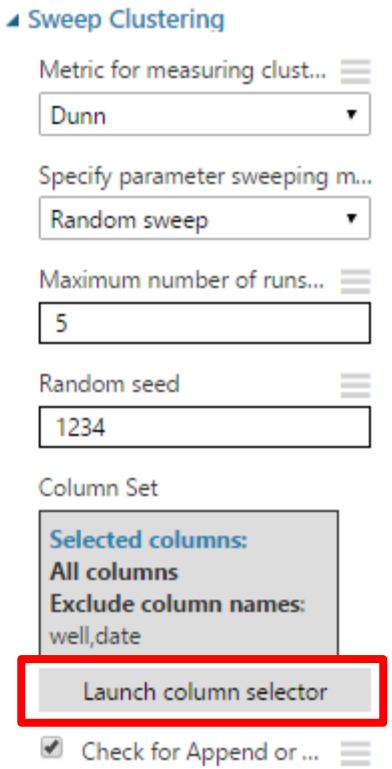
Step 5.8 : Q? How to develop the Machine Learning Algorithm





- Machine Learning
  - Click on Sweep Cluster
  - Set Metric for measuring clustering to “Dunn”
  - Set the Random seed to “1234”
  - Then click on “Launch column selector”

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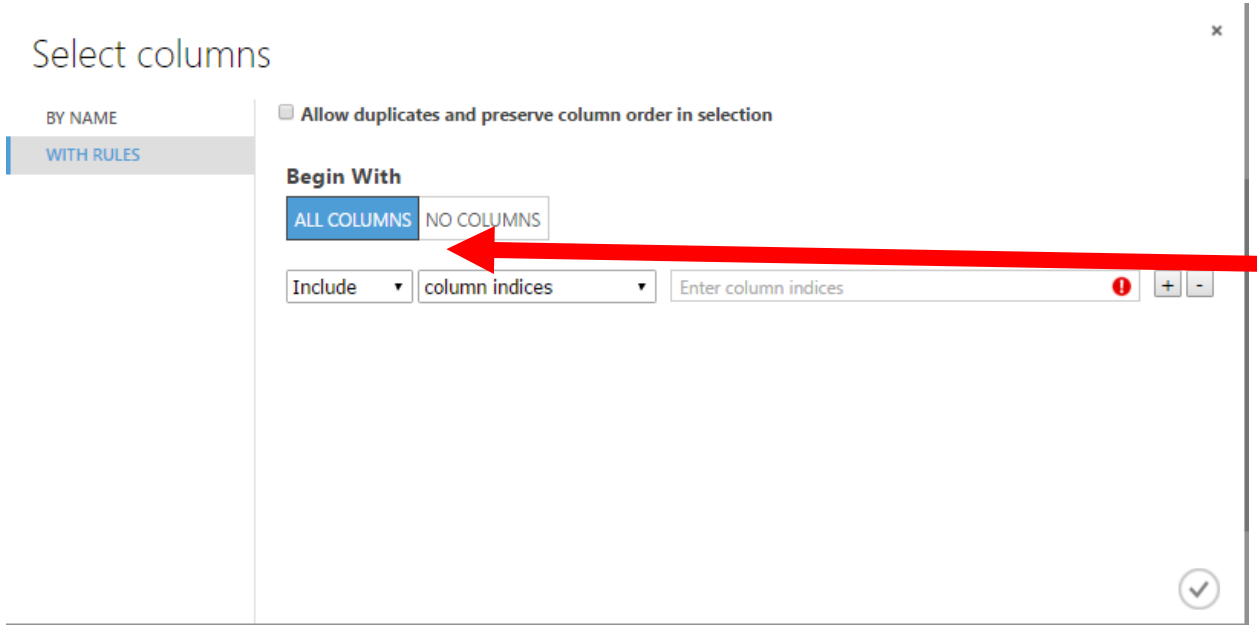
Step 5.9 : Q? How to develop the Machine Learning Algorithm



- Machine Learning
  - Select “With Rules”
  - Select “All Columns” from list ***Begin with***

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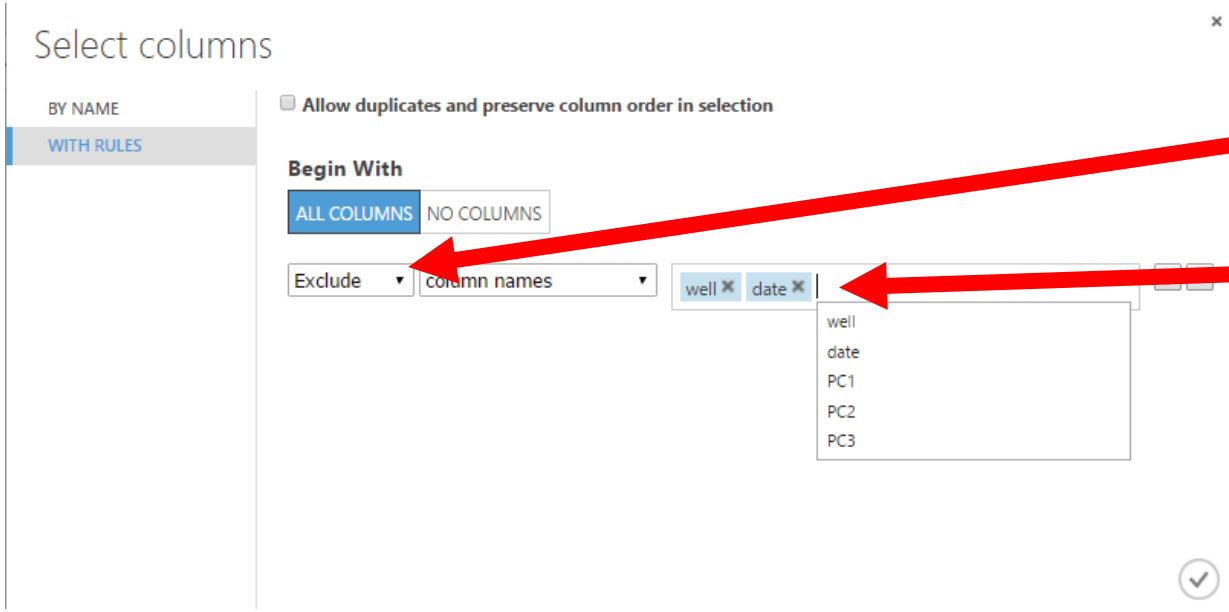
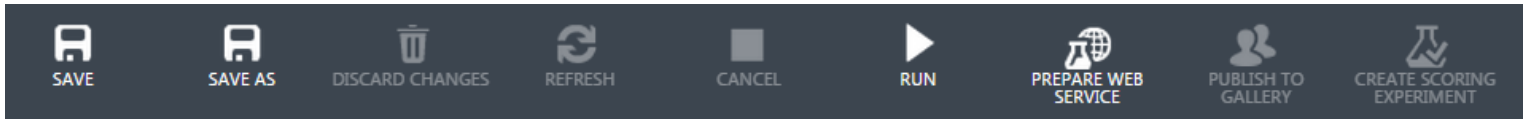
Step 5.10 : Q? How to develop the Machine Learning Algorithm



- Machine Learning
  - Select Exclude from the dropdown
  - Chose the following columns:
    - well
    - date
  - Then click on Check sign to close window
  - Click “Run”



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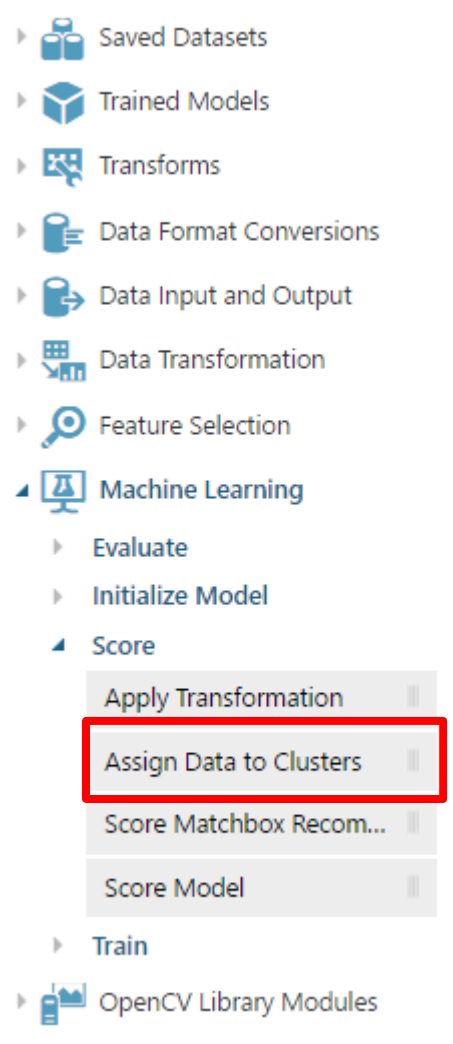
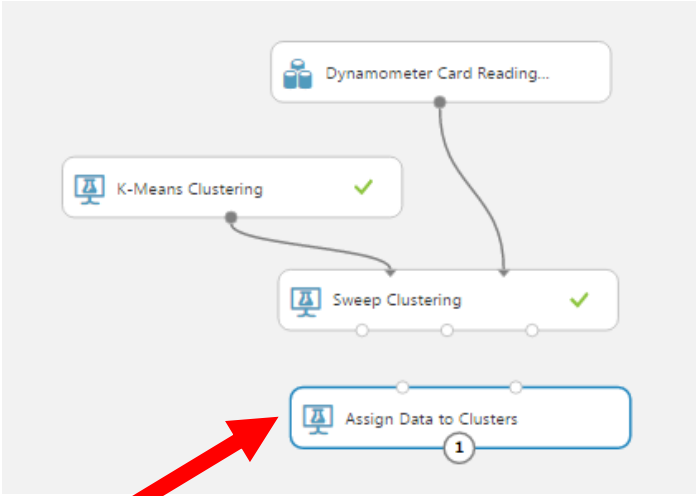
Step 5.11 : Q? How to develop the Machine Learning Algorithm?





- Open “Machine Learning” and then “Score” from the navigation pane at the left
- Drag “Assign Data to Clusters” module to the canvas
  - “Assign Data to Clusters” assigns data to clusters using an existing trained clustering model

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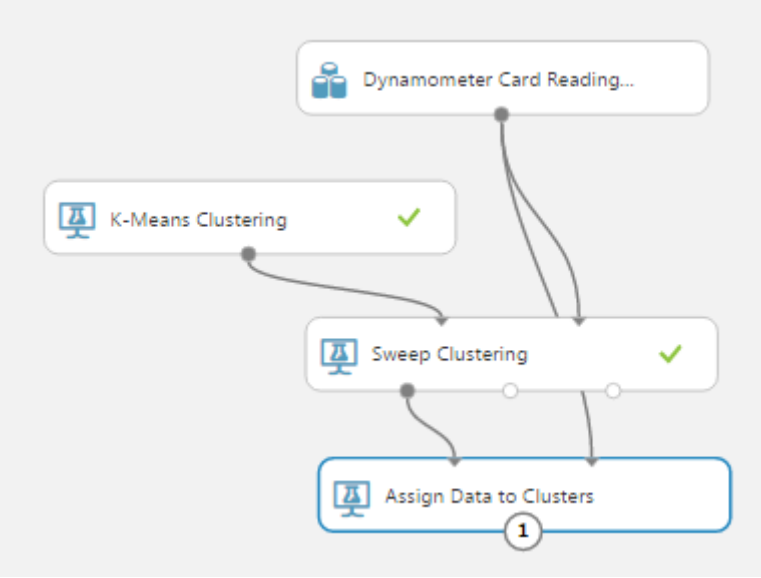
Step 5.12 : Q? How to develop the Machine Learning Algorithm?



- Next, click and hold on the bottom left circle of your “Sweep Clustering” module and drag the line to the top left circle of the “Assign Data to Clusters” module.
- Similarly, click and hold on the bottom middle circle of your “Dataset” module and drag the line to the top right circle of the “Assign Data to Clusters” module.

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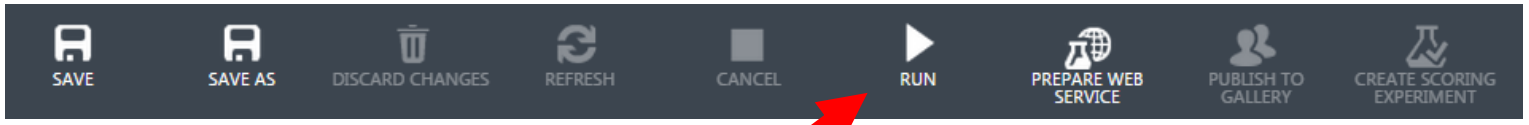
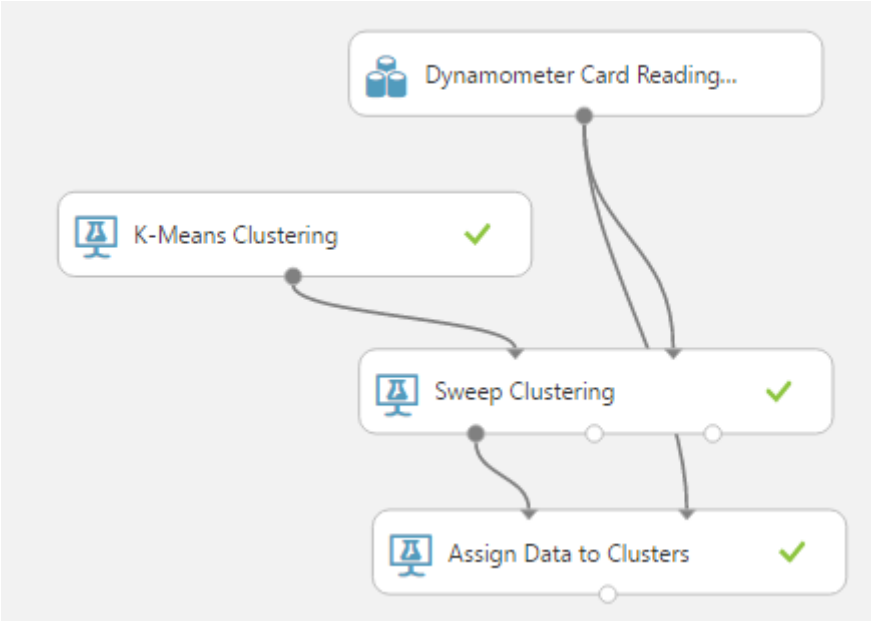
Step 5.13 : Run the Experiment



Click “Run”



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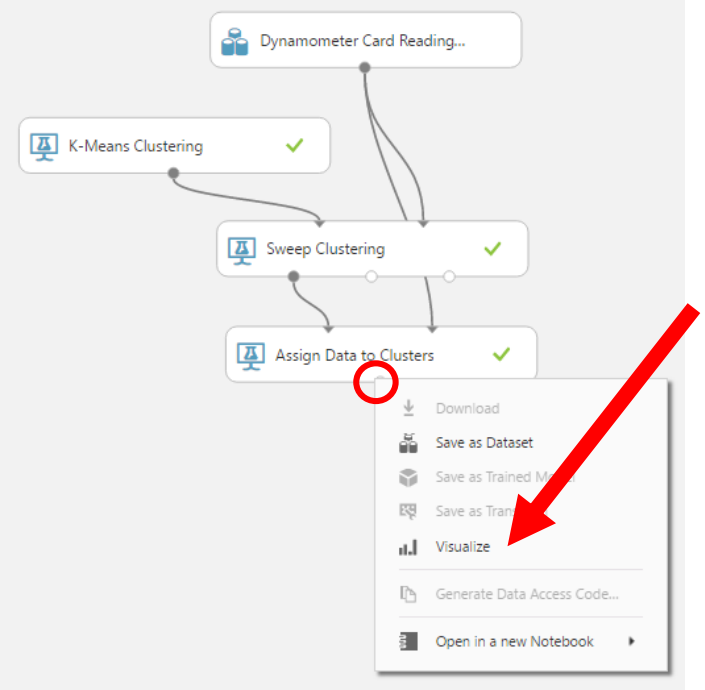
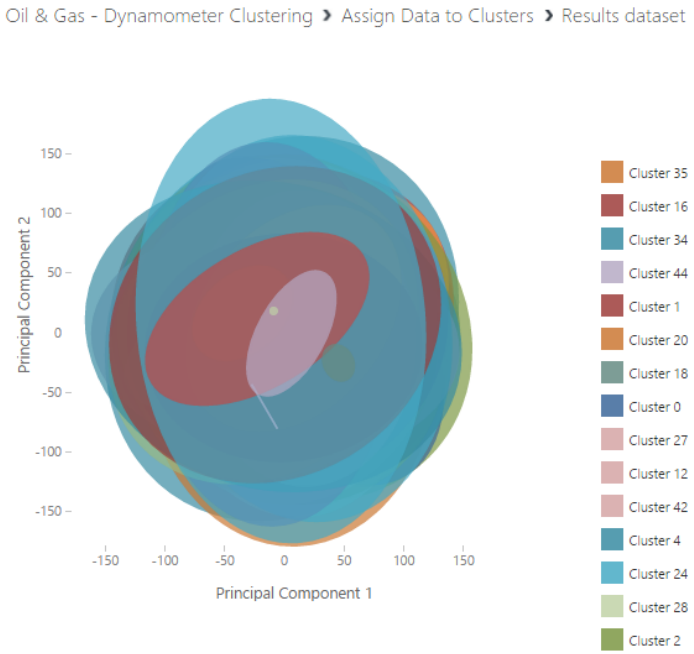
Step 5.14 : Visualize the Results



- The Clustering algorithm has assigned a cluster across each item given by variable “Assignments”
- Right click on the bottom-middle circle of “Assign Data to Clusters” module and select “Visualize”



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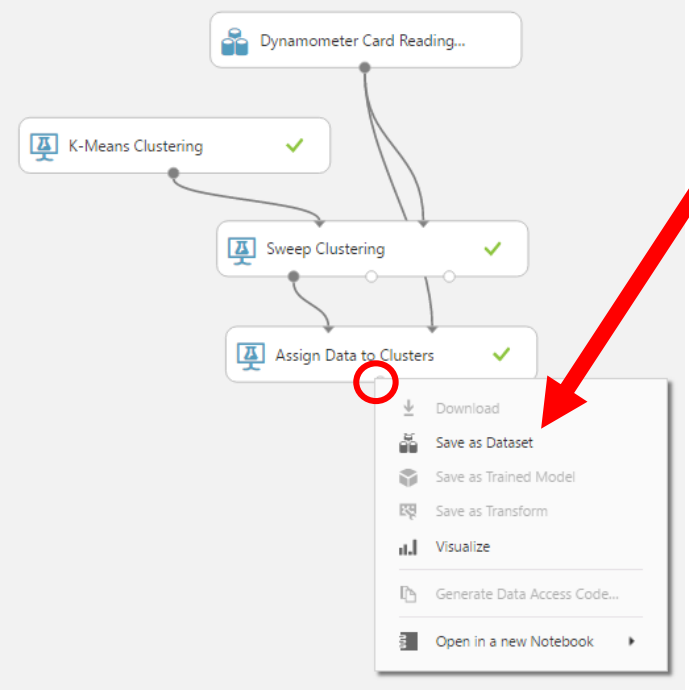
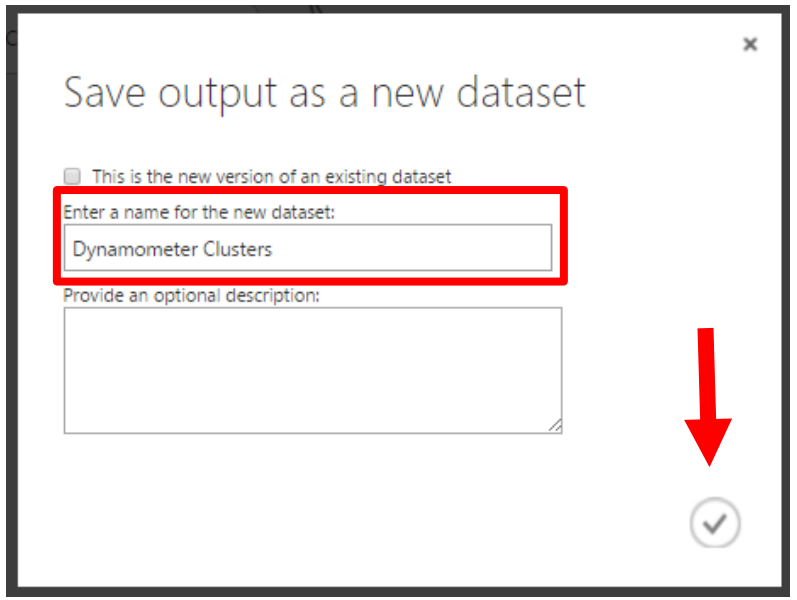
Step 5.15 : Save the Result as a Dataset



- Right click on the bottom-middle circle of “Assign Data to Clusters” module and select “Save as Dataset”
- A pop-up will appear. Call the new dataset “Dynamometer Clusters”
- Click on the check mark



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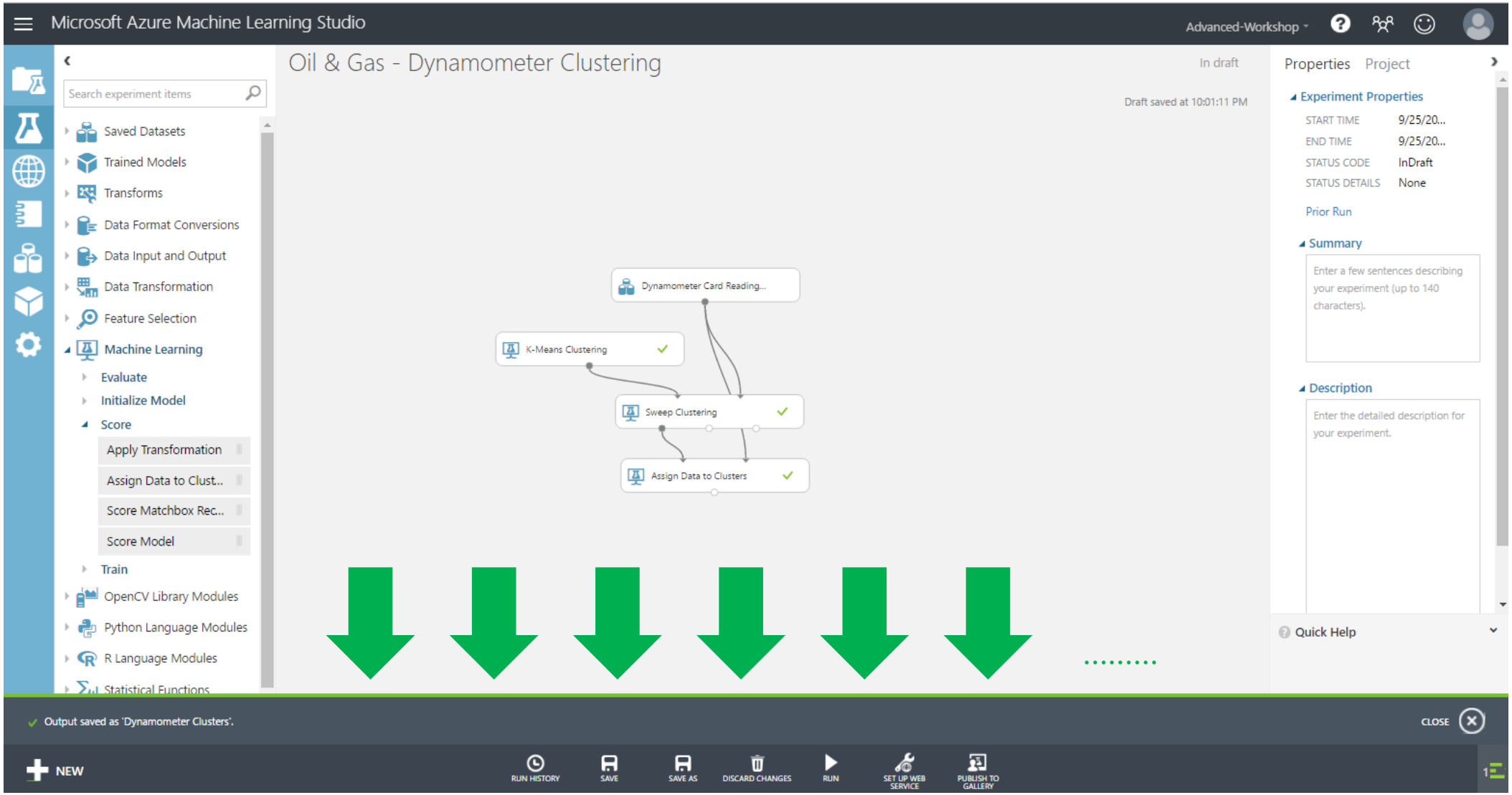
Step 5.16 : Save the Result as a Dataset



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