Big Data Assignment-5

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Part-a

1.

Azure data lake- It is the landing zone for all types of raw data (structured, semi structured, unstructured). It can also be used as our primary storage for all the required data.

Azure Databricks- It is databricks hosted on the azure cloud. It uses spark cluster to transform data in the form of RDDs and data frames.

Azure data factory- is used to transfer data from one service to another or one location to another with the help of linked services.

Azure synapse analytics- is a unified data warehouse platform built on top of azure data lake which takes care of ingestion of data and the analysis of it with the help of SQL or Spark engine.

Azure cosmos db- is a no-SQL data warehouse that is globally distributed and has very low latency.

Ingest data- azure data factory, azure synapse analytics

Data store- azure data lake, Azure cosmos db (noSQL data)

Prepare and transform data- azure databricks, azure synapse analytics

Model and serve data- azure cosmos db, azure synapse analytics

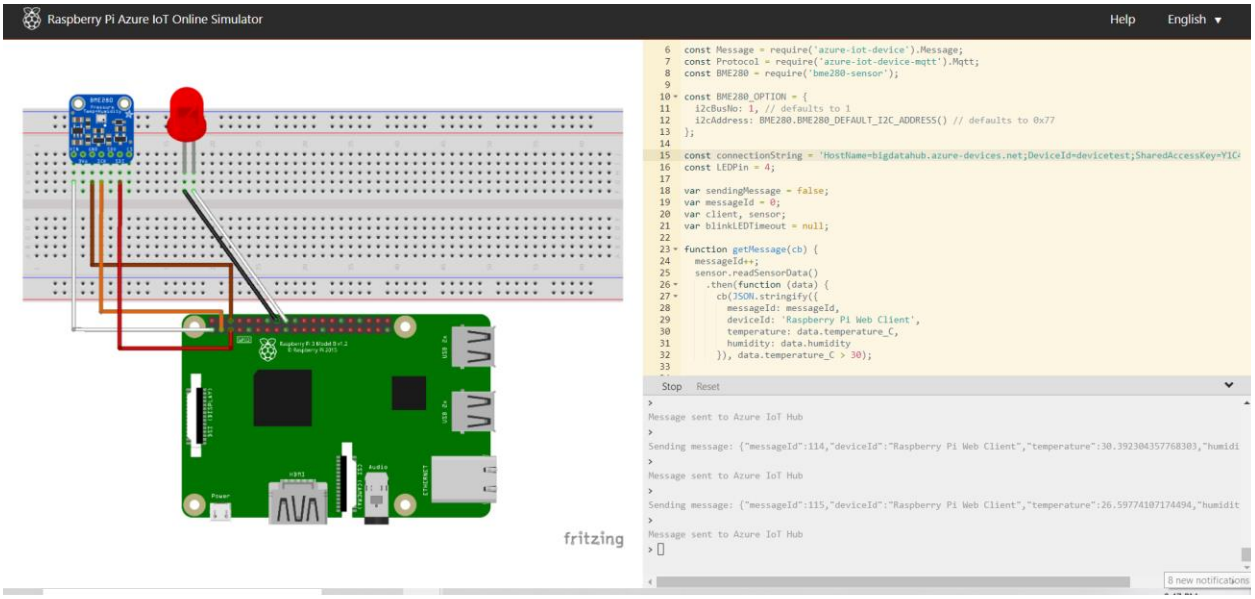
2.

Azure stream analytics has three major steps-

1. Ingest/ input
2. processed
3. Store/ output

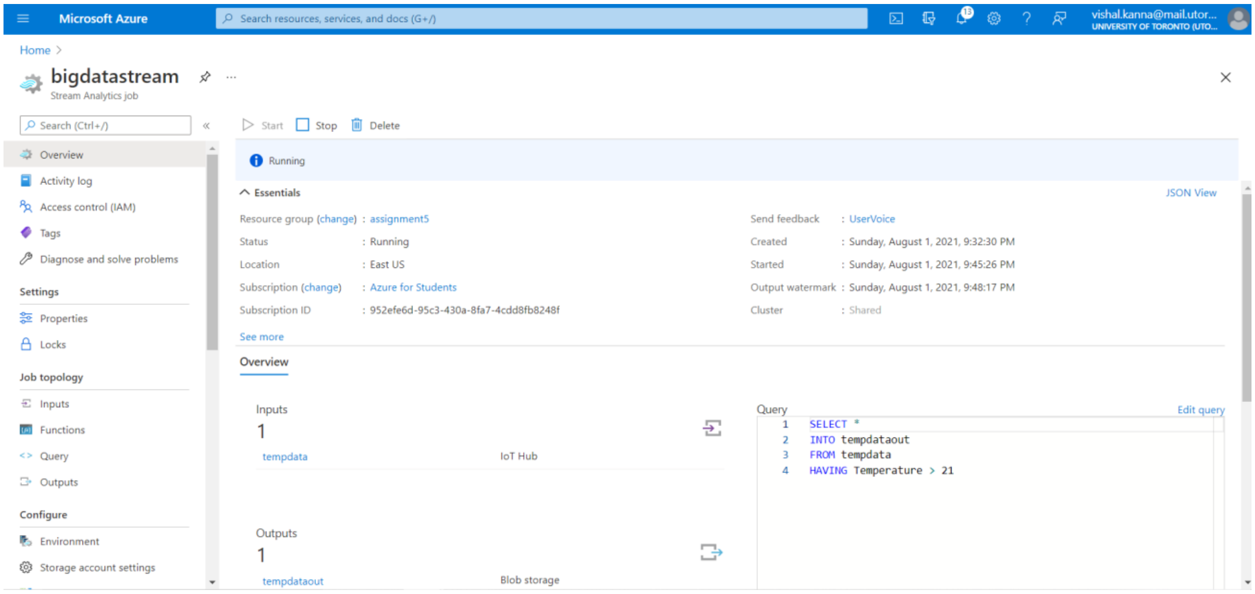
In the first step stream analytics ingests data with the help azure event hubs, azure iot hub, and azure blob storage in a continuous manner. This data is then processed; this can be simple SQL queries or more complex ML services. This processed data might have several types of outputs; it might be in the form of alerts/ actions which will be sent to azure functions, service bus, event hub. It may be used for real time dashboarding; then the data is sent to power BI. The prcessed data may also be stored in a warehouse or normal storage such as data lake or cosmos db.

3.



```
const Message = require('azure-iot-device').Message;
const Protocol = require('azure-iot-device-mqtt').Mqtt;
const BME280 = require('bme280-sensor');

const BME280_OPTION = {
  i2cBusNo: 1, // defaults to 1
  i2cAddress: BME280.BME280_DEFAULT_I2C_ADDRESS() // defaults to 0x77
};

const connectionString = 'HostName=bigdatahub.azure-devices.net;DeviceId=devicetest;SharedAccessKey=Y1C
const LEDPin = 4;

var sendingMessage = false;
var messageId = 0;
var client, sensor;
var blinkLEDTimeout = null;

function getMessage(cb) {
  messageId++;
  sensor.readSensorData()
    .then(function (data) {
      cb(JSON.stringify({
        messageId: messageId,
        deviceId: 'Raspberry Pi Web Client',
        temperature: data.temperature_C,
        humidity: data.humidity
      }), data.temperature_C > 30);

```

```
>
Message sent to Azure IoT Hub
>
Sending message: {"messageId":114,"deviceId":"Raspberry Pi Web Client","temperature":30.392304357768303,"humidi
>
Message sent to Azure IoT Hub
>
Sending message: {"messageId":115,"deviceId":"Raspberry Pi Web Client","temperature":26.59774107174494,"humidit
>
Message sent to Azure IoT Hub
>
```



Resource group (change) : assignment5
Status : Running
Location : East US
Subscription (change) : Azure for Students
Subscription ID : 952efe6d-95c3-430a-8fa7-4cdd8fb8248f

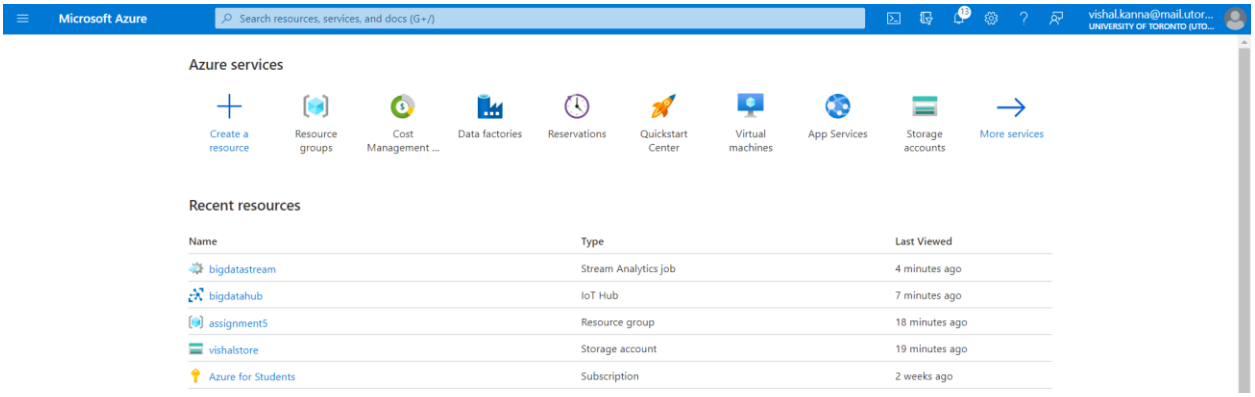
Send feedback : UserVoice
Created : Sunday, August 1, 2021, 9:32:30 PM
Started : Sunday, August 1, 2021, 9:45:26 PM
Output watermark : Sunday, August 1, 2021, 9:48:17 PM
Cluster : Shared

Inputs
1
tempdata IoT Hub

Outputs
1
tempdataout Blob storage

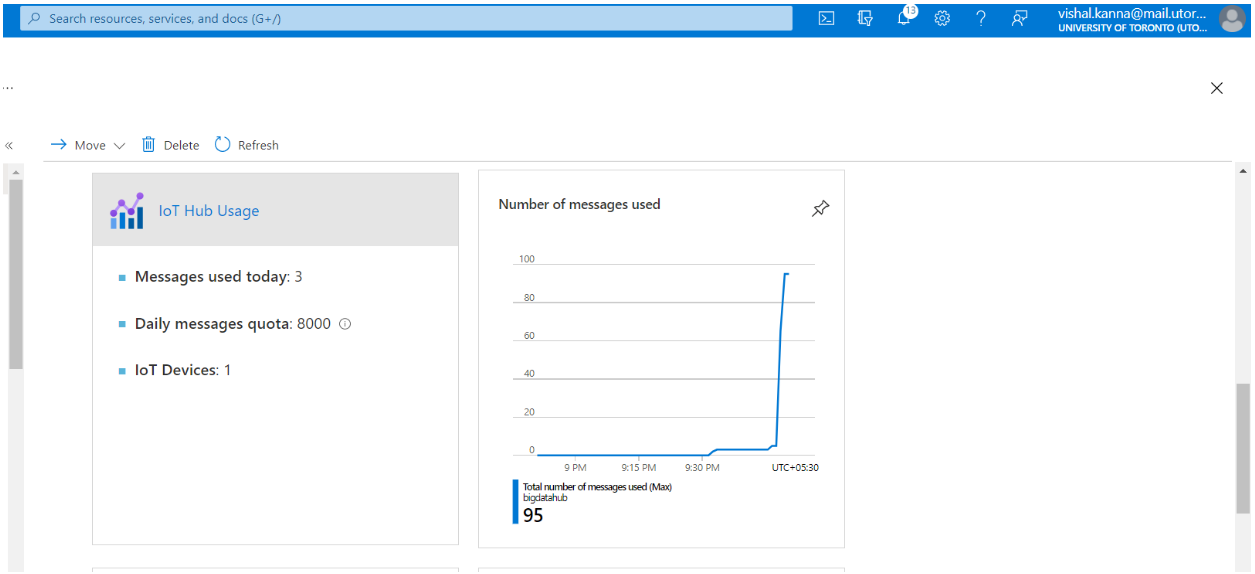
Query

```
SELECT *
INTO tempdataout
FROM tempdata
HAVING Temperature > 21
```



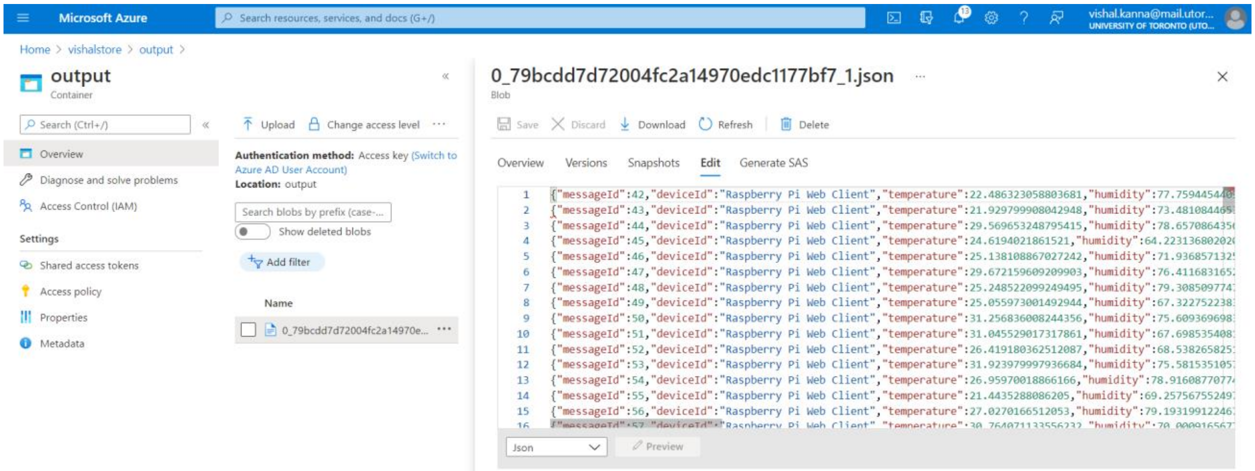
Recent resources

Name	Type	Last Viewed
bigdatastream	Stream Analytics job	4 minutes ago
bigdatahub	IoT Hub	7 minutes ago
assignment5	Resource group	18 minutes ago
vishalstore	Storage account	19 minutes ago
Azure for Students	Subscription	2 weeks ago


Search resources, services, and docs (G+/)
vishal.kanna@mail.utor...
UNIVERSITY OF TORONTO (UTO...
...
Move
Delete
Refresh
IoT Hub Usage

- Messages used today: 3
- Daily messages quota: 8000
- IoT Devices: 1

Number of messages used
100
80
60
40
20
0
9 PM
9:15 PM
9:30 PM
UTC+05:30
Total number of messages used (Max)
bigdatahub
95



Authentication method: Access key (Switch to Azure AD User Account)
Location: output

```
{"messageId":42,"deviceId":"Raspberry Pi Web Client","temperature":22.486323058803681,"humidity":77.7594454
{"messageId":43,"deviceId":"Raspberry Pi Web Client","temperature":21.929799908042948,"humidity":73.48108446
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{"messageId":47,"deviceId":"Raspberry Pi Web Client","temperature":29.672159609209903,"humidity":76.41168316
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{"messageId":51,"deviceId":"Raspberry Pi Web Client","temperature":31.045529017317861,"humidity":67.69853540
{"messageId":52,"deviceId":"Raspberry Pi Web Client","temperature":26.419180362512087,"humidity":68.53826582
{"messageId":53,"deviceId":"Raspberry Pi Web Client","temperature":31.923979997936684,"humidity":75.58153510
{"messageId":54,"deviceId":"Raspberry Pi Web Client","temperature":26.95970018866166,"humidity":78.91608770
{"messageId":55,"deviceId":"Raspberry Pi Web Client","temperature":21.4435288086205,"humidity":69.25756755
{"messageId":56,"deviceId":"Raspberry Pi Web Client","temperature":27.0270166512053,"humidity":79.19319912
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```

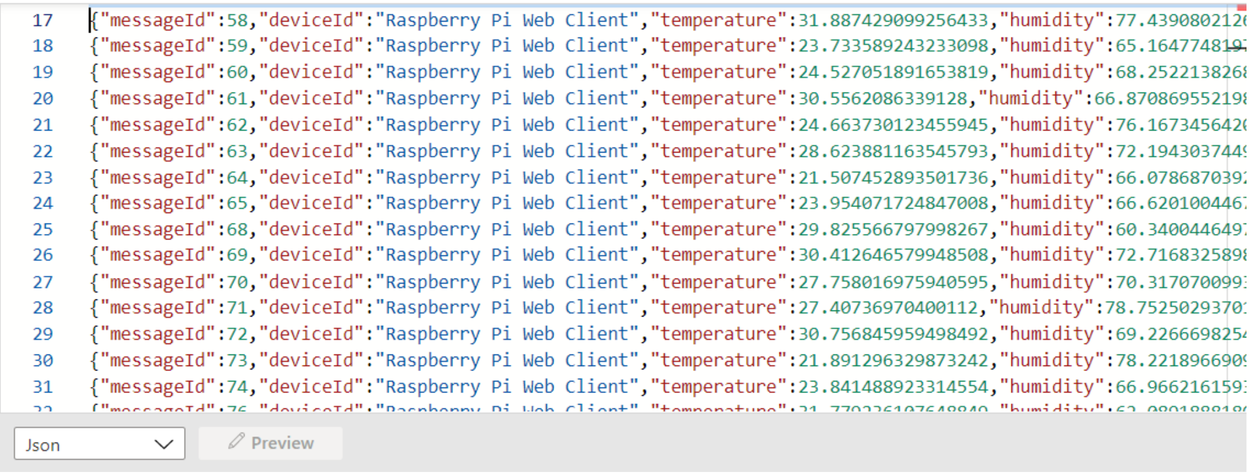

```
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{"messageId":59,"deviceId":"Raspberry Pi Web Client","temperature":23.733589243233098,"humidity":65.164774819
{"messageId":60,"deviceId":"Raspberry Pi Web Client","temperature":24.527051891653819,"humidity":68.252213826
{"messageId":61,"deviceId":"Raspberry Pi Web Client","temperature":30.5562086339128,"humidity":66.87086955219
{"messageId":62,"deviceId":"Raspberry Pi Web Client","temperature":24.663730123455945,"humidity":76.167345642
{"messageId":63,"deviceId":"Raspberry Pi Web Client","temperature":28.623881163545793,"humidity":72.194303744
{"messageId":64,"deviceId":"Raspberry Pi Web Client","temperature":21.507452893501736,"humidity":66.078687039
{"messageId":65,"deviceId":"Raspberry Pi Web Client","temperature":23.954071724847008,"humidity":66.620100446
{"messageId":68,"deviceId":"Raspberry Pi Web Client","temperature":29.825566797998267,"humidity":60.340044649
{"messageId":69,"deviceId":"Raspberry Pi Web Client","temperature":30.412646579948508,"humidity":72.716832589
{"messageId":70,"deviceId":"Raspberry Pi Web Client","temperature":27.758016975940595,"humidity":70.317070099
{"messageId":71,"deviceId":"Raspberry Pi Web Client","temperature":27.40736970400112,"humidity":78.7525029370
{"messageId":72,"deviceId":"Raspberry Pi Web Client","temperature":30.756845959498492,"humidity":69.226669825
{"messageId":73,"deviceId":"Raspberry Pi Web Client","temperature":21.891296329873242,"humidity":78.221896690
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```

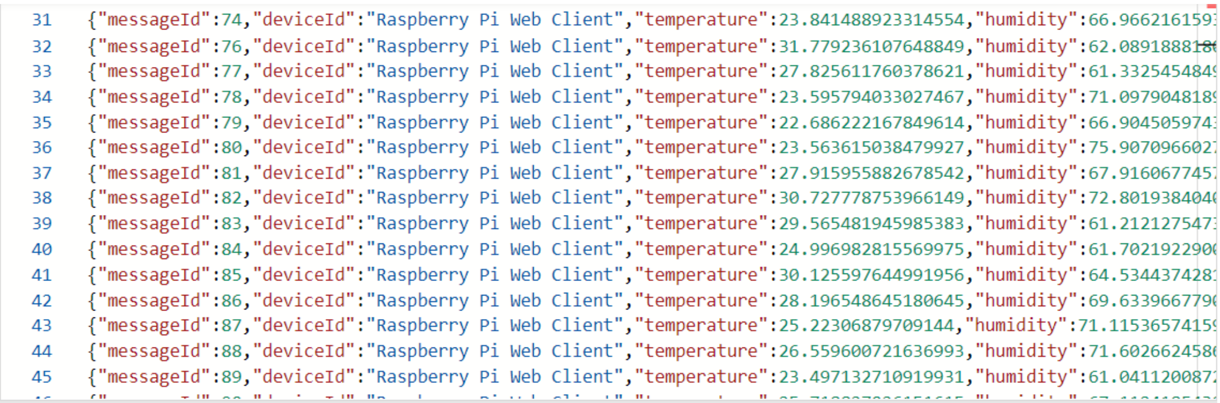

```
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{"messageId":80,"deviceId":"Raspberry Pi Web Client","temperature":23.563615038479927,"humidity":75.907096602
{"messageId":81,"deviceId":"Raspberry Pi Web Client","temperature":27.915955882678542,"humidity":67.916067745
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{"messageId":83,"deviceId":"Raspberry Pi Web Client","temperature":29.565481945985383,"humidity":61.212127547
{"messageId":84,"deviceId":"Raspberry Pi Web Client","temperature":24.996982815569975,"humidity":61.702192290
{"messageId":85,"deviceId":"Raspberry Pi Web Client","temperature":30.125597644991956,"humidity":64.534437428
{"messageId":86,"deviceId":"Raspberry Pi Web Client","temperature":28.196548645180645,"humidity":69.633966779
{"messageId":87,"deviceId":"Raspberry Pi Web Client","temperature":25.22306879709144,"humidity":71.1153657415
{"messageId":88,"deviceId":"Raspberry Pi Web Client","temperature":26.559600721636993,"humidity":71.602662458
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```

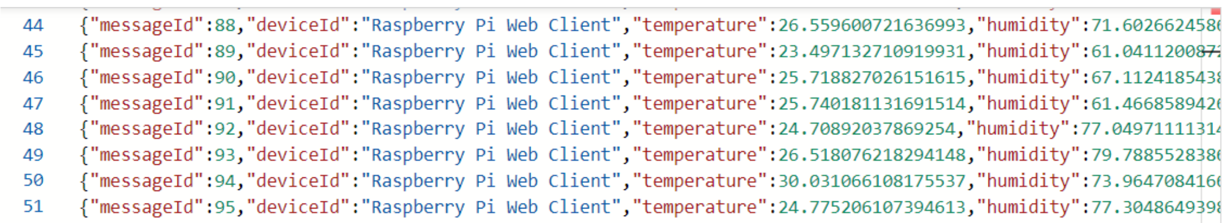

```
{"messageId":88,"deviceId":"Raspberry Pi Web Client","temperature":26.559600721636993,"humidity":71.602662458
{"messageId":89,"deviceId":"Raspberry Pi Web Client","temperature":23.497132710919931,"humidity":61.04112008
{"messageId":90,"deviceId":"Raspberry Pi Web Client","temperature":25.718827026151615,"humidity":67.112418543
{"messageId":91,"deviceId":"Raspberry Pi Web Client","temperature":25.740181131691514,"humidity":61.466858942
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{"messageId":94,"deviceId":"Raspberry Pi Web Client","temperature":30.031066108175537,"humidity":73.964708416
{"messageId":95,"deviceId":"Raspberry Pi Web Client","temperature":24.775206107394613,"humidity":77.304864939
```

ASSIGNMENT 5

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PART - B

1. **Explain what problem you are going to solve using this dataset. Provide a brief overview of your problem statement.**

   The dataset chosen is **Gait Classification Dataset**. The dataset was created by calculating the walking parameters of 16 different volunteers aged between 20 and 34 years old. A total of 321 attributes are present and out of which only 26 attributes have proper labels.

   Problem Statement: One of the gait attributes is gait variability. Gait variability is the fluctuation of gait measures between steps. Higher variability indicates the risk of falling or frailty or developing a neuro-degenerative disease and is more common in aged people. Lower variability indicates that a person is physically fit. Our target here is gait variability. We are trying to train a model to predict whether a person is prone to the risk of having a neuro degenerative disease or is physically fit with the help of the other gait attributes.

   Cleaning: The dataset has a large number of attributes with no proper labels and these attributes are removed.

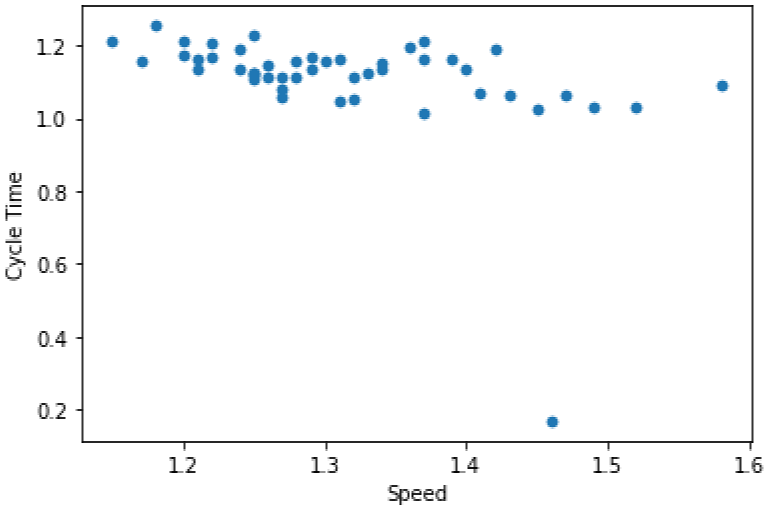
   Preprocessing: We have to map the variability feature to 1's and 0's as it will be our target feature for our models.

   Modelling: For the modelling, we chose two algorithms - Logistic Regression and Naive Bayes.

2. **Explain your dataset. Explore your dataset and provide at least 5 meaningful charts/graphs with explanation.**

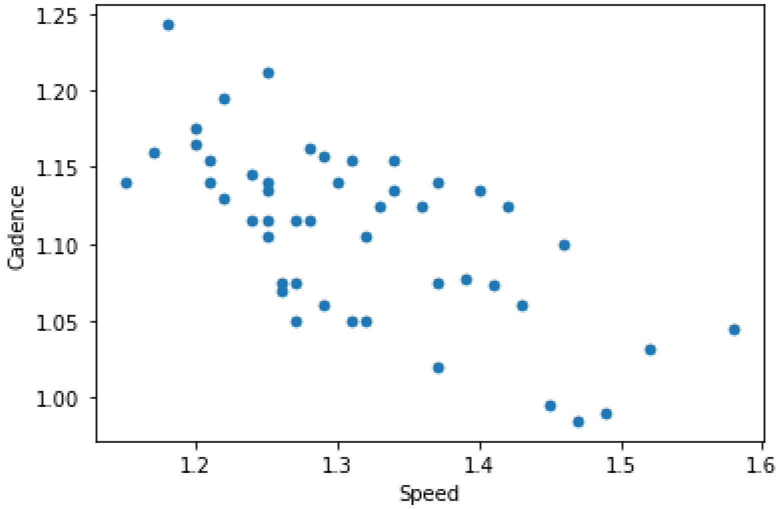
   1. **Cycle Time Vs Speed**

   Gait cycle time is the time interval between two successive occurrences of one of the repetitive events of the locomotion. Gait Speed is the time one takes to walk a specified distance. From the graph below, we could see that the cycle time remains almost equal for all the volunteers irrespective of the time taken by them to cover a specified distance.



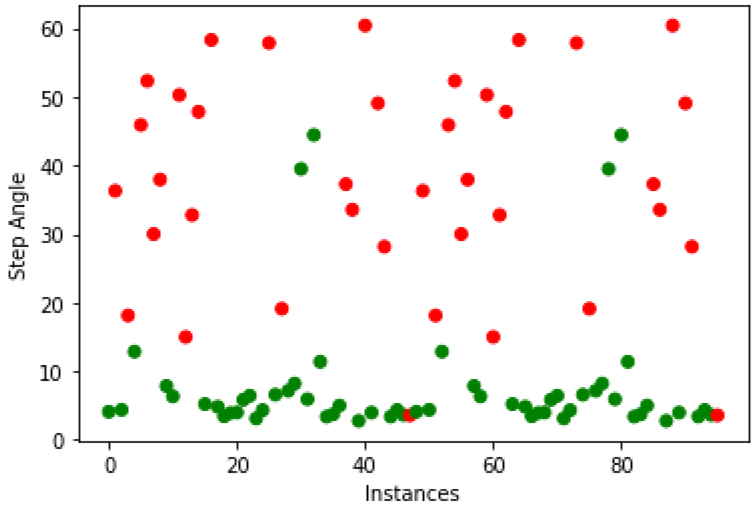
2. Speed Vs Cadence

Gait Cadence is the number of steps or cycles completed by a person in a specified period of time i.e., steps or cycles per minute. From the graph, it is evident that as the speed increases the number of steps taken to complete a specified distance decreases. The graph shows a linearly decreasing behaviour.



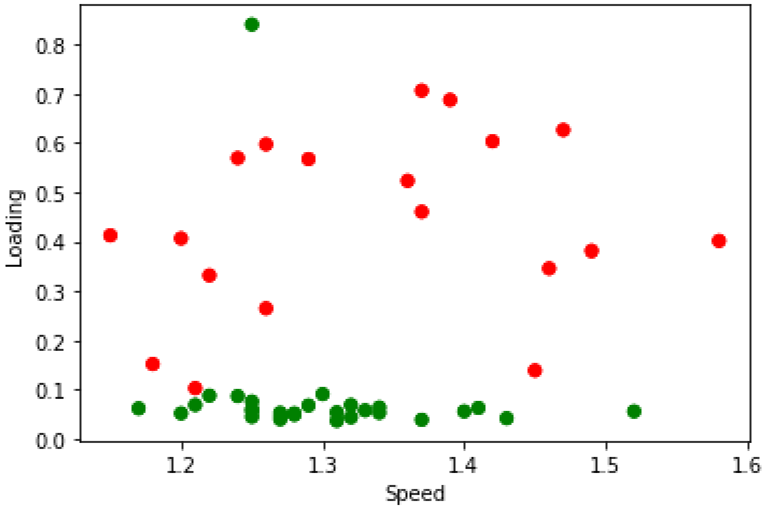
3. Step Angle Grouped by variability

The step angle captures the angular change (ie, rotation) in the sagittal plane of lower limbs during walking. From the graph below, it is evident that people without risks of neurodegenerative diseases have larger step angles (indicated by red) and those with the risks show smaller step angles (indicated by green).



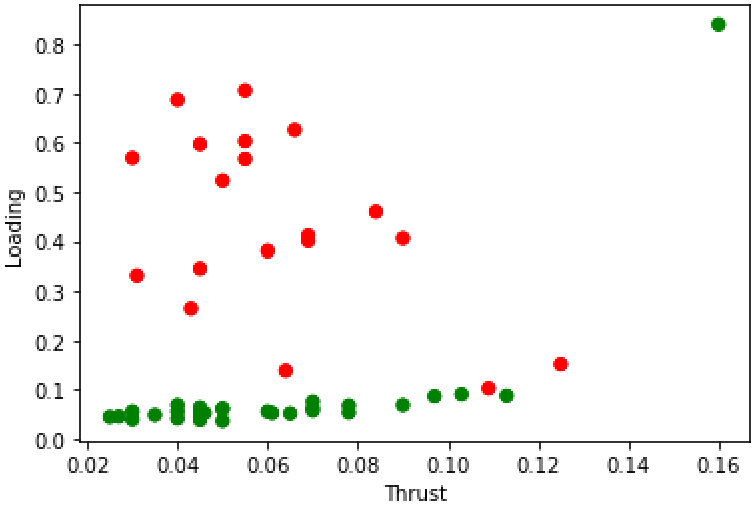
4. **Speed Vs Loading - Grouped by Variability**

Gait loading is the phase where the body absorbs the impact of the foot and the trunk of the body moves forward to align with the line of gravity. The graph shows that the loading is almost zero in people with the risks of developing the neurodegenerative diseases.



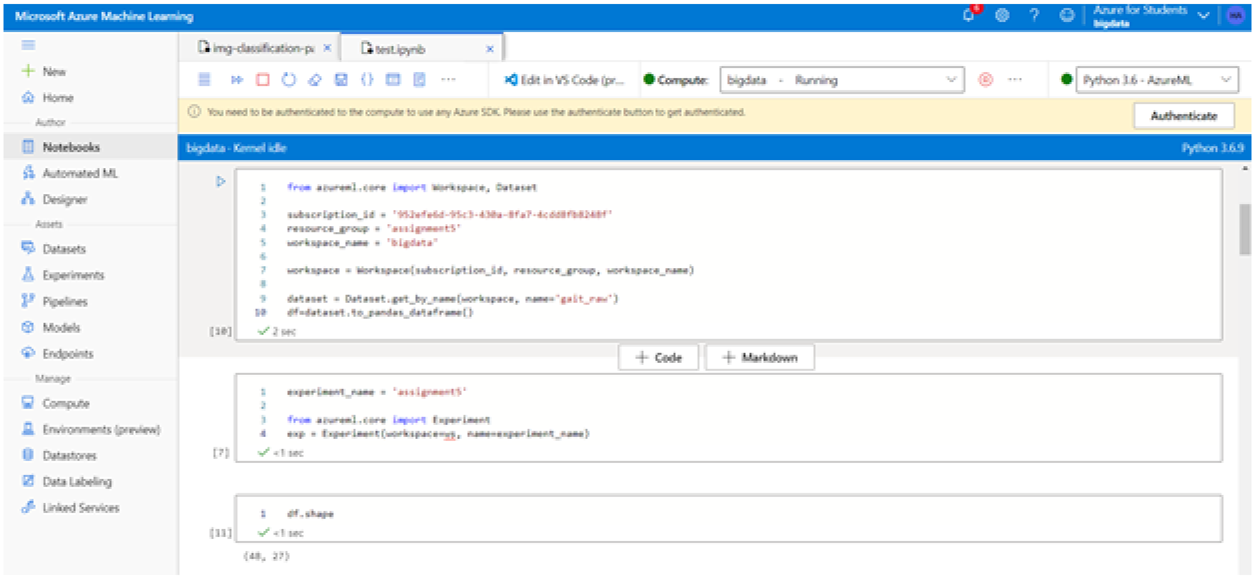
5. Thrust Vs Loading - Grouped by Variability

Like the previous graph, irrespective of the thrust, loading remains zero.



3. **Do data cleaning/pre-processing as required and explain what you have done for your dataset and why?**

Loading dataset into notebook and exploring



You need to be authenticated to the compute to use any Azure SDK. Please use the authenticate button to get authenticated.

```
from azureml.core import Workspace, Dataset

subscription_id = '952efe6d-95c3-430a-8fa7-4cdd8fb8248f'
resource_group = 'assignment5'
workspace_name = 'bigdata'

workspace = Workspace(subscription_id, resource_group, workspace_name)

dataset = Dataset.get_by_name(workspace, name='gait_raw')
df=dataset.to_pandas_dataframe()
```

[10] ✓ 2 sec

```
experiment_name = 'assignment5'

from azureml.core import Experiment
exp = Experiment(workspace=ws, name=experiment_name)
```

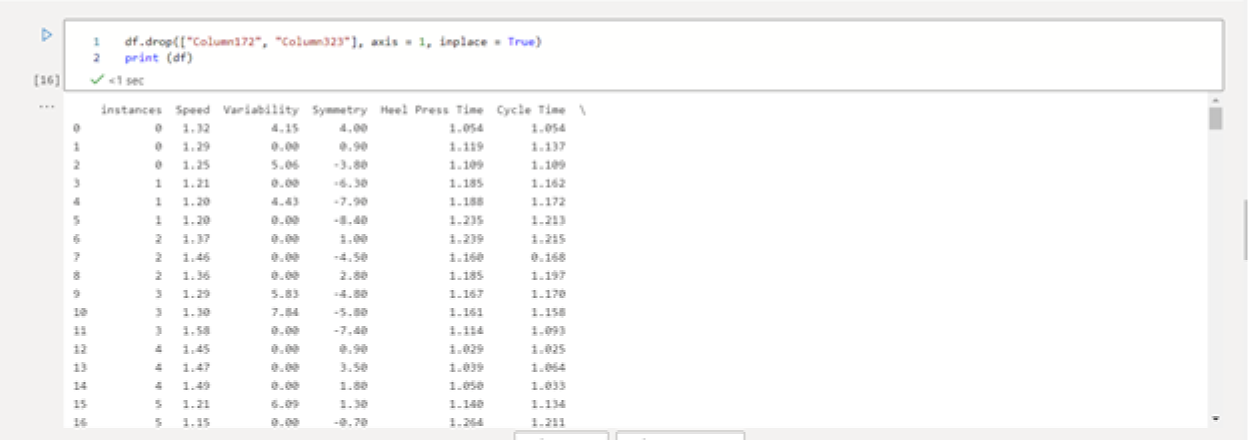
[7] ✓ <1 sec

```
df.shape
```

[11] ✓ <1 sec

```
(48, 27)
```

Removing unwanted columns- while we uploaded the file as dataset to azure ml service we removed most of the unlabeled columns but some still persisted. These columns were removed with the code below.

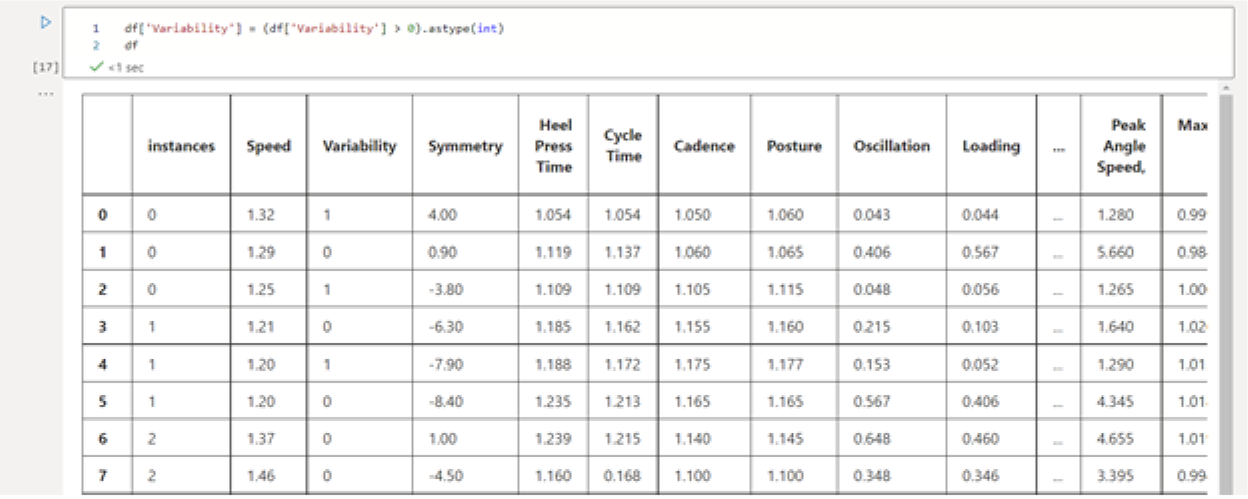


```
df.drop(["Column172", "Column323"], axis = 1, inplace = True)
print (df)
```

[16] ✓ <1 sec

```
    instances  Speed  Variability  Symmetry  Heel Press Time  Cycle Time  \
0           0   1.32         4.15      4.00            1.054       1.054
1           0   1.29         0.00      0.90            1.119       1.137
2           0   1.25         5.06     -3.80            1.109       1.109
3           1   1.21         0.00     -6.30            1.185       1.162
4           1   1.20         4.43     -7.90            1.188       1.172
5           1   1.20         0.00     -8.40            1.235       1.213
6           2   1.37         0.00      1.00            1.239       1.215
7           2   1.46         0.00     -4.50            1.160       0.168
8           2   1.36         0.00      2.80            1.185       1.197
9           3   1.29         5.83     -4.80            1.167       1.170
10          3   1.30         7.84     -5.80            1.161       1.158
11          3   1.58         0.00     -7.40            1.114       1.093
12          4   1.45         0.00      0.90            1.029       1.025
13          4   1.47         0.00      3.50            1.039       1.064
14          4   1.49         0.00      1.80            1.050       1.033
15          5   1.21         6.09      1.30            1.140       1.134
16          5   1.15         0.00     -0.70            1.264       1.211
```

Updating target column(Variability)- to 1 and 0 so that we can proceed to make a valid classification model. All the classification models the target feature needs to be distinct classes for the model to function properly.

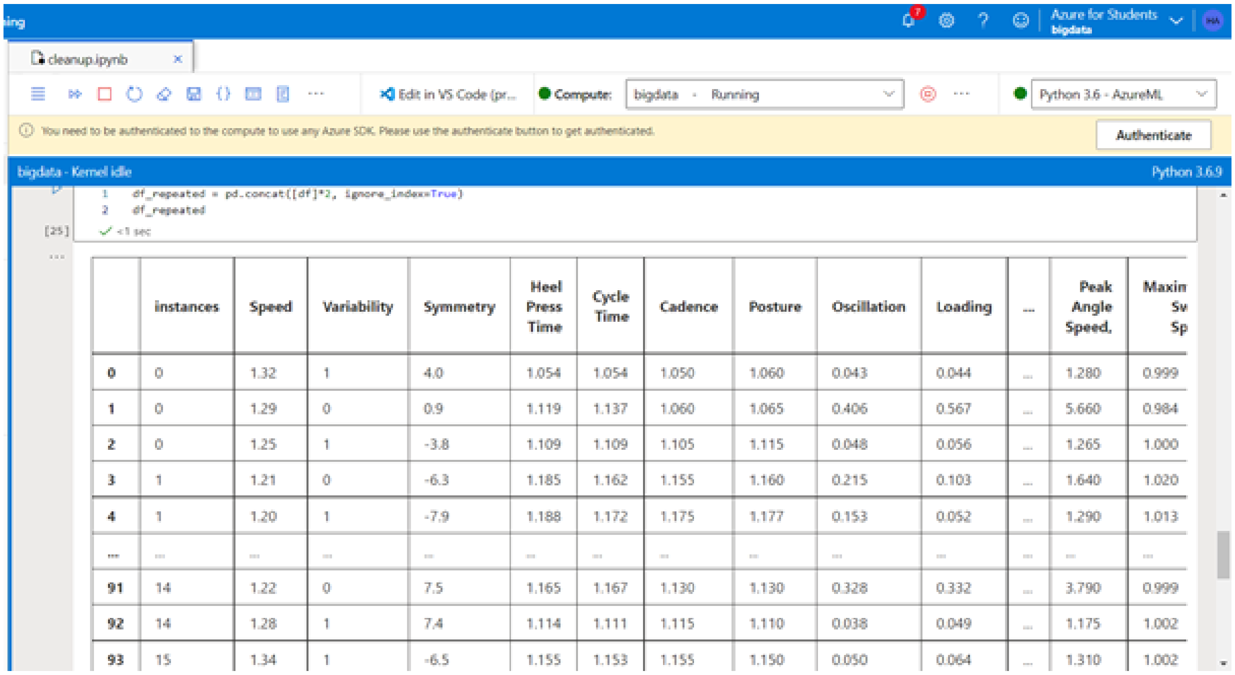


```
df['Variability'] = (df['Variability'] > 0).astype(int)
df
```

[17] ✓ <1 sec

	instances	Speed	Variability	Symmetry	Heel Press Time	Cycle Time	Cadence	Posture	Oscillation	Loading	...	Peak Angle Speed,	Max
0	0	1.32	1	4.00	1.054	1.054	1.050	1.060	0.043	0.044	...	1.280	0.99
1	0	1.29	0	0.90	1.119	1.137	1.060	1.065	0.406	0.567	...	5.660	0.98
2	0	1.25	1	-3.80	1.109	1.109	1.105	1.115	0.048	0.056	...	1.265	1.00
3	1	1.21	0	-6.30	1.185	1.162	1.155	1.160	0.215	0.103	...	1.640	1.02
4	1	1.20	1	-7.90	1.188	1.172	1.175	1.177	0.153	0.052	...	1.290	1.01
5	1	1.20	0	-8.40	1.235	1.213	1.165	1.165	0.567	0.406	...	4.345	1.01
6	2	1.37	0	1.00	1.239	1.215	1.140	1.145	0.648	0.460	...	4.655	1.01
7	2	1.46	0	-4.50	1.160	0.168	1.100	1.100	0.348	0.346	...	3.395	0.99

Replicating rows- to create more data for automated ml, as the process requires a minimum of 50 rows to run.



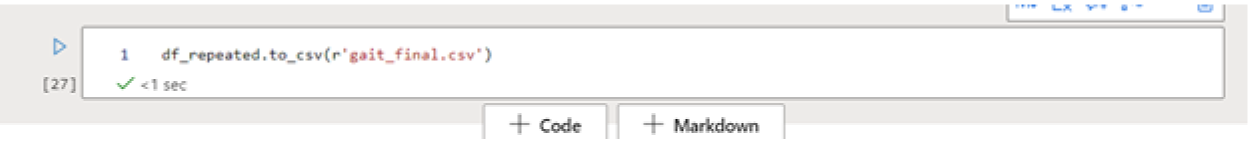
You need to be authenticated to the compute to use any Azure SDK. Please use the authenticate button to get authenticated.

```
[25]
df_repeated = pd.concat([df]*2, ignore_index=True)
df_repeated
```

✓ <1 sec

	instances	Speed	Variability	Symmetry	Heel Press Time	Cycle Time	Cadence	Posture	Oscillation	Loading	...	Peak Angle Speed,	Maxin Sv Sp
0	0	1.32	1	4.0	1.054	1.054	1.050	1.060	0.043	0.044	...	1.280	0.999
1	0	1.29	0	0.9	1.119	1.137	1.060	1.065	0.406	0.567	...	5.660	0.984
2	0	1.25	1	-3.8	1.109	1.109	1.105	1.115	0.048	0.056	...	1.265	1.000
3	1	1.21	0	-6.3	1.185	1.162	1.155	1.160	0.215	0.103	...	1.640	1.020
4	1	1.20	1	-7.9	1.188	1.172	1.175	1.177	0.153	0.052	...	1.290	1.013
...	...	...	...	...	...	...	...	...	...	...	...	...	...
91	14	1.22	0	7.5	1.165	1.167	1.130	1.130	0.328	0.332	...	3.790	0.999
92	14	1.28	1	7.4	1.114	1.111	1.115	1.110	0.038	0.049	...	1.175	1.002
93	15	1.34	1	-6.5	1.155	1.153	1.155	1.150	0.050	0.064	...	1.310	1.002

Saving cleaned and processed file-

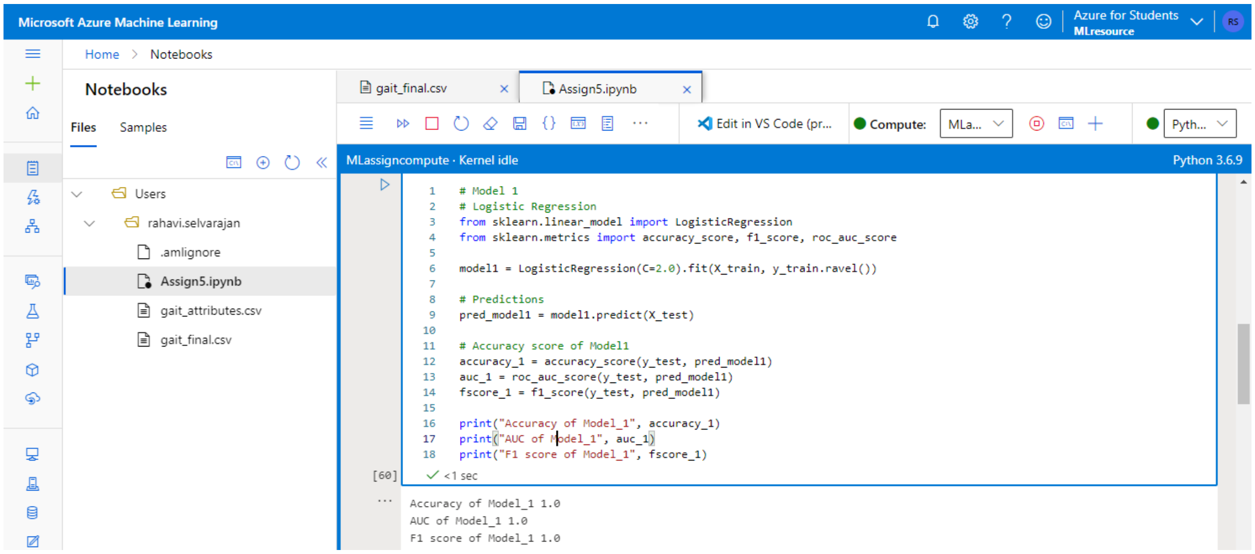


```
[27]
df_repeated.to_csv(r'gait_final.csv')
```

✓ <1 sec

4. **Implement 2 machine learning models, explain which algorithms you have selected and why. Compare them and show success metrics (Accuracy/RMSE/Confusion Matrix) as per your problem. Explain results.**

Model 1:
Algorithm: Logistic Regression
Regularization Parameter: 2.0
Reason for choosing Logistic Regression: Logistic Regression is the most common algorithm used for binary classification involving numerical values and is known to prevent overfitting.



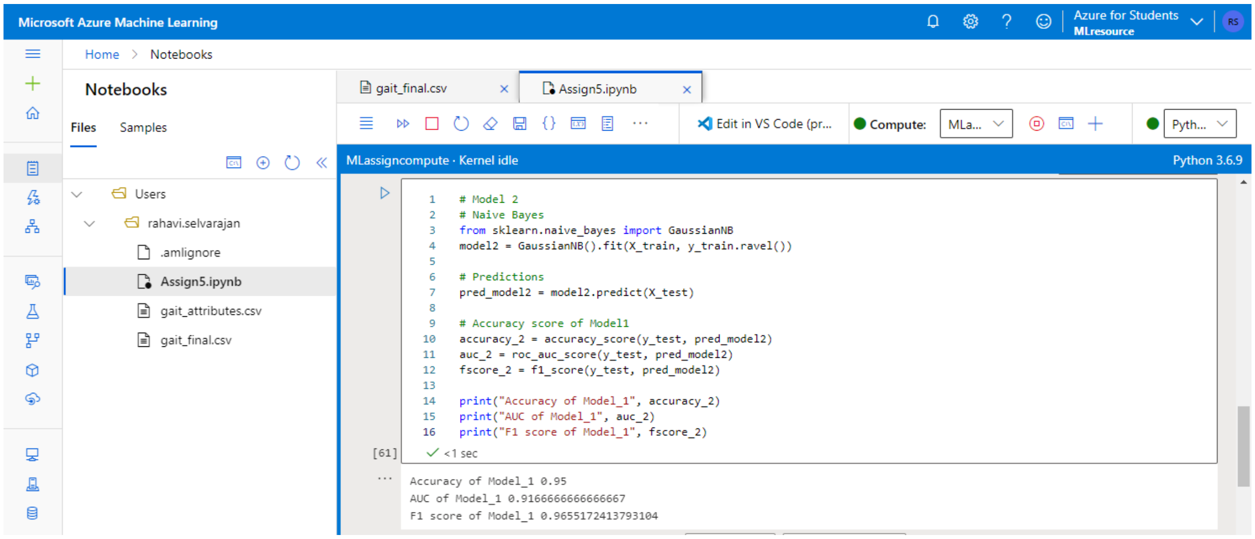
```
# Model 1
# Logistic Regression
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, f1_score, roc_auc_score

model1 = LogisticRegression(C=2.0).fit(X_train, y_train.ravel())

# Predictions
pred_model1 = model1.predict(X_test)

# Accuracy score of Model1
accuracy_1 = accuracy_score(y_test, pred_model1)
auc_1 = roc_auc_score(y_test, pred_model1)
fscore_1 = f1_score(y_test, pred_model1)

print("Accuracy of Model_1", accuracy_1)
print("AUC of Model_1", auc_1)
print("F1 score of Model_1", fscore_1)
```

```
Accuracy of Model_1 1.0
AUC of Model_1 1.0
F1 score of Model_1 1.0
```

Model 2:

Algorithm: Naive Bayes

Reason for choosing Naive Bayes: It is easy to implement and performs well in test dataset.



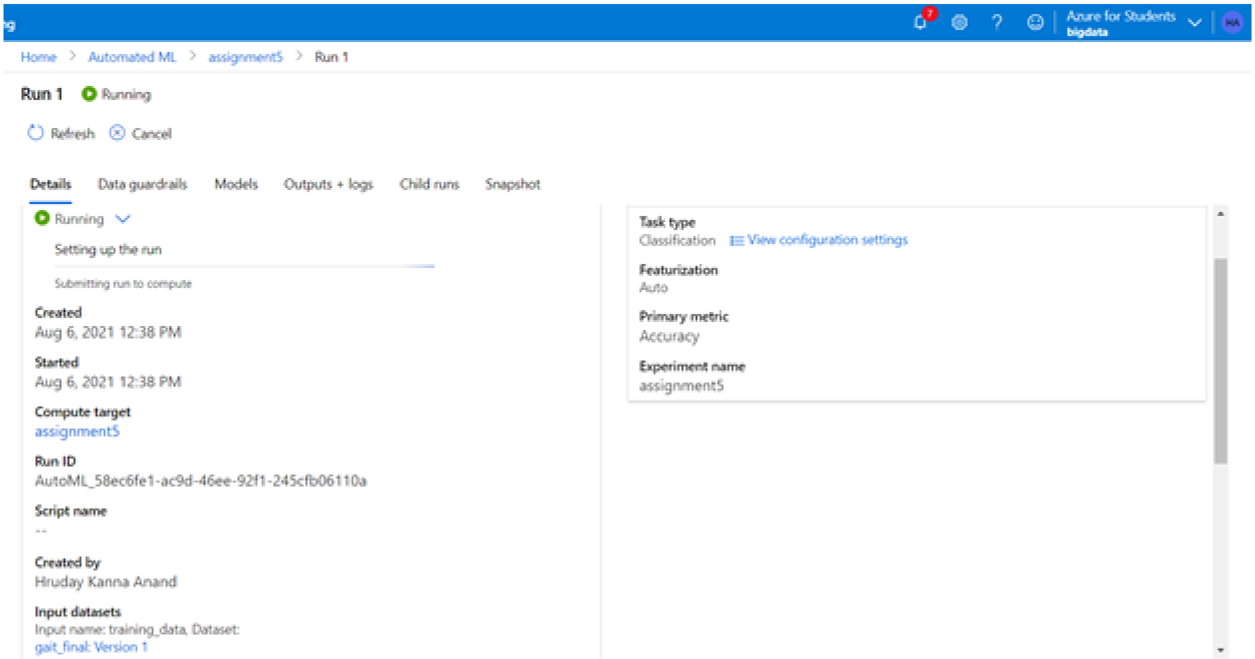
```
# Model 2
# Naive Bayes
from sklearn.naive_bayes import GaussianNB
model2 = GaussianNB().fit(X_train, y_train.ravel())

# Predictions
pred_model2 = model2.predict(X_test)

# Accuracy score of Model1
accuracy_2 = accuracy_score(y_test, pred_model2)
auc_2 = roc_auc_score(y_test, pred_model2)
fscore_2 = f1_score(y_test, pred_model2)

print("Accuracy of Model_1", accuracy_2)
print("AUC of Model_1", auc_2)
print("F1 score of Model_1", fscore_2)
```

```
Accuracy of Model_1 0.95
AUC of Model_1 0.9166666666666667
F1 score of Model_1 0.9655172413793104
```

From the above two models, Logistic Regression performs better compared to the Naive Bayes. The Accuracy, F1 score and AUC scores of the first model are better compared to the model 2 i.e, Naive Bayes. F1 score shows the accuracy of the test set and logistic regression shows better performance on the test set.

5. **Use Automated ML for your data set. Explain best model results.**

Automated ml run initiated-



Home > Automated ML > assignment5 > Run 1

Run 1 Running

Refresh Cancel

Details Data guardrails Models Outputs + logs Child runs Snapshot

Running

Setting up the run

Submitting run to compute

Created
Aug 6, 2021 12:38 PM

Started
Aug 6, 2021 12:38 PM

Compute target
assignment5

Run ID
AutoML_58ec6fe1-ac9d-46ee-92f1-245cfb06110a

Script name
--

Created by
Hruday Kanna Anand

Input datasets
Input name: training_data, Dataset:
gait_final: Version 1

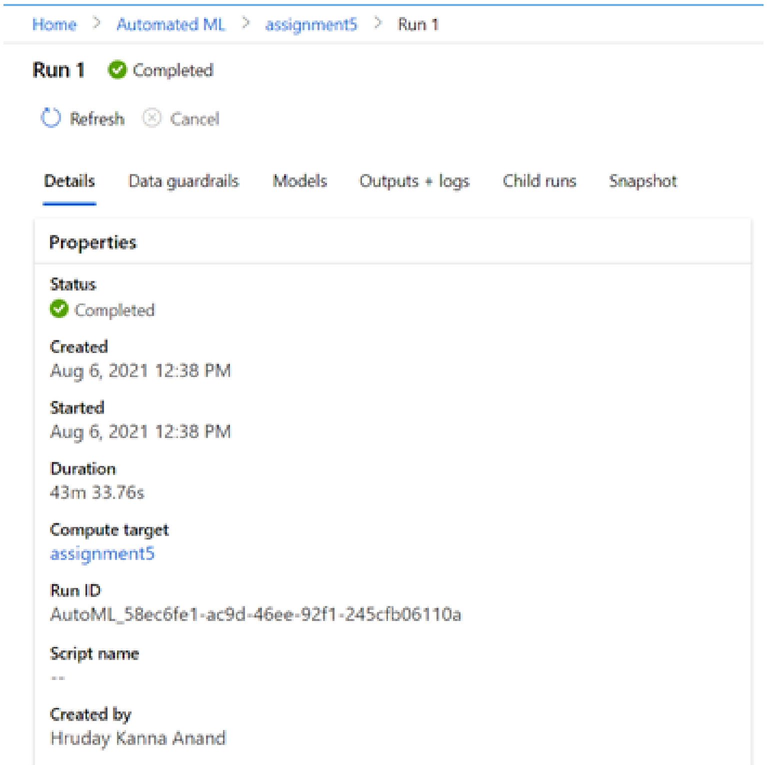
Task type
Classification View configuration settings

Featurization
Auto

Primary metric
Accuracy

Experiment name
assignment5

Automated run completed



Home > Automated ML > assignment5 > Run 1

Run 1 Completed

Refresh Cancel

Details Data guardrails Models Outputs + logs Child runs Snapshot

Properties

Status
Completed

Created
Aug 6, 2021 12:38 PM

Started
Aug 6, 2021 12:38 PM

Duration
43m 33.76s

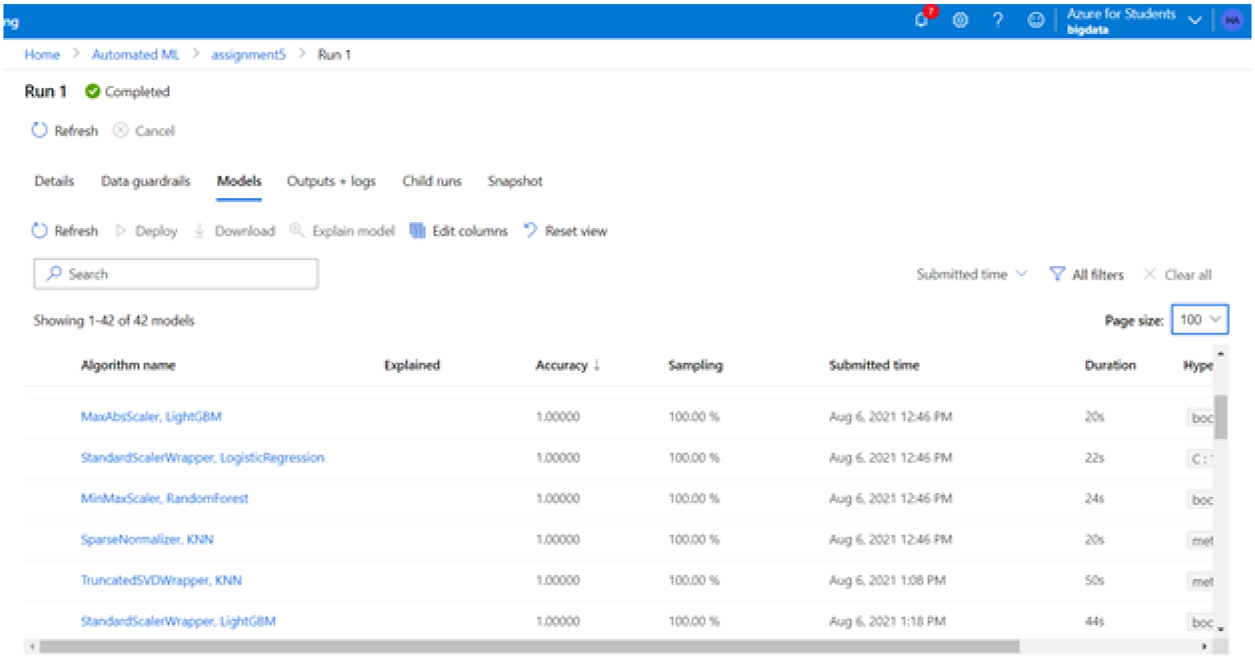
Compute target
assignment5

Run ID
AutoML_58ec6fe1-ac9d-46ee-92f1-245cfb06110a

Script name
--

Created by
Hruday Kanna Anand

Models-



Run 1 Completed

Showing 1-42 of 42 models

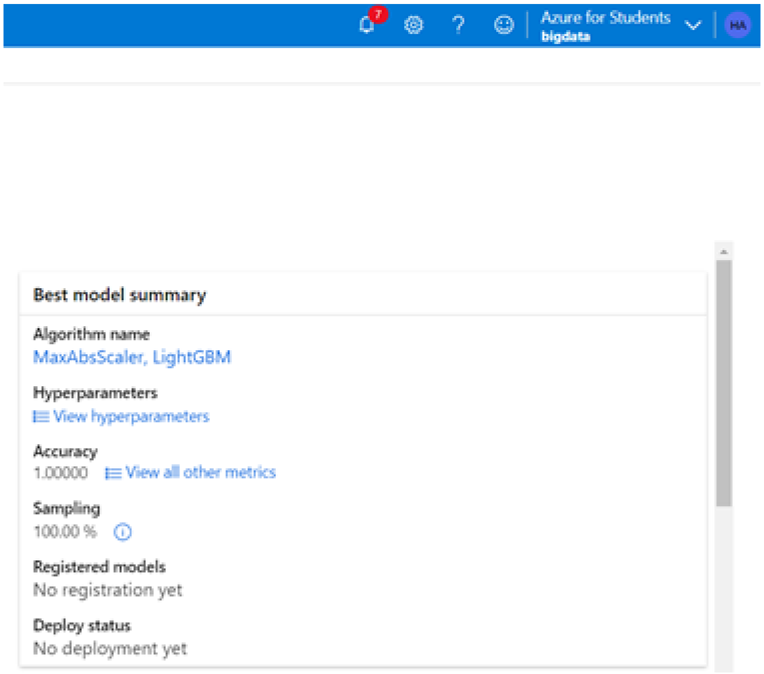
Page size: 100

Algorithm name	Explained	Accuracy ↓	Sampling	Submitted time	Duration	Hype
MaxAbsScaler, LightGBM		1.00000	100.00 %	Aug 6, 2021 12:46 PM	20s	boc
StandardScalerWrapper, LogisticRegression		1.00000	100.00 %	Aug 6, 2021 12:46 PM	22s	C :
MinMaxScaler, RandomForest		1.00000	100.00 %	Aug 6, 2021 12:46 PM	24s	boc
SparseNormalizer, KNN		1.00000	100.00 %	Aug 6, 2021 12:46 PM	20s	met
TruncatedSVDWrapper, KNN		1.00000	100.00 %	Aug 6, 2021 1:08 PM	50s	met
StandardScalerWrapper, LightGBM		1.00000	100.00 %	Aug 6, 2021 1:18 PM	44s	boc

We can see that 42 models have been made and trained and almost all of them have an accuracy of 1.

Best model-

The best model with Light GBM with max abs scaler. Light GBM is a gradient boosting framework that uses tree based learning algorithms. Max abs scaler is used to preprocess our features dividing our features by the maximum value to scale down the features to a common scale.



Best model summary

Algorithm name
MaxAbsScaler, LightGBM

Hyperparameters
View hyperparameters

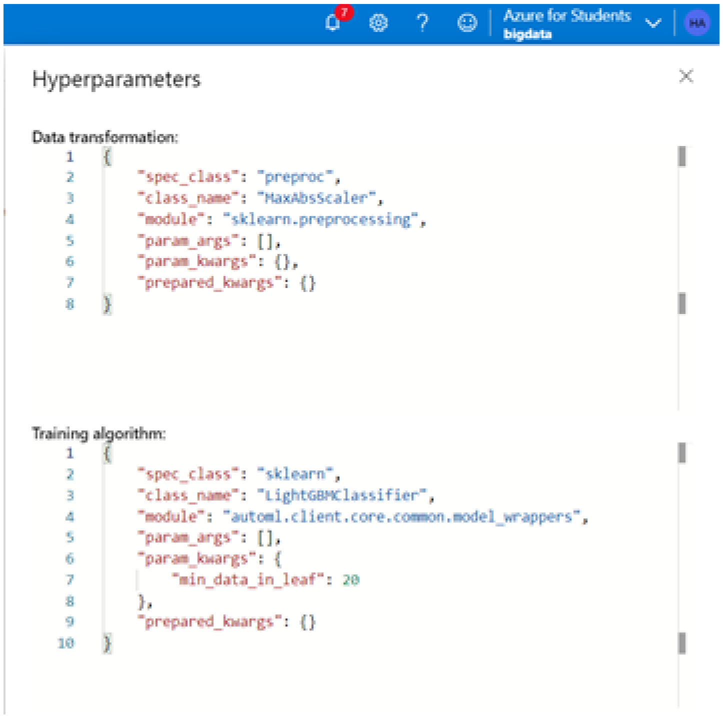
Accuracy
1.00000 View all other metrics

Sampling
100.00 %

Registered models
No registration yet

Deploy status
No deployment yet

Hyperparameters of the best model-



Hyperparameters

Data transformation:

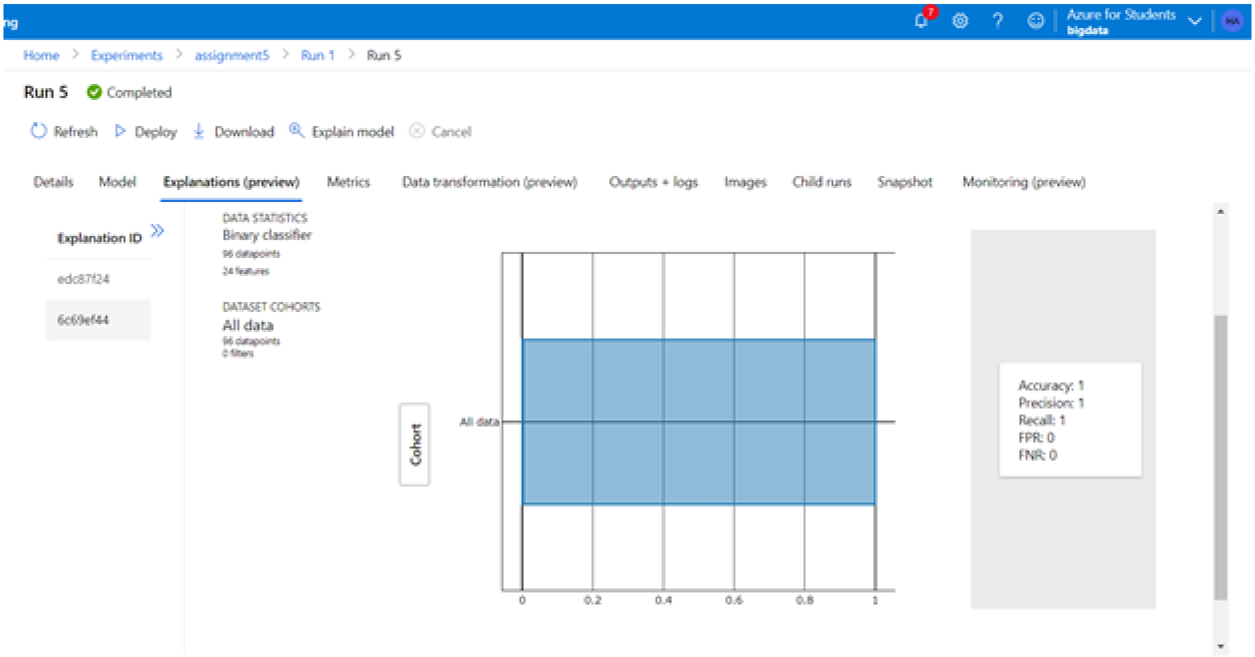
```
{
    "spec_class": "preproc",
    "class_name": "MaxAbsScaler",
    "module": "sklearn.preprocessing",
    "param_args": [],
    "param_kwargs": {},
    "prepared_kwargs": {}
}
```

Training algorithm:

```
{
    "spec_class": "sklearn",
    "class_name": "LightGBMClassifier",
    "module": "automl.client.core.common.model_wrappers",
    "param_args": [],
    "param_kwargs": {
        "min_data_in_leaf": 20
    },
    "prepared_kwargs": {}
}
```

Model explanation-

We can see the model has an accuracy, precision and recall 1.

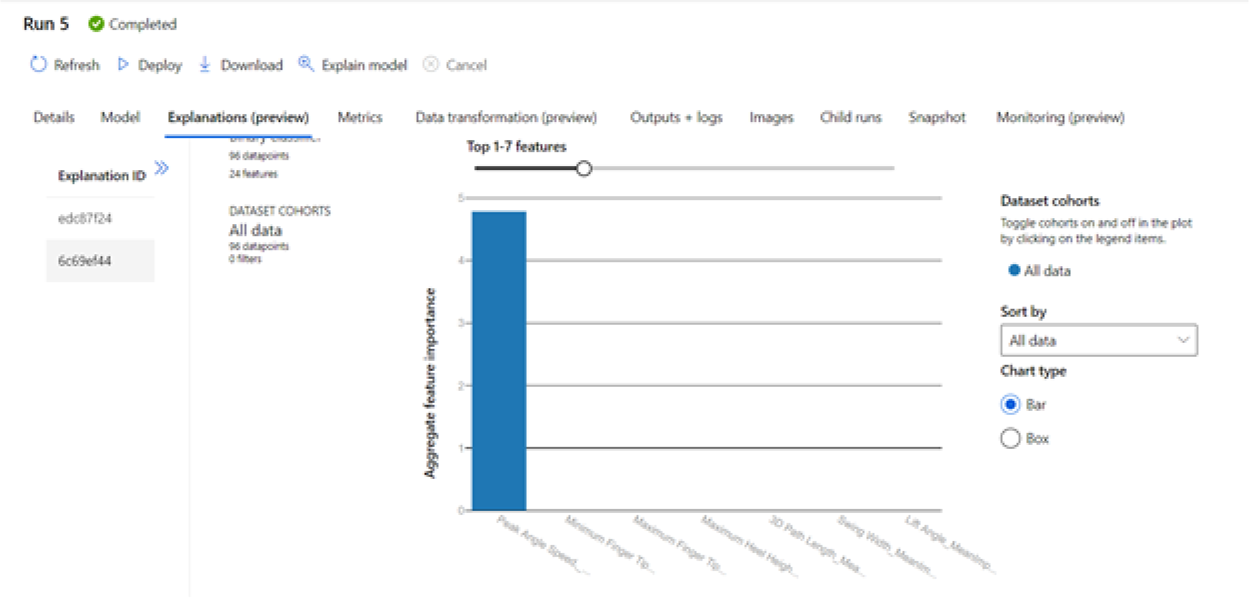


DATA STATISTICS
Binary classifier
96 datapoints
24 features

DATASET COHORTS
All data
96 datapoints
0 filters

Accuracy: 1
Precision: 1
Recall: 1
FPR: 0
FNR: 0

From this graph we can see our model relies largely on the peak angle speed feature to come up with an accurate output.



96 datapoints
24 features

DATASET COHORTS
All data
96 datapoints
0 filters

Sort by: All data