

# Assignment 3

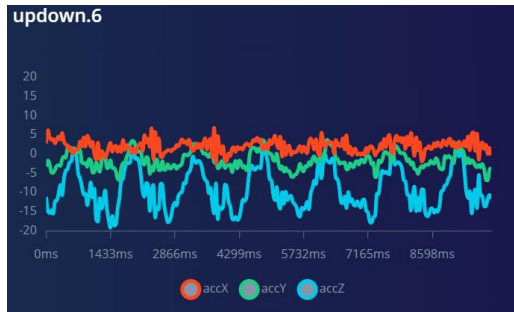
## Pankaja Balasooriya

### SKF2400104

#### Task 1 – Dataset

Motion: UP DOWN

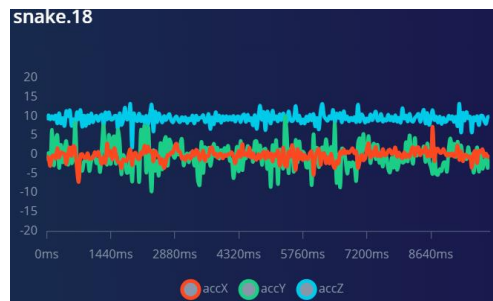
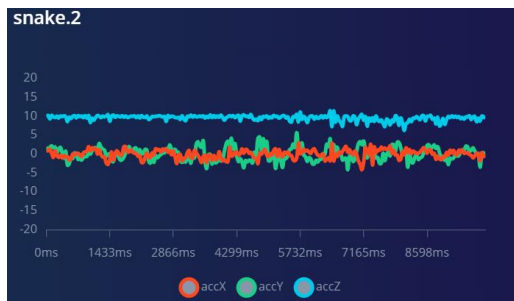
Waveform:



When device is moved up and down it is moved mainly along the z axis. So by examining the waveforms we can see that there is a significant variation of the waveform of the accZ (along z axis) while accX and accY show insignificant variation. When device is moved up or down along the z axis its acceleration increases in that direction comes to its maximum and accelerates in the opposite direction. This variation is depicted in the accZ waveform.

Motion: Snake

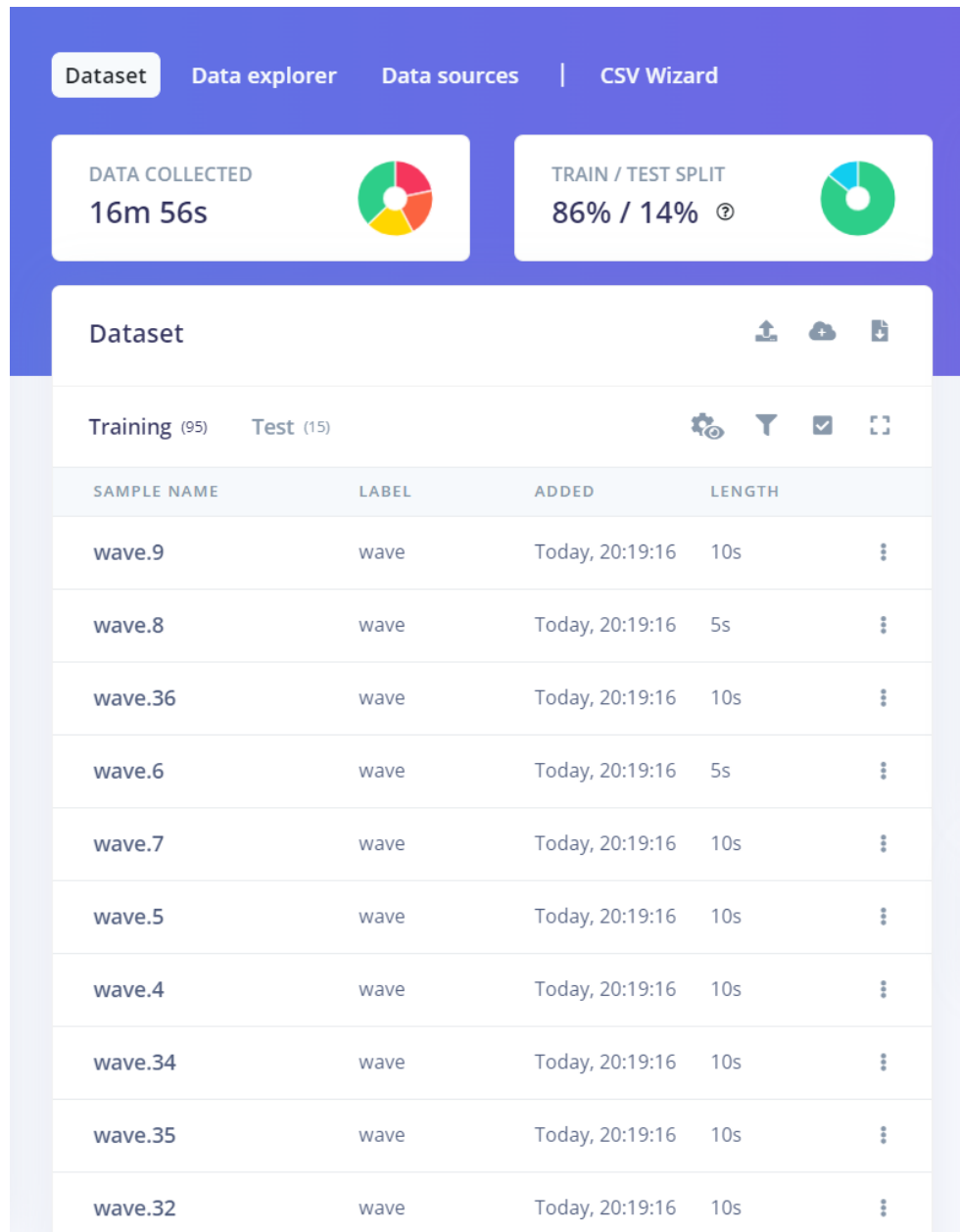
Waveform:



When device is moved in snake motion, there is no significant movement of the device along z axis. This is also visible in the waveform of accZ as it shows a very small to no significant change in the waveform. In the snake motion device mainly moves along the Y axis of the device. This can be verified by the

changes shown in the accY waveform. Also, there is some motion along the X axis so we can see that also in the waveform. Even though is not significant as Y axis there is some little motion along X axis during snake motion of the device.


### Loaded Dataset on Edge Impulse:



## Task 2 – Creating an impulse

### Impulse created

Impulse #2

 An impulse takes raw data, uses signal processing to extract features, and then uses a learning block to classify new data.

**Time series data**

Input axes (3)  
accX, accY, accZ

Window size  
2,000 ms.

Window increase  
80 ms.

Frequency (Hz)  
62.5

Zero-pad data

**Spectral Analysis**

Name  
Spectral features

Input axes (3)  
☒ accX  
☒ accY  
☒ accZ

**Classification**

Name  
Classifier

Input features  
☒ Spectral features

Output features  
4 (idle, snake, updown, wave)

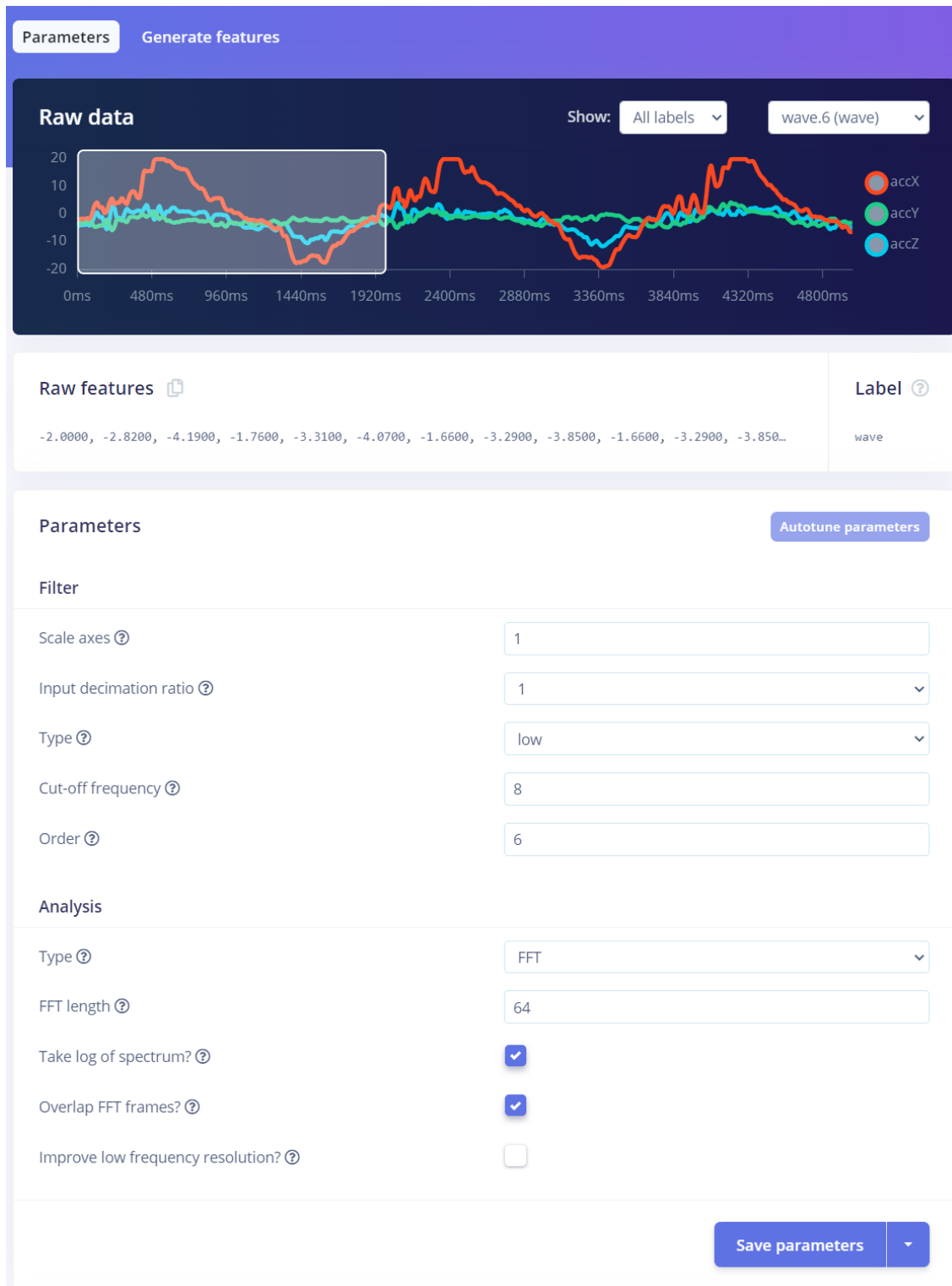
**Output features**

4 (idle, snake, updown, wave)

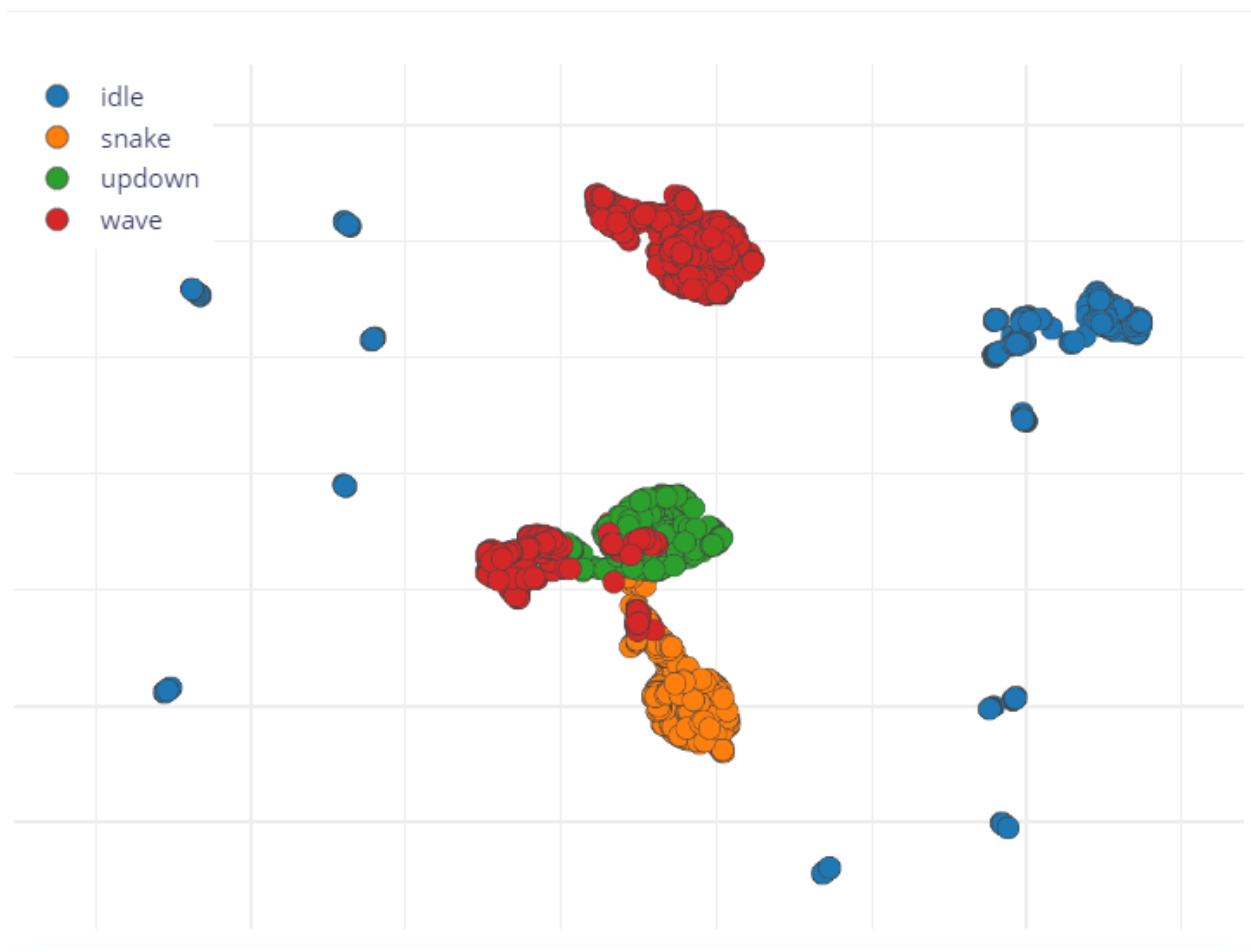
Save Impulse

## Task 3 – Feature extraction

### Selected parameters



## Feature explorer ⓘ



## Task 4 – Model training and testing

### Neural Network settings and architecture

#### Neural Network settings



#### Training settings

Number of training cycles 

30

Use learned optimizer 



Learning rate 

0.0005

Training processor 

CPU



#### Advanced training settings



#### Neural network architecture

Input layer (39 features)

Dense layer (20 neurons)

Dense layer (10 neurons)

Add an extra layer

Output layer (4 classes)

# Training performance

Last training performance (validation set)



ACCURACY  
99.7%



LOSS  
0.01

## Confusion matrix (validation set)

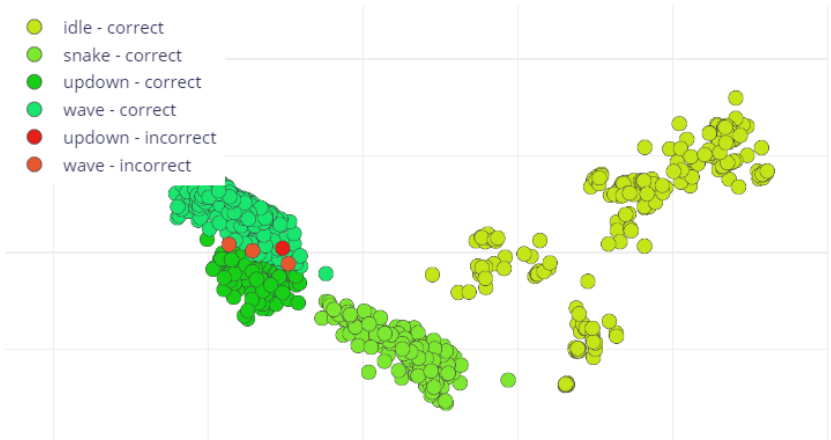
	IDLE	SNAKE	UPDOWN	WAVE
IDLE	100%	0%	0%	0%
SNAKE	0%	99.7%	0.3%	0%
UPDOWN	0%	0%	99.4%	0.6%
WAVE	0%	0%	0.3%	99.7%
F1 SCORE	1.00	1.00	0.99	1.00

## Metrics (validation set)



METRIC	VALUE
Area under ROC Curve ?	1.00
Weighted average Precision ?	1.00
Weighted average Recall ?	1.00
Weighted average F1 score ?	1.00

## Data explorer (full training set) ?



# Results for Test Dataset

Test data

Classify all

Set the 'expected outcome' for each sample to the desired outcome to automatically score the impulse.

SAMPLE NAME	EXPECTED OUTCOME	LENGTH	ACCURACY	RESULT	
updown.1	updown	10s	100%	100 updown	⋮
updown.3	updown	10s	100%	100 updown	⋮
idle.2	idle	10s	100%	100 idle	⋮
wave.2	wave	10s	100%	100 wave	⋮
updown.2	updown	5s	89%	34 updown, 4 snake	⋮
wave.3	wave	10s	100%	100 wave	⋮
snake.0	snake	10s	100%	100 snake	⋮
wave.0	wave	10s	100%	100 wave	⋮
updown.0	updown	10s	100%	100 updown	⋮
wave.1	wave	10s	100%	100 wave	⋮
idle.0	idle	10s	100%	100 idle	⋮
shake.0	shake	10s		101 wave	⋮
idle.3	idle	10s	100%	100 idle	⋮





Reasoning for selected parameters.

Different values for each of the parameters were tested and loss was compared against each other. Then ideal values given above were selected to avoid over fitting and significant accuracy.

## **Task 5 – Deployment**

The model was deployed in Arduino Nano 33 BLE sense and following motions were performed.

Idle:

```
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 17 ms., Classification: 0 ms., Anomaly: 0 ms.):
#Classification results:
  idle: 1.000000
  snake: 0.000000
  updown: 0.000000
  wave: 0.000000
```

Snake:

```
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 17 ms., Classification: 0 ms., Anomaly: 0 ms.):
#Classification results:
  idle: 0.000065
  snake: 0.999935
  updown: 0.000000
  wave: 0.000001
```

Updown:

```
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 17 ms., Classification: 0 ms., Anomaly: 0 ms.):
#Classification results:
  idle: 0.000000
  snake: 0.000132
  updown: 0.998397
  wave: 0.001471
```

Wave:

```
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 14 ms., Classification: 0 ms., Anomaly: 0 ms.):
#Classification results:
  idle: 0.000000
  snake: 0.000002
  updown: 0.000196
  wave: 0.999802
```