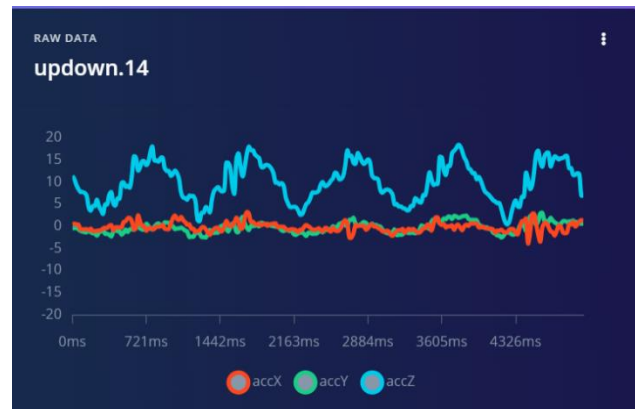
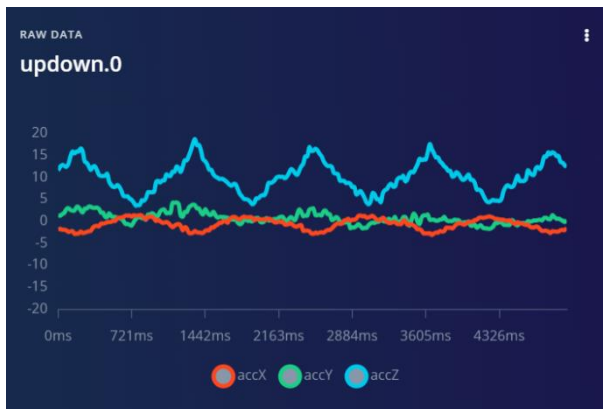


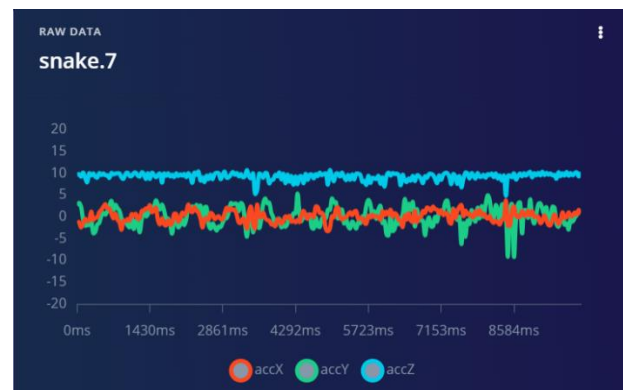
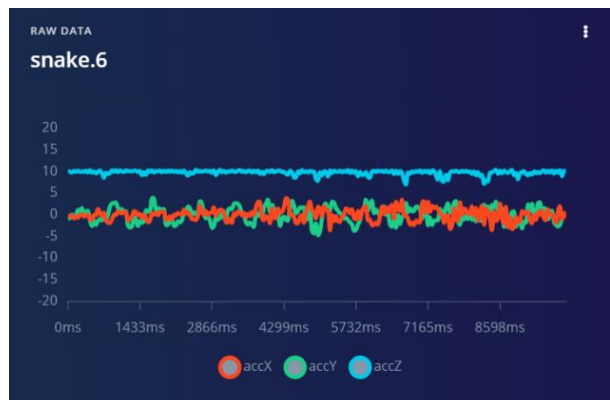
Assignment 3: Motion detection using Edge Impulse

Task 1: Dataset

Briefly explain the reason for the shape of the waveforms of the 2 movements updown and snake



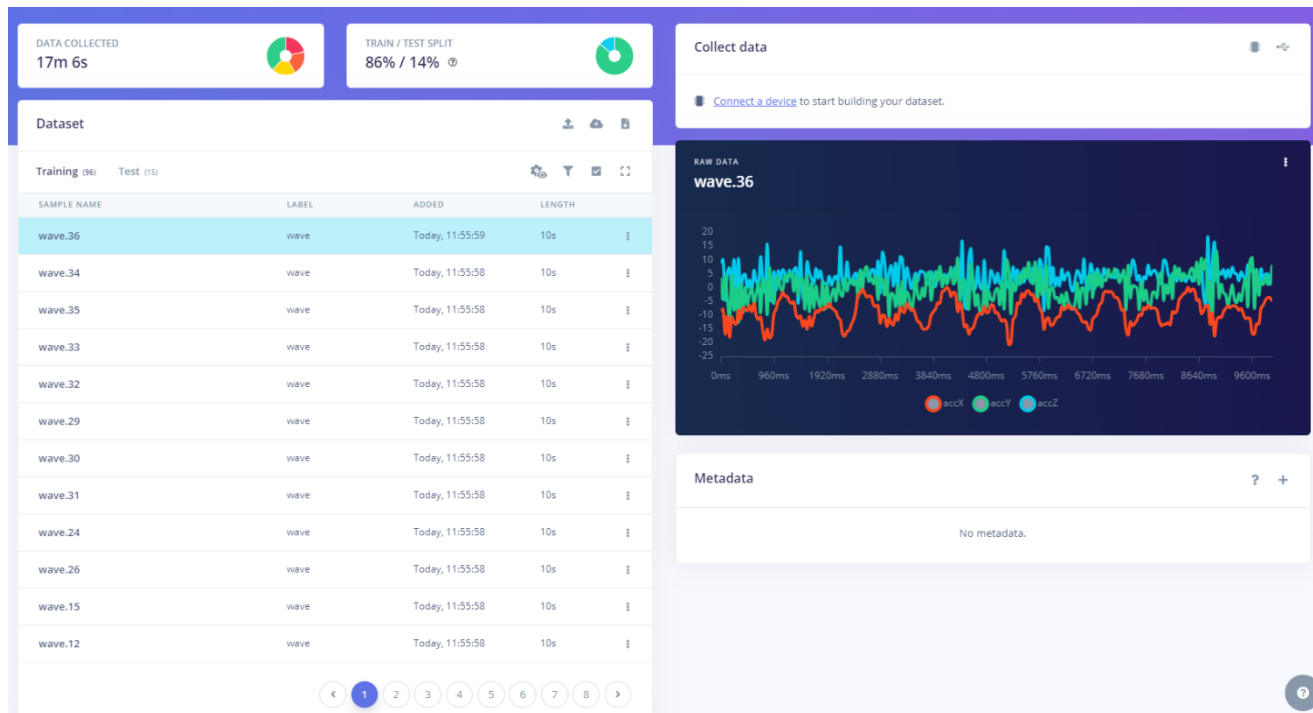
Updown movement typically involves moving the device vertically, either upwards and downwards. As a result, the accelerometer primarily detects significant changes in the Z-axis (which is aligned with the vertical direction). The waveform for the Z-axis (accZ) will show a periodic pattern corresponding to the upward and downward motion. The X and Y axes might show minor variations depending on the stability of the hand or slight tilts during the movement. The most significant changes will be observed in the accZ data, as this axis aligns with the vertical motion.



The "snake" movement involves moving the device in a serpentine or side-to-side manner on a flat surface. This movement primarily affects the X and Y axes as the device is dragged across the surface. The Z-axis (accZ) remains relatively constant as there is no significant

vertical motion involved. The most significant variations will be in the accX and accY data, representing the horizontal motions, while the Z-axis shows minimal variation.

Include a screenshot to show that the dataset is properly loaded to the project.



Have Uploaded the provided training and testing data separately with appropriate labeles.

Task 2: Creating an Impulse

Time series data

Input axes (3)
accX, accY, accZ

Window size

2,000 ms.

Window increase

80 ms.

Frequency (Hz)

Zero-pad data
☒

Spectral Analysis

Name

Input axes (3)
☒ accX
☒ accY
☒ accZ

Add a processing block

Classification

Name

Input features
☒ Spectral features

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

Add a learning block

Have created an Impulse with given parameters for Time Series data. Also added Spectral Analysis block as processing block and classification block as learning block. Impulse Outputs 4 features.

Include a screenshot that clearly shows the impulse you have created.

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Impulse #1

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

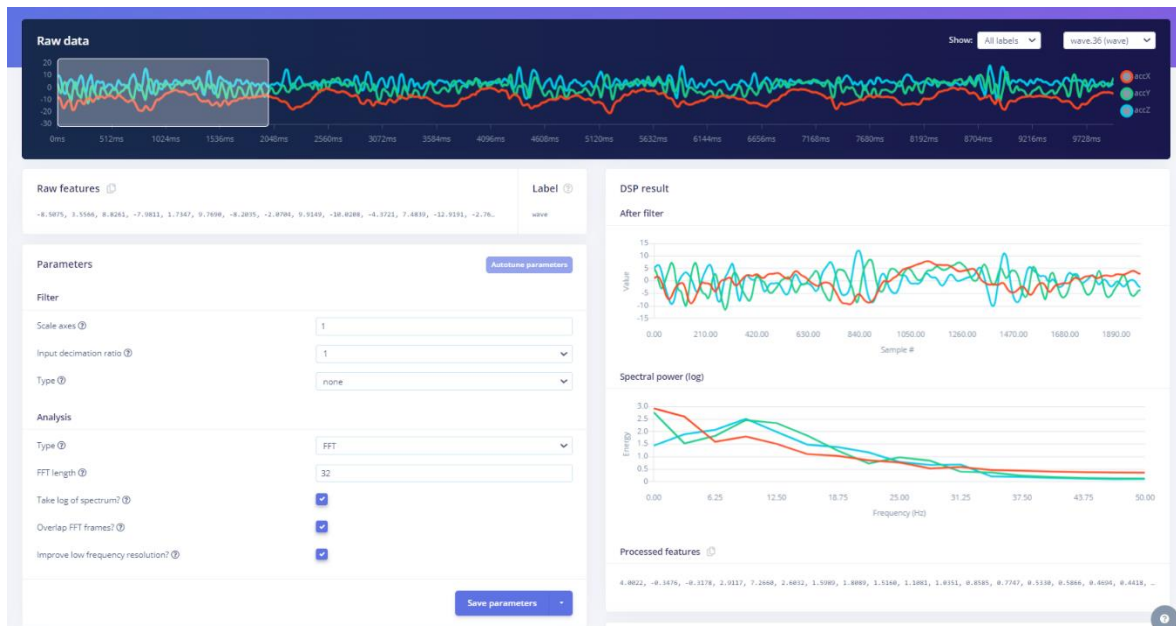
4 (idle, snake, updown, wave)

Save Impulse

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Task 3: Feature Extraction

Include screenshots to clearly show the selected parameters and the feature explorer



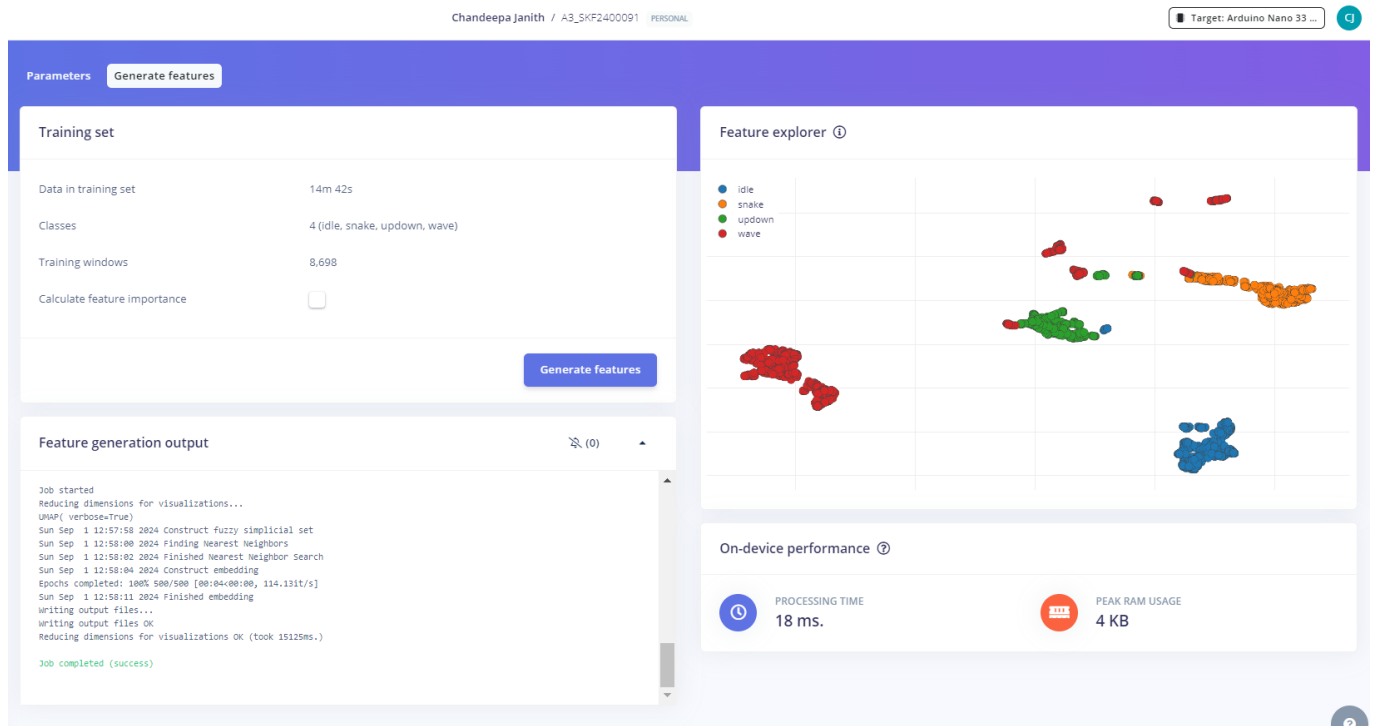
How parameters were selected:

The parameters for the spectral feature extraction were selected to optimize motion data analysis. Scale Axes was set to 1 for consistent data normalization, and Input Decimation Ratio was kept at 1 to retain full data resolution. No filter was applied initially to avoid altering the raw signal. The FFT Length was increased to 32 for better frequency resolution, which is essential for detailed spectral analysis of complex motions. The Log of Spectrum was enabled to help the model manage large variations in spectral energy, and Overlap FFT Frames was activated to ensure continuous feature capture. Improve Low-Frequency Resolution was enabled to provide detailed analysis of low-frequency components, which are important for distinguishing subtle motion patterns like the "snake" movement. These settings were chosen to extract useful information from the data while keeping the signal accurate and clear.

The screenshot shows a 'Parameters' configuration window. It has a title bar with 'Parameters' and an 'Autotune parameters' button. The window is divided into two main sections: 'Filter' and 'Analysis'. The 'Filter' section contains three settings: 'Scale axes' (set to 1), 'Input decimation ratio' (set to 1), and 'Type' (set to none). The 'Analysis' section contains four settings: 'Type' (set to FFT), 'FFT length' (set to 32), 'Take log of spectrum?' (checked), 'Overlap FFT frames?' (checked), and 'Improve low frequency resolution?' (checked). At the bottom right, there is a 'Save parameters' button with a dropdown arrow.

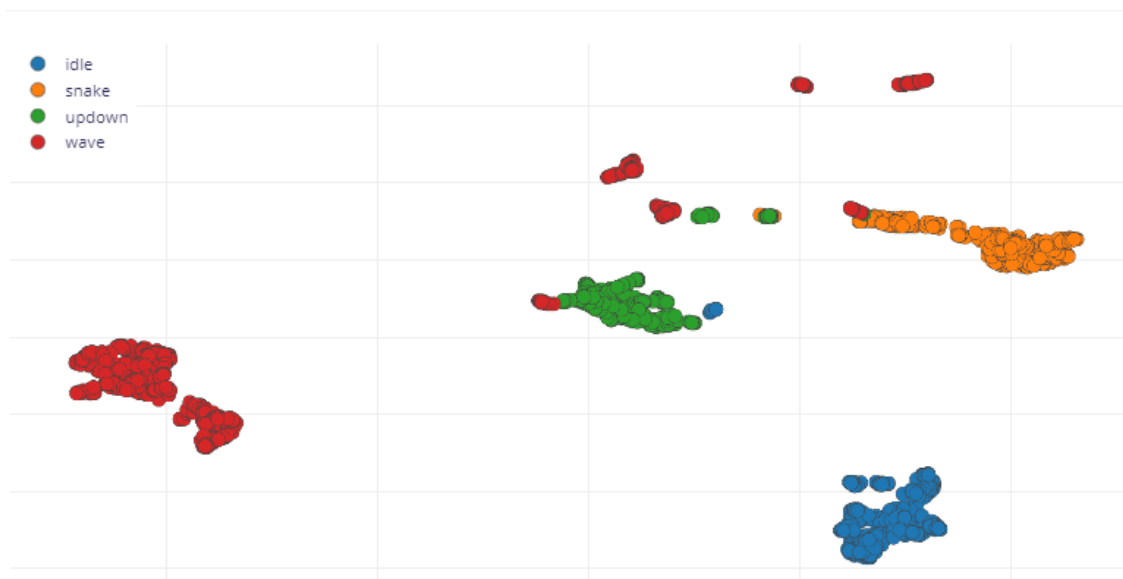
Section	Parameter	Value
Filter	Scale axes	1
	Input decimation ratio	1
	Type	none
Analysis	Type	FFT
	FFT length	32
	Take log of spectrum?	✓
	Overlap FFT frames?	✓
	Improve low frequency resolution?	✓

Feature extraction



The feature explorer shows that the features in your dataset are well-extracted. The clear, separate groups for the four classes—idle, snake, updown, and wave—mean that the features are doing a good job of capturing what makes each class different.

Feature explorer ⓘ



Task 4: Model training and testing

Neural network settings and network architecture

Neural Network settings

Training settings

Number of training cycles

30

Use learned optimizer

☐

Learning rate

0.05

Training processor

CPU

Advanced training settings

Neural network architecture

Input layer (126 features)

Dense layer (20 neurons)

Dense layer (10 neurons)

Add an extra layer

Output layer (4 classes)

Save & train

Training performance. (Confusion matrix, metrics for the validation set and data explorer)

Confusion Matrix

Model

Model version: Quantized (int8)

Last training performance (validation set)

%

ACCURACY

97.9%

📈

LOSS

0.09

Confusion matrix (validation set)

	IDLE	SNAKE	UPDOWN	WAVE
IDLE	100%	0%	0%	0%
SNAKE	0%	100%	0%	0%
UPDOWN	0.6%	5.4%	94.0%	0%
WAVE	0%	0.5%	1.8%	97.7%
F1 SCORE	1.00	0.97	0.95	0.99

Achieved 97.9% accuracy for testing data without overfitting.

Metrics

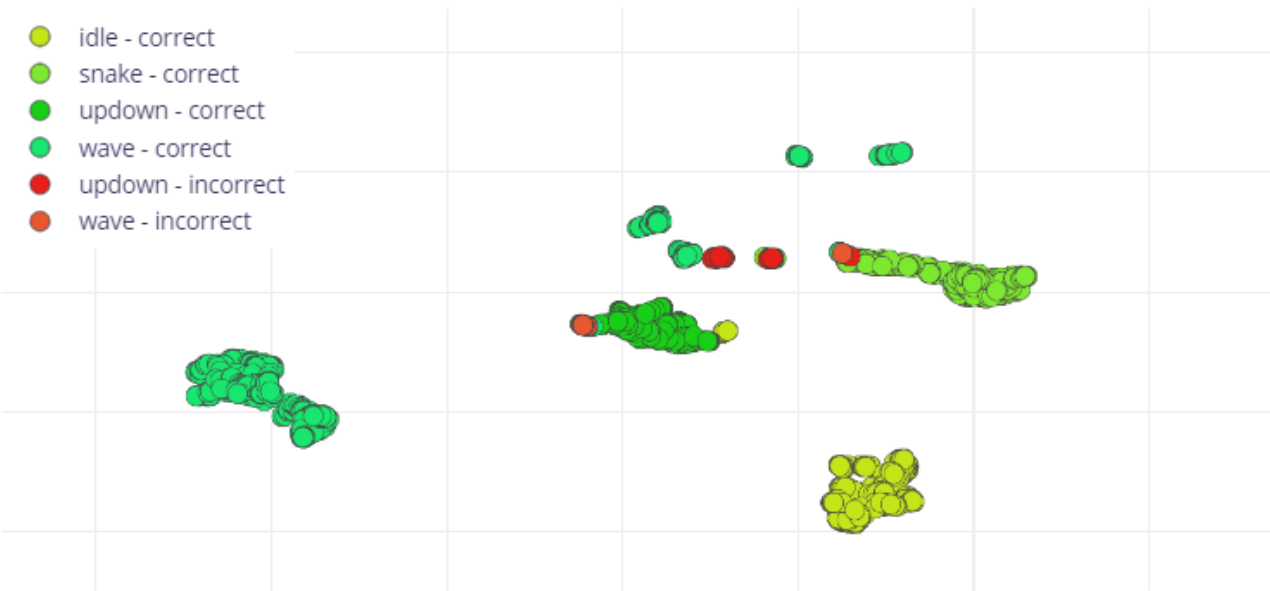
Metrics (validation set)



METRIC	VALUE
Area under ROC Curve ?	1.00
Weighted average Precision ?	0.98
Weighted average Recall ?	0.98
Weighted average F1 score ?	0.98

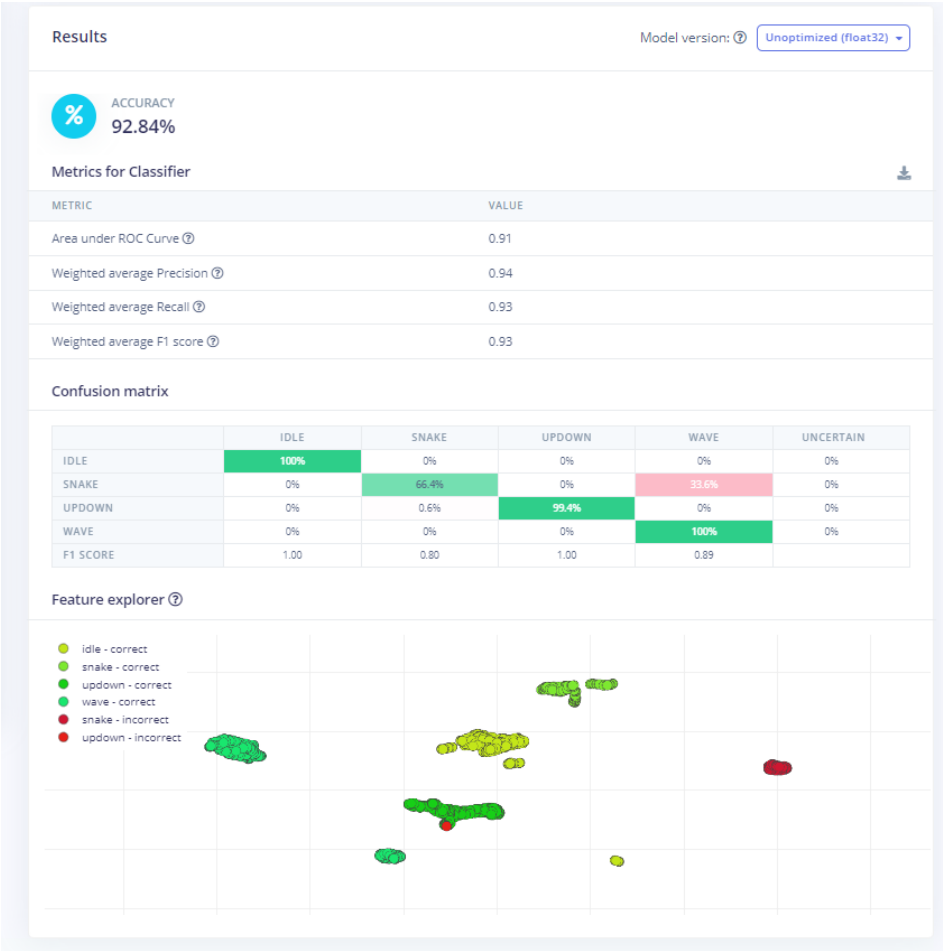
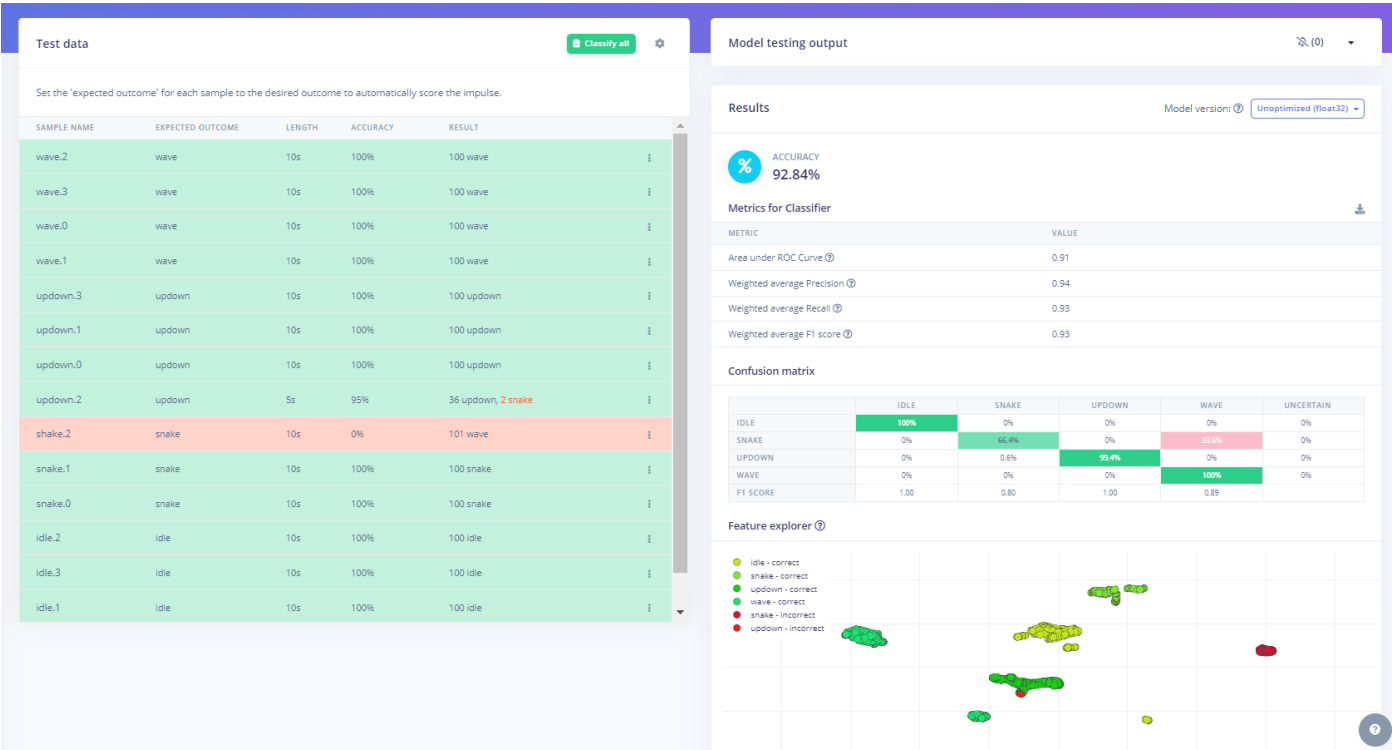
Data Explorer

Data explorer (full training set) ?



Results obtained for the testing dataset

Achieved 92.84% accuracy for testing data



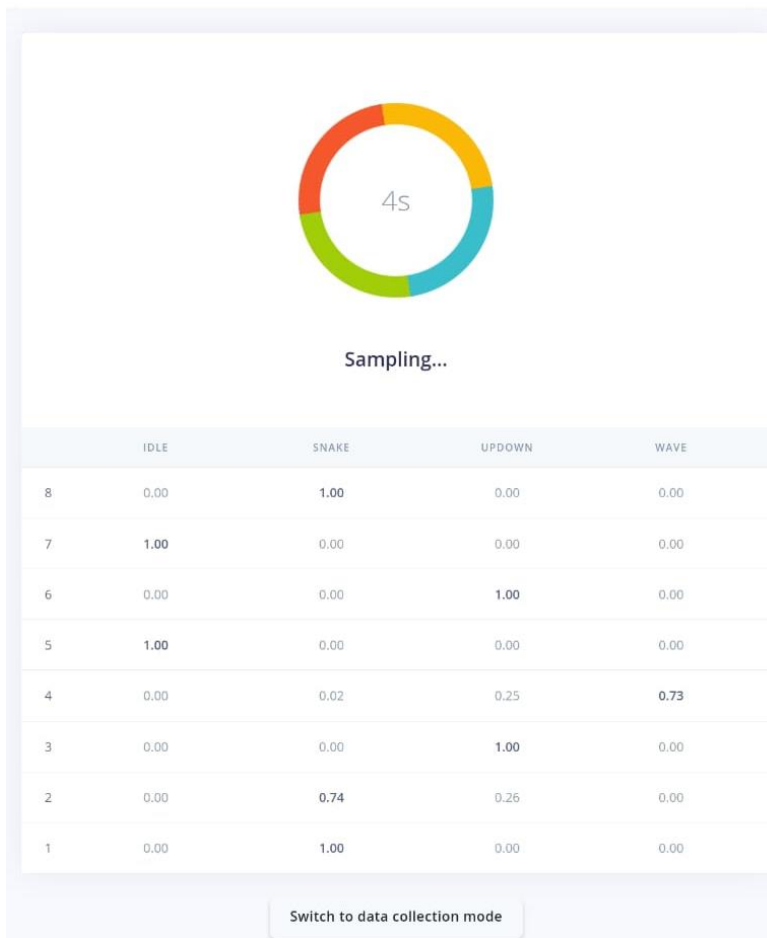
Simple reasoning of the parameters you have chosen.

Have selected 30 training cycles with a learning rate of 0.05 to avoid overfitting the data. The neural network architecture includes an input layer followed by two dense layers—one with 20 neurons and the other with 10 neurons. Finally, the output layer is designed to classify the data into 4 distinct classes. This setup allow the network to learn effectively while minimizing the risk of overfitting, ensuring that the model generalizes well to new data

Task 5: Deployment



Chandeepea Janith / A3_SKF2400091



Have done 3 snake movements, 2 idle instances, 2 up down movements and 1 wave movement using my phone from this deployed model. I got the correct results as expected.