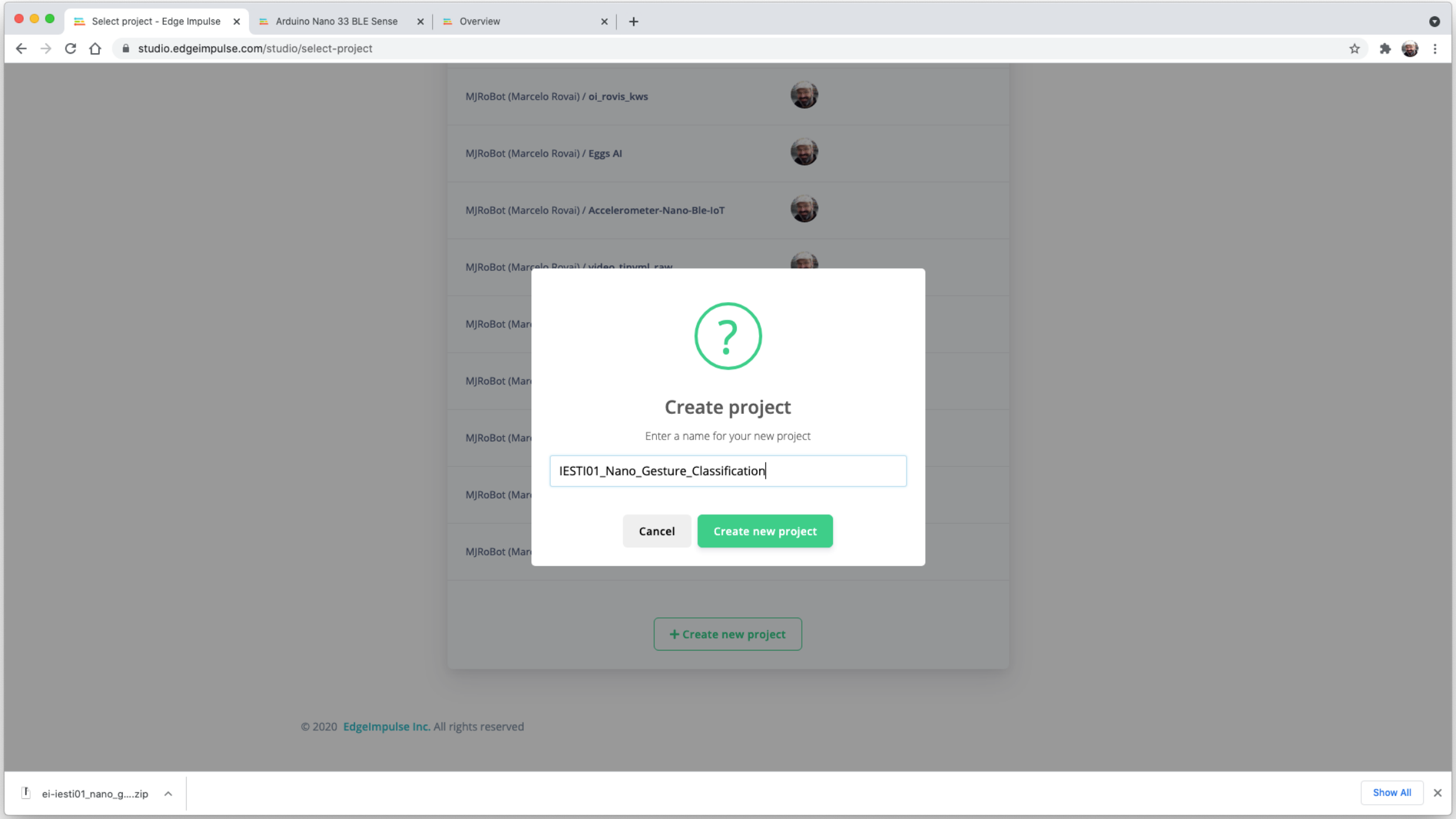
IESTI01 - TinyML

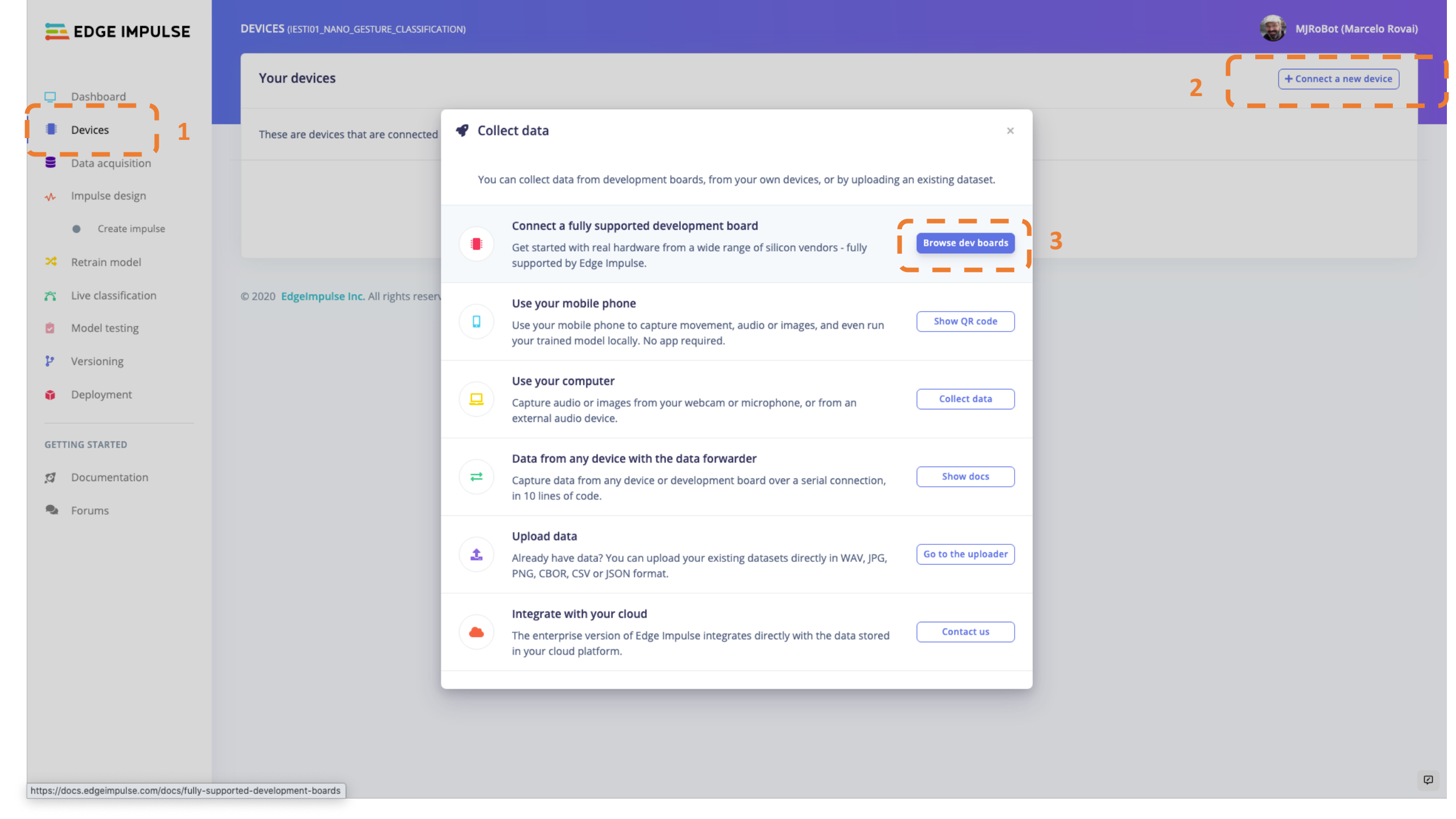
Gesture Classification &
Anomaly Detection with
Arduino Nano-33 BLE

Prof. Marcelo Rovai

June 30rd, 2021

Arduino Nano-33 BLE
Edge Impulse – Installation


Select project - Edge Impulse
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/select-project
MJRoBot (Marcelo Rovai) / oi_rovis_kws
MJRoBot (Marcelo Rovai) / Eggs AI
MJRoBot (Marcelo Rovai) / Accelerometer-Nano-Ble-IoT
Create project
Enter a name for your new project
IESTI01_Nano_Gesture_Classification
Cancel
Create new project
+ Create new project
© 2020 EdgeImpulse Inc. All rights reserved
ei-iesti01_nano_g....zip
Show All


EDGE IMPULSE
DEVICES (IESTI01_NANO_GESTURE_CLASSIFICATION)
MJRoBot (Marcelo Rovai)
Dashboard
Devices
1
Data acquisition
Impulse design
Create impulse
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
Your devices
2
+ Connect a new device
These are devices that are connected
© 2020 EdgeImpulse Inc. All rights reserv
Collect data
You can collect data from development boards, from your own devices, or by uploading an existing dataset.
Connect a fully supported development board
Get started with real hardware from a wide range of silicon vendors - fully supported by Edge Impulse.
Browse dev boards
3
Use your mobile phone
Use your mobile phone to capture movement, audio or images, and even run your trained model locally. No app required.
Show QR code
Use your computer
Capture audio or images from your webcam or microphone, or from an external audio device.
Collect data
Data from any device with the data forwarder
Capture data from any device or development board over a serial connection, in 10 lines of code.
Show docs
Upload data
Already have data? You can upload your existing datasets directly in WAV, JPG, PNG, CBOR, CSV or JSON format.
Go to the uploader
Integrate with your cloud
The enterprise version of Edge Impulse integrates directly with the data stored in your cloud platform.
Contact us
https://docs.edgeimpulse.com/docs/fully-supported-development-boards

Overview

There is a list of development boards that are fully supported by Edge Impulse. These boards come with a special firmware which enables data collection from all their sensors, allows you to build new ready-to-go binaries that include your trained impulse, and come with examples on integrating your impulse with your custom firmware. These boards are the perfect way to start building Machine Learning solutions on real embedded hardware.

- ST B-L475E-IOT01A (IoT Discovery Kit)
- Arduino Nano 33 BLE Sense
- Eta Compute ECM3532 AI Sensor
- Eta Compute ECM3532 AI Vision
- OpenMV Cam H7 Plus
- Himax WE-I Plus
- Nordic Semiconductor nRF52840 DK
- Nordic Semiconductor nRF5340 DK
- Silicon Labs Thunderboard Sense 2
- Sony's Spresense
- Arduino Portenta H7 + Vision shield (preview support)
- Raspberry Pi 4
- NVIDIA Jetson Nano

Different development board? No problem, you can always collect data using the Data forwarder or the Edge Impulse for Linux SDK, and deploy your model back to the device with the Running your impulse locally tutorials.

Just want to experience Edge Impulse? You can also use your Mobile phone!

Updated 7 days ago

Arduino Nano 33 BLE Sense

The Arduino Nano 33 BLE Sense is a tiny development board with a Cortex-M4 microcontroller, motion sensors, a microphone and BLE - and it's fully supported by Edge Impulse. You'll be able to sample raw data, build models, and deploy trained machine learning models directly from the studio. It's available for around 30 USD from Arduino and a wide range of distributors.

The Edge Impulse firmware for this development board is open source and hosted on GitHub: edgeimpulse/firmware-arduino-nano-33-ble-sense.

Arduino Nano 33 BLE Sense

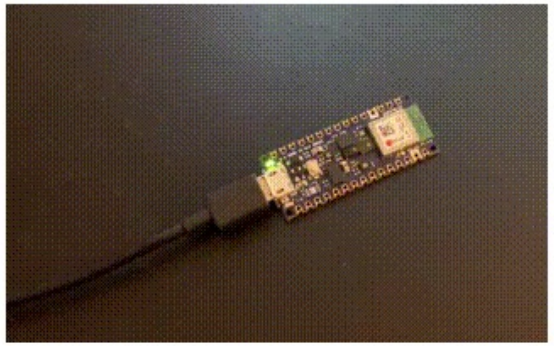
Installing dependencies

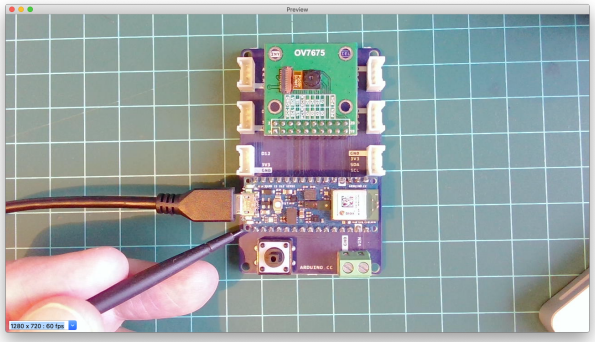
To set this device up in Edge Impulse, you will need to install the following software:

1. Edge Impulse CLI.
2. Arduino CLI.
   - Here's an instruction video for Windows.
   - The Arduino website has instructions for macOS and Linux.
3. On Linux:
   - GNU Screen: install for example via `sudo apt install screen`.

1. Connect the development board to your computer

Use a micro-USB cable to connect the development board to your computer. Then press RESET twice to launch into the bootloader. The on-board LED should start pulsating to indicate this.





Press RESET twice quickly to launch the bootloader on the Arduino Nano 33 BLE Sense.

2. Update the firmware

The development board does not come with the right firmware yet. To update the firmware:

1. Download the latest Edge Impulse firmware, and unzip the file.
2. Open the flash script for your operating system (`flash_windows.bat` , `flash_mac.command` or `flash_linux.sh`) to flash the firmware.
3. Wait until flashing is complete, and press the RESET button once to launch the new firmware.

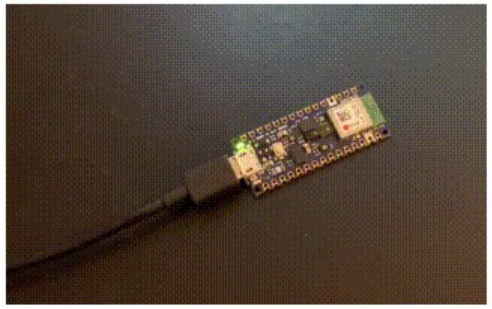
3. Setting keys

Nano 33 BLE Sense | Overview

docs/arduino-nano-33-ble-sense

1. Connect the development board to your computer

Use a micro-USB cable to connect the development board to your computer. Then press RESET twice to launch into the bootloader. The on-board LED should start pulsating to indicate this.



Press RESET twice quickly to launch the bootloader on the Arduino Nano 33 BLE Sense.

1

2. Update the firmware

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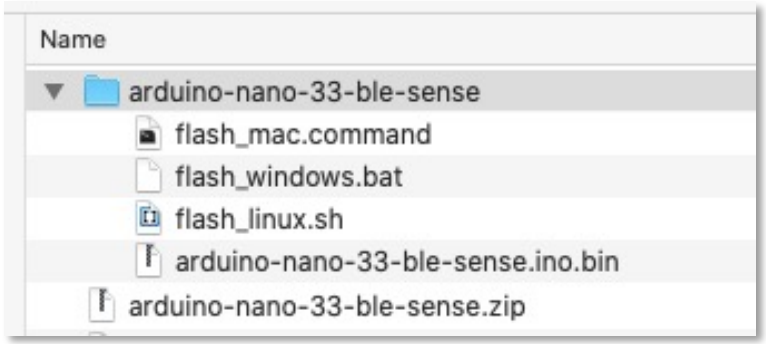
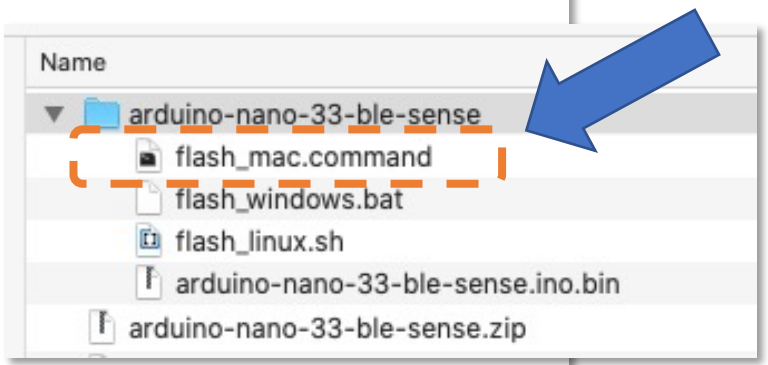
3. Setting keys



2

```
mjrovai — flash_mac.command — 124×43
Last login: Mon Jun 28 08:58:22 on ttys002
You have new mail.
/Users/mjrovai/Downloads/arduino-nano-33-ble-sense/flash_mac.command ; exit;

The default interactive shell is now zsh.
To update your account to use zsh, please run `chsh -s /bin/zsh`.
For more details, please visit https://support.apple.com/kb/HT208050.
(base) MacBook-Pro-de-Marcelo:~ mjrovai$ /Users/mjrovai/Downloads/arduino-nano-33-ble-sense/flash_mac.command ; exit;
Finding Arduino Mbed core...
Finding Arduino Mbed OK
Finding Arduino Nano 33 BLE...
Finding Arduino Nano 33 BLE OK
Flashing board...
Device        : nRF52840-QIAA
Version       : Arduino Bootloader (SAM-BA extended) 2.0 [Arduino:IKXYZ]
Address       : 0x0
Pages         : 256
Page Size     : 4096 bytes
Total Size    : 1024KB
Planes        : 1
Lock Regions  : 0
Locked        : none
Security      : false
Erase flash

Done in 0.001 seconds
Write 525440 bytes to flash (129 pages)
[==============================] 100% (129/129 pages)
Done in 20.533 seconds

Flashed your Arduino Nano 33 BLE development board.
To set up your development with Edge Impulse, run 'edge-impulse-daemon'
To run your impulse on your development board, run 'edge-impulse-run-impulse'
logout
Saving session...
...copying shared history...
...saving history...truncating history files...
...completed.

[Process completed]
```

1. Press Nano-33 Reset button Twice
2. With Nano-33 LED Flashing:

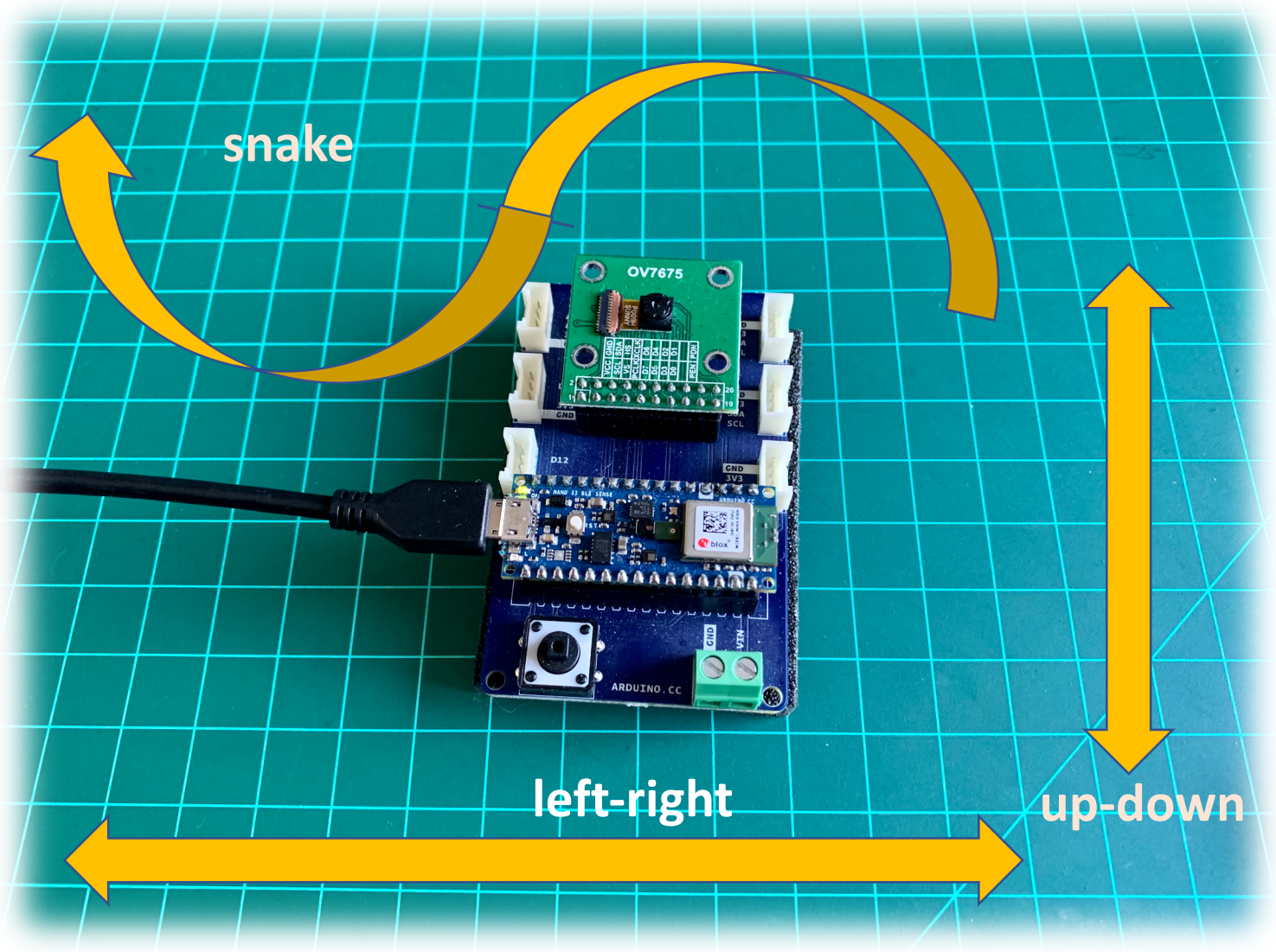


3.Nano-33 LED Stop Flashing

Nano-33 BLE
Gesture Classification Project

https://studio.edgeimpulse.com/public/37762/latest

Gesture Data Capture (2D Plan)



Data Acquisition

EDGE IMPULSE

Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Retrain model
Live classification
Model testing
Versioning
Deployment

GETTING STARTED
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Forums

MJRoBot (Marcelo Rovai) / IESTI01_Nano_Gesture_Classification

This is your Edge Impulse project. From here you acquire new training data, design impulses and train models.

Creating your first impulse (0% complete)

Acquire data

Every Machine Learning project starts with data. You can capture data from a development board or your phone, or import data you already collected.

LET'S COLLECT SOME DATA

Design an impulse

Teach the model to interpret previously unseen data, based on historical data. Use this to categorize new data, or to find anomalies in sensor readings.

GETTING STARTED: CONTINUOUS MOTION RECOGNITION
GETTING STARTED: RESPONDING TO YOUR VOICE
GETTING STARTED: ADDING SIGHT TO YOUR SENSORS

Deploy

Package the complete impulse up, from signal processing code to trained model, and deploy it on your device. This ensures that the impulse runs with low latency and without requiring a network connection.

DEPLOY YOUR MODEL

Sharing

Your project is private.

Make this project public

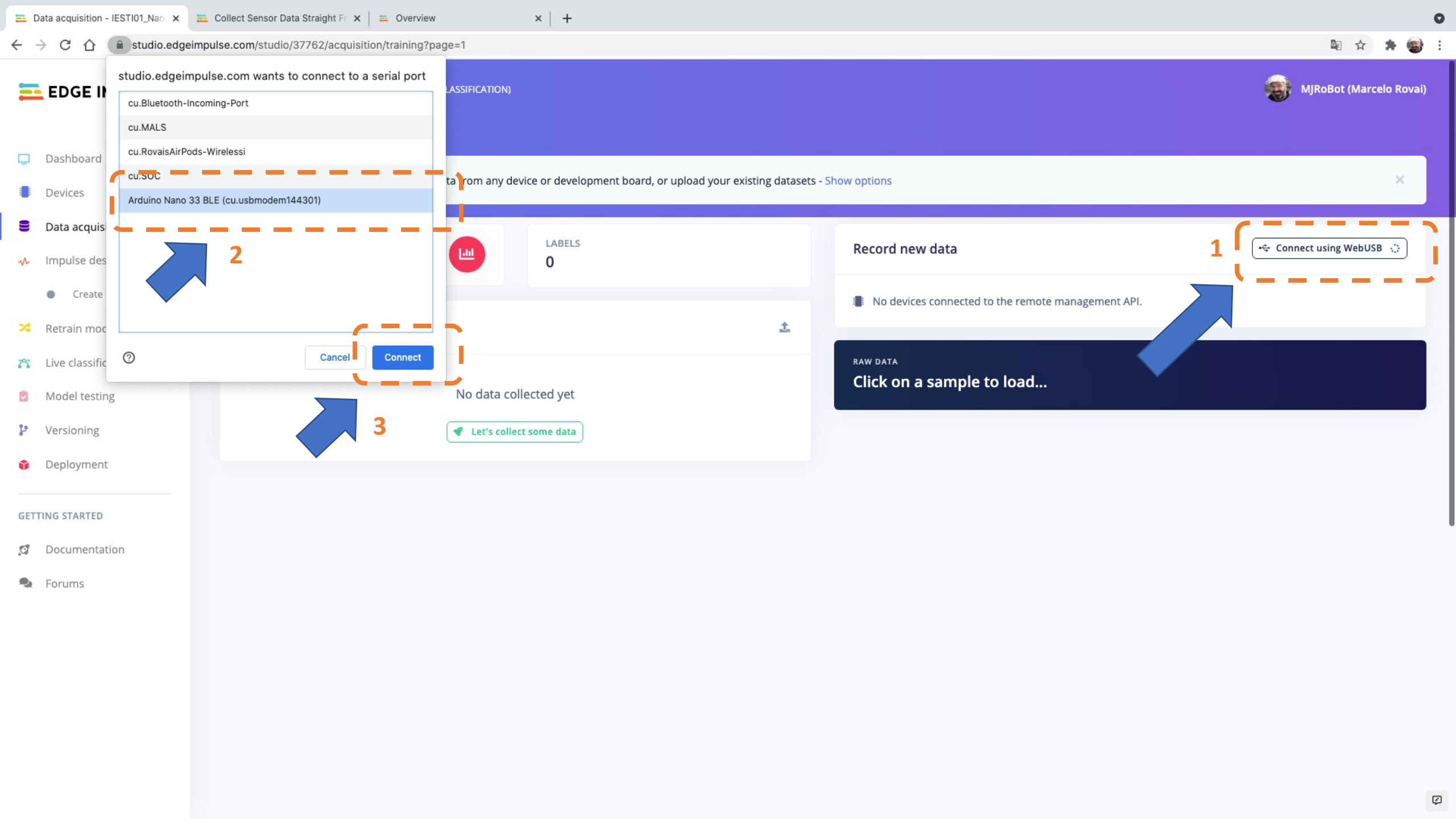
Summary

DEVICES CONNECTED
0

DATA COLLECTED
-

Collaborators

MJRoBot (Marcelo Rovai) OWNER


Data acquisition - IESTI01_Nan
Collect Sensor Data Straight Fr
Overview
studio.edgeimpulse.com/studio/37762/acquisition/training?page=1
studio.edgeimpulse.com wants to connect to a serial port
cu.Bluetooth-Incoming-Port
cu.MALS
cu.RovaisAirPods-Wirelessi
cu.SOC
Arduino Nano 33 BLE (cu.usbmodem144301)
Cancel
Connect
2
3
1
MJRoBot (Marcelo Rovai)
Dashboard
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Impulse des
Create
Retrain mod
Live classific
Model testing
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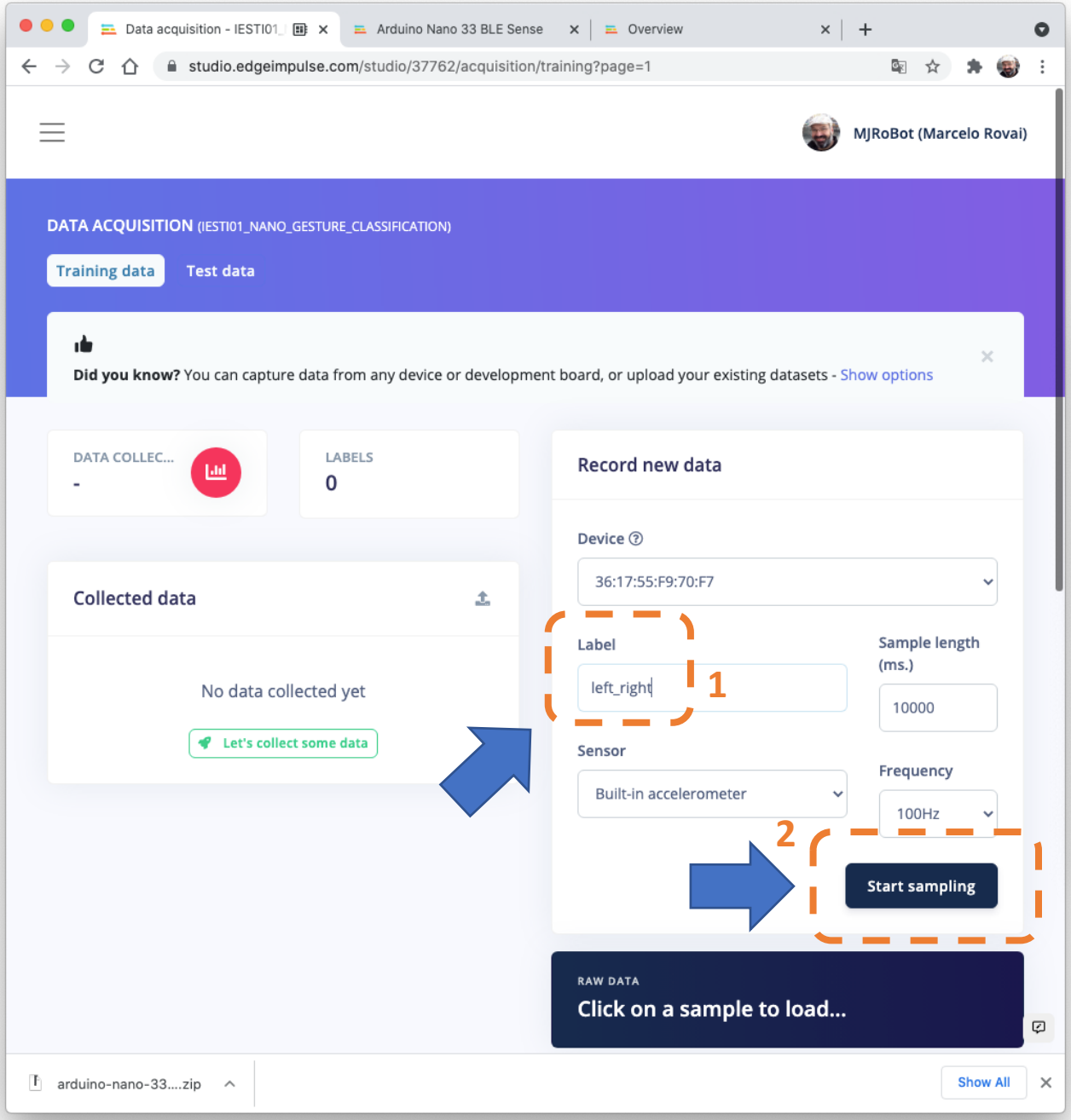
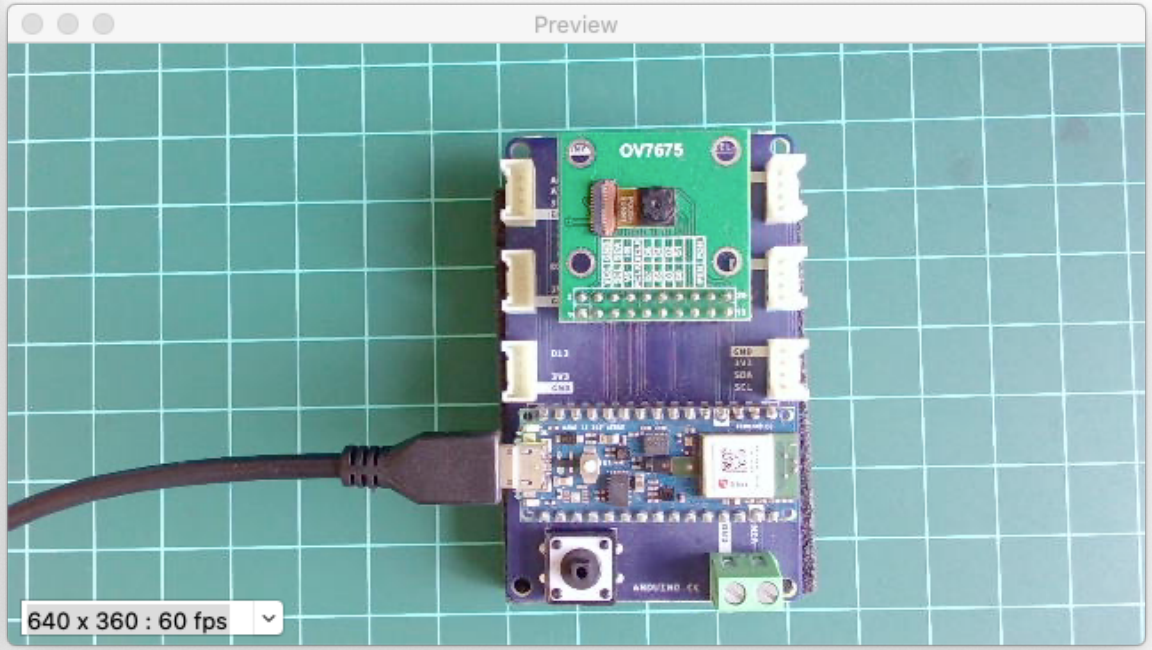
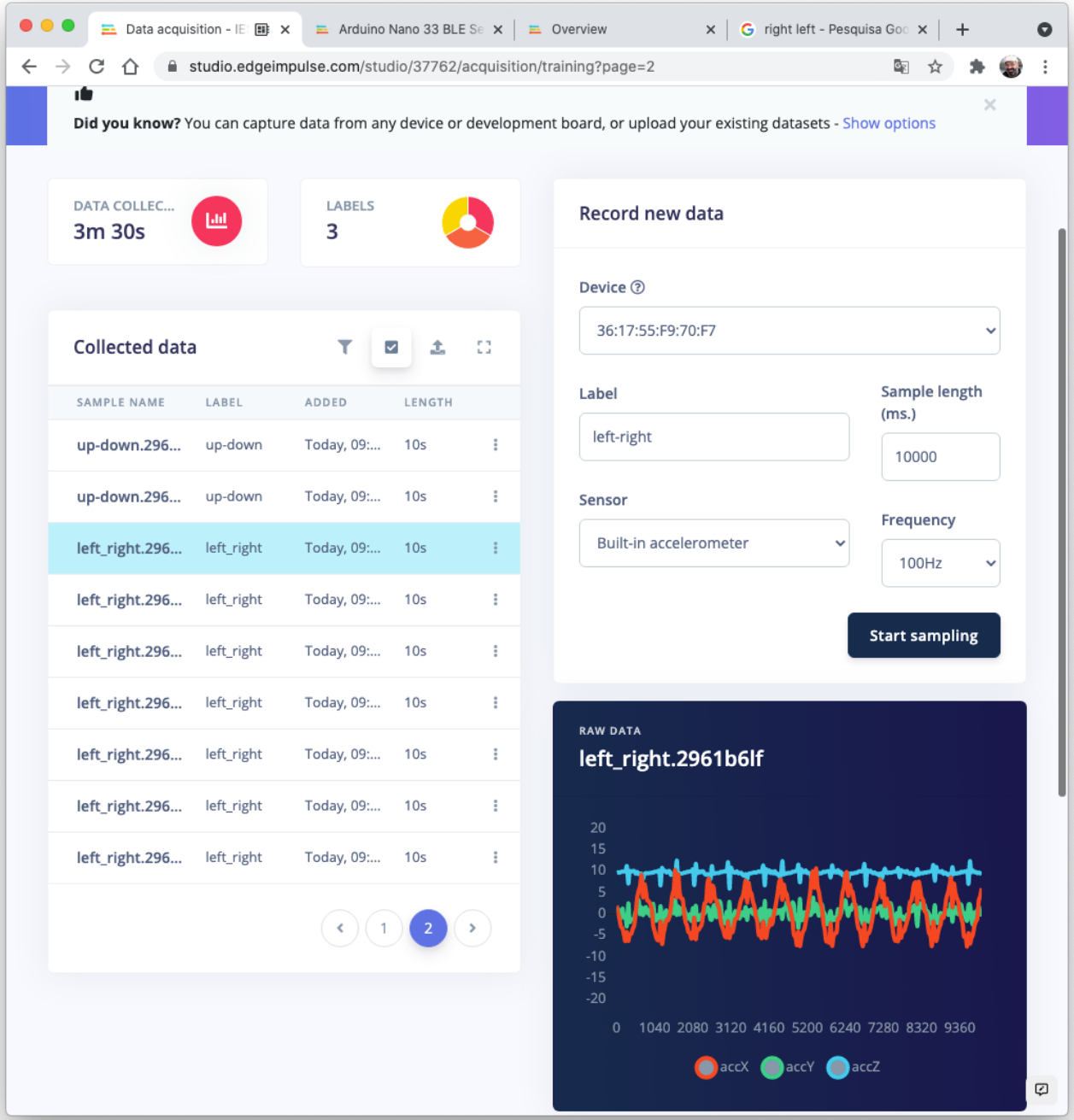
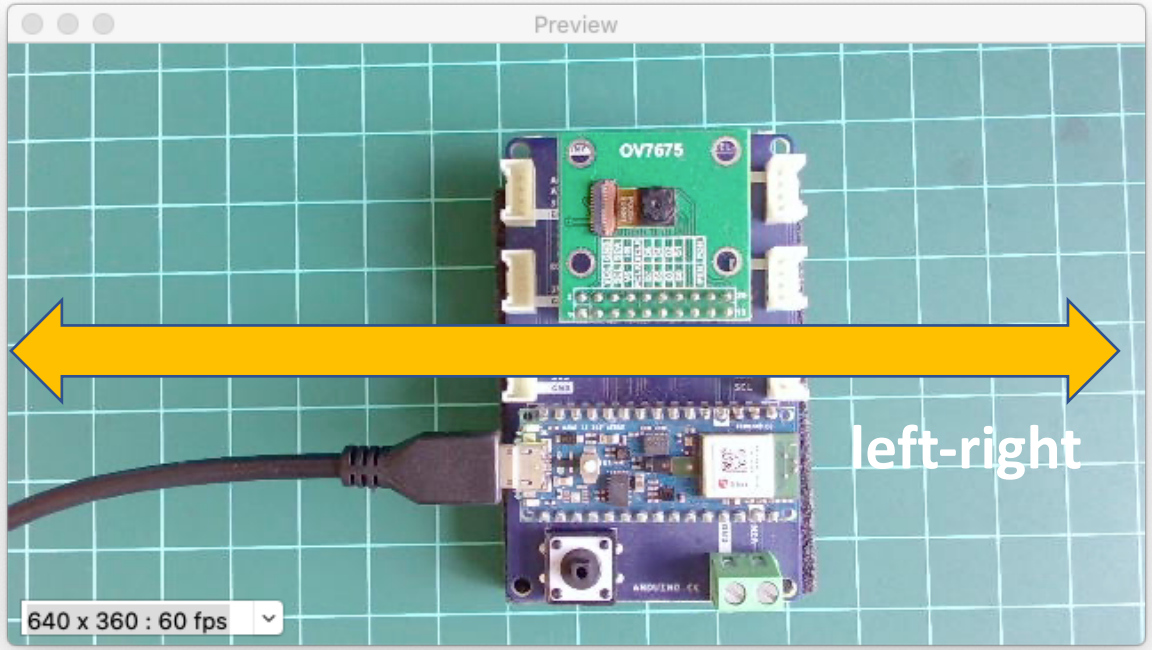
ta rom any device or development board, or upload your existing datasets - Show options
LABELS
0
No data collected yet
Let's collect some data
Record new data
Connect using WebUSB
No devices connected to the remote management API.
RAW DATA
Click on a sample to load...

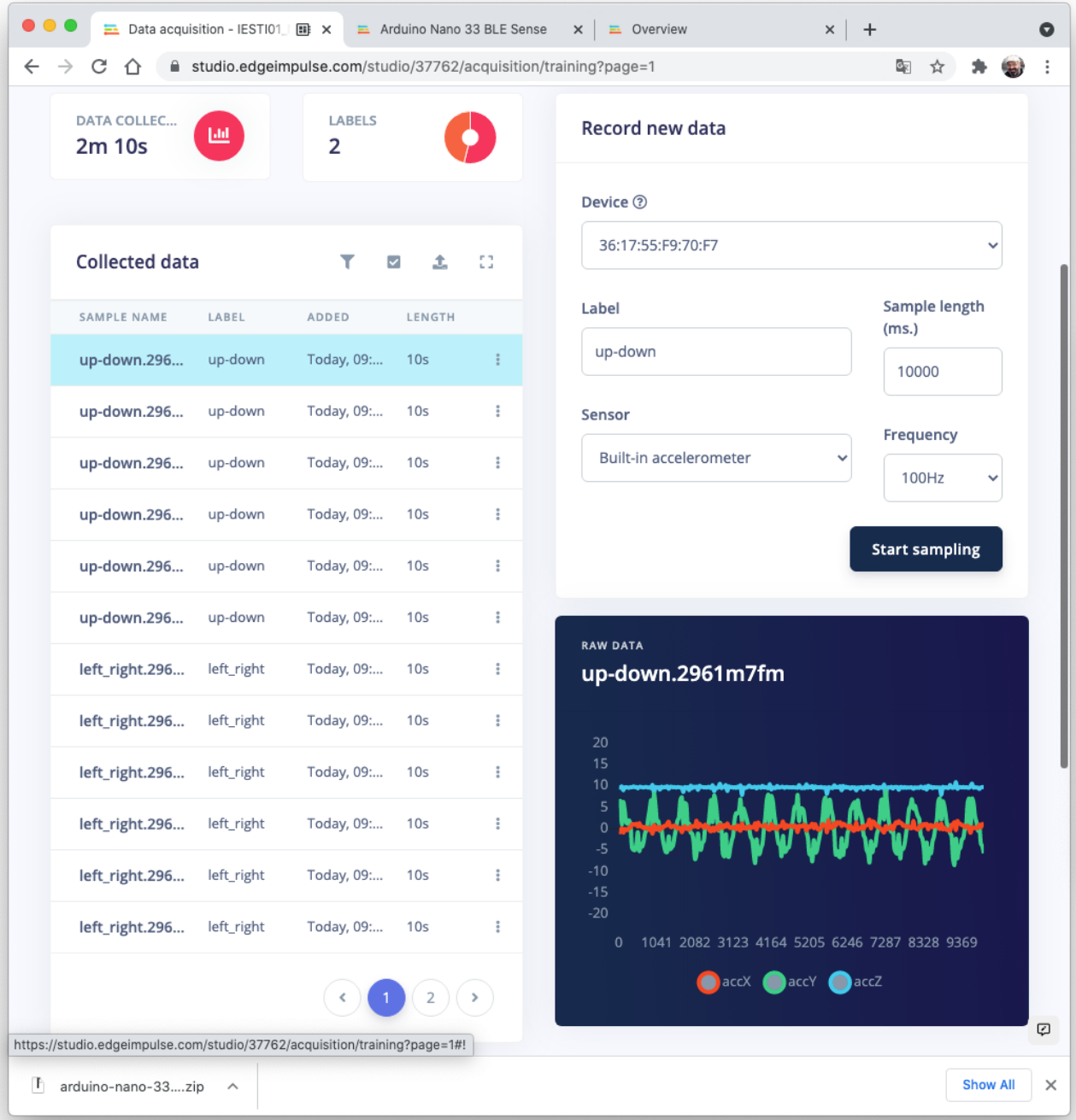


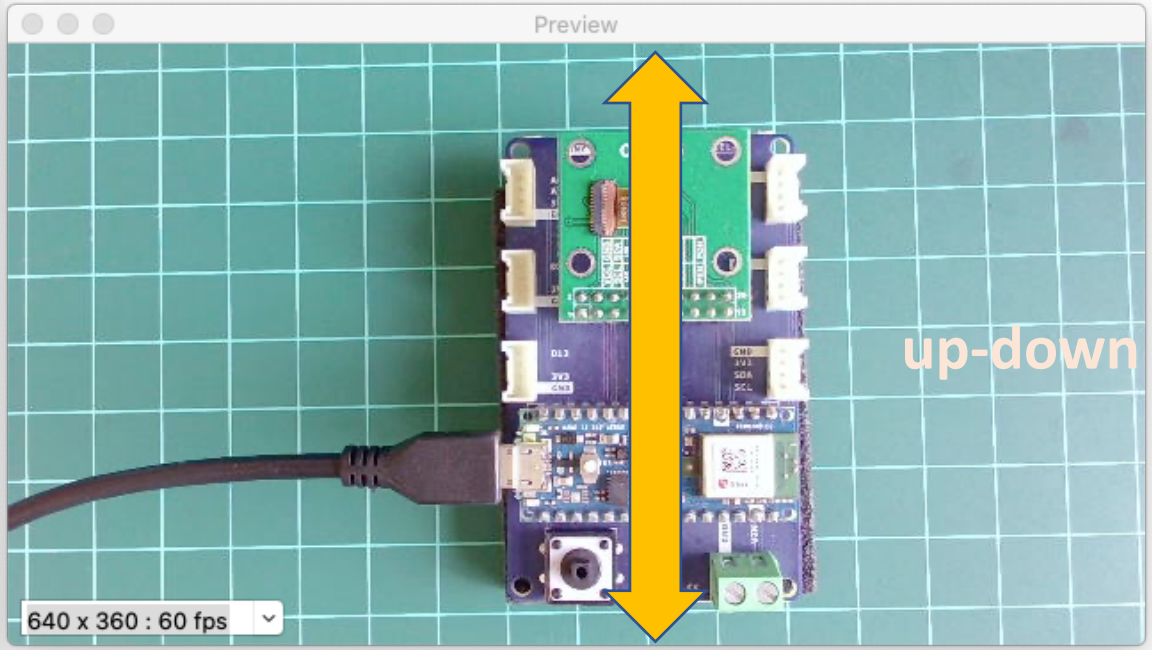


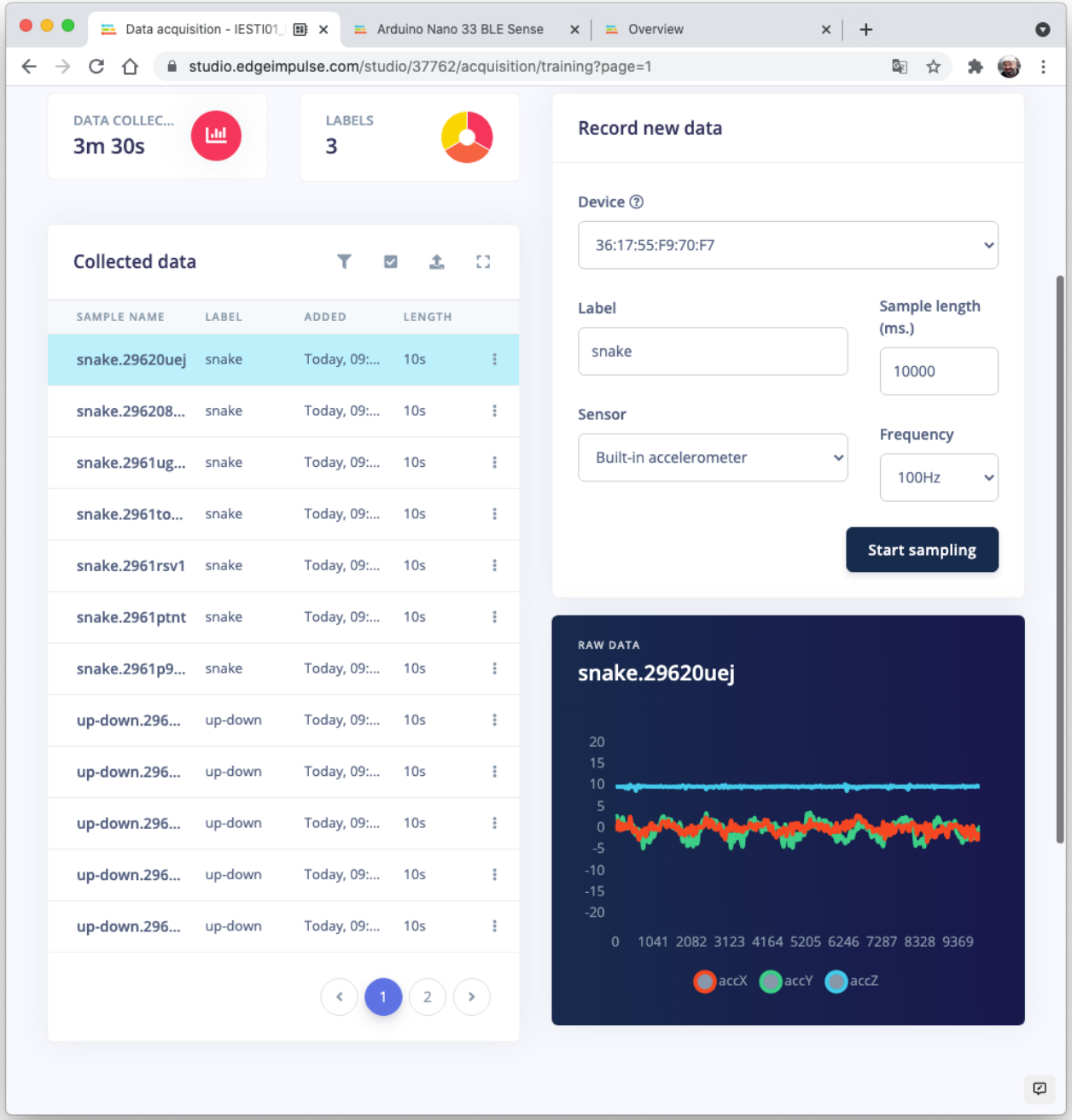
If conection broken during data capture, press Nano-33 Reset button once and, start over reconecting it, via Web-USB

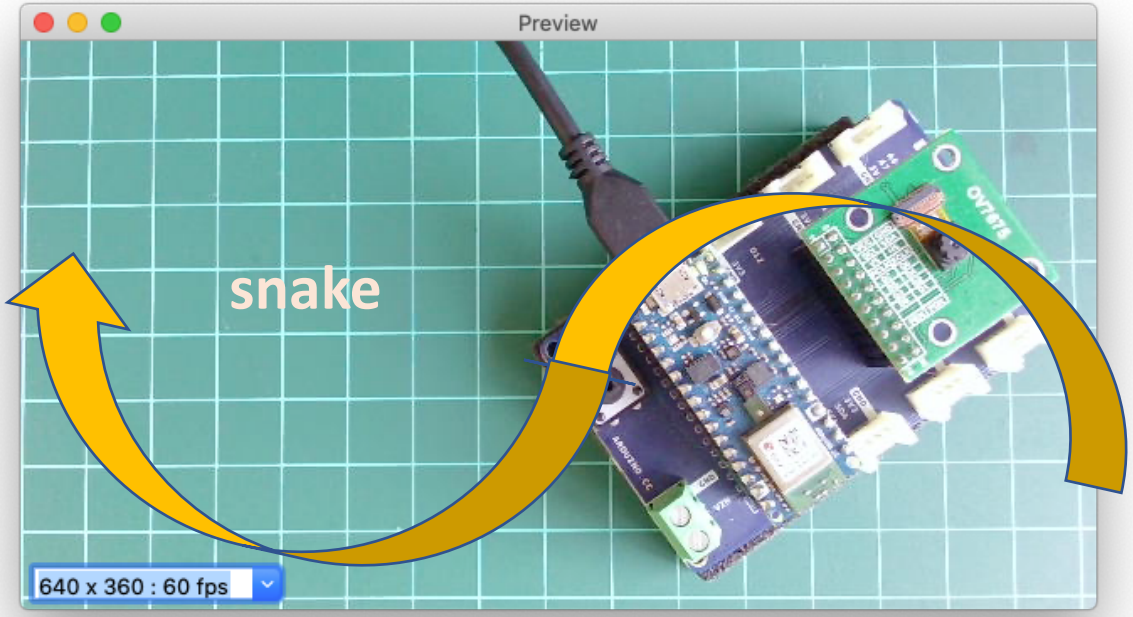

Data acquisition - IE
Arduino Nano 33 BLE Se
Overview
right left - Pesquisa Goo
studio.edgeimpulse.com/studio/37762/acquisition/training?page=2
Did you know? You can capture data from any device or development board, or upload your existing datasets - Show options
DATA COLLEC...
3m 30s
LABELS
3
Collected data
SAMPLE NAME
LABEL
ADDED
LENGTH
up-down.296... up-down Today, 09:... 10s
up-down.296... up-down Today, 09:... 10s
left_right.296... left_right Today, 09:... 10s
left_right.296... left_right Today, 09:... 10s
left_right.296... left_right Today, 09:... 10s
left_right.296... left_right Today, 09:... 10s
left_right.296... left_right Today, 09:... 10s
left_right.296... left_right Today, 09:... 10s
left_right.296... left_right Today, 09:... 10s
left_right.296... left_right Today, 09:... 10s
1
2
Record new data
Device
36:17:55:F9:70:F7
Label
left-right
Sample length (ms.)
10000
Sensor
Built-in accelerometer
Frequency
100Hz
Start sampling
RAW DATA
left_right.2961b6lf
20
15
10
5
0
-5
-10
-15
-20
0 1040 2080 3120 4160 5200 6240 7280 8320 9360
accX
accY
accZ


Preview
OV7675
left-right
640 x 360 : 60 fps


Data acquisition - IESTI01
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/acquisition/training?page=1
DATA COLLEC...
2m 10s
LABELS
2
Collected data
SAMPLE NAME
LABEL
ADDED
LENGTH
up-down.296... up-down Today, 09:... 10s
left_right.296... left_right Today, 09:... 10s
Record new data
Device
36:17:55:F9:70:F7
Label
up-down
Sample length (ms.)
10000
Sensor
Built-in accelerometer
Frequency
100Hz
Start sampling
RAW DATA
up-down.2961m7fm
20
15
10
5
0
-5
-10
-15
-20
0 1041 2082 3123 4164 5205 6246 7287 8328 9369
accX
accY
accZ
1
2
https://studio.edgeimpulse.com/studio/37762/acquisition/training?page=1#!
arduino-nano-33....zip
Show All


Preview
up-down
640 x 360 : 60 fps


Data acquisition - IESTI01
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/acquisition/training?page=1
DATA COLLEC...
3m 30s
LABELS
3
Collected data
SAMPLE NAME
LABEL
ADDED
LENGTH
snake.29620uej snake Today, 09:... 10s
snake.296208... snake Today, 09:... 10s
snake.2961ug... snake Today, 09:... 10s
snake.2961to... snake Today, 09:... 10s
snake.2961rsv1 snake Today, 09:... 10s
snake.2961ptnt snake Today, 09:... 10s
snake.2961p9... snake Today, 09:... 10s
up-down.296... up-down Today, 09:... 10s
up-down.296... up-down Today, 09:... 10s
up-down.296... up-down Today, 09:... 10s
up-down.296... up-down Today, 09:... 10s
up-down.296... up-down Today, 09:... 10s
1
2
Record new data
Device
36:17:55:F9:70:F7
Label
snake
Sample length (ms.)
10000
Sensor
Built-in accelerometer
Frequency
100Hz
Start sampling
RAW DATA
snake.29620uej
20
15
10
5
0
-5
-10
-15
-20
0 1041 2082 3123 4164 5205 6246 7287 8328 9369
accX
accY
accZ


Preview
snake
640 x 360 : 60 fps

Data acquisition - IE | Arduino Nano 33 BLE Se | Overview | right left - Pesquisa Goo

studio.edgeimpulse.com/studio/37762/acquisition/training?page=1

Did you know? You can capture data from any device or development board, or upload your existing datasets - Show options

DATA COLLEC...
4m 40s

LABELS
4

Collected data

SAMPLE NAME	LABEL	ADDED	LENGTH
idle.296391i5	idle	Today, 09:...	10s
idle.29638777	idle	Today, 09:...	10s
idle.29636mpq	idle	Today, 09:...	10s
idle.296365s6	idle	Today, 09:...	10s
idle.29635k0p	idle	Today, 09:...	10s
idle.296351me	idle	Today, 09:...	10s
idle.29634d9b	idle	Today, 09:...	10s
snake.29620uej	snake	Today, 09:...	10s
snake.296208...	snake	Today, 09:...	10s
snake.2961ug...	snake	Today, 09:...	10s
snake.2961to...	snake	Today, 09:...	10s
snake.2961rsv1	snake	Today, 09:...	10s

1 2 3

Record new data

Device
36:17:55:F9:70:F7

Label
idle

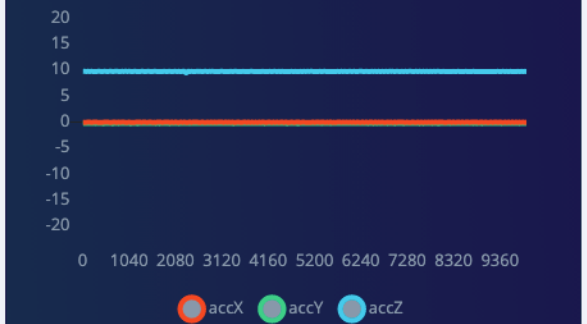
Sample length (ms.)
10000

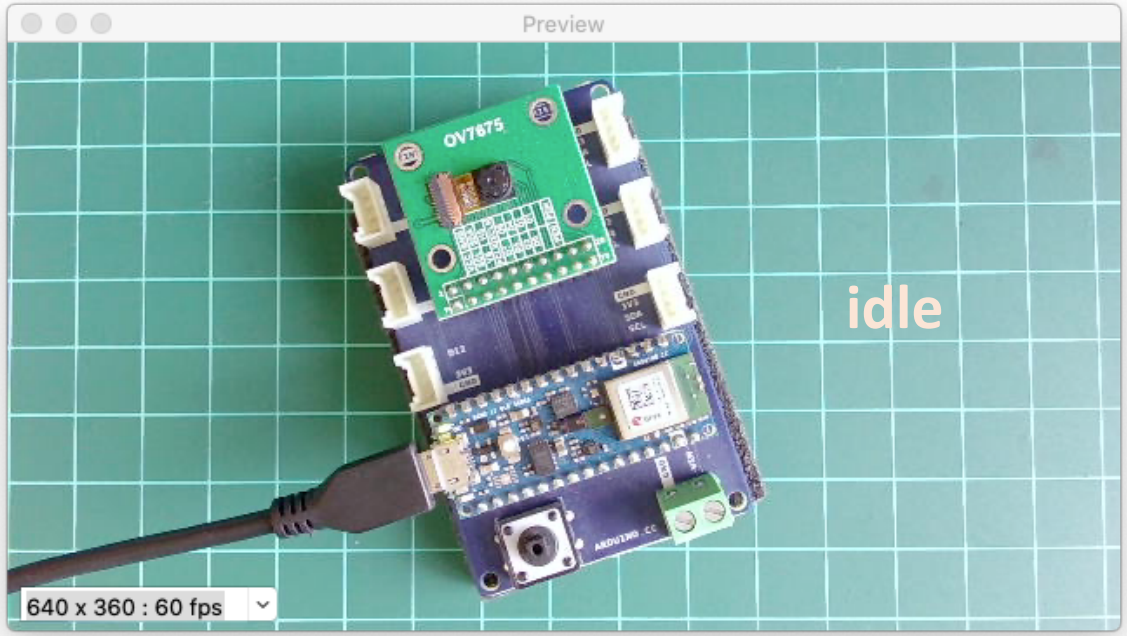
Sensor
Built-in accelerometer

Frequency
100Hz

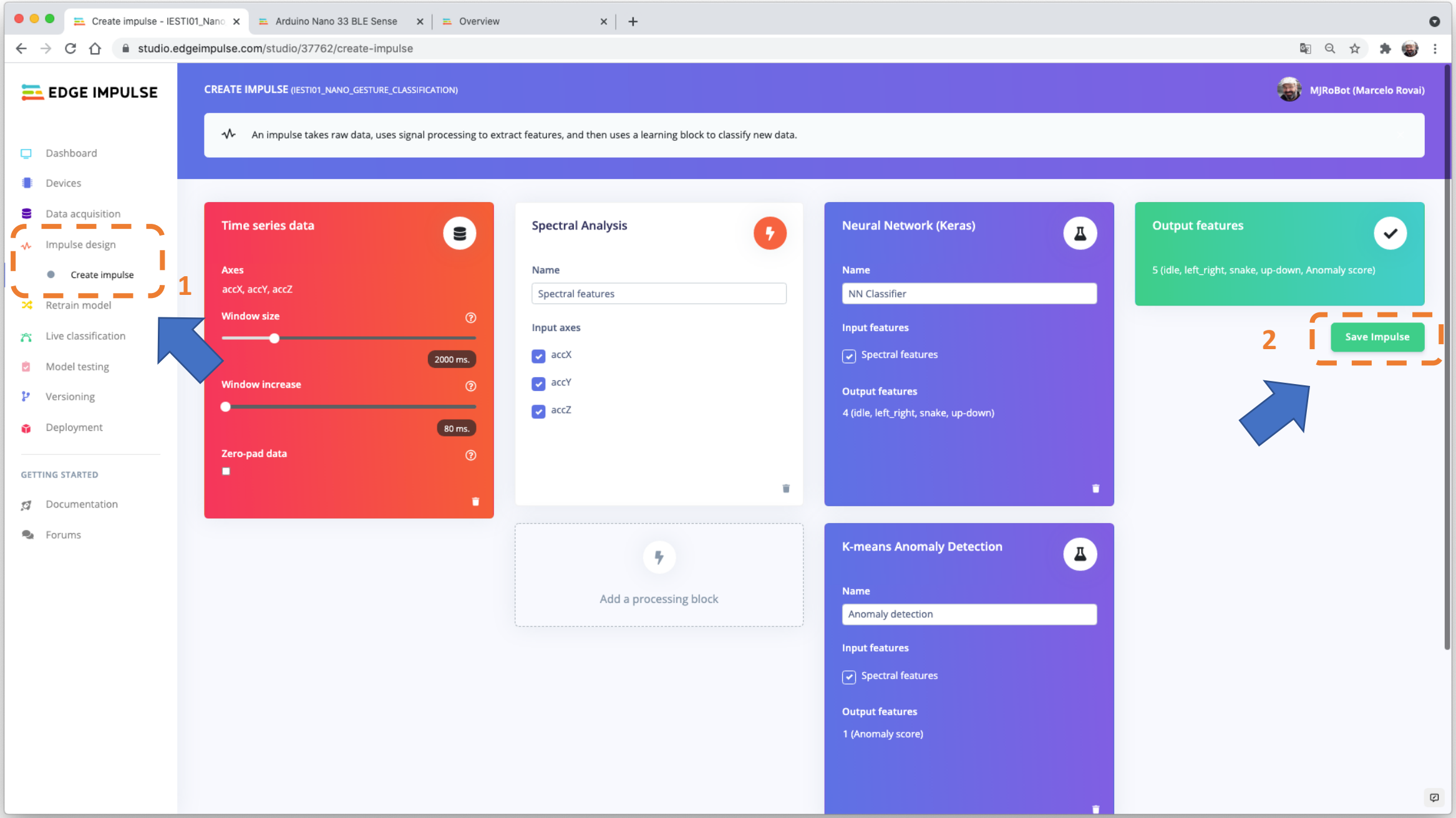
Start sampling

RAW DATA
idle.296391i5





Feature Engineering and Model training


Create impulse - IESTI01_Nano
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/create-impulse
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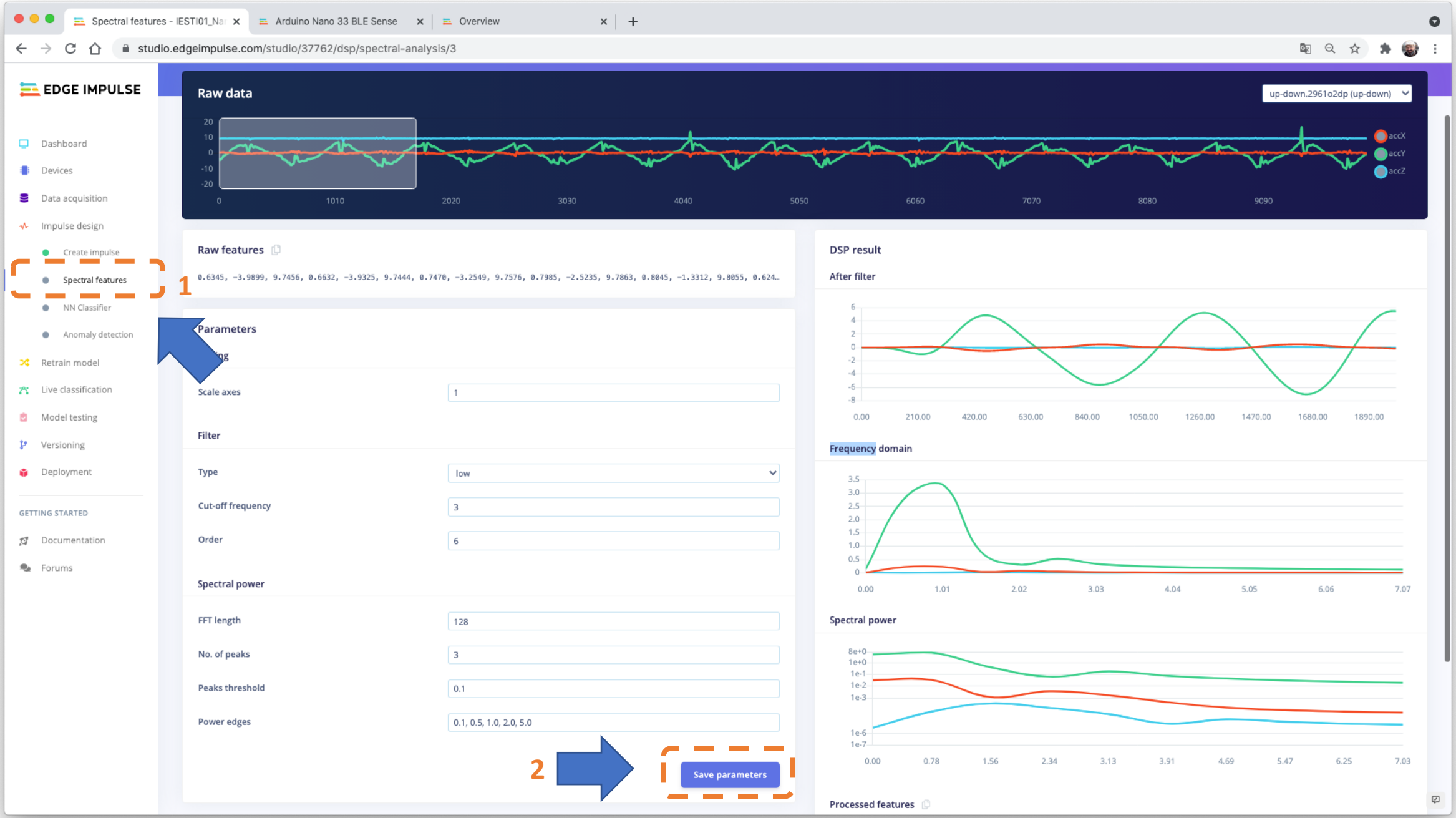
CREATE IMPULSE (IESTI01_NANO_GESTURE_CLASSIFICATION)
MJRoBot (Marcelo Rovai)
An impulse takes raw data, uses signal processing to extract features, and then uses a learning block to classify new data.
1
Time series data
Axes
accX, accY, accZ
Window size
2000 ms.
Window increase
80 ms.
Zero-pad data
Spectral Analysis
Name
Spectral features
Input axes
accX
accY
accZ
Add a processing block
Neural Network (Keras)
Name
NN Classifier
Input features
Spectral features
Output features
4 (idle, left_right, snake, up-down)
K-means Anomaly Detection
Name
Anomaly detection
Input features
Spectral features
Output features
1 (Anomaly score)
Output features
5 (idle, left_right, snake, up-down, Anomaly score)
2
Save Impulse


Spectral features - IESTI01_Na
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/dsp/spectral-analysis/3
EDGE IMPULSE
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1
Raw data
up-down.2961o2dp (up-down)
accX
accY
accZ
Raw features
0.6345, -3.9899, 9.7456, 0.6632, -3.9325, 9.7444, 0.7470, -3.2549, 9.7576, 0.7985, -2.5235, 9.7863, 0.8045, -1.3312, 9.8055, 0.624…
Parameters
Scale axes
1
Filter
Type
low
Cut-off frequency
3
Order
6
Spectral power
FFT length
128
No. of peaks
3
Peaks threshold
0.1
Power edges
0.1, 0.5, 1.0, 2.0, 5.0
2
Save parameters
DSP result
After filter
Frequency domain
Spectral power
Processed features

Spectral features - IESTI01_Na | Arduino Nano 33 BLE Sense | Overview

studio.edgeimpulse.com/studio/37762/dsp/spectral-analysis/3/generate-features

EDGE IMPULSE

- Dashboard
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  - NN Classifier
  - Anomaly detection
- Retrain model
- Live classification
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GETTING STARTED

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- Forums

SPECTRAL FEATURES (IESTI01_NANO_GESTURE_CLASSIFICATION)

MJRoBot (Marcelo Rovai)

Parameters | Generate features

Training set

1

Data in training set	4m 40s
Classes	4 (idle, left_right, snake, up-down)
Window length	2000 ms.
Window increase	80 ms.
Training windows	2,828

Generate features 2

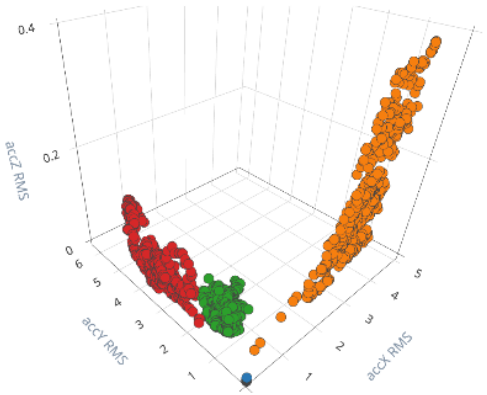
Feature generation output

```
Scheduling job in cluster...
Job started
Creating windows from 28 files...
[ 1/28] Creating windows from files...
[28/28] Creating windows from files...
Created 2828 windows: idle: 707, left_right: 707, snake: 707, up-down: 707

Creating features
[   1/2828] Creating features...
[1053/2828] Creating features...
[2110/2828] Creating features...
[2828/2828] Creating features...
Created features

Job completed
```

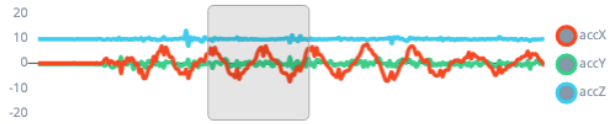
Feature explorer (2,828 samples)

X Axis: accX RMS | Y Axis: accY RMS | Z Axis: accZ RMS

- idle
- left_right
- snake
- up-down



left_right.29619fp9
Window: 3360 - 5360 ms.
Label: left_right
View sample
View features



On-device performance

PROCESSING TIME
9 ms.

PEAK RAM USAGE
5 KB

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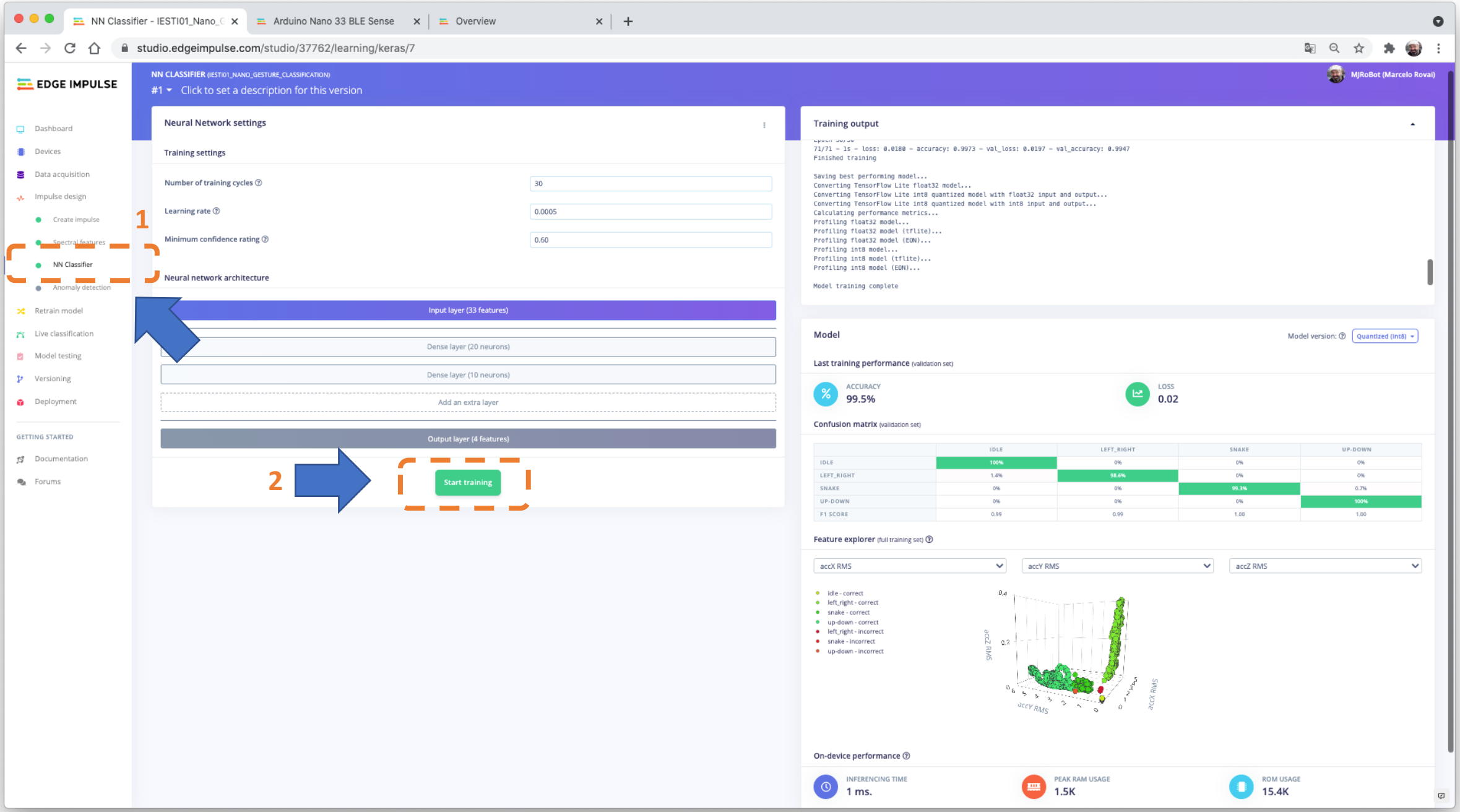
NN Classifier - IESTI01_Nano_
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/learning/keras/7
EDGE IMPULSE
NN CLASSIFIER (IESTI01_NANO_GESTURE_CLASSIFICATION)
#1 Click to set a description for this version
MJRoBot (Marcelo Rovai)
Dashboard
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Spectral features
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Anomaly detection
Retrain model
Live classification
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GETTING STARTED
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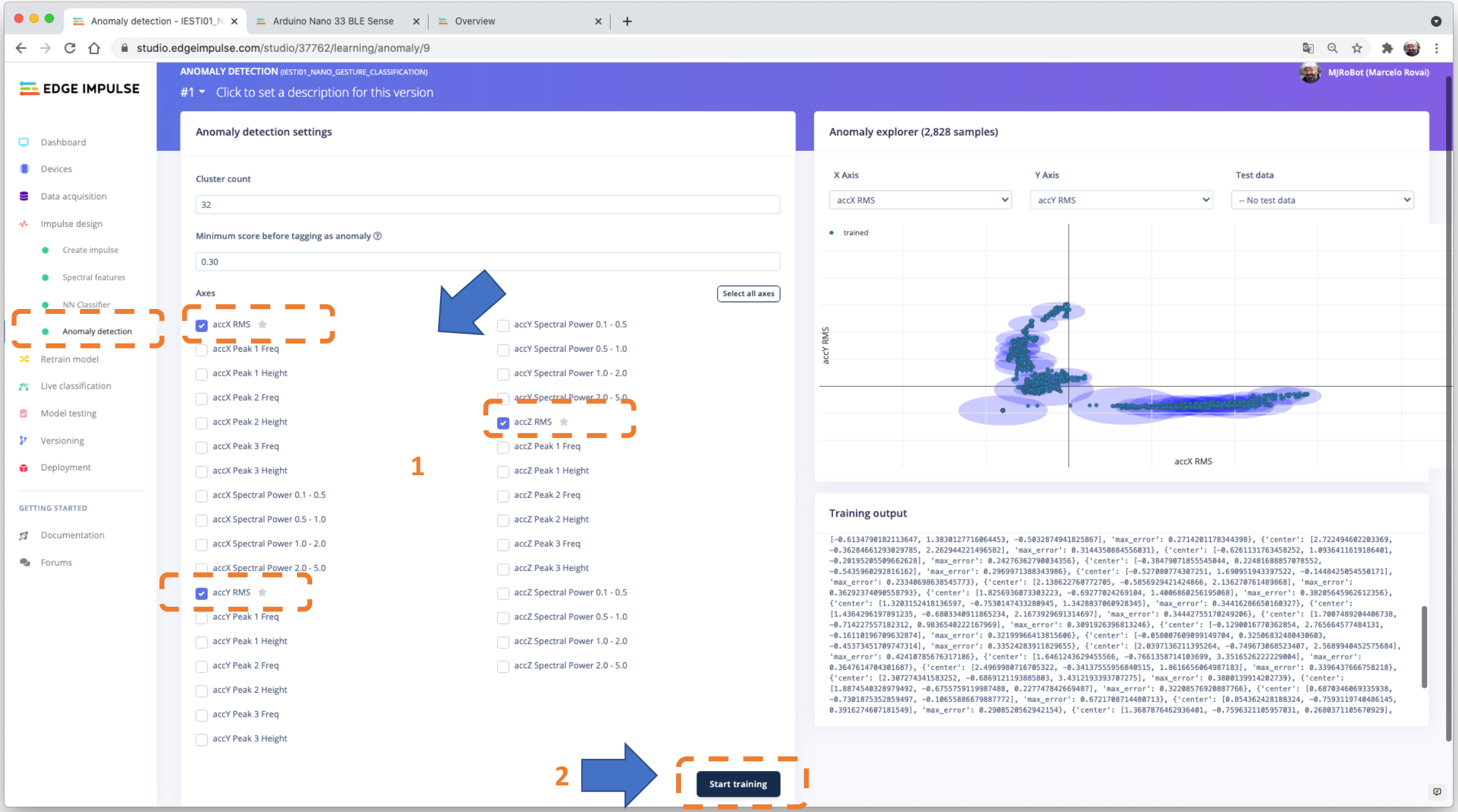
1
Neural Network settings
Training settings
Number of training cycles 30
Learning rate 0.0005
Minimum confidence rating 0.60
Neural network architecture
Input layer (33 features)
Dense layer (20 neurons)
Dense layer (10 neurons)
Add an extra layer
Output layer (4 features)
2
Start training
Training output
71/71 - 1s - loss: 0.0180 - accuracy: 0.9973 - val_loss: 0.0197 - val_accuracy: 0.9947
Finished training
Saving best performing model...
Converting TensorFlow Lite float32 model...
Converting TensorFlow Lite int8 quantized model with float32 input and output...
Converting TensorFlow Lite int8 quantized model with int8 input and output...
Calculating performance metrics...
Profiling float32 model...
Profiling float32 model (tflite)...
Profiling float32 model (EON)...
Profiling int8 model...
Profiling int8 model (tflite)...
Profiling int8 model (EON)...
Model training complete
Model
Model version: Quantized (int8)
Last training performance (validation set)
ACCURACY 99.5%
LOSS 0.02
Confusion matrix (validation set)
IDLE LEFT_RIGHT SNAKE UP-DOWN
IDLE 100% 0% 0% 0%
LEFT_RIGHT 1.4% 98.6% 0% 0%
SNAKE 0% 0% 99.3% 0.7%
UP-DOWN 0% 0% 0% 100%
F1 SCORE 0.99 0.99 1.00 1.00
Feature explorer (full training set)
accX RMS
accY RMS
accZ RMS
idle - correct
left_right - correct
snake - correct
up-down - correct
left_right - incorrect
snake - incorrect
up-down - incorrect
On-device performance
INFERENCING TIME 1 ms.
PEAK RAM USAGE 1.5K
ROM USAGE 15.4K


Anomaly detection - IESTI01_N
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/learning/anomaly/9
EDGE IMPULSE
ANOMALY DETECTION (IESTI01_NANO_GESTURE_CLASSIFICATION)
#1 Click to set a description for this version
MJRoBot (Marcelo Rovai)
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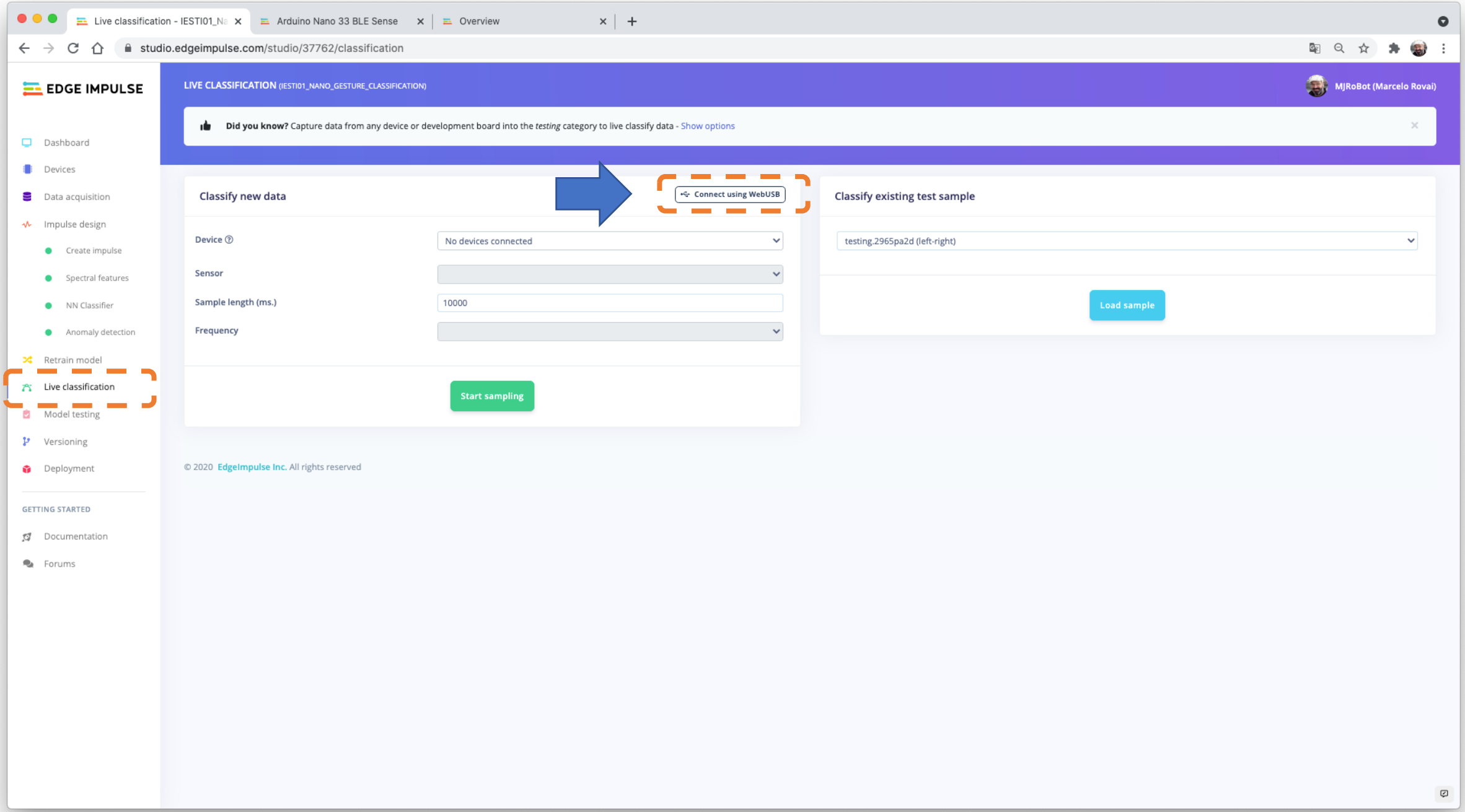
Anomaly detection settings
Cluster count
32
Minimum score before tagging as anomaly
0.30
Axes
Select all axes
accX RMS
accX Peak 1 Freq
accX Peak 1 Height
accX Peak 2 Freq
accX Peak 2 Height
accX Peak 3 Freq
accX Peak 3 Height
accX Spectral Power 0.1 - 0.5
accX Spectral Power 0.5 - 1.0
accX Spectral Power 1.0 - 2.0
accX Spectral Power 2.0 - 5.0
accY RMS
accY Peak 1 Freq
accY Peak 1 Height
accY Peak 2 Freq
accY Peak 2 Height
accY Peak 3 Freq
accY Peak 3 Height
accY Spectral Power 0.1 - 0.5
accY Spectral Power 0.5 - 1.0
accY Spectral Power 1.0 - 2.0
accY Spectral Power 2.0 - 5.0
accZ RMS
accZ Peak 1 Freq
accZ Peak 1 Height
accZ Peak 2 Freq
accZ Peak 2 Height
accZ Peak 3 Freq
accZ Peak 3 Height
accZ Spectral Power 0.1 - 0.5
accZ Spectral Power 0.5 - 1.0
accZ Spectral Power 1.0 - 2.0
accZ Spectral Power 2.0 - 5.0
1
2
Start training
Anomaly explorer (2,828 samples)
X Axis
Y Axis
Test data
accX RMS
accY RMS
-- No test data
trained
accY RMS
accX RMS
Training output
[-0.6134790182113647, 1.3830127716064453, -0.5032874941825867], 'max_error': 0.2714201178344398}, {'center': [2.722494602203369, -0.3628466129302978 5, 2.262944221496582], 'max_error': 0.3144350884556031}, {'center': [-0.6261131763458252, 1.0936411619186401, -0.20195205509662628], 'max_error': 0.24276362790034356}, {'center': [-0.38479071855545044, 0.22481688857078552, -0.5435960292816162], 'max_error': 0.2969971388343986}, {'center': [-0.527080774307251, 1.690951943397522, -0.1448425054550171], 'max_error': 0.23340698638545773}, {'center': [2.138622760772705, -0.5856929421424866, 2.136270761489868], 'max_error': 0.3629237409055879 3}, {'center': [1.8256936073303223, -0.69277024269104, 1.4006860256195068], 'max_error': 0.38205645962612356}, {'center': [1.3203152418136597, -0.7530147433280945, 1.3428837060928345], 'max_error': 0.34416286650160327}, {'center': [1.4364296197891235, -0.6803340911865234, 2.1673929691314697], 'max_error': 0.34442755170249206}, {'center': [1.7007489204406738, -0.714227557182312, 0.9836540222167969], 'max_error': 0.3091926396813246}, {'center': [-0.1290016770362854, 2.765664577484131, -0.16110196709632874], 'max_error': 0.32199966413815606}, {'center': [-0.05800760909914970 4, 0.3250683248043060 3, -0.4537345170974731 4], 'max_error': 0.33524283911829655}, {'center': [2.0397136211395264, -0.749673068523407, 2.5689940452575684], 'max_error': 0.42410785676317186}, {'center': [1.6461243629455566, -0.7661358714103699, 3.3516526222229004], 'max_error': 0.3647614704301687}, {'center': [2.4969980716705322, -0.34137555956840515, 1.8616656064987183], 'max_error': 0.3396437666758218}, {'center': [2.307274341583252, -0.6869121193885803, 3.4312193393707275], 'max_error': 0.3800139914202739}, {'center': [1.8874540328979492, -0.6755759119987488, 0.227747842669487], 'max_error': 0.32208576920887766}, {'center': [0.6870346069335938, -0.7301875352859497, -0.10655886679887772], 'max_error': 0.6721708714480713}, {'center': [0.854362428188324, -0.7593119740486145, 0.3916274607181549], 'max_error': 0.2908520562942154}, {'center': [1.3687876462936401, -0.7596321105957031, 0.2680371105670929],

Model testing


Live classification - IESTI01_Na
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/classification
EDGE IMPULSE
LIVE CLASSIFICATION (IESTI01_NANO_GESTURE_CLASSIFICATION)
MJRoBot (Marcelo Rovai)
Did you know? Capture data from any device or development board into the testing category to live classify data - Show options
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Classify new data
Connect using WebUSB
Device
No devices connected
Sensor
Sample length (ms.)
10000
Frequency
Start sampling
Classify existing test sample
testing.2965pa2d (left-right)
Load sample
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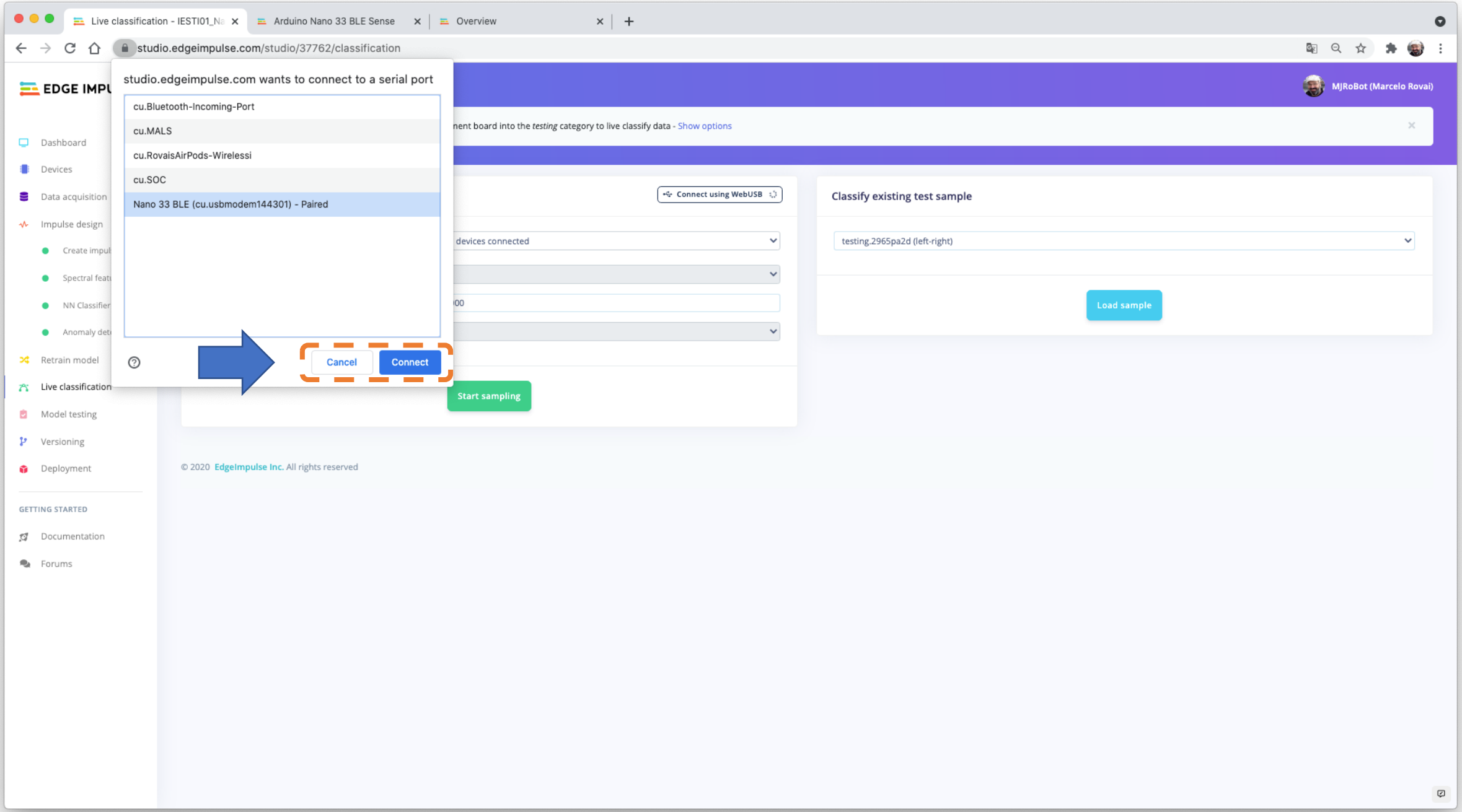
Live classification - IESTI01_Na
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/classification
studio.edgeimpulse.com wants to connect to a serial port
cu.Bluetooth-Incoming-Port
cu.MALS
cu.RovaisAirPods-Wirelessi
cu.SOC
Nano 33 BLE (cu.usbmodem144301) - Paired
Cancel
Connect
MJRoBot (Marcelo Rovai)
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Connect using WebUSB
devices connected
Start sampling
Classify existing test sample
testing.2965pa2d (left-right)
Load sample
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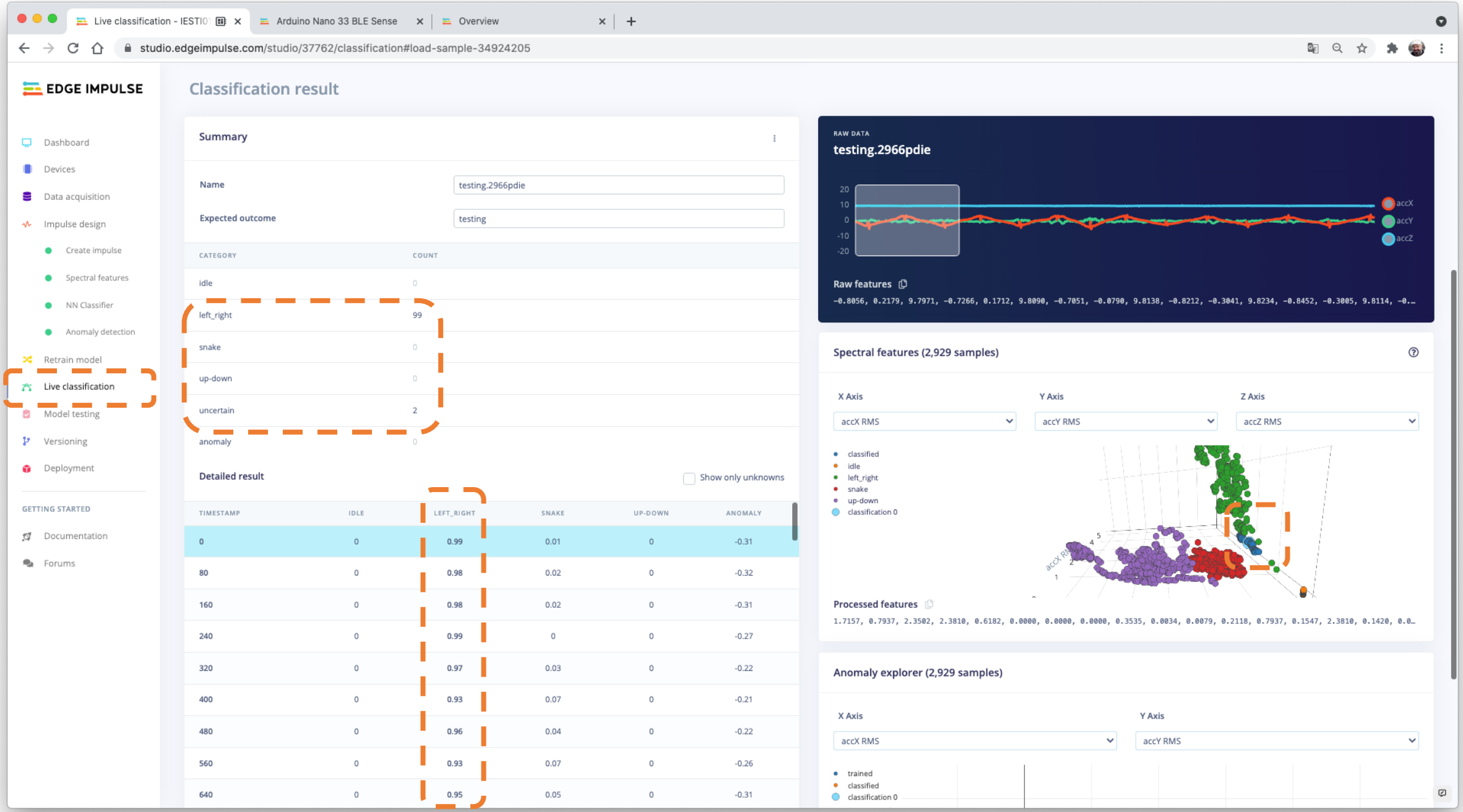
Live classification - IESTI0
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/classification#load-sample-34924205
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Classification result
Summary
Name
testing.2966pdie
Expected outcome
testing
CATEGORY
COUNT
idle 0
left_right 99
snake 0
up-down 0
uncertain 2
anomaly 0
Detailed result
Show only unknowns
TIMESTAMP
IDLE
LEFT_RIGHT
SNAKE
UP-DOWN
ANOMALY
0 0 0.99 0.01 0 -0.31
80 0 0.98 0.02 0 -0.32
160 0 0.98 0.02 0 -0.31
240 0 0.99 0 0 -0.27
320 0 0.97 0.03 0 -0.22
400 0 0.93 0.07 0 -0.21
480 0 0.96 0.04 0 -0.22
560 0 0.93 0.07 0 -0.26
640 0 0.95 0.05 0 -0.31
RAW DATA
testing.2966pdie
20
10
0
-10
-20
accX
accY
accZ
Raw features
−0.8056, 0.2179, 9.7971, −0.7266, 0.1712, 9.8090, −0.7051, −0.0790, 9.8138, −0.8212, −0.3041, 9.8234, −0.8452, −0.3005, 9.8114, −0.…
Spectral features (2,929 samples)
X Axis
Y Axis
Z Axis
accX RMS
accY RMS
accZ RMS
classified
idle
left_right
snake
up-down
classification 0
Processed features
1.7157, 0.7937, 2.3502, 2.3810, 0.6182, 0.0000, 0.0000, 0.0000, 0.3535, 0.0034, 0.0079, 0.2118, 0.7937, 0.1547, 2.3810, 0.1420, 0.0…
Anomaly explorer (2,929 samples)
X Axis
Y Axis
accX RMS
accY RMS
trained
classified
classification 0

Live classification - IESTI0 | Arduino Nano 33 BLE Sense | Overview

studio.edgeimpulse.com/studio/37762/classification#load-sample-34924191

EDGE IMPULSE

- Dashboard
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  - Anomaly detection
- Retrain model
- Live classification
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GETTING STARTED

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Classification result

Summary

Name	testing.2966l26d
Expected outcome	testing

CATEGORY	COUNT
idle	0
left_right	0
snake	7
up-down	87
uncertain	7
anomaly	0

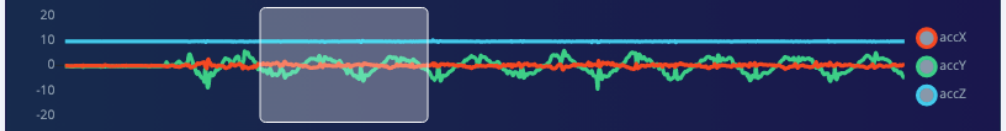
Detailed result

Show only unknowns

TIMESTAMP	IDLE	LEFT_RIGHT	SNAKE	UP-DOWN	ANOMALY
400	0.06	0.06	0.63	0.25	-0.08
480	0.04	0.06	0.58	0.31	-0.09
560	0	0.02	0.95	0.03	-0.09
640	0	0.02	0.92	0.06	-0.10
720	0	0.01	0.83	0.16	-0.08
800	0	0.01	0.49	0.49	-0.05
880	0	0	0.85	0.14	-0.02
960	0	0	0.58	0.42	-0.04
1040	0	0	0.31	0.69	-0.05

RAW DATA

testing.2966l26d

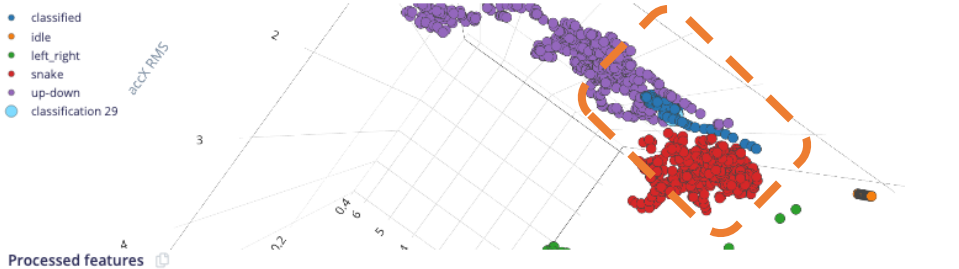


Raw features

0.5519, -1.0738, 9.8102, 0.6273, -1.1217, 9.8246, 0.4956, -1.1205, 9.7923, 0.5004, -1.4533, 9.7959, 1.0391, -2.1308, 9.7851, 0.8021…

Spectral features (2,929 samples)

X Axis: accX RMS | Y Axis: accY RMS | Z Axis: accZ RMS



Processed features

0.3685, 0.7937, 0.4497, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0129, 0.0052, 0.0003, 2.3360, 0.7937, 2.5732, 3.1746, 0.3635, 0.0…

Anomaly explorer (2,929 samples)

X Axis: accX RMS | Y Axis: accY RMS

Live classification - IESTI0 | Arduino Nano 33 BLE Sense | Overview

studio.edgeimpulse.com/studio/37762/classification#load-sample-34929236

EDGE IMPULSE

- Dashboard
- Devices
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  - NN Classifier
  - Anomaly detection
- Retrain model
- Live classification
- Model testing
- Versioning
- Deployment

GETTING STARTED

- Documentation
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Classification result

Summary

Name: testing.29675kbr

Expected outcome: testing

CATEGORY	COUNT
idle	22
left_right	0
snake	65
up-down	0
uncertain	14
anomaly	0

Detailed result

Show only unknowns

TIMESTAMP	IDLE	LEFT_RIGHT	SNAKE	UP-DOWN	ANOMALY
2000	0.31	0.05	0.64	0	-0.17
2080	0.03	0.03	0.94	0	-0.17
2160	0.27	0.04	0.69	0	-0.17
2240	0.21	0.04	0.75	0	-0.17
2320	0.35	0.05	0.59	0.02	-0.17
2400	0.27	0.05	0.67	0	-0.19
2480	0.30	0.07	0.63	0	-0.18
2560	0.79	0.10	0.10	0	-0.19
2640	0.02	0.15	0.84	0	-0.18

RAW DATA

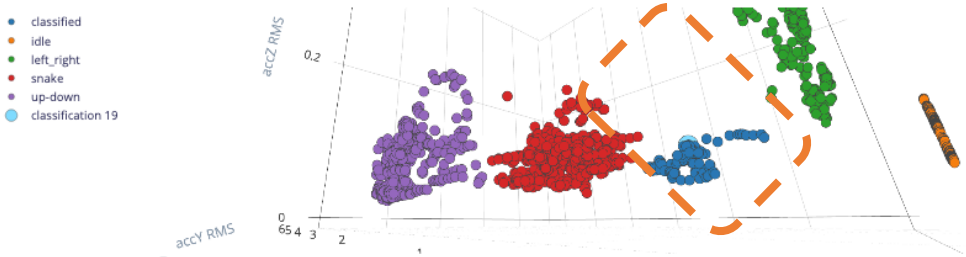
testing.29675kbr

Raw features

0.2658, 0.1508, 9.8067, 0.0838, 0.4178, 9.8222, 0.0084, 0.5279, 9.7875, -0.0958, 0.4764, 9.8090, -0.1520, -0.0503, 9.8150, -0.1879,…

Spectral features (2,929 samples)

X Axis: accX RMS | Y Axis: accY RMS | Z Axis: accZ RMS



Processed features

0.2145, 3.1746, 0.1163, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0012, 0.0002, 0.0003, 0.5103, 0.0000, 0.0000, 0.0000, 0.0000, 0.0…

Anomaly explorer (2,929 samples)

X Axis: accX RMS | Y Axis: accY RMS

Live classification - IESTI0 | Arduino Nano 33 BLE Sense | Overview

studio.edgeimpulse.com/studio/37762/classification#load-sample-34931252

EDGE IMPULSE

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GETTING STARTED

- Documentation
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Classification result

Summary

Name: testing.2968kh59

Expected outcome: idle

CATEGORY	COUNT
idle	101
left_right	0
snake	0
up-down	0
uncertain	0
anomaly	0

Detailed result

Show only unknowns

TIMESTAMP	IDLE	LEFT_RIGHT	SNAKE	UP-DOWN	ANOMALY
480	0.98	0	0	0	-0.51
560	0.98	0	0	0	-0.51
640	0.98	0	0	0	-0.51
720	0.98	0	0	0	-0.51
800	0.98	0	0	0	-0.51
880	0.98	0	0	0	-0.51
960	0.98	0	0	0	-0.51
1040	0.98	0	0	0	-0.50
1120	0.98	0	0	0	-0.50

RAW DATA

testing.2968kh59

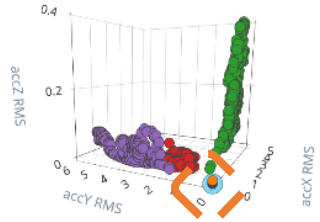
Raw features

0.0132, -0.1832, 9.8019, 0.0156, -0.1951, 9.7959, 0.0239, -0.1879, 9.7971, 0.0084, -0.1796, 9.8055, 0.0144, -0.1856, 9.8078, 0.0168…

Spectral features (2,929 samples)

X Axis: accX RMS | Y Axis: accY RMS | Z Axis: accZ RMS

- classified
- idle
- left_right
- snake
- up-down
- classification 0



Processed features

0.0016, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0012, 0.0000, 0.0000, 0.0000, 0.0000, 0.0…

Anomaly explorer (2,929 samples)

X Axis: accX RMS | Y Axis: accY RMS

- trained
- classified
- classification 0

Live classification - IESTI0 | Arduino Nano 33 BLE Sense | Overview

studio.edgeimpulse.com/studio/37762/classification#load-sample-34929936

EDGE IMPULSE

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  - Anomaly detection
- Retrain model
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- Versioning
- Deployment

GETTING STARTED

- Documentation
- Forums

Summary

Name: testing.2967slu4

Expected outcome: testing

CATEGORY	COUNT
idle	0
left_right	0
snake	0
up-down	0
certa	0
anomaly	101

Detailed result — Show only unknowns

TIMESTAMP	IDLE	LEFT_RIGHT	SNAKE	UP-DOWN	ANOMALY
80	0	0.92	0	0.08	45.07
160	0	1.00	0	0	45.56
240	0	1.00	0	0	45.82
320	0	0.95	0	0.05	46.00
400	0	1.00	0	0	45.93
480	0	0.30	0	0.70	44.65
560	0	0.95	0	0.05	43.52
640	0	1.00	0	0	42.88
720	0	1.00	0	0	43.07
800	0	1.00	0	0	43.12
880	0	1.00	0	0	42.75

RAW DATA

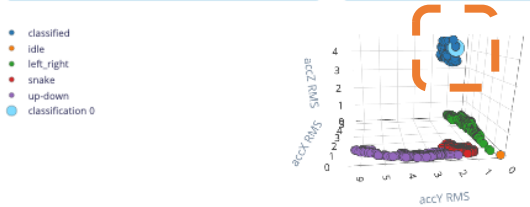
testing.2967slu4

Raw features

0.8775, -2.2051, 6.7576, 0.6907, -1.9201, 7.0210, 0.7590, -1.8567, 7.2377, 0.5507, -1.8675, 7.6555, 0.3316, -2.2817, 8.1918, 0.2023, -2.1069, 8.2744, 0.1532, -1.642…

Spectral features (2,929 samples)

X Axis: accX RMS | Y Axis: accY RMS | Z Axis: accZ RMS

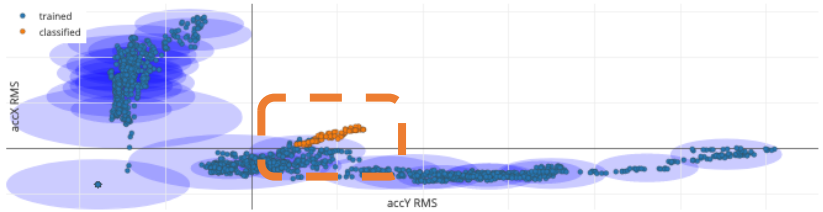


Processed features

1.1784, 0.7937, 1.3914, 4.7619, 0.1173, 0.0000, 0.0000, 0.0000, 0.1239, 0.0162, 0.0049, 1.9500, 0.7937, 2.2970, 3.9683, 0.1699, 0.0000, 0.0000, 0.0000, 0.3377, 0.05…

Anomaly explorer (2,929 samples)

X Axis: accY RMS | Y Axis: accX RMS



Distance from closest cluster

accX RMS: 2.2272, accY RMS: 1.0098, accZ RMS: 45.4578

Model testing - IESTI01_Nano_ | Arduino Nano 33 BLE Sense | Overview

studio.edgeimpulse.com/studio/37762/validation

EDGE IMPULSE

- Dashboard
- Devices
- Data acquisition
- Impulse design
  - Create impulse
  - Spectral features
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- Retrain model
- Live classification
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This lists all test data. You can manage this data through Data acquisition.

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
testing.2968kh59	idle	10s	100%	101 idle
testing.2967slu4	testing	10s		101 anomaly
testing.29675kbr	snake	10s	64%	65 snake, 22 idle, 14 uncertain
testing.2966pdie	left_right	10s	98%	99 left_right, 2 uncertain
testing.2966l26d	up-down	10s	86%	87 up-down, 7 snake, 7 uncertain
testing.2965pa2d	left-right	10s		100 left_right, 1 uncertain

Model testing output

```
Scheduling job in cluster...
Job started
Classifying data for NN Classifier OK

Classifying data for Anomaly detection...
Copying features from DSP block...
Copying features from DSP block OK
Classifying data...
Scheduling job in cluster...
Classifying data for Anomaly detection OK


Job completed
```

Model testing results

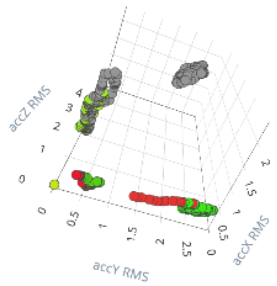
ACCURACY
87.13%

	IDLE	LEFT_RIGHT	SNAKE	UP-DOWN	ANOMALY	UNCERTAIN
IDLE	100%	0%	0%	0%	0%	0%
LEFT_RIGHT	0%	98.0%	0%	0%	0%	2.0%
SNAKE	21.8%	0%	64.4%	0%	0%	13.9%
UP-DOWN	0%	0%	6.9%	86.1%	0%	6.9%
ANOMALY	-	-	-	-	-	-

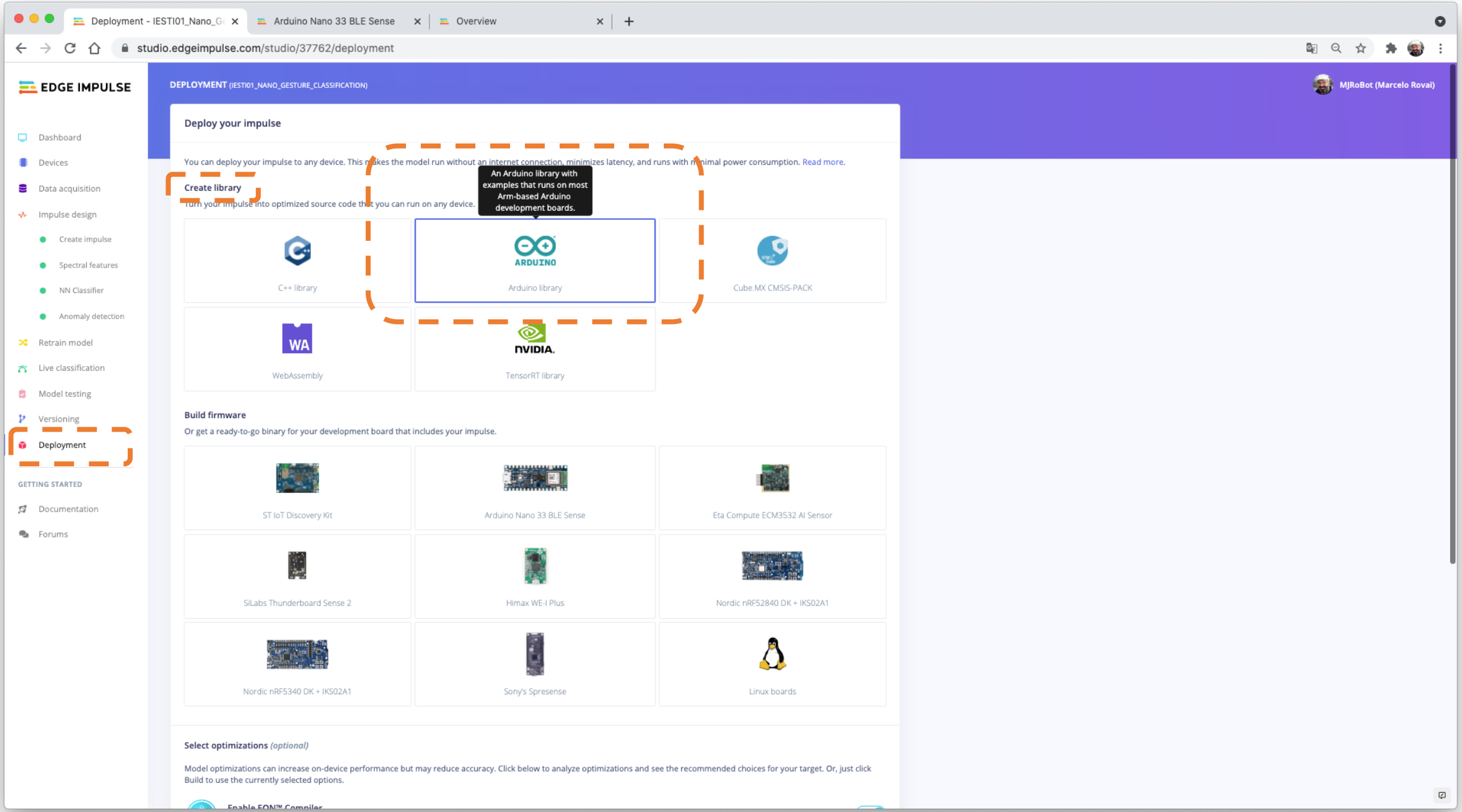
Feature explorer

accX RMS | accY RMS | accZ RMS

- idle - correct
- left_right - correct
- snake - correct
- up-down - correct
- left_right - incorrect
- snake - incorrect
- up-down - incorrect
- left-right
- testing



Model Deployment


Deployment - IESTI01_Nano_G
Arduino Nano 33 BLE Sense
Overview
studio.edgeimpulse.com/studio/37762/deployment
EDGE IMPULSE
DEPLOYMENT (IESTI01_NANO_GESTURE_CLASSIFICATION)
MJRoBot (Marcelo Rovai)
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Spectral features
NN Classifier
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Deploy your impulse
You can deploy your impulse to any device. This makes the model run without an internet connection, minimizes latency, and runs with minimal power consumption. Read more.
Create library
Turn your impulse into optimized source code that you can run on any device.
An Arduino library with examples that runs on most Arm-based Arduino development boards.
C++ library
Arduino library
Cube.MX CMSIS-PACK
WebAssembly
TensorRT library
Build firmware
Or get a ready-to-go binary for your development board that includes your impulse.
ST IoT Discovery Kit
Arduino Nano 33 BLE Sense
Eta Compute ECM3532 AI Sensor
SiLabs Thunderboard Sense 2
Himax WE-I Plus
Nordic nRF52840 DK + IKS02A1
Nordic nRF5340 DK + IKS02A1
Sony's Spresense
Linux boards
Select optimizations (optional)
Model optimizations can increase on-device performance but may reduce accuracy. Click below to analyze optimizations and see the recommended choices for your target. Or, just click Build to use the currently selected options.

Deployment - IESTI01_Nano_G | Arduino Nano 33 BLE Sense | Overview

studio.edgeimpulse.com/studio/37762/deployment

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Nordic nRF5340 DK + IKS02A1

Sony's Spresense

Linux boards

Select optimizations *(optional)*

Model optimizations can increase on-device performance but may reduce accuracy. Click below to analyze optimizations and see the recommended choices for your target. Or, just click Build to use the currently selected options.

Enable EON™ Compiler
Same accuracy, up to 50% less memory. Open source.

Available optimizations for NN Classifier

Quantized (int8)
Currently selected

RAM USAGE	LATENCY
1.5K	1 ms
ROM USAGE	ACCURACY
15.4K	-

Unoptimized (float32)
Click to select

RAM USAGE	LATENCY
1.5K	1 ms
ROM USAGE	ACCURACY
17.8K	-

Analyze optimizations

Estimate for Cortex-M4F 80MHz (ST IoT Discovery Kit)

Build

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Deployment - IESTI01_Nano_G | Arduino Nano 33 BLE Sense | Overview

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EDGE IMPULSE

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SiLabs Thunderboard Sense 2 | Himax WE-I Plus | Nordic nRF52840 DK + IKS02A1

Nordic nRF5340 DK + IKS02A1

Sony's Spresense

Linux boards

Select optimizations *(optional)*

Model optimizations can increase on-device performance but may reduce accuracy. Click below to analyze optimizations and see the recommended choices for your target. Or, just click Build to use the currently selected options.

Enable EON™ Compiler
Same accuracy, up to 50% less memory. Open source.

Available optimizations for NN Classifier

Quantized (int8) ⭐

Currently selected

This optimization is recommended for best performance.

RAM USAGE	LATENCY
1.5K	1 ms
ROM USAGE	ACCURACY
15.4K	87.87%

CONFUSION MATRIX

100	0	0	0	0	0
0	98.0	0	0	0	2.0
20.8	0	67.3	0	0	11.9
0	0	7.9	86.1	0	5.9
-	-	-	-	-	-

Unoptimized (float32)

Click to select

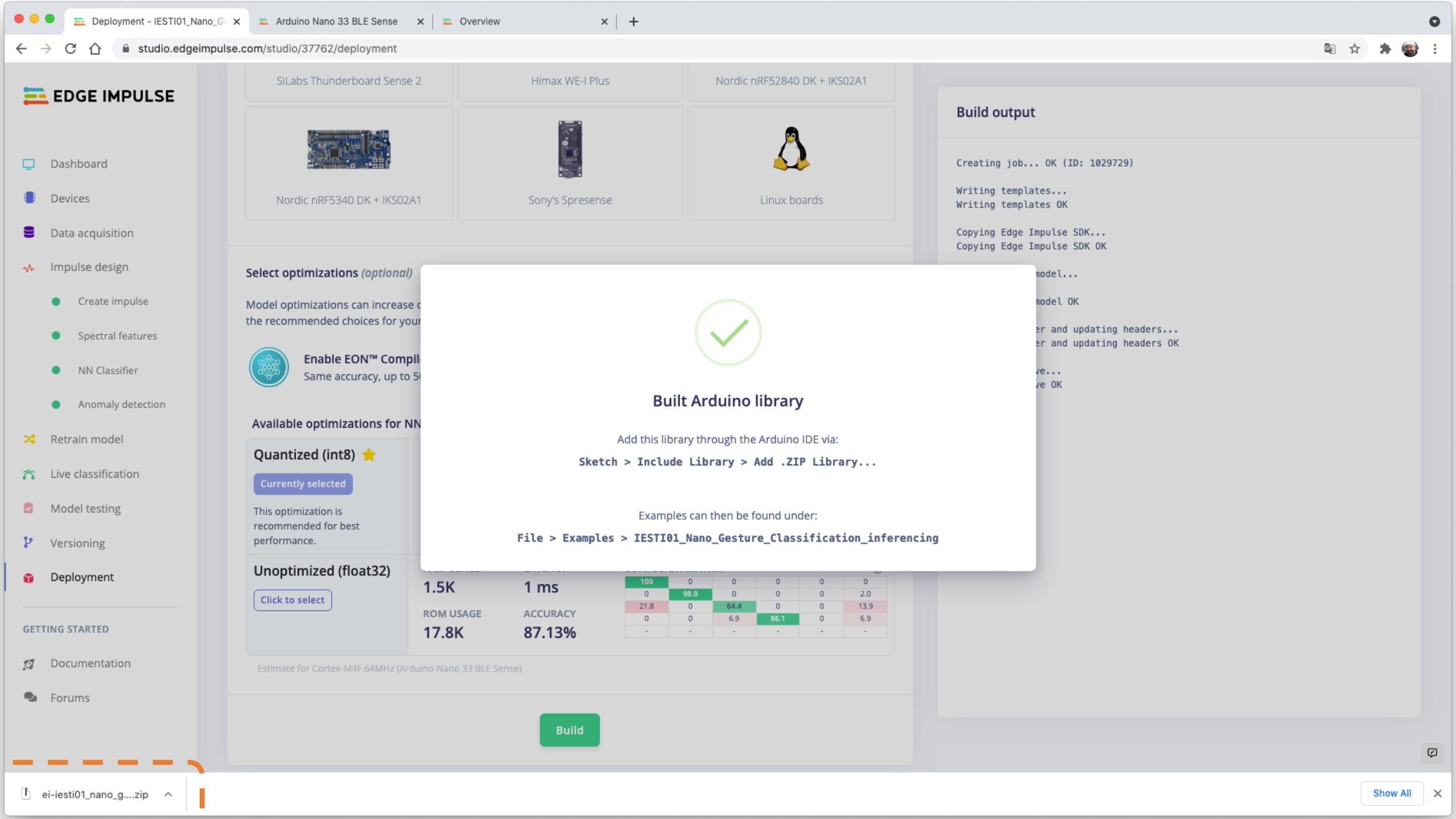
RAM USAGE	LATENCY
1.5K	1 ms
ROM USAGE	ACCURACY
17.8K	87.13%

CONFUSION MATRIX

100	0	0	0	0	0
0	98.0	0	0	0	2.0
21.8	0	64.4	0	0	13.9
0	0	6.9	86.1	0	6.9
-	-	-	-	-	-

Estimate for Cortex-M4F 64MHz (Arduino Nano 33 BLE Sense)

Build


Deployment - IESTI01_Nano_G
Arduino Nano 33 BLE Sense
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EDGE IMPULSE
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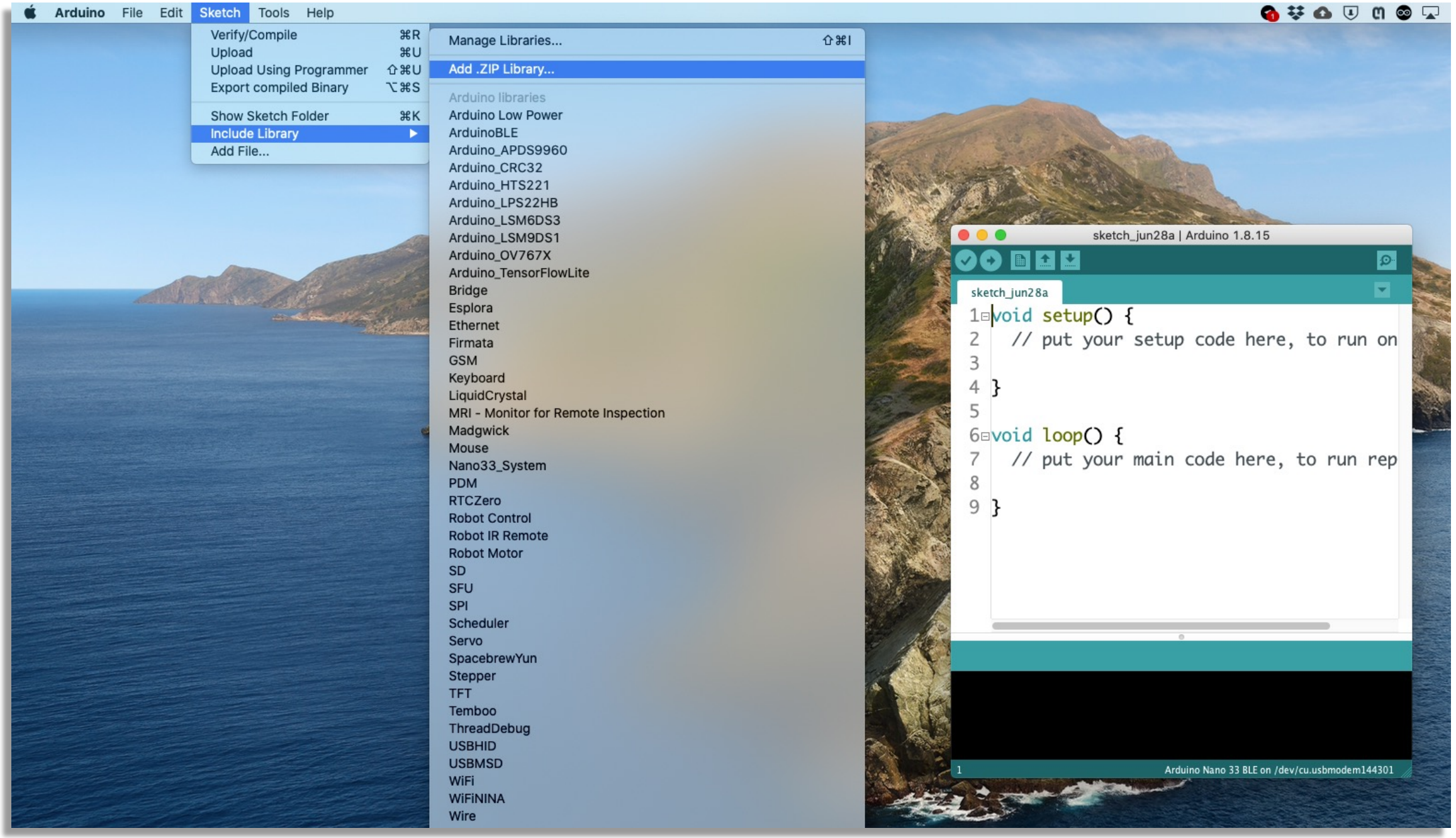
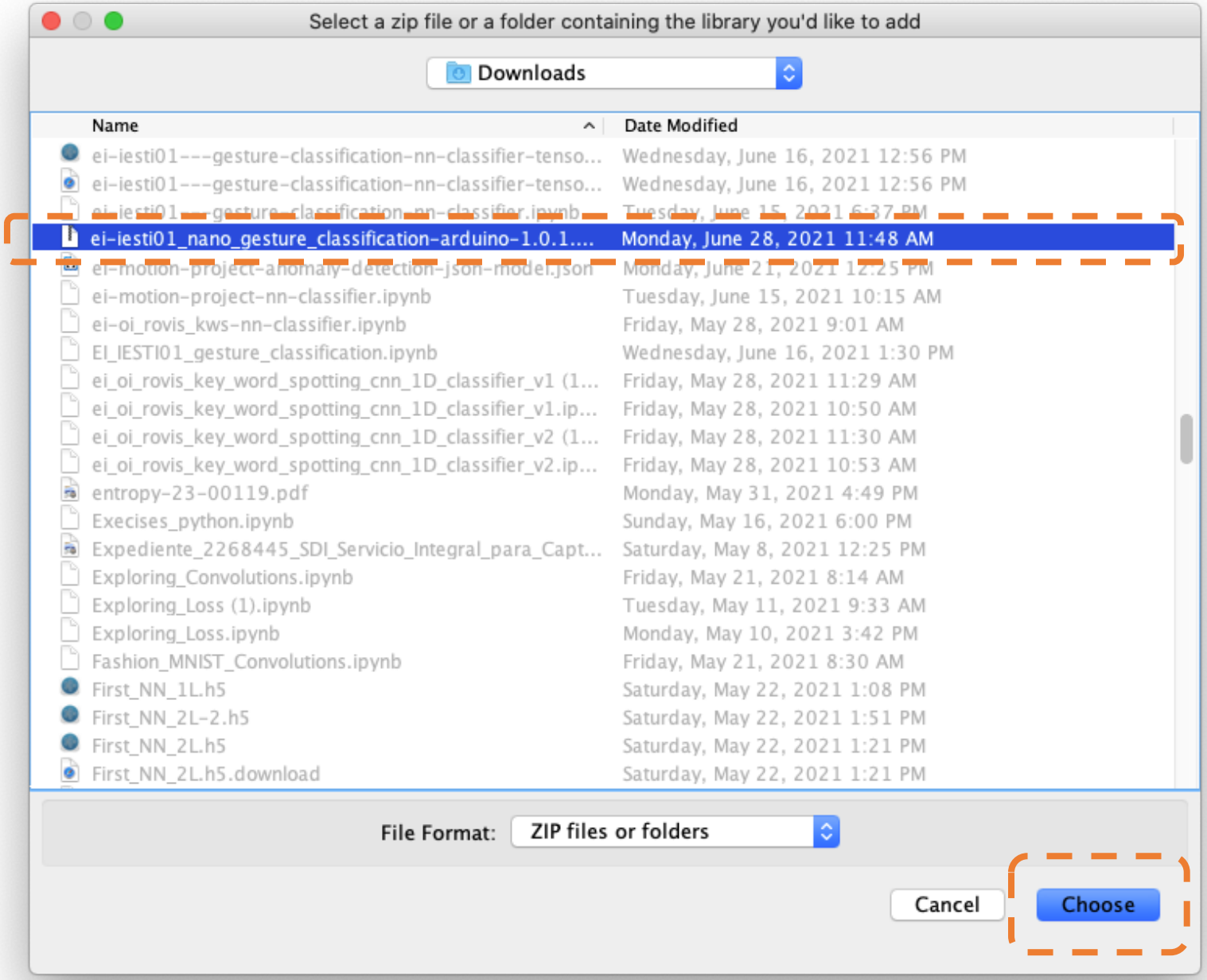
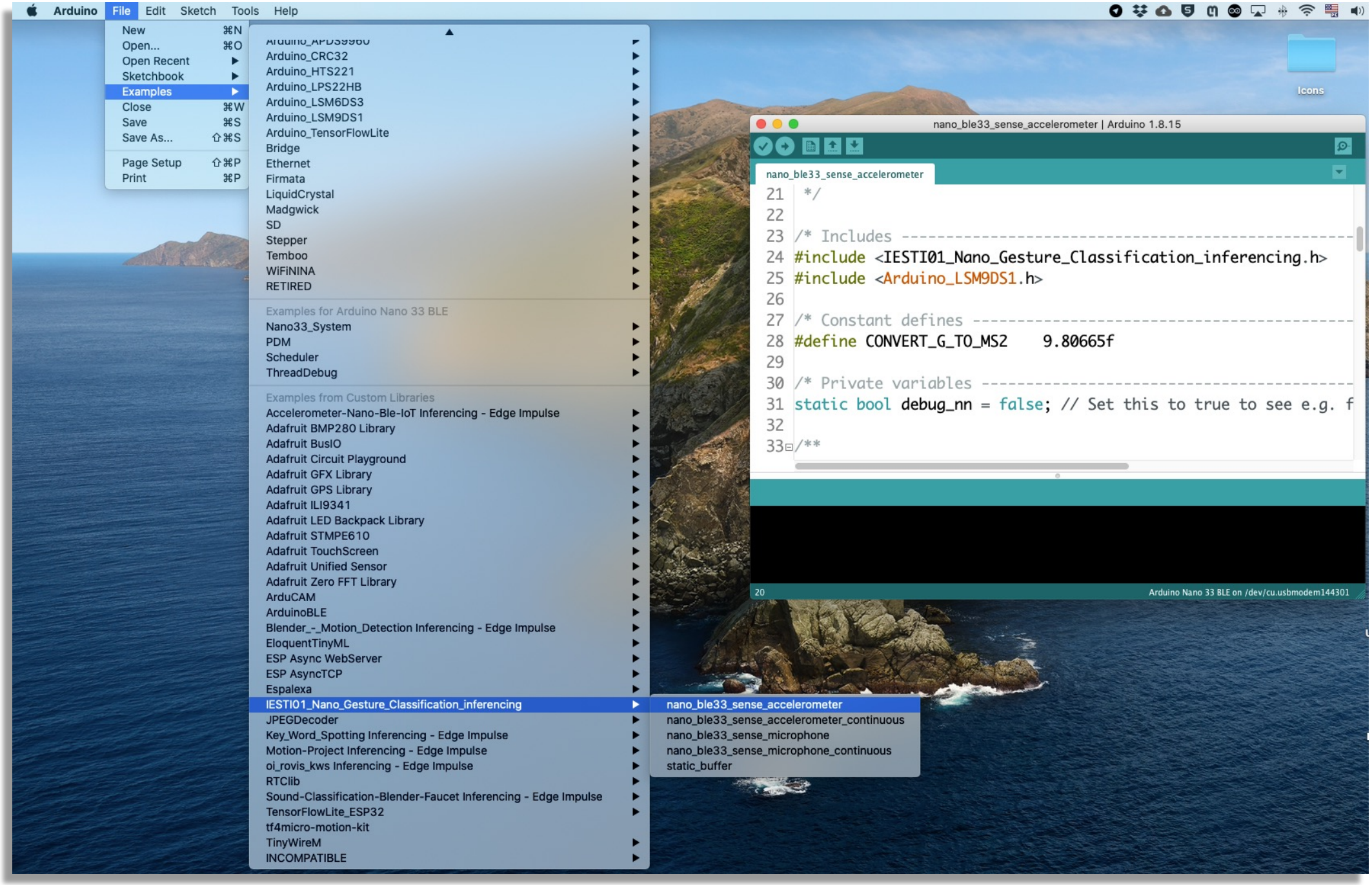
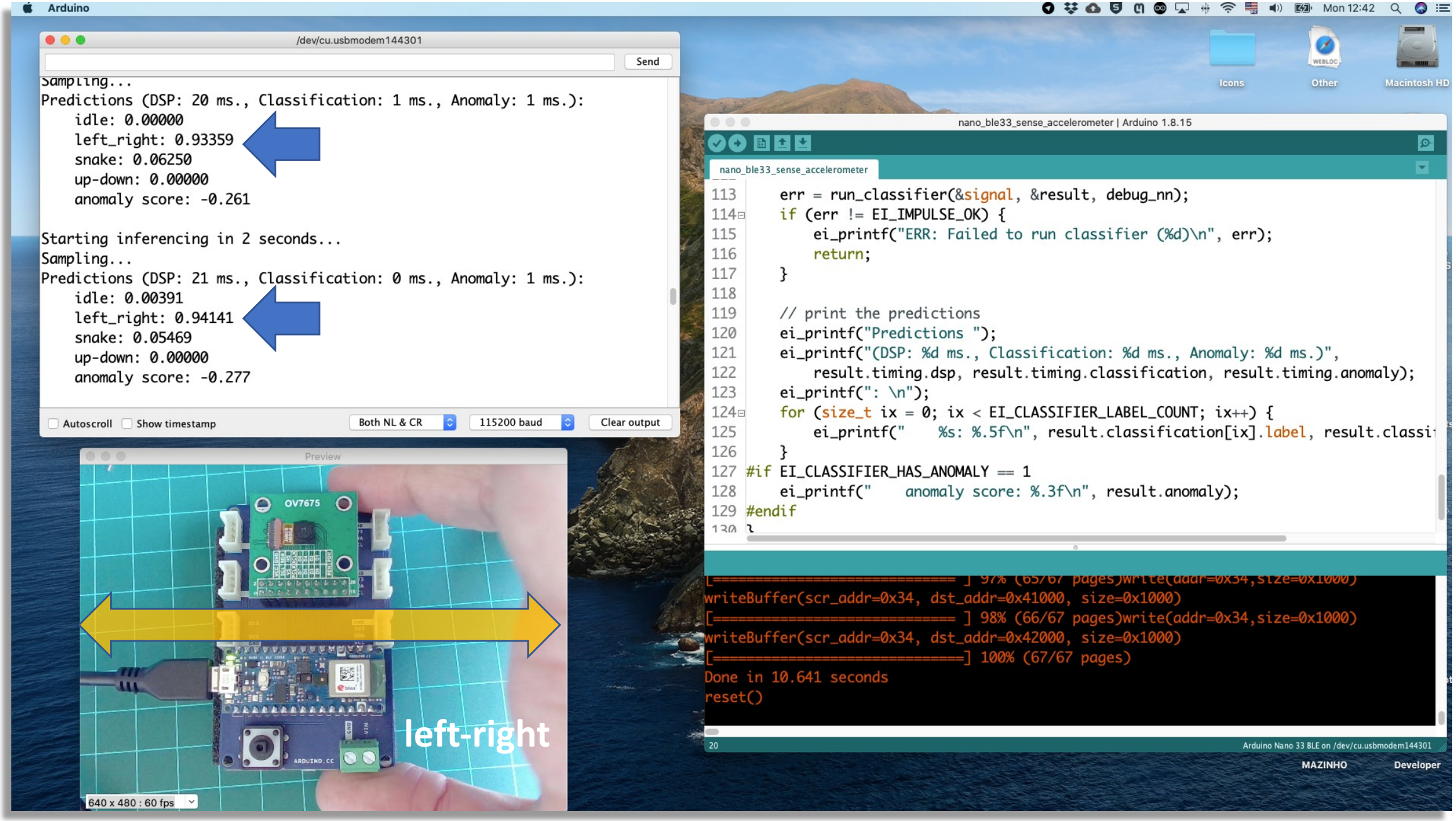
Himax WE-I Plus
Nordic nRF52840 DK + IKS02A1
Nordic nRF5340 DK + IKS02A1
Sony's Spresense
Linux boards
Select optimizations (optional)
Model optimizations can increase
the recommended choices for your
Enable EON™ Compil
Same accuracy, up to 5
Available optimizations for NN
Quantized (int8)
Currently selected
This optimization is recommended for best performance.
Unoptimized (float32)
Click to select
1.5K
1 ms
ROM USAGE
17.8K
ACCURACY
87.13%
Estimate for Cortex-M4F 64MHz (Arduino Nano 33 BLE Sense)
Build
Built Arduino library
Add this library through the Arduino IDE via:
Sketch > Include Library > Add .ZIP Library...
Examples can then be found under:
File > Examples > IESTI01_Nano_Gesture_Classification_inferencing
Build output
Creating job... OK (ID: 1029729)
Writing templates...
Writing templates OK
Copying Edge Impulse SDK...
Copying Edge Impulse SDK OK
ei-iesti01_nano_g....zip
Show All

Model Inference


Arduino File Edit Sketch Tools Help
Verify/Compile ⌘R
Upload ⌘U
Upload Using Programmer ⇧⌘U
Export compiled Binary ⌥⌘S
Show Sketch Folder ⌘K
Include Library
Add File...
Manage Libraries... ⇧⌘I
Add .ZIP Library...
Arduino libraries
Arduino Low Power
ArduinoBLE
Arduino_APDS9960
Arduino_CRC32
Arduino_HTS221
Arduino_LPS22HB
Arduino_LSM6DS3
Arduino_LSM9DS1
Arduino_OV767X
Arduino_TensorFlowLite
Bridge
Esplora
Ethernet
Firmata
GSM
Keyboard
LiquidCrystal
MRI - Monitor for Remote Inspection
Madgwick
Mouse
Nano33_System
PDM
RTCZero
Robot Control
Robot IR Remote
Robot Motor
SD
SFU
SPI
Scheduler
Servo
SpacebrewYun
Stepper
TFT
Temboo
ThreadDebug
USBHID
USBMSD
WiFi
WiFiNINA
Wire
sketch_jun28a | Arduino 1.8.15
sketch_jun28a
1 void setup() {
2 // put your setup code here, to run on
3
4 }
5
6 void loop() {
7 // put your main code here, to run rep
8
9 }
1
Arduino Nano 33 BLE on /dev/cu.usbmodem144301


Select a zip file or a folder containing the library you'd like to add
Downloads
Name
Date Modified
ei-iesti01---gesture-classification-nn-classifier-tenso...
Wednesday, June 16, 2021 12:56 PM
ei-iesti01---gesture-classification-nn-classifier-tenso...
Wednesday, June 16, 2021 12:56 PM
ei-iesti01_nano_gesture_classification-arduino-1.0.1....
Monday, June 28, 2021 11:48 AM
ei-motion-project-nn-classifier.ipynb
Tuesday, June 15, 2021 10:15 AM
ei-oi_rovis_kws-nn-classifier.ipynb
Friday, May 28, 2021 9:01 AM
EI_IESTI01_gesture_classification.ipynb
Wednesday, June 16, 2021 1:30 PM
ei_oi_rovis_key_word_spotting_cnn_1D_classifier_v1 (1...
Friday, May 28, 2021 11:29 AM
ei_oi_rovis_key_word_spotting_cnn_1D_classifier_v1.ip...
Friday, May 28, 2021 10:50 AM
ei_oi_rovis_key_word_spotting_cnn_1D_classifier_v2 (1...
Friday, May 28, 2021 11:30 AM
ei_oi_rovis_key_word_spotting_cnn_1D_classifier_v2.ip...
Friday, May 28, 2021 10:53 AM
entropy-23-00119.pdf
Monday, May 31, 2021 4:49 PM
Execises_python.ipynb
Sunday, May 16, 2021 6:00 PM
Expediente_2268445_SDI_Servicio_Integral_para_Capt...
Saturday, May 8, 2021 12:25 PM
Exploring_Convolutions.ipynb
Friday, May 21, 2021 8:14 AM
Exploring_Loss (1).ipynb
Tuesday, May 11, 2021 9:33 AM
Exploring_Loss.ipynb
Monday, May 10, 2021 3:42 PM
Fashion_MNIST_Convolutions.ipynb
Friday, May 21, 2021 8:30 AM
First_NN_1L.h5
Saturday, May 22, 2021 1:08 PM
First_NN_2L-2.h5
Saturday, May 22, 2021 1:51 PM
First_NN_2L.h5
Saturday, May 22, 2021 1:21 PM
First_NN_2L.h5.download
Saturday, May 22, 2021 1:21 PM
File Format:
ZIP files or folders
Cancel
Choose


Arduino File Edit Sketch Tools Help
New ⌘N
Open... ⌘O
Open Recent
Sketchbook
Examples
Close ⌘W
Save ⌘S
Save As... ⇧⌘S
Page Setup ⇧⌘P
Print ⌘P
Arduino_CRC32
Arduino_HTS221
Arduino_LPS22HB
Arduino_LSM6DS3
Arduino_LSM9DS1
Arduino_TensorFlowLite
Bridge
Ethernet
Firmata
LiquidCrystal
Madgwick
SD
Stepper
Temboo
WiFiNINA
RETIRED
Examples for Arduino Nano 33 BLE
Nano33_System
PDM
Scheduler
ThreadDebug
Examples from Custom Libraries
Accelerometer-Nano-Ble-IoT Inferencing - Edge Impulse
Adafruit BMP280 Library
Adafruit BusIO
Adafruit Circuit Playground
Adafruit GFX Library
Adafruit GPS Library
Adafruit ILI9341
Adafruit LED Backpack Library
Adafruit STMPE610
Adafruit TouchScreen
Adafruit Unified Sensor
Adafruit Zero FFT Library
ArduCAM
ArduinoBLE
Blender_-_Motion_Detection Inferencing - Edge Impulse
EloquentTinyML
ESP Async WebServer
ESP AsyncTCP
Espalexa
IESTI01_Nano_Gesture_Classification_inferencing
JPEGDecoder
Key_Word_Spotting Inferencing - Edge Impulse
Motion-Project Inferencing - Edge Impulse
oi_rovis_kws Inferencing - Edge Impulse
RTClib
Sound-Classification-Blender-Faucet Inferencing - Edge Impulse
TensorFlowLite_ESP32
tf4micro-motion-kit
TinyWireM
INCOMPATIBLE
nano_ble33_sense_accelerometer
nano_ble33_sense_accelerometer_continuous
nano_ble33_sense_microphone
nano_ble33_sense_microphone_continuous
static_buffer
Icons
nano_ble33_sense_accelerometer | Arduino 1.8.15
nano_ble33_sense_accelerometer
21 */
22
23 /* Includes ----------
24 #include <IESTI01_Nano_Gesture_Classification_inferencing.h>
25 #include <Arduino_LSM9DS1.h>
26
27 /* Constant defines ----------
28 #define CONVERT_G_TO_MS2 9.80665f
29
30 /* Private variables ----------
31 static bool debug_nn = false; // Set this to true to see e.g. f
32
33 /**
20
Arduino Nano 33 BLE on /dev/cu.usbmodem144301


Arduino
Mon 12:42
/dev/cu.usbmodem144301
Send
Sampling...
Predictions (DSP: 20 ms., Classification: 1 ms., Anomaly: 1 ms.):
idle: 0.00000
left_right: 0.93359
snake: 0.06250
up-down: 0.00000
anomaly score: -0.261
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 21 ms., Classification: 0 ms., Anomaly: 1 ms.):
idle: 0.00391
left_right: 0.94141
snake: 0.05469
up-down: 0.00000
anomaly score: -0.277
Autoscroll
Show timestamp
Both NL & CR
115200 baud
Clear output
Preview
OV7675
left-right
640 x 480 : 60 fps
nano_ble33_sense_accelerometer | Arduino 1.8.15
nano_ble33_sense_accelerometer
113 err = run_classifier(&signal, &result, debug_nn);
114 if (err != EI_IMPULSE_OK) {
115 ei_printf("ERR: Failed to run classifier (%d)\n", err);
116 return;
117 }
118
119 // print the predictions
120 ei_printf("Predictions ");
121 ei_printf("(DSP: %d ms., Classification: %d ms., Anomaly: %d ms.)",
122 result.timing.dsp, result.timing.classification, result.timing.anomaly);
123 ei_printf(": \n");
124 for (size_t ix = 0; ix < EI_CLASSIFIER_LABEL_COUNT; ix++) {
125 ei_printf(" %s: %.5f\n", result.classification[ix].label, result.classi
126 }
127 #if EI_CLASSIFIER_HAS_ANOMALY == 1
128 ei_printf(" anomaly score: %.3f\n", result.anomaly);
129 #endif
writeBuffer(scr_addr=0x34, dst_addr=0x41000, size=0x1000)
[============================] 98% (66/67 pages)write(addr=0x34,size=0x1000)
writeBuffer(scr_addr=0x34, dst_addr=0x42000, size=0x1000)
[============================] 100% (67/67 pages)
Done in 10.641 seconds
reset()
20
Arduino Nano 33 BLE on /dev/cu.usbmodem144301
MAZINHO
Developer
Icons
Other
Macintosh HD

Reading Material

Main references

- Harvard School of Engineering and Applied Sciences - CS249r: Tiny Machine Learning
- Professional Certificate in Tiny Machine Learning (TinyML) – edX/Harvard
- Introduction to Embedded Machine Learning (Coursera)
- Text Book: "TinyML" by Pete Warden, Daniel Situnayake

I want to thank Shawn Hymel and Edge Impulse, Laurence Moroney from Google, Harvard professor Vijay Janapa Reddi, Ph.D. student Brian Plancher and their staff for preparing the excellent material on TinyML that is the basis of this course at UNIFEI.

The IESTI01 course is part of the TinyML4D, an initiative to make TinyML education available to everyone globally.

Thanks

And stay safe!