

Track 7



Inteligencia Artificial Aplicada

E. TinyML Kit: Motion Classification and Anomaly Detection Hands-On

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Set up connection between Arduino Nano
and Edge Impulse

Login - Edge Impulse

studio.edgeimpulse.com/login

EDGE IMPULSE

Log in

rovai@mjrobot.org

.....

Forgot your password?

Log in

Don't have an account? [Sign up](#)



Start building embedded machine learning models today.

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Select project - Edge Impulse

studio.edgeimpulse.com/studio/select-project

EDGE IMPULSE

MJRoBot (Marcelo Rovai)

Select project

Select your Edge Impulse project, or create a new one.

NAME	COLLABORATORS
MJRoBot (Marcelo Rovai) / IESTI01 - Nano Motion Classification	?
MJRoBot (Marcelo Rovai) / oi_rovis_kws	
MJRoBot (Marcelo Rovai) / Eggs AI	
MJRoBot (Marcelo Rovai) / Accelerometer-Nano-Ble-IoT	
MJRoBot (Marcelo Rovai) / video_tinyml_raw	
MJRoBot (Marcelo Rovai) / Pico_Motion_Detection	
MJRoBot (Marcelo Rovai) / oi_rovis_kws_meetup	

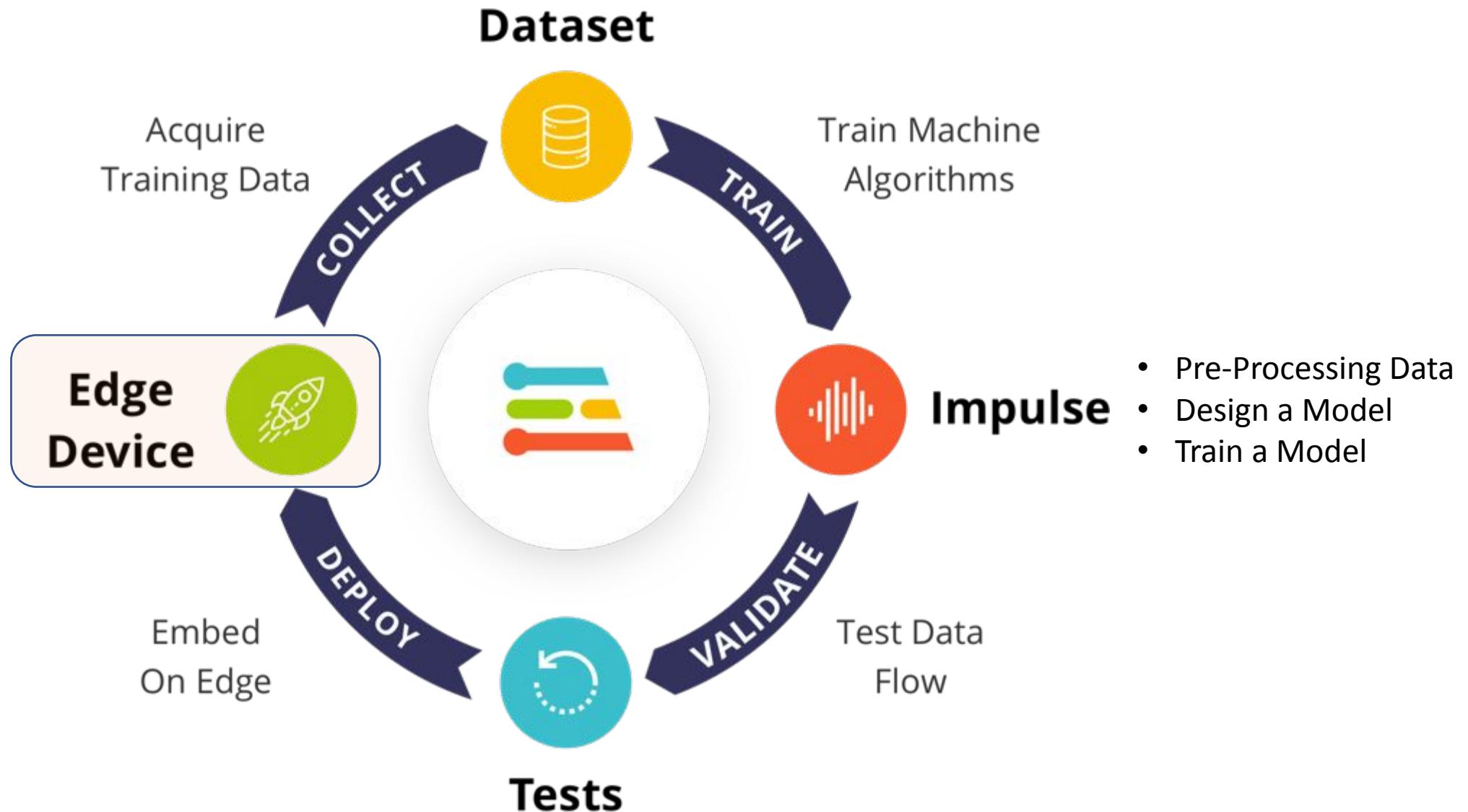
Create project

Enter a name for your new project

Cancel Create new project

?

4



Devices - IESTI01 - Nano Motion Classification

studio.edgeimpulse.com/studio/61345/devices

EDGE IMPULSE

DEVICES (IESTI01 - NANO MOTION CLASSIFICATION)

MJRoBot (Marcelo Rovai)

Your devices

These are devices that are connected to the Edge Impulse remote management API, or have posted data to the ingestion SDK.

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

Use your mobile phone

Use your computer

Data from any device with the data forwarder

Upload data

Integrate with your cloud

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1 Devices

2 + Connect a new device

3 Browse dev boards

<https://docs.edgeimpulse.com/docs/fully-supported-development-boards>

Devices - IESTI01 - Nano Motic Overview - Edge Impulse Docu +

docs.edgeimpulse.com/docs/development-platforms/fully-supported-development-boards

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Frequently asked questions

EDGE IMPULSE STUDIO
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DEVELOPMENT PLATFORMS
Overview
Officially supported MCU targets >
Officially supported CPU/GPU targets >

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.

Officially supported MCU targets

- Arduino Nano 33 BLE Sense
- Arduino Nicla Sense ME
- Arduino Portenta H7 + Vision Shield
- Espressif ESP32
- Himax WE-I Plus
- Nordic Semi nRF52840 DK
- Nordic Semi nRF5340 DK
- Nordic Semi nRF9160 DK
- Nordic Semi Thingy:91
- Open MV Cam H7 Plus
- Silicon Labs xG24 Dev Kit
- Silicon Labs Thunderboard Sense 2
- Sony's Spresense
- ST B-L475E-IOT01A
- Syntiant Tiny ML Board
- TI CC1352P Launchpad
- Raspberry Pi RP2040



EI/Arduino CLI

The screenshot shows a web browser displaying the Edge Impulse documentation for the Arduino Nano 33 BLE Sense. The page title is "Arduino Nano 33 BLE Sense". The left sidebar lists various development boards, with "Arduino Nano 33 BLE Sense" highlighted. The main content area describes the board and its features, including its Cortex-M4 microcontroller, motion sensors, microphone, and BLE support. It also mentions the availability from Arduino and its use with the Arduino Tiny Machine Learning Kit. A blue arrow points from the text "Go to 2. Arduino CLI" to the "Installing dependencies" section at the bottom of the page.

(Note that the 1. Edge Impulse CLI is not necessary for Arduino Nano-33. We will use WebUSB instead)

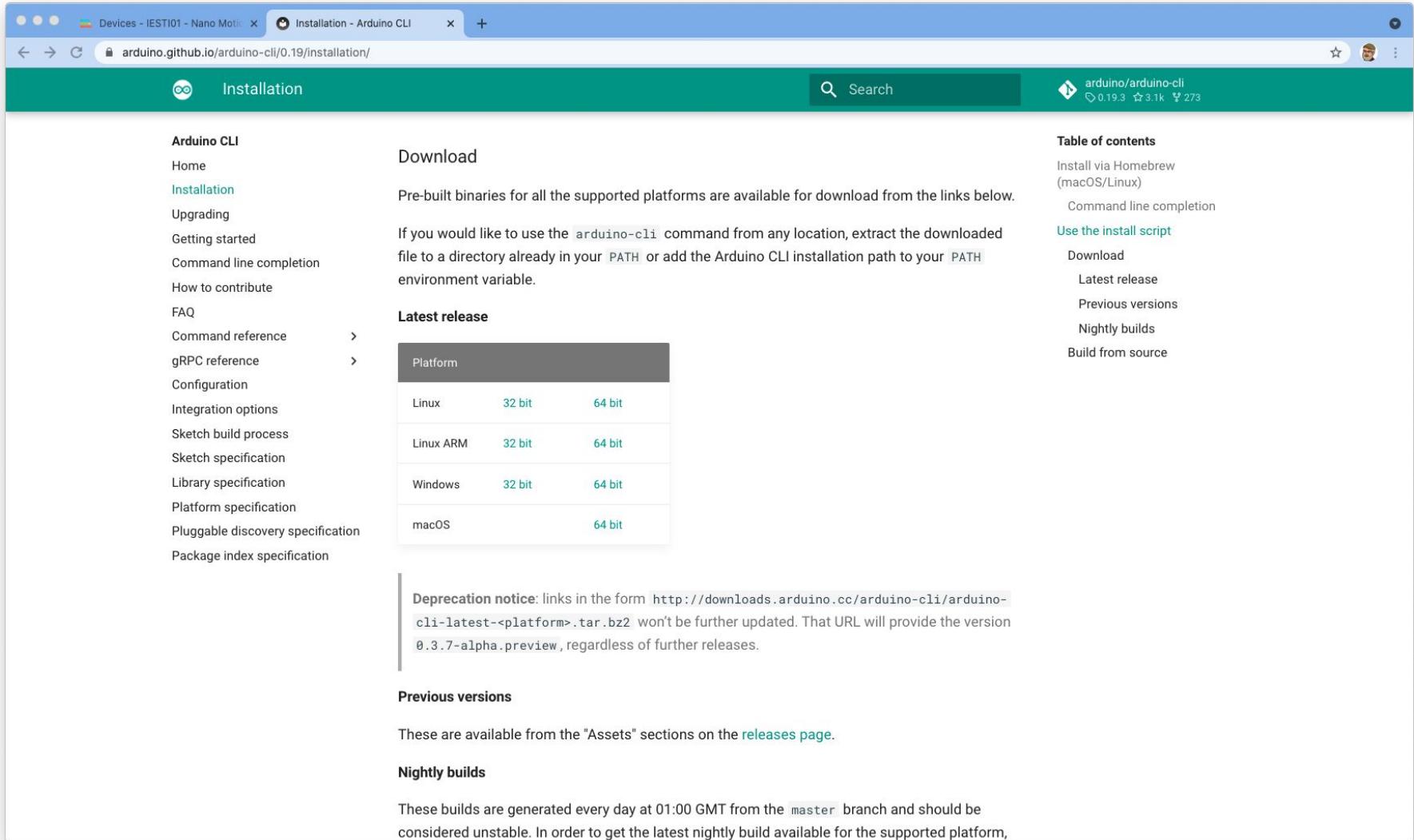
Go to 2. Arduino CLI

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.

Arduino CLI



The screenshot shows the "Installation" page for the Arduino CLI on GitHub. The URL is arduino.github.io/arduino-cli/0.19/installation/. The page has a green header with the title "Installation". On the left, there's a sidebar with links like Home, Installation (which is active), Upgrading, Getting started, Command line completion, How to contribute, FAQ, Command reference, gRPC reference, Configuration, Integration options, Sketch build process, Sketch specification, Library specification, Platform specification, Pluggable discovery specification, and Package index specification. The main content area has a section titled "Download" with instructions for pre-built binaries. It includes a table for the "Latest release" showing download links for Linux, Linux ARM, Windows, and macOS in 32-bit and 64-bit versions. Below this is a "Deprecation notice" about old URLs. There are also sections for "Previous versions" and "Nightly builds". A "Table of contents" sidebar on the right lists various installation and usage options.

Platform	32 bit	64 bit
Linux	32 bit	64 bit
Linux ARM	32 bit	64 bit
Windows	32 bit	64 bit
macOS		64 bit

Deprecation notice: links in the form `http://downloads.arduino.cc/arduino-cli/arduino-cli-latest-<platform>.tar.bz2` won't be further updated. That URL will provide the version `0.3.7-alpha.preview`, regardless of further releases.

Previous versions
These are available from the "Assets" sections on the [releases page](#).

Nightly builds
These builds are generated every day at 01:00 GMT from the `master` branch and should be considered unstable. In order to get the latest nightly build available for the supported platform,



See this video for Windows installation: <https://www.youtube.com/watch?v=1jMWsFER-Bc>

Arduino CLI Installation Summary

If you're on Windows:

- Unzip the .zip file to C:\Program Files\arduino-cli
- Open System Properties > Advanced > Environment Variables
- Path under "user variables" > Edit
- Add C:\Program Files\arduino-cli

If you're on macOS:

- I recommend using the curl method or homebrew shown on the installation page:
<https://arduino.github.io/arduino-cli/0.21/installation/>
- if you use the curl method, it likely installs arduino-cli to ~/bin. That might not be on your path. So, you might need to run: `export PATH=$PATH:~/bin`

Devices - SciTinyML-Motion-A X Arduino Nano 33 BLE Sense - E Installation - Arduino CLI x +

docs.edgeimpulse.com/docs/development-boards/arduino-nano-33-ble-sense

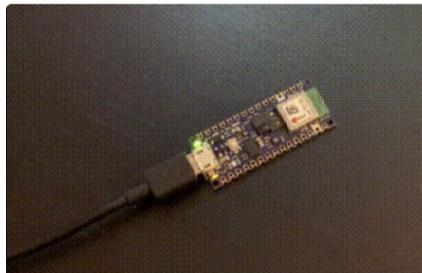
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DEVELOPMENT BOARDS
Overview
ST B-L475E-IOT01A
Arduino Nano 33 BLE Sense
Arduino Portenta H7 + Vision Shield
Open MV Cam H7 Plus
Himax WE-I Plus
Nordic Semi nRF52840 DK
Nordic Semi nRF5340 DK
Nordic Semi nRF9160 DK
Nordic Semi Thingy:91
SiLabs Thunderboard Sense 2
Sony's Spresense
Syntiant Tiny ML Board

Powered By GitBook

1 **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.



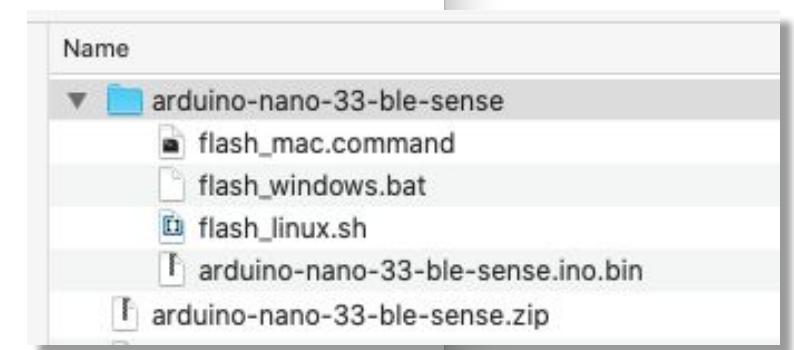
Press RESET twice quickly to launch the bootloader on the Arduino Nano 33 BLE Sense.

2 **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 **3. Setting keys**
From a command prompt or terminal, run:

```
1_edge-impulse-daemon
```



MacOS

```
mjrovai — flash_mac.command — 126x44
Last login: Tue Nov  9 12:15:56 on ttys002
You have new mail.
/Users/mjrovai/Downloads/arduino-nano-33-ble-sense\ \(2\)/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\ \(2\)/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

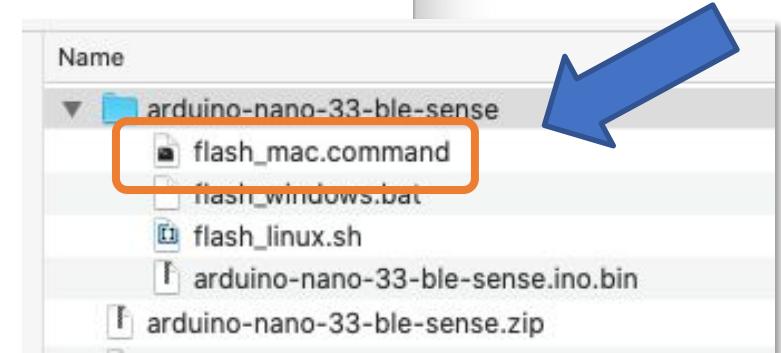
Done in 0.001 seconds
Write 280848 bytes to flash (69 pages)
[=====] 100% (69/69 pages)
Done in 10.984 seconds

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]
```

3.Nano-33 LED Stop Flashing

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



Windows 10

```
Prompt de Comando
Microsoft Windows [versão 10.0.19041.1052]
(c) Microsoft Corporation. Todos os direitos reservados.

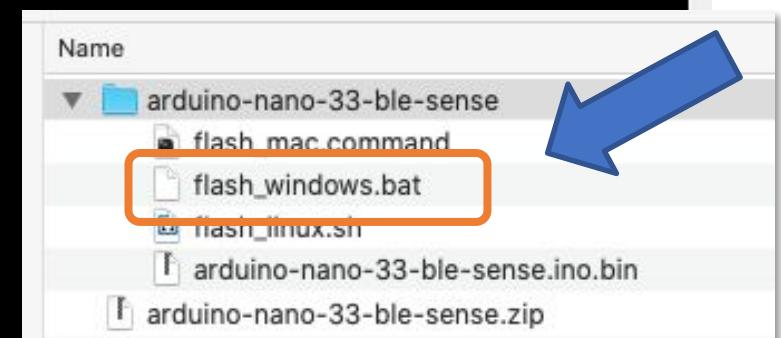
C:\Users\GUILH>arduino-cli
Arduino Command Line Interface (arduino-cli).

Usage:
  arduino-cli [command]

Examples:
  arduino-cli <command> [flags...]

Available Commands:
  board           Arduino board commands.
  burn-bootloader Upload the bootloader.
  cache           Arduino cache commands.
  compile         Compiles Arduino sketches.
  completion     Generates completion scripts
  config          Arduino configuration commands.
  core            Arduino core operations.
  daemon          Run as a daemon on port 50051
  debug           Debug Arduino sketches.
  help            Help about any command
  lib              Arduino commands about libraries.
  outdated        Lists cores and libraries that can be upgraded
  sketch          Arduino CLI sketch commands.
  update          Updates the index of cores and libraries
  upgrade         Upgrades installed cores and libraries.
  upload          Upload Arduino sketches.
  version         Shows version number of Arduino CLI.
```

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



Windows 10

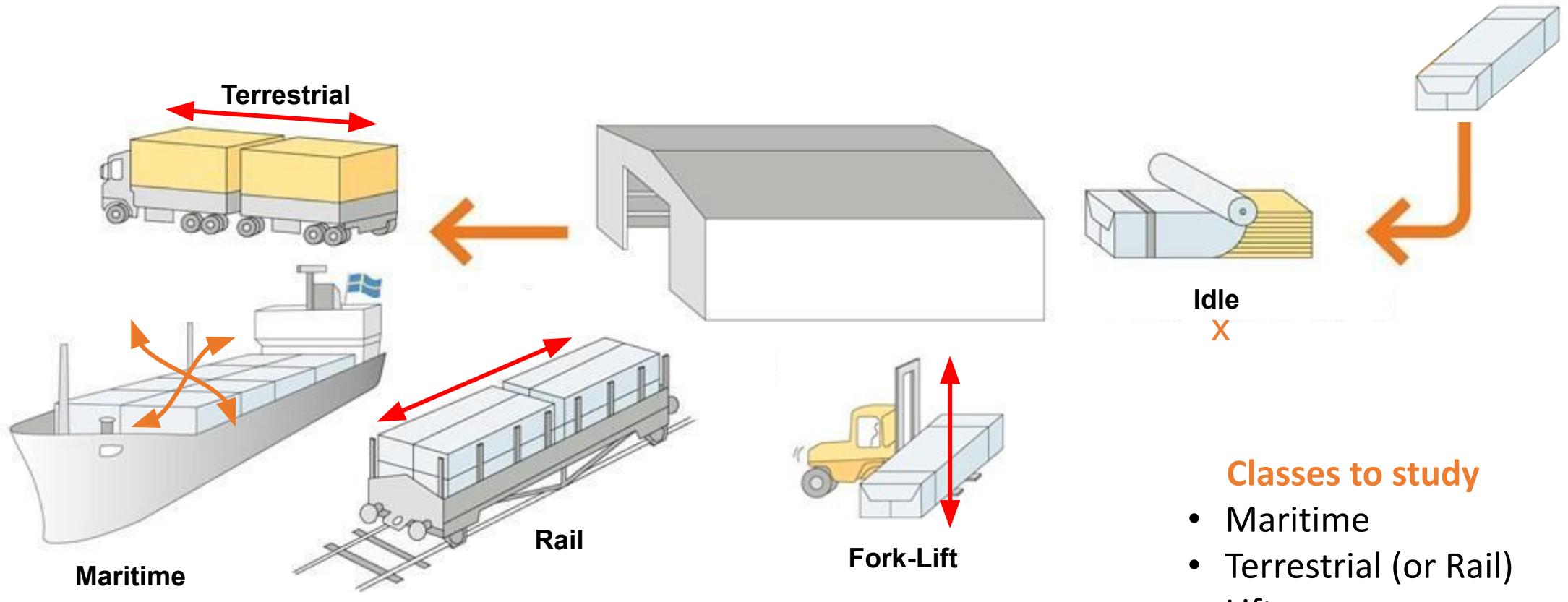
```
cmd C:\WINDOWS\system32\cmd.exe
Finding Arduino Mbed core...
arduino:mbed_nano 2.0.0      2.0.0  Arduino Mbed OS Nano Boards
Finding Arduino Mbed core OK
Finding Arduino Nano 33 BLE...
Finding Arduino Nano 33 BLE OK at COM11
arduino:mbed_nano 2.0.0      2.0.0  Arduino Mbed OS Nano Boards
Device      : 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 0.002 seconds
Write 525440 bytes to flash (129 pages)
[=====] 100% (129/129 pages)
Done in 22.296 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'
Pressione qualquer tecla para continuar. . .
```

□ Nano-33 LED Stop Flashing

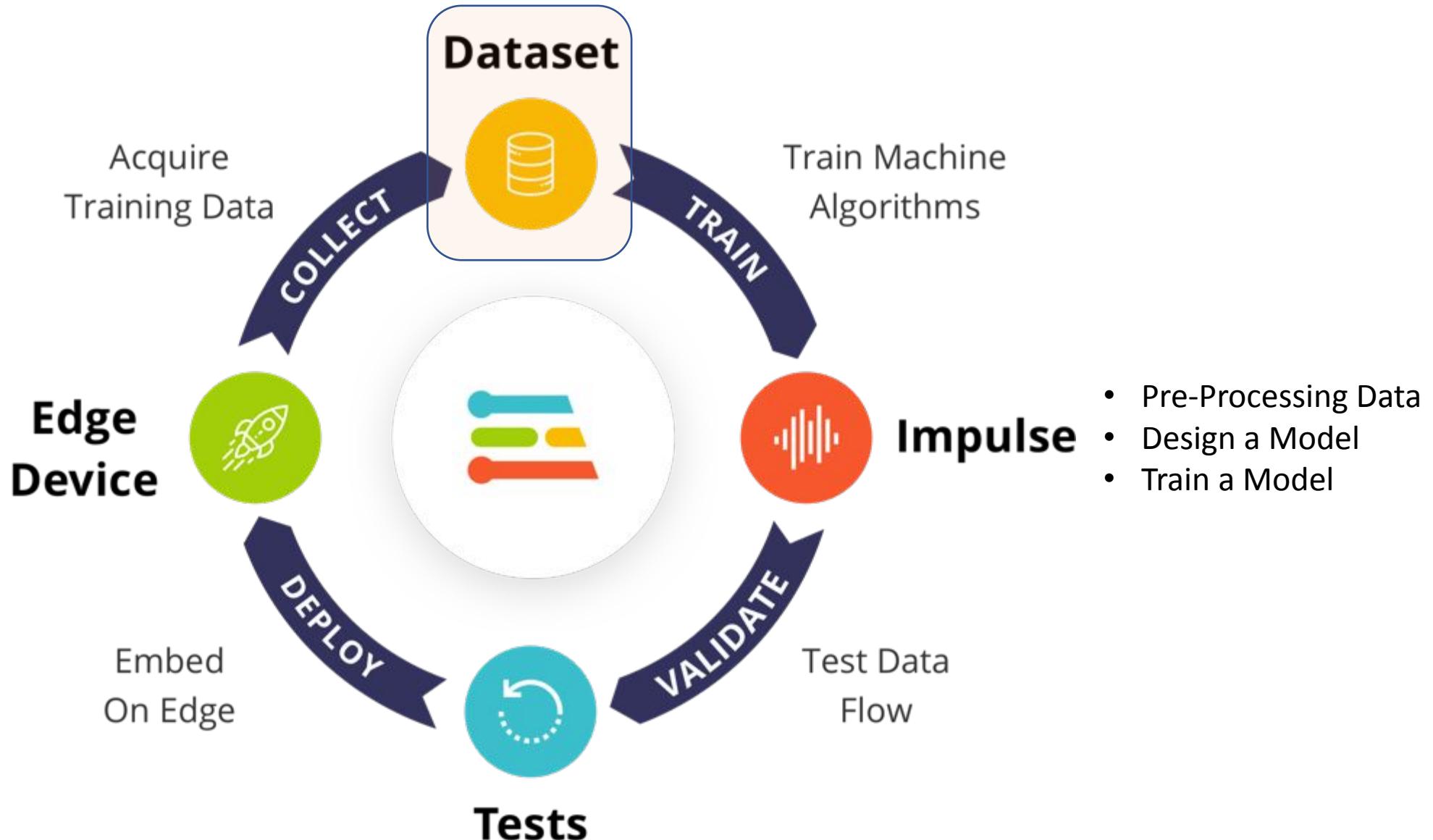
Hands-on lab for motion classification

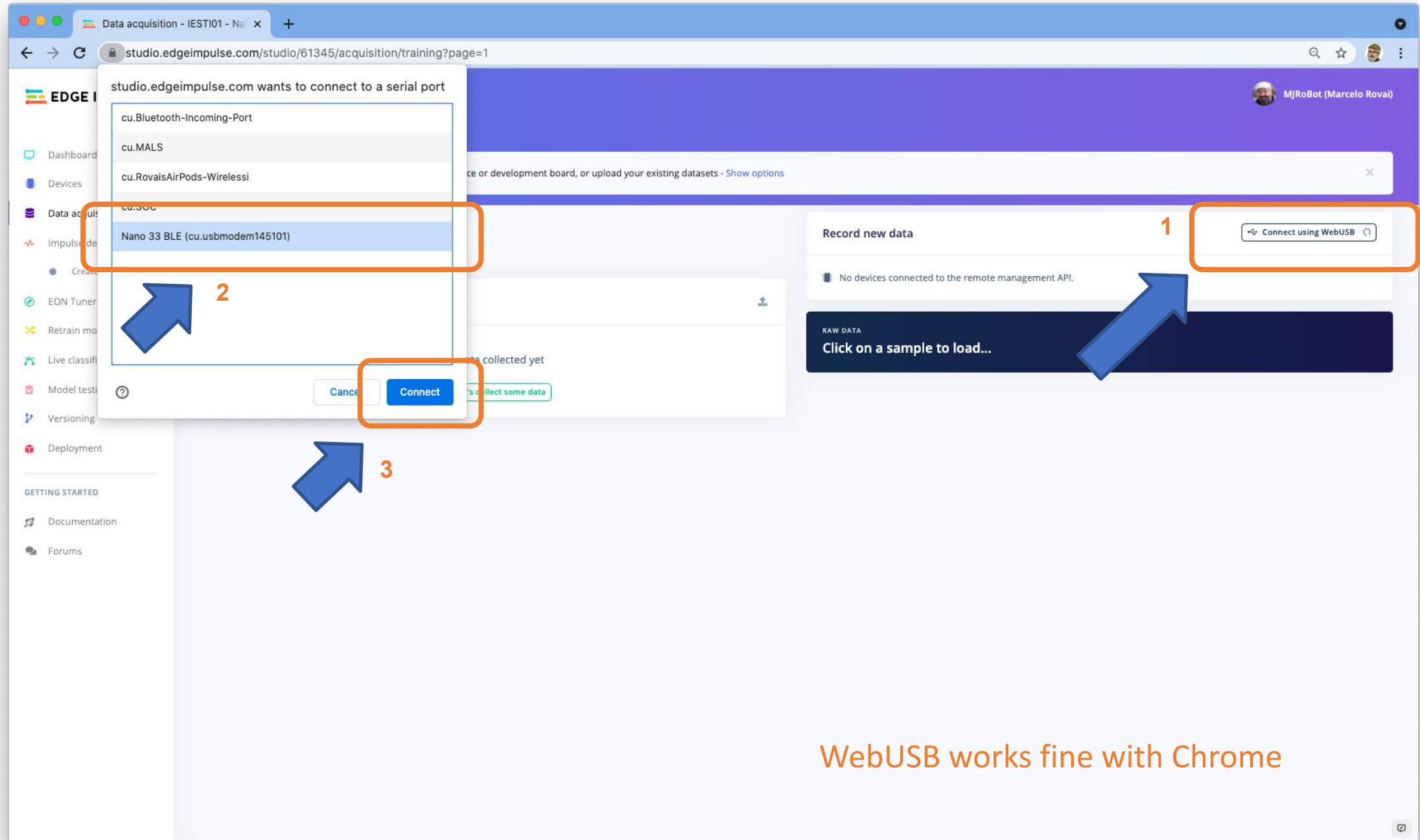
Case Study: Mechanical Stresses in Transport



Classes to study

- Maritime
- Terrestrial (or Rail)
- Lift
- Idle





WebUSB works fine with Chrome

DATA ACQUISITION (IESTI01 - NANO MOTION CLASSIFICATION)

Training data Test data

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

DATA COLLECTED

Collected data

No data collected yet

Let's collect some data

Record new data

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

Label: terrestrial (highlighted with orange border)

Sample length (ms.): 10000

Sensor: Built-in accelerometer

Frequency: 100Hz

Start sampling

RAW DATA
Click on a sample to load...

The screenshot shows the Edge Impulse Data Acquisition interface. On the left sidebar, under 'Data acquisition', there are several options: Dashboard, Devices, Data acquisition (selected), Impulse design, Create impulse, EON Tuner, Retrain model, Live classification, Model testing, Versioning, Deployment, Documentation, and Forums. The main area is titled 'DATA ACQUISITION (IESTI01 - NANO MOTION CLASSIFICATION)' and shows 'Training data' selected. A banner at the top says 'Did you know? You can capture data from any device or development board, or upload your existing datasets - Show options'. Below this is a 'DATA COLLECTED' section with a 'Collected data' sub-section showing 'No data collected yet' and a 'Let's collect some data' button. To the right is a 'Record new data' form with fields for 'Device' (set to 36:17:55:F9:70:F7), 'Label' (set to 'terrestrial' and highlighted with an orange border), 'Sample length (ms.)' (set to 10000), 'Sensor' (set to 'Built-in accelerometer'), and 'Frequency' (set to 100Hz). A large blue arrow points from the 'Label' field towards the 'Start sampling' button. Another large blue arrow points from the 'Start sampling' button back towards the 'Label' field.

Devices - IESTI01 - Nano Motion Classification

studio.edgeimpulse.com/studio/61345/devices

EDGE IMPULSE

DEVICES (IESTI01 - NANO MOTION CLASSIFICATION)

MJRoBot (Marcelo Rovai)

Your devices

+ Connect a new device

These are devices that are connected to the Edge Impulse remote management API, or have posted data to the ingestion SDK.

NAME	ID	TYPE	SENSORS	REMOTE M...	LAST SEEN
 36:17:55:F9:70:F7	36:17:55:F9:70:F7	ARDUINO_NANO33BLE	Built-in accelerometer, Built-in microphone...	●	Today, 12:26:49

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GETTING STARTED

Documentation

Forums

DATA ACQUISITION (IESTI01 - NANO MOTION CLASSIFICATION)

Training data **Test data**

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

DATA COLLECTED 10s  **TRAIN / TEST SPLIT** 100% / 0% 

SAMPLE NAME	LABEL	ADDED	LENGTH
terrestrial.json.2jbimlk	terrestrial	Today, 13:01:46	10s

Record new data 

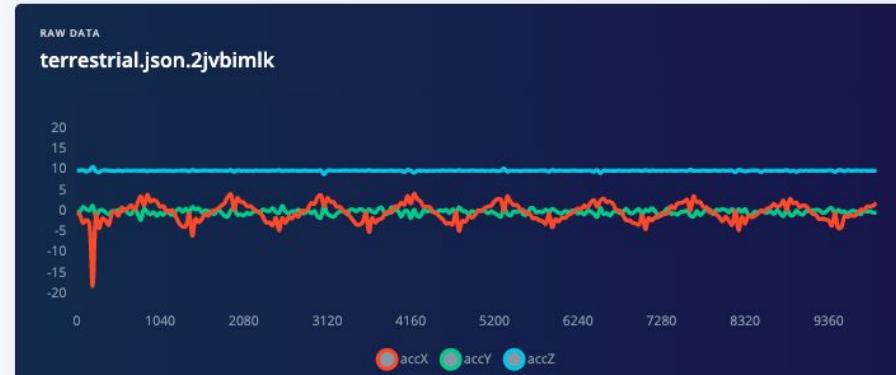
Device Nano

Label terrestrial **Sample length (ms.)** 10000

Sensor Sensor with 3 axes (accX, accY, accZ) **Frequency** 100Hz

Start sampling

RAW DATA
terrestrial.json.2jbimlk

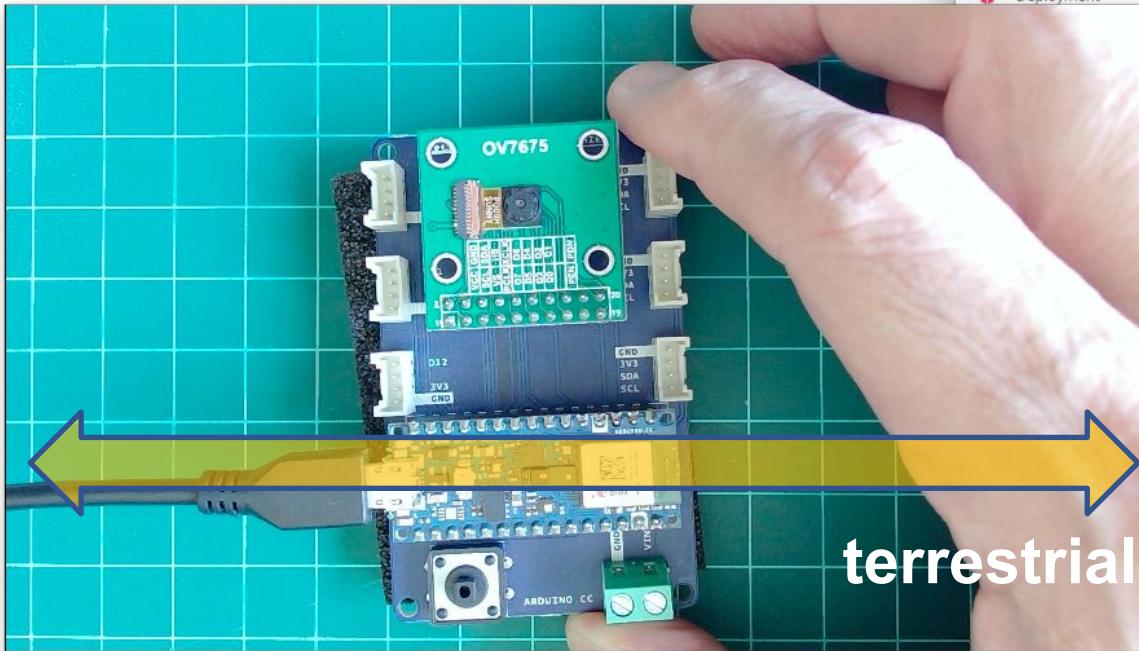
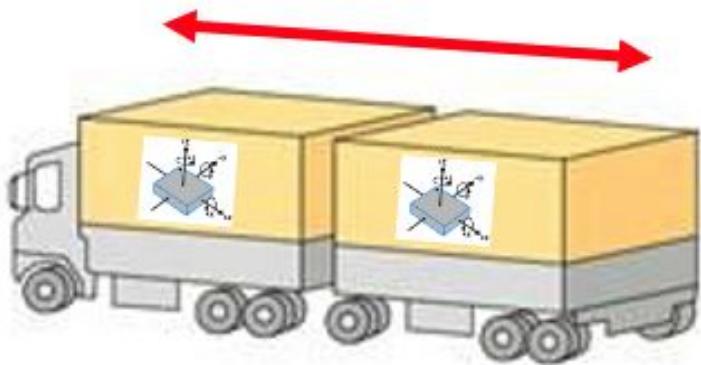


0 1040 2080 3120 4160 5200 6240 7280 8320 9360

accX accY accZ

<https://studio.edgeimpulse.com/studio/61345/acquisition/training?page=1#>

Label: terrestrial



studio.edgeimpulse.com/studio/61345/acquisition/training?page=1

DATA ACQUISITION (IESTI01 - NANO MOTION CLASSIFICATION)

Training data Test data

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

DATA COLLECTED 1m 40s TRAIN / TEST SPLIT 100% / 0%

SAMPLE NAME	LABEL	ADDED	LENGTH
terrestrial.json.2jv...	terrestrial	Today, 14:26:56	10s
terrestrial.json.2jv...	terrestrial	Today, 14:26:29	10s
terrestrial.json.2jv...	terrestrial	Today, 14:26:06	10s
terrestrial.json.2jv...	terrestrial	Today, 14:25:48	10s
terrestrial.json.2jv...	terrestrial	Today, 14:25:29	10s
terrestrial.json.2jv...	terrestrial	Today, 14:25:04	10s
terrestrial.json.2jv...	terrestrial	Today, 14:24:45	10s
terrestrial.json.2jv...	terrestrial	Today, 14:24:21	10s
terrestrial.json.2jvf...	terrestrial	Today, 14:17:45	10s
terrestrial.json.2jv...	terrestrial	Today, 13:01:46	10s

Record new data

Device: Nano

Label: terrestrial

Sample length (ms.): 10000

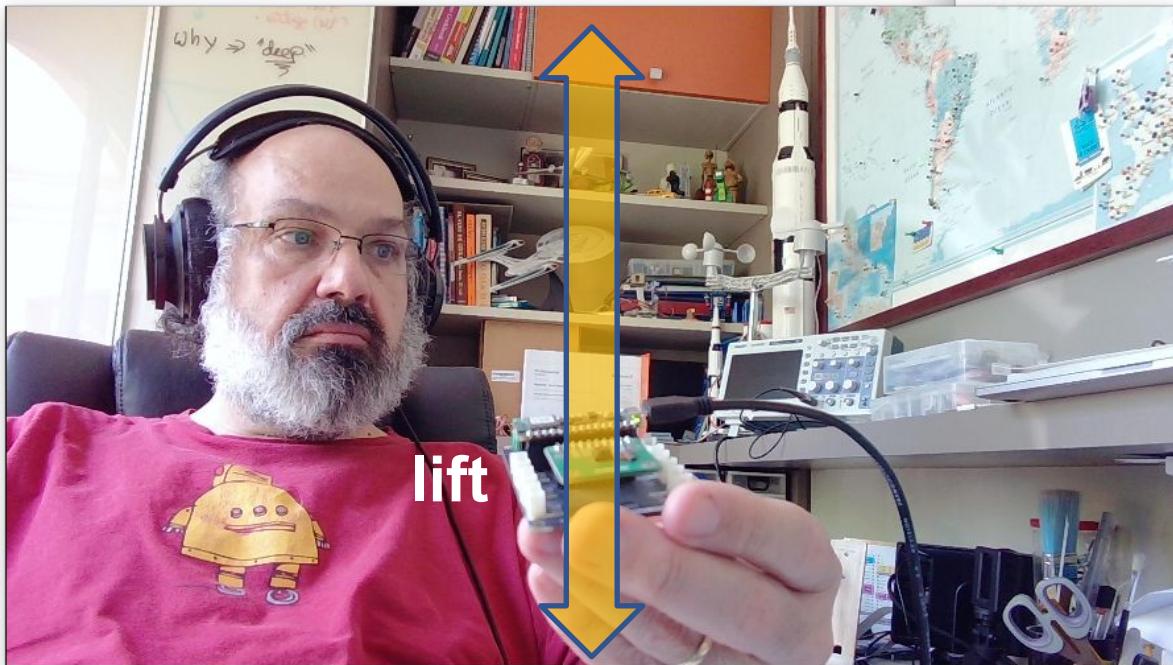
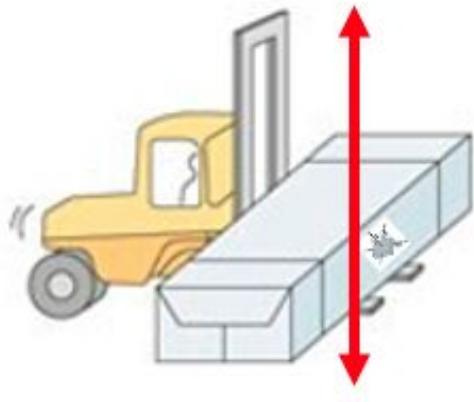
Sensor: Sensor with 3 axes (accX, accY, accZ)

Frequency: 100Hz

Start sampling

RAW DATA terrestrial.json.2jvgelce

Label: LIFT



studio.edgeimpulse.com/studio/61345/acquisition/training?page=1

EDGE IMPULSE

DATA ACQUISITION (IESTI01 - NANO MOTION CLASSIFICATION)

MJRoBot (Marcelo Rovai)

Training data Test data

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

DATA COLLECTED 3m 20s TRAIN / TEST SPLIT 100% / 0%

SAMPLE NAME	LABEL	ADDED	LENGTH
lift.json.2jvhbt7	lift	Today, 14:42:04	10s
lift.json.2jvh9pe3	lift	Today, 14:41:45	10s
lift.json.2jvh96uh	lift	Today, 14:41:26	10s
lift.json.2jvh8j6q	lift	Today, 14:41:06	10s
lift.json.2jvh80rg	lift	Today, 14:40:47	10s
lift.json.2jvh7g2v	lift	Today, 14:40:30	10s
lift.json.2jvh6uqu	lift	Today, 14:40:12	10s
lift.json.2jvh6c6a	lift	Today, 14:39:53	10s
lift.json.2jvh5qbe	lift	Today, 14:39:35	10s
lift.json.2jvh55hs	lift	Today, 14:39:14	10s
terrestrial.json.2jv...	terrestrial	Today, 14:26:56	10s
terrestrial.json.2jv...	terrestrial	Today, 14:26:29	10s

Record new data

Device Nano

Label lift

Sample length (ms.) 10000

Sensor Sensor with 3 axes (accX, accY, accZ)

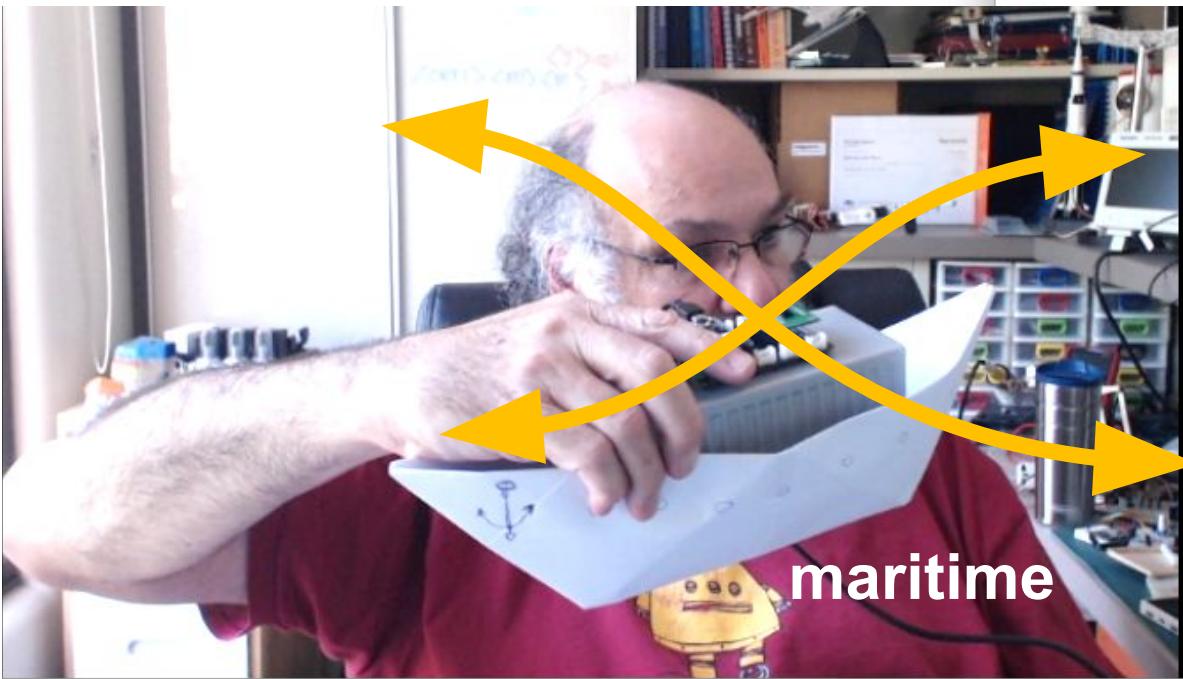
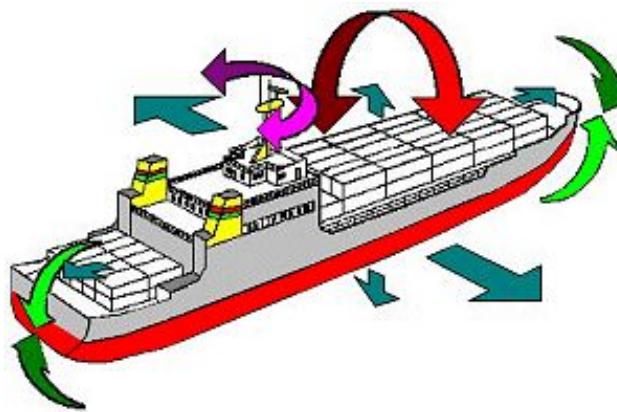
Frequency 100Hz

Start sampling

RAW DATA lift.json.2jvhbt7

A line graph titled "RAW DATA lift.json.2jvhbt7". The y-axis ranges from -20 to 20. The x-axis shows time points at 0, 1040, 2080, 3120, 4160, 5200, 6240, 7280, 8320, and 9360. Three data series are plotted: accX (red), accY (green), and accZ (blue). The accX series shows a high-frequency oscillation between approximately -10 and 15. The accY and accZ series show much lower amplitude oscillations between approximately -5 and 5.

Label: maritime



Data acquisition - IESTI01 - Na +

studio.edgeimpulse.com/studio/61345/acquisition/training?page=1

MJRoBot (Marcelo Rovai)

EDGE IMPULSE

DATA ACQUISITION (IESTI01 - NANO MOTION CLASSIFICATION)

Training data Test data

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

DATA COLLECTED 5m 0s TRAIN / TEST SPLIT 100% / 0% ▲

SAMPLE NAME	LABEL	ADDED	LENGTH
maritime.json.2jvi6...	maritime	Today, 14:57:35	10s
maritime.json.2jvi6...	maritime	Today, 14:57:13	10s
maritime.json.2jvi5...	maritime	Today, 14:56:48	10s
maritime.json.2jvi4...	maritime	Today, 14:56:31	10s
maritime.json.2jvi4...	maritime	Today, 14:56:13	10s
maritime.json.2jvi3...	maritime	Today, 14:55:55	10s
maritime.json.2jvi3...	maritime	Today, 14:55:36	10s
maritime.json.2jvi2...	maritime	Today, 14:55:19	10s
maritime.json.2jvi2...	maritime	Today, 14:55:00	10s
maritime.json.2jvi1...	maritime	Today, 14:54:42	10s
lift.json.2jhbt7	lift	Today, 14:42:04	10s
lift.json.2vh9pe3	lift	Today, 14:41:45	10s

Record new data Connect using WebUSB

Device Nano

Label maritime Sample length (ms.) 10000

Sensor Sensor with 3 axes (accX, accY, accZ) Frequency 100Hz

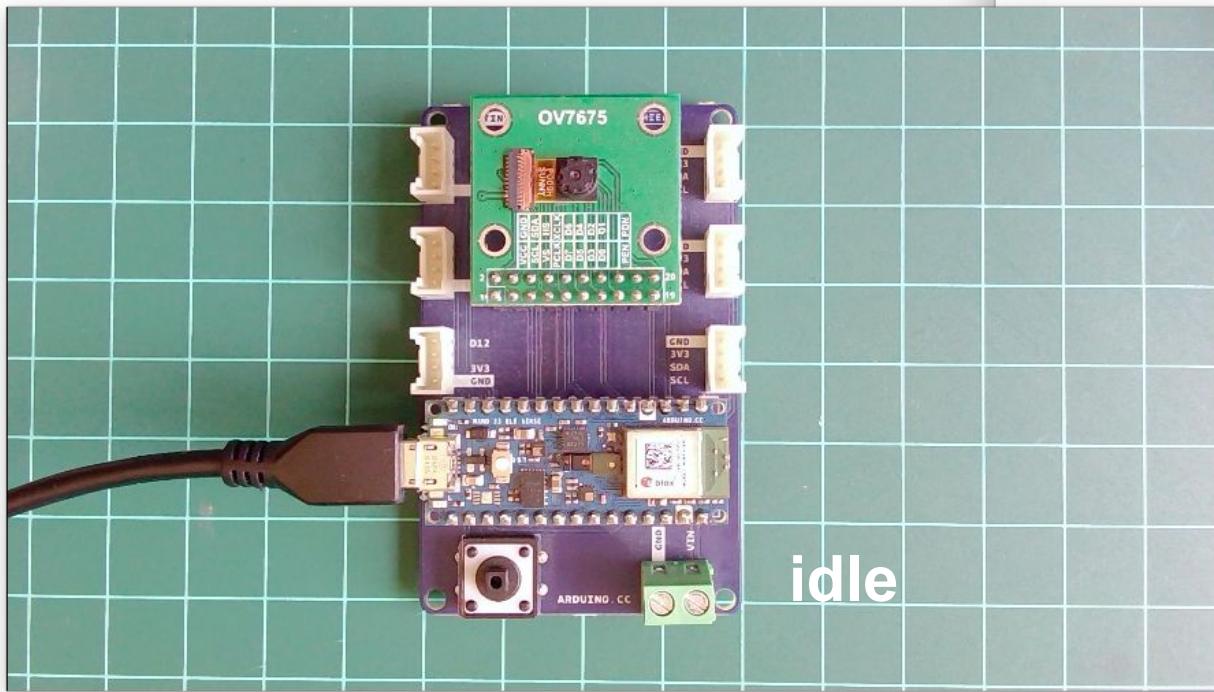
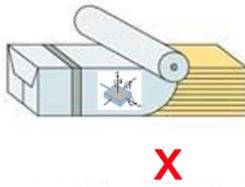
Start sampling

RAW DATA maritime.json.2jvi6p3r

accX accY accZ

24

Label: idle



Data acquisition - IESTI01 - Na +

studio.edgeimpulse.com/studio/61345/acquisition/training?page=1

MJRoBot (Marcelo Rovai)

EDGE IMPULSE

DATA ACQUISITION (IESTI01 - NANO MOTION CLASSIFICATION)

Training data Test data

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

DATA COLLECTED 6m 40s TRAIN / TEST SPLIT 100% / 0% ▲

Record new data Connect using WebUSB

Device Nano

Label idle Sample length (ms.) 100000

Sensor Sensor with 3 axes (accX, accY, accZ) Frequency 100Hz

Start sampling

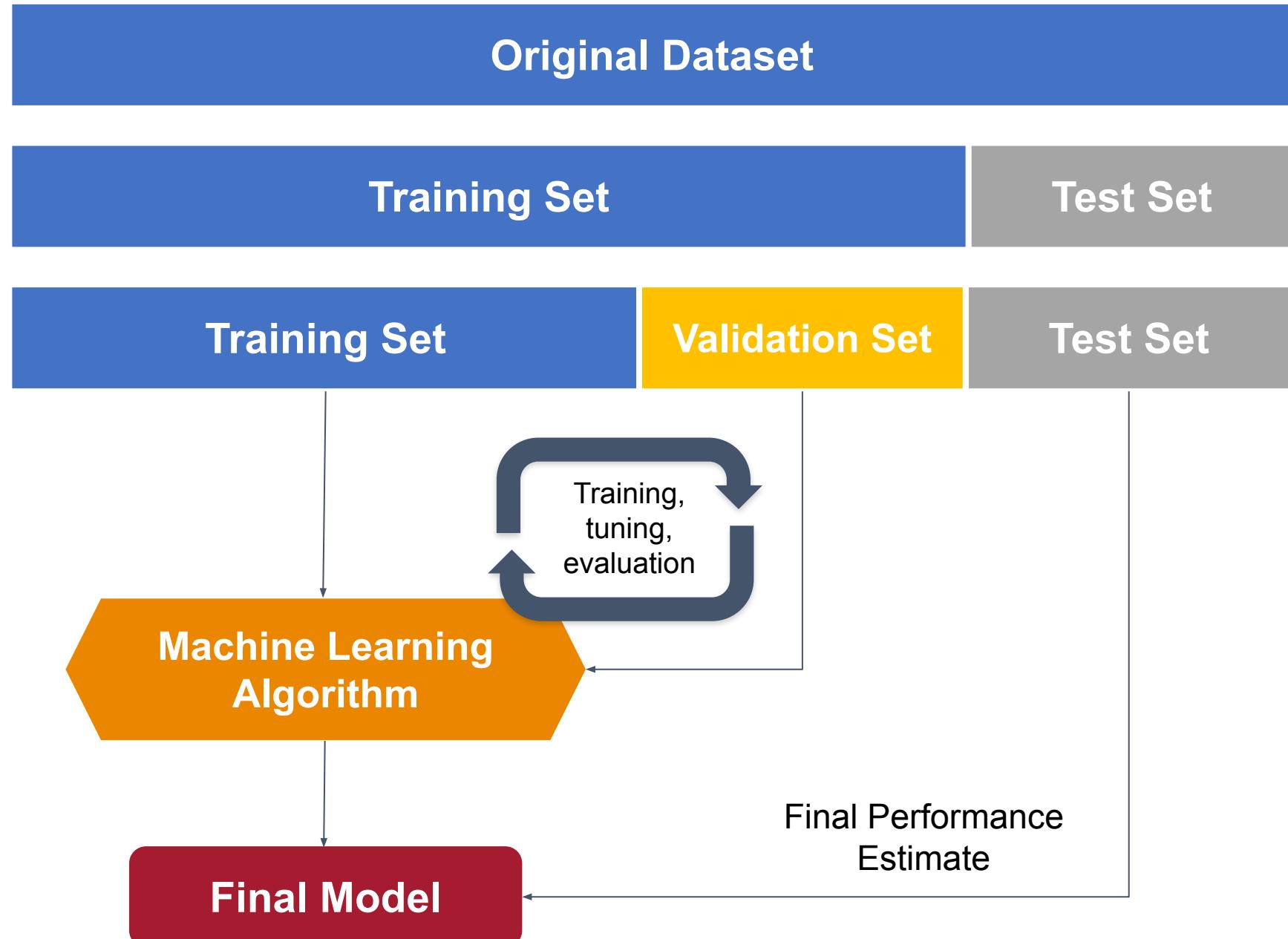
Collected data

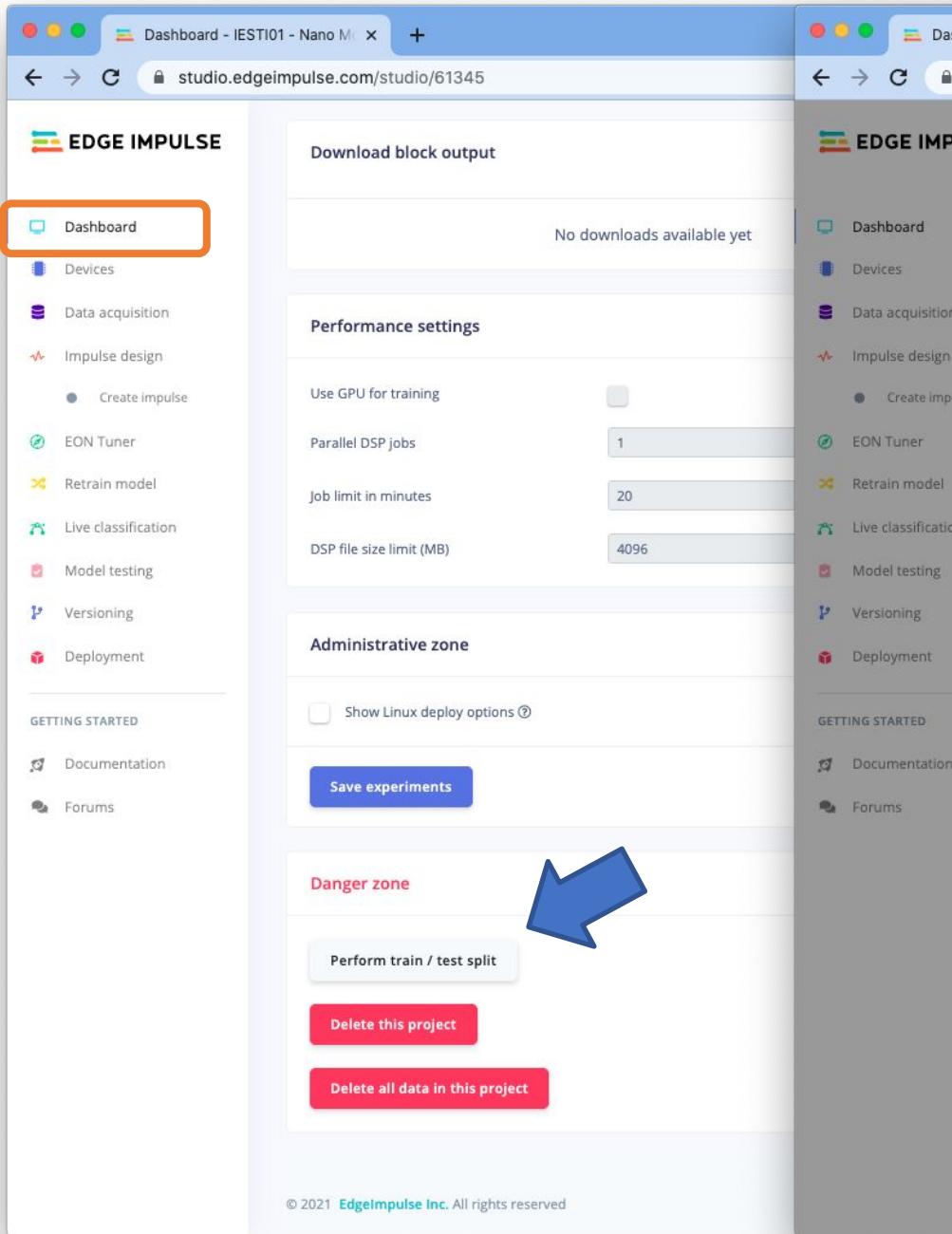
SAMPLE NAME	LABEL	ADDED	LENGTH	⋮
idle.json.2jvif14	idle	Today, 15:06:09	1m 40s	⋮
maritime.json.2jvi6...	maritime	Today, 14:57:35	10s	⋮
maritime.json.2jvi6...	maritime	Today, 14:57:13	10s	⋮
maritime.json.2jvi5...	maritime	Today, 14:56:48	10s	⋮
maritime.json.2jvi4...	maritime	Today, 14:56:31	10s	⋮
maritime.json.2jvi4...	maritime	Today, 14:56:13	10s	⋮
maritime.json.2jvi3...	maritime	Today, 14:55:55	10s	⋮
maritime.json.2jvi3...	maritime	Today, 14:55:36	10s	⋮
maritime.json.2jvi2...	maritime	Today, 14:55:19	10s	⋮
maritime.json.2jvi2...	maritime	Today, 14:55:00	10s	⋮
maritime.json.2jvi1...	maritime	Today, 14:54:42	10s	⋮
lift.json.2jhbt7	lift	Today, 14:42:04	10s	⋮

RAW DATA idle.json.2jvif14

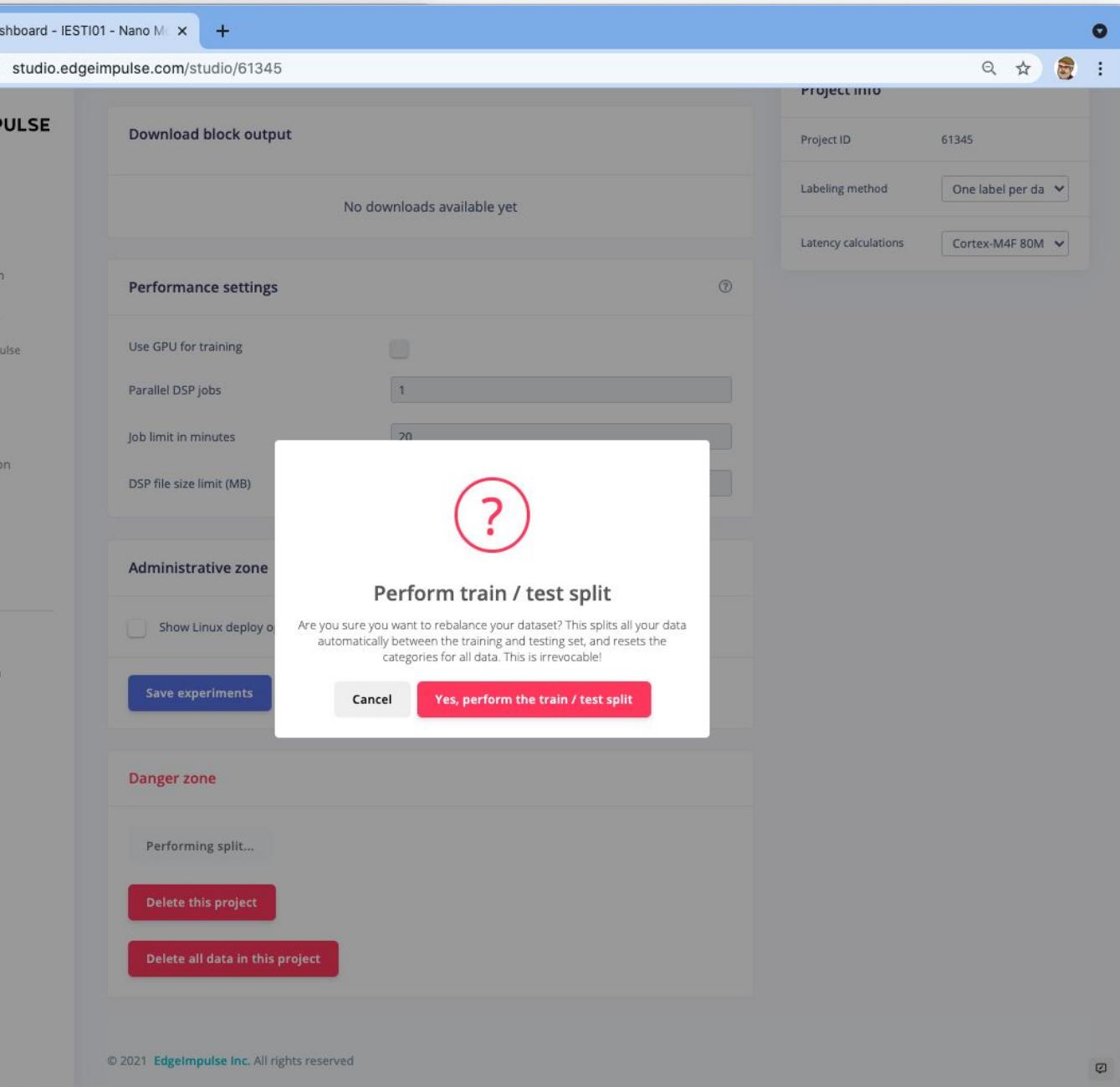
accX accY accZ

25





The screenshot shows the Edge Impulse Studio dashboard. On the left, a sidebar lists various project management and documentation links. The main area features a 'Performance settings' section with options like 'Use GPU for training' (radio button), 'Parallel DSP jobs' (input field set to 1), 'Job limit in minutes' (input field set to 20), and 'DSP file size limit (MB)' (input field set to 4096). Below this is an 'Administrative zone' with a checkbox for 'Show Linux deploy options'. A prominent red button labeled 'Save experiments' is visible. In the bottom right corner of the main area, there's a 'Danger zone' section containing three buttons: 'Perform train / test split' (highlighted with a blue arrow), 'Delete this project', and 'Delete all data in this project'.



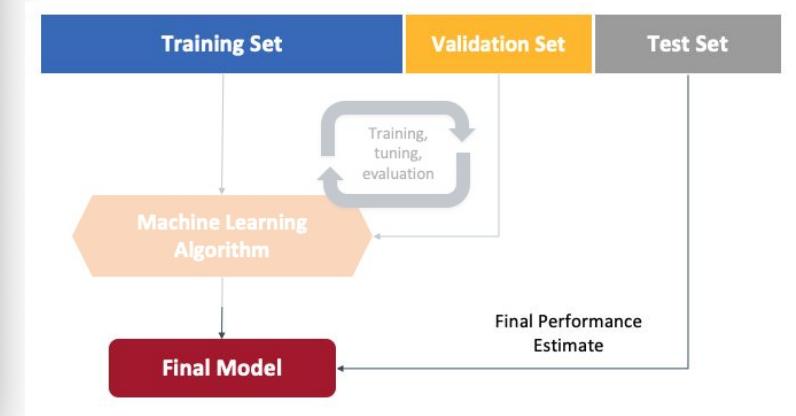
The screenshot shows the same dashboard with a modal dialog box centered over the 'Danger zone' section. The dialog has a large red question mark icon at the top. Below it, the title 'Perform train / test split' is displayed. A message in the center states: 'Are you sure you want to rebalance your dataset? This splits all your data automatically between the training and testing set, and resets the categories for all data. This is irrevocable!' At the bottom of the dialog are two buttons: 'Cancel' (gray) and 'Yes, perform the train / test split' (red).

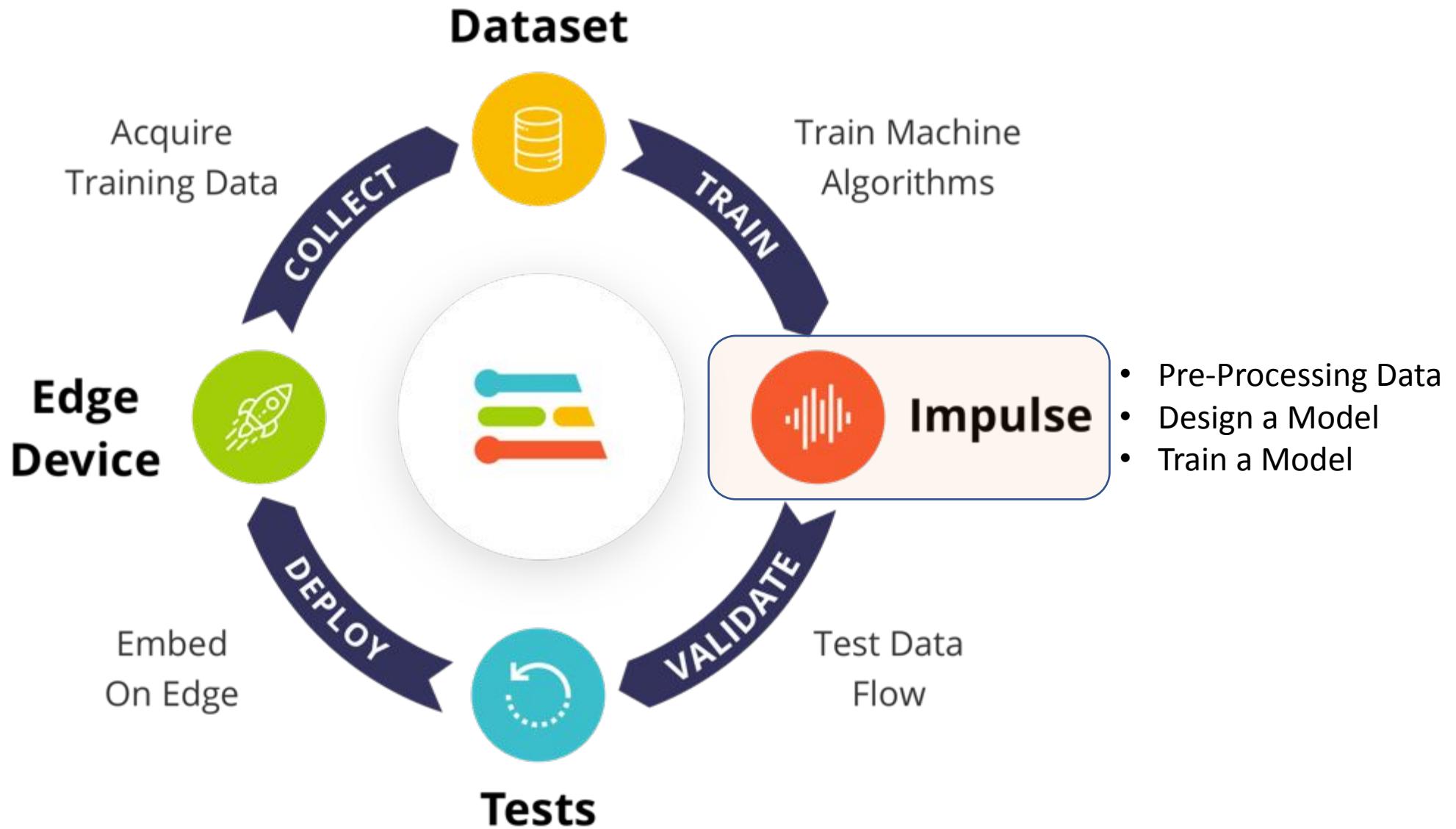
The screenshot shows the Edge Impulse studio interface for data acquisition testing. On the left, a sidebar menu is visible with various options like Dashboard, Devices, Data acquisition (which is highlighted with an orange border), Create impulse, EON Tuner, Retrain model, Live classification, Model testing, Versioning, Deployment, Documentation, and Forums. The main area is titled "DATA ACQUISITION - TESTING (IE5)" and shows "COLLECTED DATA" from a "Data collected" session that ran for "40s". A pie chart indicates a "TRAIN / TEST SPLIT" of "90% / 10%". Below this, a table lists four samples: "maritime.json.2jvi4..." (label: maritime), "maritime.json.2jvi1..." (label: maritime), "lift.json.2jvh6uqu" (label: lift), and "terrestrial.json.2jv..." (label: terrestrial). To the right, there's a "Record new data" section with fields for Device (set to "Nano"), Label ("idle"), Sample length (ms.) (set to "100000"), Sensor (set to "Sensor with 3 axes (accX, accY, accZ)"), Frequency (set to "100Hz"), and a "Start sampling" button. At the bottom, a dark blue bar says "RAW DATA Click on a sample to load...".



The screenshot shows the Edge Impulse Studio interface. On the left, a sidebar menu includes 'Data acquisition' (highlighted with an orange box), 'Devices', 'Create impulse', 'EON Tuner', 'Retrain model', 'Live classification', 'Model testing', 'Versioning', and 'Deployment'. Under 'GETTING STARTED', there are links for 'Documentation' and 'Forums'. The main area is titled 'DATA ACQUISITION - TESTING (IE500 - ACTION CLASSIFICATION)' and shows 'Training data' and 'Test data' tabs. A message says 'Did you know? You can capture data from any device or development board, or upload your existing datasets - Show options'. Below this, it says 'DATA COLLECTED 1m 20s' and 'TRAIN / TEST SPLIT 80% / 20%'. A table titled 'Collected data' lists samples: 'terrestrial.json.2jv...', 'lift.json.2jhbt7', 'idle.json.2jvjlon', 'maritime.json.2ji4...', 'maritime.json.2jvi1...', 'lift.json.2jvh6uqu', and 'terrestrial.json.2jv...'. The 'Test data' tab is active. An orange arrow points from the text 'Dataset is balanced (has representative samples from all classes) and split 80%/20%' to the 'TRAIN / TEST SPLIT' section.

Dataset is balanced (has representative samples from all classes) and split 80%/20%





Time series data

Axes
accX, accY, accZ

Window size
2000 ms.

Window increase
80 ms.

Frequency (Hz)
62.5

Zero-pad data

Spectral Analysis

Name
Spectral Analysis

Input axes
 accX
 accY
 accZ

Neural Network (Keras)

Name
Neural Network (Keras)

Input features
 Spectral Analysis

Output features
4 (idle, lift, maritime, terrestrial)

Output features

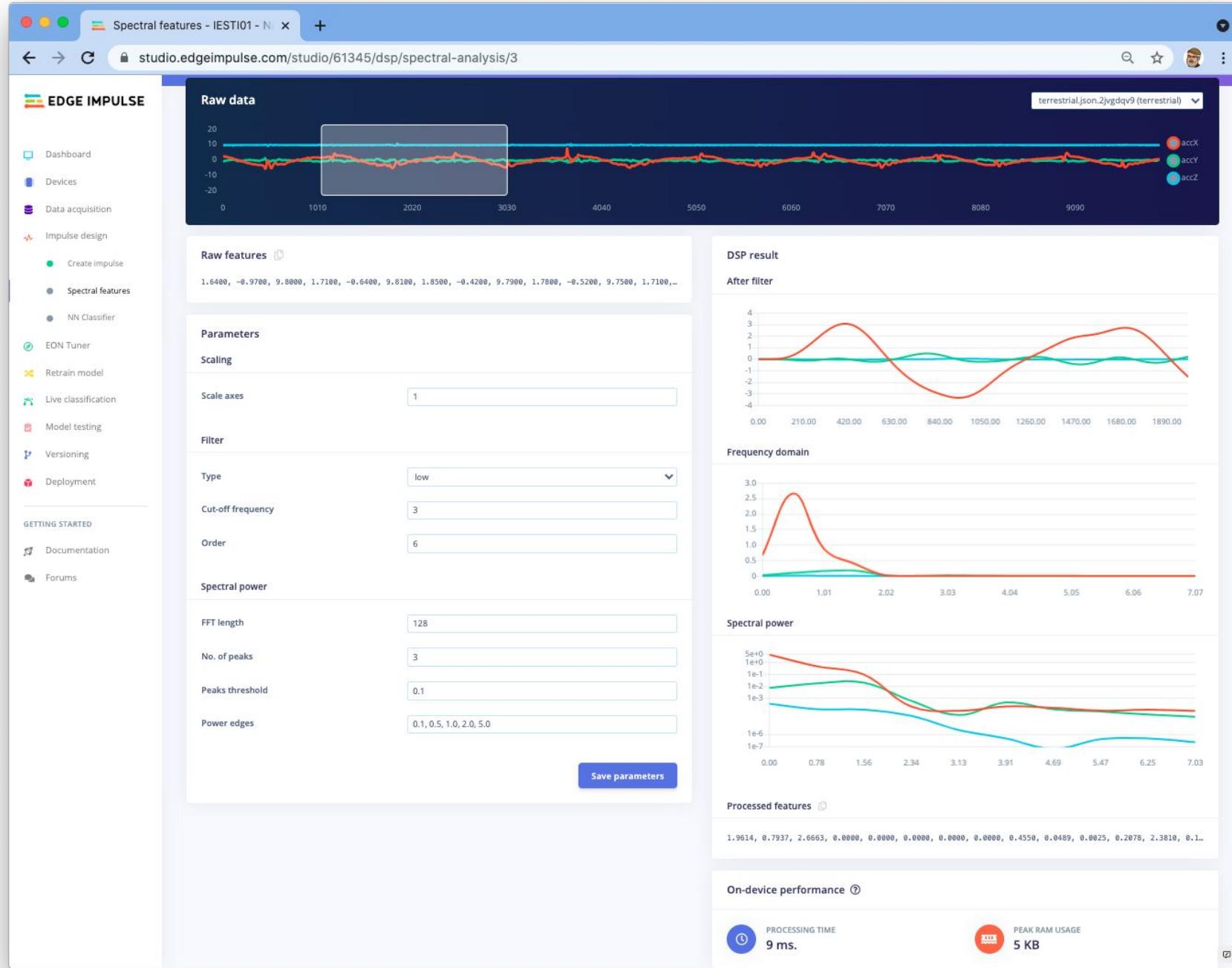
4 (idle, lift, maritime, terrestrial)

Save Impulse



Classes

- Lift
- Terrestrial
- Maritime
- Idle



Spectral features - IESTI01 - N

studio.edgeimpulse.com/studio/61345/dsp/spectral-analysis/3/generate-features

EDGE IMPULSE

SPECTRAL FEATURES (IESTI01 - NANO MOTION CLASSIFICATION)

#1 ▾ Click to set a description for this version

Parameters **Generate features**

Training set

- Data in training set 5m 20s
- Classes 4 (idle, lift, maritime, terrestrial)
- Window length 2000 ms.
- Window increase 80 ms.
- Training windows 3,400

Feature explorer (3,400 samples)

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

idle (blue), lift (orange), maritime (green), terrestrial (red)

Feature generation output

```

Job started
Creating windows from 25 files...
[ 0/25] Creating windows from files...
[ 1/25] Creating windows from files...
[25/25] Creating windows from files...
Created 3400 windows: idle: 976, lift: 808, maritime: 808, terrestrial: 808

Creating features
[ 1/3400] Creating features...
[ 898/3400] Creating features...
[1798/3400] Creating features...
[2704/3400] Creating features...
[3400/3400] Creating features...
Created features
  
```

On-device performance

PROCESSING TIME 9 ms. PEAK RAM USAGE 5 KB

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MJRoBot (Marcelo Roval)

Neural Network settings

Training settings

Number of training cycles ?
30

Learning rate ?
0.0005

Neural network architecture

- Input layer (33 features)**
- Dense layer (20 neurons)
- Dense layer (10 neurons)
- Add an extra layer
- Output layer (4 classes)**

Start training

Model

Model version: ? Quantized (int8)

Last training performance (validation set)

%	ACCURACY 99.9%	graph	LOSS 0.01
--	---------------------------------	--	----------------------------

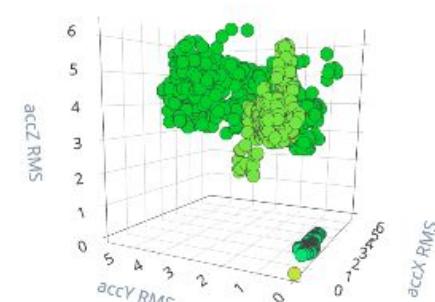
Confusion matrix (validation set)

	IDLE	LIFT	MARITIME	TERRESTRIAL
IDLE	100%	0%	0%	0%
LIFT	0%	99.4%	0.6%	0%
MARITIME	0%	0%	100%	0%
TERRESTRIAL	0%	0%	0%	100%
F1 SCORE	1.00	1.00	1.00	1.00

Feature explorer (full training set) ?

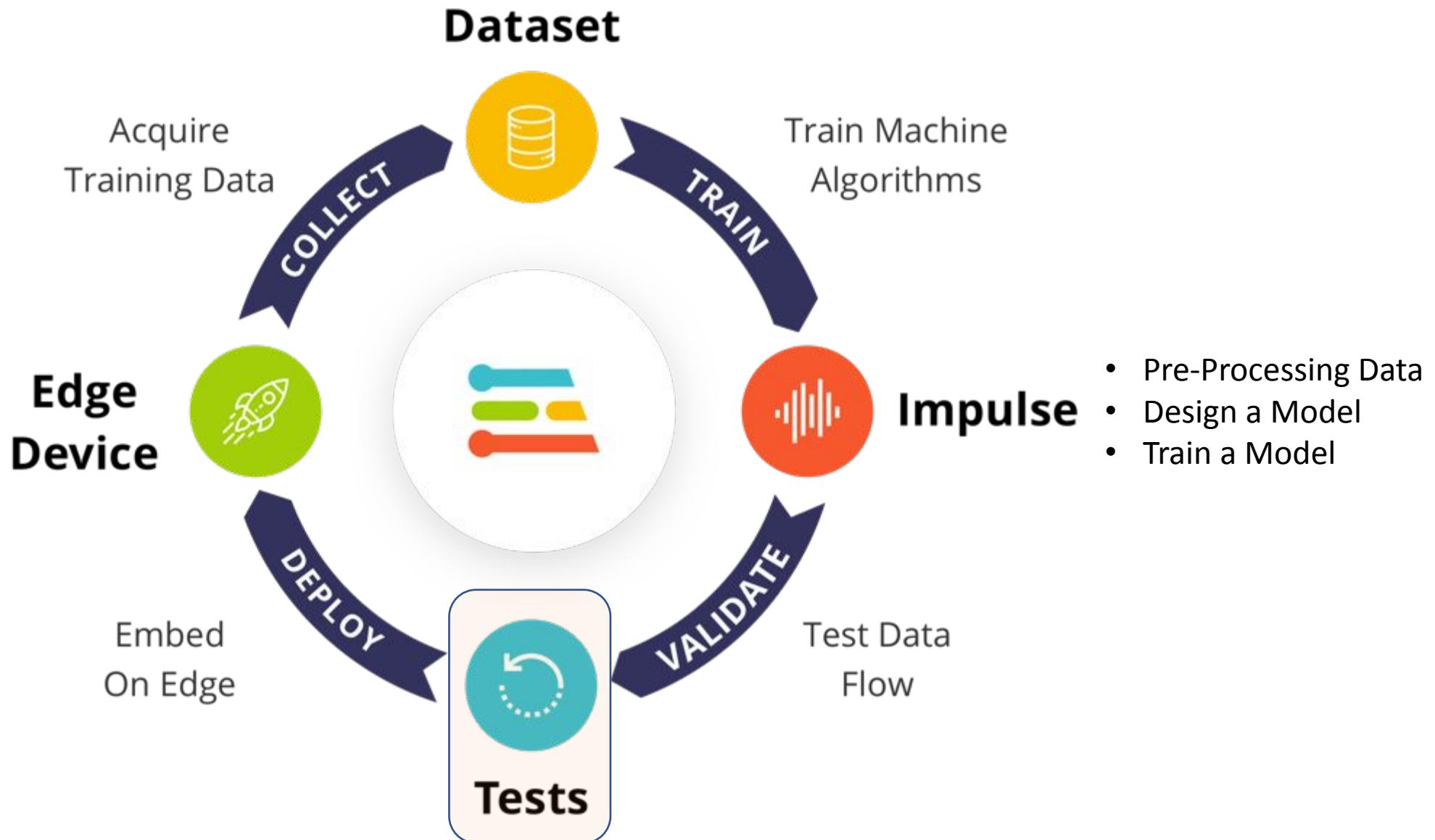
accX RMS ▼ accY RMS ▼ accZ RMS ▼

● idle - correct
● lift - correct
● maritime - correct
● terrestrial - correct
● lift - incorrect



On-device performance ?

clock	INFERRING TIME 1 ms.	memory	PEAK RAM USAGE 1.7K	flash	FLASH USAGE 19.0K
--	---------------------------------------	---	--------------------------------------	--	------------------------------------



Model testing - IESTI01 - Nano

studio.edgeimpulse.com/studio/61345/validation

Test data

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

SAMPLE NAME	EXPECTED OUTCOME	LENGTH	ACCURACY	RESULT	⋮
terrestrial.json.2...	terrestrial	10s	100%	101 terrestrial	⋮
lift.json.2jhbt7	lift	10s	100%	101 lift	⋮
idle.json.2jvjlvn	idle	20s	100%	226 idle	⋮
maritime.json.2j...	maritime	10s	100%	101 maritime	⋮
maritime.json.2j...	maritime	10s	100%	101 maritime	⋮
lift.json.2jh6uqu	lift	10s	100%	101 lift	⋮
terrestrial.json.2...	terrestrial	10s	100%	101 terrestrial	⋮

Model testing output

Classifying data for NN Classifier...
 Copying features from processing blocks...
 Copying features from DSP block...
 Copying features from DSP block OK
 Copying features from processing blocks OK

Classifying data for float32 model...
 Scheduling job in cluster...
 Job started
 Classifying data for NN Classifier OK

Job completed

Model testing results

ACCURACY
100.00%

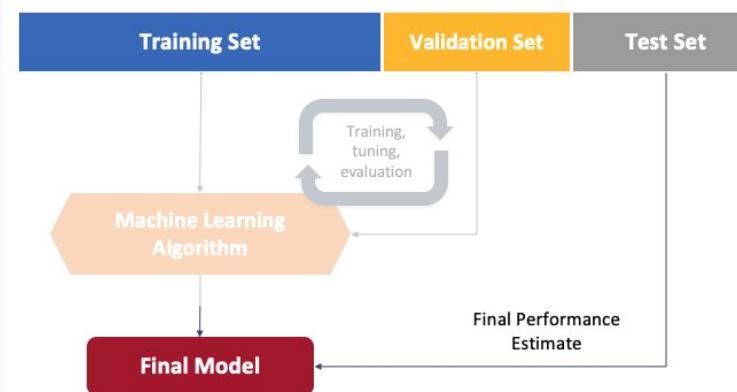
	IDLE	LIFT	MARITIME	TERRESTRIAL	UNCERTAIN
IDLE	100%	0%	0%	0%	0%
LIFT	0%	100%	0%	0%	0%
MARITIME	0%	0%	100%	0%	0%
TERRESTRIAL	0%	0%	0%	100%	0%
F1 SCORE	1.00	1.00	1.00	1.00	

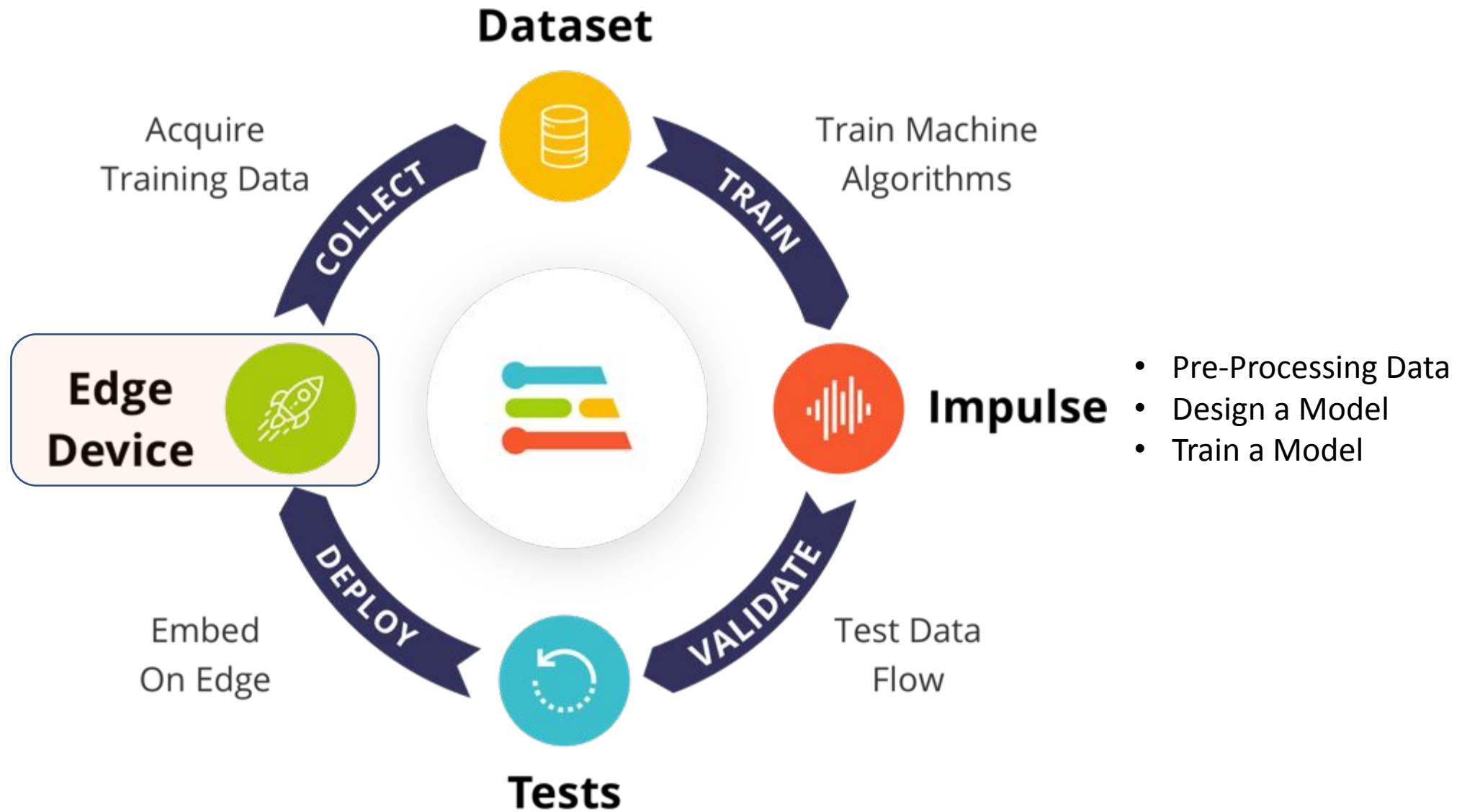
Feature explorer

accX RMS accY RMS accZ RMS

- idle - correct
- lift - correct
- maritime - correct
- terrestrial - correct

The Feature explorer displays a 3D scatter plot with axes accX RMS, accY RMS, and accZ RMS. Data points are colored by class: green for idle, yellow for lift, red for maritime, and blue for terrestrial. A legend indicates which points are correctly classified for each class. The plot shows distinct clusters for each class, with most points falling into their respective color-coded regions.





Deployment - IESTI01 - Nano Motion Classification

studio.edgeimpulse.com/studio/61345/deployment

MJRoBot (Marcelo Rovai)

DEPLOYMENT (IESTI01 - NANO MOTION CLASSIFICATION)

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.

- 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.

		 END OF LIFE
		
		

ei-iesti01---nano....zip

Show All

Build output

```
Creating job... OK (ID: 1646786)
Writing templates...
Writing templates OK
Copying Edge Impulse SDK...
Copying Edge Impulse SDK OK
Compiling EON model...
Compiling EON model OK
Removing clutter and updating headers...
Removing clutter and updating headers OK
Creating archive...
Job started
Creating archive OK
Job completed
```

Deployment - IESTI01 - Nano Motion Classification

studio.edgeimpulse.com/studio/61345/deployment

EDGE IMPULSE

- Dashboard
- Devices
- Data acquisition
- Impulse design
 - Create impulse
 - Spectral features
 - NN Classifier
- EON Tuner
- Retrain model
- Live classification
- Model testing
- Versioning
- Deployment

GETTING STARTED

- Documentation
- Forums

SiLabs Thunderboard Sense 2

Himax WE-I Plus

Nordic nRF52840 DK + IKS02A1

Nordic nRF5340 DK + IKS02A1

Nordic nRF9160 DK + IKS02A1

Nordic Thingy:91

Sony's Spsesense

Select optimizations (optional)

Model optimizations can increase on-device performance. Choose from recommended choices for your target. Click **Enable EON™ Compiler** for same accuracy, up to 50% less RAM usage.

Enable EON™ Compiler
Same accuracy, up to 50% less RAM usage

Available optimizations for NN Classifier

Optimization	RAM Usage	Latency	Confusion Matrix																								
Quantized (int8) ★ <small>Currently selected</small>	1.1K	1 ms	<table border="1"> <tr><td>100</td><td>0</td><td>0</td><td>0</td><td>100</td><td>0</td></tr> <tr><td>0</td><td>100</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>100</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>100</td><td>0</td><td>0</td></tr> </table>	100	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	0	0	0	0	100	0	0
100	0	0	0	100	0																						
0	100	0	0	0	0																						
0	0	100	0	0	0																						
0	0	0	100	0	0																						
Unoptimized (float32) <small>Click to select</small>	19.0K	100%	<table border="1"> <tr><td>100</td><td>0</td><td>0</td><td>0</td><td>100</td><td>0</td></tr> <tr><td>0</td><td>100</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>100</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>100</td><td>0</td><td>0</td></tr> </table>	100	0	0	0	100	0	0	100	0	0	0	0	0	0	100	0	0	0	0	0	0	100	0	0
100	0	0	0	100	0																						
0	100	0	0	0	0																						
0	0	100	0	0	0																						
0	0	0	100	0	0																						

Estimate for Cortex-M4F 80MHz

Built Arduino library

Add this library through the Arduino IDE via:
Sketch > Include Library > Add .ZIP Library...

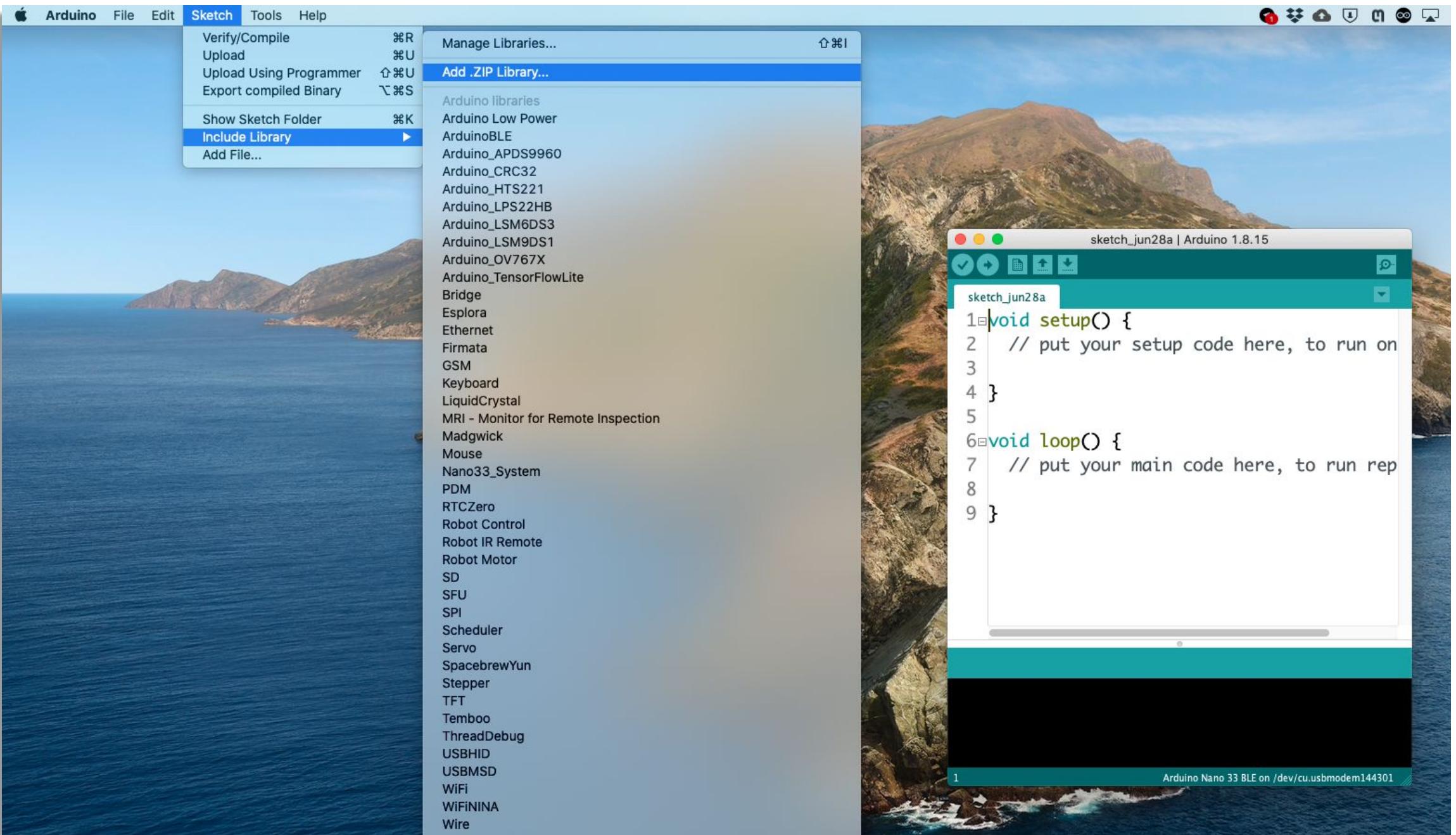
Examples can then be found under:
File > Examples > IESTI01_-_Nano_Motion_Classification_inferencing

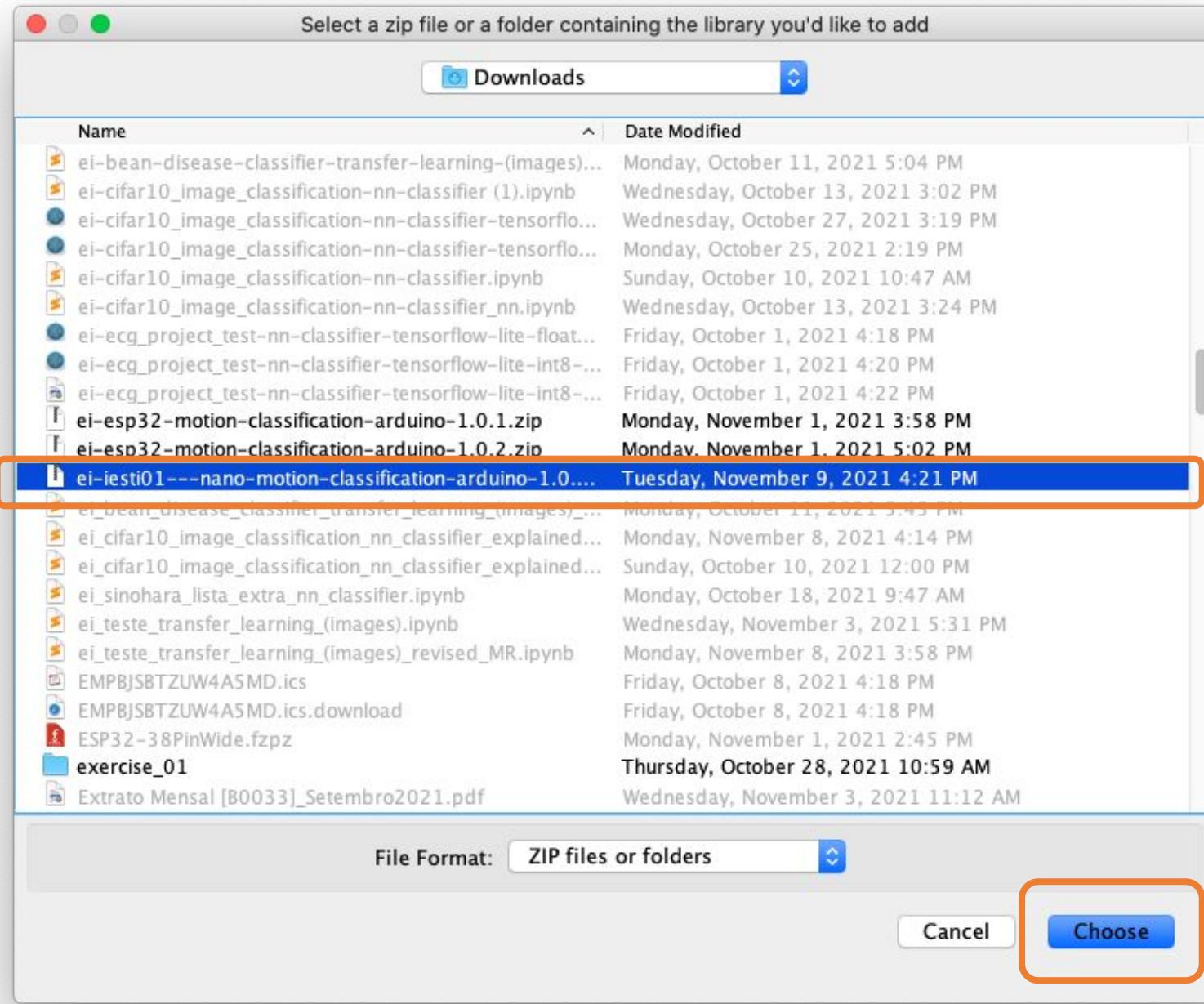
Build output

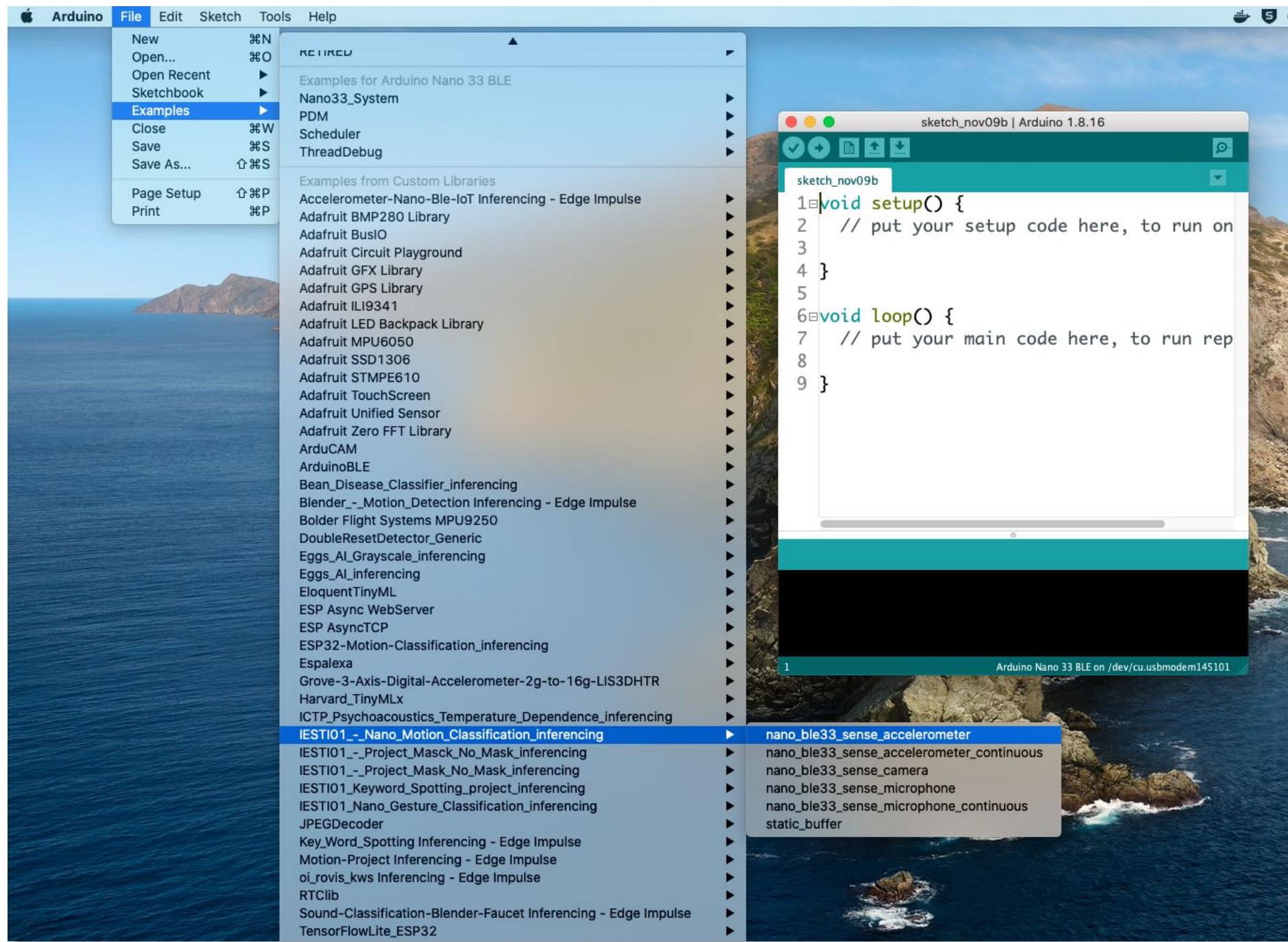
- Creating job... OK (ID: 1646786)
- Writing templates... Writing templates OK
- Copying Edge Impulse SDK... Copying Edge Impulse SDK OK
- Compiling EON model... Compiling EON model OK
- Removing clutter and updating headers... Removing clutter and updating headers OK
- Creating archive... archive OK

ei-iesti01---nano....zip

Show All







Model Inference

Arduino File Edit Sketch Tools Help

/dev/cu.usbmodem145101

Sampling...

Predictions (DSP: 20 ms., Classification: 0 ms., Anomaly: 0 ms.):

- idle: 0.00000
- lift: 0.00000
- maritime: 0.00000
- terrestrial: 0.99609

Starting inferencing in 2 seconds...

Sampling...

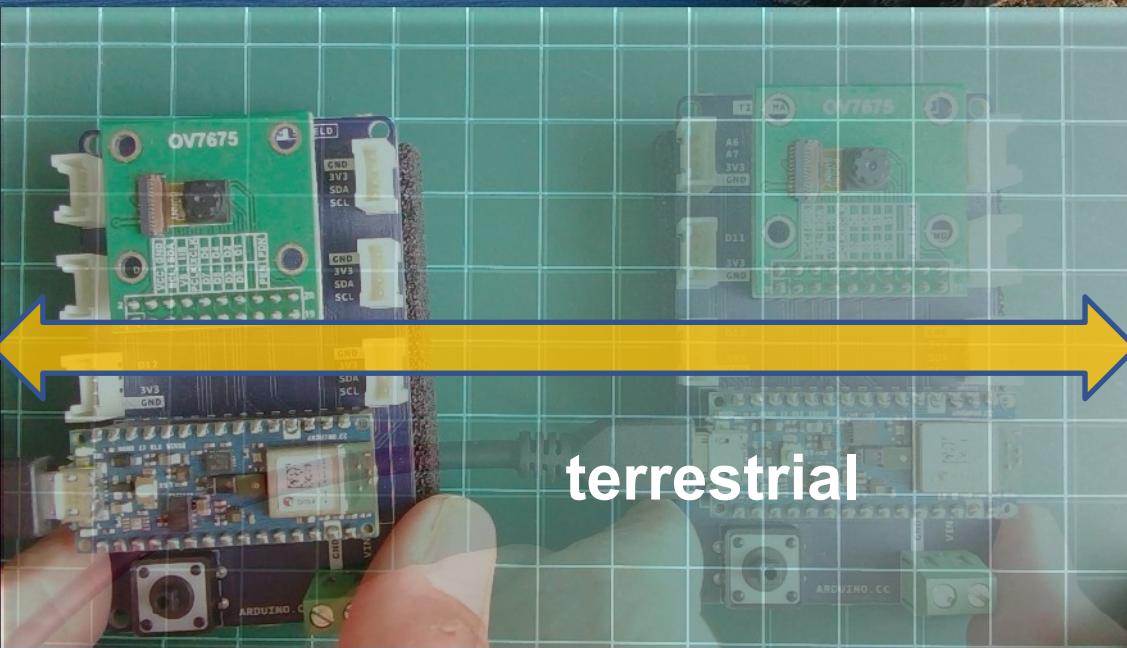
Predictions (DSP: 20 ms., Classification: 1 ms., Anomaly: 0 ms.):

- idle: 0.00000
- lift: 0.00000
- maritime: 0.00000
- terrestrial: 0.99609

Starting inferencing in 2 seconds...

Autoscroll Show timestamp

Both NL & CR 115200 baud Clear output



terrestrial

nano_ble33_sense_accelerometer | Arduino 1.8.16

```
/* Edge Impulse Arduino examples
 * Copyright (c) 2021 EdgeImpulse Inc.
 *
 * Permission is hereby granted, free of charge, to any person obtaining a copy
 * of this software and associated documentation files (the "Software"), to
 * deal in the Software without restriction, including without limitation the rights
 * to use, copy, modify, merge, publish, distribute, sublicense, and/or sell
 * copies of the Software, and to permit persons to whom the Software is
 * furnished to do so, subject to the following conditions:
 *
 * The above copyright notice and this permission notice shall be included in
 * all copies or substantial portions of the Software.
 *
 * THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
 * IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY,
 * FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE
 * AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER
 * LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM
 * OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN
 * THE SOFTWARE.
 */
/*
 * Includes -----
#include <IESTI01_-_Nano_Motion_Classification_inferencing.h>
#include <Arduino_LSM9DS1.h>
*
/* Constant defines -----
#define CONVERT_G_TO_MS2 9.80665f
*
/* Private variables -----
static bool debug_nn = false; // Set this to true to see e.g. features generated by the neural network
*/
Done in 6.027 seconds
reset()
```

15

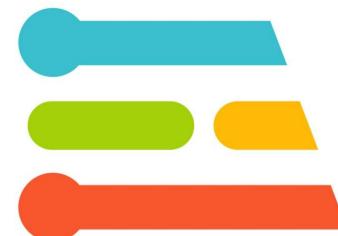
Arduino Nano 33 BLE on /dev/cu.usbmodem145101

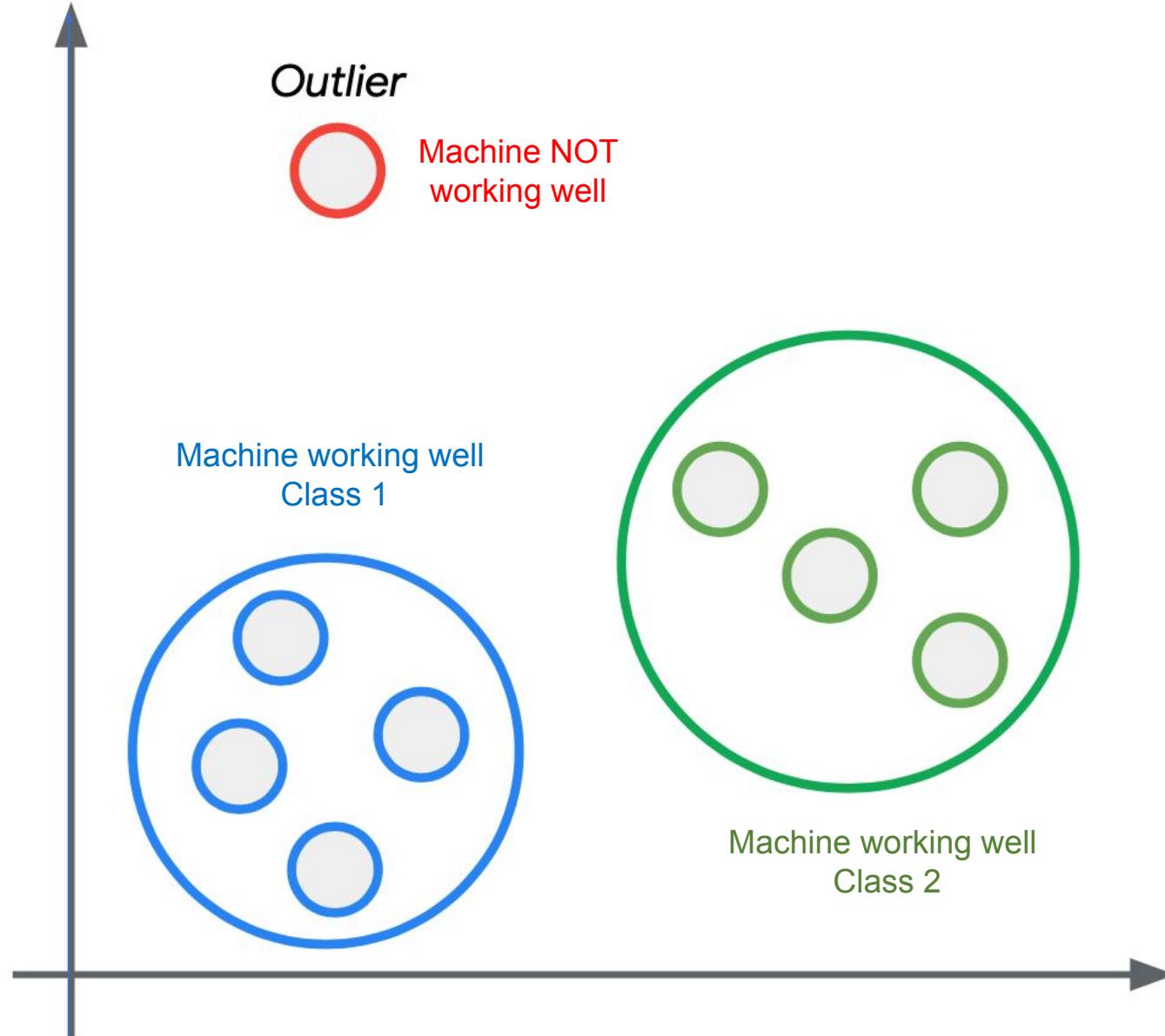
```
/dev/cu.usbmodem145101  
Send  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 27 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 27 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 27 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 27 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 27 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 27 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,  
Predictions (DSP: 29 ms., Classification: 0 ms., Anomaly: 0 ms.): terrestrial [ 0, 0, 0, 10, 0, 0,
```

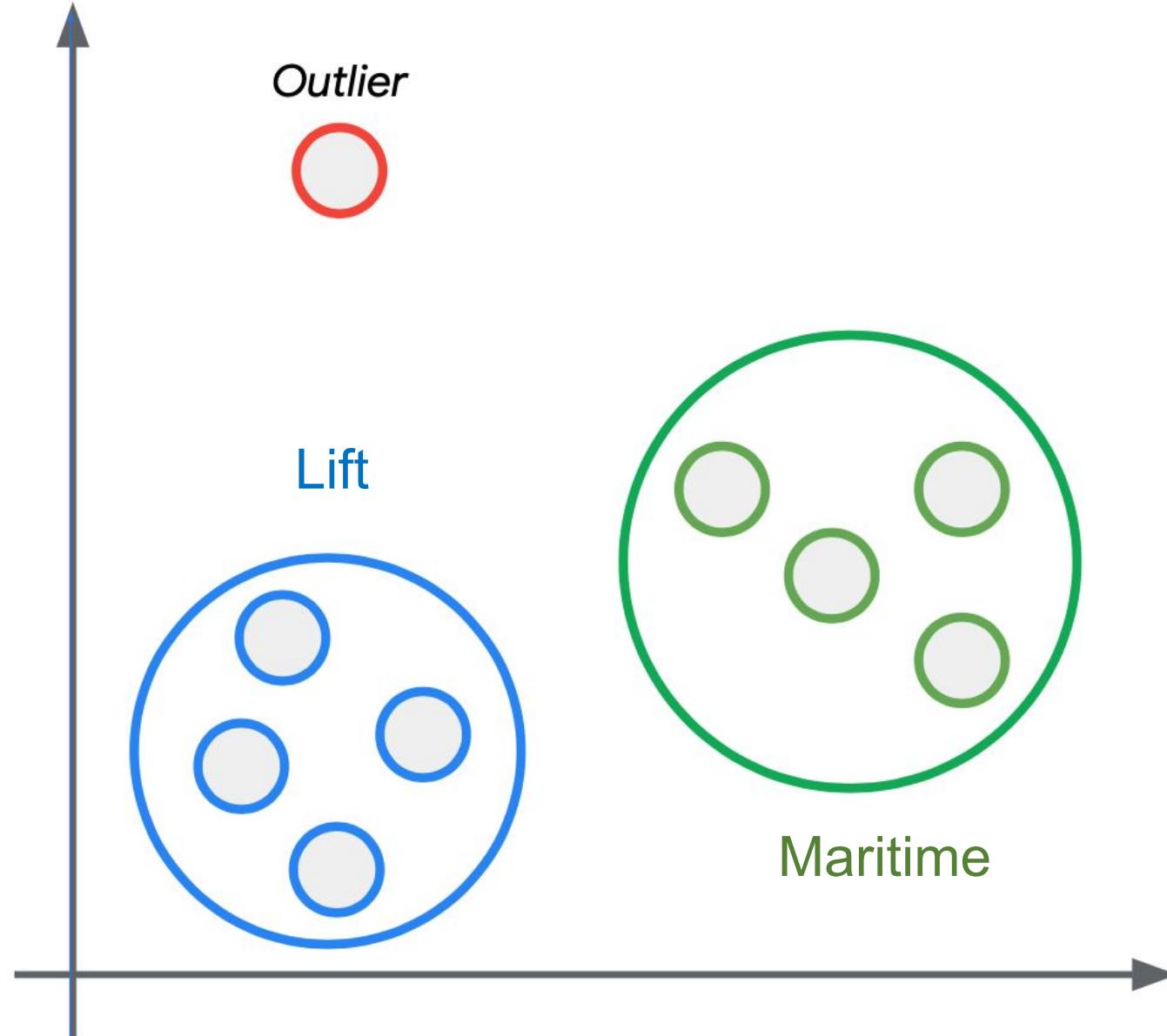


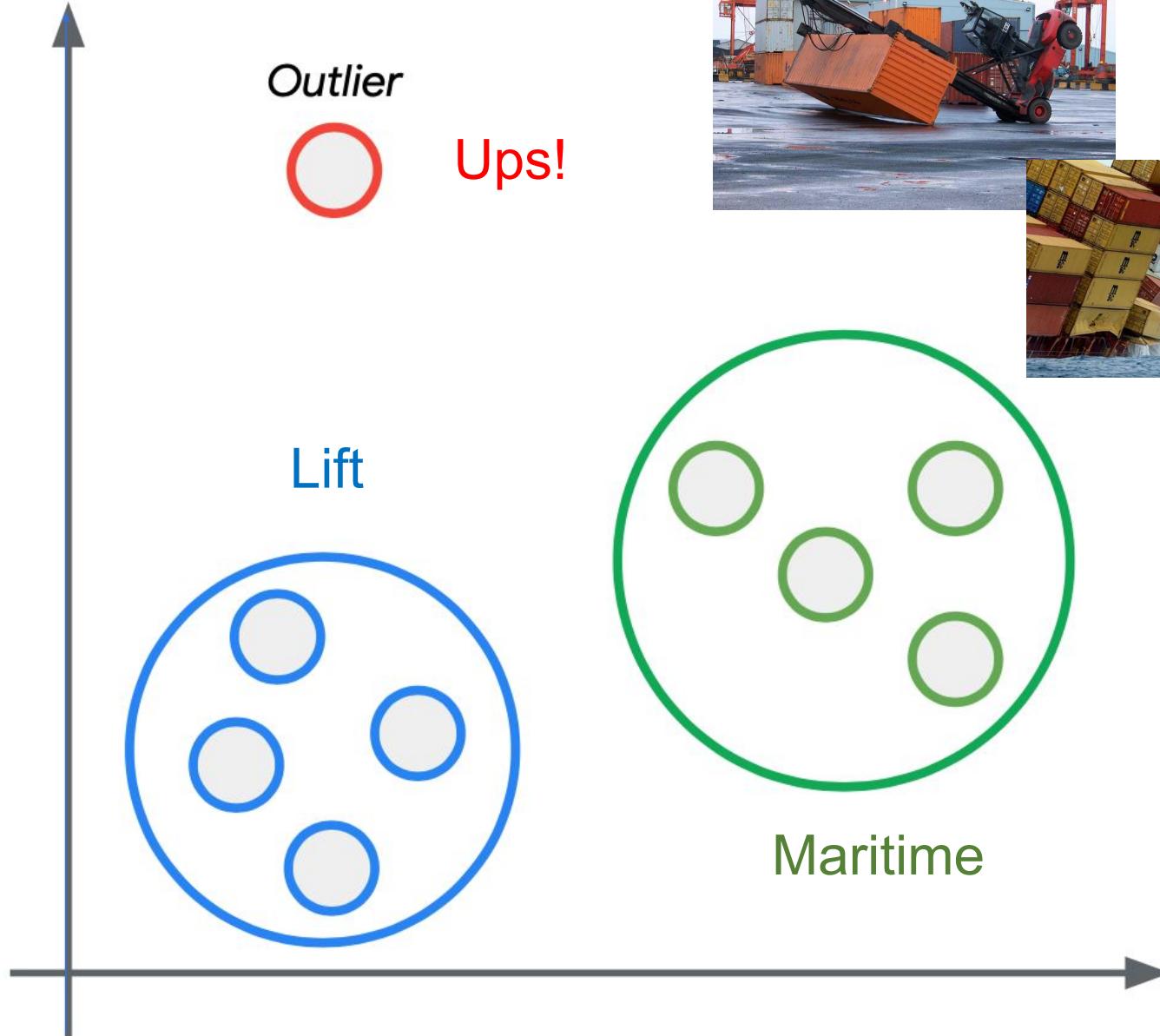
```
nano_ble33_sense_accelerometer_continuous | Arduino 1.8.16  
nano_ble33_sense_accelerometer_continuous  
22  
23 /* Includes -----  
24 #include <IESTI01_-_Nano_Motion_Classification_inferencing.h>  
25 #include <Arduino_LSM9DS1.h>  
26  
27 /* Constant defines -----  
28 #define CONVERT_G_TO_MS2 9.80665f  
29  
30 /* Private variables -----  
31 static bool debug_nn = false; // Set this to true to see e.g. features  
32 static uint32_t run_inference_every_ms = 200;  
33 static rtos::Thread inference_thread(osPriorityLow);  
34 static float buffer[EI_CLASSIFIER_DSP_INPUT_FRAME_SIZE] = { 0 };  
35 static float inference_buffer[EI_CLASSIFIER_DSP_INPUT_FRAME_SIZE];  
36  
37 /* Forward declaration */  
38 void run_inference_background();  
39  
40 /**  
41 * @brief Arduino setup function  
42 */  
43 void setup()  
44{  
    // put your setup code here, to run once:  
    Serial.begin(115200);  
    Serial.println("Edge Impulse Inferencing Demo");  
      
    if (!IMU.begin()) {  
        ei_printf("Failed to initialize IMU!\r\n");  
    }  
    else {  
        ei_printf("IMU initialized\r\n");  
    }  
}  
Done uploading.  
Done in 6.034 seconds  
reset()
```

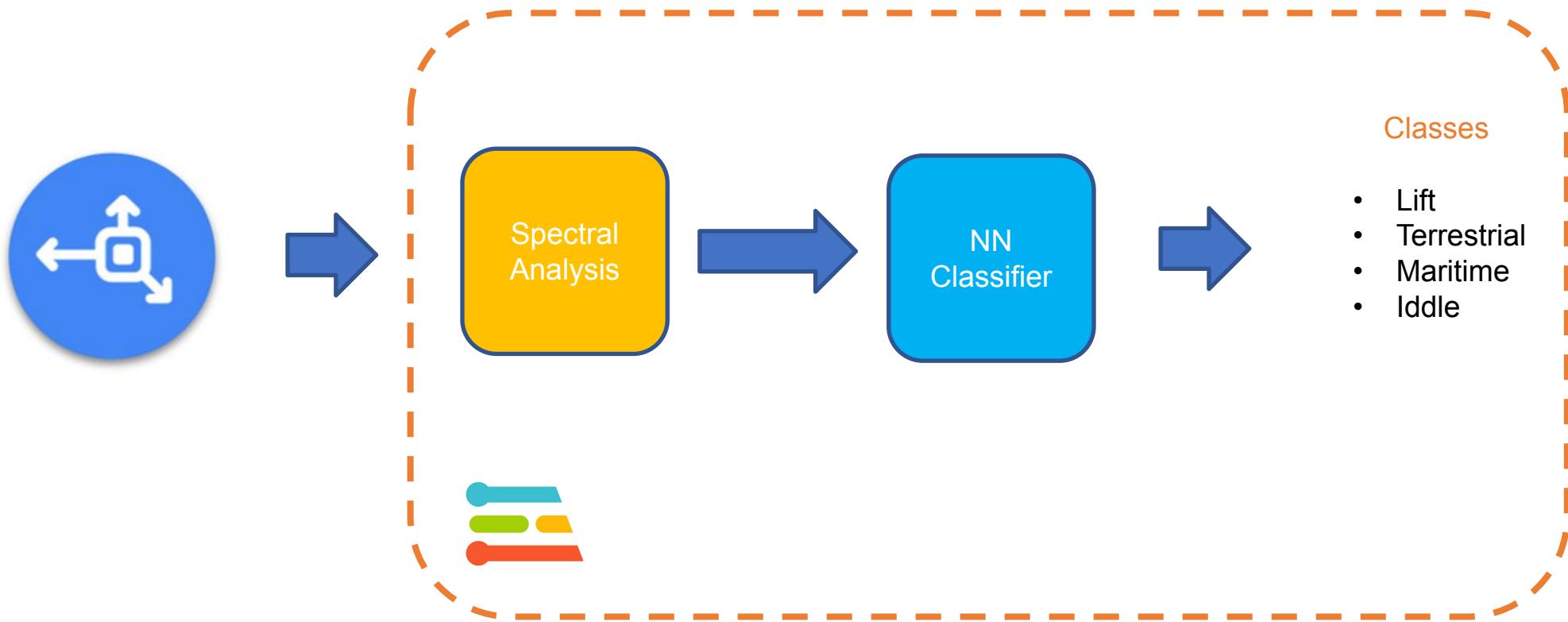
Anomaly Detection Hands-On

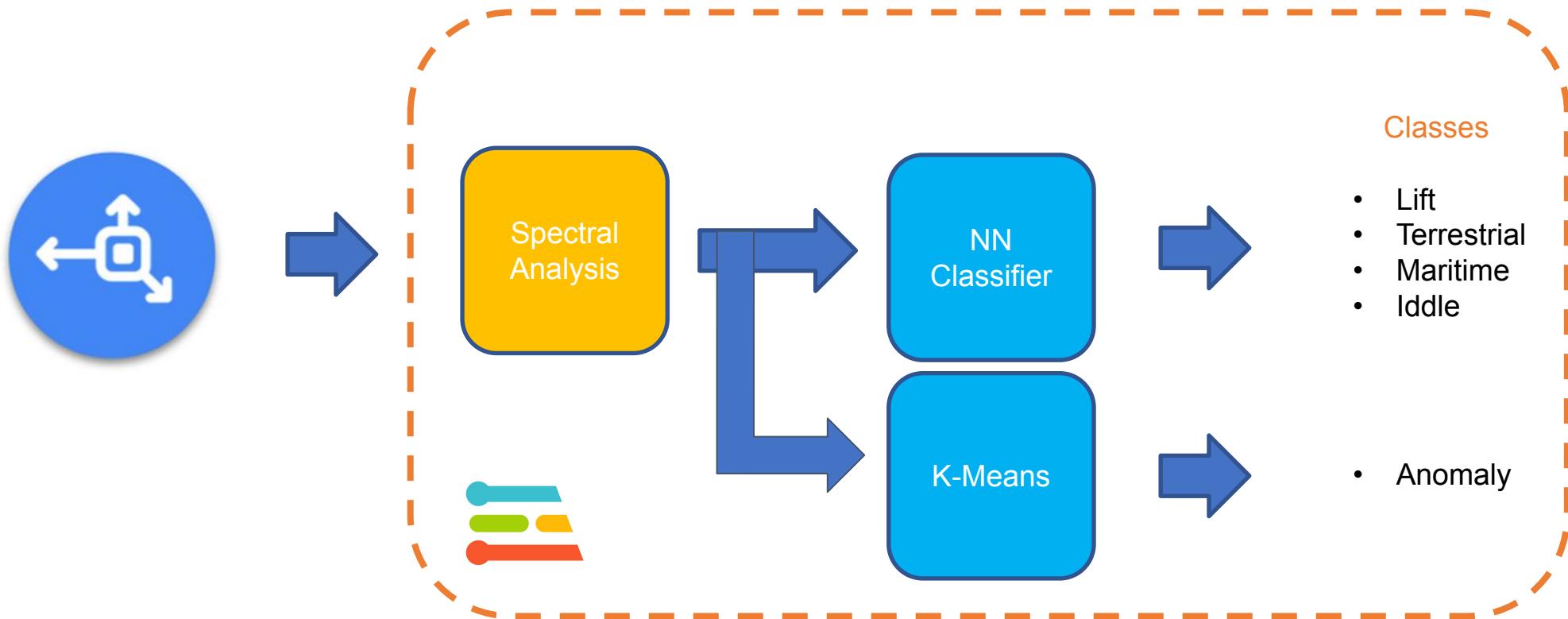












Create impulse - IESTI01 - Nano Motion Classification

studio.edgeimpulse.com/studio/61345/create-impulse

MJRoBot (Marcelo Rovai)

EDGE IMPULSE

CREATE IMPULSE (IESTI01 - NANO MOTION CLASSIFICATION)

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

Time series data

Spectral Analysis

Classification (Keras)

Output features

Axes
accX, accY, accZ

Window size

Window increase

Frequency (Hz)
100

Zero-pad data

Add a learning block

Some learning blocks have been hidden based on the data in your project.

DESCRIPTION	AUTHOR	RECOMMENDED
Classification (Keras) Learns patterns from data, and can apply these to new data. Great for categorizing movement or recognizing audio.	EdgImpulse Inc.	
Anomaly Detection (K-means) Find outliers in new data. Good for recognizing unknown states, and to complement classifiers.	EdgImpulse Inc.	
Regression (Keras) Learns patterns from data, and can apply these to new data. Great for predicting numeric continuous values.	EdgImpulse Inc.	

Save Impulse

Cancel

GETTING STARTED

Documentation

Forums

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Create impulse - IESTI01 - Nano Motion Classification

studio.edgeimpulse.com/studio/61345/create-impulse

MJRoBot (Marcelo Rovai)

EDGE IMPULSE

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

Time series data

Axes: accX, accY, accZ

Window size: 2000 ms.

Window increase: 80 ms.

Frequency (Hz): 100

Zero-pad data:

Spectral Analysis

Name: Spectral features

Input axes: accX, accY, accZ

Classification (Keras)

Name: NN Classifier

Input features: Spectral features

Output features: 4 (idle, lift, maritime, terrestrial)

Output features

5 (idle, lift, maritime, terrestrial, Anomaly score)

Anomaly Detection (K-means)

Name: Anomaly detection

Input features: Spectral features

Output features: 1 (Anomaly score)

Add a processing block

Save Impulse

53

Anomaly detection - IESTI01 - [X](#)

[studio.edgeimpulse.com/studio/61345/learning/anomaly/15](#)

EDGE IMPULSE

ANOMALY DETECTION (IESTI01 - NANO MOTION CLASSIFICATION)

#1 ▾ Click to set a description for this version

Anomaly detection settings

Cluster count: 32

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

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

Select all axes

Anomaly explorer (3,400 samples)

X Axis: accX RMS **Y Axis:** accY RMS **Test data:** -- No test data

● trained

Training output

```

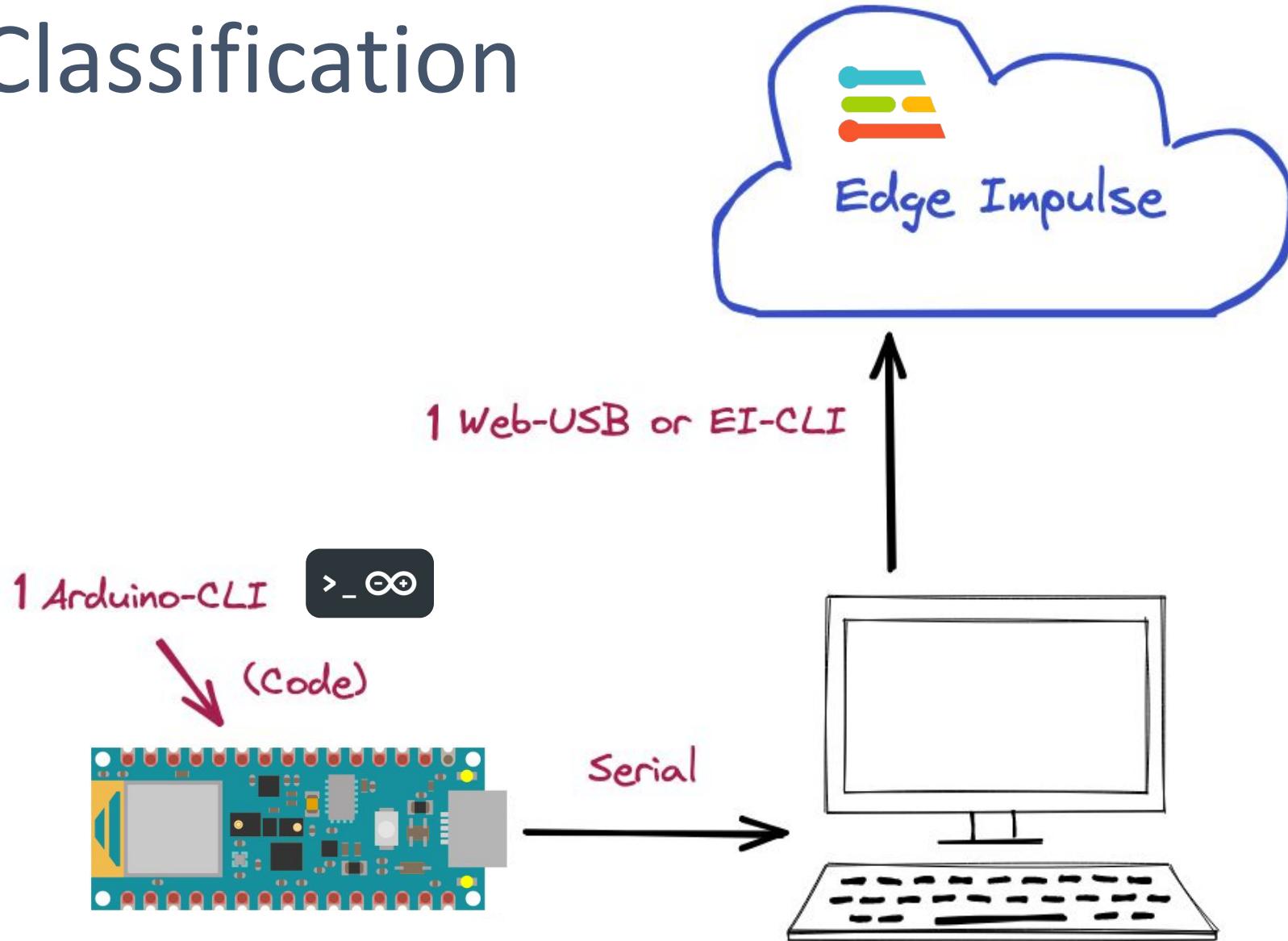
0.6082163453102112, 0.25316372513771057], 'max_error': 0.34954408210594134}, {'center':
[-0.5115050673484802, -0.004735563416033983, 0.709574282169342], 'max_error': 0.2947459724666345},
{'center': [0.031501531600952, 1.2126123905181885, 1.129497766494751], 'max_error': 0.6769873962564943},
{'center': [1.391443133354187, 0.902986841171265, 0.8108663558959961], 'max_error': 0.5210900944982784},
{'center': [0.035471659153699875, 1.796299695968628, 1.2969461679458618], 'max_error':
0.5249936584588187}, {'center': [0.10634401440620422, 2.2963626384735107, 0.7528869005052185],
'max_error': 0.44105256183930464}, {'center': [1.645737767219543, 1.7475732564926147,
1.4299843311309814], 'max_error': 0.5520137297917197}, {'center': [2.21975709915161, 2.0978941917419434,
0.7476416230201721], 'max_error': 0.5746162180430946}, {'center': [0.032550420612096786,
-0.03719609975814819, 1.5903402566989761], 'max_error': 0.4070282568799601}, {'center':
[0.2832728922367096, 2.612391710281372, 1.1812870502471924], 'max_error': 0.43737044666248764},
{'center': [1.6214791536331177, 3.0532443523406982, 1.385027527809143], 'max_error': 0.7516882902121258},
{'center': [0.974504049412384, 1.682228883789062, 1.557731032371521], 'max_error': 0.7167072825903013},
{'center': [3.062652111053467, 0.4566035866737366, 0.4609105587005615], 'max_error': 0.444618109668133}

```

Job completed

Start training

Live Classification



Devices - IESTI01 - Nano Motic Arduino Nano 33 BLE Sense

studio.edgeimpulse.com/studio/61345/devices

EDGE IMPULSE

Devices (IESTI01 - NANO MOTION CLASSIFICATION)

Deleted device (" Nano ")

Your devices

These are devices that are connected to the Edge Impulse studio.

Connect a new device

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

Use your mobile phone

Use your computer

Data from any device with the data forwarder

Upload data

Integrate with your cloud

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Devices

Dashboard

Data acquisition

Impulse design

- Create impulse
- Spectral features
- NN Classifier
- Anomaly detection

EON Tuner

Retrain model

Live classification

Model testing

Versioning

Deployment

GETTING STARTED

Documentation

Forums

MJRobot (Marcelo Roval)

The screenshot shows the Edge Impulse studio interface. The left sidebar has a 'Devices' menu item highlighted with an orange box. The main content area shows a 'Deleted device (" Nano ")' message. A central modal window titled 'Collect data' is open, listing several ways to collect data: 'Connect a fully supported development board' (highlighted with an orange box), 'Use your mobile phone', 'Use your computer', 'Data from any device with the data forwarder', 'Upload data', and 'Integrate with your cloud'. The 'Connect a fully supported development board' section includes a 'Browse dev boards' button. The 'Collect data' modal has its own 'Connect a new device' button in the top right corner, which is also highlighted with an orange box. The bottom of the modal shows the copyright notice '© 2021 EdgImpulse Inc. All rights reserved'.

Devices - IESTI01 - Nano Motic X Arduino Nano 33 BLE Sense +

docs.edgeimpulse.com/docs/arduino-nano-33-ble-sense

DOCUMENTATION

Getting Started

API and SDK references

What is embedded ML, anyway?

Frequently asked questions

DEVELOPMENT BOARDS

Overview

ST B-L475E-IOT01A

Arduino Nano 33 BLE Sense

Eta Compute ECM3532 AI Sensor

Eta Compute ECM3532 AI Vision

OpenMV Cam H7 Plus

Himax WE-I Plus

Nordic Semi nRF52840 DK

Nordic Semi nRF5340 DK

Nordic Semi nRF9160 DK

Nordic Semi Thingy:91

SiLabs Thunderboard Sense 2

Sony's Spresense

Syntiant TinyML Board

TI CC1352P Launchpad

Arduino Portenta H7 + Vision shield (preview)

Raspberry Pi 4

NVIDIA Jetson Nano

Mobile phone

Porting guide



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

From a command prompt or terminal, run:

```
edge-impulse-daemon
```

This will start a wizard which will ask you to log in, and choose an Edge Impulse project. If you want to switch projects run the command with `--clean`.

Alternatively, recent versions of Google Chrome and Microsoft Edge can collect data directly from your development board, without the need for the Edge Impulse CLI. See [this blog post](#) for more information.

4. Verifying that the device is connected

That's all! Your device is now connected to Edge Impulse. To verify this, go to [your Edge Impulse project](#), and click Devices. The device will be listed here.

Your devices

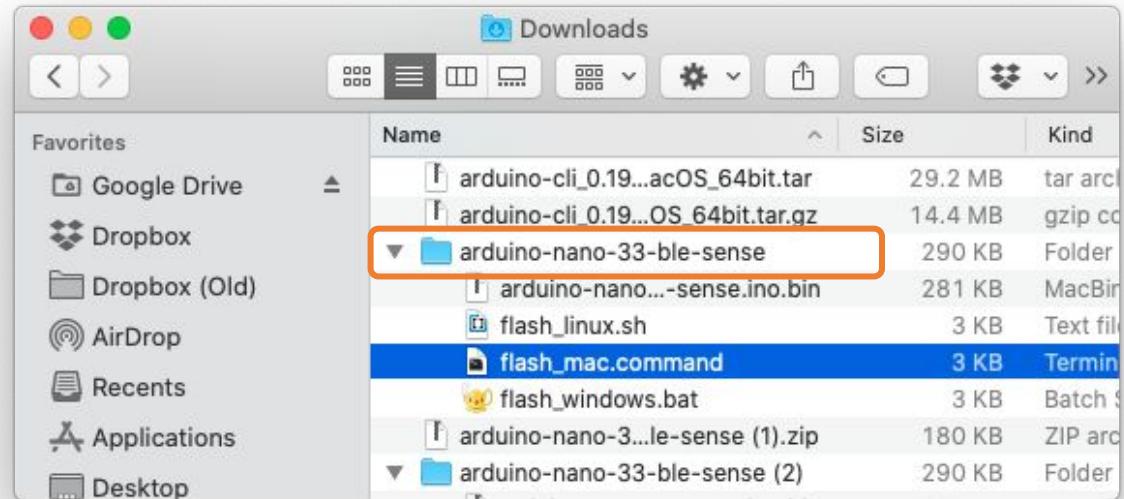
+ Connect a new device

These are devices that are connected to the Edge Impulse remote management API, or have posted data to the ingestion SDK.

NAME	ID	TYPE	SENSORS	REM...	LAST SEEN
 Jan's Nano 33 BLE Sense	51:05:F2:F4:3D:C1	ARDUINO_NANO3...	Built-in accelerometer...	●	Today, 18:40:09

https://cdn.edgeimpulse.com/firmware/arduino-nano-33-ble-sense.zip

arduino-nano-33....zip ^ Show All X



```
mjrovai — flash_mac.command — 80x43
Last login: Thu Nov 11 14:24:32 on ttys000
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 280848 bytes to flash (69 pages)
[=====] 100% (69/69 pages)
Done in 10.982 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.
Deleting expired sessions...none found.

[Process completed]
```

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.usbmodem145101) - Paired**

Cancel Connect

development board, or upload your existing datasets - Show options

TRAIN / TEST SPLIT
80% / 20%

ADDED	LENGTH
Nov 09 2021, 15:06:09	1m 20s
Nov 09 2021, 14:57:35	10s
Nov 09 2021, 14:57:13	10s
Nov 09 2021, 14:56:48	10s
Nov 09 2021, 14:56:31	10s
Nov 09 2021, 14:55:55	10s
Nov 09 2021, 14:55:36	10s
Nov 09 2021, 14:55:19	10s
Nov 09 2021, 14:55:00	10s
Nov 09 2021, 14:41:45	10s
Nov 09 2021, 14:41:26	10s
Nov 09 2021, 14:41:06	10s

Record new data

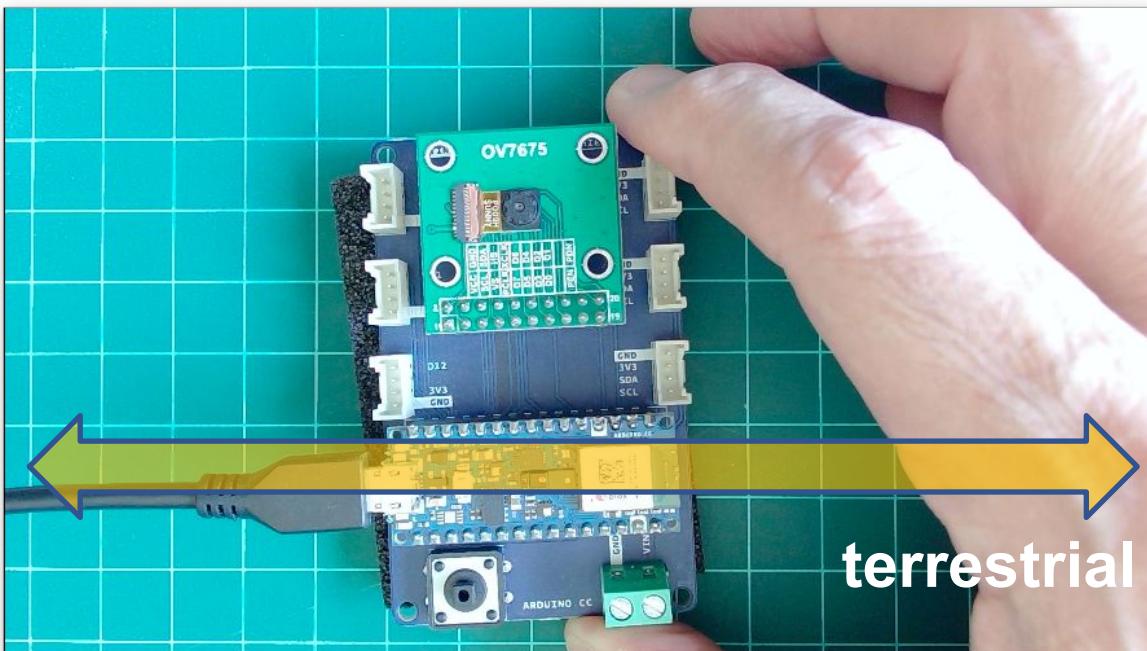
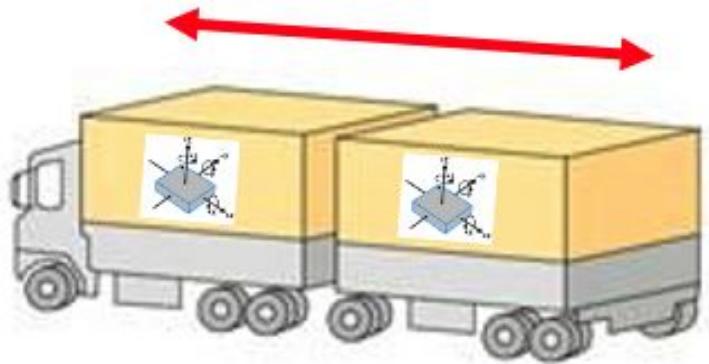
Connect using WebUSB

No devices connected to the remote management API.

RAW DATA
Click on a sample to load...

ei-iesti01---nano....zip

Test: terrestrial





Classification result

Summary

Name

Expected outcome

CATEGORY	COUNT
idle	0
lift	0
maritime	7
terrestrial	0
uncertain	0
anomaly	94

Anomaly explorer (3,501 samples)



Deploy

DEPLOYMENT (ESTI01 - NANO MOTION CLASSIFICATION)

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.

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

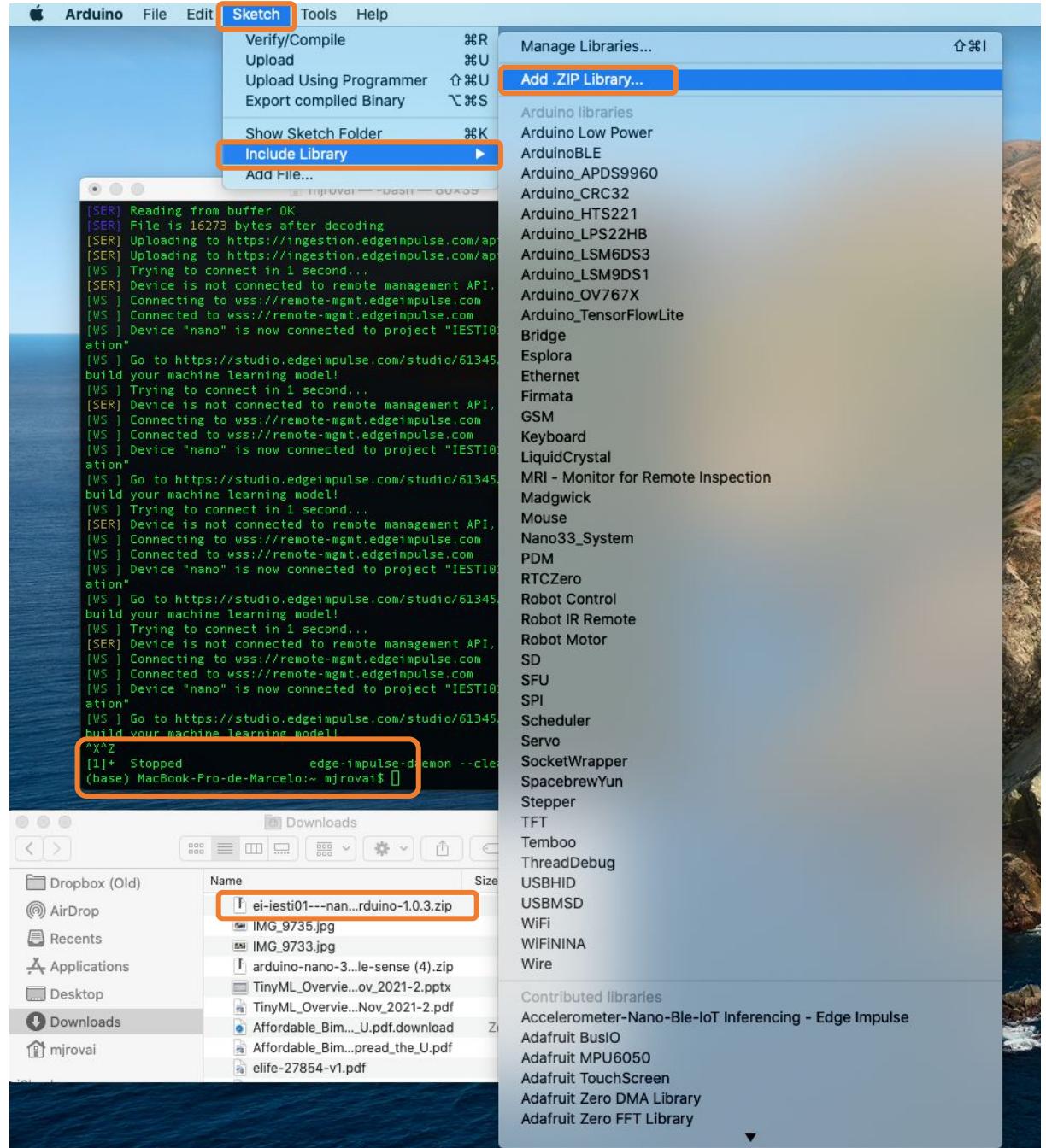
Same accuracy, up to 50% less memory. Open source.

Available optimizations for NN Classifier

Quantized (int8) ★	RAM USAGE 1.7K	LATENCY 1 ms	CONFUSION MATRIX	?																																			
Currently selected			<table border="1"> <tr><td>100</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>100</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>98.5</td><td>0</td><td>1.5</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>100</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> </table>	100	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	98.5	0	1.5	0	0	0	0	0	100	0	0	0	-	-	-	-	-	-	-	
100	0	0	0	0	0	0																																	
0	100	0	0	0	0	0																																	
0	0	98.5	0	1.5	0	0																																	
0	0	0	100	0	0	0																																	
-	-	-	-	-	-	-																																	
This optimization is recommended for best performance.																																							
Unoptimized (float32)	RAM USAGE 1.8K	LATENCY 1 ms	CONFUSION MATRIX	?																																			
Click to select			<table border="1"> <tr><td>100</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>100</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>98.5</td><td>0</td><td>1.5</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>0</td><td>100</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td></tr> </table>	100	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	98.5	0	1.5	0	0	0	0	0	100	0	0	0	-	-	-	-	-	-	-	
100	0	0	0	0	0	0																																	
0	100	0	0	0	0	0																																	
0	0	98.5	0	1.5	0	0																																	
0	0	0	100	0	0	0																																	
-	-	-	-	-	-	-																																	
TensorRT	RAM USAGE 21.3K	LATENCY 99.64%	CONFUSION MATRIX	?																																			

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

[Build](#)



```
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 1 ms., Anomaly: 1 ms.):
    idle: 0.00000
    lift: 0.00000
    maritime: 0.99609
    terrestrial: 0.00000
    anomaly score: 0.620

Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 0 ms., Anomaly: 2 ms.):
    idle: 0.00000
    lift: 0.00000
    maritime: 0.99609
    terrestrial: 0.00000
    anomaly score: 1.470
```

Autoscroll Show timestamp Both NL & CR 115200 baud Clear output

Pos-processing

Turn on/off LEDS

- Idle : ==> All OFF
- lift: ==> **Green ON**
- maritime: ==> **Red ON**
- terrestrial: ==> **Blue ON**
- Anomaly ==> **LED_BUILTIN ON**

```
motion_classification_nano_ble33_sense_accelerometer | Arduino 1.8.16

motion_classification_nano_ble33_sense_accelerometer §
36 void setup()
37 {
38     Serial.begin(115200);
39     while (!Serial);
40
41     Serial.println("IESTI01 - Nano Motion Classification - Inferencing Test");
42
43     pinMode(LED_BUILTIN, OUTPUT);
44     pinMode(LED_R, OUTPUT);
45     pinMode(LED_G, OUTPUT);
46     pinMode(LED_B, OUTPUT);
47
48     // Ensure the LED is off by default.
49     digitalWrite(LED_BUILTIN, LOW);
50     digitalWrite(LED_R, HIGH);
51     digitalWrite(LED_G, HIGH);
52     digitalWrite(LED_B, HIGH);
53
54     if (!IMU.begin()) {
55         ei_printf("Failed to initialize IMU!\r\n");
56     }
57     else {
58         ei_printf("IMU initialized\r\n");
59     }
60
61     if (EI_CLASSIFIER_RAW_SAMPLES_PER_FRAME != 3) {
62         ei_printf("ERR: EI_CLASSIFIER_RAW_SAMPLES_PER_FRAME should be equal to 3 (t
63         return;
64     }
65 }


```

Done Saving.

[=====] 100% (39/39 pages)

Done in 6.193 seconds

`reset()`

136

Arduino Nano 33 BLE on /dev/cu.usbmodem145101

```
motion_classification_nano_ble33_sense_accelerometer | Arduino 1.8.16

motion_classification_nano_ble33_sense_accelerometer \$

66
67 void turn_off_leds(){
68     digitalWrite(LED_R, HIGH);
69     digitalWrite(LED_G, HIGH);
70     digitalWrite(LED_B, HIGH);
71 }
72 /*
73
74 void turn_on_leds(int pred_index) {
75     switch (pred_index)
76     {
77         case 0:      // Idle:      [0] ==> All OFF
78             turn_off_leds();
79             break;
80
81         case 1:      // lift:      [1] ==> Green ON
82             turn_off_leds();
83             digitalWrite(LED_G, LOW);
84             break;
85
86         case 2:      // maritime:  [2] ==> Red ON
87             turn_off_leds();
88             digitalWrite(LED_R, LOW);
89             break;
90
91         case 3:      // terrestrial:[3] ==> Blue ON
92             turn_off_leds();
93             digitalWrite(LED_B, LOW);
94             break;
95
96     }
97 }
```

Done Savin'

W: libcurl (curl_64.dll - 0x551, curl_64.dll - 0xE00000, 3128 - 0x1000)

[=====] 100% (39/39 pages)
Page: 6 103

Done in 6.193 seconds

reset()

97

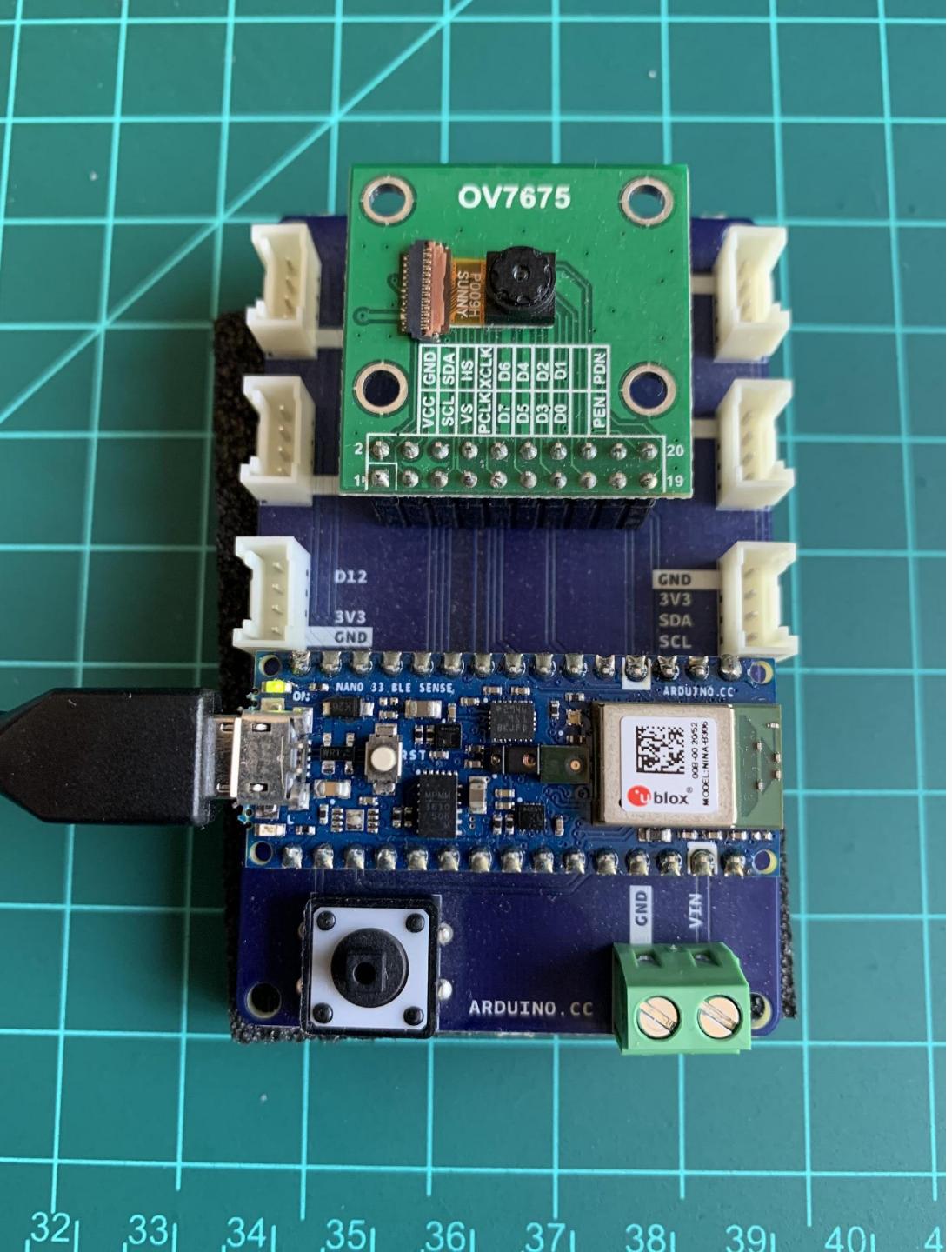
Arduino Nano 33 BLE on /dev/cu.usbmodem145101

The screenshot shows the Arduino IDE interface with the following details:

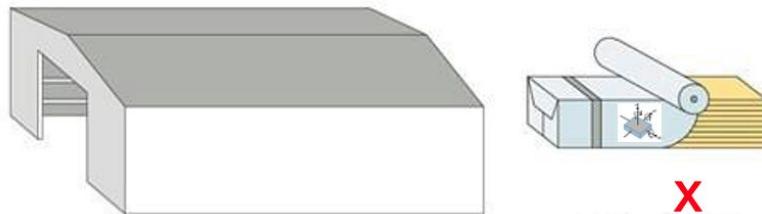
- Title Bar:** motion_classification_nano_ble33_sense_accelerometer | Arduino 1.8.16
- Code Area:** The code is for a motion classification sketch. It includes logic to run a classifier, print predictions, and handle anomalies. The code uses the `ei` library for BLE communication.

```
159 // Run the classifier
160 ei_impulse_result_t result = { 0 };
161 err = run_classifier(&signal, &result, debug_nn);
162 if (err != EI_IMPULSE_OK) {
163     ei_printf("ERR: Failed to run classifier (%d)\n", err);
164     return;
165 }
166
167 // print the predictions
168 ei_printf("Predictions ");
169 ei_printf("(DSP: %d ms., Classification: %d ms., Anomaly: %d ms.)",
170         result.timing.dsp, result.timing.classification, result.timing.anomaly);
171 ei_printf(": \n");
172
173 int pred_index = 0;
174 float pred_value = result.classification[0].value;
175
176 for (size_t ix = 0; ix < EI_CLASSIFIER_LABEL_COUNT; ix++) {
177     ei_printf("%s: %.5f\n", result.classification[ix].label, result.classif
178     if (result.classification[ix].value > pred_value){
179         pred_index = ix;
180         pred_value = result.classification[ix].value;
181     }
182 }
183 ei_printf(" Prediction: %s with probability %.2f\n", result.classification[pre
184 turn_on_leds (pred_index);
185
186 #if EI_CLASSIFIER_HAS_ANOMALY == 1
187     ei_printf(" anomaly score: %.3f\n", result.anomaly);
188     if (result.anomaly > 0.5)
189         digitalWrite(LED_BUILTIN, HIGH);
190     else
191         digitalWrite(LED_BUILTIN, LOW);
192 #endif
193 }
```

- Upload Progress:** The bottom status bar shows "Done uploading." followed by a progress bar indicating the upload was successful at 97% completion.
- Bottom Status:** The status bar also displays the board as "Arduino Nano 33 BLE on /dev/cu.usbmodem145101".



label: idle



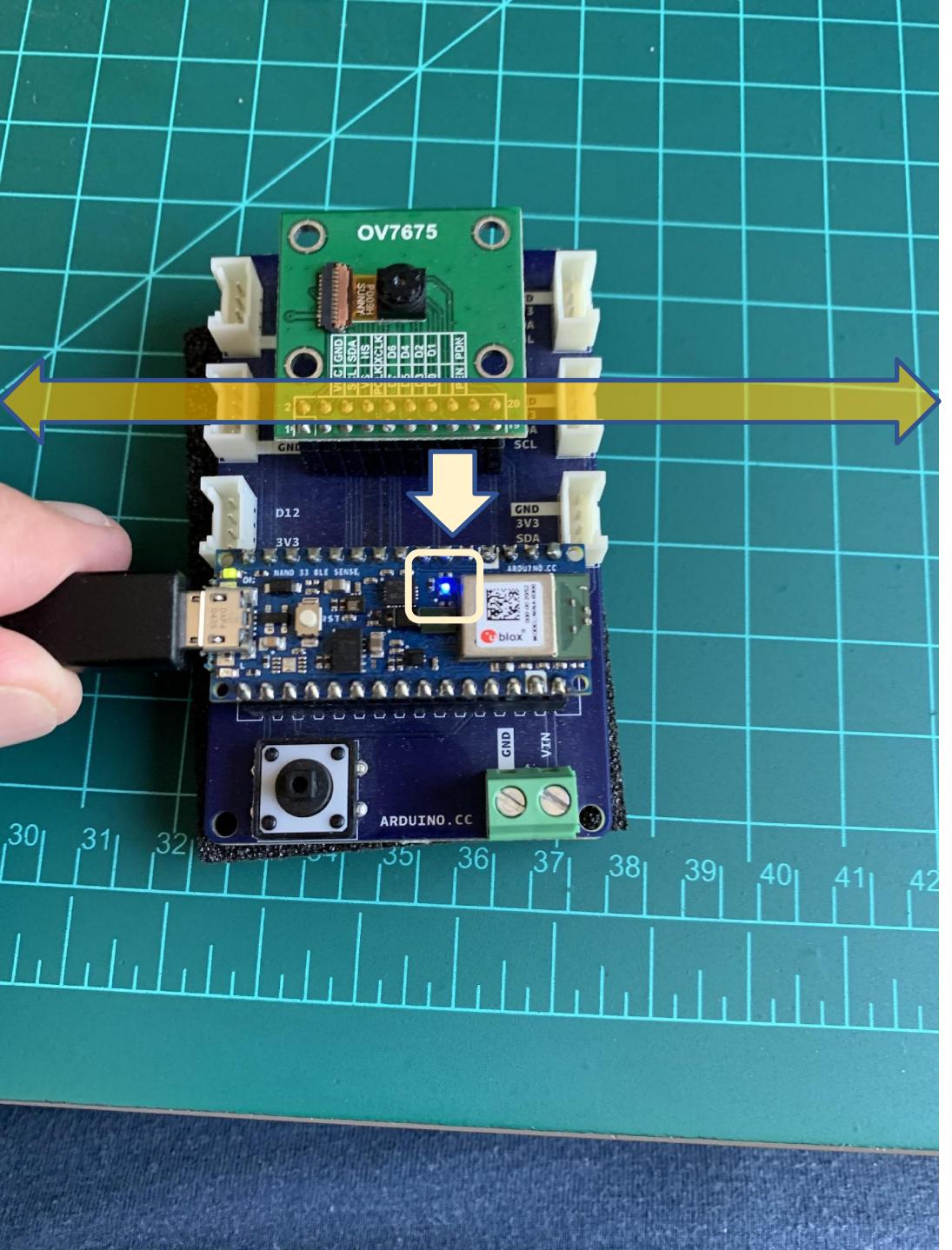
```
/dev/cu.usbmodem145101
Send

IESTI01 - Nano Motion Classification - Inferencing Test
IMU initialized

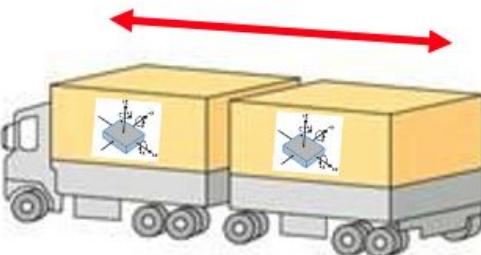
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 0 ms., Anomaly: 2 ms.):
    idle: 0.99219
    lift: 0.00391
    maritime: 0.00391
    terrestrial: 0.00000
Prediction: idle with probability 0.99
anomaly score: 0.001

Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 1 ms., Anomaly: 1 ms.):
    idle: 0.99219
    lift: 0.00391
    maritime: 0.00391
    terrestrial: 0.00000
Prediction: idle with probability 0.99
anomaly score: -0.001

 Autoscroll  Show timestamp Both NL & CR 115200 baud Clear output
```



label: terrestrial

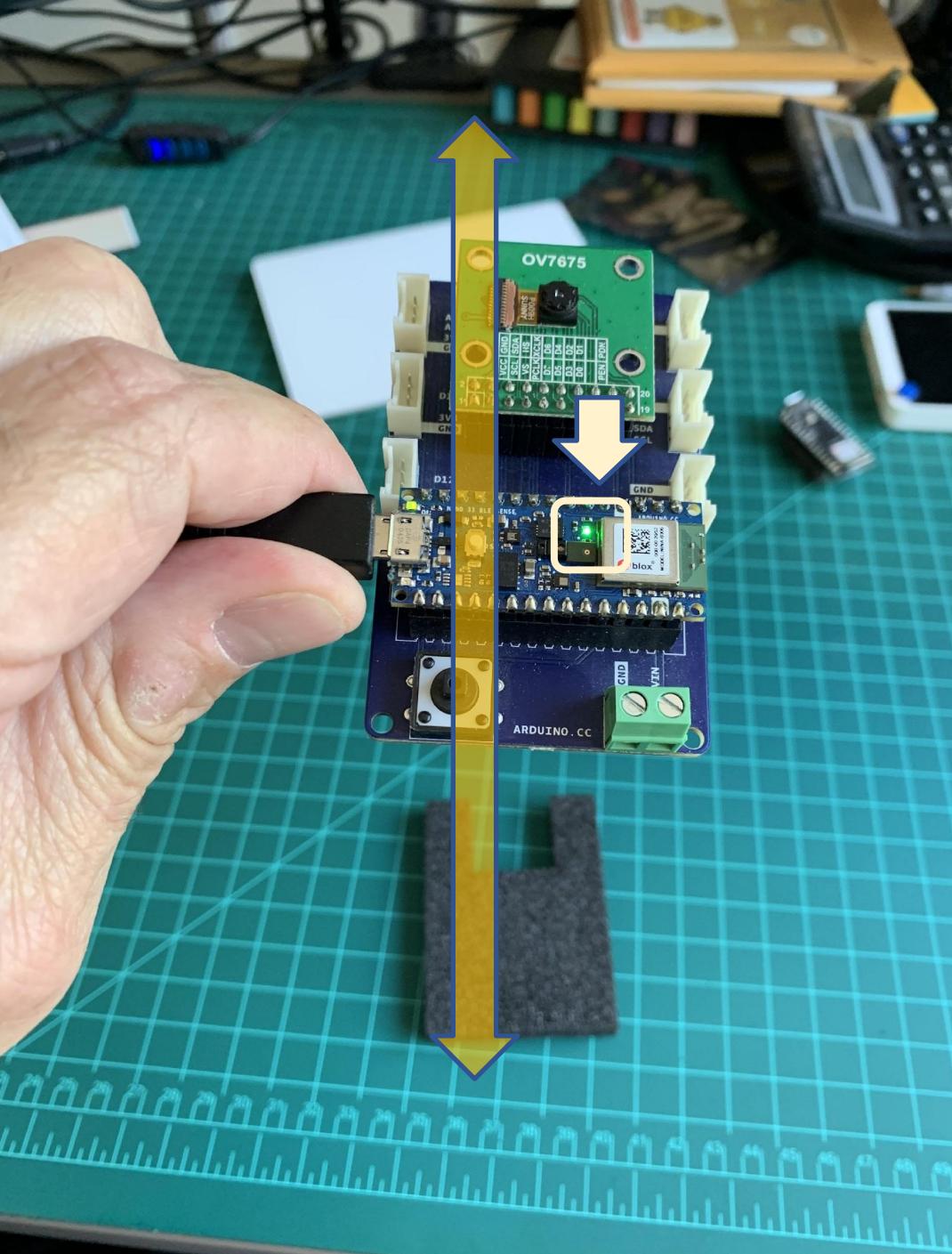


```
/dev/cu.usbmodem145101
Send

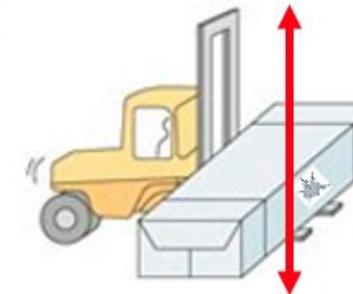
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 1 ms., Anomaly: 1 ms.):
  idle: 0.00000
  lift: 0.00000
  maritime: 0.00000
  terrestrial: 0.99609
Prediction: terrestrial with probability 1.00
anomaly score: -0.190

Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 0 ms., Anomaly: 2 ms.):
  idle: 0.00000
  lift: 0.00000
  maritime: 0.00000
  terrestrial: 0.99609
Prediction: terrestrial with probability 1.00
anomaly score: -0.096

 Autoscroll  Show timestamp Both NL & CR 115200 baud Clear output
```



label: lift



```
/dev/cu.usbmodem145101
Send

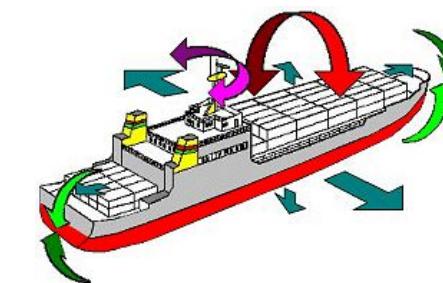
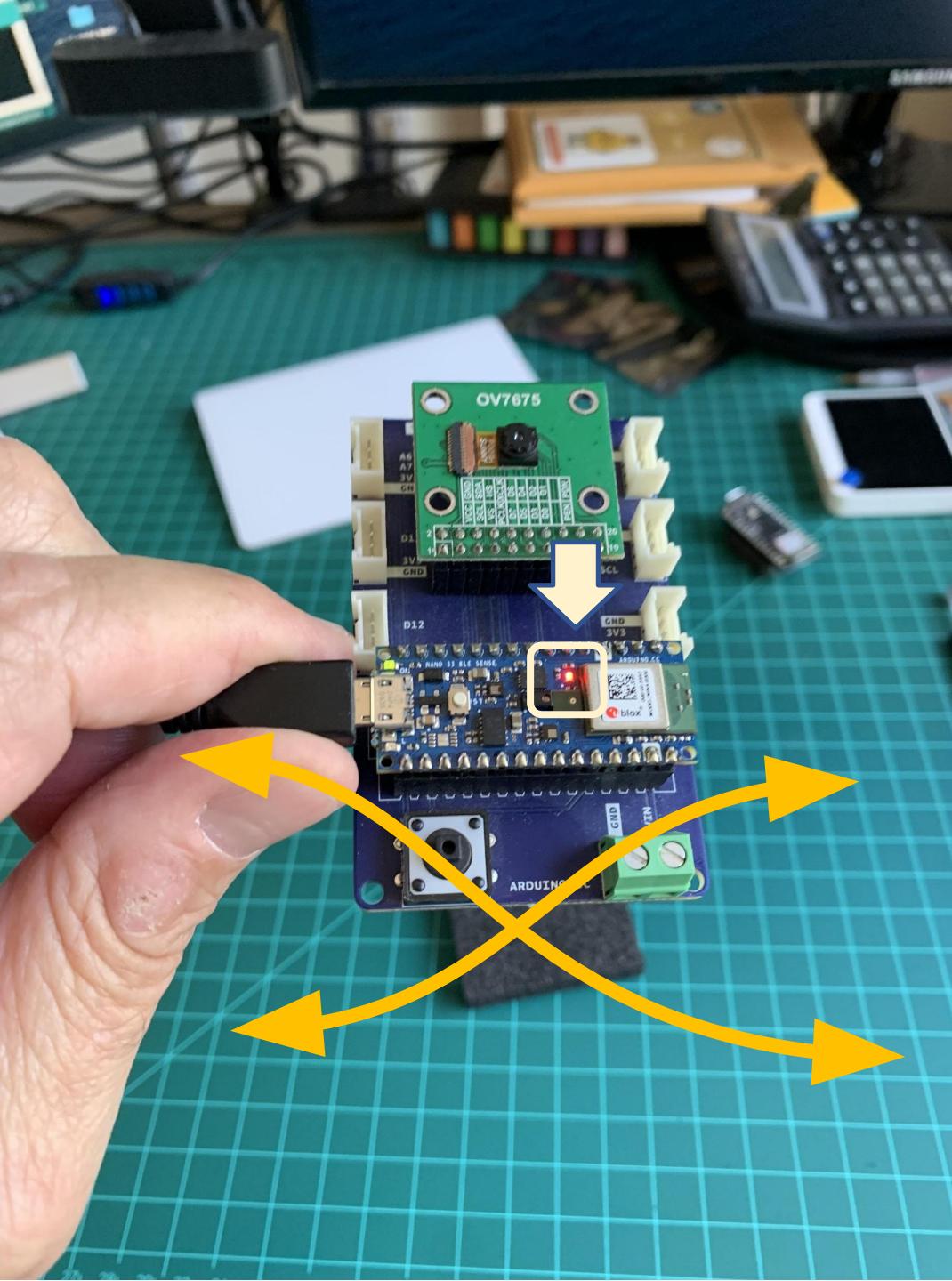
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 0 ms., Anomaly: 2 ms.):
    idle: 0.0000
    lift: 0.99609
    maritime: 0.0000
    terrestrial: 0.0000
Prediction: lift with probability 1.00
anomaly score: 0.047

Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 1 ms., Anomaly: 1 ms.):
    idle: 0.76172
    lift: 0.12500
    maritime: 0.10547
    terrestrial: 0.00781
Prediction: idle with probability 0.76
anomaly score: 0.874

 Autoscroll  Show timestamp Both NL & CR 115200 baud Clear output
```

A screenshot of a terminal window showing the results of a machine learning inference. The terminal is connected to the serial port /dev/cu.usbmodem145101. The output shows the model is starting to infer in 2 seconds, then sampling. It lists predictions for four categories: idle, lift, maritime, and terrestrial. The 'lift' category has the highest probability of 0.99609. A red box highlights this prediction. Below another inference, the 'idle' category has the highest probability of 0.76172. The terminal also includes checkboxes for 'Autoscroll' and 'Show timestamp', and dropdown menus for 'Both NL & CR' and '115200 baud'.

label: maritime

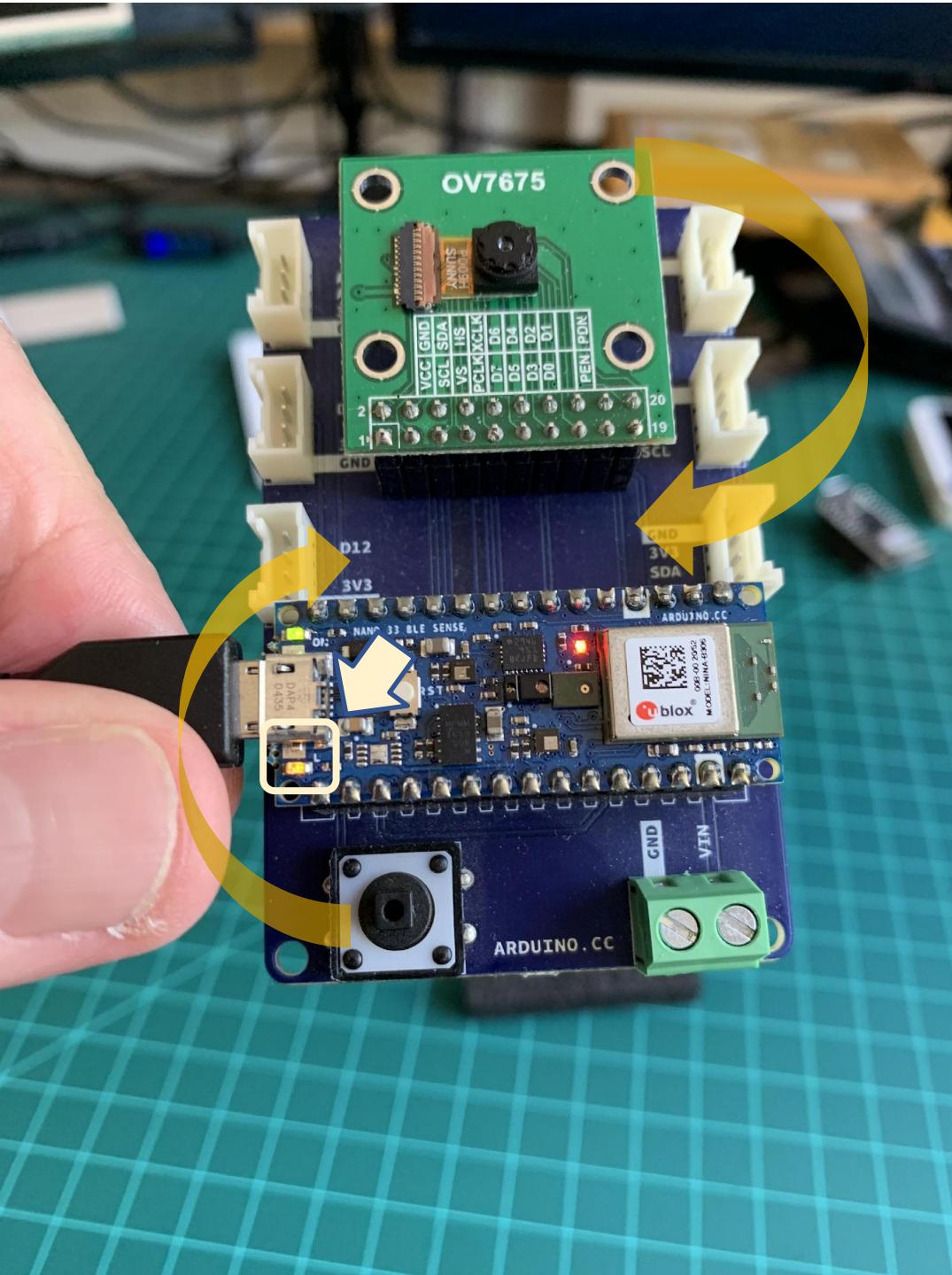


```
Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 0 ms., Anomaly: 2 ms.):
  idle: 0.00391
  lift: 0.29297
  maritime: 0.40625
  terrestrial: 0.29297
Prediction: maritime with probability 0.41
anomaly score: 0.431

Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 0 ms., Anomaly: 1 ms.):
  idle: 0.95312
  lift: 0.03516
  maritime: 0.00781
  terrestrial: 0.00391
Prediction: idle with probability 0.95
anomaly score: 0.247
```

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label: anomaly



```
/dev/cu.usbmodem145101
Send

Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 1 ms., Anomaly: 1 ms.):
    idle: 0.00781
    lift: 0.12109
    maritime: 0.87109
    terrestrial: 0.00000
Prediction: maritime with probability 0.87
anomaly score: 0.902

Starting inferencing in 2 seconds...
Sampling...
Predictions (DSP: 20 ms., Classification: 1 ms., Anomaly: 1 ms.):
    idle: 0.89453
    lift: 0.08984
    maritime: 0.01172
    terrestrial: 0.00781
Prediction: idle with probability 0.89
anomaly score: 0.248

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```

Thanks



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