

SciTinyML

Scientific Use of Machine Learning on Low Power Devices

Regional Workshop - ASIA 2022

Hands-On Motion Detection Using Wio Terminal and **Edge Impulse**



WIO TERMINAL

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Product Manager
seed studio

潘石 | Peter
App. Engineer
seed studio

AGENDA

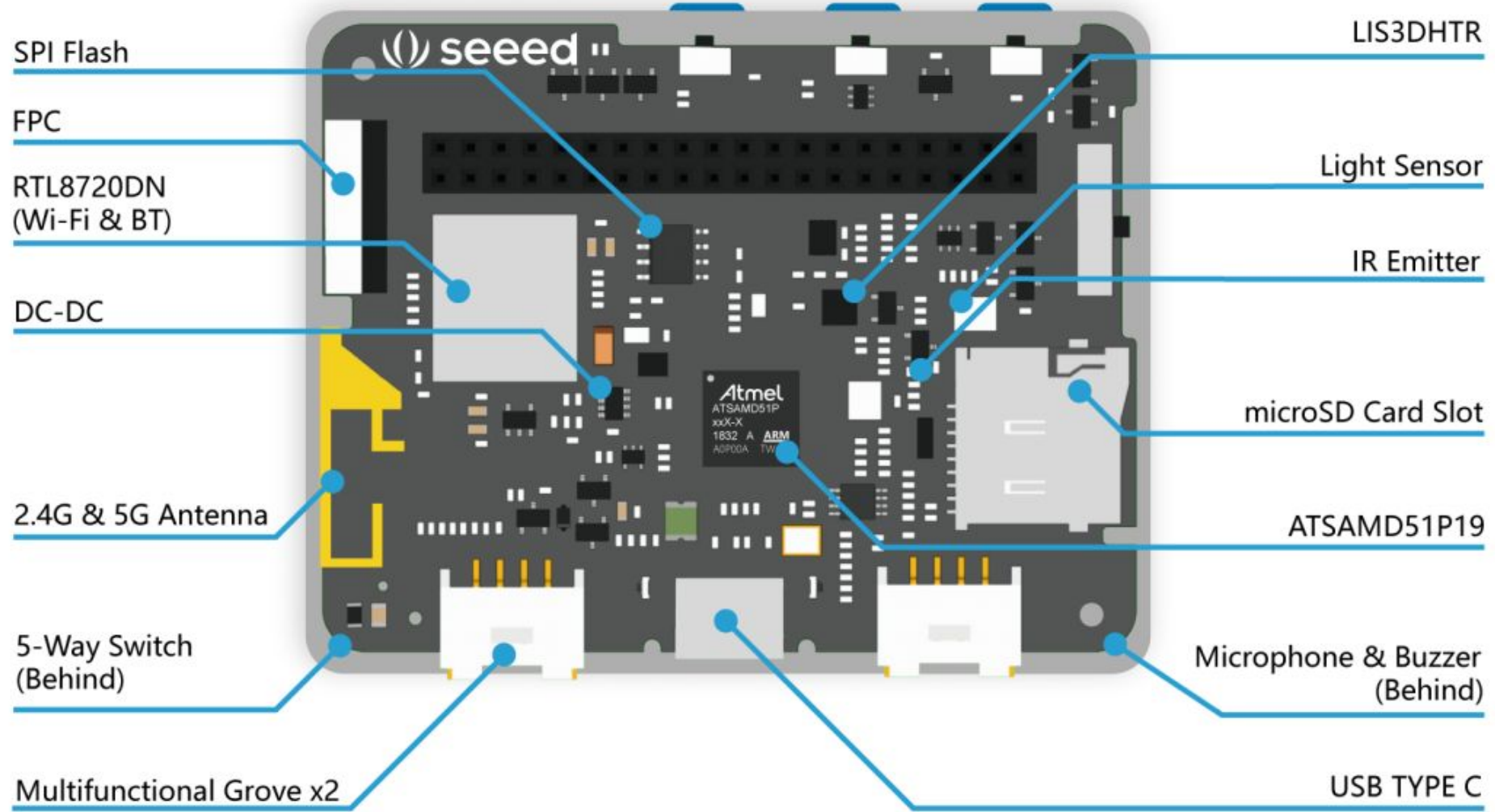
- ◆ A quick recap of yesterday's session
- ◆ Brief overview of Motion detection and its application
- ◆ An overview of the accelerometer
- ◆ Demo project walkthrough
 - Data collection
 - Data processing
 - Model Training
 - Testing and deploying
 - Inferencing
- ◆ Recommended resources
- ◆ Question and answers

Review

- How many features of Wio Terminal can you remember?
- What is memory size of wio terminal?
- Based on your current knowledge about wio terminal, how many types of projects can you implement with it?
- Have you installed all the libraries and softwares required to start working with wio terminal and edge impulse?

Answers

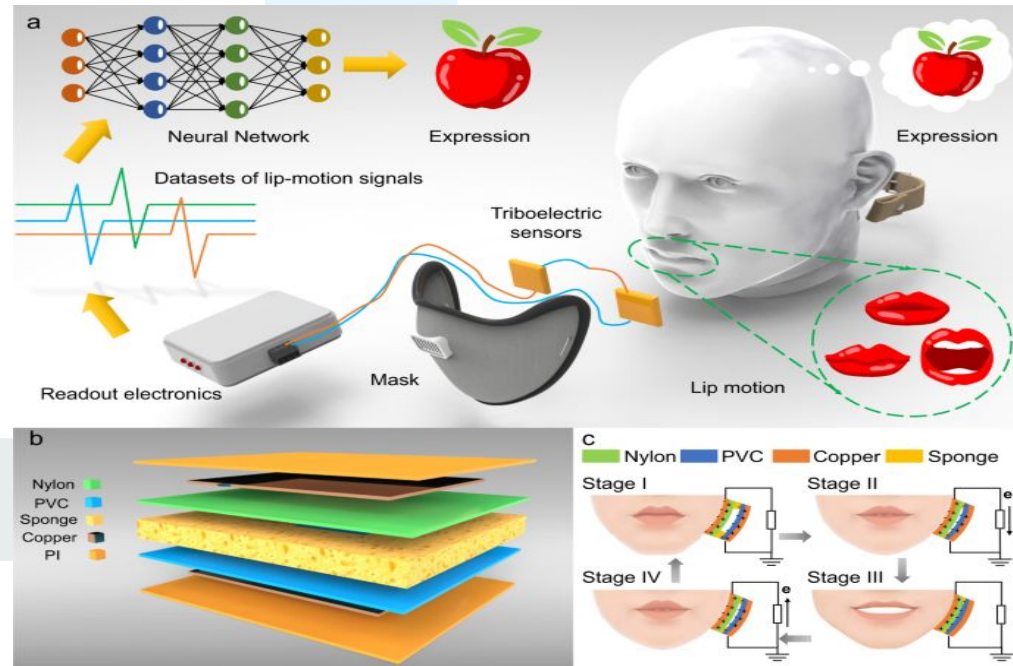
Review



Motion / Anomaly Detection

Motion detection:

- detecting moving entities.



Anomaly detection:

- identifying data points that don't fit a normal patterns.

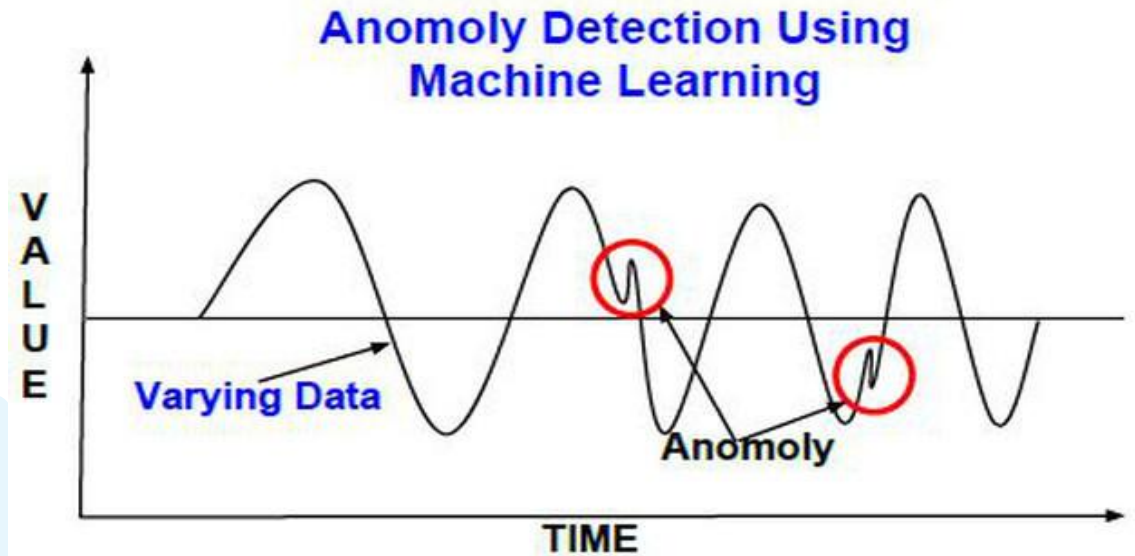


Image credit: Dale Montrone of Domanisystems

Types of Motion Detection Sensor

- Passive Infrared Sensor
- Ultrasonic Sensor
- Microwave Sensor
- Tomographic Sensor
- Accelerator Sensor: Is it a motion sensor?
- Yes it can be classified a motion sensor since it has axis-based motion sensing

- Example: compass on your map, camera app and etc.



Motion Detection Applications

- Earthquake detection.
- Bionic limbs.
- Hard drive protection.
- Drone flight stability.
- To understand the surrounding of an item.

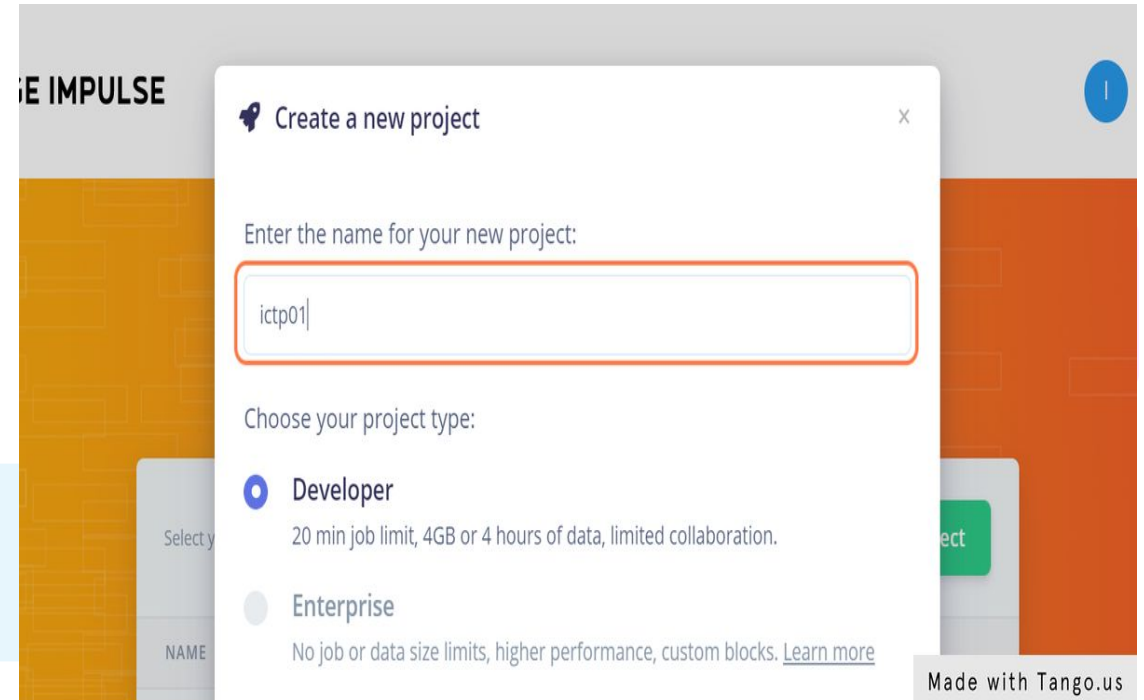
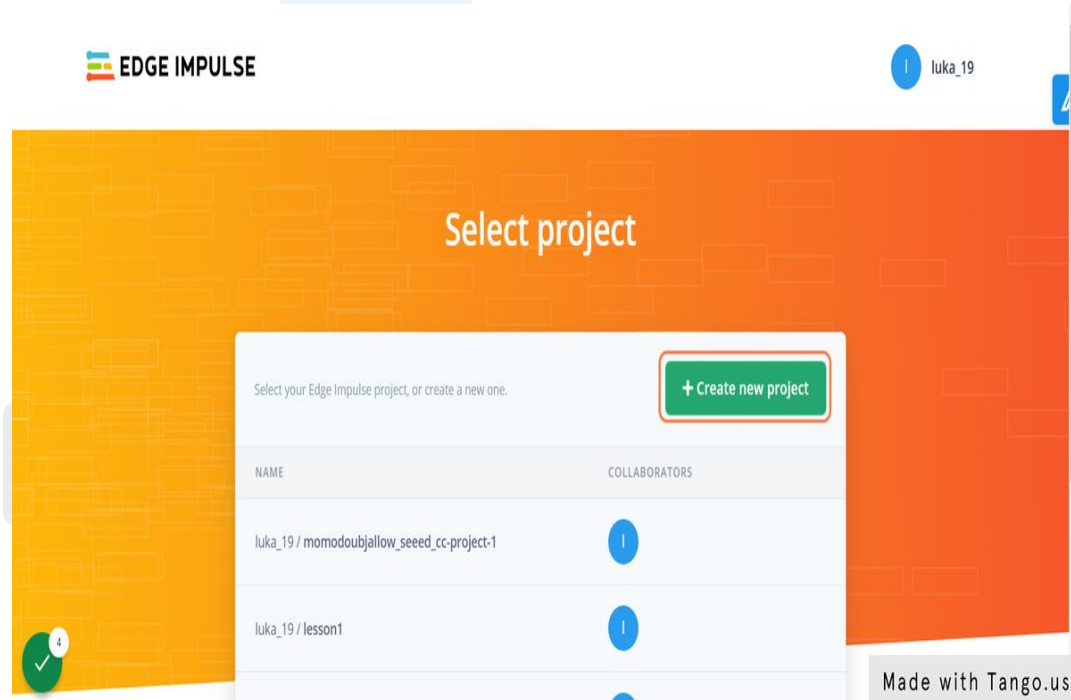
Accelerometer

- Measure vibration or acceleration of motion of an object.
- It uses an electromechanical sensor designed to measure either static or dynamic acceleration.
- For digital device
- Automobile:- e.g airbag
- Drones:- stability in orientation flight
- Rotating machine:- undulating vibration
- They are generally of two types;
- High and low impedance
- High impedance are common in high end research facilities or high temperature applications.
- Low impedance commonly used in industry

Demo Project Walkthrough

If you've already had an existing account

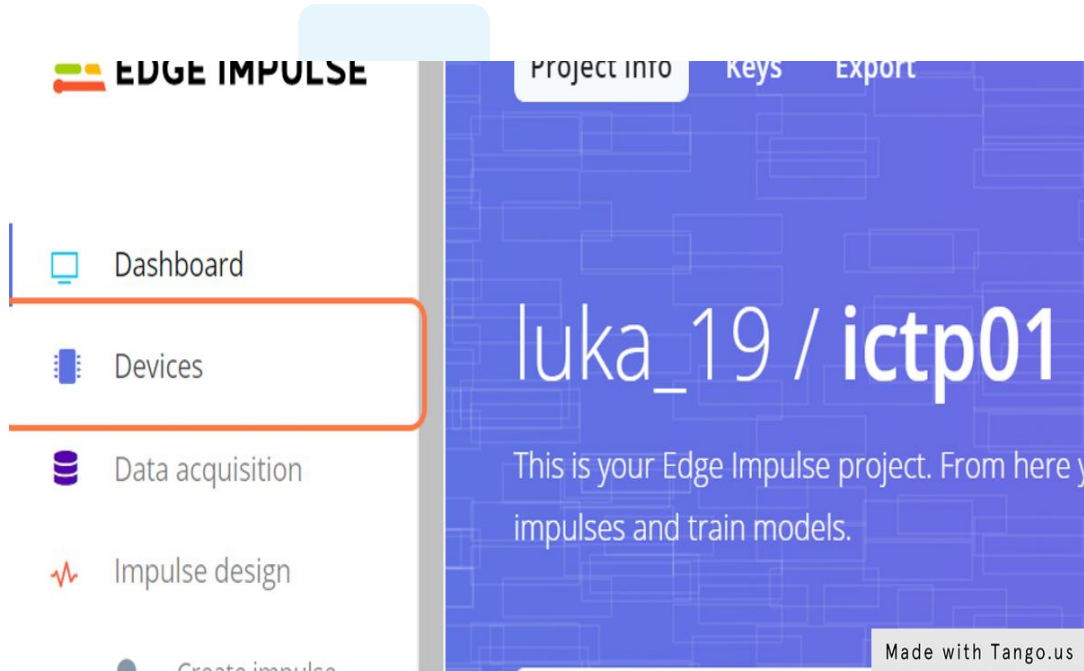
Give a name to your project. In my case below, "ictp01"



Click on "Devices" on the left panel to connect a device.

After you click on Devices,

at are connected to the Edge Impulse remote management API, or have posted data to the ingesti



No devices connected yet.

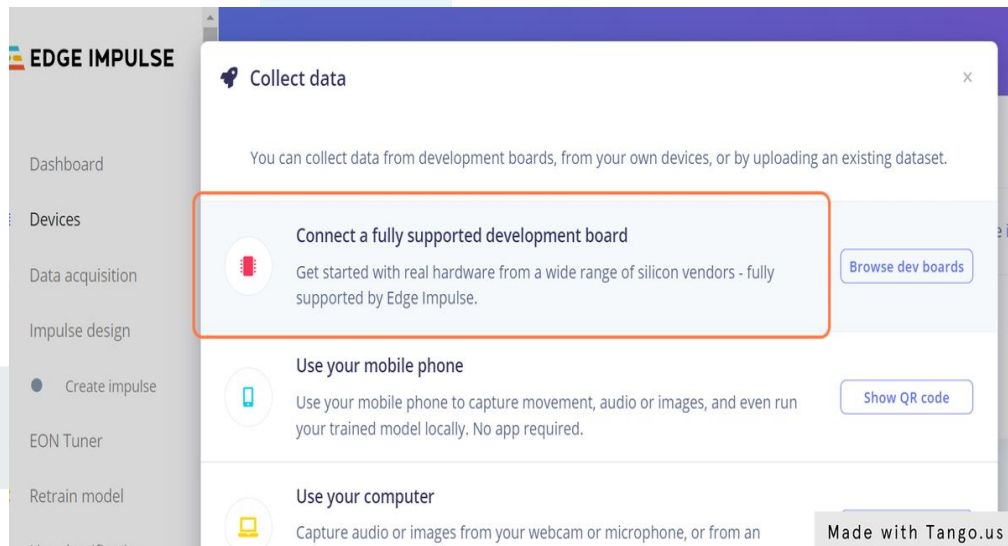
[Learn how to connect a new device](#)

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In the future, you can explore all the features below.

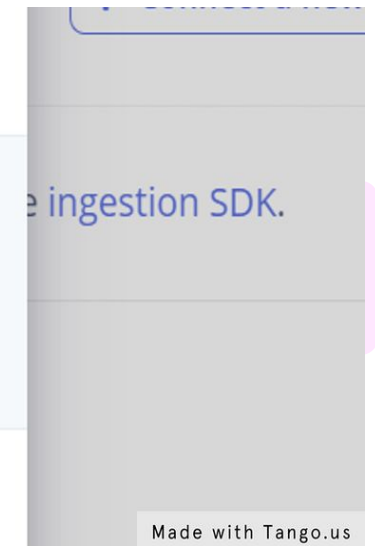
But since today, with are time constrained, we will only focus on how to connect Wio Terminal to edge impulse.



ices, or by uploading an existing dataset.

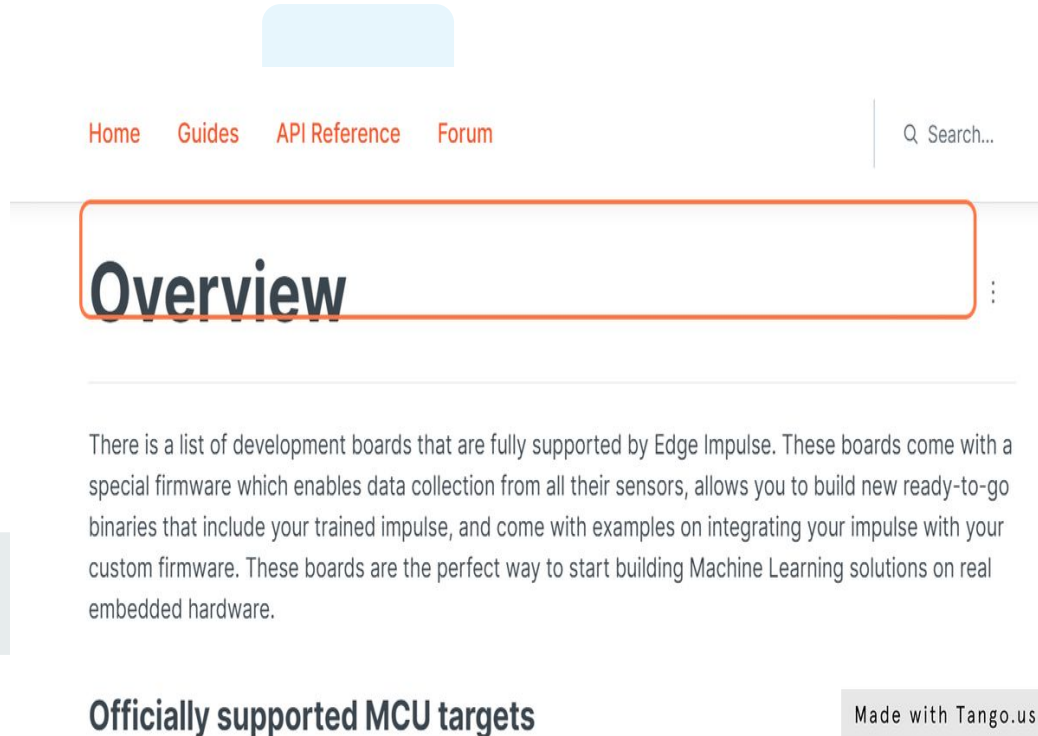
vendors - fully

[Browse dev boards](#)



On this page, you will find all the supported devices.

Scroll down to the button



The screenshot shows the top navigation bar of the Seeed Studio website. It includes links for Home, Guides, API Reference, and Forum, along with a search bar. The 'Overview' link is highlighted with a red border. Below the navigation bar, there is a section titled 'Officially supported MCU targets'.

- Intel Based Macs
- Linux x86_64
- NVIDIA Jetson Nano
- Raspberry Pi 4

Community boards [Ⓡ]

- Seeed Wio Terminal
- Arducam Pico4ML TinyML Dev Kit
- Blues Wireless Swan

Different development board? No problem, you can always collect data using the [Data for Edge Impulse for Linux SDK](#) and deploy your model back to the device with the [Running](#)

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You can read more about Wio terminal with edge impulse here.

So here comes one of the challenging parts for most starters

Terminal

Wio Terminal Edge Impulse Getting Started



EDGE IMPULSE

Edge Impulse enables developers to create the next generation of intelligent device solutions with embedded Machine Learning. Machine Learning at the very edge will enable valuable use of the 99% of sensor data that is discarded today due to cost, bandwidth or power constraints.

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Bazaar Fusion Services Forum Solution

nal/TinyML/Edge Impulse Projects/Edge Impulse Getting Started

Search

Terminal

Installing dependencies

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

1. [Node.js v12](#) or higher.
2. [Arduino CLI](#)
3. The Edge Impulse CLI and a serial monitor. Install by opening command prompt or terminal and run:

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Download Node.js v12 or higher

Go to the link below and download the Nodejs LTS installer.

<https://nodejs.org/en/download/>

If you also need a step by step to follow for installing node js on your system, here is a good step by step guide to follow:

<https://kinsta.com/blog/how-to-install-node-js/>

Bazaar Fusion Services Forum Solution

TinyML/Edge Impulse Projects/Edge Impulse Getting Started

Search

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

1. Node.js v12 or higher.
2. Arduino CLI
3. The Edge Impulse CLI and a serial monitor. Install by opening command prompt or terminal and run:

```
npm install -g edge-impulse-cli
```

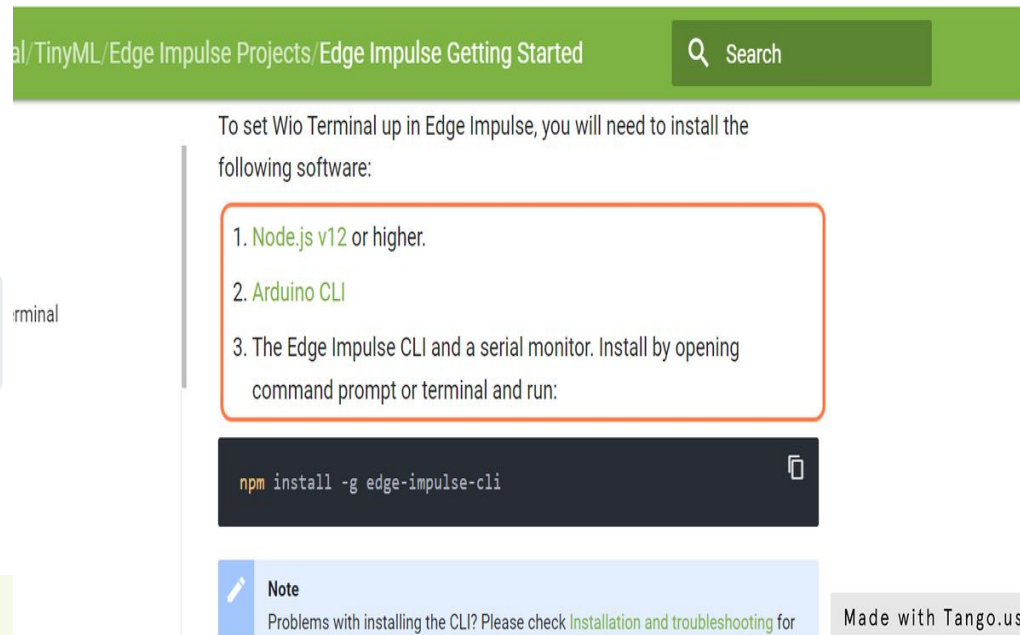
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Install Arduino CLI

Go to the link below and download the CLI installer

here is the link:

<https://arduino.github.io/arduino-cli/0.22/installation/>



al/TinyML/Edge Impulse Projects/Edge Impulse Getting Started

Search

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

1. Node.js v12 or higher.
2. Arduino CLI
3. The Edge Impulse CLI and a serial monitor. Install by opening command prompt or terminal and run:

```
npm install -g edge-impulse-cli
```

Note
Problems with installing the CLI? Please check [Installation and troubleshooting](#) for

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Latest release

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

Adding Arduino CLI to path

Editing environment variables is pretty straightforward but a little mistake can be very frustrating.

Windows: To access you environment variable

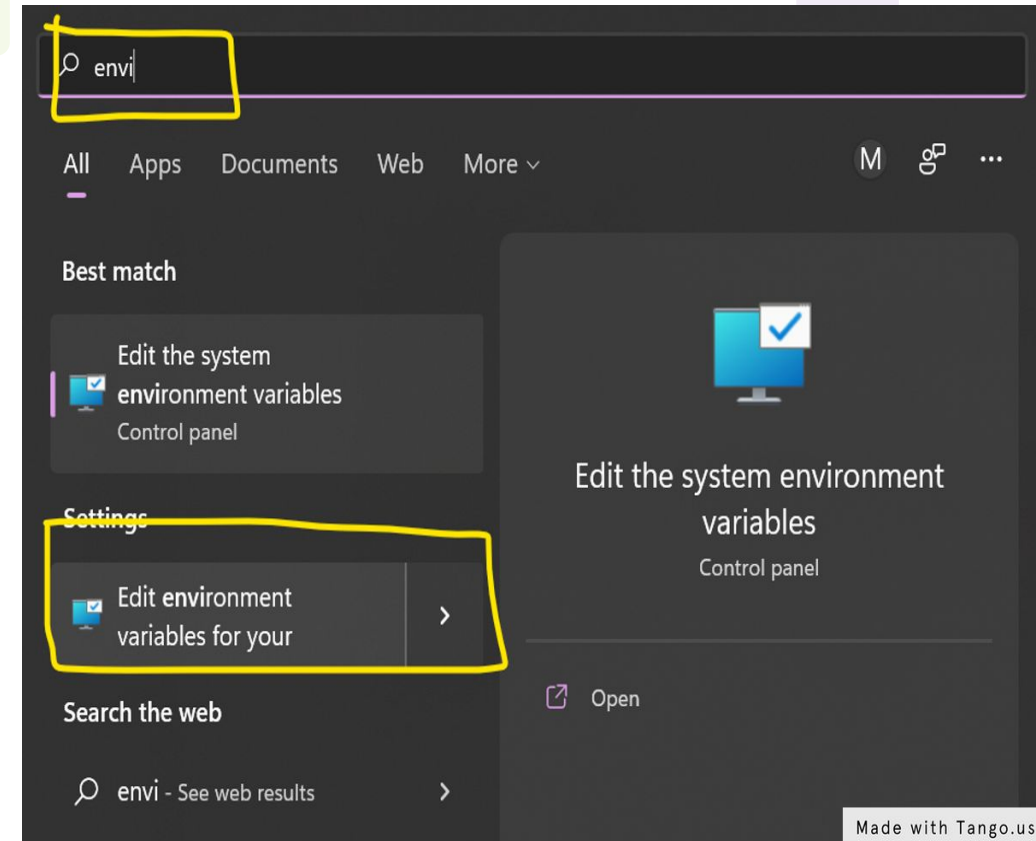
quick shortcut: Press "**windows key + R**"

Enter this command:

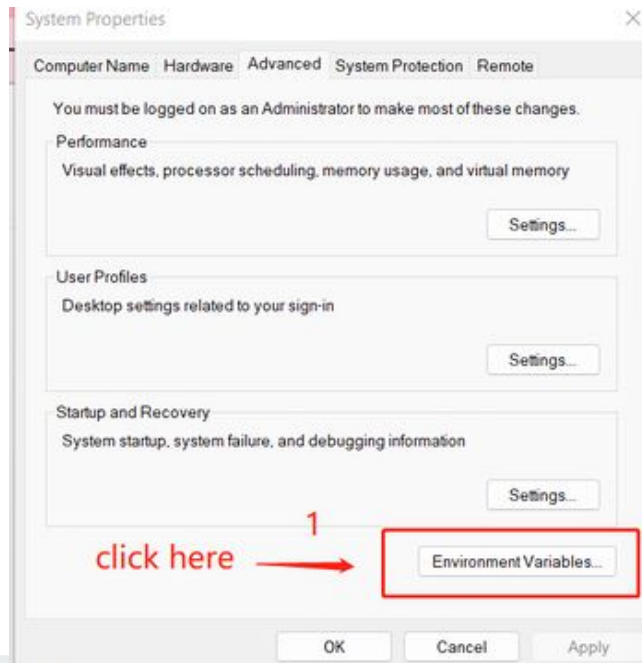
**rundll32
sysdm.cpl,EditEnvironmentVariables**

Or

Press "**windows key**" and start typing **envi**



Adding Arduino CLI to path



System Properties

Computer Name Hardware Advanced System Protection Remote

You must be logged on as an Administrator to make most of these changes.

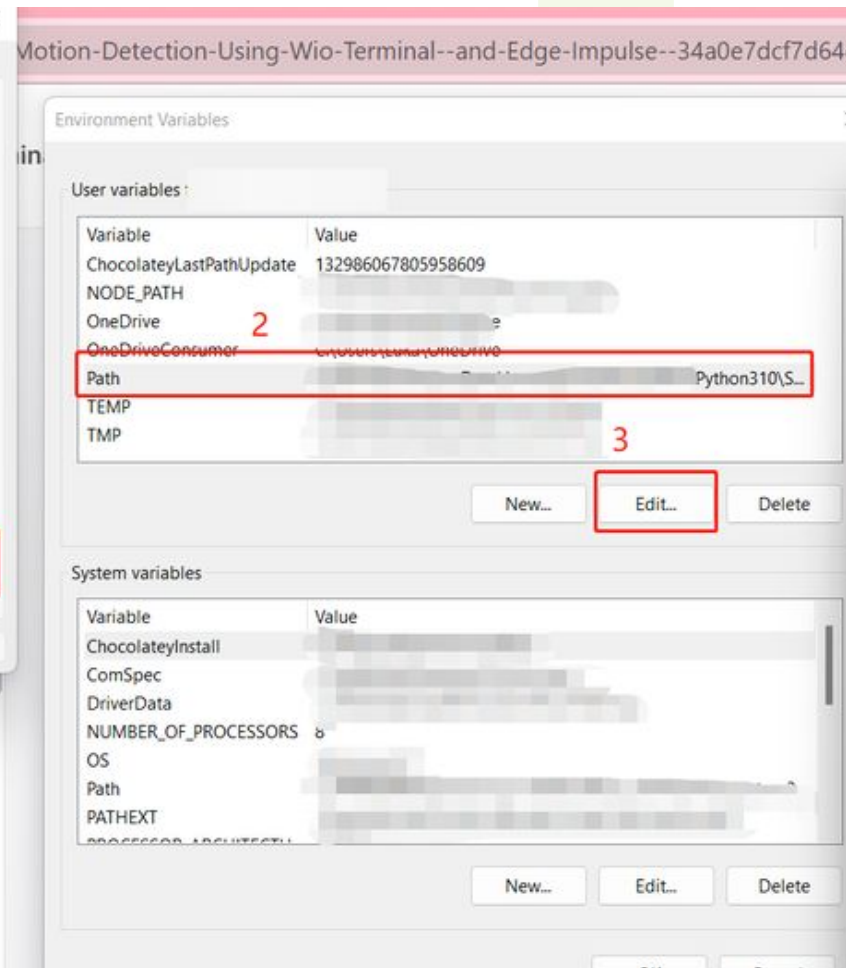
Performance
Visual effects, processor scheduling, memory usage, and virtual memory

User Profiles
Desktop settings related to your sign-in

Startup and Recovery
System startup, system failure, and debugging information

click here → Environment Variables...

OK Cancel Apply

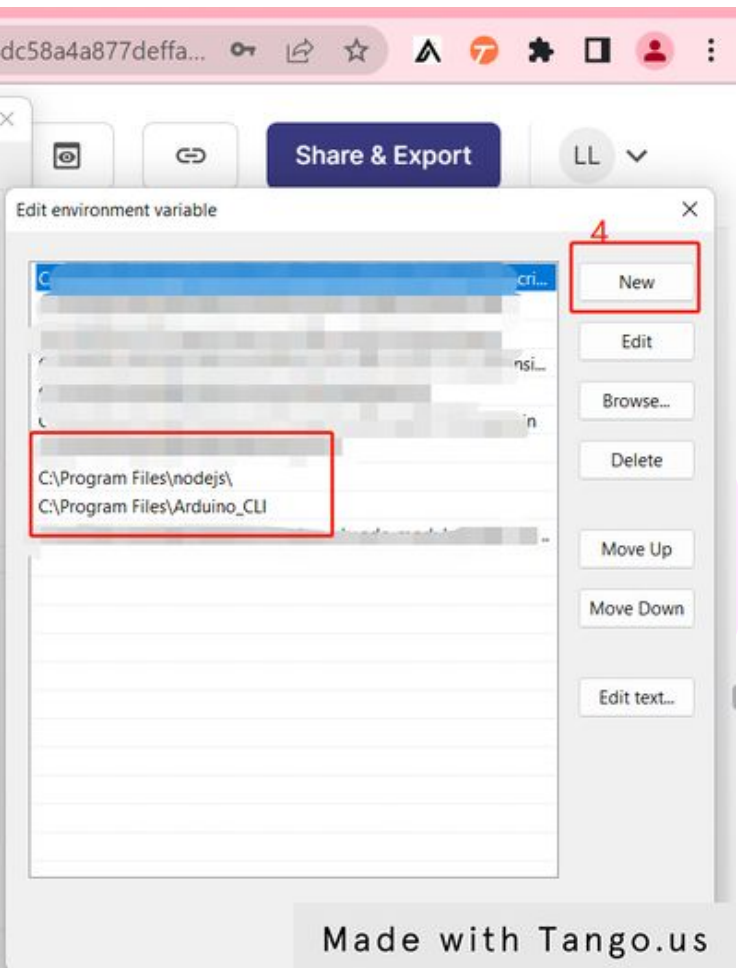


Environment Variables

User variables:

Variable	Value
ChocolateyLastPathUpdate	132986067805958609
NODE_PATH	
OneDrive	
OneDriveConsumer	
Path	Python310\S...
TEMP	
TMP	

New... Edit... Delete



Edit environment variable

C:\Program Files\nodejs\
C:\Program Files\Arduino_CLI

New Edit Browse... Delete Move Up Move Down Edit text...

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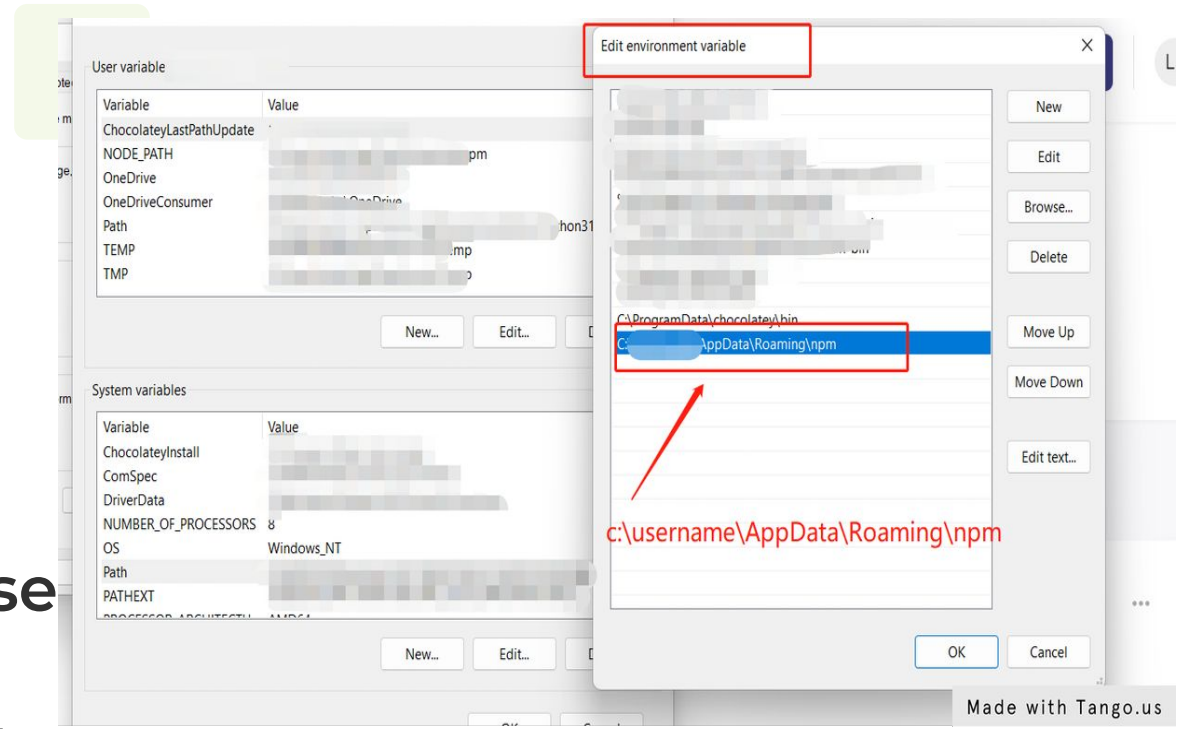
17

Install edge-impulse-cli using npm
node package manager

Open your terminal as administrator
and enter the command below

npm install -g edge-impulse-cli

- In some cases this command will add the **edge-impulse-cli** to your path but this is not always the case I had issue with this at first but a quick workaround is instead of adding it to the user environment path, add it to the system path.



Now it's time to connect our Wio Terminal to our computer



Connect your device to your computer and reset Wio Terminal

Use the button on the side wio terminal; push it down and release it twice. See the gif below for your reference.

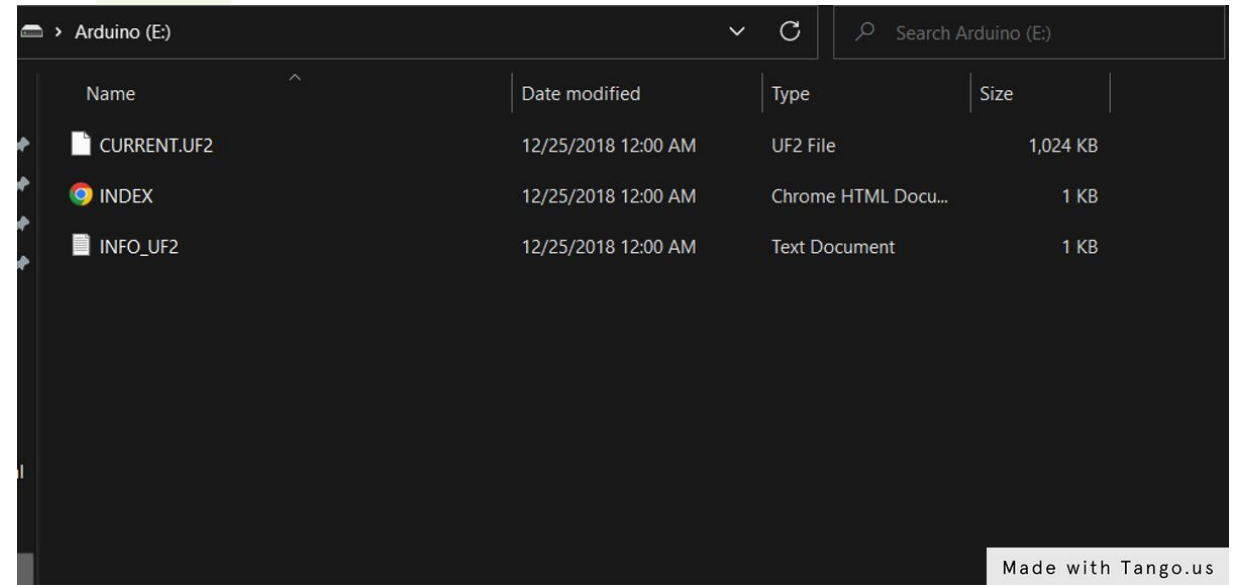
Add the edge impulse uf2 firmware files

when you rest your wio terminal device.

Open your file manager.

You will see a new drive in the file manager.

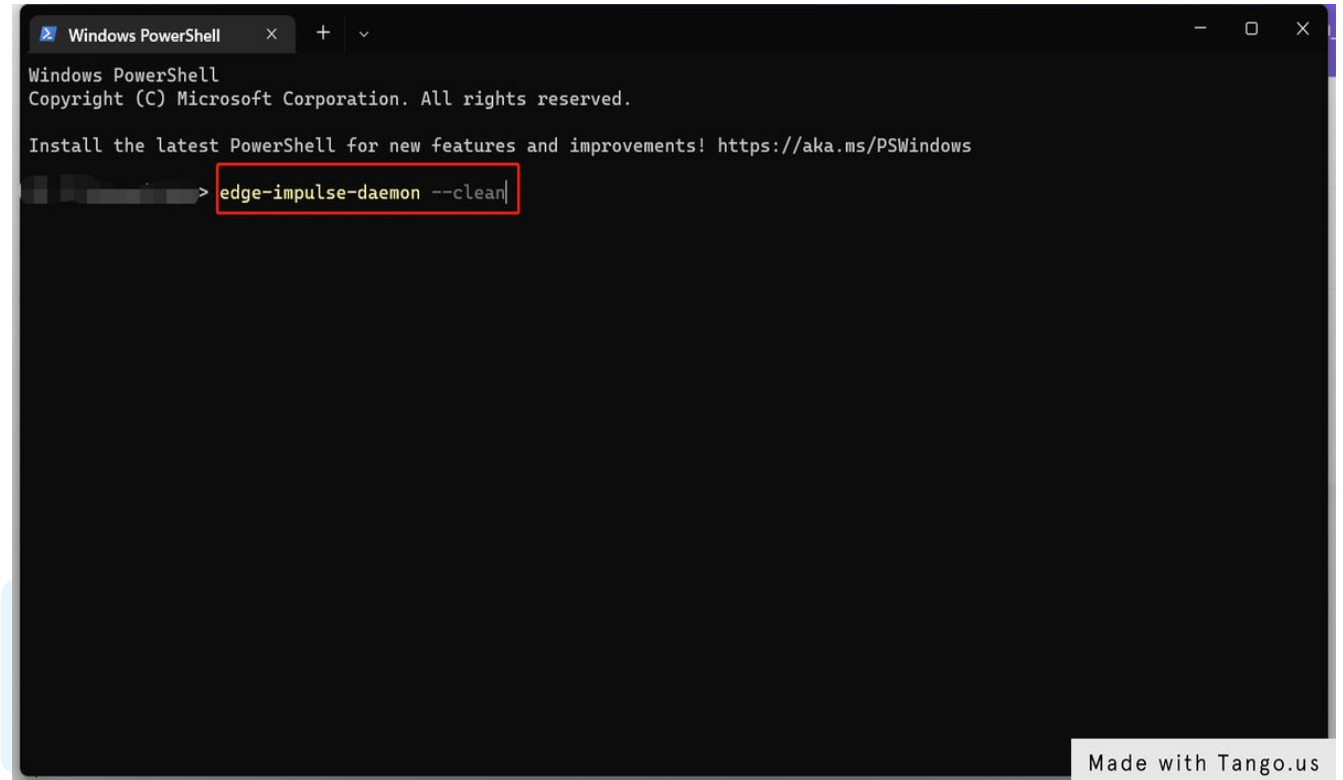
Open it and paste the **uf2 firmware file**



Open your command prompt

Type this command

edge-impulse-daemon --clean

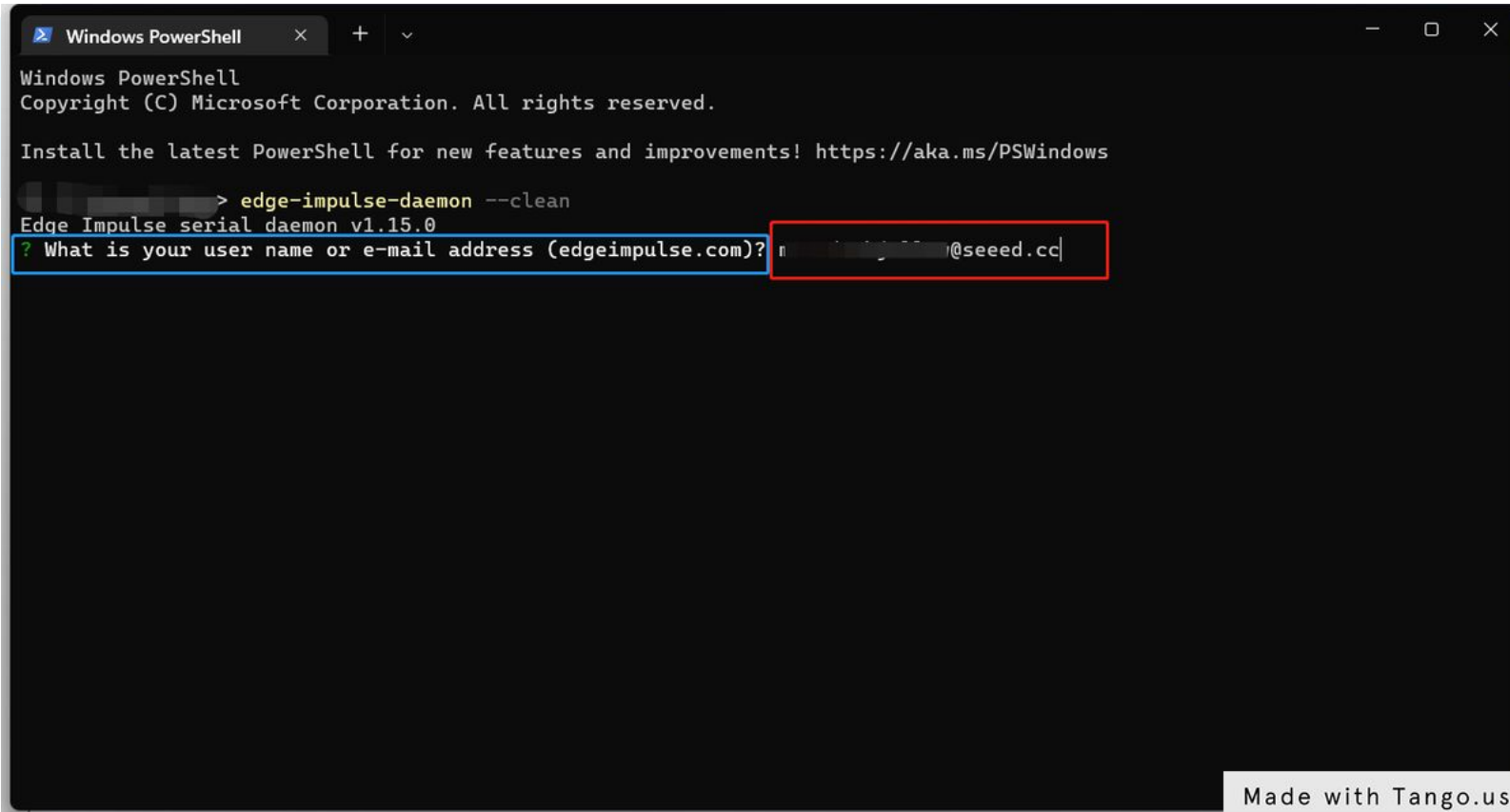


```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

> edge-impulse-daemon --clean
```

Enter your edge impulse account's email address



```
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

PS C:\> edge-impulse-daemon --clean
Edge Impulse serial daemon v1.15.0
? What is your user name or e-mail address (edgeimpulse.com)? info@seeed.cc
```

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Enter your password

```
Windows PowerShell
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Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

[redacted] > edge-impulse-daemon --clean
Edge Impulse serial daemon v1.15.0
? What is your user name or e-mail address (edgeimpulse.com)? momodoubjallow@seeed.cc
? What is your password? [input is hidden] | [redacted]
                                     edge impulse password
```

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Choose the port your device is connected to

Select project

```

Windows PowerShell
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Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

> edge-impulse-daemon --clean
Edge Impulse serial daemon v1.15.0
? What is your user name or e-mail address (edgeimpulse.com)? momodoubjallow@seeed.cc
? What is your password? [hidden]
Endpoints:
  Websocket: wss://remote-mgmt.edgeimpulse.com
  API:       https://studio.edgeimpulse.com/v1
  Ingestion: https://ingestion.edgeimpulse.com

? Which device do you want to connect to? (Use arrow keys)
> COM12 (Microsoft)
  COM3 (Microsoft)
  COM4 (Microsoft)
  
```

if you don't know which port if your device connected to, unplug you device, run the command again. In my case COM3 COM4 will be the only ports available when i unplug my wio terminal. that means COM12 is the port corresponding to my device.

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```

Windows PowerShell
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Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

> edge-impulse-daemon --clean
Edge Impulse serial daemon v1.15.0
? What is your user name or e-mail address (edgeimpulse.com)? momodoubjallow@seeed.cc
? What is your password? [hidden]
Endpoints:
  Websocket: wss://remote-mgmt.edgeimpulse.com
  API:       https://studio.edgeimpulse.com/v1
  Ingestion: https://ingestion.edgeimpulse.com

? Which device do you want to connect to? COM12 (Microsoft)
[SER] Connecting to COM12
[SER] Serial is connected, trying to read config...
[SER] Clearing configuration
[SER] Clearing configuration OK
[SER] Retrieved configuration
[SER] Device is running AT command version 1.3.0

? To which project do you want to connect this device?
  luka_19 / momodoubjallow_seeed_cc-project-1
  luka_19 / lesson1
  luka_19 / key_word_1
  luka_19 / video_tinyml_raw
> luka_19 / ictp01
  
```

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Name your device (Optional but good practice)

```

Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

> edge-impulse-daemon --clean
Edge Impulse serial daemon v1.15.0
? What is your user name or e-mail address (edgeimpulse.com)? momodoubjallow@seeed.cc
? What is your password? [hidden]
Endpoints:
  Websocket: wss://remote-mgmt.edgeimpulse.com
  API:       https://studio.edgeimpulse.com/v1
  Ingestion: https://ingestion.edgeimpulse.com

? Which device do you want to connect to? COM12 (Microsoft)
[SER] Connecting to COM12
[SER] Serial is connected, trying to read config...
[SER] Clearing configuration
[SER] Clearing configuration OK
[SER] Retrieved configuration
[SER] Device is running AT command version 1.3.0

? To which project do you want to connect this device? luka_19 / ictp01
Setting upload host in device... OK
Configuring remote management settings... OK
Configuring API key in device... OK
Configuring HMAC key in device... OK
[SER] Device is not connected to remote management API, will use daemon
[WS ] Connecting to wss://remote-mgmt.edgeimpulse.com
[WS ] Connected to wss://remote-mgmt.edgeimpulse.com
[WS ] Connected to wss://remote-mgmt.edgeimpulse.com
? What name do you want to give this device? wio-terminal

```

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Hurray! That's it. Our device is connected, and we are ready to start.

```

Windows PowerShell
> edge-impulse-daemon --clean
Edge Impulse serial daemon v1.15.0
? What is your user name or e-mail address (edgeimpulse.com)? momodoubjallow@seeed.cc
? What is your password? [hidden]
Endpoints:
  Websocket: wss://remote-mgmt.edgeimpulse.com
  API:       https://studio.edgeimpulse.com/v1
  Ingestion: https://ingestion.edgeimpulse.com

? Which device do you want to connect to? COM12 (Microsoft)
[SER] Connecting to COM12
[SER] Serial is connected, trying to read config...
[SER] Clearing configuration
[SER] Clearing configuration OK
[SER] Retrieved configuration
[SER] Device is running AT command version 1.3.0

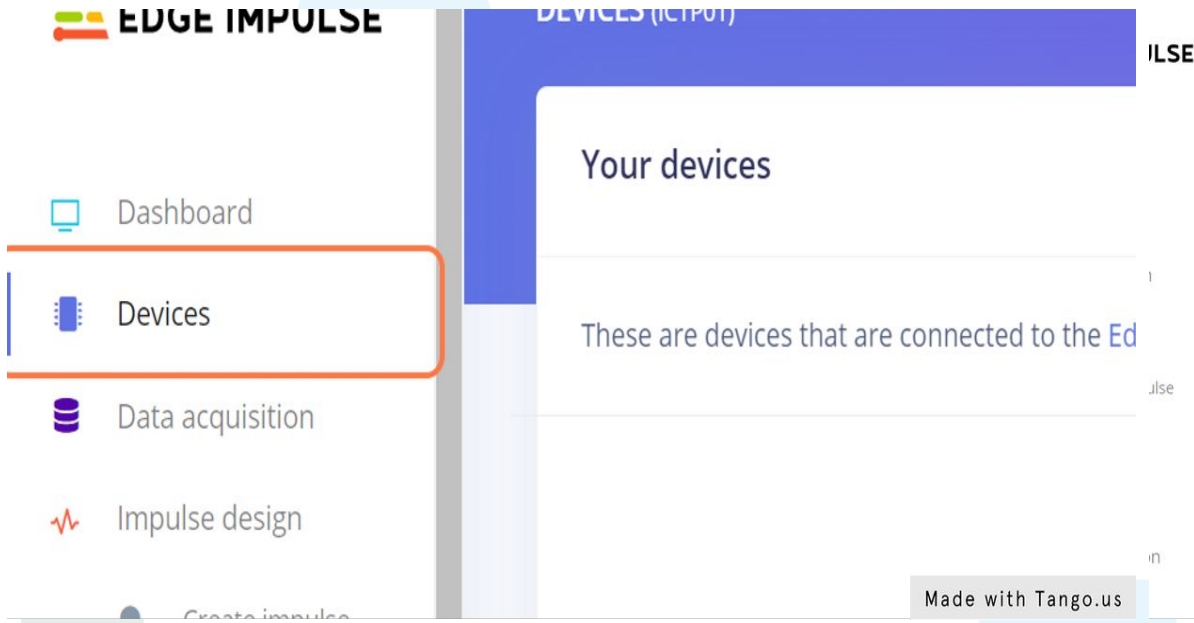
? To which project do you want to connect this device? luka_19 / ictp01
Setting upload host in device... OK
Configuring remote management settings... OK
Configuring API key in device... OK
Configuring HMAC key in device... OK
[SER] Device is not connected to remote management API, will use daemon
[WS ] Connecting to wss://remote-mgmt.edgeimpulse.com
[WS ] Connected to wss://remote-mgmt.edgeimpulse.com
? What name do you want to give this device? wio-terminal
[WS ] Device "wio-terminal" is now connected to project "ictp01"
[WS ] Go to https://studio.edgeimpulse.com/studio/110654/acquisition/training to build your machine learning model!

```

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Click on Devices

The green spot below indicates that your device is connected



EDGE IMPULSE

DEVICES (ICTP01)

Your devices

These are devices that are connected to the Ed

Dashboard

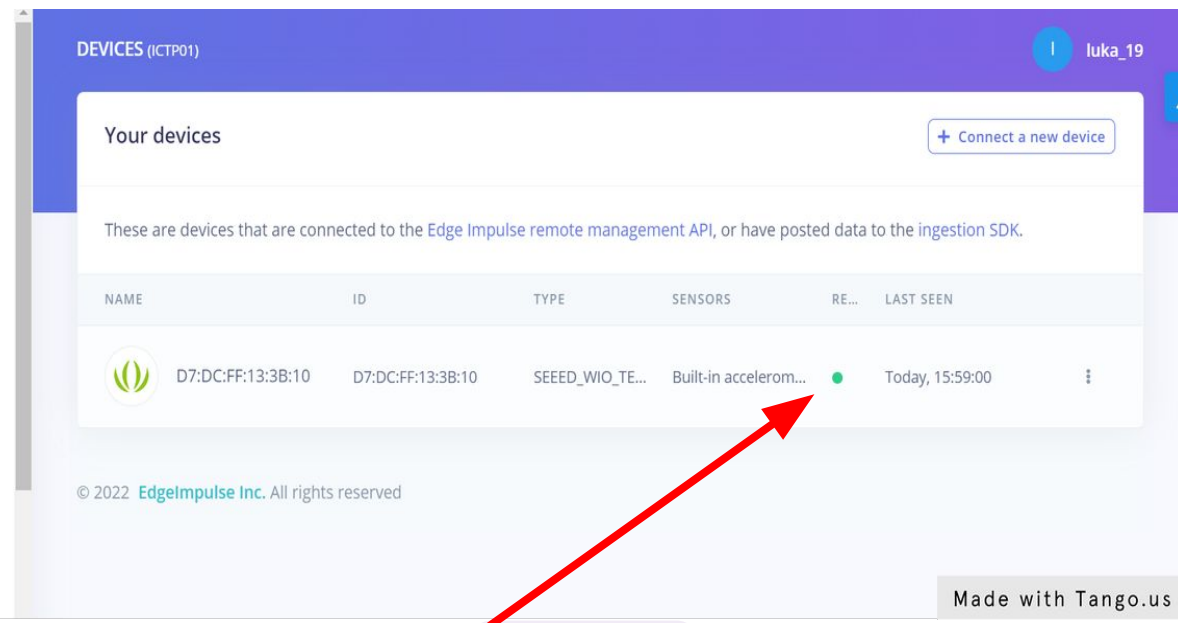
Devices

Data acquisition

Impulse design

Created impulse

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DEVICES (ICTP01)

luka_19

Your devices

+ Connect a new device

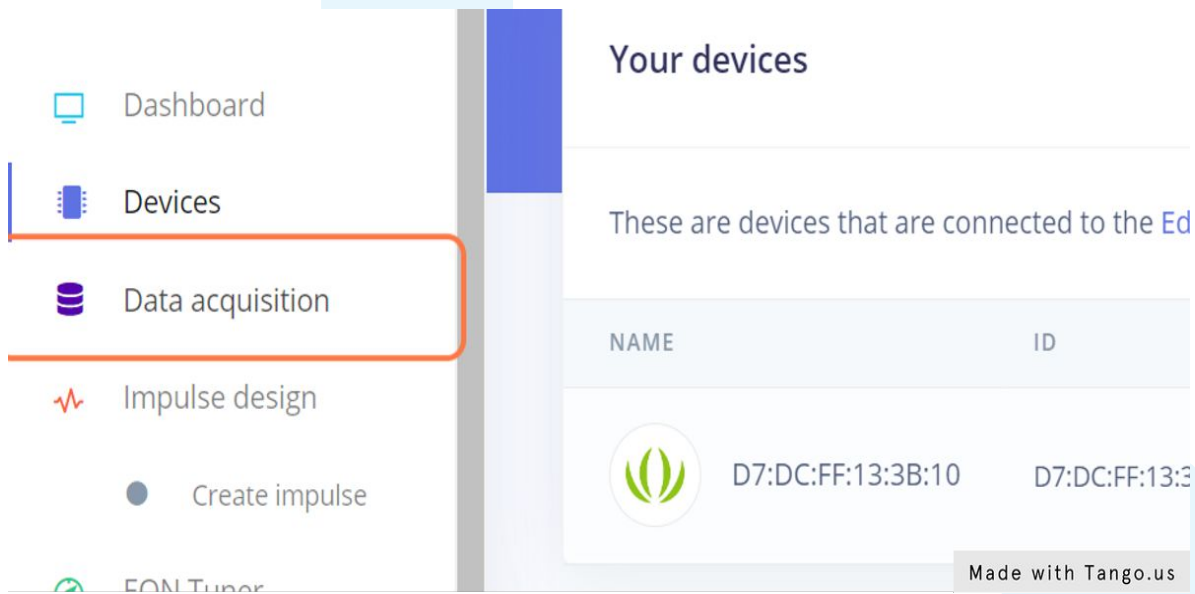
These are devices that are connected to the Edge Impulse remote management API, or have posted data to the ingestion SDK.

NAME	ID	TYPE	SENSORS	RE...	LAST SEEN	
 D7:DC:FF:13:3B:10	D7:DC:FF:13:3B:10	SEED_WIO_TE...	Built-in accelerom...		Today, 15:59:00	

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Since our device is connected, we can now start collecting data by clicking on the Data acquisition tab on your left.



Dashboard

Devices

Data acquisition


Impulse design

Create impulse

FON Tuner

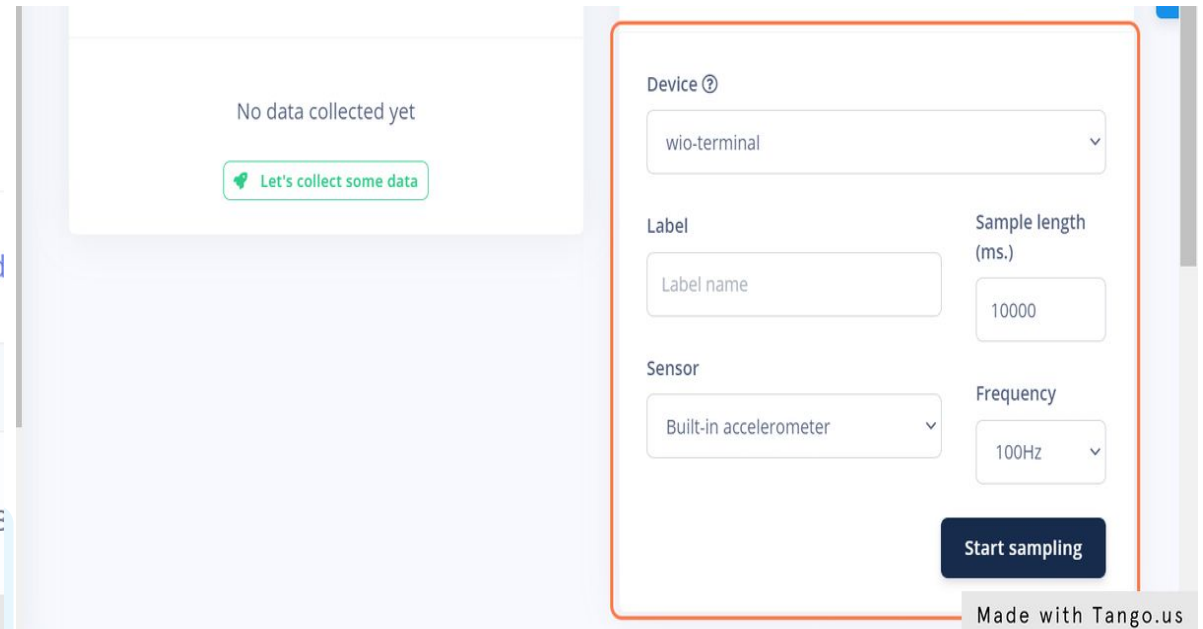
Your devices

These are devices that are connected to the Ed

NAME	ID
 D7:DC:FF:13:3B:10	D7:DC:FF:13:3B:10

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Select your device and start collecting data



No data collected yet

Let's collect some data

Device ?

wio-terminal

Label

Label name

Sample length (ms.)

10000

Sensor

Built-in accelerometer

Frequency

100Hz

Start sampling

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Add a label name

Select the sensor for your data collection

wio-terminal

Label

Jump

Sensor

Built-in accelerometer

Sample len (ms.)

10000

Frequency

100Hz

Jump

Built-in accelerometer

10000

100Hz

Start sampling

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Click on the label to see more details



Collected data

SAMPLE NAME	LABEL	ADDED	LENGTH
Jump.34ol8opm	Jump	Today, 16:...	10s

Navigation: < 1 >

There will be a training/test data split warning

your dataset have a poor train / test split. Click to learn how to rebalance your dataset.

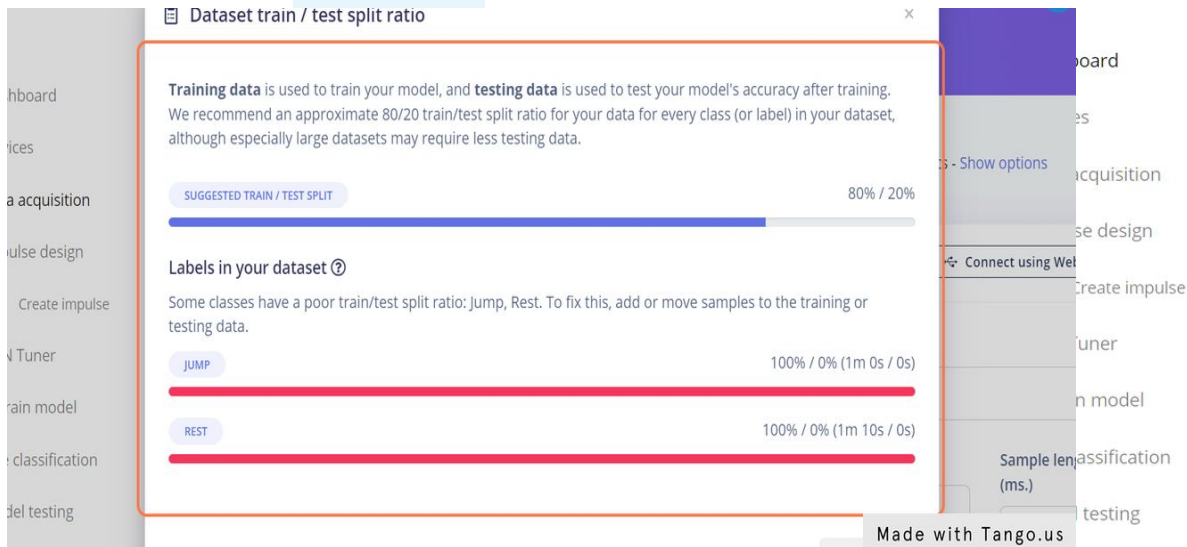
100...  

Record

Device ?

Click on the warning alert to see more details

Edge Impulse has an auto training/test split



Dataset train / test split ratio

Training data is used to train your model, and testing data is used to test your model's accuracy after training. We recommend an approximate 80/20 train/test split ratio for your data for every class (or label) in your dataset, although especially large datasets may require less testing data.

SUGGESTED TRAIN / TEST SPLIT 80% / 20%

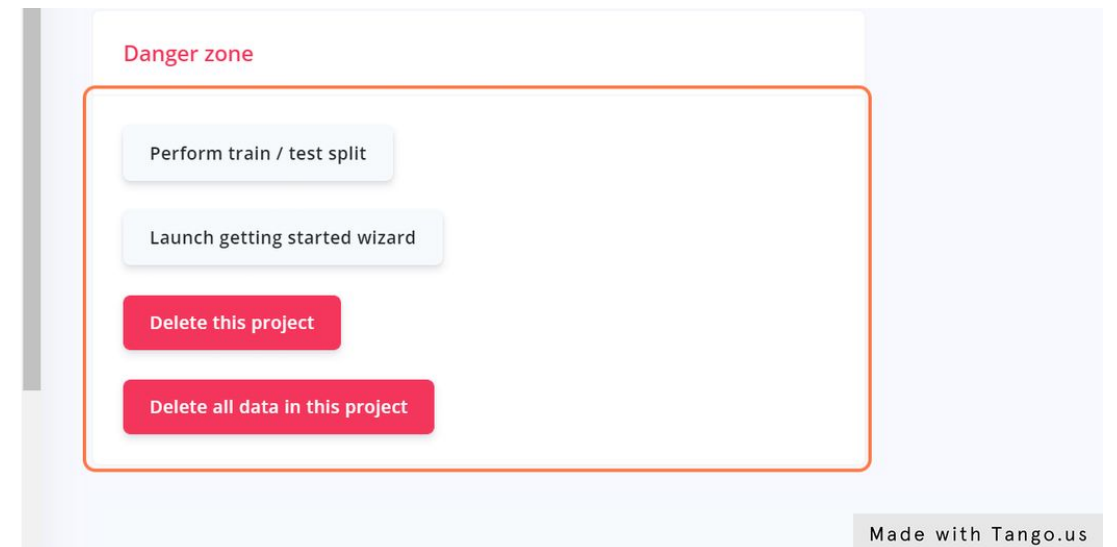
Labels in your dataset ⓘ

Some classes have a poor train/test split ratio: Jump, Rest. To fix this, add or move samples to the training or testing data.

Label	Train / Test Split Ratio
JUMP	100% / 0% (1m 0s / 0s)
REST	100% / 0% (1m 10s / 0s)

Sample length (ms.)

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Danger zone

Perform train / test split

Launch getting started wizard

Delete this project

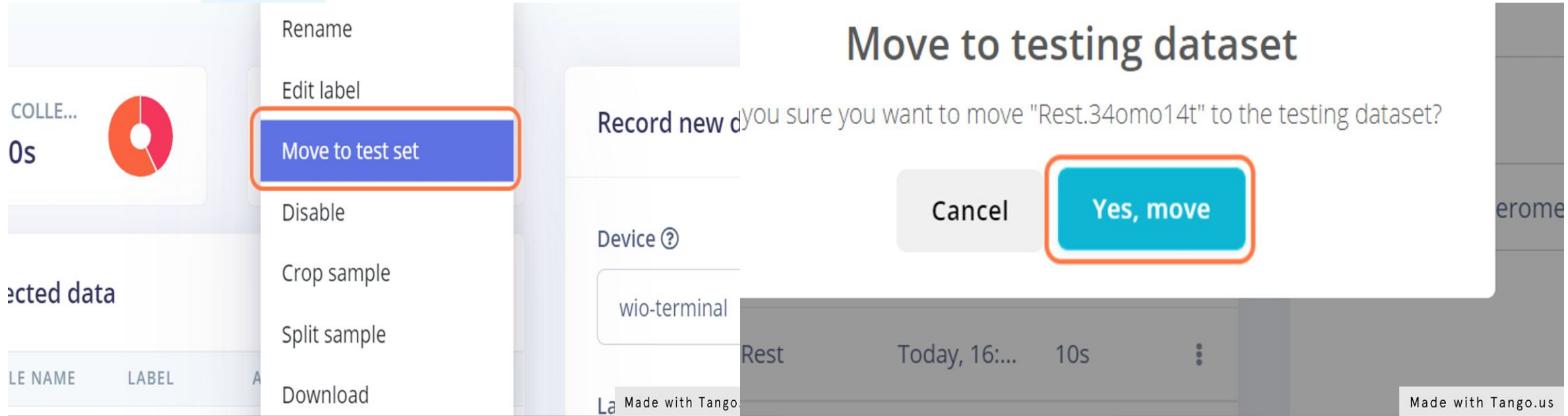
Delete all data in this project

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Move data to test

Click on Yes, move

Move to testing dataset



The screenshot shows the seed studio interface. On the left, a data collection card is visible with a red and orange donut chart and the text "COLLE... 0s". A context menu is open over the card, listing several actions: "Rename", "Edit label", "Move to test set" (highlighted with a blue background and an orange border), "Disable", "Crop sample", "Split sample", and "Download". In the center, a confirmation dialog box is displayed with the text "Record new d... you sure you want to move 'Rest.34omo14t' to the testing dataset?". The dialog has two buttons: "Cancel" and "Yes, move" (highlighted with a blue background and an orange border). Below the dialog, a table shows a record with the label "Rest", a timestamp "Today, 16:...", and a duration of "10s".

Label	Timestamp	Duration
Rest	Today, 16:...	10s

Now let's create an ML pipeline

Add a data processing pipeline

Data acquisition

Impulse design

- Create impulse

EON Tuner

Retrain model

DATA COLLE...
40s

Collected data

1000 ms.

Data series

- axes (3)
- accY, accZ
- row size

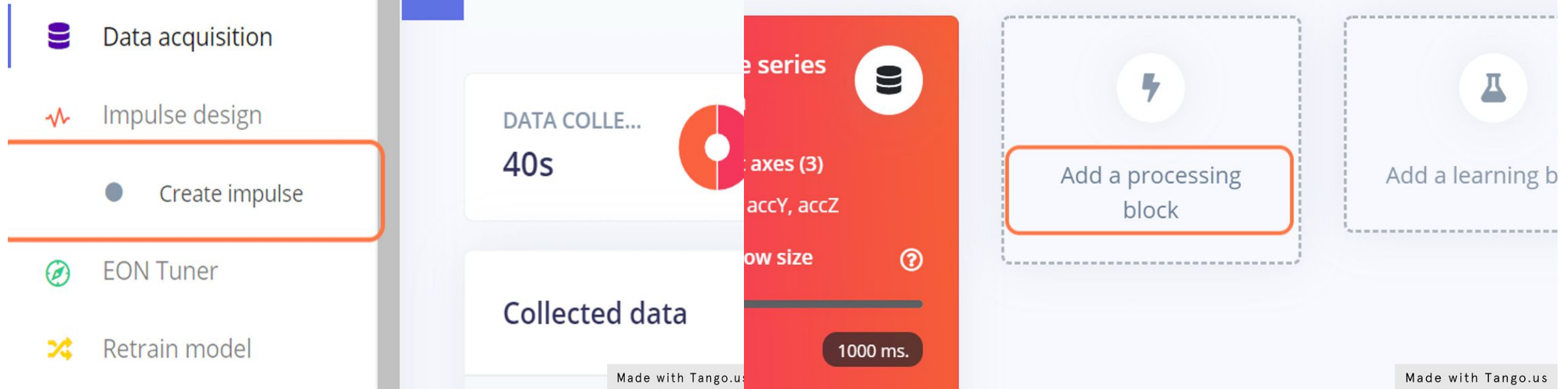
Add a processing block

Add a learning block

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Now let's create an ML pipeline

Add a data processing pipeline



The screenshot displays the 'Impulse design' section of the seed studio interface. On the left, a sidebar lists several options: 'Data acquisition', 'Impulse design', 'EON Tuner', and 'Retrain model'. The 'Impulse design' option is selected, and a sub-menu is open with 'Create impulse' highlighted. An orange line connects this sub-menu to the main workspace. The workspace shows a data processing pipeline with three blocks: 'DATA COLLE...' (40s), 'Collected data', and '1000 ms.'. A red overlay box highlights the 'Data series' section, which includes 'axes (3)' (accY, accZ) and 'row size'. To the right, two dashed boxes indicate where to 'Add a processing block' and 'Add a learning block'. The interface is watermarked with 'Made with Tango.us'.

Resources

1. Getting started with wio terminal
<https://wiki.seeedstudio.com/Wio-Terminal-Getting-Started/>
 2. Repositories with tinymt projects
<https://github.com/topics/tinymt>
 3. Organised list of tinymt resources
<https://github.com/gigwegbe/tinymt-papers-and-projects>
 4. Tinymt cookbook repository
<https://github.com/PacktPublishing/TinyML-Cookbook>
1. Introduction to arduino
<https://wiki.seeedstudio.com/Arduino/>
 2. Arduino reference materials
<https://www.exploringarduino.com/resources/>
 3. Arduino lessons with examples
<https://www.arduino.cc/en/Tutorial/HomePage>
 4. Arduino project guides
<https://www.programmingelectronics.com/free-arduino-guides-and-resources/>

Youtube channels to learn machine learning and microboard programming.
<https://www.youtube.com/c/joshstarmar>
<https://www.youtube.com/c/DeepLearningTV>
<https://www.youtube.com/c/mcwhorpi>
<https://www.youtube.com/c/Dronebotworkshop1>

Thank you and see you tomorrow.

inference code can be found here:

<https://drive.google.com/drive/folders/1NWFm-dR XDagdkm3qv0FXmiAvDy3C6Drr?usp=sharing>

You can always reach out to me if you have any questions:-

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