



DesignNews

Machine Learning Application Design using STM32 MCU's

DAY 2 : Capturing, Cleaning and Labeling Data

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Webinar Logistics

- Turn on your system sound to hear the streaming presentation.
- If you have technical problems, click “Help” or submit a question asking for assistance.
- Participate in ‘Group Chat’ by maximizing the chat widget in your dock.
- Submit questions for the lecturer using the Q&A widget. They will follow-up after the lecture portion concludes.

Course Sessions

- Introduction to Machine Learning on MCU's
- **Capturing, Cleaning and Labeling Data**
- Training a Neural Network Part 1
- Training a Neural Network Part 2
- Running an Inference on Target

Neural Network (NN) Model Creation

Operating Mode

Capture data



1

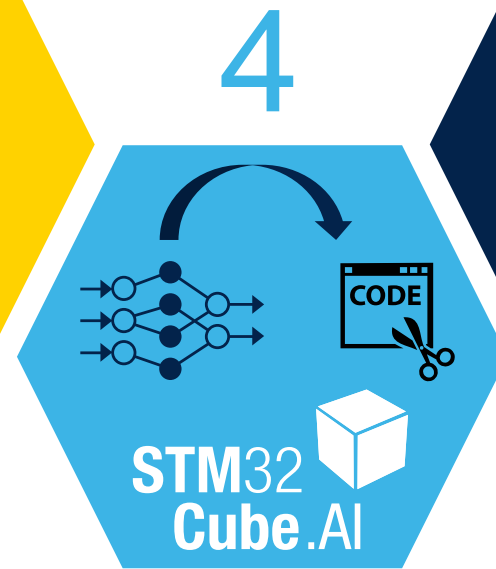
Train NN Model



Clean, label data
Build NN topology

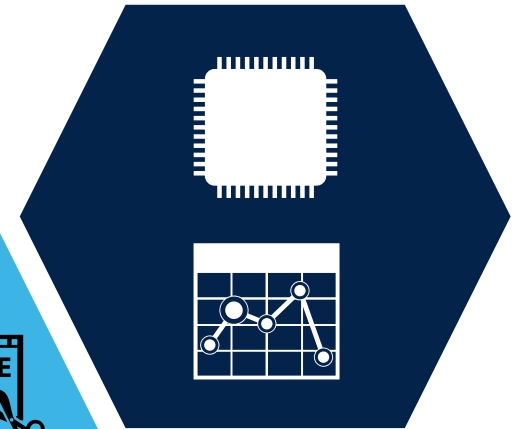


3

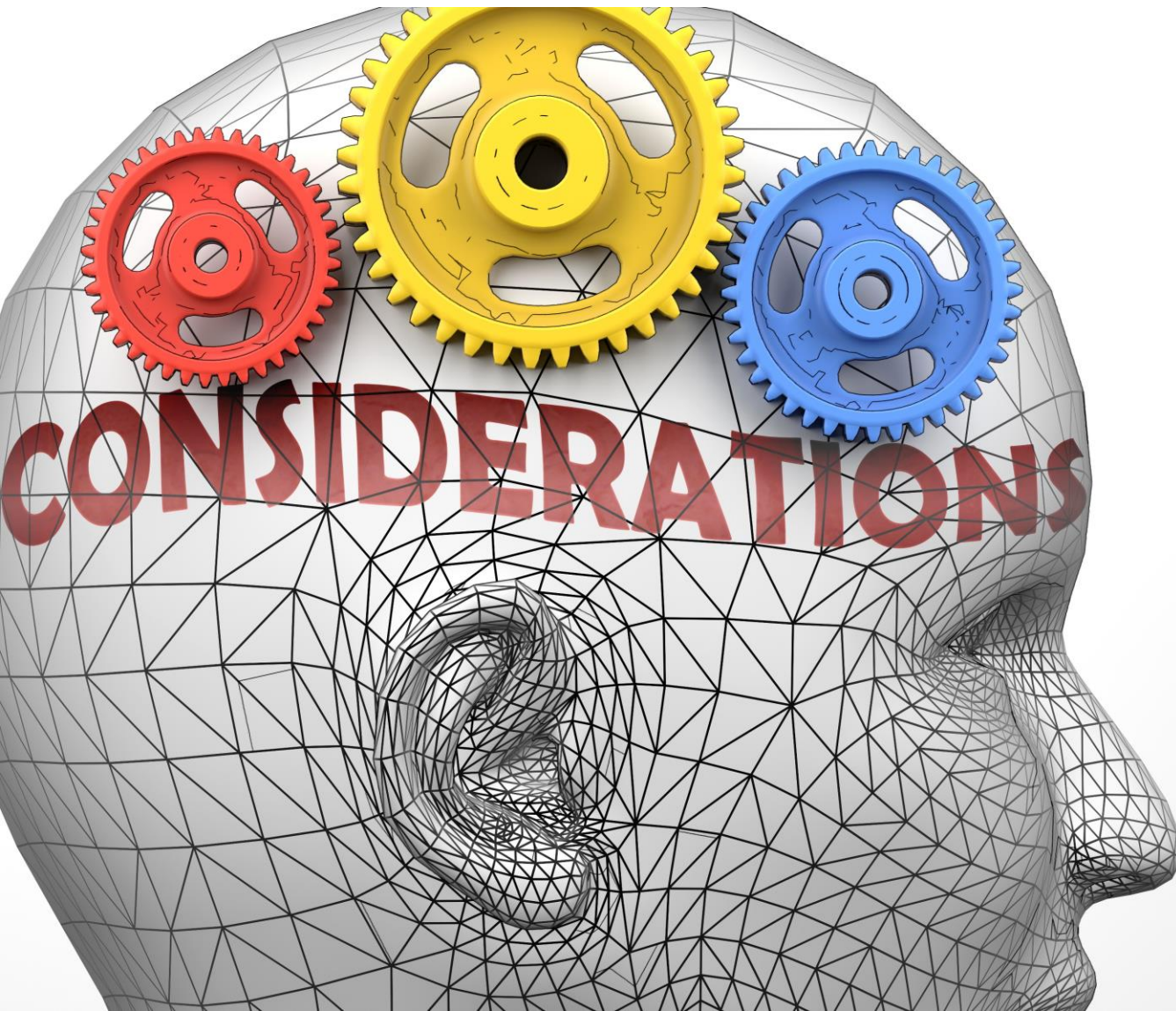


Convert NN into
optimized code for MCU

Process & analyze new
data using trained NN

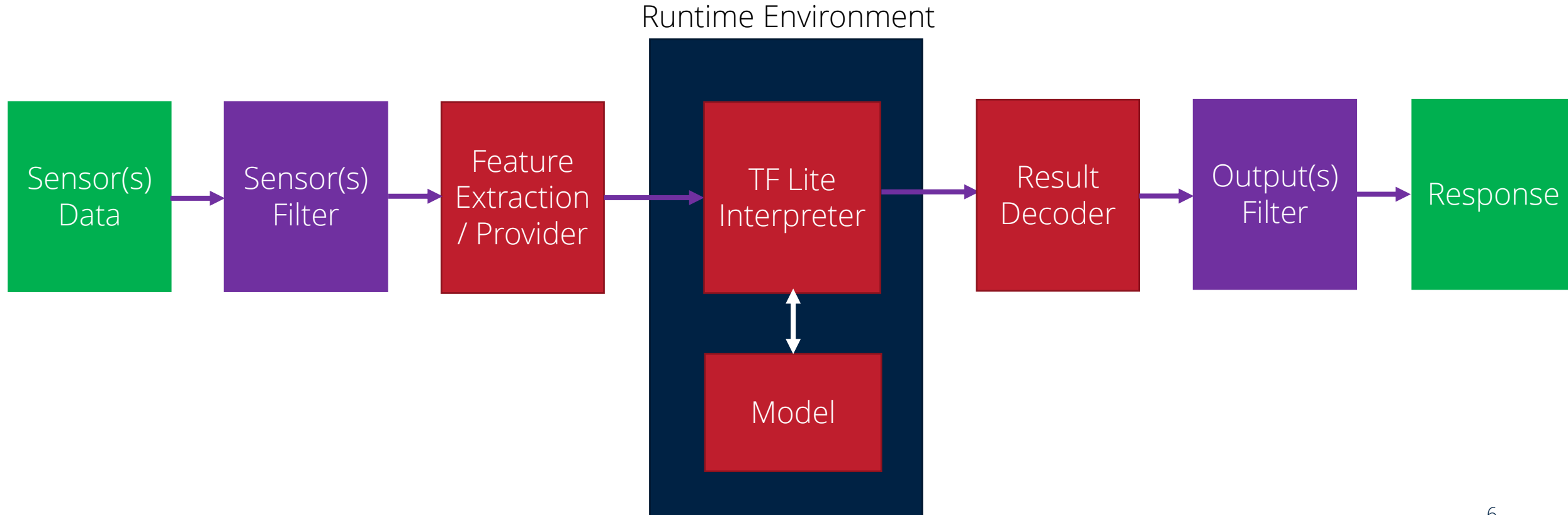


5



- 1) What problem are you trying to solve?
- 2) What are the models' inputs?
- 3) Do the inputs need to be processed?
- 4) What are the features?
- 5) What are the outputs?
- 6) How is the output processed?
- 7) Will this run on an MCU?

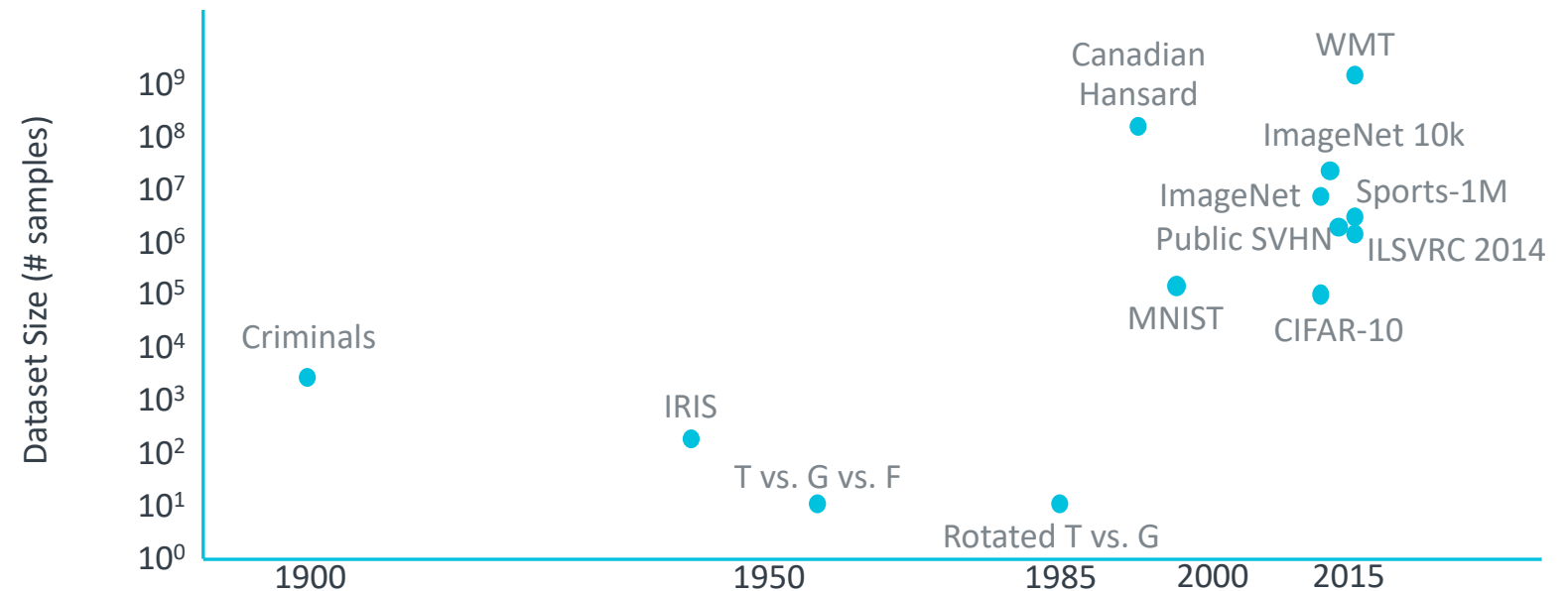
A General High-Level Software Architecture



Options for getting Training Data

- 1) Online Data Sets
- 2) Generate it
- 3) Collect it
- 4) Buy it

Collecting it is the most interesting ... (and the most work)

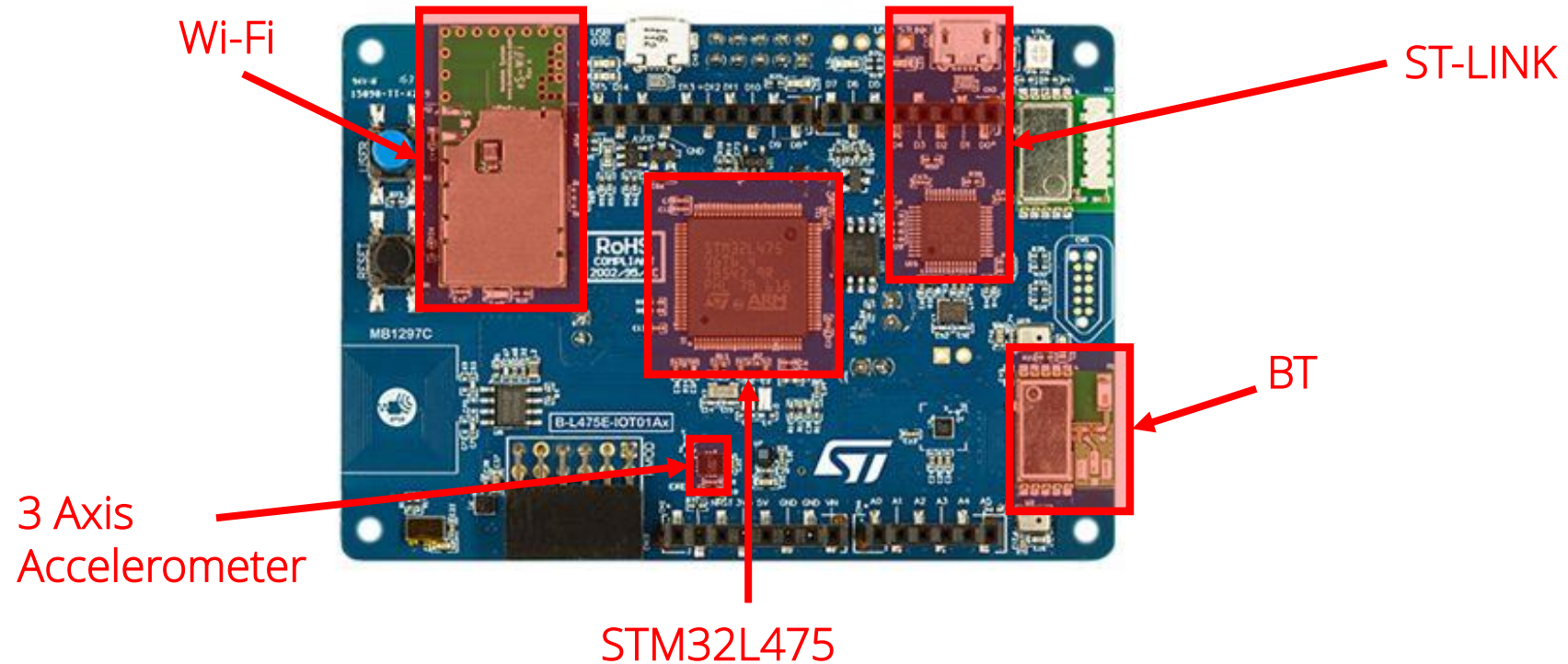


How do you plan to get the data for your own applications?

- 1) Online Data Sets
- 2) Generate it (through simulation)
- 3) Collect it (experimentation)
- 4) Buy it

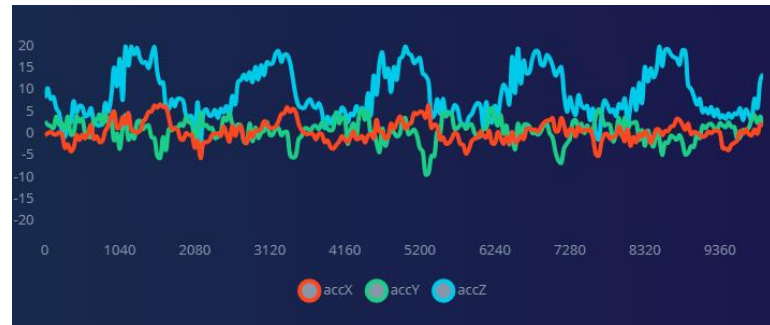
Example Application – Gesture Classification

STM32L475 IoT Discovery Kit (B-L475E-IOT01A)

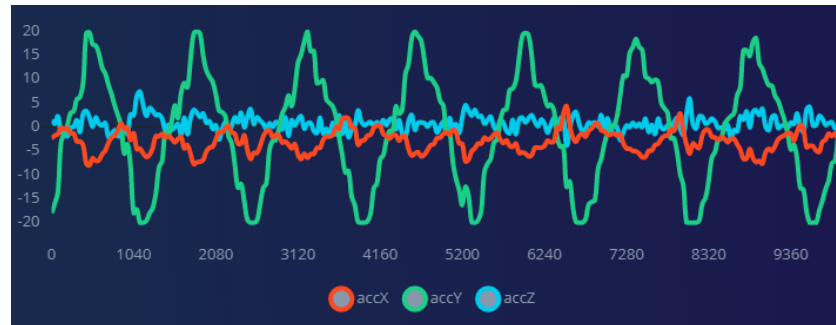


Example Application – Gesture Classification

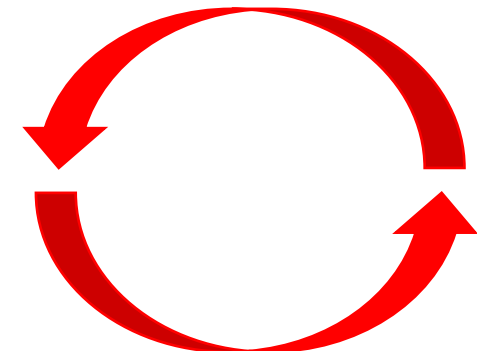
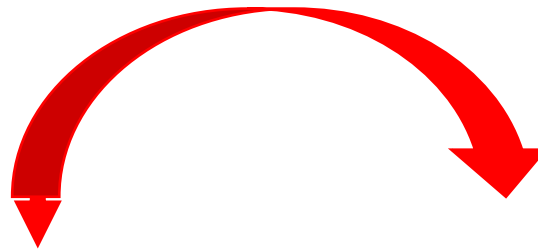
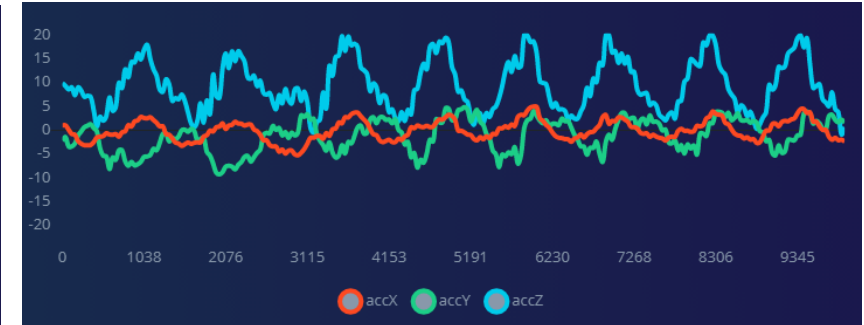
Label 1 – Up and Down



Label 2 – Wave



Label 3 – Circle



With these three gestures, do you think the machine learning model will have any classification issues?

- Yes
- No
- Not sure

Edge Impulse

Edge Impulse was designed for software developers, engineers and domain experts to solve real problems using machine learning on edge devices without a PhD in machine learning.

www.edgeimpulse.com

EDGE IMPULSE

- Dashboard
- Devices
- Data acquisition
- Impulse design
 - Create impulse
 - Spectral features
 - Spectrogram
 - NN Classifier
 - Anomaly detection
- Retrain model
- Live classification
- Model testing
- Versioning

Creating your first impulse (100% complete)

- Acquire data**

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

LET'S COLLECT SOME DATA
- Design an impulse**

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

GETTING STARTED: CONTINUOUS MOTION RECOGNITION

GETTING STARTED: RESPONDING TO YOUR VOICE

GETTING STARTED: ADDING SIGHT TO YOUR SENSORS
- Deploy**

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

DEPLOY YOUR MODEL

Edge Impulse



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machine learning
models today.

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Edge Impulse

DevBoards Running EdgeImpulse Software

Data Collection
Model Design

Training
Live Testing
Model Validation

EDGE IMPULSE

Dashboard

Devices

Data acquisition

Impulse design

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

Retrain model

Live classification

Model testing

Versioning

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

DEPLOY YOUR MODEL

Design Space

Edge Impulse – Board Setup

Visit <https://docs.edgeimpulse.com/docs>

📌 Get started with any device

Follow these three steps to build your first embedded Machine Learning model - no worries, you can use almost any device to get started.

1. You'll need some data:

- If you have an existing development board or device, you can collect data with a few lines of code using the [Data forwarder](#).
- If you have one of the fully supported development boards, follow these steps to collect data from the real world:
 - [ST B-L475E-IOT01A](#)
 - [Arduino Nano 33 BLE Sense](#)
 - [Eta Compute ECM3532 AI Sensor](#)
 - [Eta Compute ECM3532 AI Vision](#)
 - [Himax WE-I Plus](#)
 - [Nordic Semiconductor nRF52840 DK](#)
 - [Nordic Semiconductor nRF5340 DK](#)
 - [Silicon Labs Thunderboard Sense 2](#)
 - [OpenMV Cam H7 Plus](#)
 - [Arduino Portenta H7 + Vision shield](#)
- If you already have a dataset, you can upload it via the [Uploader](#).
- If you have a mobile phone you can use it as a sensor to collect data, see [Mobile phone](#).

Edge Impulse – Board Setup

Installation - macOS and Windows

1. Install [Python 3](#) on your host computer.
2. Install [Node.js](#) v14 or higher on your host computer.
 - For Windows users, install the **Additional Node.js tools** when prompted. You may skip this setup if you have Visual Studio 2015 or more.
3. Install the CLI tools via:

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

You should now have the tools available in your PATH.

Edge Impulse – Board Setup

- 1 Connect the development board to your computer



Edge Impulse – Board Setup

2 Update Firmware

- 1) The development board is mounted as a USB mass-storage device (like a USB flash drive), with the name DIS_L4IOT. Make sure you can see this drive.
- 2) Download the latest Edge Impulse firmware.
- 3) Drag the DISCO-L475VG-IOT01A.bin file to the DIS_L4IOT drive.
- 4) Wait until the LED stops flashing red and green.

`$ edge-impulse-daemon`
This will start a wizard which will ask you to log in, choose an Edge Impulse project, and set up your WiFi network. If you want to switch projects run the command with
`--clean`



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Edge Impulse – Board Setup

- 3 Setting keys and WiFi credentials

From a command prompt or terminal, run:

```
$ edge-impulse-daemon
```

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

\$ edge-impulse-daemon

This will start a wizard which will ask you to log in, choose an Edge Impulse project, and set up your WiFi network. If you want to switch projects run the command with

-clean




Edge Impulse – Board Setup

4 Verify that the device is connected

DEVICES (BENINGO-PROJECT-1) Jacob Beningo

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 ...	LAST SEEN
 C4:7F:51:03:EC:54	C4:7F:51:03:EC:54	DISCO_L475VG_IOT01A	Built-in accelerometer, Built-in mic...	●	Today, 10:33:05

Capturing and Labeling Data

Record new data

Device ?

C4:7F:51:03:EC:54

Label

Circle

Sensor

Built-in accelerometer

Sample length (ms.)

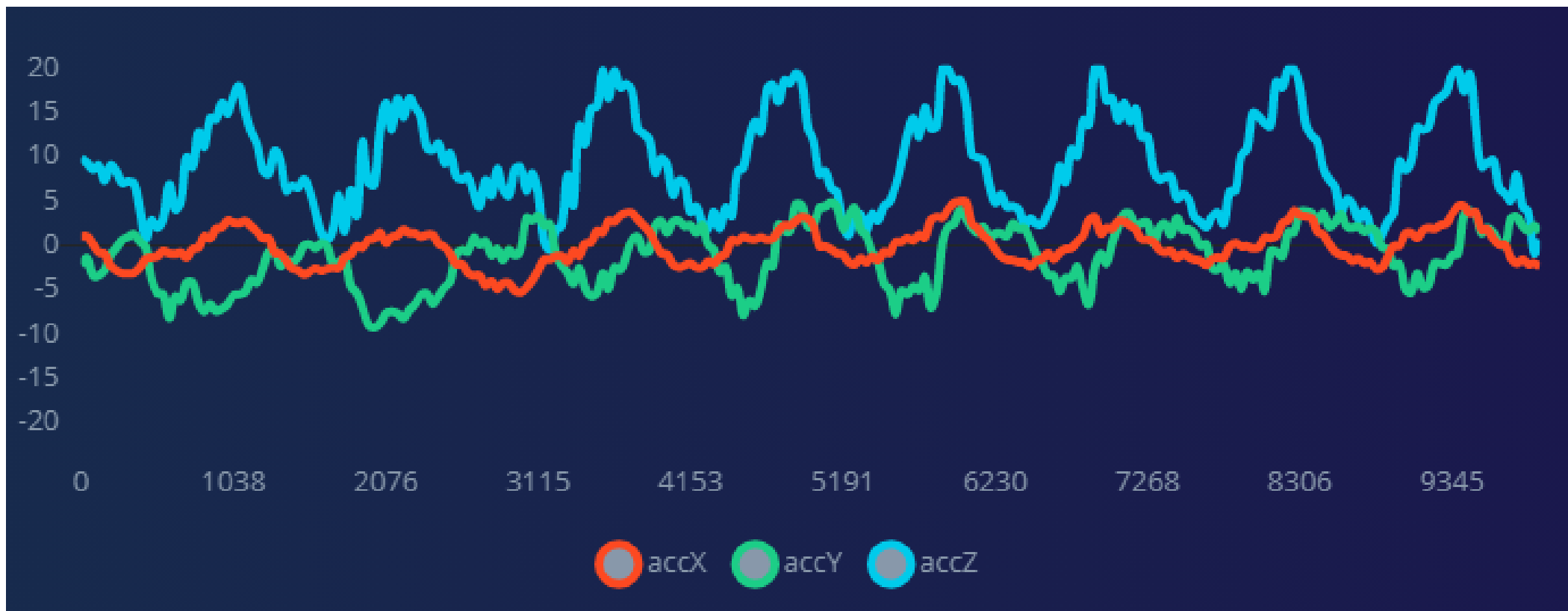
10000

Frequency

62.5Hz

Start sampling

Capturing and Labeling Data



Capturing and Labeling Data

DATA ACQUISITION (BENINGO-PROJECT-1)

Training data

Test data



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

DATA COLLECTED

7m 30s



LABELS

3



Capturing and Labeling Data

DATA ACQUISITION - TESTING (BENINGO-PROJECT-1)

Training data

Test data



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

DATA COLLECTED

3m 19s



LABELS

4



Do you plan on collecting your own data so that you can train your own model during tomorrows class?

- Yes
- No
- undecided

Thank you for attending

Please consider the resources below:

- www.beningo.com
 - Blog, White Papers, Courses
 - Embedded Bytes Newsletter
 - <http://bit.ly/1BAHYXm>



From www.beningo.com under

- Blog > CEC – Machine Learning Application Design using STM32 MCUs



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