



<http://iot.barcelona>



# Hands-On Edge AI Workshop with free hardware

15th Sep 2025 | 6pm CET | Canòdrom - Ateneu d'Innovació Digital i Democràtica

Special thanks

seeed studio

 EDGE IMPULSE

# **Hands-on!**

# **Train from scratch your**

# **first Edge AI model**

# **with Edge Impulse**



Marc Pous

Developer Relations @ Edge Impulse

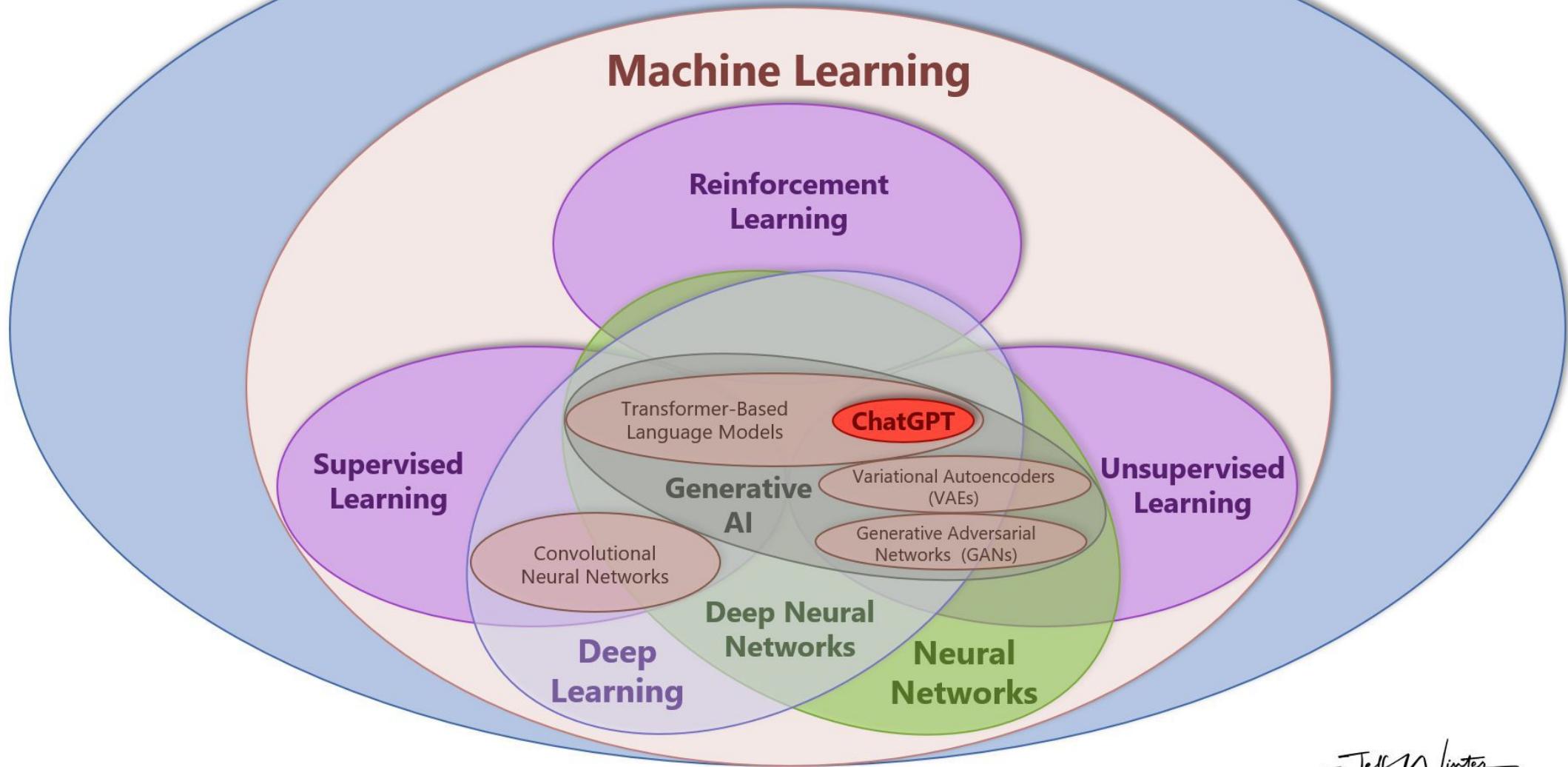


**seeed studio**

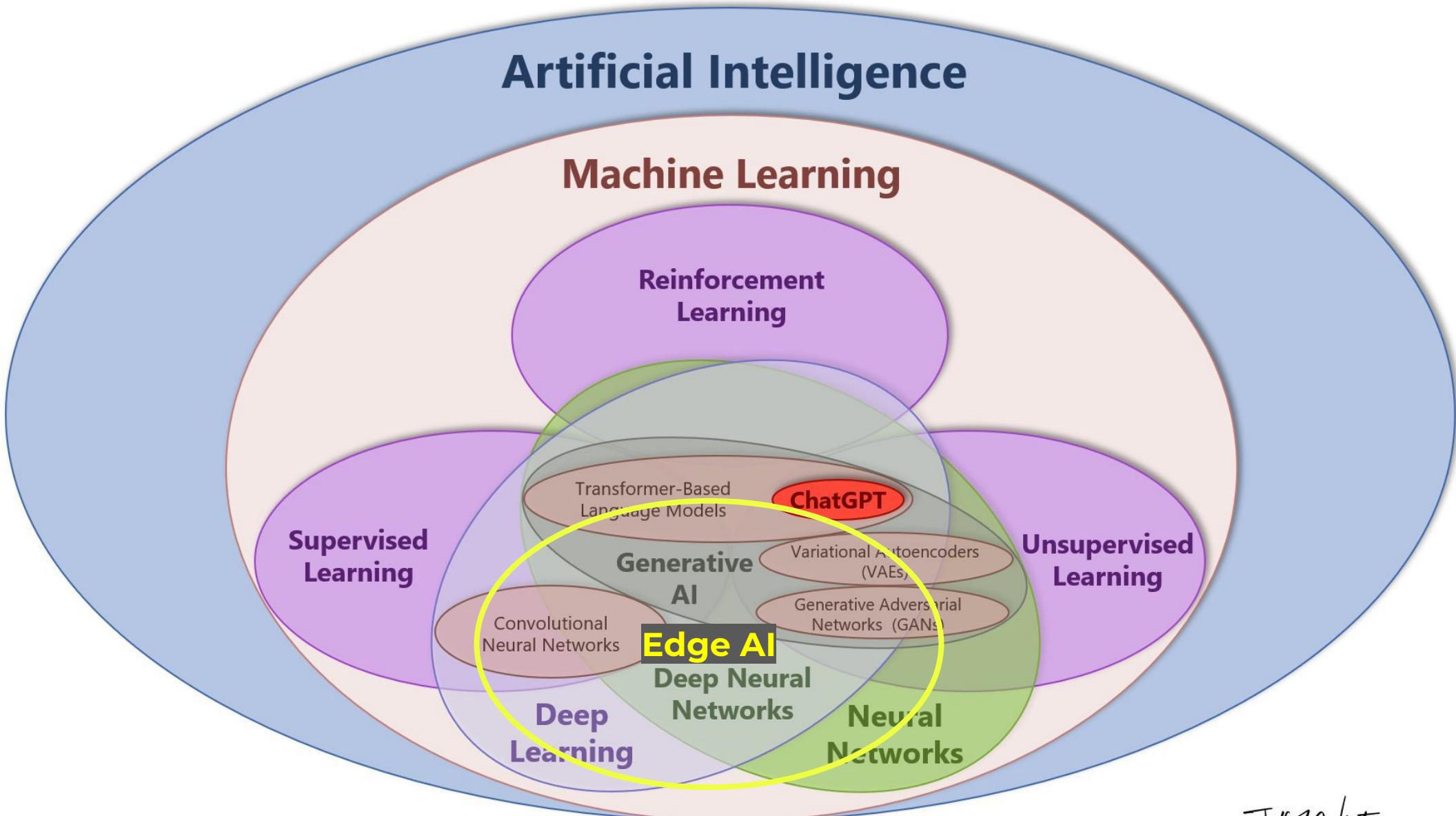
Question?

**What do you know  
about Artificial Intelligence?**

# Artificial Intelligence

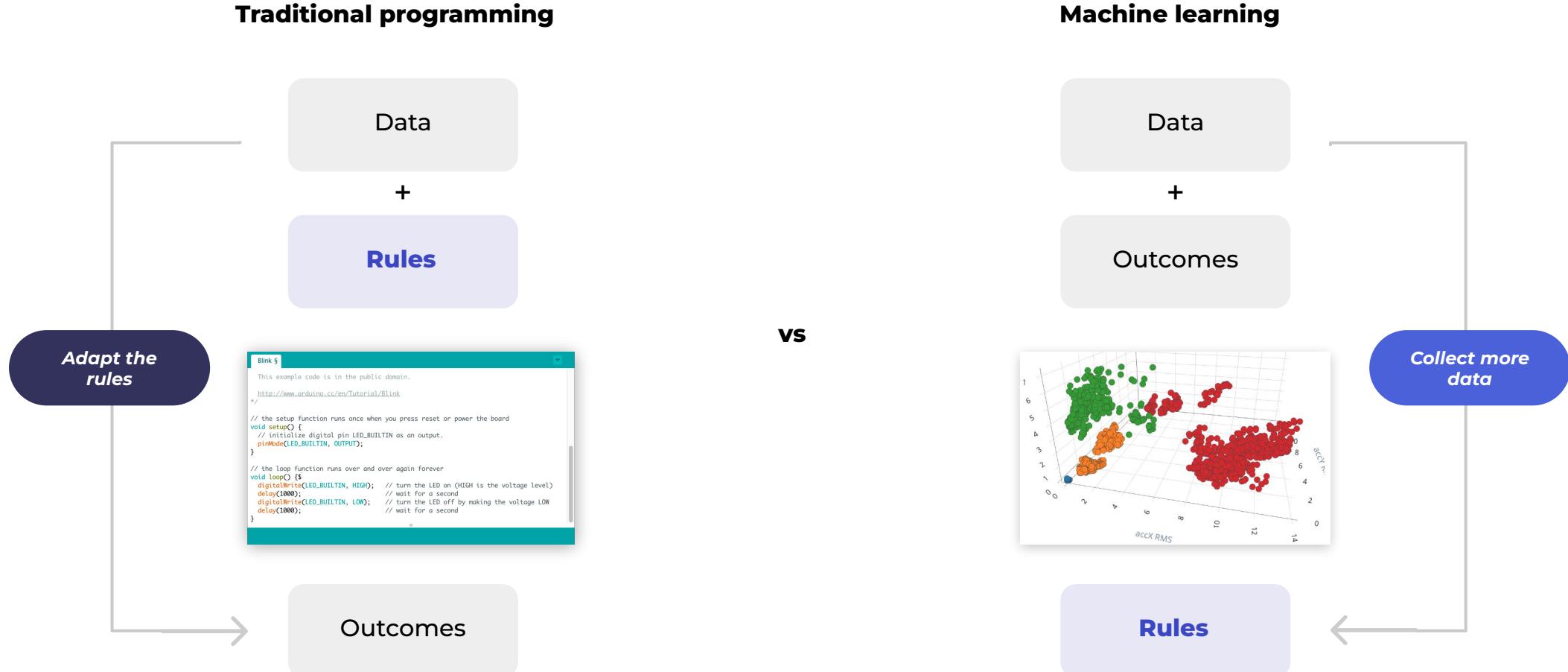


Jeff Winter



Jeff Winter

# A paradigm shift

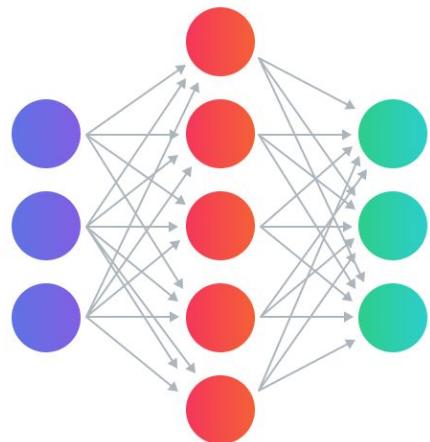


# Neural Networks

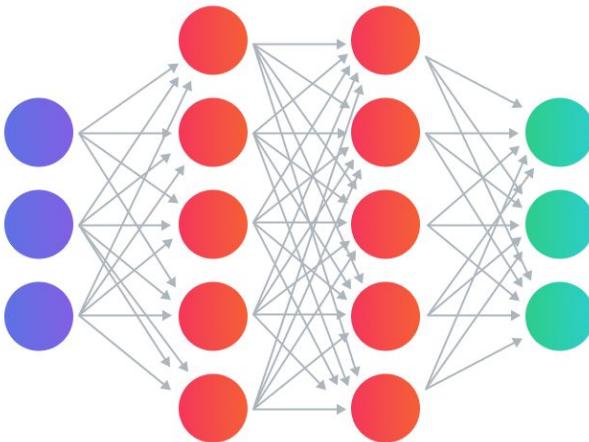
## Deep Neural Network

Artificial Neural Network Architecture

Simple Neural Network

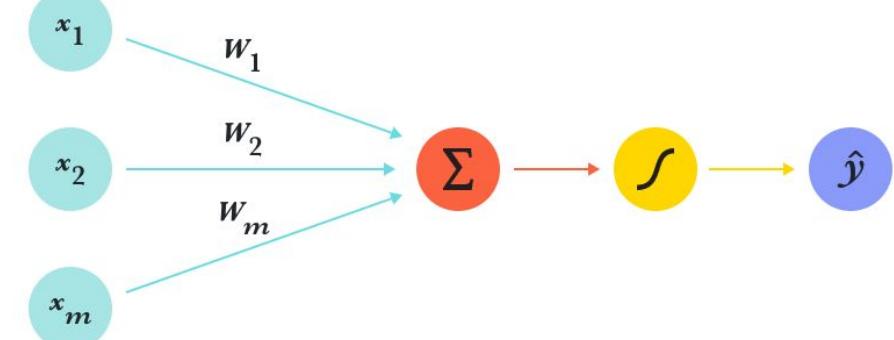


Deep Learning Neural Network



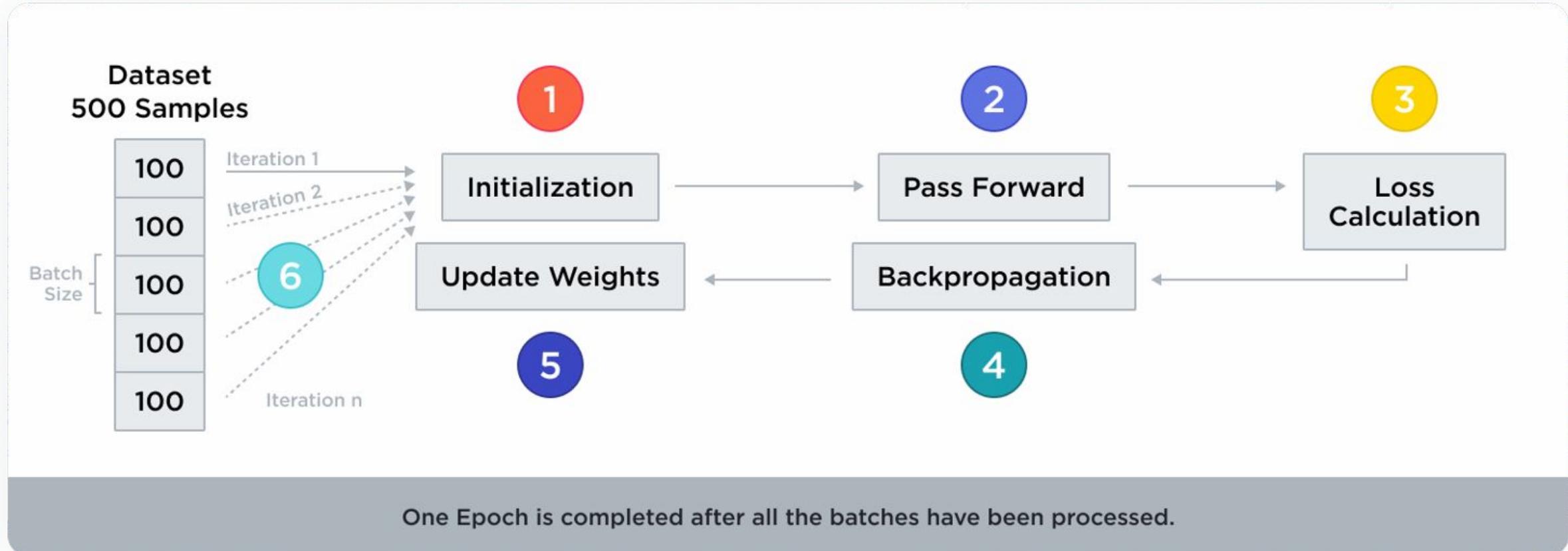
● Input Layer   ● Hidden Layer   ● Output Layer

## Single Neuron

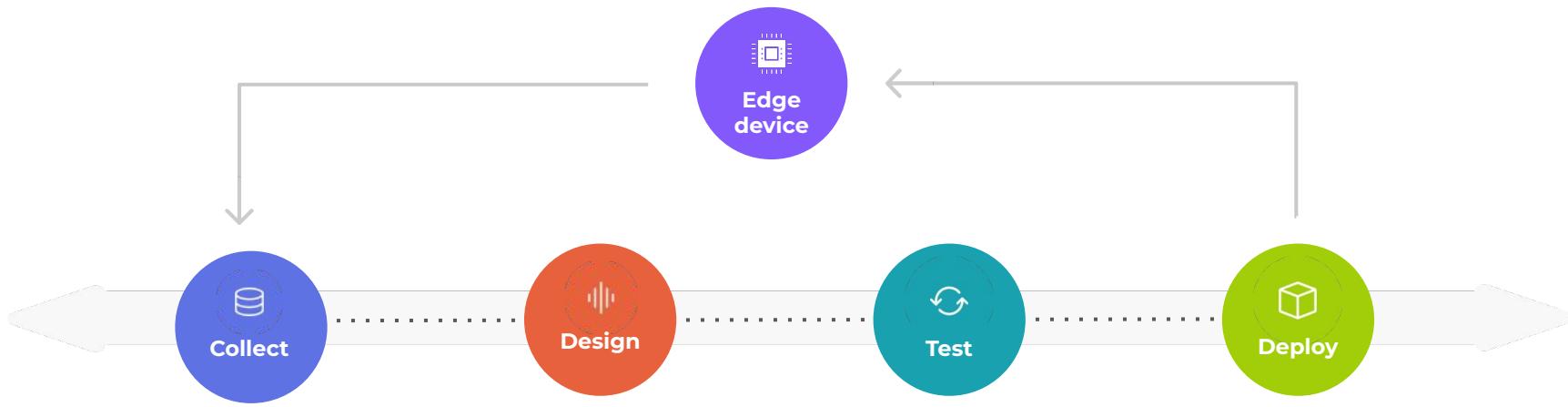


Inputs   Weights   Sum   Non-Linearity   Output

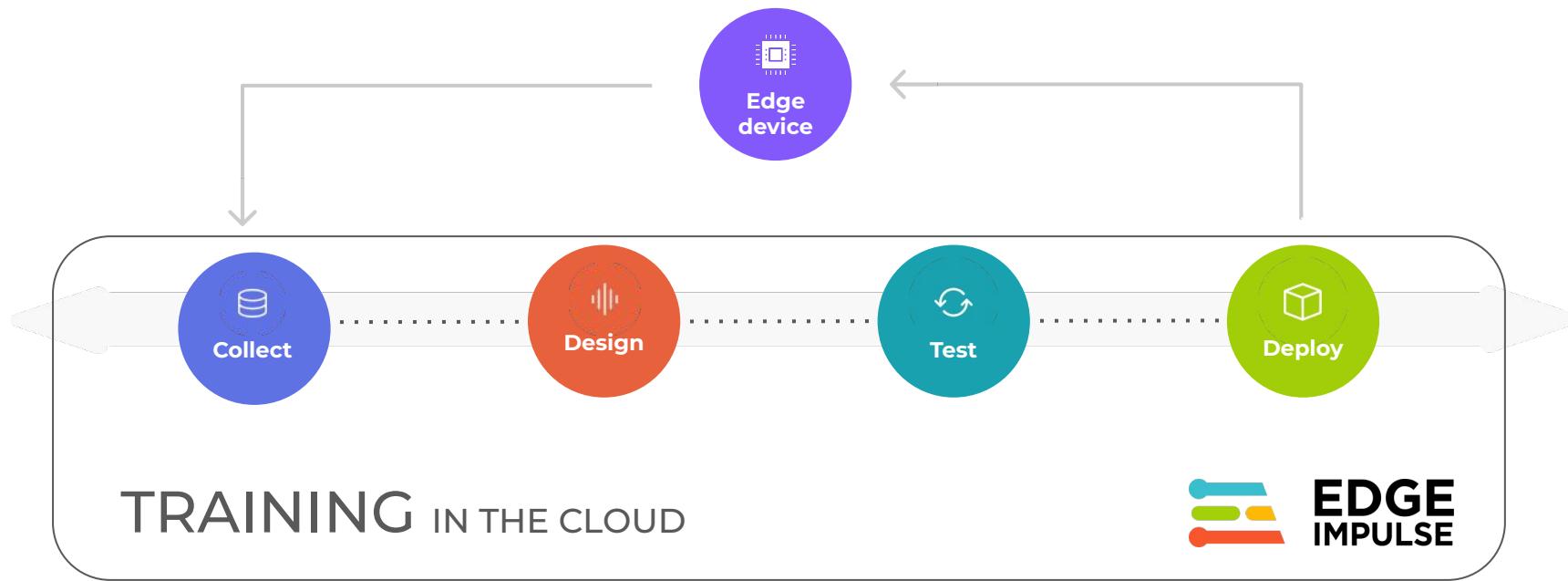
# A model learns by adjusting its parameters



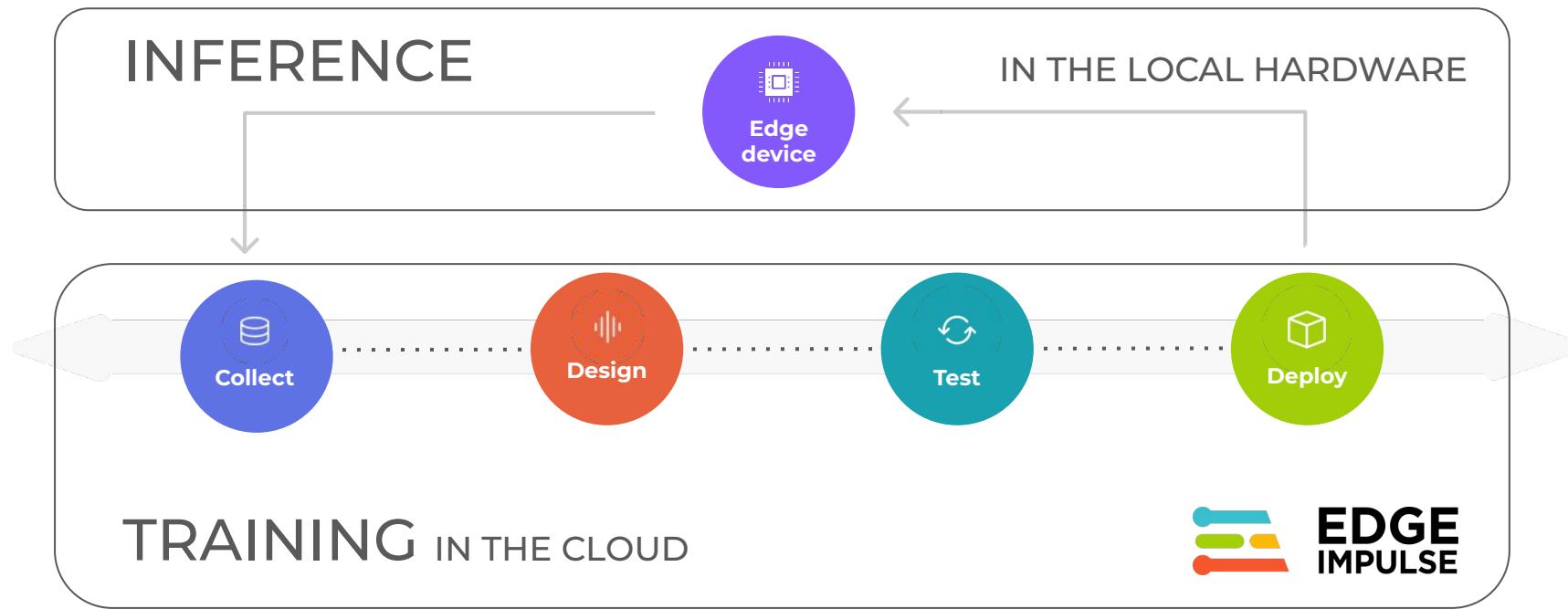
# Edge AI



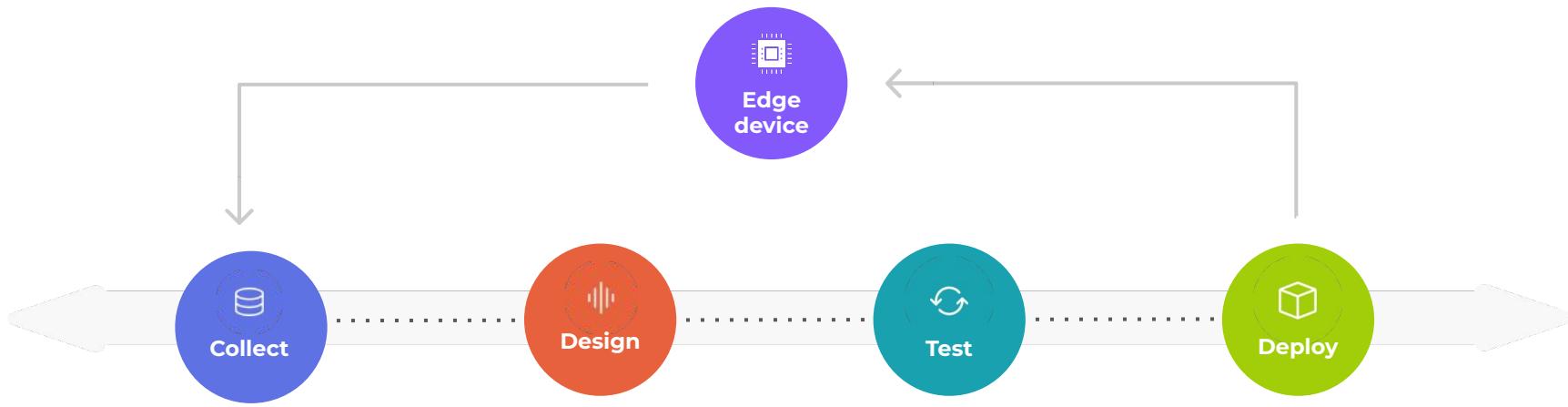
# Edge AI



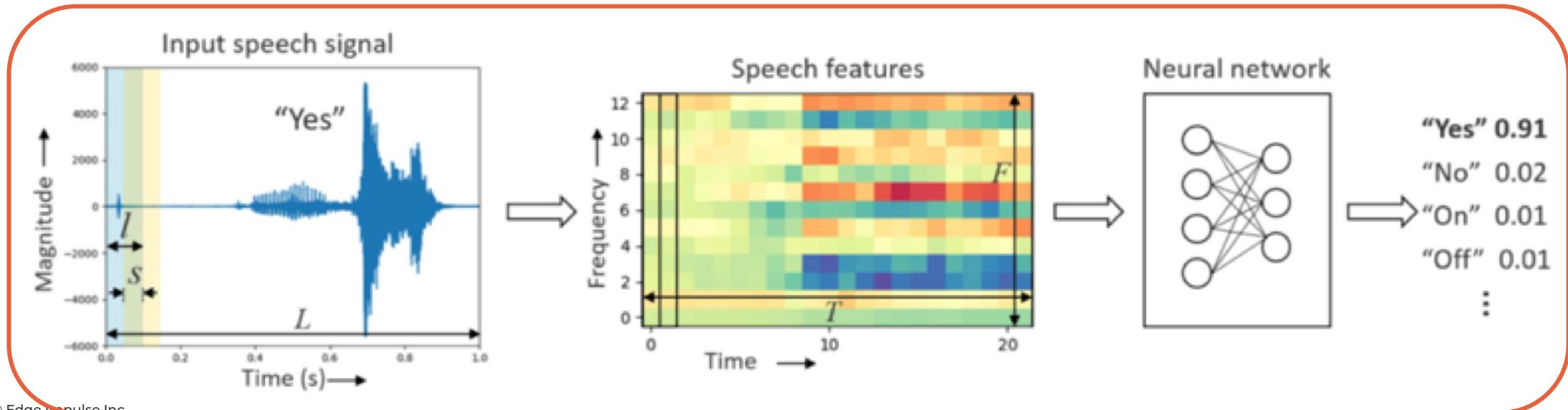
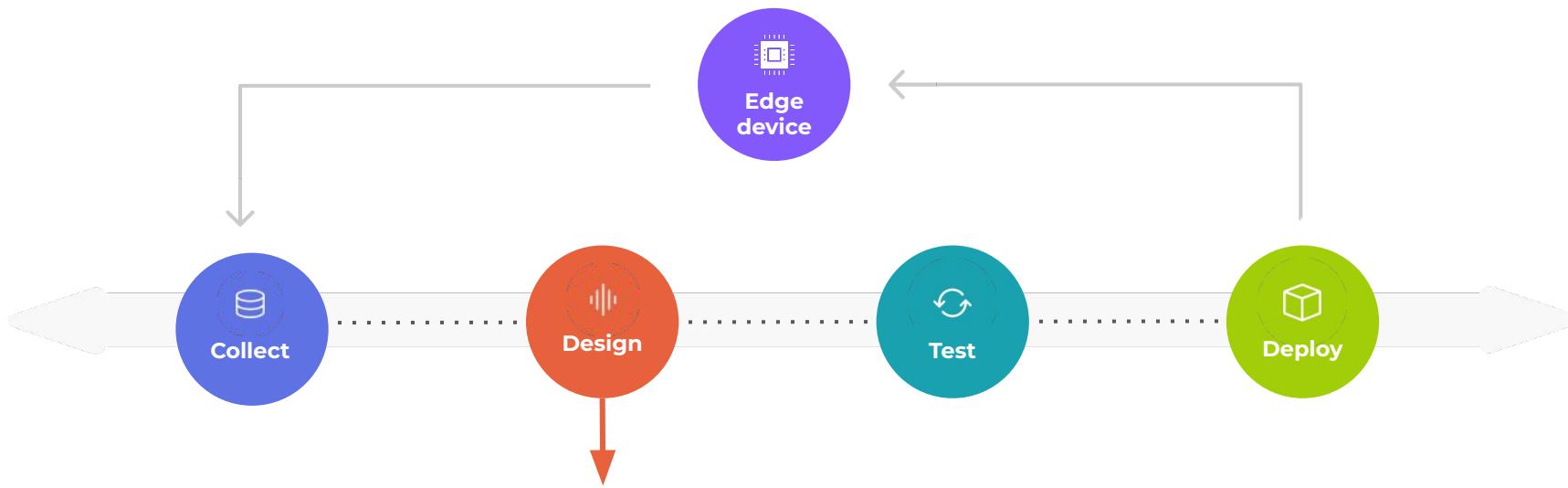
# Edge AI



# Edge AI



# Edge AI



# Edge Impulse



# Any sensor, any data, any use case

|                  | <b>Ultra low power</b>  | <b>Low-end MCU</b>   | <b>High-end MCU</b>  | <b>NPU</b>   | <b>MPU</b>  | <b>GPU</b>   |
|------------------|---|--|--|--|---|--|
| <b>Use cases</b> | <ul style="list-style-type: none"><li>• Wake word smart helmet</li><li>• O&amp;G drill bit applied force prediction</li></ul> | <ul style="list-style-type: none"><li>• Glass breaking detection</li><li>• Pallet situation awareness</li><li>• Pump anomaly detection</li></ul> | <ul style="list-style-type: none"><li>• MCSA (motor)</li><li>• Fire detection</li><li>• Washing machine load estimation</li><li>• Object detection</li></ul> | <ul style="list-style-type: none"><li>• Smart kitchen visual aid</li><li>• Fitness tracker</li><li>• KWS enterprise headsets</li></ul> | <ul style="list-style-type: none"><li>• Worker safety assembly line manufacturing</li><li>• QA food conveyor</li><li>• Smart camera</li></ul> | <ul style="list-style-type: none"><li>• Crowd management</li><li>• Multi-object detection</li><li>• Traffic management</li></ul> |
| <b>Memory</b>    | Anomaly detection<br>10kB   | Sensor fusion classification<br>18kB   | Audio classification<br>50kB   | Image classification<br>256kB  | Object detection complex voice processing<br>1MB+   | Video classification<br>1GB+   |
| <b>Sensor</b>    | ✓   | ✓  | ✓  | ✓  | ✓   | ✓  |
| <b>Audio</b>     | ✓   | ✓  | ✓  | ✓  | ✓   | ✓  |
| <b>Image</b>     |   |  | ✓  | ✓  | ✓   | ✓  |
| <b>Video</b>     |   |  |  |  | ✓   | ✓  |

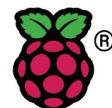


brainchip



# Comprehensive hardware support

Benefit from the leading edge ML silicon ecosystem



# Benefits of Edge AI



## Innovation

Add new differentiating features, become a market leader by standing out from your competition



## Privacy

Data stays on the device, gets processed locally and drives remote alerts, notifications, and actions



## Power

Stay operational for longer periods of time



## Cost

Save on storage and compute costs by not sending raw data constantly to the cloud



## Reliability

Be operational in low connectivity environments



## Bandwidth & Latency

Process data real-time on the edge device, without having to wait for a response back from the cloud

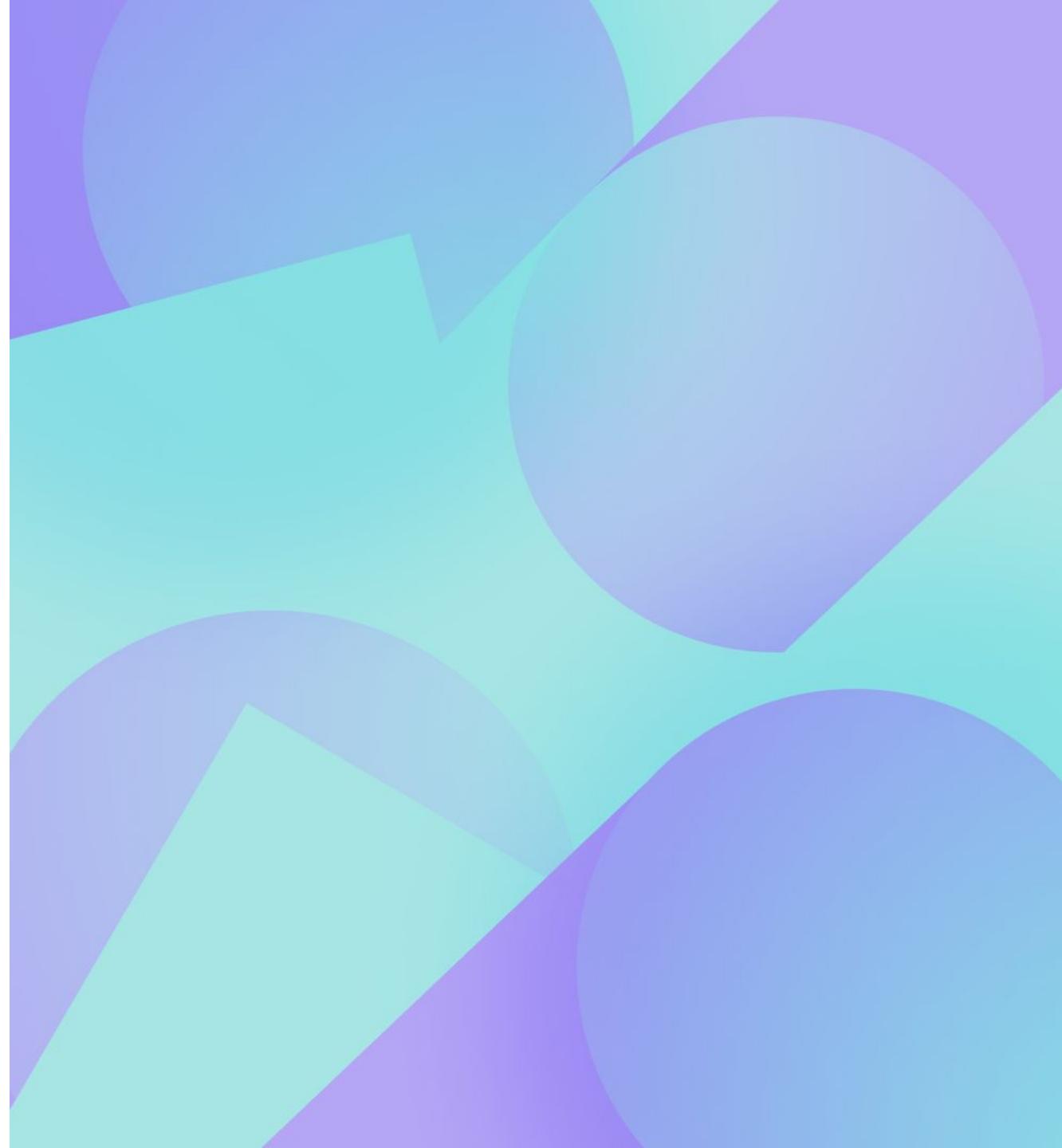
# Let's start!

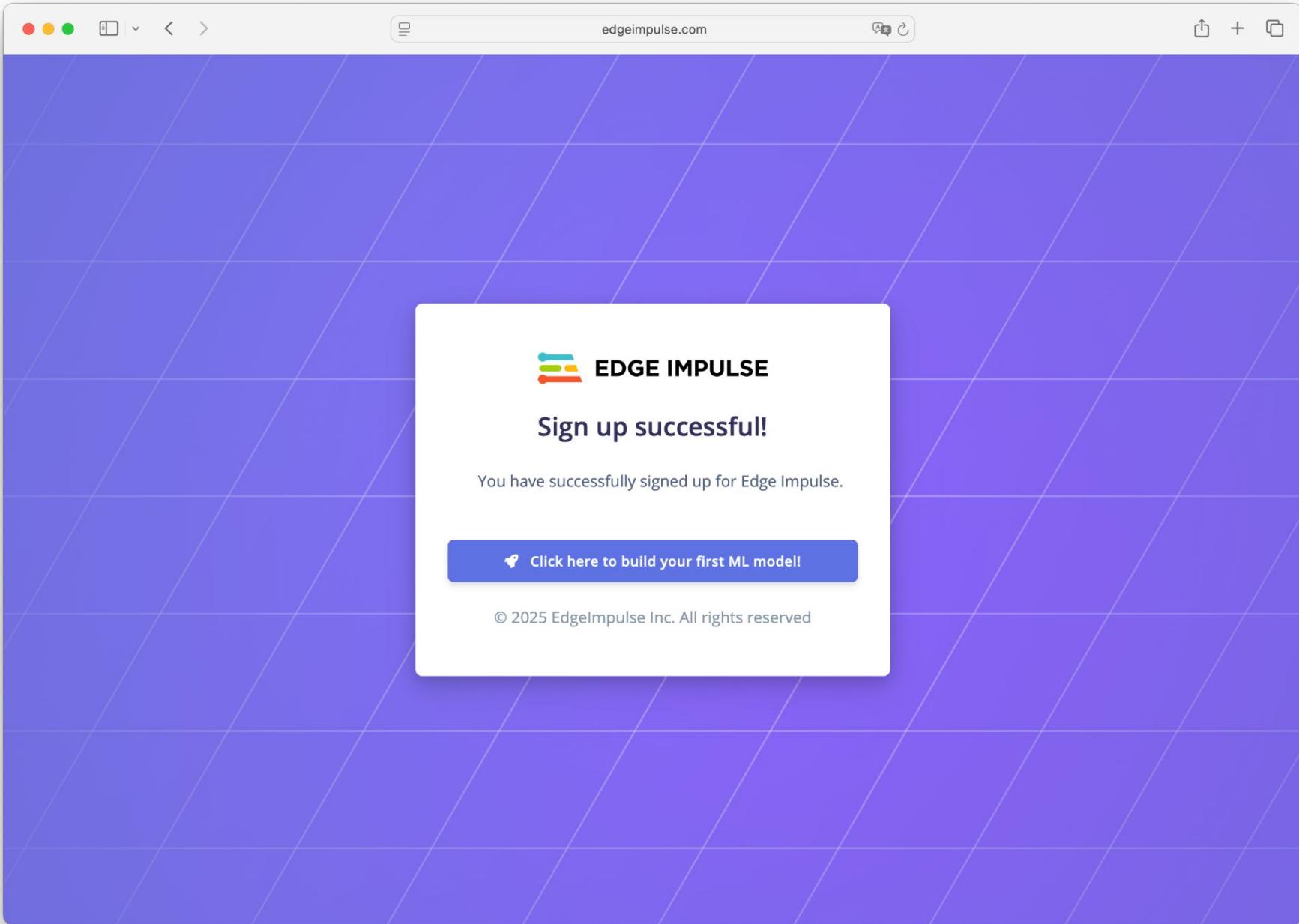
# **Keyword Spotting**

## **Audio classification**

You are train a keyword spotting ML model using your browser

[Register here](#)





studio.edgeimpulse.com

iotbcn / iotbcn-project-1 PERSONAL

Target: Cortex-M4F 80MHz

# Welcome 🎉

You're only minutes away from making your devices feel, hear and see the real world using edge AI!  
Build your first model in minutes! Select a use case to get started

 **Audio detection**  
Build a keyword spotting model that can detect any wake word, like "Hey Edge Impulse" or "Hey Siri", in just a few minutes.

 **Image classification**  
Build an image classification model that can recognize and distinguish between two real-world objects, such as identifying tires.

Or, get started manually

Build my first model!

Collaborators (1/3)

Project is private, only invited members can edit and view.

Published versions (0)

Project has no published versions.

Publish a version of your project

View plans

GETTING STARTED

**Upgrade Plan**

Get access to higher job limits and more collaborators.

View plans



The screenshot shows the Edge Impulse studio interface on a Mac OS X system. The window title is "iotbcn / iotbcn-project-1 PERSONAL". The top bar includes standard OS X controls (red, yellow, green buttons) and a search bar with the URL "studio.edgeimpulse.com". The main content area is titled "iotbcn-project-1".

**Project info** tab is selected. The sidebar on the left lists project management options: Dashboard, Devices, Data acquisition, Experiments, EON Tuner, Impulse design (with sub-options: Create impulse, Retrain model, Live classification, Model testing, Deployment, Versioning), and Getting Started (Upgrade Plan). The "Getting Started" section features a "Start with a tutorial" button and three circular icons representing different projects.

The central panel displays a step-by-step guide for creating a voice recognition model:

- Step 1 of 9: Responding to your voice 🎙️**
- Description: "You can use machine learning to analyze complex streams of sensor data in realtime, for example, to wake up when a device hears an audible event. Let's put that into practice, by making your device listen to your voice - similar to how your phone wakes up when it hears "OK, Google" or "Hey Siri"."
- Text input field: "Type your keyword or sentence"
- Blue button: "Next, collect some data"
- Information box: "This project is private, only invited users can edit and view."

Other visible sections include "Collaborators (1/3)" and "Published versions (0)".



The screenshot shows the Edge Impulse Studio interface on a Mac OS X system. The window title is "iotbcn / iotbcn-project-1 PERSONAL". The top navigation bar includes tabs for "Dataset", "Data explorer", "Data sources", "Synthetic data", "AI labeling (NEW)", and "CSV Wizard". A banner at the top right indicates the "Target: Arduino Portenta...".

The main content area displays a "Dataset" card with upload and cloud icons, and a "Collect data" card with a microphone icon. A prominent blue overlay titled "Step 2 of 9: Collecting some data" contains the following text:

To build your machine learning model we need to have some samples of how "IoT Barcelona" sounds like.

Click the button below, then give permission to access your microphone, and say "IoT Barcelona" a number of times. Make sure to add ~1 second pause between saying the sentences.

A large blue button in the center says "Record yourself saying 'IoT Barcelona' for 38 seconds". Below it, a smaller text says "Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step." At the bottom left of the overlay is a "Quit tutorial" link, and at the bottom right is a "Next, adding other data" button.

The left sidebar lists various project management and development tools:

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

Below the sidebar, under "GETTING STARTED", there is an "Upgrade Plan" section with a star icon, a brief description, and a "View plans" button.



The screenshot shows the Edge Impulse web studio interface. The left sidebar includes options like Dashboard, Devices, Data acquisition, Experiments, EON Tuner, Impulse design (with Create impulse and Retrain model), Live classification, Model testing, Deployment, Versioning, and an Upgrade Plan section. The main area is titled 'Dataset' and shows a step-by-step guide for collecting data. A prominent modal dialog box in the center asks for microphone permission: 'Permet que studio.edgeimpulse.com utilitzi el micròfon?' with three options: 'Permet', 'Mai per a aquest lloc web', and 'No permetis'. The background shows tabs for Data explorer, Data sources, Synthetic data, AI labeling (NEW), and CSV Wizard.



studio.edgeimpulse.com

iotbcn / iotbcn-project-1 PERSONAL

Target: Arduino Portenta...

EDGE IMPULSE

Dataset Data explorer Data sources Synthetic data AI labeling NEW CSV Wizard

Step 2 of 9: Collecting some data 🎙

To build your machine learning model we need to have some samples of how "IoT Barcelona" sounds like.

Click the button below, then give permission to access your microphone, and say "IoT Barcelona" a number of times. Make sure to add ~1 second pause between saying the sentences.

33s

Keep saying "IoT Barcelona"

Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step.

Quit tutorial

Next, adding other data

?

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

UPGRADE PLAN

Get access to higher job limits and more collaborators.

View plans



The screenshot shows the Edge Impulse Studio interface on a Mac OS X system. The main window displays a dataset collection screen with various tabs like Dataset, Data explorer, Data sources, Synthetic data, AI labeling, and CSV Wizard. A prominent feature is the 'Collect data' section which includes a timer showing '9s' and a pie chart for 'TRAIN / TEST SPLIT' at '89% / ...'. Below this, a modal dialog box is displayed with the following content:

**Just a few more!**

That was great, but we need ~6 more samples. Hit the button again and add some more data!

**OK**

The background of the studio shows a waveform visualization and several small waveform thumbnails labeled 'iot\_barcelona' with a sample length of 1s each. At the bottom right, there's a 'Metadata' section with a note 'No metadata.' and a question mark icon.



Mac OS X browser window showing the Edge Impulse Studio interface at [studio.edgeimpulse.com](https://studio.edgeimpulse.com).

The sidebar on the left includes:

- Dashboard
- Devices
- Data acquisition
- Experiments
- EON Tuner
- Impulse design
  - Create impulse
- Retrain model
- Live classification
- Model testing
- Perf. calibration
- Deployment
- Versioning

An **Upgrade Plan** section offers access to higher job limits and more collaborators, with a [View plans](#) button.

The main workspace shows a project titled "iotbcn / iotbcn-project-1" with a "PERSONAL" status. It displays metrics: DATA COLLECTED 19s and TRAIN / TEST SPLIT 84% / ... . A central callout box says "Step 2 of 9: Collecting some data" and "Great! We have recorded enough samples." with an "OK" button. Below this, three waveform preview cards show samples labeled "iot\_barcelona" with 1s sample length. A timeline at the bottom indicates -0:00:00. A "Metadata" section below the timeline shows "No metadata." with a question mark icon.



EDGE IMPULSE

iotbcn / iotbcn-project-1 PERSONAL

Target: Arduino Portenta...

Dataset Data explorer Data sources Synthetic data | AI labeling NEW CSV Wizard

DATA COLLECTED 19s TRAIN / TEST SPLIT 84% / ... Collect data

Step 2 of 9: Collecting some data 🎙

To build your machine learning model we need to have some samples of how "IoT Barcelona" sounds like.

Click the button below, then give permission to access your microphone, and say "IoT Barcelona" a number of times. Make sure to add ~1 second pause between saying the sentences.

You've collected enough data!

Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step.

Next, adding other data

Quit tutorial

LABEL: iot\_barcelona SAMPLE LENGTH: 1s LABEL: iot\_barcelona SAMPLE LENGTH: 1s LABEL: iot\_barcelona SAMPLE LENGTH: 1s

Metadata

No metadata.

This screenshot shows the Edge Impulse web interface for collecting audio data. The main header indicates the project is 'iotbcn / iotbcn-project-1' and the target is 'Arduino Portenta...'. The left sidebar contains navigation links for Dashboard, Devices, Data acquisition, Experiments, EON Tuner, Impulse design (with sub-options Create impulse, Retrain model, Live classification, Model testing, Perf. calibration, Deployment, and Versioning), and an Upgrade Plan section. The central workspace is titled 'Dataset' and shows 'DATA COLLECTED 19s' and 'TRAIN / TEST SPLIT 84% / ...'. A large callout box is overlaid on the interface, instructing the user to click a button, grant microphone access, and say 'IoT Barcelona' multiple times with a one-second pause between each sentence. Below this, a message says 'You've collected enough data!' and provides a link to 'Next, adding other data'. At the bottom, there are three waveform thumbnails labeled 'LABEL: iot\_barcelona SAMPLE LENGTH: 1s' each, and a 'Metadata' section stating 'No metadata.' with a '+' button. The overall theme is dark with purple and blue highlights.



studio.edgeimpulse.com

iotbcn / iotbcn-project-1 PERSONAL

Target: Arduino Portenta...

EDGE IMPULSE

Dataset Data explorer Data sources Synthetic data | AI labeling NEW CSV Wizard

Step 3 of 9: Adding other data 🎧

That was great! We now have some examples of "IoT Barcelona". Next, we also need some other keywords and background noise so the model can learn to distinguish between IoT Barcelona and other sounds. We've put together some of this for you already. Just click the button to add this data to your project.

Let's mix in other keywords and background noise

Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step.

Quit tutorial

Next, design an impulse

LABEL: iot\_barcelona SAMPLE LENGTH: 1s

LABEL: iot\_barcelona SAMPLE LENGTH: 1s

LABEL: iot\_barcelona SAMPLE LENGTH: 1s

Metadata

No metadata.

The screenshot shows the Edge Impulse Studio interface. On the left is a sidebar with various project management and development tools. The main workspace is titled 'iotbcn / iotbcn-project-1' and shows a 'Dataset' tab. A prominent overlay window is displayed, titled 'Step 3 of 9: Adding other data' with a microphone icon. The overlay contains text explaining the need for additional data like keywords and background noise, and a blue button labeled 'Let's mix in other keywords and background noise'. At the bottom of the overlay, there are 'Quit tutorial' and 'Next, design an impulse' buttons. Below the overlay, three audio samples are listed, each labeled 'LABEL: iot\_barcelona' and 'SAMPLE LENGTH: 1s'. A 'Metadata' section at the bottom right indicates 'No metadata.' A large waveform visualization is visible on the right side of the screen.



studio.edgeimpulse.com

iotbcn / iotbcn-project-1 PERSONAL

Target: Arduino Portenta...

EDGE IMPULSE

Dashboard

Devices

Data acquisition

Experiments

EON Tuner

Impulse design

- Create impulse
- Retrain model
- Live classification
- Model testing
- Perf. calibration
- Deployment

Versioning

Upgrade Plan

Get access to higher job limits and more collaborators.

[View plans](#)

Step 3 of 9: Adding other data 🎙

That was great! We now have some examples of "IoT Barcelona". Next, we also need some other keywords and background noise so the model can learn to distinguish between IoT Barcelona and other sounds. We've put together some of this for you already. Just click the button to add this data to your project.

[Let's mix in other keywords and background noise](#)

Creating job... OK (ID: 37680880)

✓ Job scheduled at 12 Sep 2025 09:34:17

✓ Job started at 12 Sep 2025 09:34:18

[ 1/400] Uploading...

[200/400] Uploading...

[400/400] Uploading...

[Cancel job](#)

Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step.

Quit tutorial [Next, design an impulse](#)

LABEL: unknown SAMPLE LENGTH: 1s

LABEL: unknown SAMPLE LENGTH: 1s

LABEL: unknown SAMPLE LENGTH: 1s

Metadata

No metadata.

on\_voice\_rw\_21...

4ms 672ms 840ms

-00:00



The screenshot shows the Edge Impulse Studio interface on a Mac OS X desktop. The window title is "studio.edgeimpulse.com". The main area displays "Impulse #1" for the project "iotbcn / iotbcn-project-1 PERSONAL". A tooltip overlay provides information about what an impulse is: "An impulse takes raw data, uses signal processing to extract features, and then uses a learning block to classify new data." The interface includes a sidebar with navigation links like Dashboard, Devices, Data acquisition, Experiments, EON Tuner, Impulse design (selected), Create impulse, MFE, Transfer learning (Keyword Spotting), Retrain model, Live classification, Model testing, and Perf. calibration. An "Upgrade Plan" section offers access to higher job limits and more collaborators with a "View plans" button. The main workspace contains four blocks: "Time series data" (red card, audio input, window size 1,000 ms, window increase 1,000 ms, frequency 16000 Hz, zero-pad data checked), "Audio (MFE)" (gray card, name MFE, input axes audio), "Transfer learning (Keyword Spotting)" (purple card, name Transfer learning (Keywo...), input axes audio, input features MFE), and "Output features" (green card, 3 output classes: iot\_barcelona, noise, unknown). A "Save Impulse" button is located at the bottom right of the workspace. A tooltip overlay titled "Step 4 of 9: Designing your impulse" explains the purpose of the impulse and provides instructions to look around or resume the tutorial.

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

Time series data

Input axes: audio

Window size: 1,000 ms.

Window increase (stride): 1,000 ms.

Frequency (Hz): 16000

Zero-pad data:

Audio (MFE)

Name: MFE

Input axes (1):  audio

Transfer learning (Keyword Spotting)

Name: Transfer learning (Keywo...)

Input axes (1):  audio

Input features:  MFE

Output features

3 (iot\_barcelona, noise, unknown)

Save Impulse

Step 4 of 9: Designing your impulse

To detect "IoT Barcelona" we'll need an 'impulse'. An impulse takes raw data, uses signal processing to extract features, and then uses a learning block to classify new data. Here we use an MFE signal processing block, and a neural network classifier. We've loaded this impulse already for you, but feel free to look around.

Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step.

Next, spectrograms



studio.edgeimpulse.com

iotbcn / iotbcn-project-1 PERSONAL Target: Arduino Portenta... i

### Parameters Generate features

**Raw data**

Show: All labels IoT Barcelona.10 (iot\_barcelona)

0ms 73ms 147ms 220ms 294ms 367ms 441ms 514ms 588ms 661ms 735ms 808ms 882ms 955ms

audio

Raw features Label DSP result

Step 5 of 9: Spectrograms

Signal processing is typically the first step in an impulse. We use it to de-noise data, highlight interesting frequencies, and reduce the amount of data. For audio we typically convert this into a spectrogram, as you can see here on the right. There's a wide variety of options that you can configure here, but we will leave this as-is for now.

Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step.

Parameters

Mel-filterbank energy feature

Frame length ?

Frame stride ?

Filter number ?

FFT length ? 256

Next, generate features

Raw data

The screenshot shows the Edge Impulse Studio interface. On the left is a sidebar with navigation links: Dashboard, Devices, Data acquisition, Experiments, EON Tuner, Impulse design (with sub-options Create impulse, MFE, Transfer learning (K...), Retrain model, Live classification, Model testing, Perf. calibration), and an Upgrade Plan section. The main workspace is titled 'Parameters Generate features'. It displays a waveform plot labeled 'Raw data' with time markers from 0ms to 955ms. Below the plot are tabs for 'Raw features', 'Label', and 'DSP result'. A modal window titled 'Step 5 of 9: Spectrograms' is open, explaining signal processing and spectrogram generation. It includes configuration fields for 'Frame length', 'Frame stride', 'Filter number', and 'FFT length' set to 256. At the bottom of the modal are 'Next, generate features' and 'Quit tutorial' buttons.



The screenshot shows the Edge Impulse studio interface on a Mac OS X system. The URL in the browser is [studio.edgeimpulse.com](https://studio.edgeimpulse.com). The project is titled "iotbcn / iotbcn-project-1" and the target is set to "Arduino Portenta...".

The left sidebar contains the following navigation items:

- Dashboard
- Devices
- Data acquisition
- Experiments
- EON Tuner
- Impulse design
  - Create impulse
  - MFE
  - Transfer learning (K...)
- Retrain model
- Live classification
- Model testing
- Perf. calibration

An "Upgrade Plan" section is visible at the bottom of the sidebar.

The main workspace has two tabs: "Parameters" and "Generate features". The "Generate features" tab is active, showing the "Training set" and "Feature explorer" sections. The "Training set" section displays the following data:

| Parameter            | Value                             |
|----------------------|-----------------------------------|
| Data in training set | 5m 34s                            |
| Classes              | 3 (iot_barcelona, noise, unknown) |
| Training windows     | 334                               |

A large blue button labeled "Generating features..." is centered below the training set data.

The "Feature explorer" section currently displays the message: "No features generated yet."

A modal window titled "Step 6 of 9: Generating features" provides instructions and status information:

With the signal processing parameters configured we will now generate features for every sample in our dataset. Afterwards you'll see the data explorer. This shows your complete dataset in one graph. If everything is right you should see a very clear cluster of data with "IoT Barcelona" in it, separate from the "noise" and "unknown" data.

Creating job... OK (ID: 37686)

Generating features...

Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step.

Quit tutorial

Next, train a neural network



Mac OS X browser window showing the Edge Impulse studio interface at [studio.edgeimpulse.com](https://studio.edgeimpulse.com).

The URL bar shows: `iotbcn / iotbcn-project-1 PERSONAL`

The Target dropdown shows: `Target: Arduino Portenta...`

**Left Sidebar:**

- Dashboard
- Devices
- Data acquisition
- Experiments
- EON Tuner
- Impulse design**
  - Create impulse
  - MFE
  - Transfer learning (K...)
  - Retrain model
  - Live classification
  - Model testing
  - Perf. calibration
- Upgrade Plan

**Main Content Area:**

**Parameters** tab selected.

**Training set** details:

- Data in training set: 5m 34s
- Classes: 3 (iot\_barcelona, noise, unknown)
- Training windows: 334

**Generate features** button.

**Feature explorer** plot showing data points clustered by class: iot\_barcelona (blue), noise (orange), and unknown (green).

**Feature generation output** log (0 items):

- [225/334] Creating features...
- [201/334] Creating features...
- [212/334] Creating features...
- [241/334] Creating features...
- [256/334] Creating features...
- [269/334] Creating features...
- [284/334] Creating features...
- [297/334] Creating features...
- [312/334] Creating features...
- [325/334] Creating features...
- [334/334] Creating features...
- Created features

**Step 6 of 9: Generating features** overlay message:

With the signal processing parameters configured we will now generate features for every sample in our dataset. Afterwards you'll see the data explorer. This shows your complete dataset in one graph. If everything is right you should see a very clear cluster of data with "IoT Barcelona" in it, separate from the "noise" and "unknown" data.

Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step.

**Next, train a neural network** button.



The screenshot shows the Edge Impulse web studio interface. On the left is a sidebar with various project management and model creation tools. The main area displays 'Neural Network settings' and 'Training output'. A central modal window provides a step-by-step tutorial for training a neural network.

**Neural Network settings**

**Training settings**

- Number of training cycles: 30
- Use learned optimizer:
- Learning rate: 0.01
- Training processor: CPU

**Advanced training settings**

**Neural network architecture**

**Step 7 of 9: Training a neural network**

And now... the moment you've been waiting for: training the machine learning model. During training the model learns to distinguish between the three different classes. After training you'll see the confusion matrix and the data explorer, which show you the accuracy of your model.

Training neural network...

Want to look around? No problem. Just close this overlay, and click 'Resume tutorial' when you're ready for the next step.

Next, take the model for a spin

Quit tutorial



studio.edgeimpulse.com

## Step Step 8 of 9: Taking the model for a spin

You have trained your model, now let's take it for a spin... Wait for the model to build, then click 'Give access to the microphone', and see how the model performs!

### iotbcn / iotbcn-project-1

Building project...

Switch to data collection mode

This client is [open source](#).

Quit tutorial

Next, check out next steps

Metrics validation set

Target: Arduino Portenta...

(0)

's': 84}, 'accuracy': 0.9101796  
on': 0.8661506707946337, 'rec  
ore': 0.7517432980989508, 'su  
recision': 0.9069529671307541,  
'f1-score': 0.8976463294623725,  
735844706143325, 'loss': 0.28  
weighted\_average': {'precisi  
0.9101796407185628, 'f1-sc  
names': ['iot\_barcelona', 'noi  
odel training complete

version: ? Quantized (int8) ▾

on set)

LOSS 0.28

| NOISE | UNKNOWN |
|-------|---------|
| 0%    | 75%     |
| 94.4% | 5.6%    |
| 1.2%  | 97.6%   |
| 0.96  | 0.92    |

Metrics validation set



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## Step Step 8 of 9: Taking the model for a spin

You have trained your model, now let's take it for a spin... Wait for the model to build, then click 'Give access to the microphone', and see how the model performs!

### iotbcn / iotbcn-project-1

Permission required

Give access to the microphone

Next, check out next steps

Metrics validation set

Target: Arduino Portenta...

(0)

': 84}, 'accuracy': 0.9101796  
on': 0.8661506707946337, 'rec  
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Quit tutorial

View plans



The screenshot shows the Edge Impulse web interface with a "Congratulations" message. The main message says: "You have trained your first embedded Machine Learning model! While you can run this model in the browser, it's also small and fast enough to run in real-time on embedded devices." Below this are three performance metrics: Inferencing Time (49 ms), Peak RAM Usage (168.5K), and Flash Usage (535.6K). A section titled "What's next?" encourages users to "Make model improvements & experiment!" with a button to "Check out experiments". To the right, there's a table of "Impulses" (3 / 3) and a "Metrics (validation set)" table.

Dashboard

Devices

Data acquisition

Experiments

EON Tuner

Impulse design

- Create impulse
- MFE
- Transfer learning (K...)
- Retrain model
- Live classification
- Model testing
- Perf. calibration

**Upgrade Plan**

Get access to higher job limits and more collaborators.

**View plans**

studio.edgeimpulse.com

iotbcn / iotbcn-project-1 PERSONAL

Target: Arduino Portenta...

# Congratulations!

You have trained your first embedded Machine Learning model! While you can run this model in the browser, it's also small and fast enough to run in real-time on embedded devices.

INFERENCING TIME  
49 ms.

PEAK RAM USAGE  
168.5K

FLASH USAGE  
535.6K

What's next?

Make model improvements & experiment!

Want to experiment with both FOMO and MobileNet SSD simultaneously on the same dataset? No problem! Learn how you can compare multiple impulses in one project with Experiments!

[Check out experiments](#)

| NAME              | INPUT    | DSP BLOCKS | LEARN BLOCKS | F32_V_ACC |
|-------------------|----------|------------|--------------|-----------|
| Impulse #1 (MFCC) | 1,000ms. | MFCC       | Classifier   | -         |
| Impulse #2 (MFE)  | 1,000ms. | MFE        | Classifier   | 91.0%     |
| Impulse #3        | 1,000ms. | MFCC       | Classifier   | 78.0%     |

[Create a public version to share!](#)

Cheers from the Edge Impulse team!

Output layer (3 classes)

F1 SCORE 0.38

| NOISE | UNKNOWN |
|-------|---------|
| 0%    | 75%     |
| 94.4% | 5.6%    |
| 1.2%  | 97.6%   |

Metrics (validation set)

LOSS 0.28



# What is a good dataset?

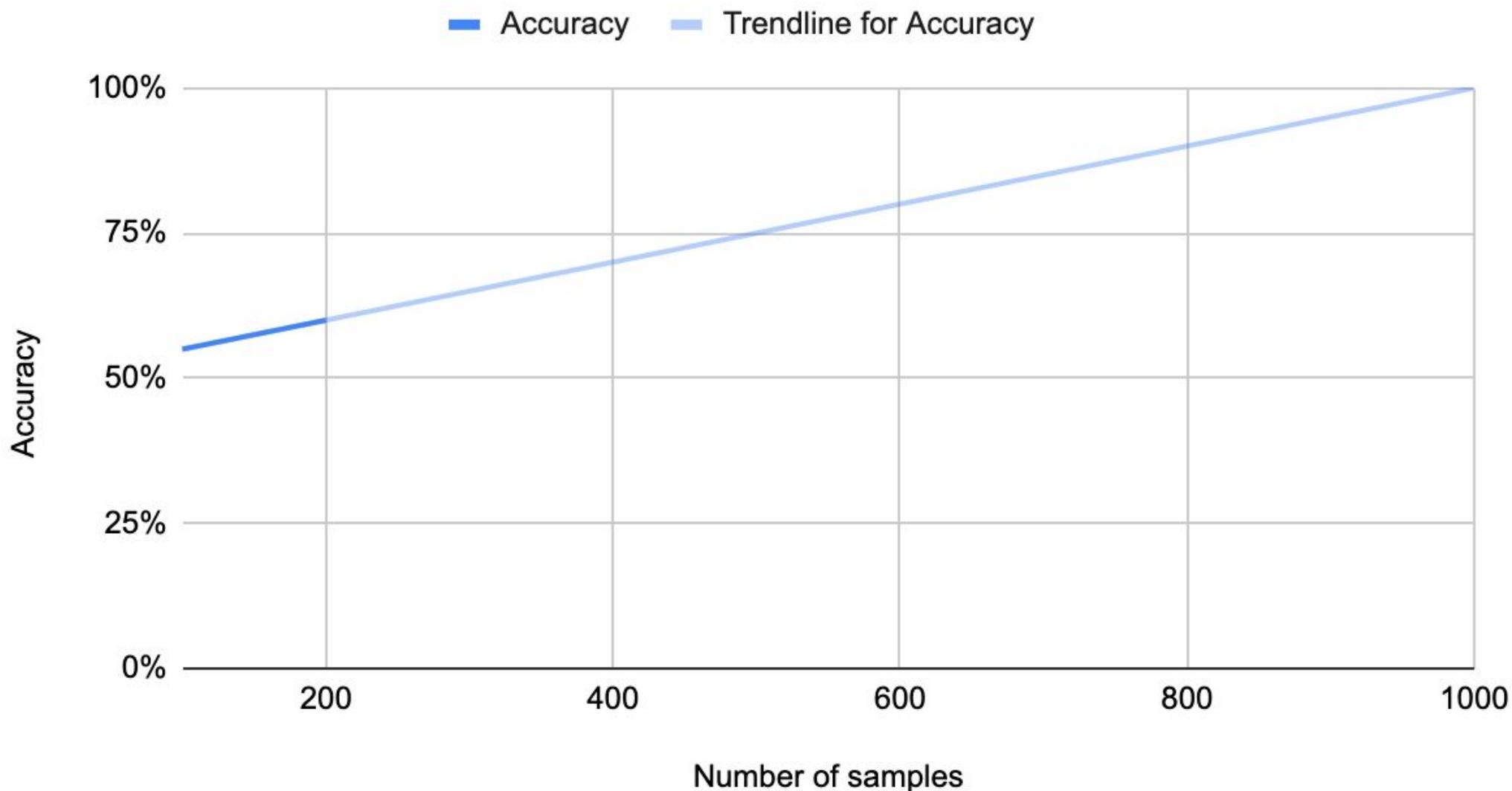
# What is a good dataset?

A good dataset is **representative of the real-world scenarios** your model will encounter. This includes variations in:

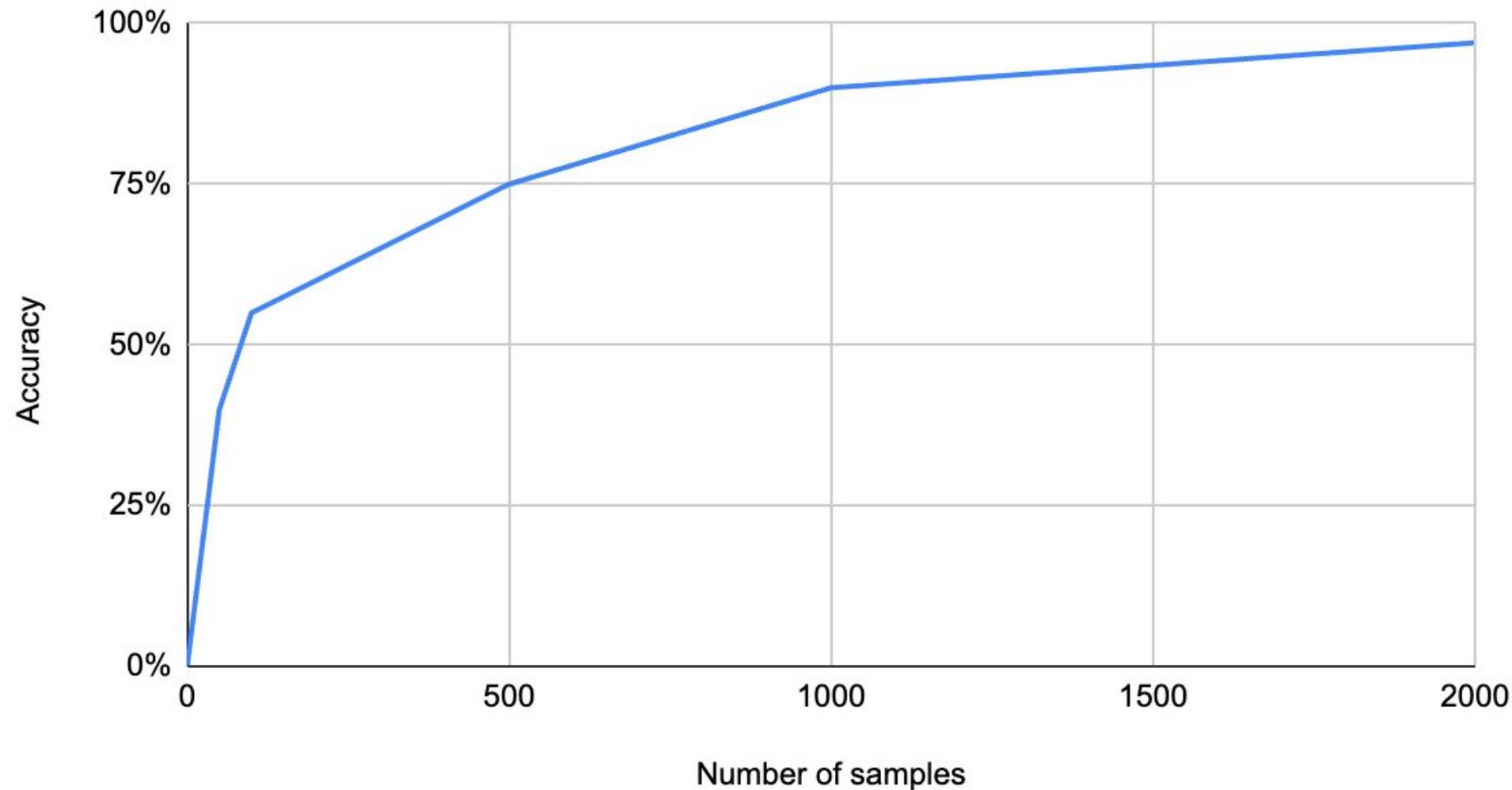
- Environmental conditions: Lighting, noise, weather, etc.
- Demographic factors: Different ages, genders, accents, etc.
- Edge cases: Unusual or rare situations that might occur.

# How much data is needed for a good dataset?

## Accuracy vs. Number of samples



## Accuracy vs. Number of samples



# **Image processing approaches**

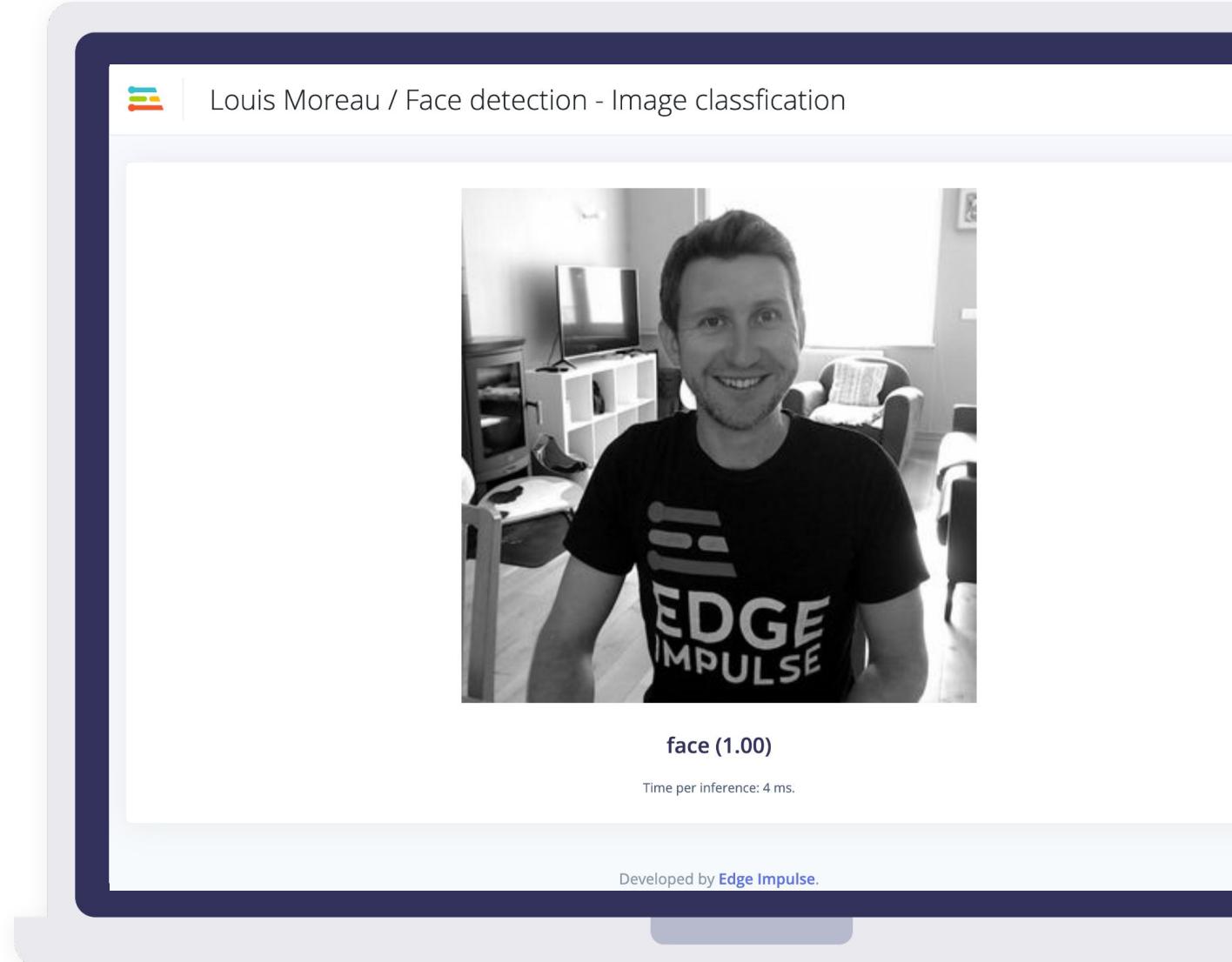
**Image classification  
Object detection**



# Image classification

*The question the model is trying to answer is:*

**“Is there a face or not in the image?”**



Louis Moreau / Face detection - Image classification

face (1.00)

Time per inference: 4 ms.

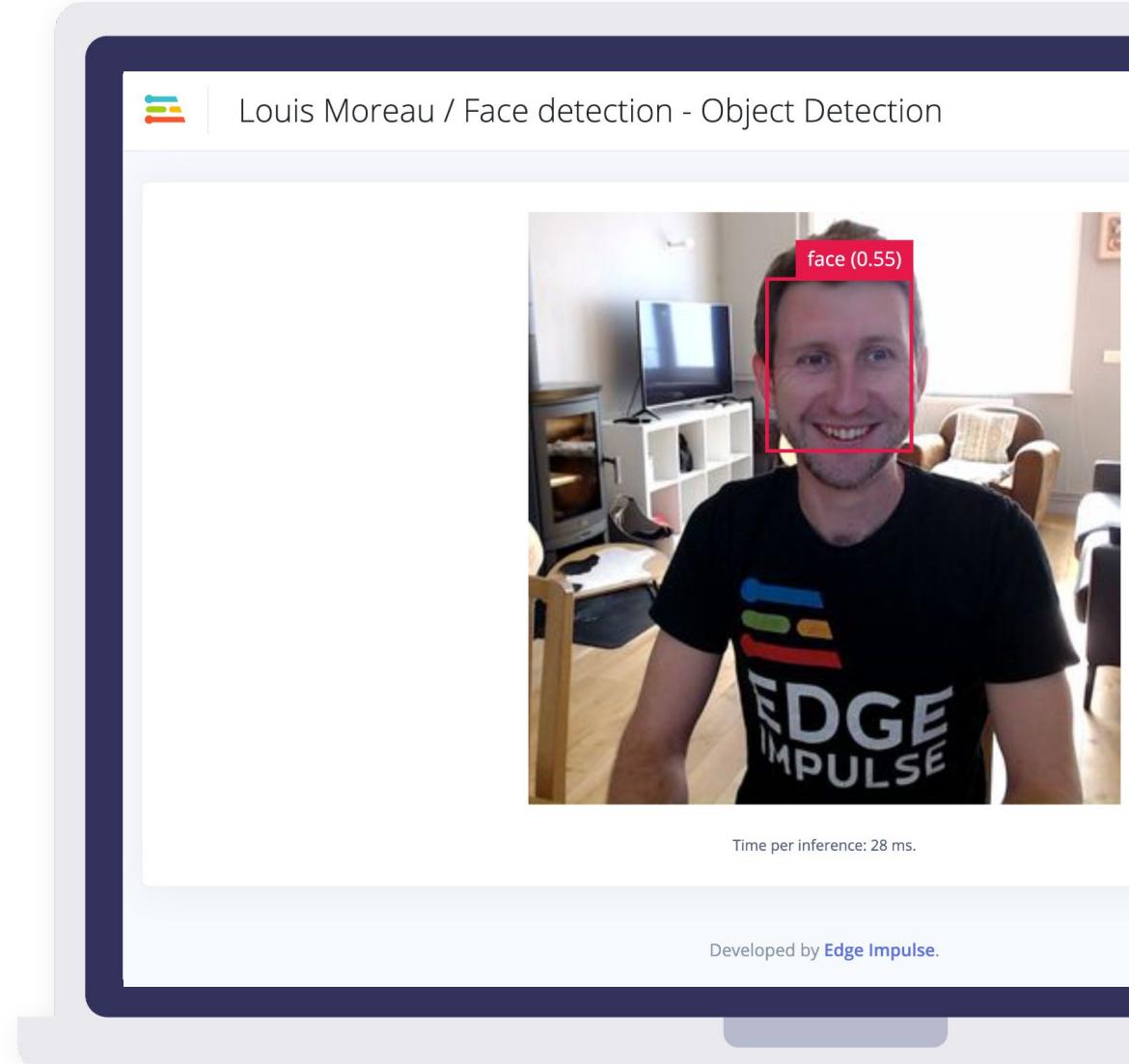
Developed by [Edge Impulse](#).

A screenshot of the Edge Impulse web interface for "Face detection - Image classification". The interface shows a grayscale photograph of a smiling man with short brown hair. A bounding box highlights his face, and the text "face (1.00)" is displayed below it, indicating a high confidence level for face detection. At the bottom of the interface, the text "Time per inference: 4 ms." is shown, along with the credit "Developed by [Edge Impulse](#)".

# Object Detection using Bounding Boxes

*The question the model is trying to answer  
is:*

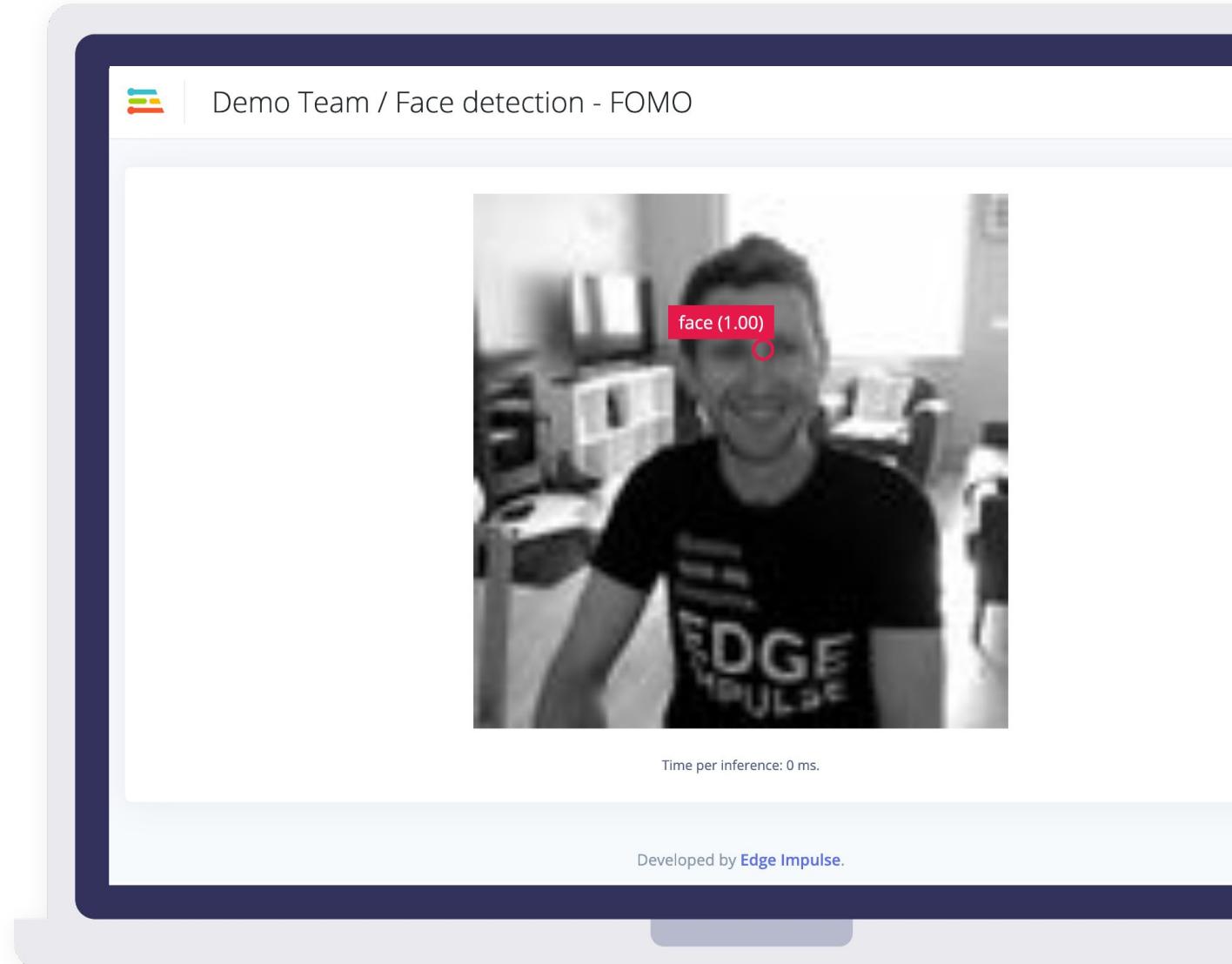
**“Are there faces in the image, where and  
what size are they?”**



# Object Detection using Centroids

*The question the model is trying to answer  
is:*

**“Are there faces in the image, where are  
they?”**



# Let's do some computer vision!

**REST BUTTON**

**BOOT BUTTON**

**CHARGE LED**

**USER LED**

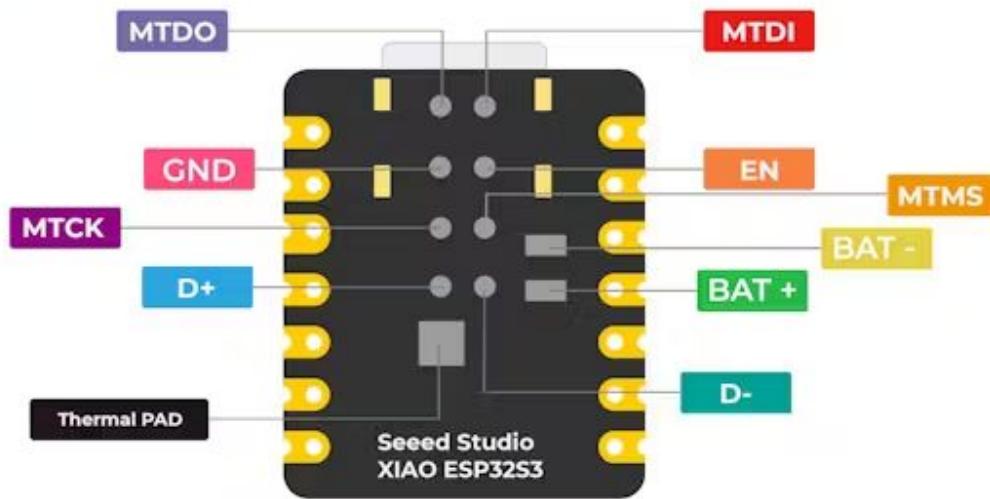
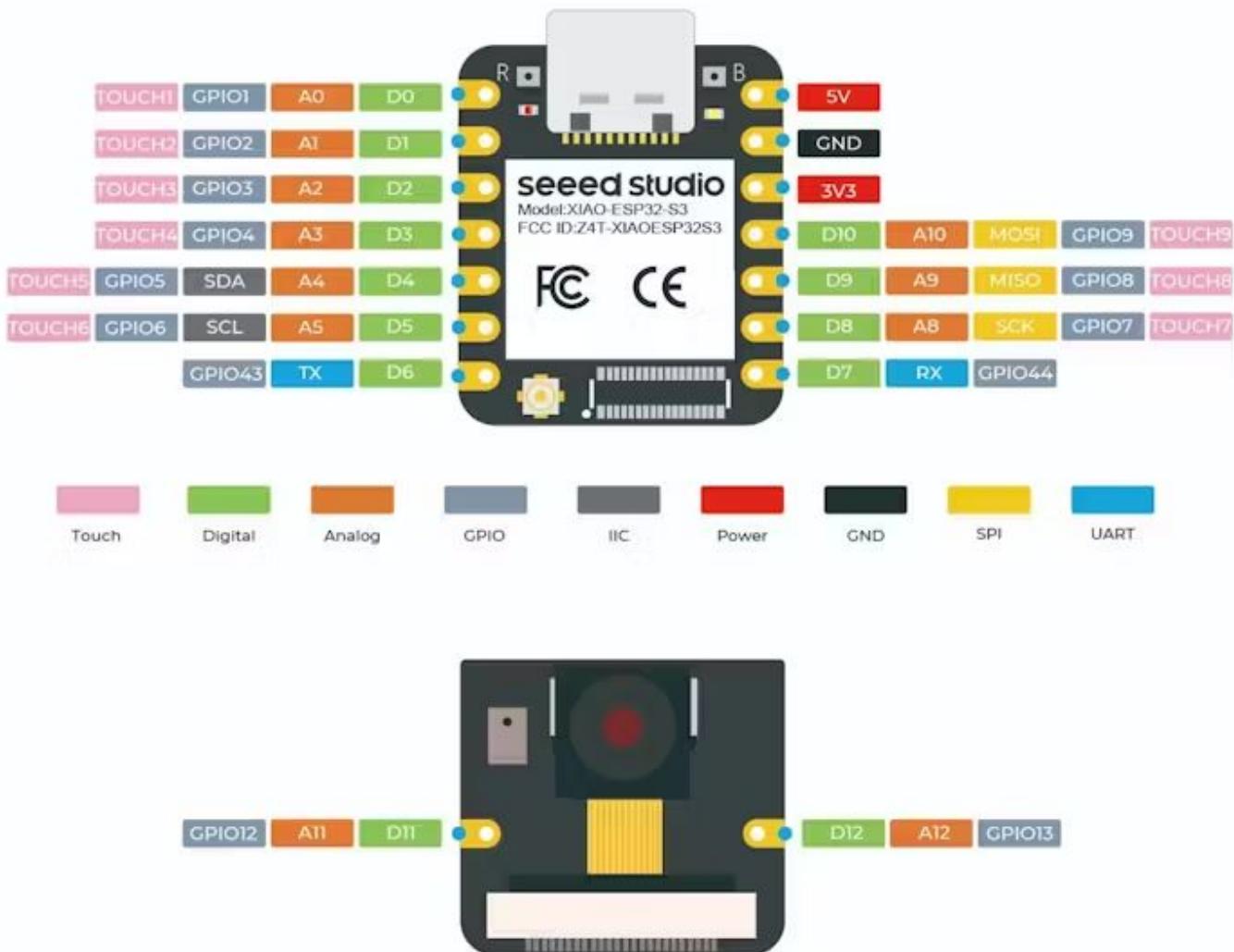
Thanks to  
**seeed studio**

**WiFi/BT ANTENNA  
CONNECTOR**

**B2B CONNECTOR  
(ONLY FOR SENSE)**



## FRONT



## INITIALIZATION



MAIN LOOP

Image provider



TensorFlow Lite Micro

Detection responder



Serial Monitor

Read Image

Crop & Convert  
(96x96) - Grayscale

Model



labels

# **Workshop with the XIAO ESP32S3 and Edge Impulse**

Step by Step instructions

<https://github.com/mpous/xiao-esp32s3-camera-edgeimpulse>

Register to Edge Impulse Studio

# Thank you!

Any questions?

*[discord.gg/edgeimpulse](https://discord.gg/edgeimpulse)*

[marc@edgeimpulse.com](mailto:marc@edgeimpulse.com)

[forum.edgeimpulse.com](https://forum.edgeimpulse.com)  
[docs.edgeimpulse.com](https://docs.edgeimpulse.com)