



Workshop on
TinyML for
Sustainable Development

FURTHER INFORMATION:

E-mail: smr3961@ictp.it
Web: <https://indico.ictp.it/event/10499/>

Female scientists are encouraged to apply.

22 - 26 July 2024

São Paulo, Brazil

Deadline:
6 May 2024

Computer Vision (CV) at the Edge

Prof. Marcelo J. Rovai

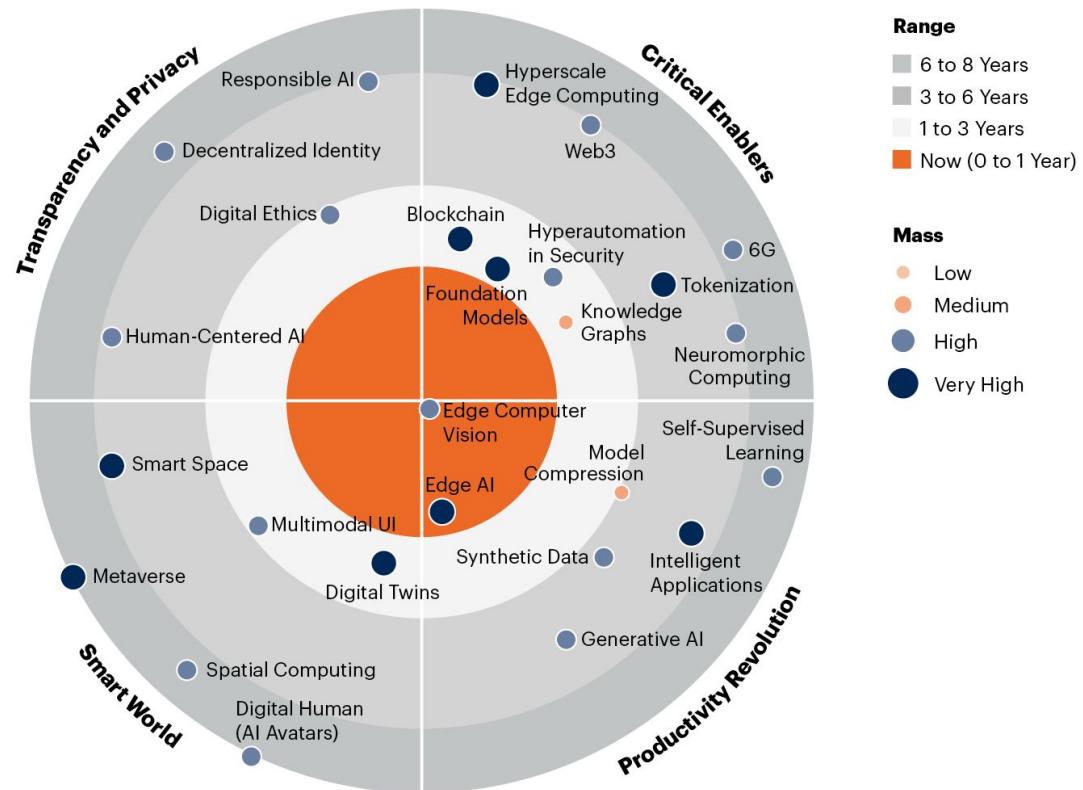
rovai@unifei.edu.br

UNIFEI - Federal University of Itajuba, Brazil
TinyML4D Academic Network Co-Chair



TINYML4D

2023 Gartner Emerging Technologies and Trends Impact Radar



gartner.com

Note: Range measures number of years it will take the technology/trend to cross over from early adopter to early majority adoption. Mass indicates how substantial the impact of the technology or trend will be on existing products and markets.

Source: Gartner
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Gartner®

Edge Computer Vision has a high impact potential, and it is for **now!**

"Visual recognition has undergone the largest changes and fastest development in the last decade, due in part to the availability of much larger labeled datasets as well as breakthroughs in deep learning."

Computer Vision: Algorithms and Applications, 2nd ed.

Computer Vision Recognition Tasks

Image Classification (Multi-Class Classification)

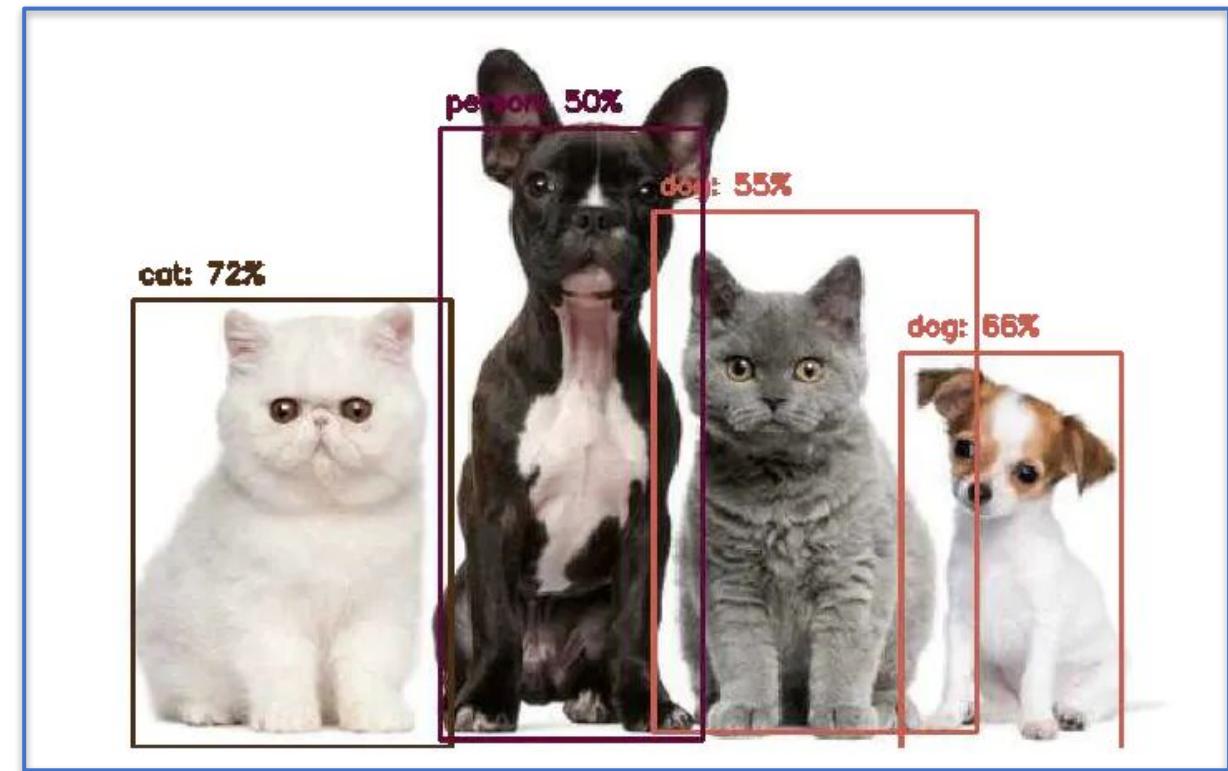


Cat: 70%



Dog: 80%

Object Detection Multi-Label Classification + Object Localization



Computer Vision Recognition Tasks

Instance Segmentation

Each pixel in an image IS CLASSIFIED into a predefined category.



Pose Estimation

Key points (or landmarks) on the object, such as joints on a human body are detect



Computer Vision Recognition Tasks

Image Classification (Multi-Class Classification)

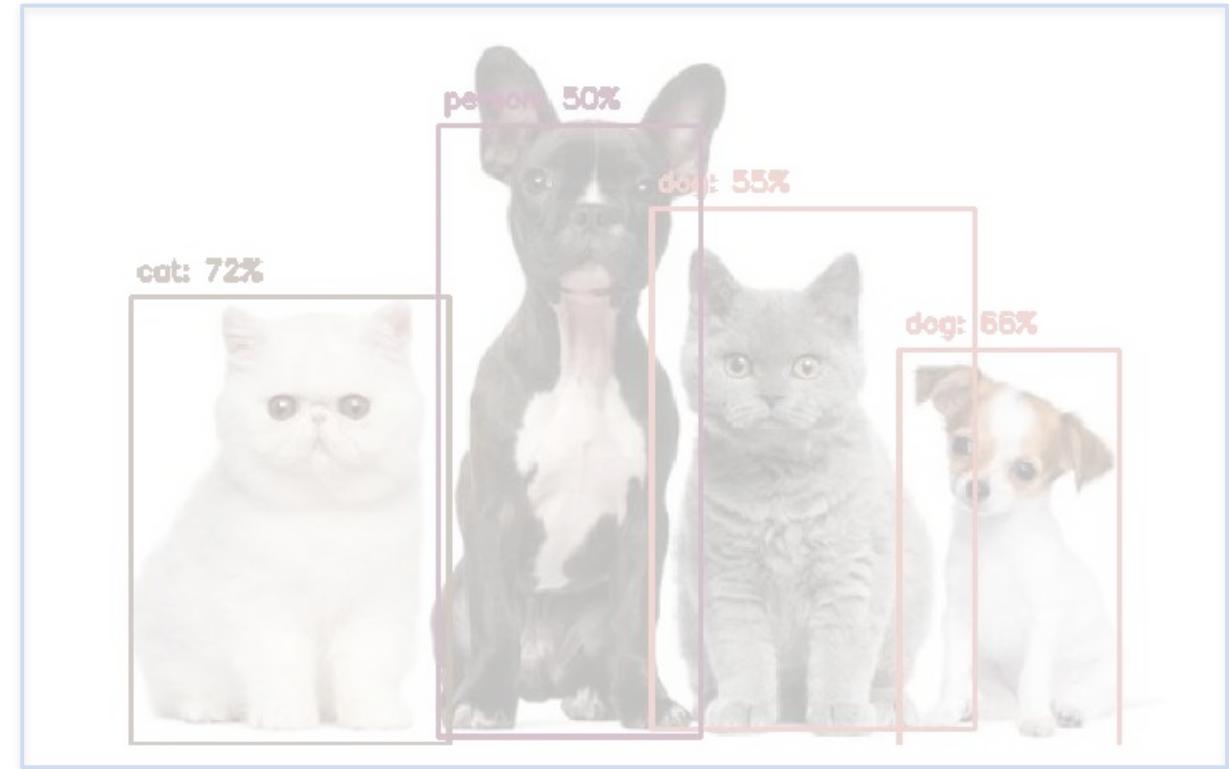


Cat: 70%



Dog: 80%

Object Detection Multi-Label Classification + Object Localization

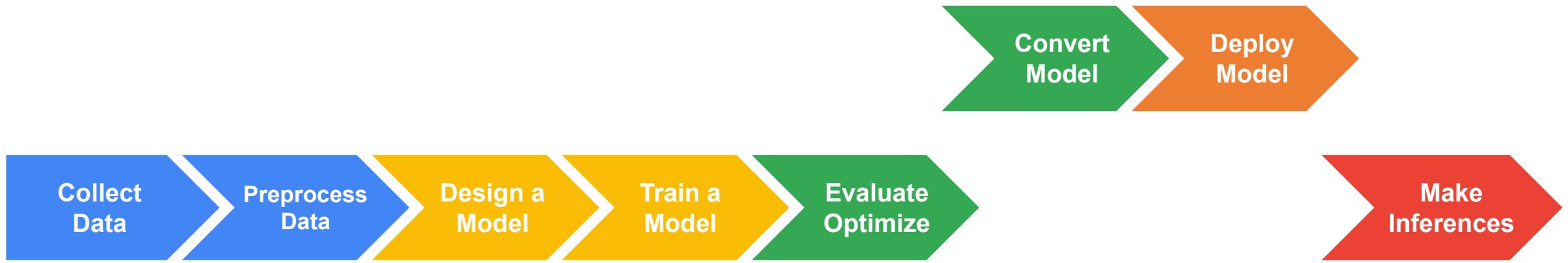


Embedded Machine Learning (TinyML) Workflow Review

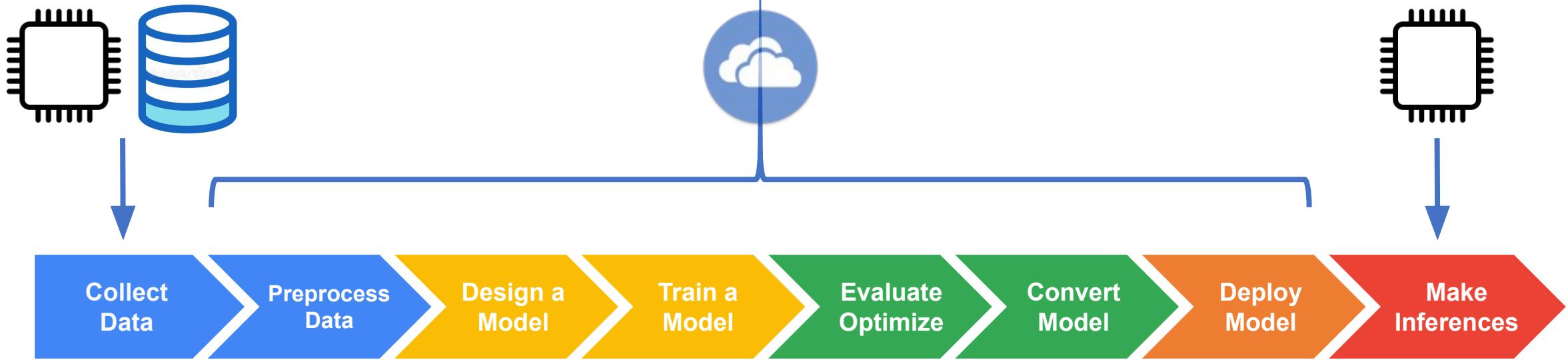
Machine Learning Workflow



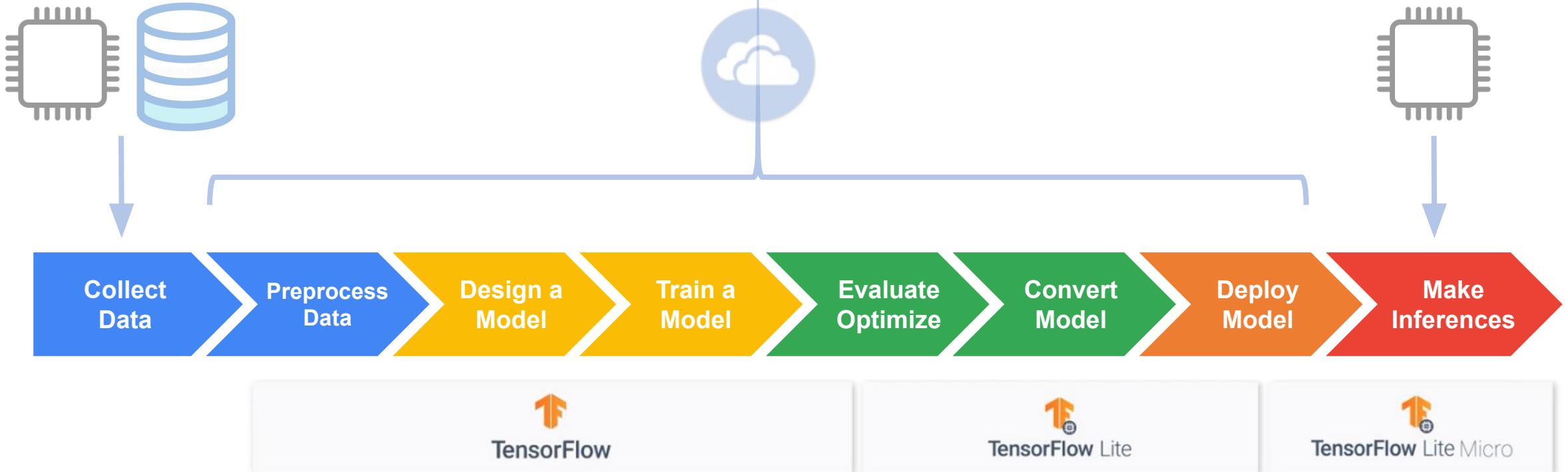
Tiny Machine Learning Workflow (“What”)



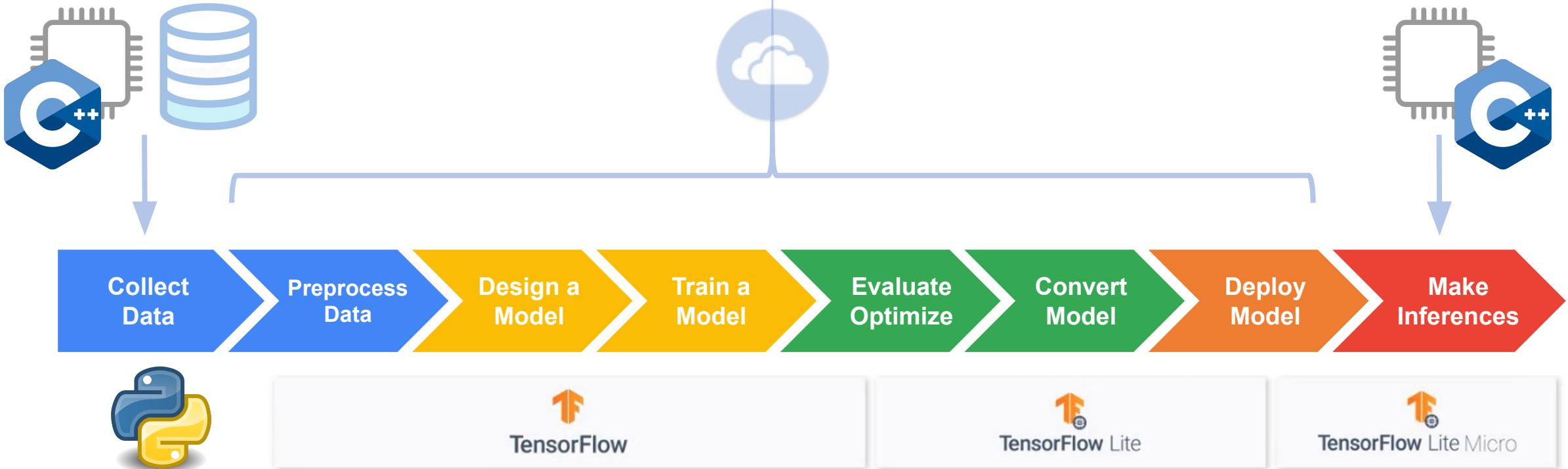
Tiny Machine Learning Workflow (“Where”)



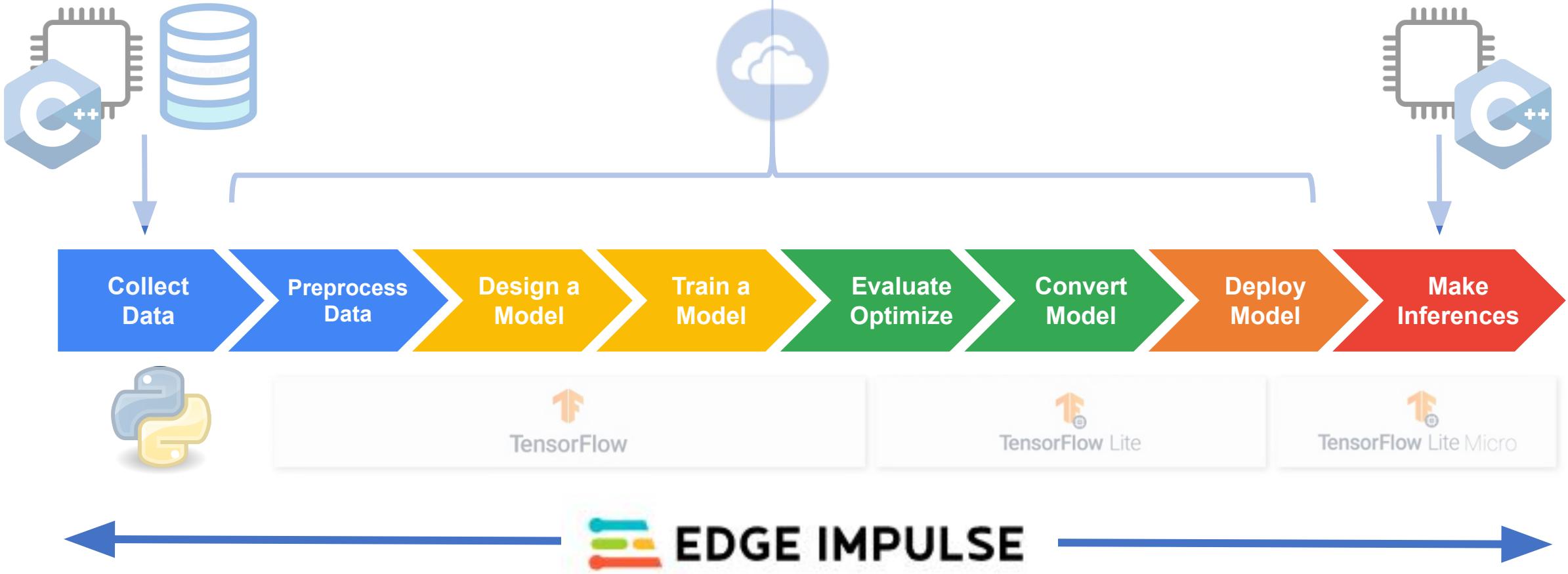
Machine Learning Workflow (“How”)

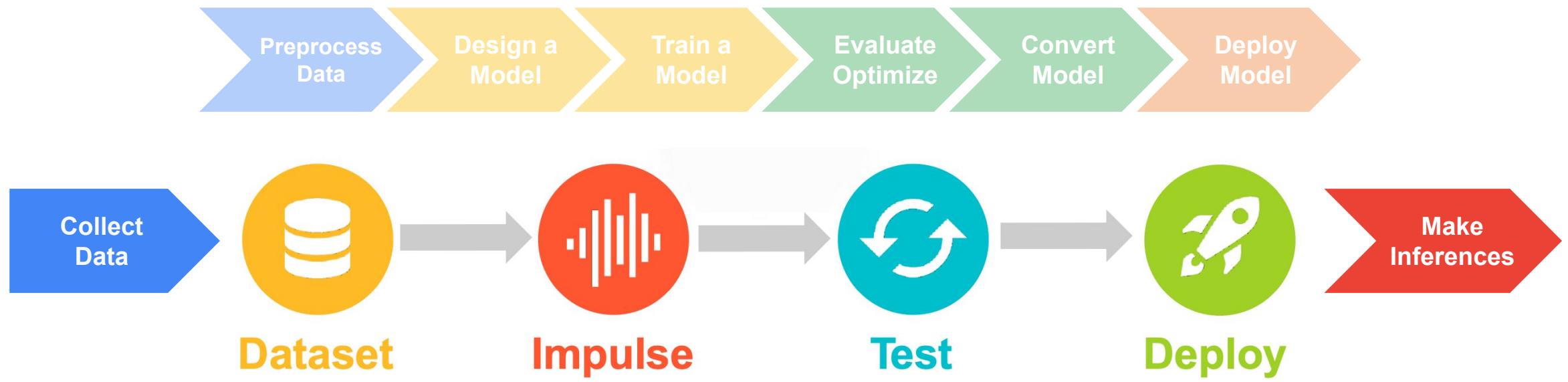


Machine Learning Workflow (“How”)

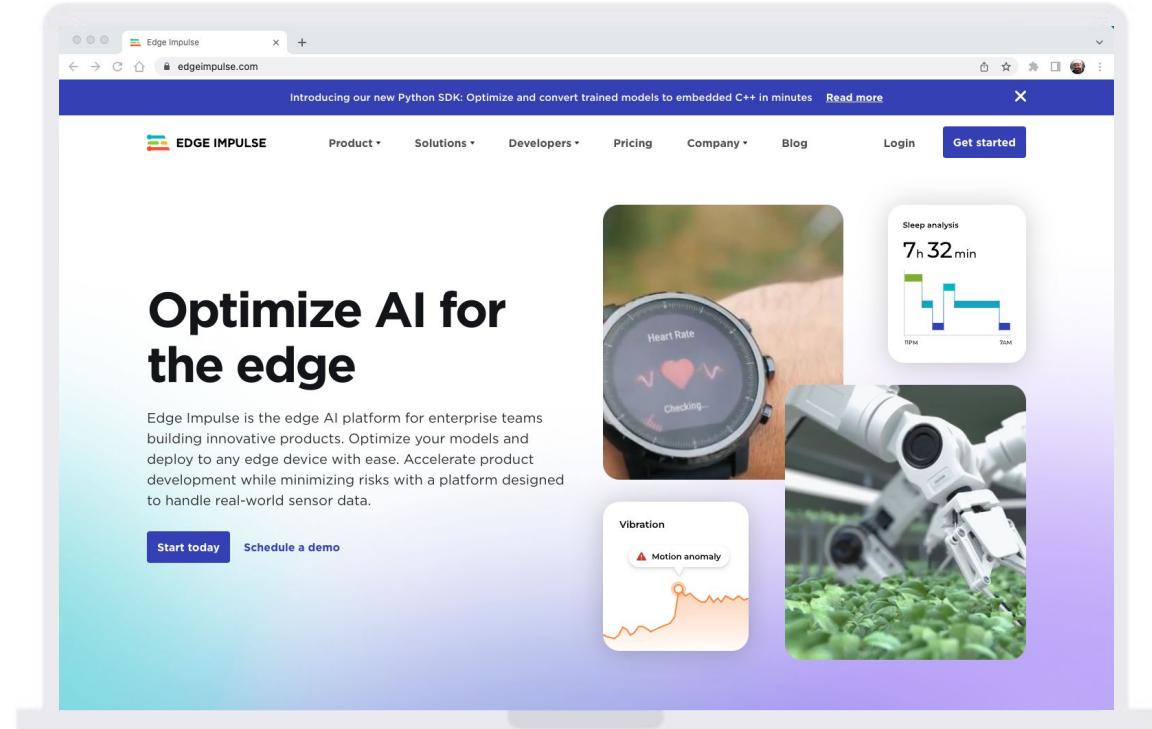
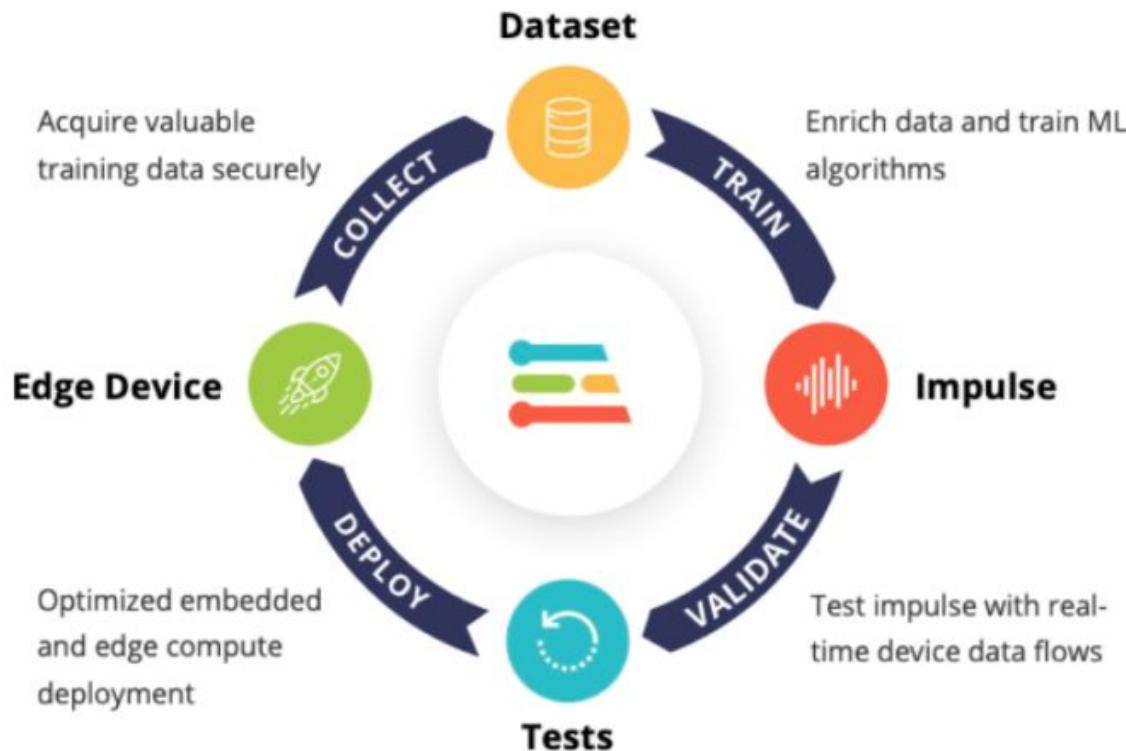


Machine Learning Workflow (“How”)





EI Studio - Embedded ML platform (“AutoML”)



Learn more at <http://edgeimpulse.com>



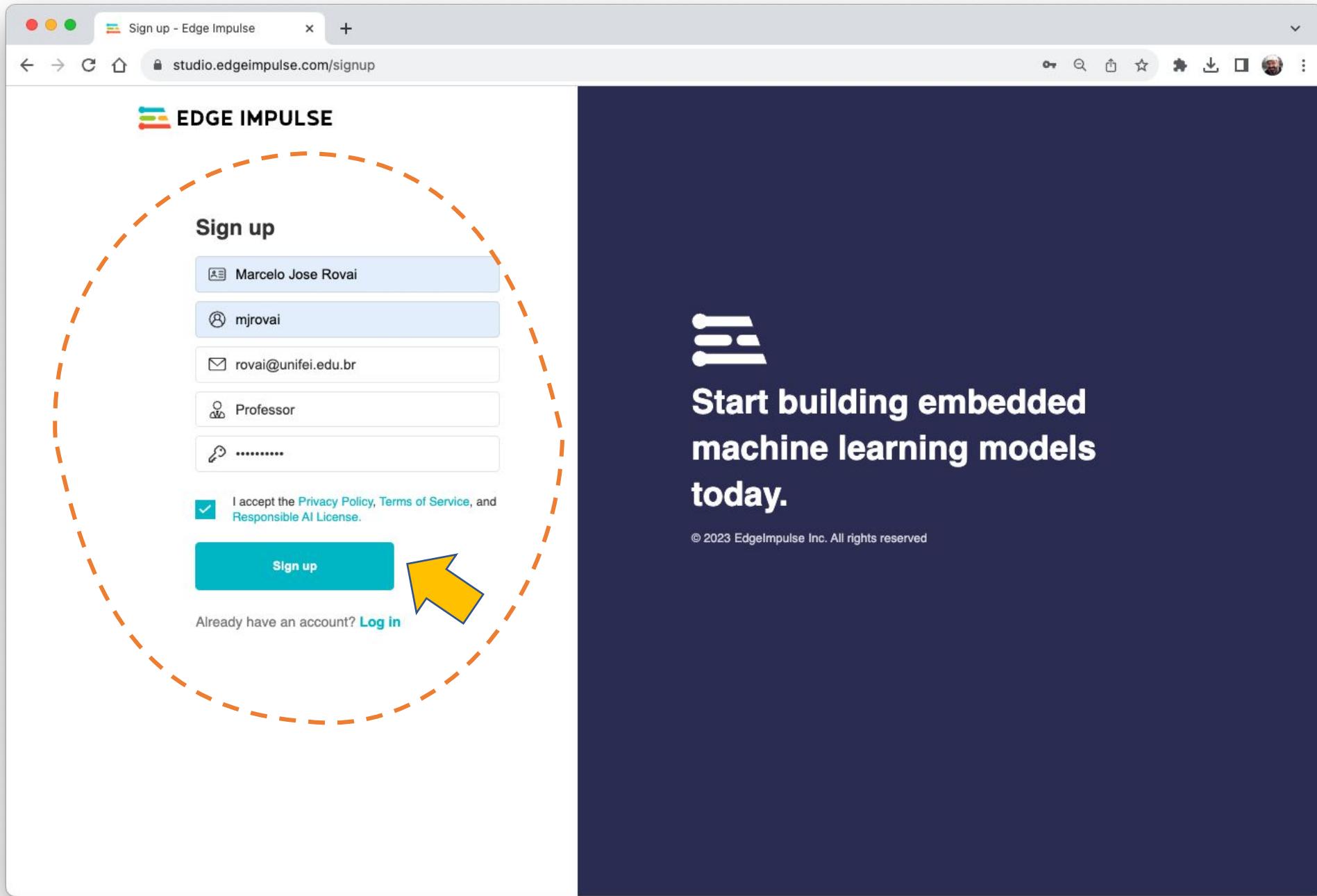
Image Classification Project

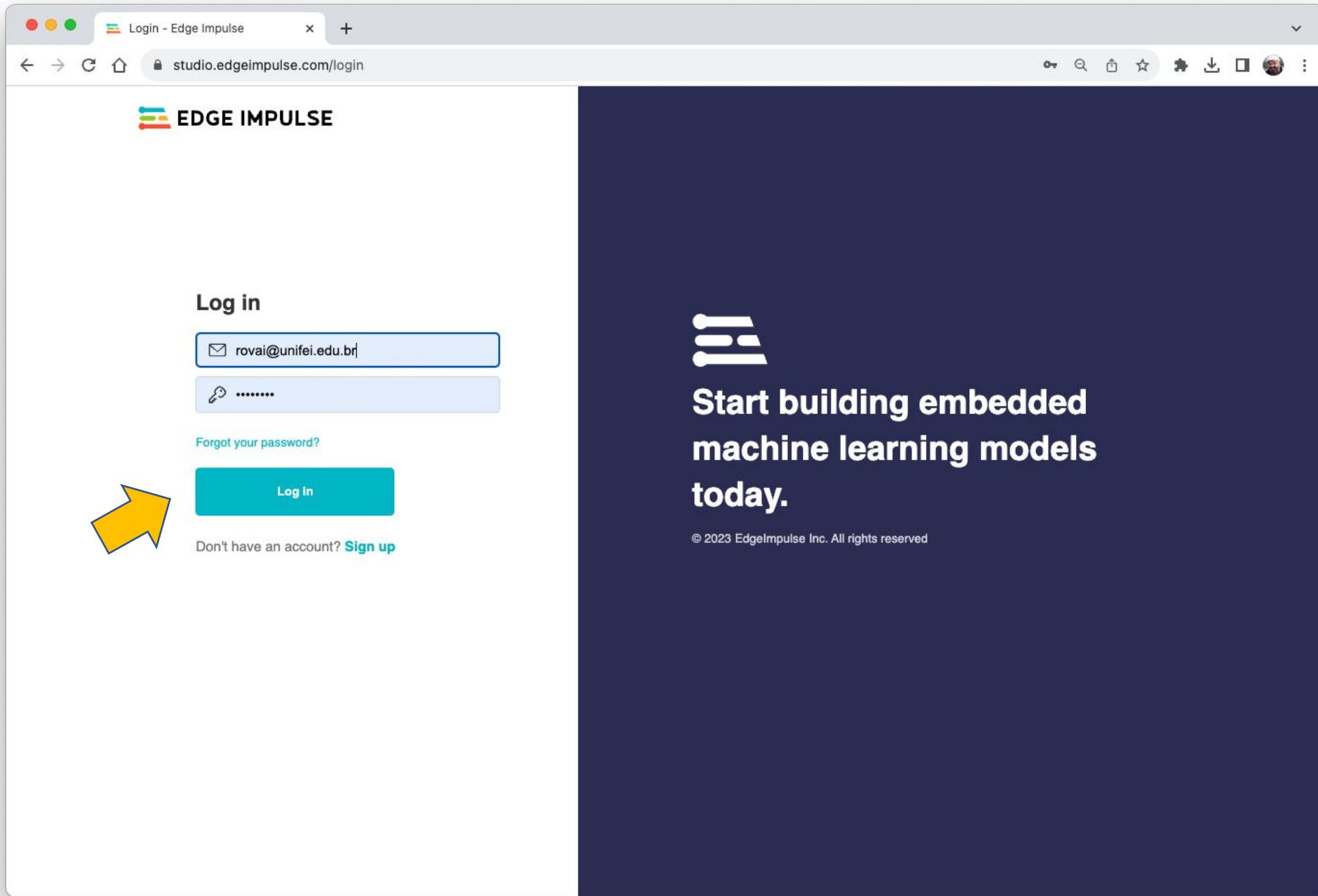
Edge Impulse Studio

<https://studio.edgeimpulse.com/public/353482/live>



The screenshot shows the homepage of the Edge Impulse website. At the top left, there's a browser address bar with a lock icon and the URL 'edgeimpulse.com'. A yellow arrow labeled '1' points to this area. To the right of the address bar is a navigation bar with links for 'Product', 'Solutions', 'Developers', 'Pricing', 'Company', and 'Blog'. On the far right of the navigation bar are 'Login' and a large blue 'Get started' button, which is also circled in orange and has a yellow arrow labeled '2' pointing to it. Below the navigation bar, a banner announces a 'Webinar November 9th: 'Fast Track AI to the Edge with NVIDIA and Edge Impulse'' with a 'Register here' link. The main headline on the page reads 'Build. Train. Optimize. AI for the edge.' in large, bold, black font. Below this, a subtext explains: 'Build datasets, train models, and optimize libraries to run on any edge device, from extremely low-power MCUs to efficient Linux CPU targets and GPUs.' There are two calls-to-action at the bottom left: a blue 'Get Started' button and a 'Schedule a demo' link. To the right of the main text are four images illustrating Edge Impulse's applications: a smartwatch displaying heart rate data, a graph titled 'Sleep analysis' showing 7 hours and 32 minutes of sleep with a bar chart below it, a robotic arm interacting with green plants, and a vibration monitoring interface showing a waveform with a red 'Motion anomaly' callout.



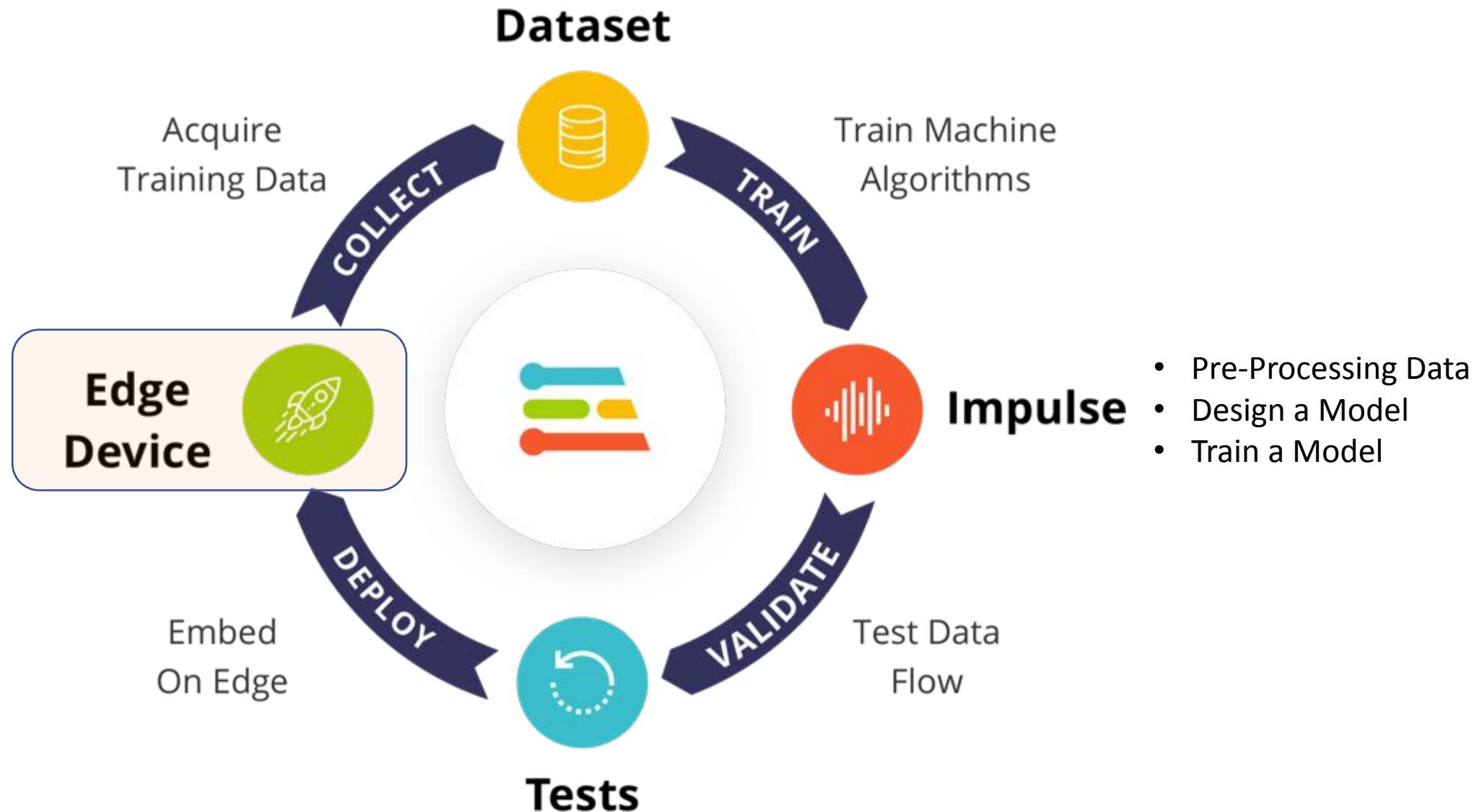


The screenshot shows the Edge Impulse studio interface. On the left, there's a sidebar with a user profile picture of a man with a beard, the name "MJRoBot (Marcelo Rovai)", and an "Organizations" section containing a purple "EIE" button. The main area has a blue header bar with the "EDGE IMPULSE" logo and a search bar. Below the header, the "Projects" tab is selected, showing a list of projects on the right and a "Create a new project" dialog box in the center. The dialog box has a title "Create a new project", a text input field containing "Cifar10_Image_Classification" which is highlighted with an orange border, and two project type options: "Developer" (selected) and "Enterprise". Below these options is a dropdown menu "Create under organization: Edge Impulse Experts". At the bottom of the dialog is a green "Create new project" button. A yellow arrow points from the bottom right towards this button. The background shows a list of other projects: "MJRoBot (Marcelo Rovai) / video_tinyml_raw", "MJRoBot (Marcelo Rovai) / Pico_Motion_Detection" (PUBLIC), and "MJRoBot (Marcelo Rovai) / LoRa_rain_level_measurer".

Decide a Goal

- Classes:
 - background
 - periquito
 - robot

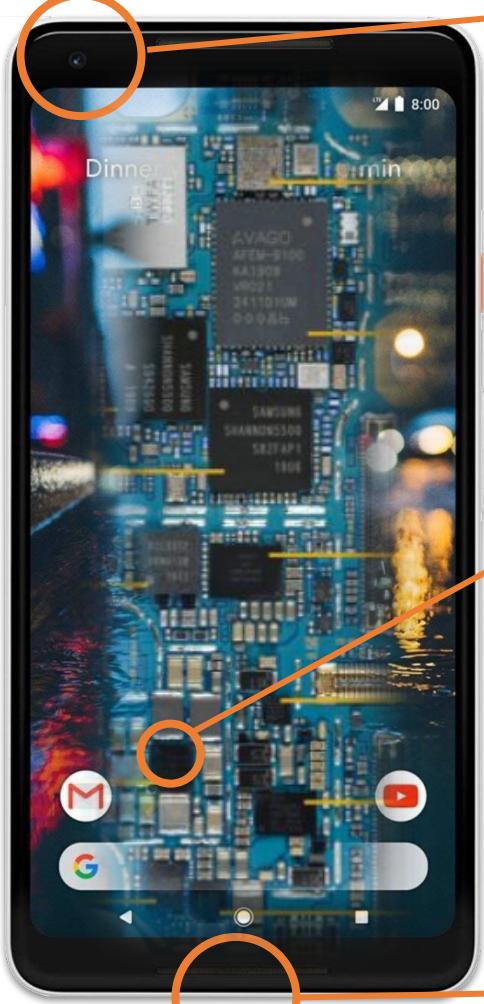




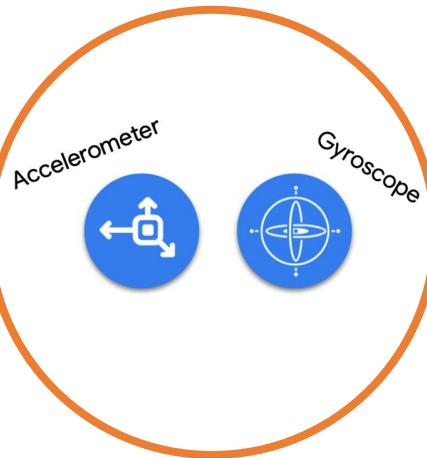
Edge Device



& Sensors



Camera



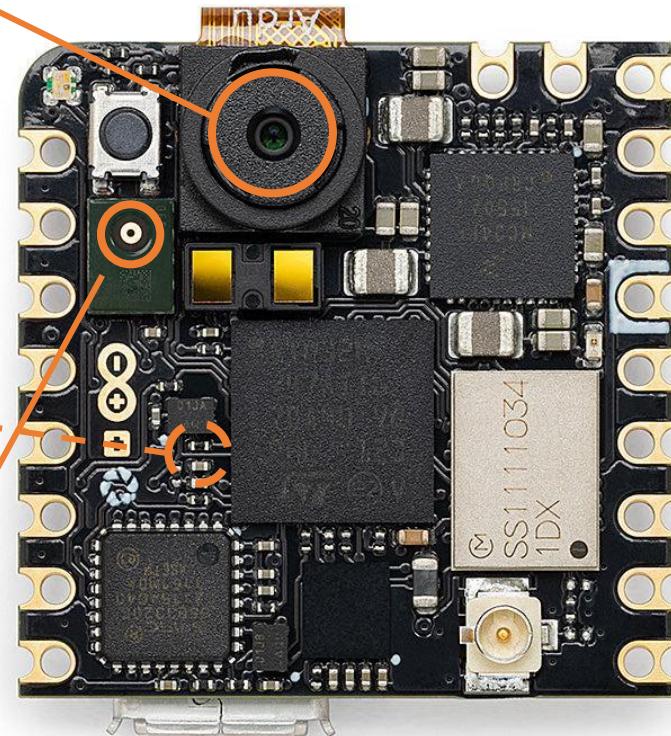
Accelerometer

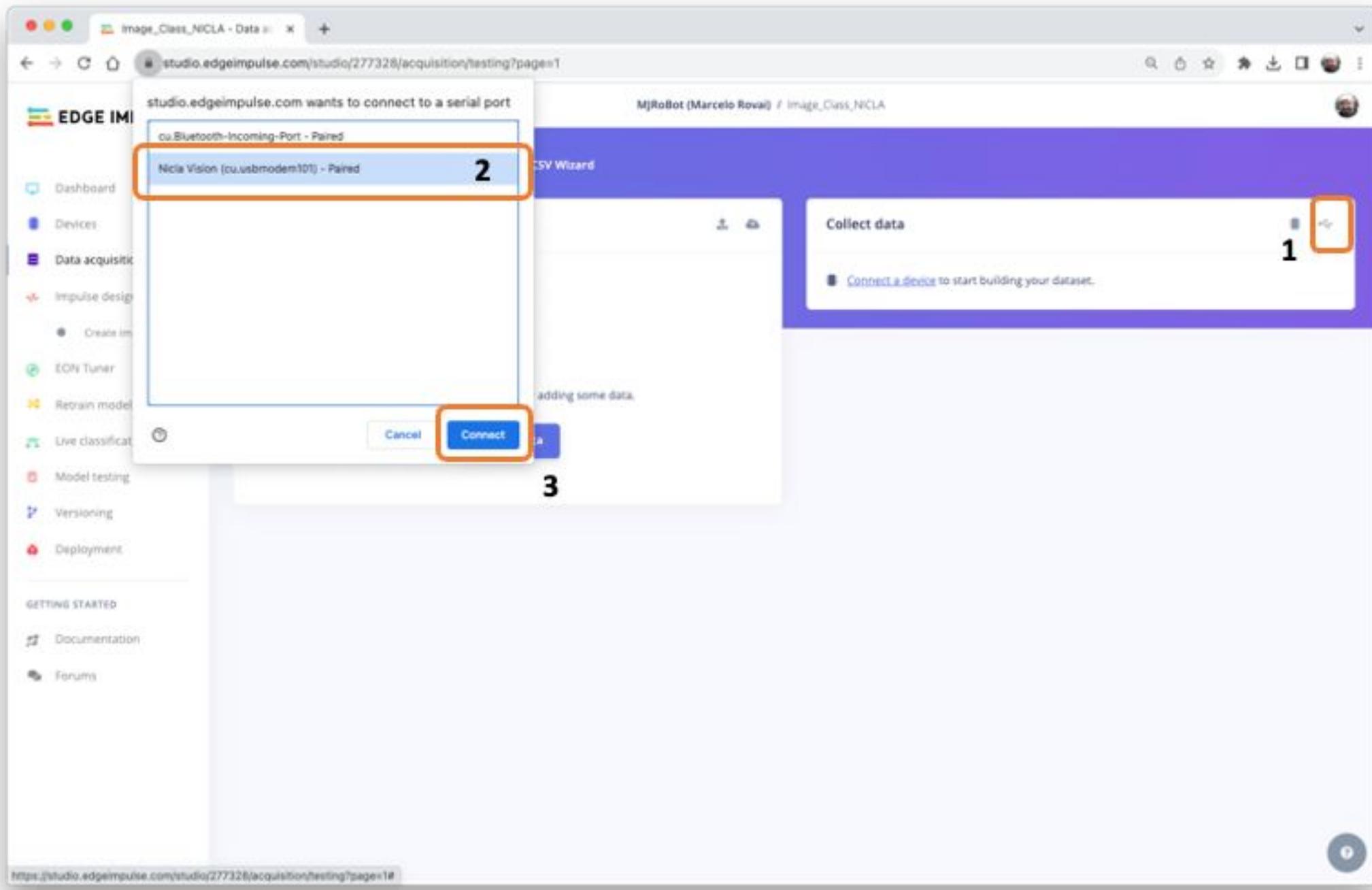


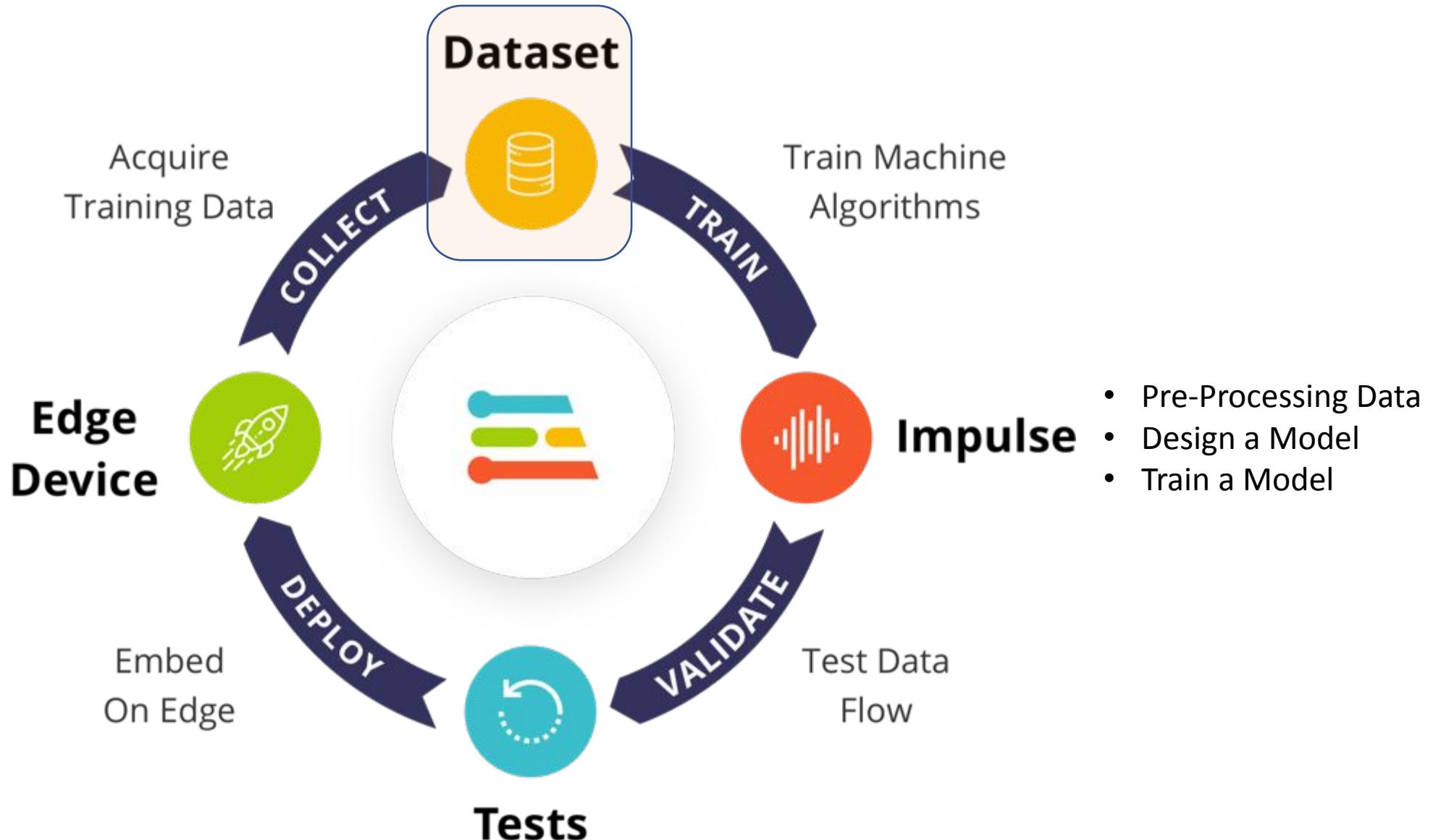
Gyroscope



Microphone







Collect Data

EDGE IMPULSE

Dataset Data explorer Data sources | CSV Wizard

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

Dataset

Training (0) Test (4)

SAMPLE NAME	LABEL	ADDED
camera.4bobcgqn	camera	Today, 18:22:44
camera.4bobb4ak	camera	Today, 18:21:59
camera.4bob85un	IMU	Today, 18:20:22
camera.4bob1fiv	camera	Today, 18:16:43

Collect data

Device ⑦ 51:0C:31:31:35:32

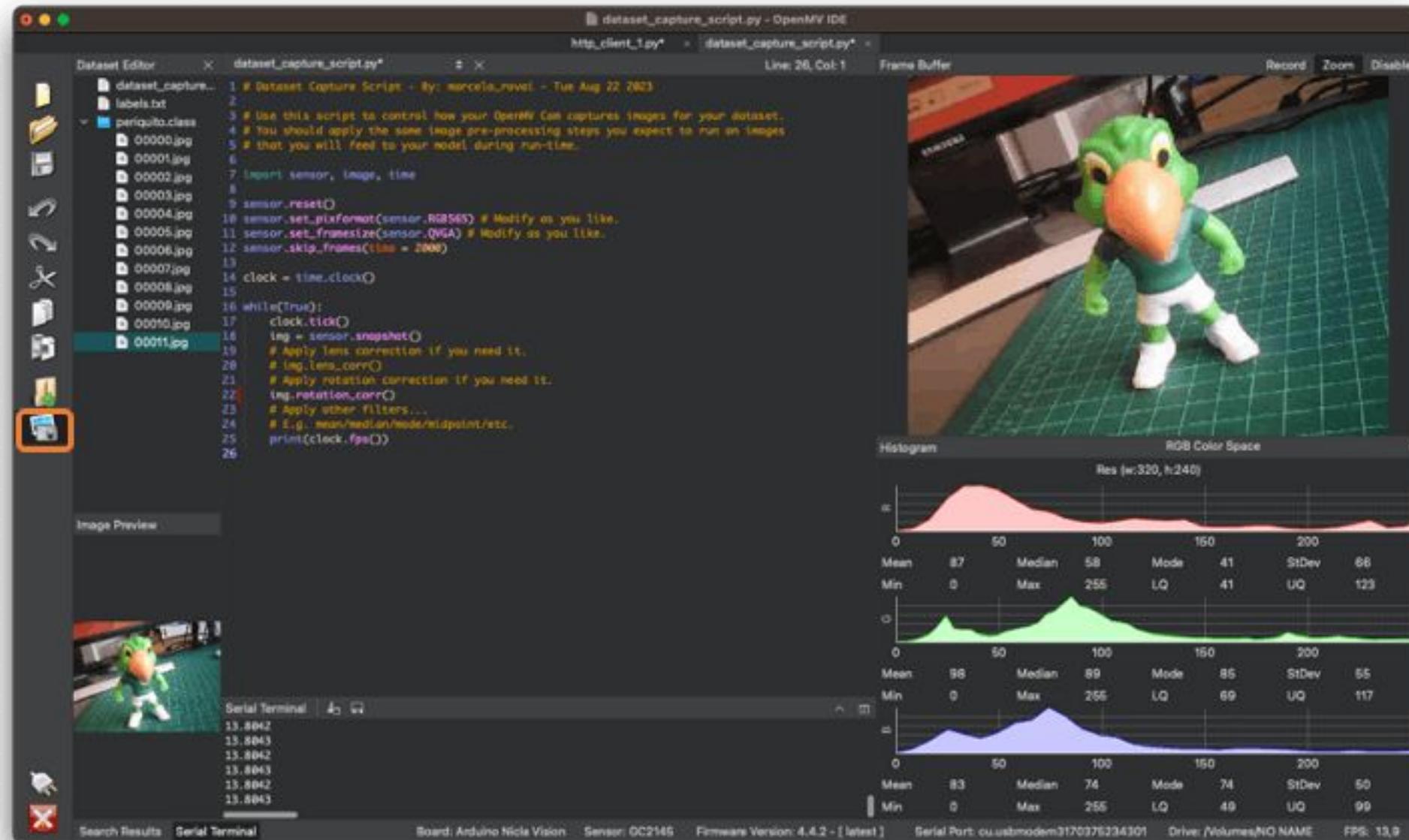
Label camera Camera feed

Sensor Camera (320x240)

Start sampling

RAW DATA
camera.4bobcgqn

Metadata



Collect Data

Upload data - Cifar10_Image_C

stUDIO.edgeimpulse.com/studio/51070/upload

EDGE IMPULSE

Dashboard

Devices

Data acquisition

Impulse design

- Create impulse
- Image
- NN Classifier

EON Tuner

Retrain model

Live classification

Model testing

Versioning

Deployment

GETTING STARTED

Documentation

Forums

UPLOAD DATA (CIFAR10_IMAGE_CLASSIFICATION)

Upload existing data

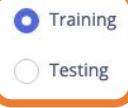
You can upload existing data to your project in the [Data Acquisition Format](#) (CBOR, JSON, CSV), or as WAV, JPG or PNG files.

Select files 

No file chosen

Upload into category

Automatically split between training and testing ?

Training 

Testing

Label

Infer from filename ?

Enter label: 

robot

Begin upload

MJRoBot (Marcelo Rovai)

Periquito vs Robot - Img Clas... x +

https://studio.edgeimpulse.com/studio/353482/acquisition/training?page=4

Collect Data

EDGE IMPULSE

Dataset Data explorer Data sources | CSV Wizard

DATA COLLECTED 162 items

TRAIN / TEST SPLIT 78% / 22%

Dataset

Training (127) Test (35)

Image ID	Image Preview	Label
00000		LABEL: periquito
00043		LABEL: periquito
00039		LABEL: periquito
00038		LABEL: periquito
00033		LABEL: periquito
00036		LABEL: periquito
00035		LABEL: periquito
00034		LABEL: periquito
00031		LABEL: periquito

Collect data

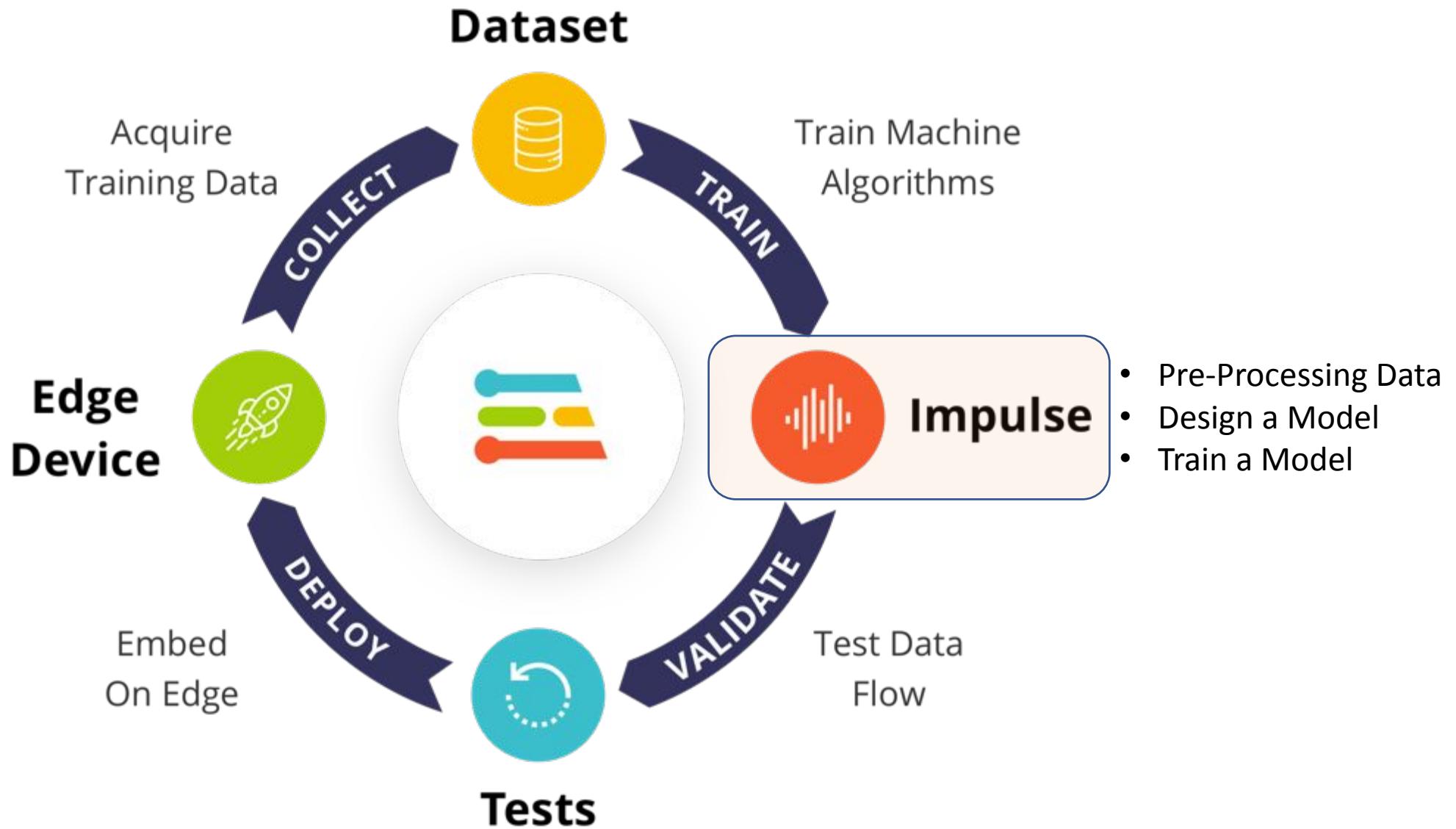
Connect a device to start building your dataset.

RAW DATA
periquito.50nsp64i

Metadata

No metadata.

?



Periquito vs Robot - Img Clas: x +

https://studio.edgeimpulse.com/studio/353482/create-impulse

EDGE IMPULSE

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

Dashboard

Devices

Data acquisition

Impulse design

Create impulse

Image

Transfer learning

EON Tuner

Retrain model

Live classification

Model testing

Versioning

Deployment

GETTING STARTED

Documentation

Forums

Image data

Input axes

Image width 96 **Image height** 96

Resize mode Squash

Image

Name: Image

Input axes (1): image

Transfer Learning (Images)

Name: Transfer learning

Input features: Image

Output features: 3 (background, periquito, robot)

Output features

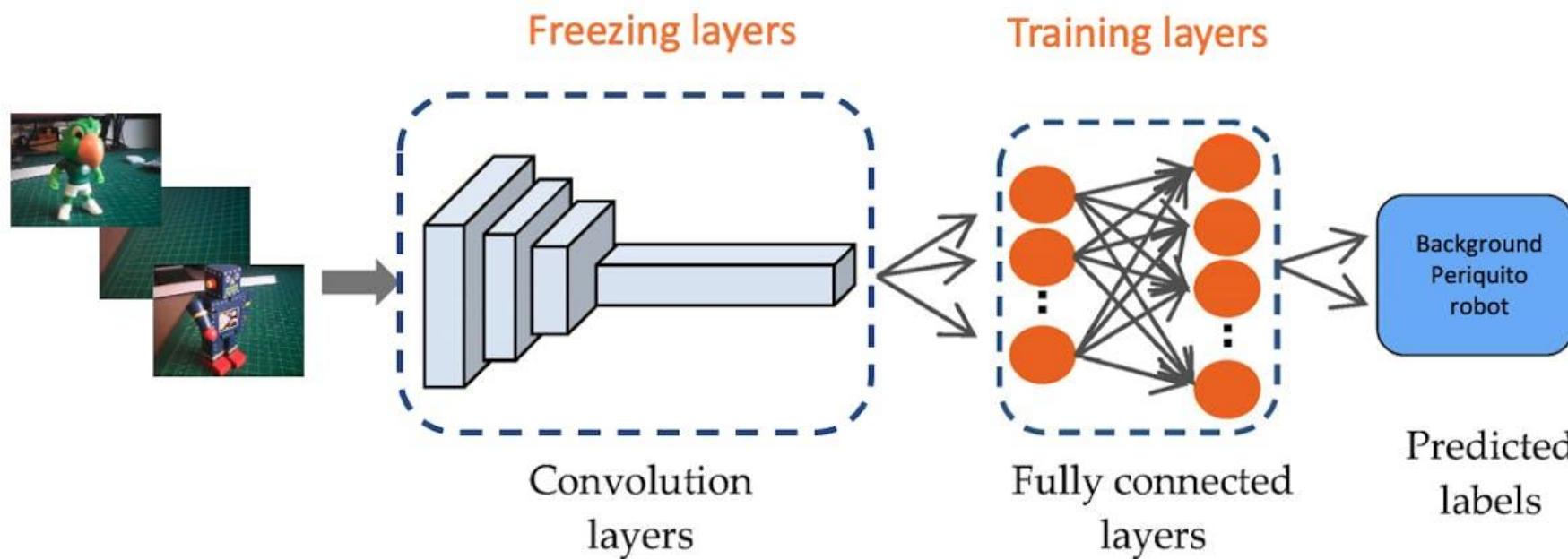
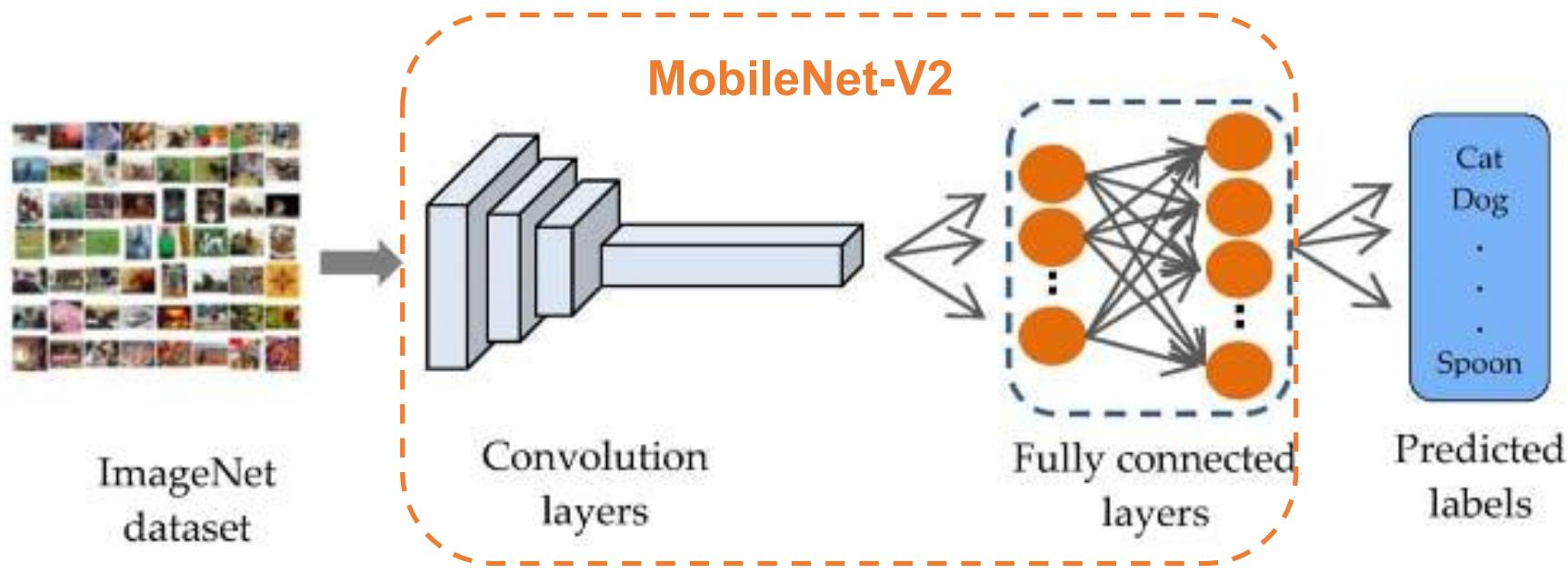
3 (background, periquito, robot)

Save Impulse

Add a processing block

Add a learning block

A screenshot of the Edge Impulse studio interface. On the left, a sidebar lists various tools and documentation. The main workspace shows the configuration of an impulse. A red box highlights the 'Image data' section, which includes fields for 'Image width' (96) and 'Image height' (96), and a 'Resize mode' dropdown set to 'Squash'. To the right, a 'Transfer Learning (Images)' block is selected, with its 'Name' field ('Transfer learning') also highlighted by an orange box. Below this block is another 'Transfer Learning (Images)' block with identical settings. A green 'Output features' block is also present. In the bottom right corner, a large yellow arrow points upwards towards the 'Save Impulse' button, which is highlighted in green. At the bottom center, there are options to 'Add a processing block' or 'Add a learning block'.



Preprocess Data

Periquito vs Robot - Img Clas... [+](#)

https://studio.edgeimpulse.com/studio/353482/dsp/image/3#

Raw data Show: All labels periquito.50nsp64i (periqu...

Raw features 

Parameters

Image

Color depth  RGB

Save parameters

DSP result

Image

 96x96x3
= 27,648

Copy 27648 features to clipboard

Processed features 

0.1647, 0.1412, 0.1216, 0.1804, 0.1412, 0.1333, 0.1882, 0.1412, 0.1373,...

On-device performance 

PROCESSING TIME 1 ms.

 PEAK RAM USAGE 4 KB

?

Preprocess Data

Periquito vs Robot - Img Class X +

https://studio.edgeimpulse.com/studio/353482/dsp/image/3/generate-features

#1 Click to set a description for this version

EDGE IMPULSE

Parameters Generate features

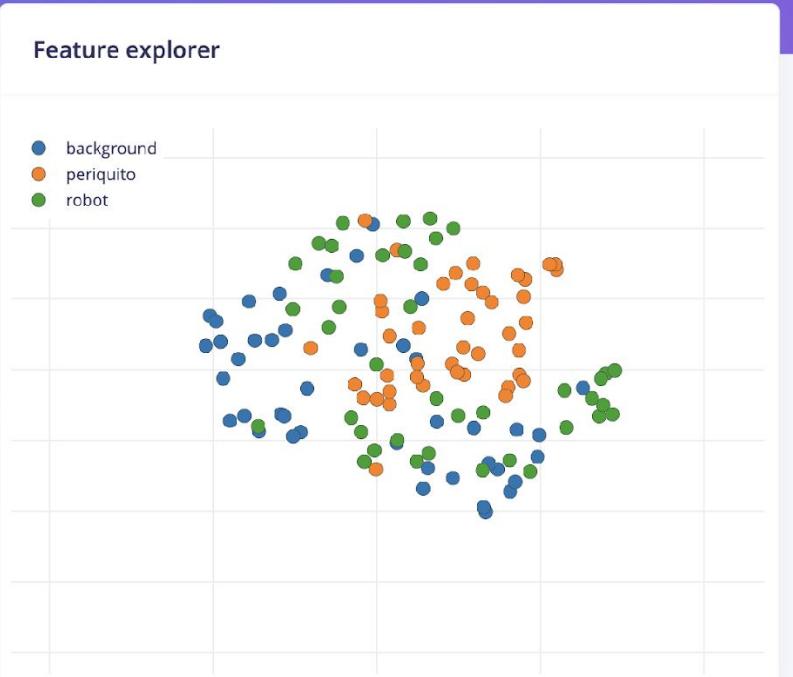
Training set

Data in training set	127 items
Classes	3 (background, periquito, robot)

Generate features

Feature generation output  (0) ▾

Feature explorer



background
periquito
robot

On-device performance

PROCESSING TIME 1 ms.

PEAK RAM USAGE 4 KB

GETTING STARTED

Documentation

Forums

Design a Model

Train a Model

The screenshot shows the Edge Impulse Studio interface for a project titled "Periquito vs Robot - Img Clas".

Training settings:

- Number of training cycles: 20
- Use learned optimizer:
- Learning rate: 0.0005
- Training processor: CPU
- Data augmentation:

Advanced training settings:

- Validation set size: 20 %
- Split train/validation set on metadata key:
- Batch size: 32
- Auto-weight classes:
- Profile int8 model:

Neural network architecture:

Input layer (27,648 features)

MobileNetV2 96x96 0.1 (final layer: 8 neurons, 0.1 dropout)

Choose a different model

Output layer (3 classes)

Start training

Model:

Last training performance (validation set)

ACCURACY	92.0%
LOSS	0.19

Confusion matrix (validation set)

	BACKGROUND	PER QUIETO	ROBOT
BACKGROUND	77.8%	22.2%	0%
PER QUIETO	0%	100%	0%
ROBOT	0%	0%	100%
F1 SCORE	0.88	0.89	1.00

Metrics (validation set)

METRIC	VALUE
Area under ROC Curve	1.00
Weighted average Precision	0.94
Weighted average Recall	0.92
Weighted average F1 score	0.92

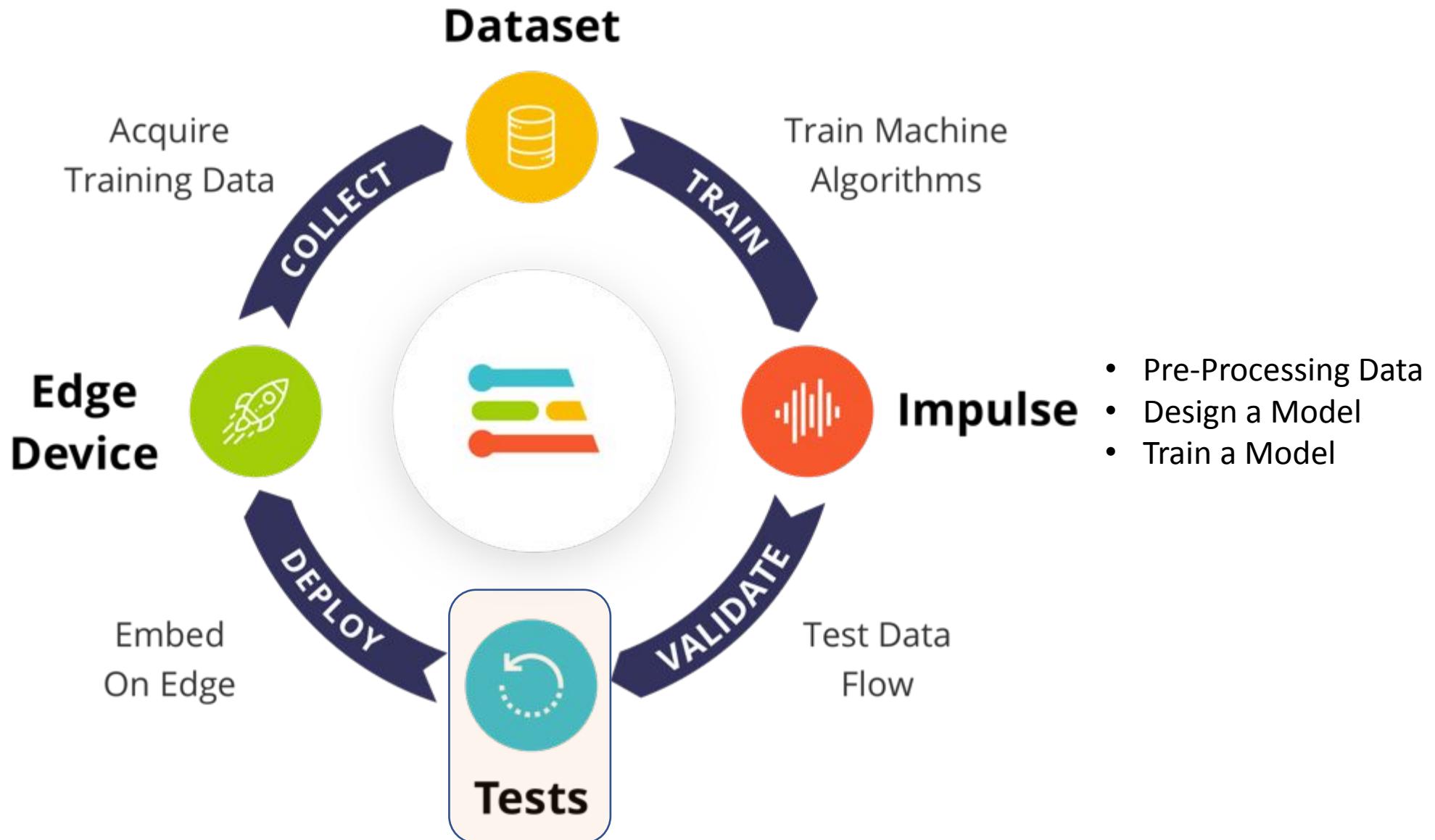
Data explorer (full training set)

Legend: background - correct, periquito - correct, robot - correct, background - incorrect, robot - incorrect

Estimate for Arduino Nicla Vision (Cortex-M7 480MHz), compiled with Edge Impulse EON™ compiler

On-device performance:

- Engine: EON™ Compiler
- INFERRING TIME: 76 ms.
- PEAK RAM USAGE: 280.9K
- FLASH USAGE: 212.0K



Evaluate Optimize

Periquito vs Robot - Img Clas... x

https://studio.edgeimpulse.com/studio/353482/validation

EDGE IMPULSE

Test data

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

Classify all

SAMPLE NAME	EXPECTED OUTCO...	LENGTH	ACCURACY	RESULT	⋮
testing.48m7...	periquito	0s	0%	1 uncertain	⋮
00000	background	0s	100%	1 background	⋮
00005	background	0s	100%	1 background	⋮
00009	background	0s	100%	1 background	⋮
00015	background	0s	100%	1 background	⋮
00017	background	0s	100%	1 background	⋮
00026	background	0s	100%	1 background	⋮
00028	background	0s	100%	1 background	⋮
00033	background	0s	100%	1 background	⋮
00044	background	0s	100%	1 background	⋮
00049	background	0s	100%	1 background	⋮

Model testing output

Results Model version: Unoptimized (float32)

ACCURACY 97.14%

Metrics for Transfer learning

METRIC	VALUE
Area under ROC Curve	1.00
Weighted average Precision	0.97
Weighted average Recall	0.97
Weighted average F1 score	0.97

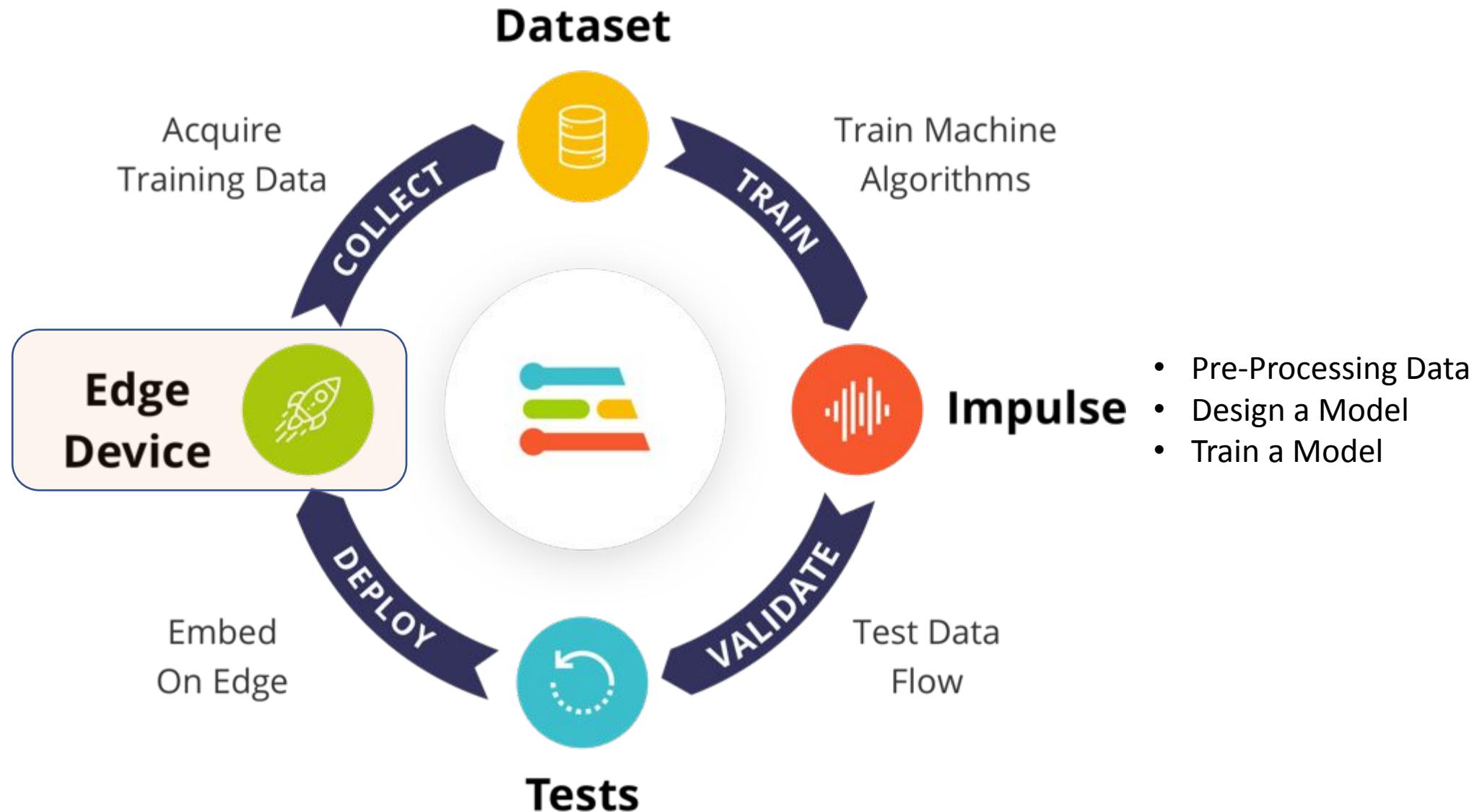
Confusion matrix

	BACKGROUND	PERIQUITO	ROBOT	UNCERTAIN
BACKGROUND	100%	0%	0%	0%
PERIQUITO	0%	91.7%	0%	8.3%
ROBOT	0%	0%	100%	0%
F1 SCORE	1.00	0.96	1.00	

Feature explorer

- background - correct
- periquito - correct
- robot - correct
- periquito - incorrect

?



Deploy Model

Periquito vs Robot - Img Clas... [+](#)

https://studio.edgeimpulse.com/studio/353482/deployment

EDGE IMPULSE

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

GETTING STARTED

- Documentation
- Forums

Configure your deployment

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.](#)

Arduino library

SELECTED DEPLOYMENT

Arduino library

An Arduino library with examples that runs on most Arm-based Arduino development boards.

MODEL OPTIMIZATIONS

Model optimizations can increase on-device performance but may reduce accuracy.

EON™ Compiler

Same accuracy, 17% less RAM, 26% less ROM.

Quantized (int8)		IMAGE	TRANSFER LEARNING	TOTAL
Selected ✓		LATENCY	1 ms.	76 ms.
		RAM	4.0K	280.9K
		FLASH	-	212.0K
		ACCURACY		94.29%

Unoptimized (float32)		IMAGE	TRANSFER LEARNING	TOTAL
Select		LATENCY	1 ms.	159 ms.
		RAM	4.0K	893.8K
		FLASH	-	401.1K
		ACCURACY		97.14%

Estimate for Arduino Nida Vision (Cortex-M7 480MHz) - [Change target](#)

Build

Latest build

v28 (Arduino library)
ARDUINO Today, 17:00:14 [View docs](#)

Build output

Creating job... OK (ID: 22412220)
Scheduling job in cluster...
Container image pulled!
Job started
Writing templates...
Writing templates OK

Writing templates...
Scheduling job in cluster...
Container image pulled!
Job started
Copying Edge Impulse SDK...
Copying Edge Impulse SDK OK

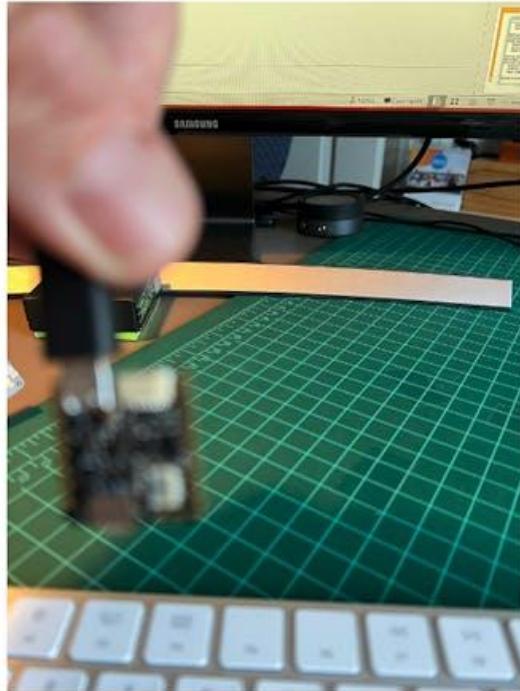
Compiling EON model...
Compiling EON model OK

Removing clutter and updating headers...
Removing clutter and updating headers OK

Creating archive...
Creating archive OK

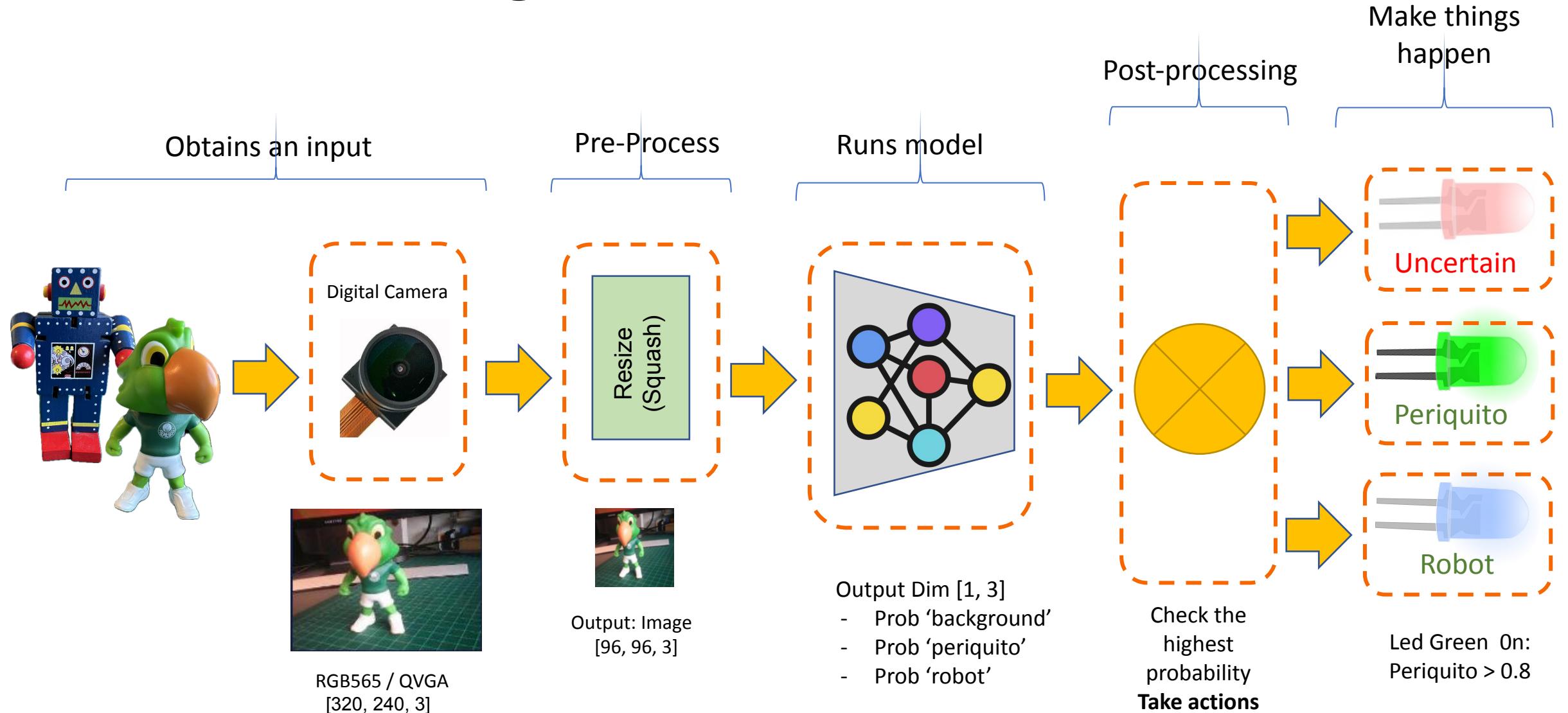
Job completed (success)

Make
Inferences



<https://youtu.be/bZPZZJblU-o?si=grsv71cER-clvsSd>

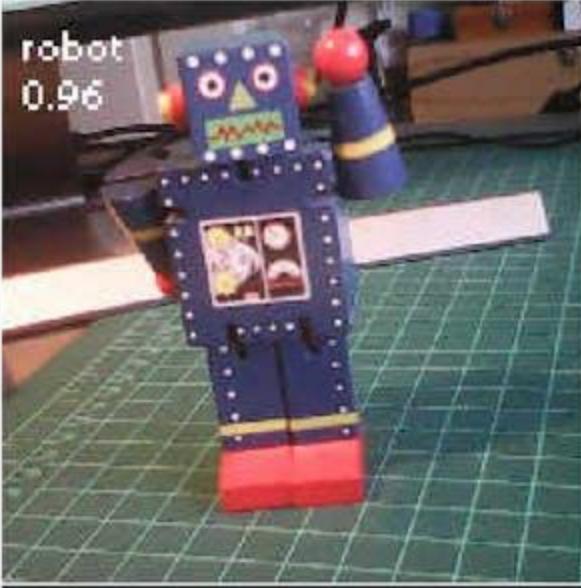
Post-Processing with LEDs:





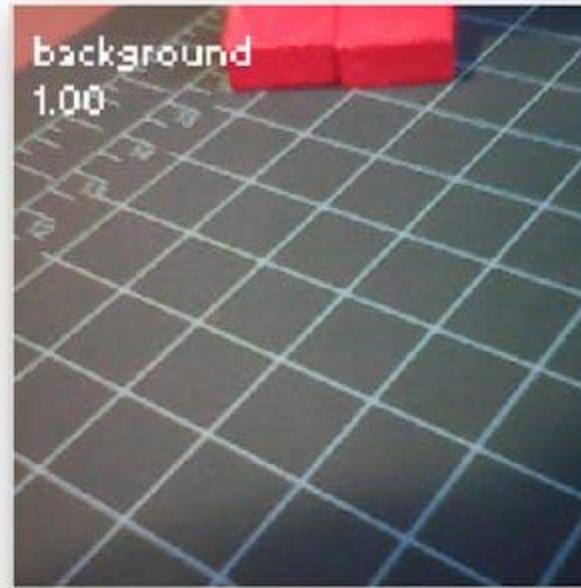
Serial Terminal | ⌂ ☰

Prediction:
periquito with a prob of 0.99
FPS: 7.37 fps ==> latency: 136 ms



Serial Terminal | ⌂ ☰

Prediction:
robot with a prob of 0.96
FPS: 7.34 fps ==> latency: 136 ms



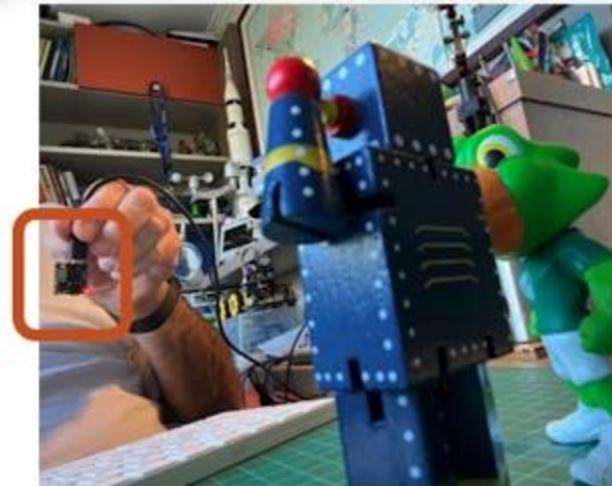
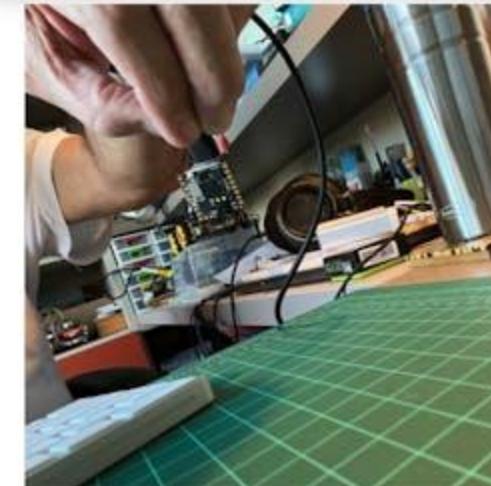
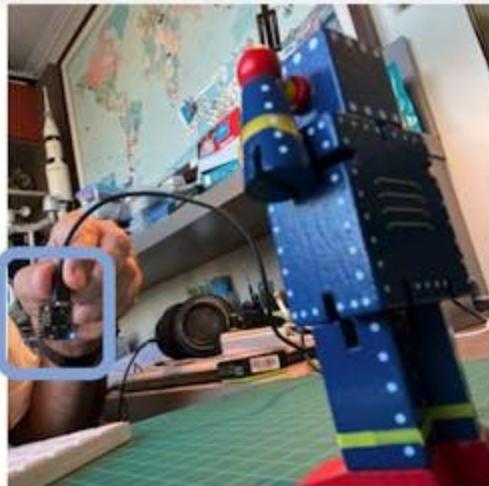
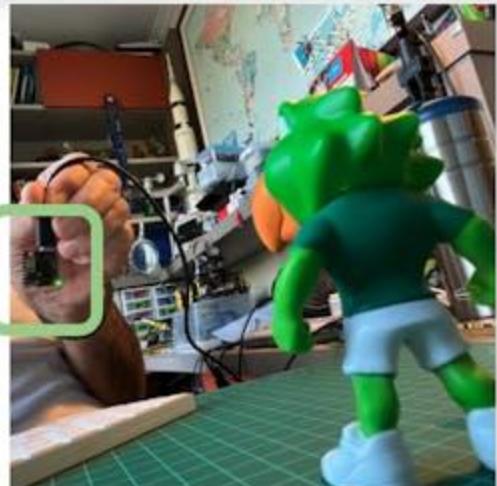
Serial Terminal | ⌂ ☰

Prediction:
background with a prob of 1.00
FPS: 7.34 fps ==> latency: 136 ms



Serial Terminal | ⌂ ☰

Prediction:
uncertain with a prob of 0.76
FPS: 7.42 fps ==> latency: 135 ms



Computer Vision Recognition Tasks

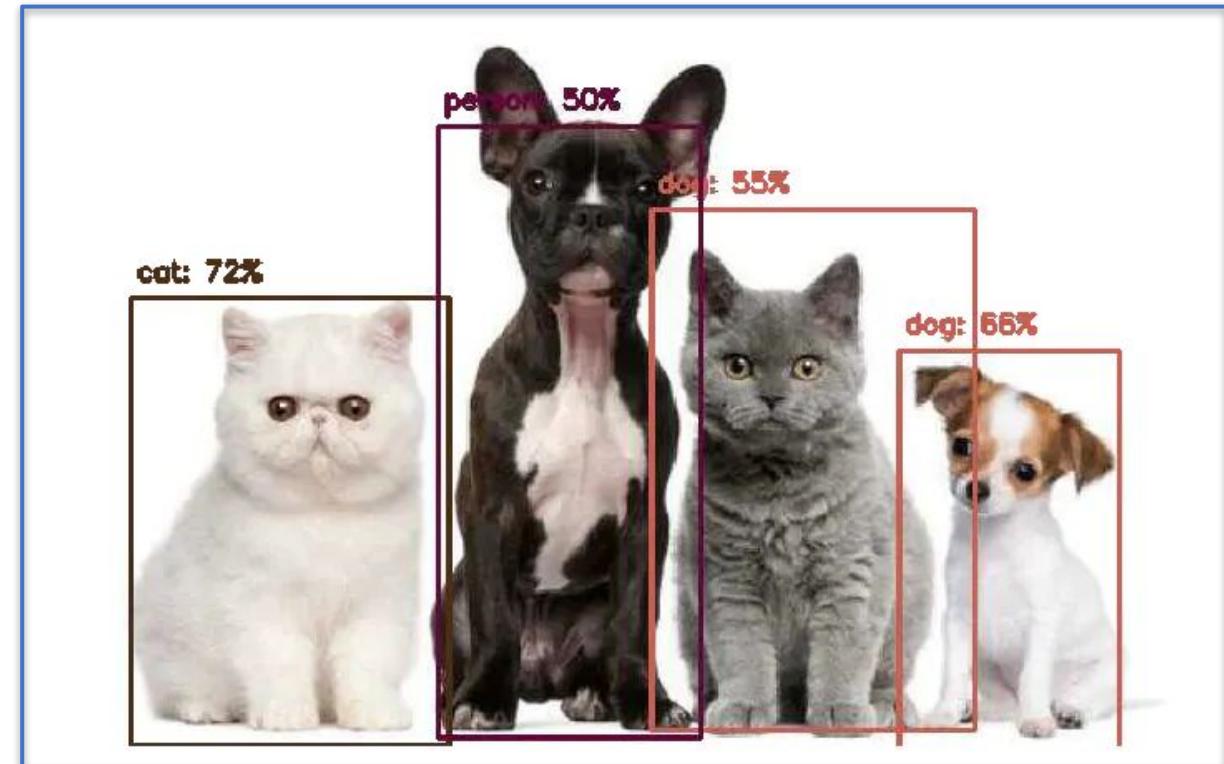
(Multi-Class Classification)

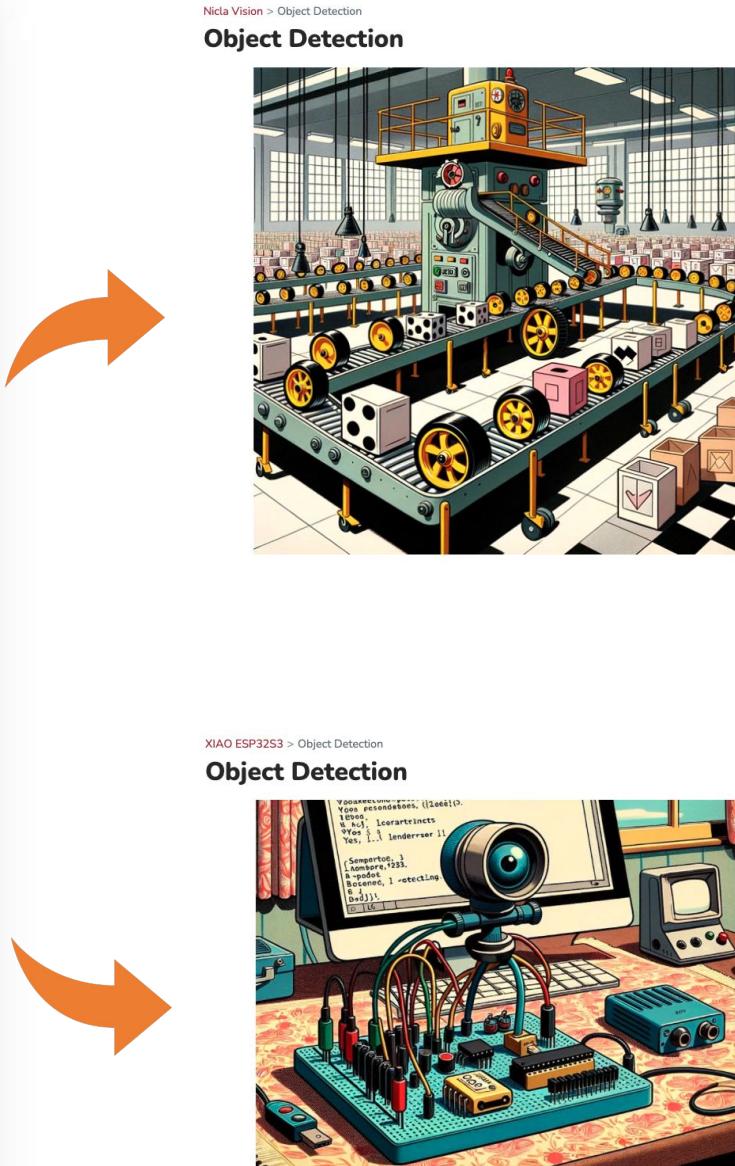
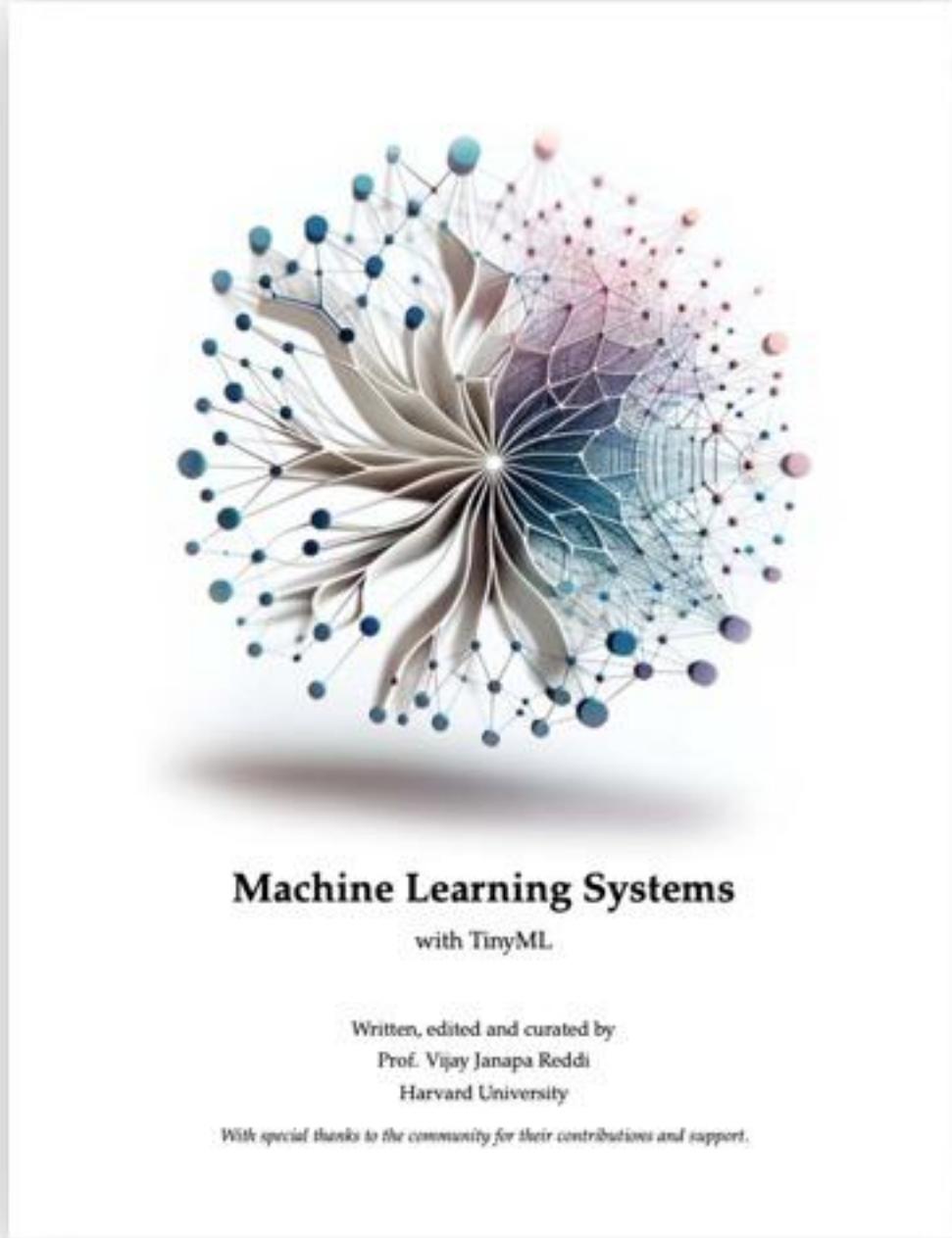
Cat: 70%

Dog: 80%

Object Detection

Multi-Label Classification + Object Localization





Nicla Vision

XIAO ESP32S3

FOMO

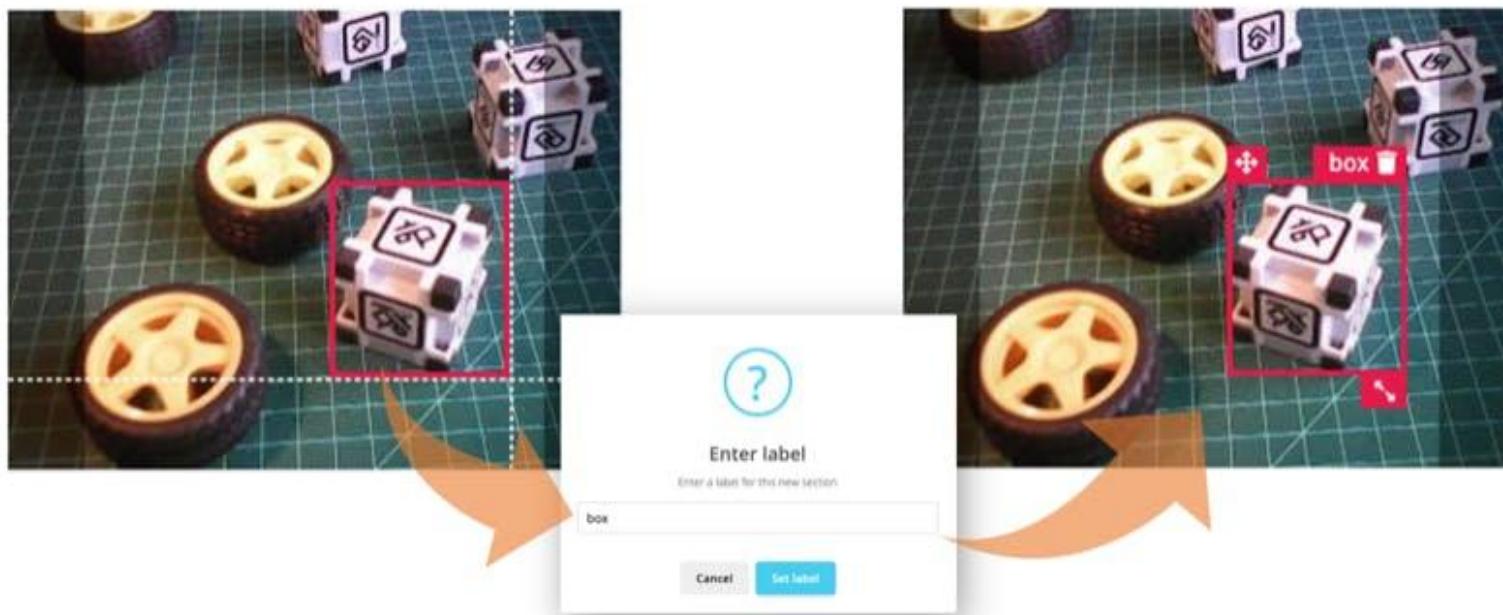
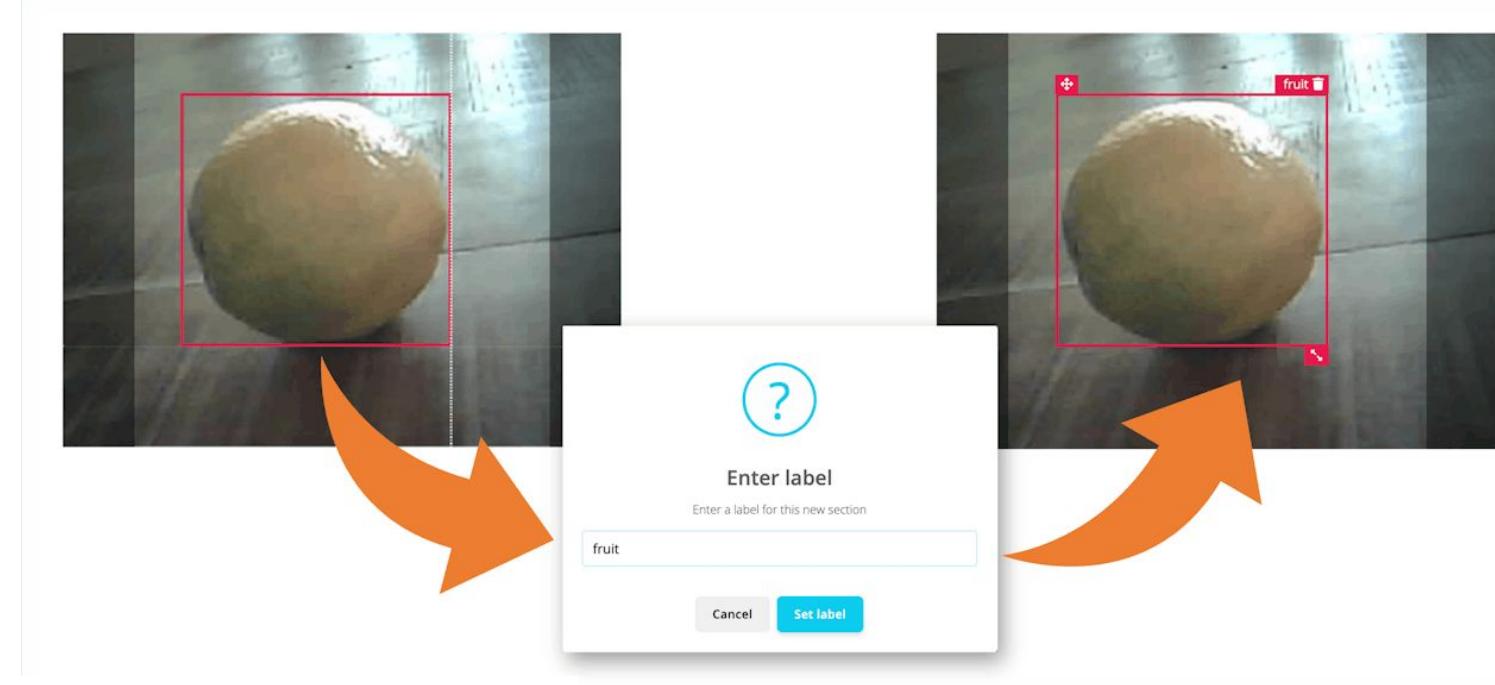
Object Detection model

Labeling

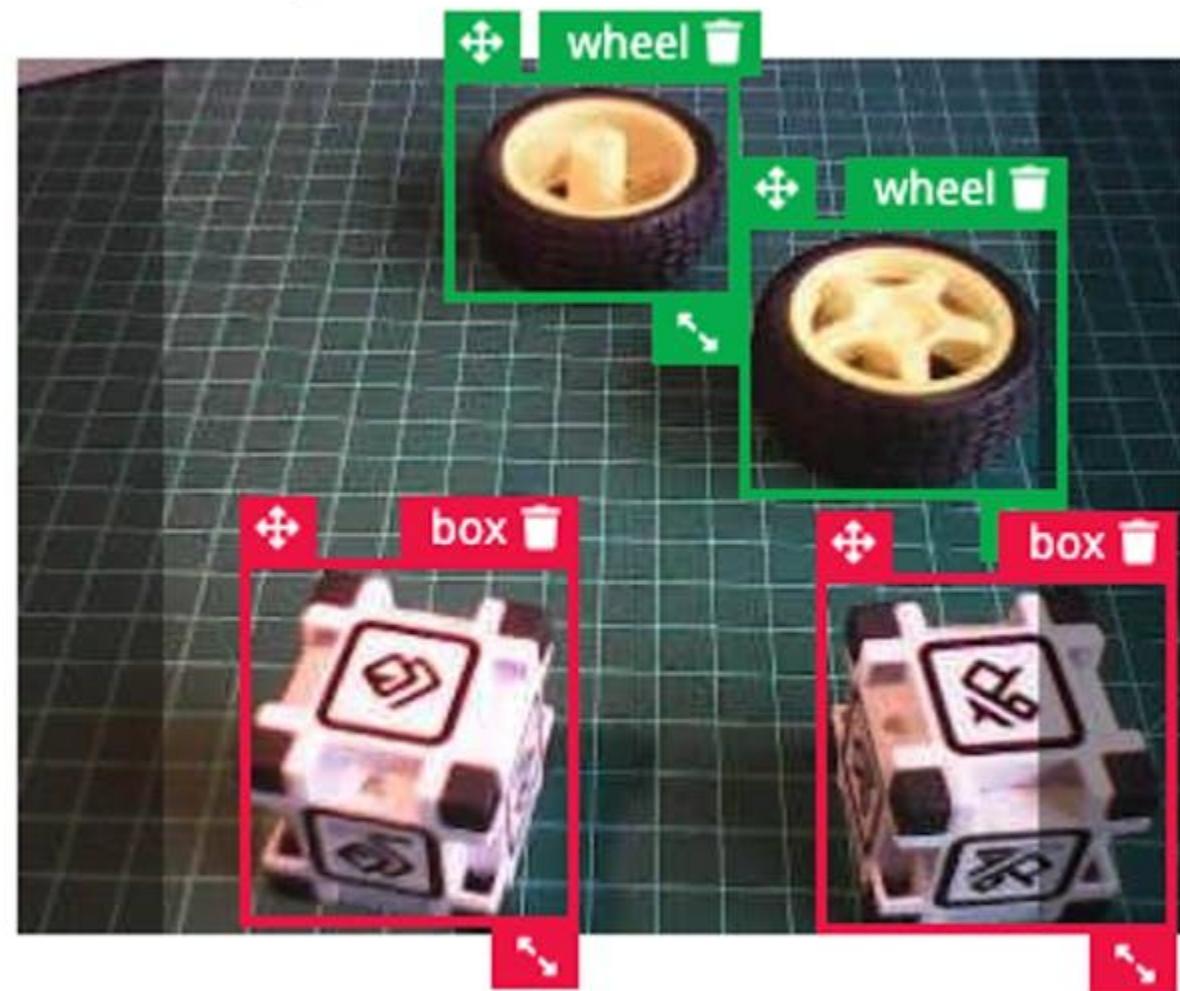
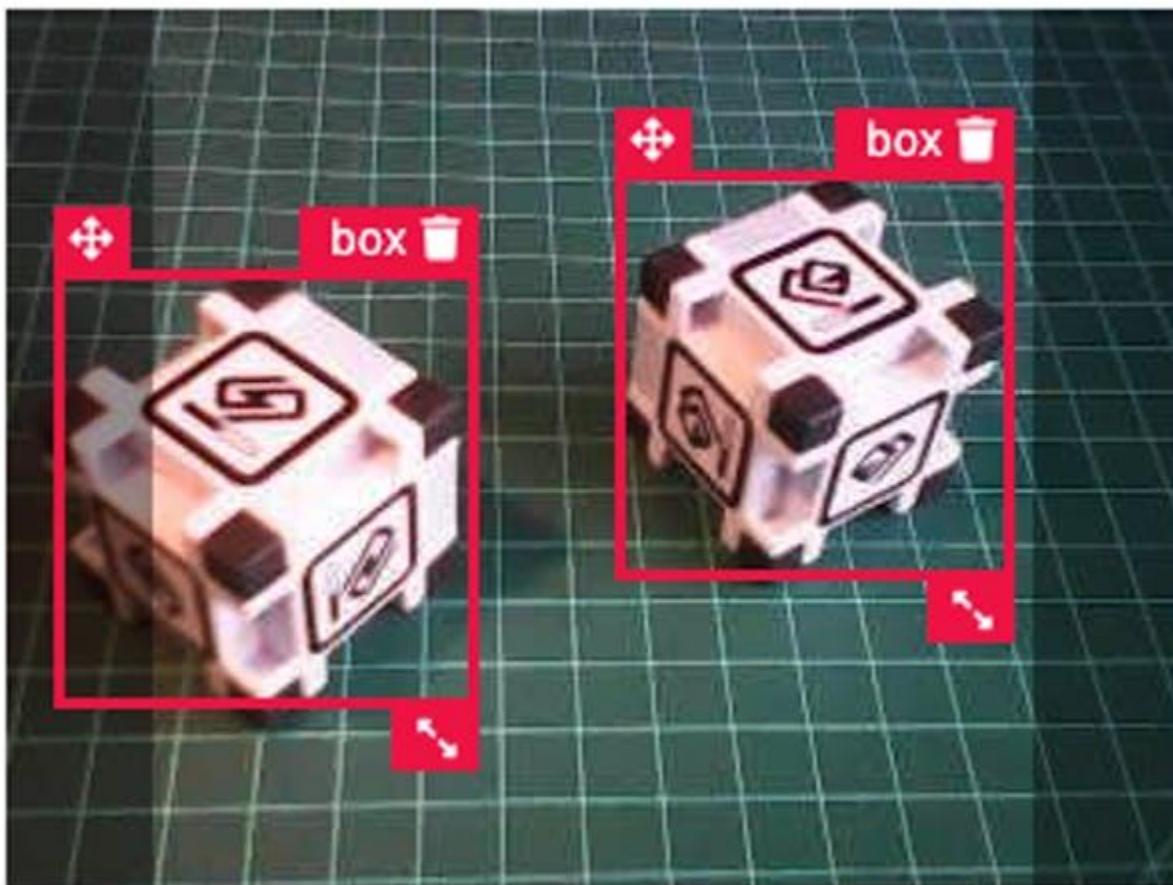
The screenshot shows the Edge Impulse web interface for dataset management. The main navigation bar includes 'Dataset', 'Data sources', and 'Labeling queue (47)', with the 'Labeling queue' tab highlighted by an orange arrow. The left sidebar lists various project management and documentation links. The central area displays a 'Dataset' table with columns for 'Training' (47), 'Test' (0), 'SAMPLE NAME', 'LABELS', 'ADDED', and 'LENGTH'. Below the table is a 'RAW DATA' section showing a timestamp '20231128151645' and a small image of two green objects on a surface. A 'Metadata' section indicates 'No metadata.'

Training	Test	SAMPLE NAME	LABELS	ADDED	LENGTH
(47)	(0)	20231128151645	-	Today, 15:27:09	-
		20231128150613	-	Today, 15:27:09	-
		20231128150604	-	Today, 15:27:09	-
		20231128150833	-	Today, 15:27:09	-
		20231128150600	-	Today, 15:27:09	-
		20231128150855	-	Today, 15:27:09	-
		20231128150458	-	Today, 15:27:09	-
		20231128150713	-	Today, 15:27:09	-
		20231128150908	-	Today, 15:27:09	-

Labeling



Labeling



XIAO-ESP32S3-Sense-Objec X +

studio.edgeimpulse.com/studio/315759/create-impulse

EDGE IMPULSE

MJRoBot (Marcelo Rovai) / XIAO-ESP32S3-Sense-Object_Detection

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

Image data

Input axes
image

Image width 96 **Image height** 96

Resize mode
Squash

For object detection use a square image size, e.g. 96x96, 160x160 or 320x320.

Image

Name Image

Input axes (1)
 image

Object Detection (Images)

Name Object detection

Input features
 Image

Output features
2 (bug, fruit)

Save Impulse

Add a processing block

Add a learning block

?

Dashboard

Devices

Data acquisition

Impulse design

- Create impulse
- Image
- Object detection

EON Tuner

Retrain model

Live classification

Model testing

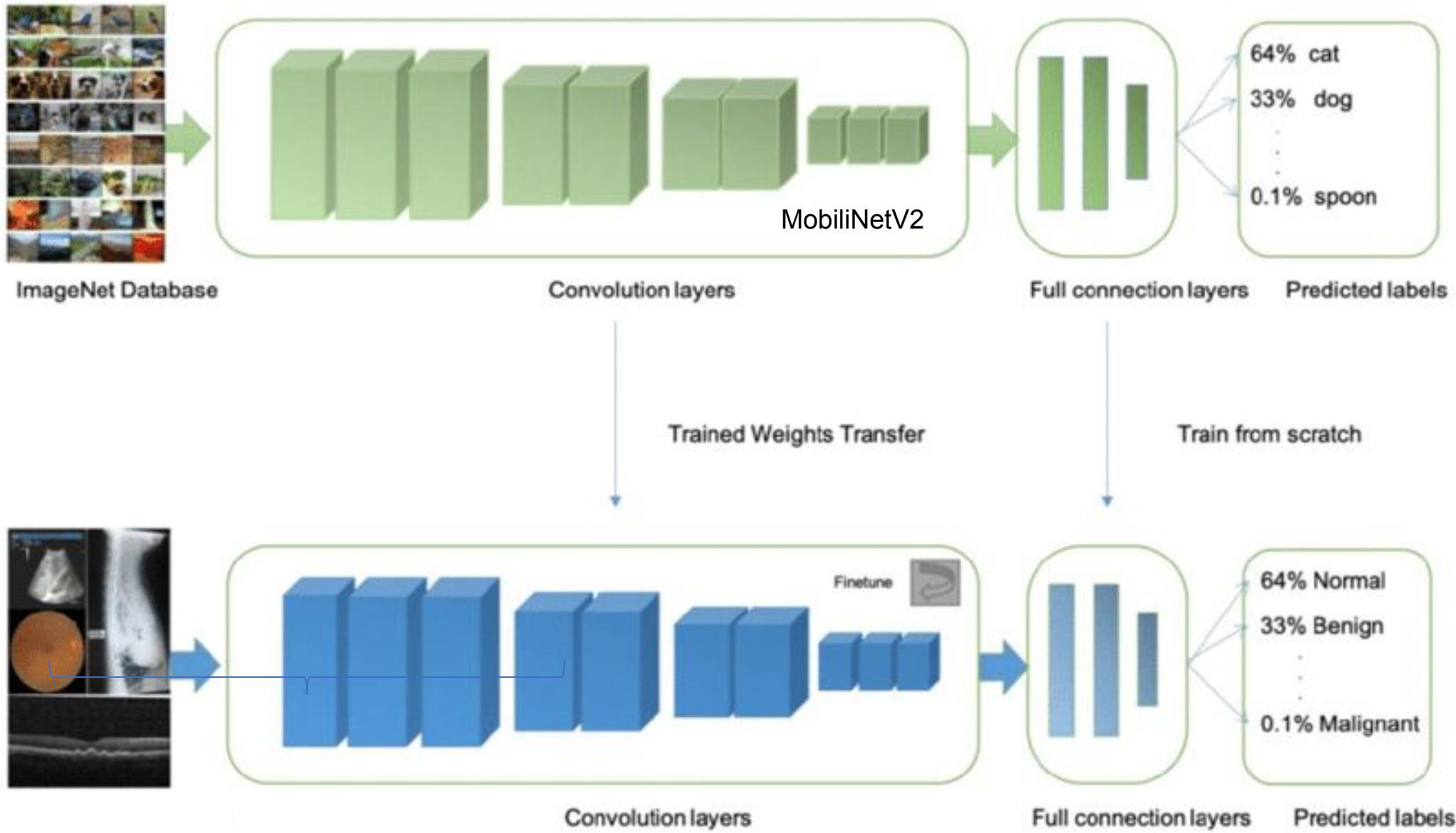
Versioning

Deployment

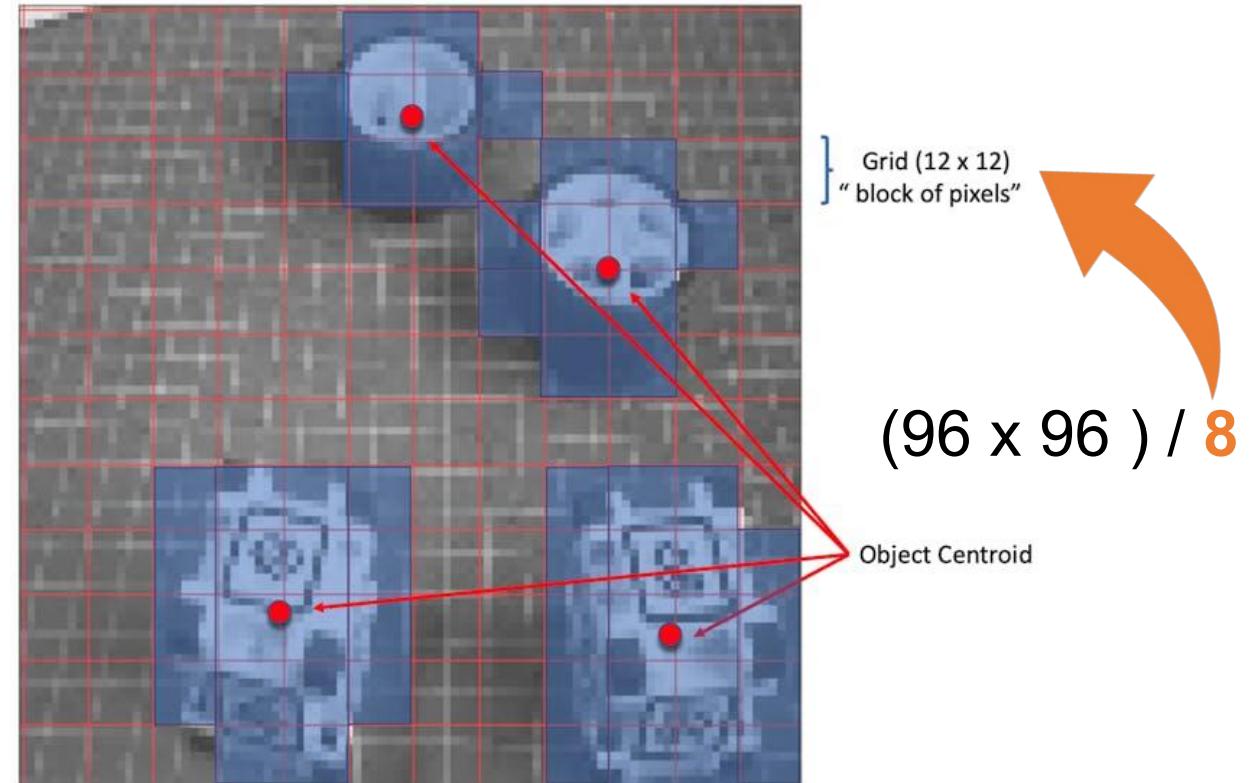
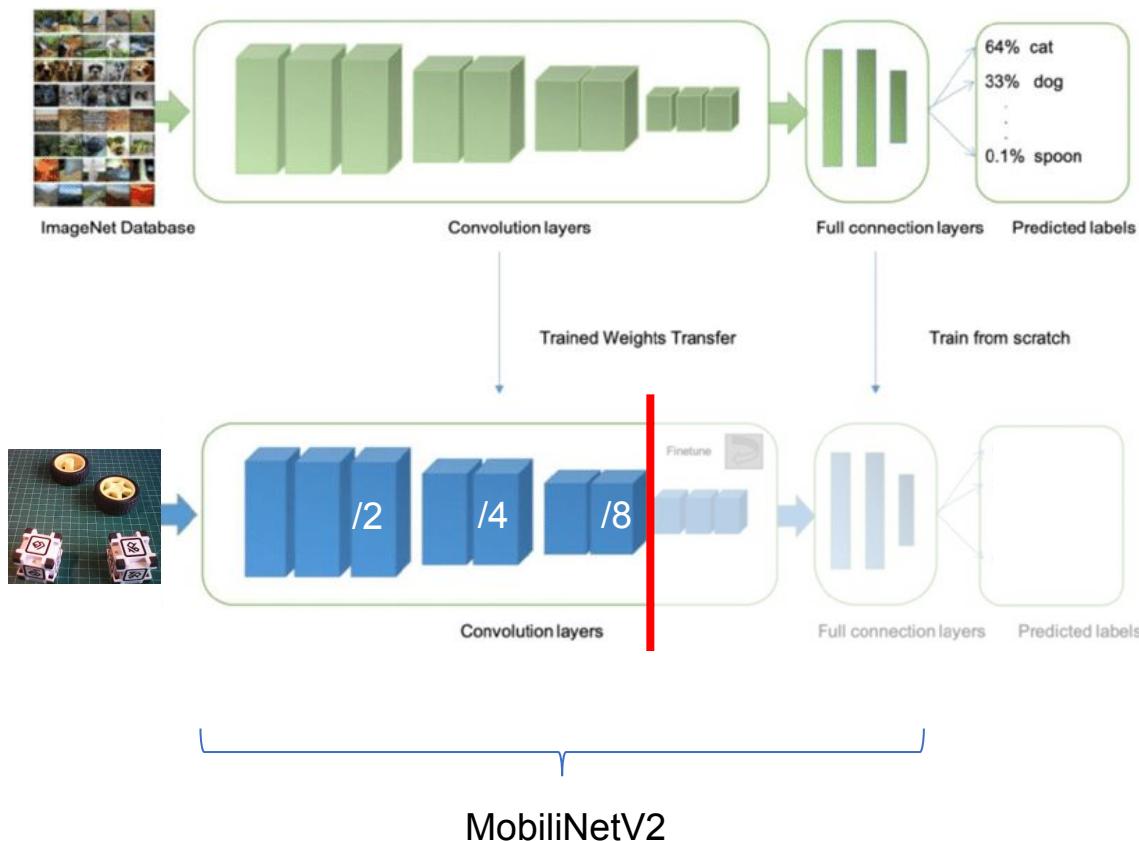
GETTING STARTED

Documentation

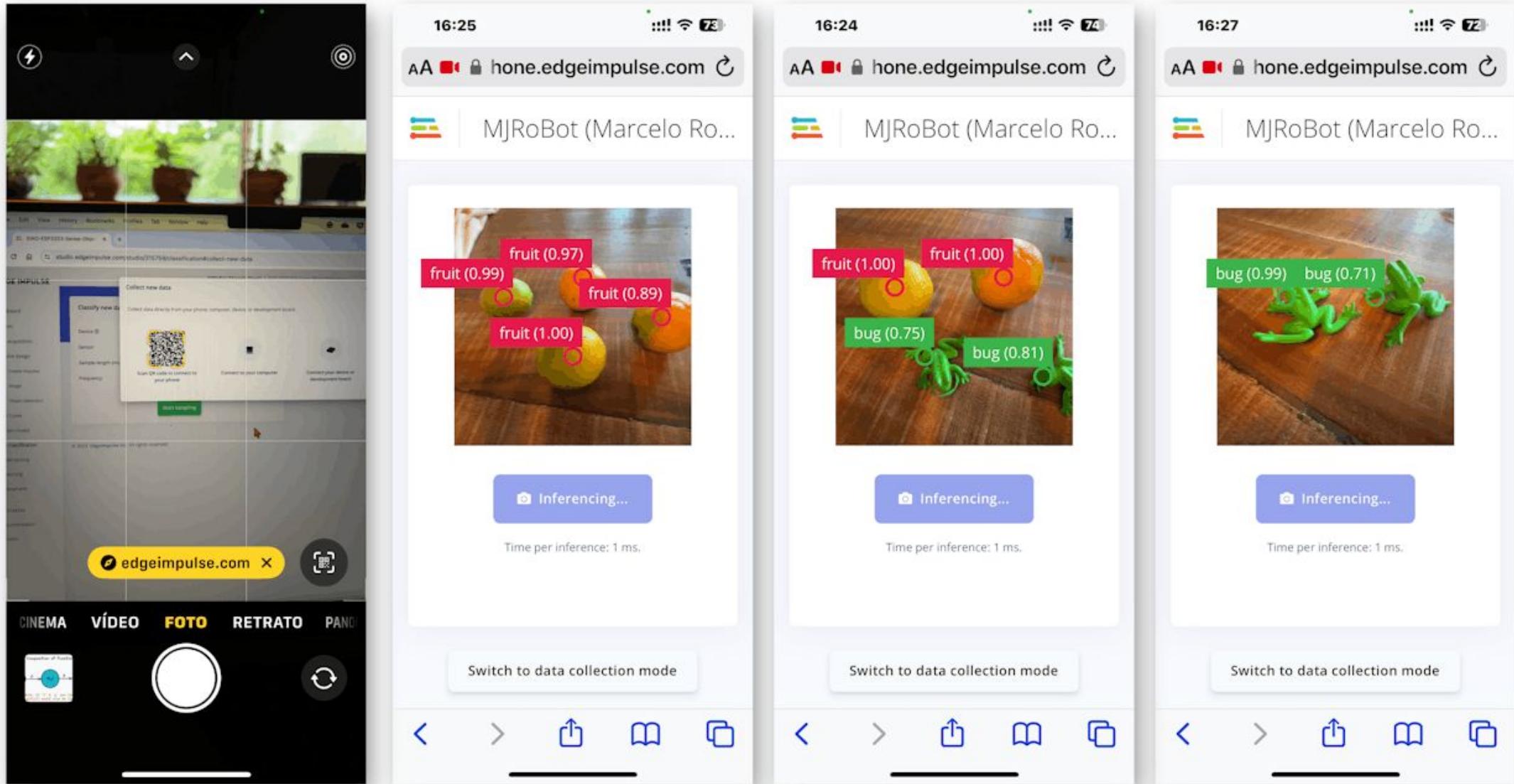
Forums



Model: FOMO



Inference Test



Deploy



esp32_camera | Arduino IDE 2.2.1

XIAO_ESP32S3

```
esp32_camera.ino

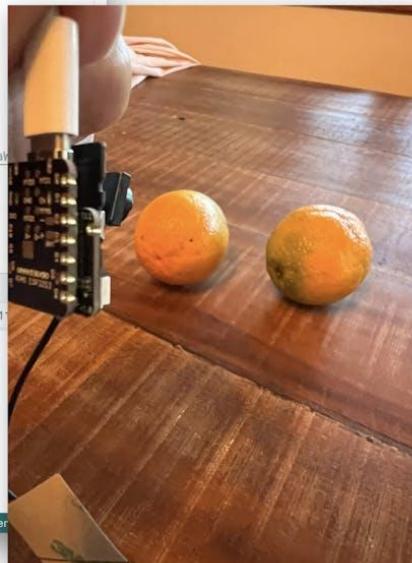
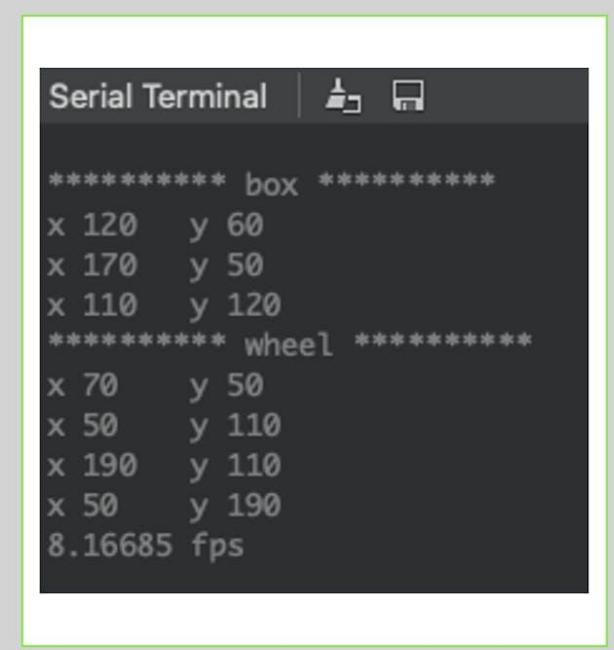
18 * LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM,
19 * OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
20 * SOFTWARE.
21 */
22
23 /* Includes ----- */
24 #include <XIAO-ESP32S3-Sense-Object_Detection_inferencing.h>
25 #include "edge-impulse-sdk/dsp/image/image.hpp"
26
27 #include "esp_camera.h"
28
29 // Select camera model - find more camera models in camera_pins.h file here
30 // https://github.com/espressif/arduino-esp32/blob/master/libraries/ESP32/examples/Camera/Camera
31
32 #define PWDN_GPIO_NUM      -1
33 #define RESET_GPIO_NUM     -1
34 #define XCLK_GPIO_NUM       10
35 #define SIOD_GPIO_NUM       40
36 #define STOC_GPIO_NUM       39

Serial Monitor x Output

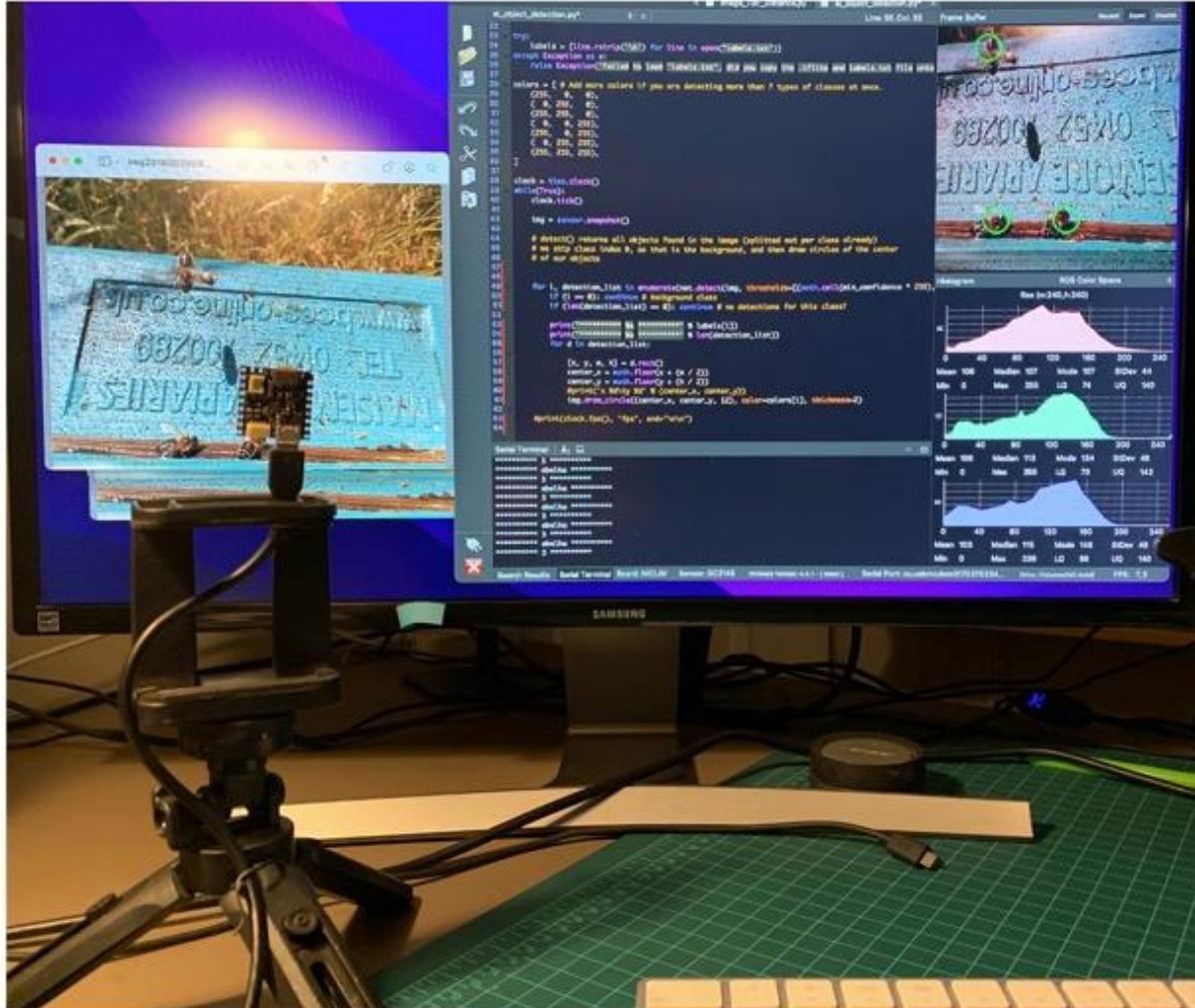
Message (Enter to send message to 'XIAO_ESP32S3' on '/dev/cu.usbmodem2101')
Both NL & CR 1

fruit (0.566406) [ x: 56, y: 32, width: 8, height: 8 ]
Predictions (DSP: 4 ms., Classification: 143 ms., Anomaly: 0 ms.):
No objects found
Predictions (DSP: 4 ms., Classification: 143 ms., Anomaly: 0 ms.):
fruit (0.582031) [ x: 48, y: 32, width: 8, height: 8 ]
fruit (0.773438) [ x: 80, y: 32, width: 8, height: 8 ]
Predictions (DSP: 4 ms., Classification: 143 ms., Anomaly: 0 ms.):
fruit (0.550781) [ x: 64, y: 16, width: 8, height: 8 ]
Predictions (DSP: 4 ms., Classification: 143 ms., Anomaly: 0 ms.):
fruit (0.722656) [ x: 64, y: 16, width: 8, height: 8 ]
```

Ln 48, Col 29 XIAO_ESP32S3 on /dev/cu.usbmodem2101



Detecting Objects using TinyML (FOMO)



MicroPython



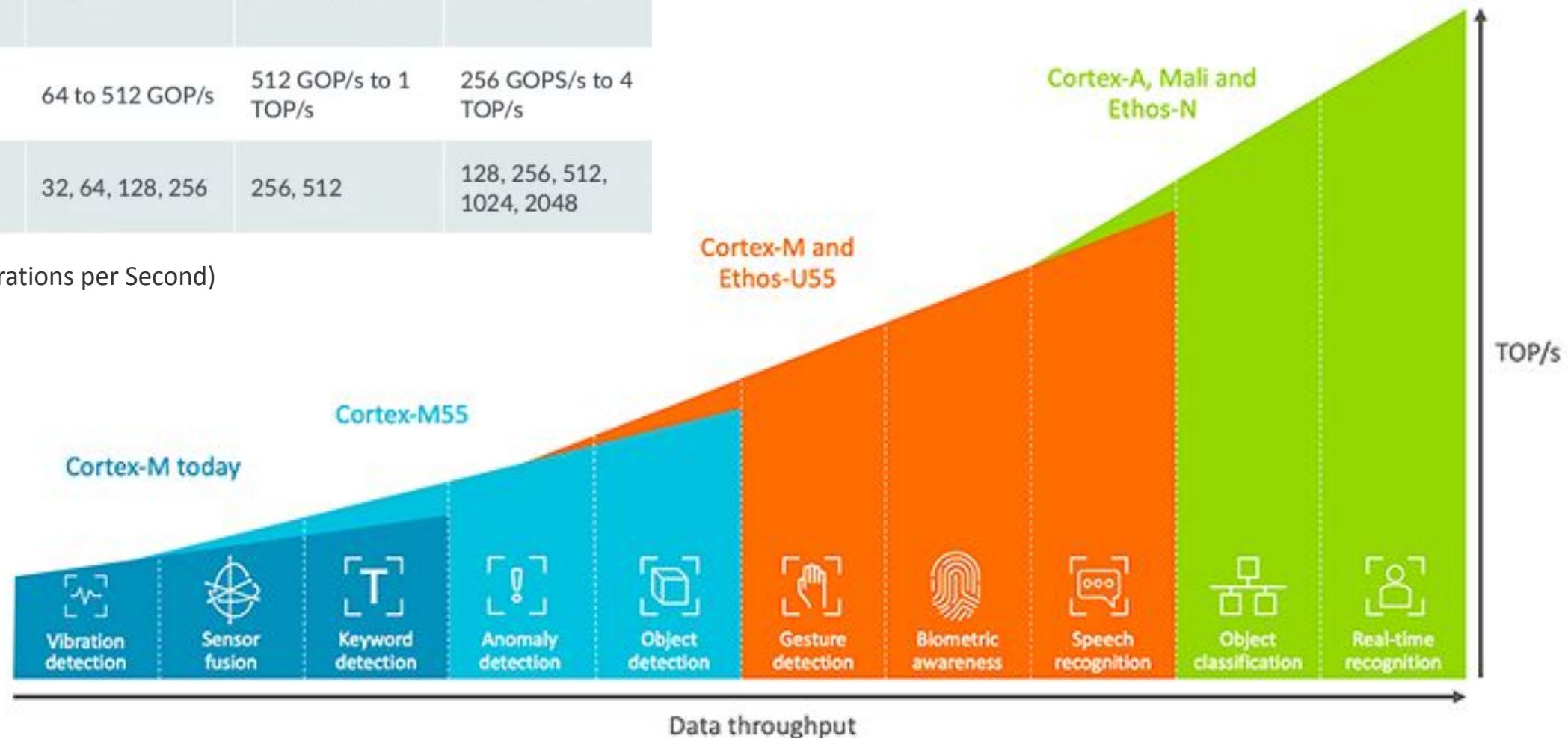
microNPU

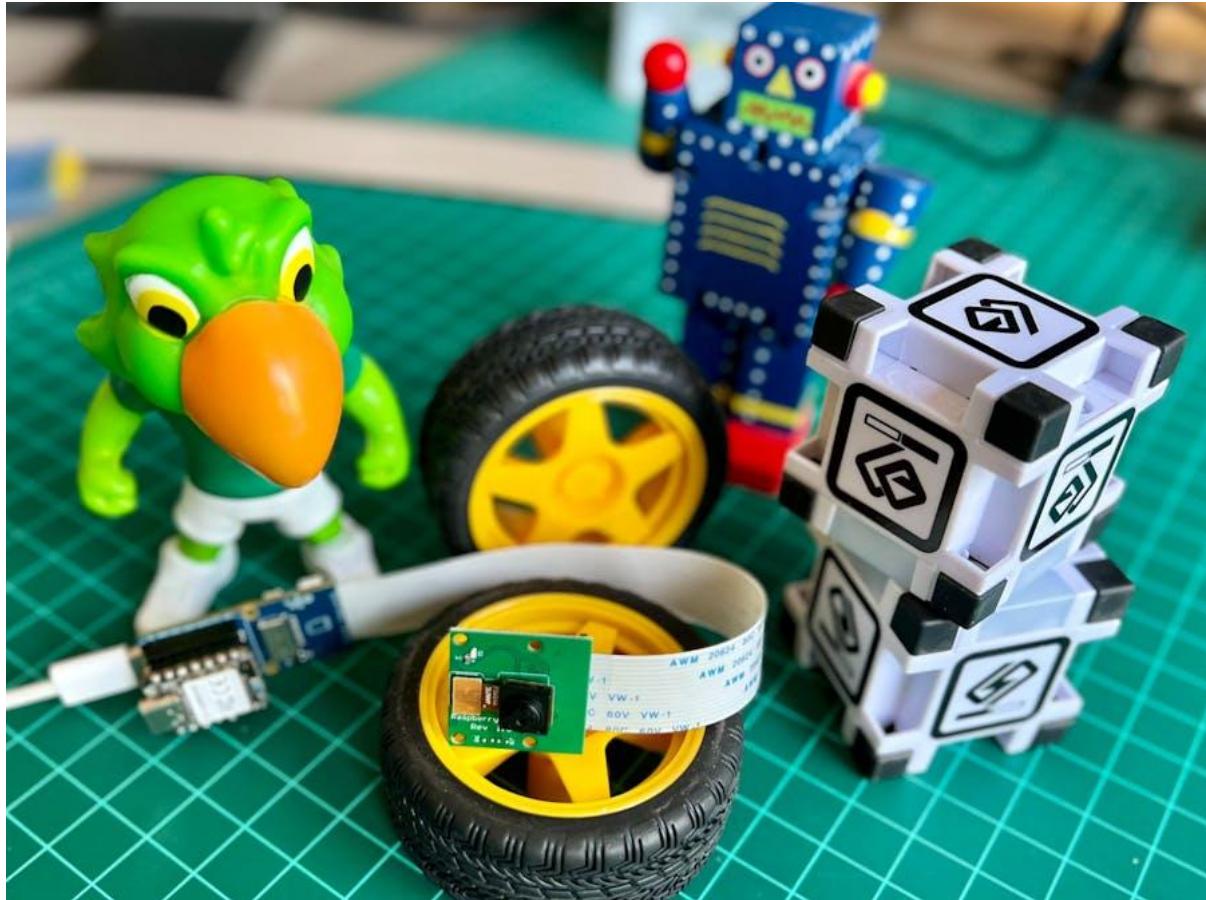
a neural network unit for TinyML

ML- optimized Solutions

	Ethos-U55	Ethos-U65	Ethos-U85
Performance (At 1 GHz)	64 to 512 GOP/s	512 GOP/s to 1 TOP/s	256 GOPS/s to 4 TOP/s
MACs (8x8)	32, 64, 128, 256	256, 512	128, 256, 512, 1024, 2048

TOPS (Tera Operations per Second)

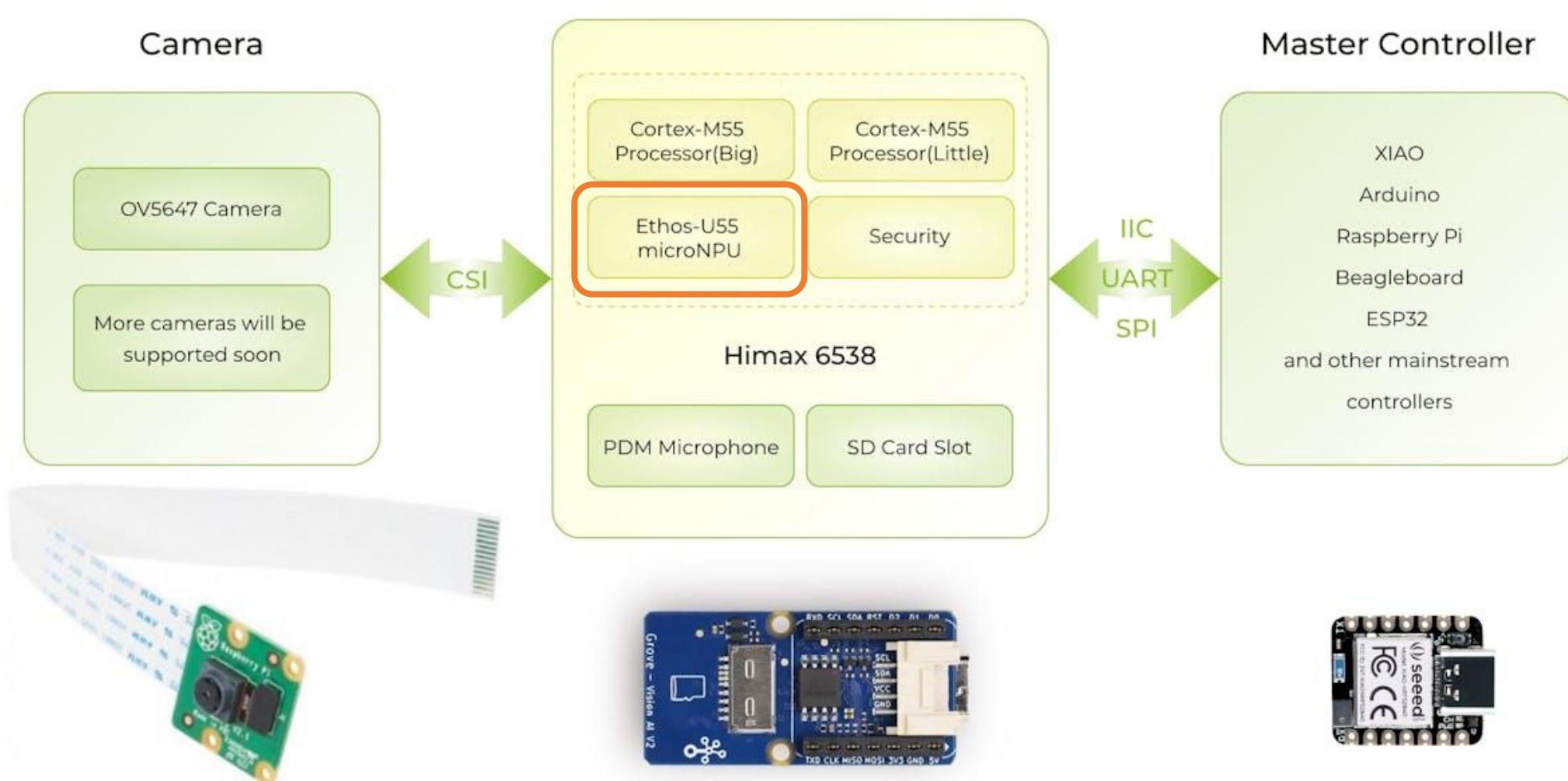


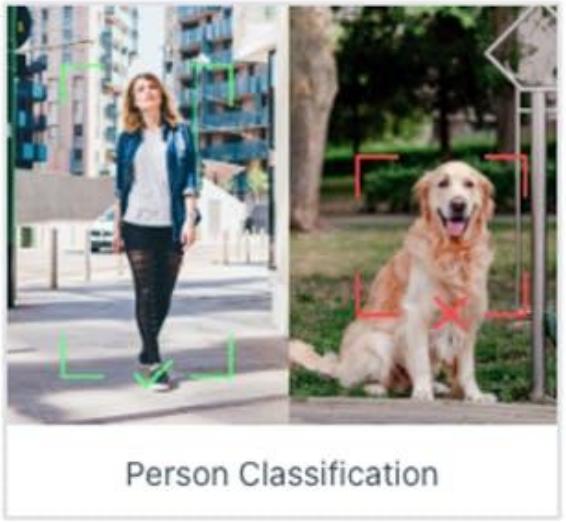


Computer Vision at the Edge with Grove Vision AI Module V2

Exploring Computer Vision applications such as Image Classification, Object Detection, and Pose estimation.

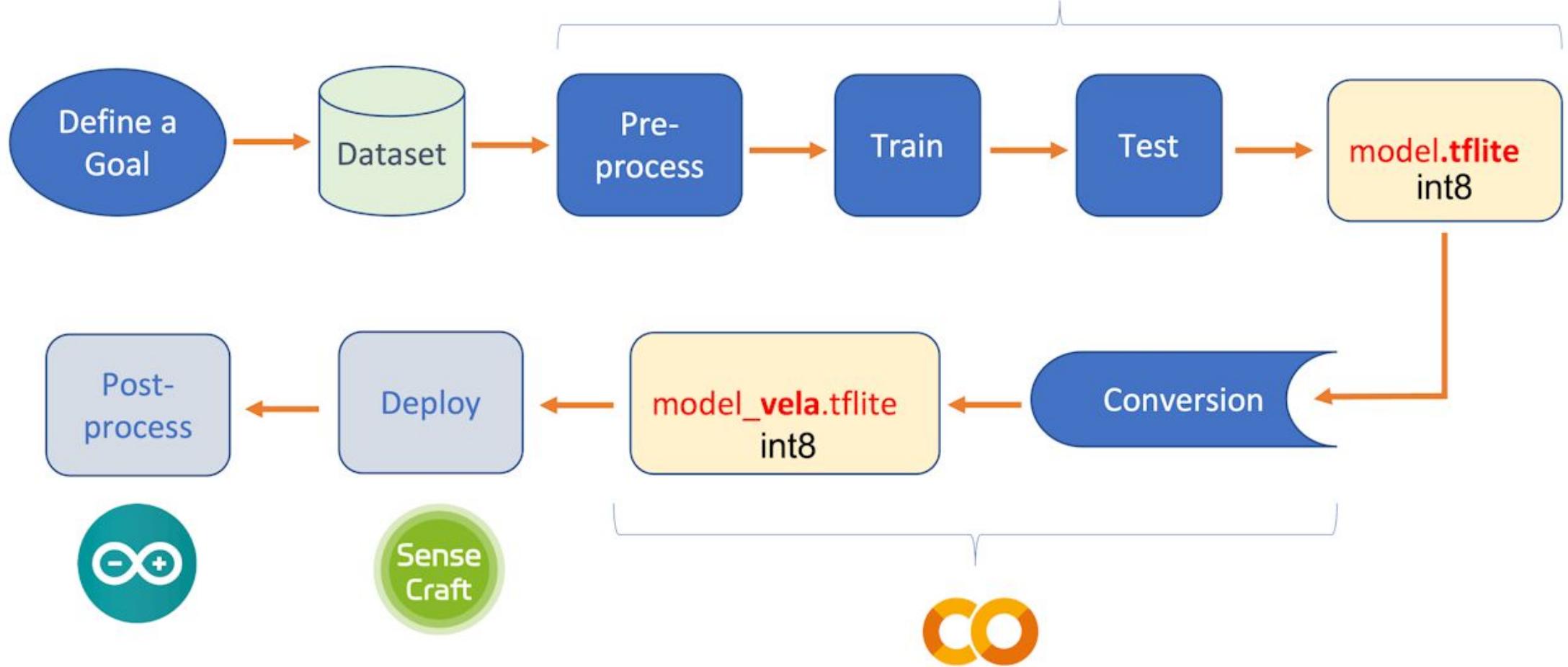
Grove Vision AI v2







EDGE IMPULSE





Classification: 687 ms

1.5 FPS



ESP - CAM
Xtensa LX6
240 MHz



Classification: 142 ms

7.0 FPS



XIAO ESP32S3
Xtensa LX7
240 MHz



Classification: 86 ms

11.6 FPS



Nicla-Vision
ARM M7
480 MHz



Classification: 83 ms

12.0 FPS



Portenta H7
ARM M7
480 MHz



Classification: 6 ms

167 FPS



Grove Vision AI V2
ARM Ethus-U55
400 MHz

450mW

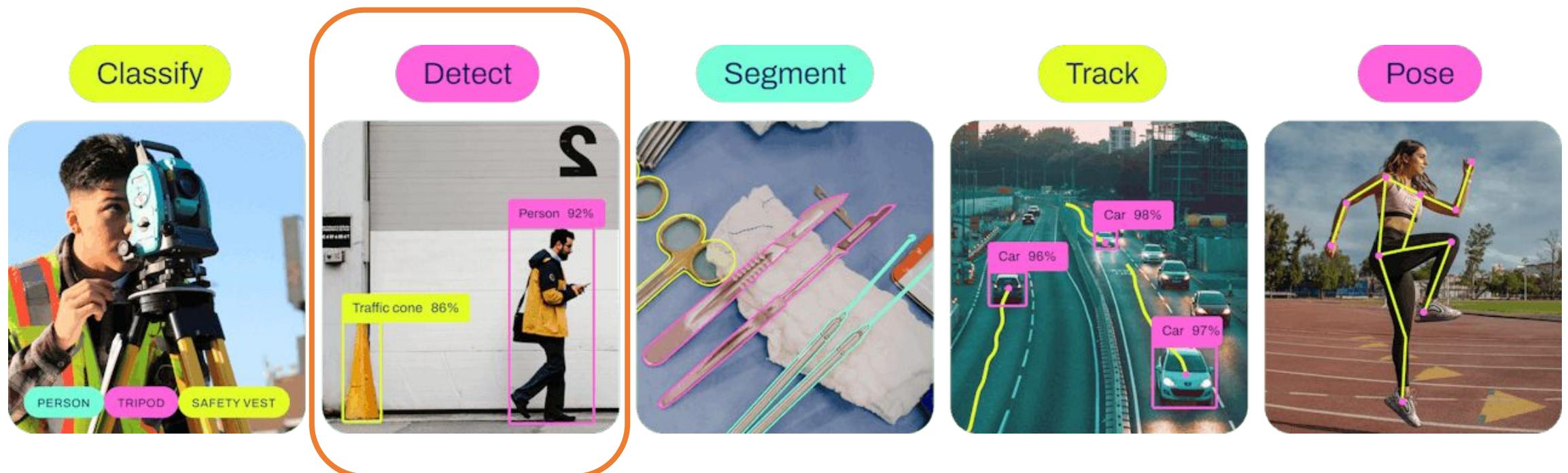
590mW

350mW

YOLO

Object Detection Model for Bee Counting

Ultralytics YOLO (You Only Look Once)



Real-time **object detection** systems that identify and classify many objects **very fast** in a single image pass.



BuzzTech: Machine Learning at the Edge

Deploying YOLOv8 on Raspberry Pi Zero 2W for Real-Time Bee Counting at the Hive Entrance.

Goal: Estimate the number of bees

Number of objects: 15 bees

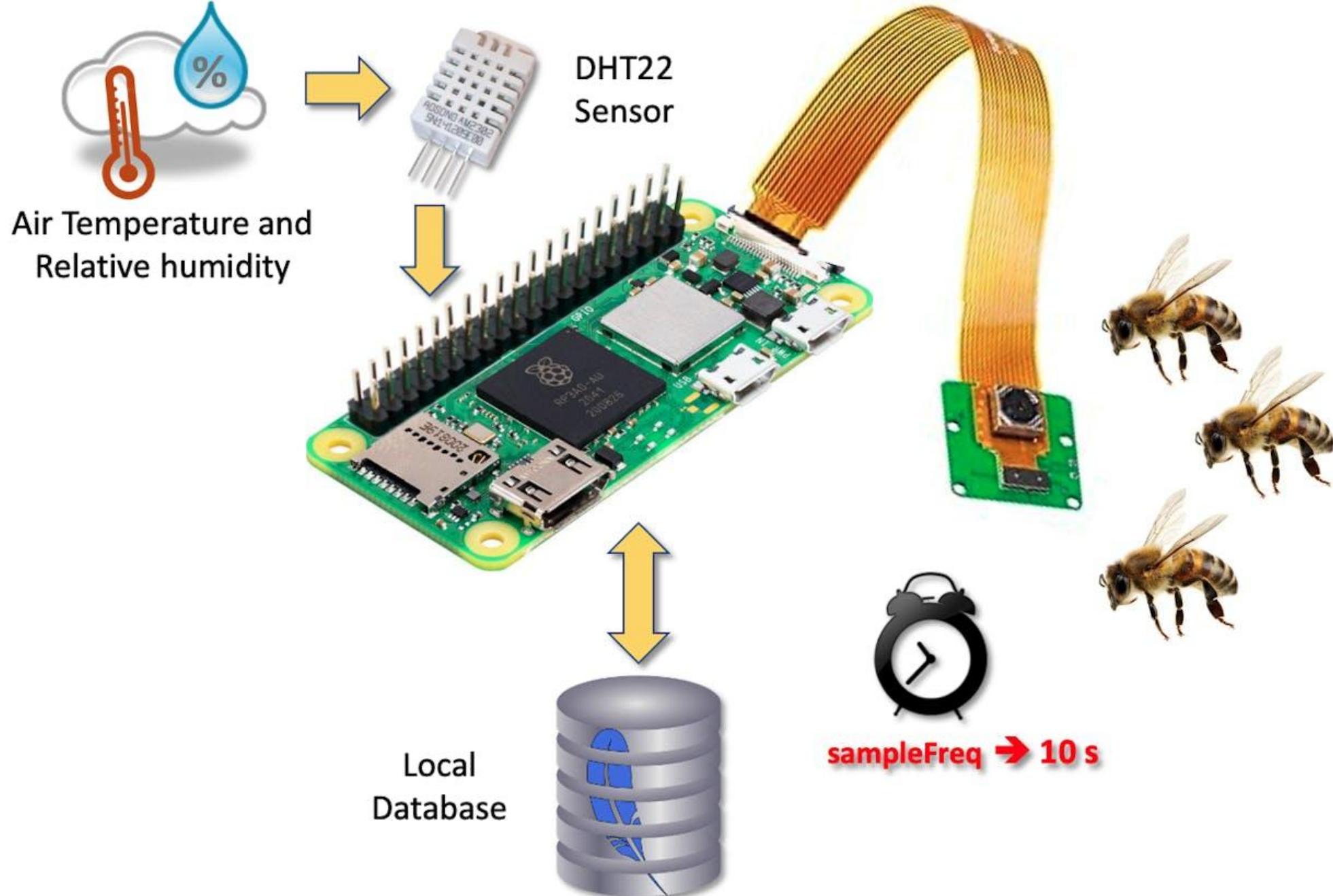


Number of objects: 36 bees



Number of objects: 28 bees





Create Project

https://app.roboflow.com/marcelo-rovali-riila/create

roboflow

Let's create your project.

Marcelo Rovai > New Public Project

Project Name: Bees_on_Hive_Landing_boards

License: CC BY 4.0

Annotation Group: bees

Project Type:

- Object Detection**: Identify objects and their positions with bounding boxes.
Best For: # Counting, % Tracking
- Classification**: Assign labels to the entire image.
Classification Type: Multi-Label (selected), Single-Label
Best For: Filtering, Content Moderation
- Instance Segmentation**: Detect multiple objects and their actual shape.
Best For: Measurements, Odd Shapes
- Keypoint Detection**: Identify keypoints ("skeletons") to subjects.
Best For: Pose Estimation

Show More ↓

Cancel Create Public Project

Bees_on_Hive_landing_board

https://app.roboflow.com/marcelo-rovali-riila/bees_on_hive_landing_boards/images/34IC4TuHjkc5VtUNSKxC?queryText=&pageSize=50&startingIndex=0&browseQuer... ☆

BEES_ON_HIVE_LANDING_BOARDS > ANNOTATE
20230711b6510.jpg

Annotations
Group: bees-4uet
CLASSES LAYERS
bee 26

Annotation Editor
bee
Delete Save (Enter)

1 bee

Options ▾

Labels Attributes Comments History Raw Data

Tags
No Tags Applied
Type and select tags below to add them to the image.

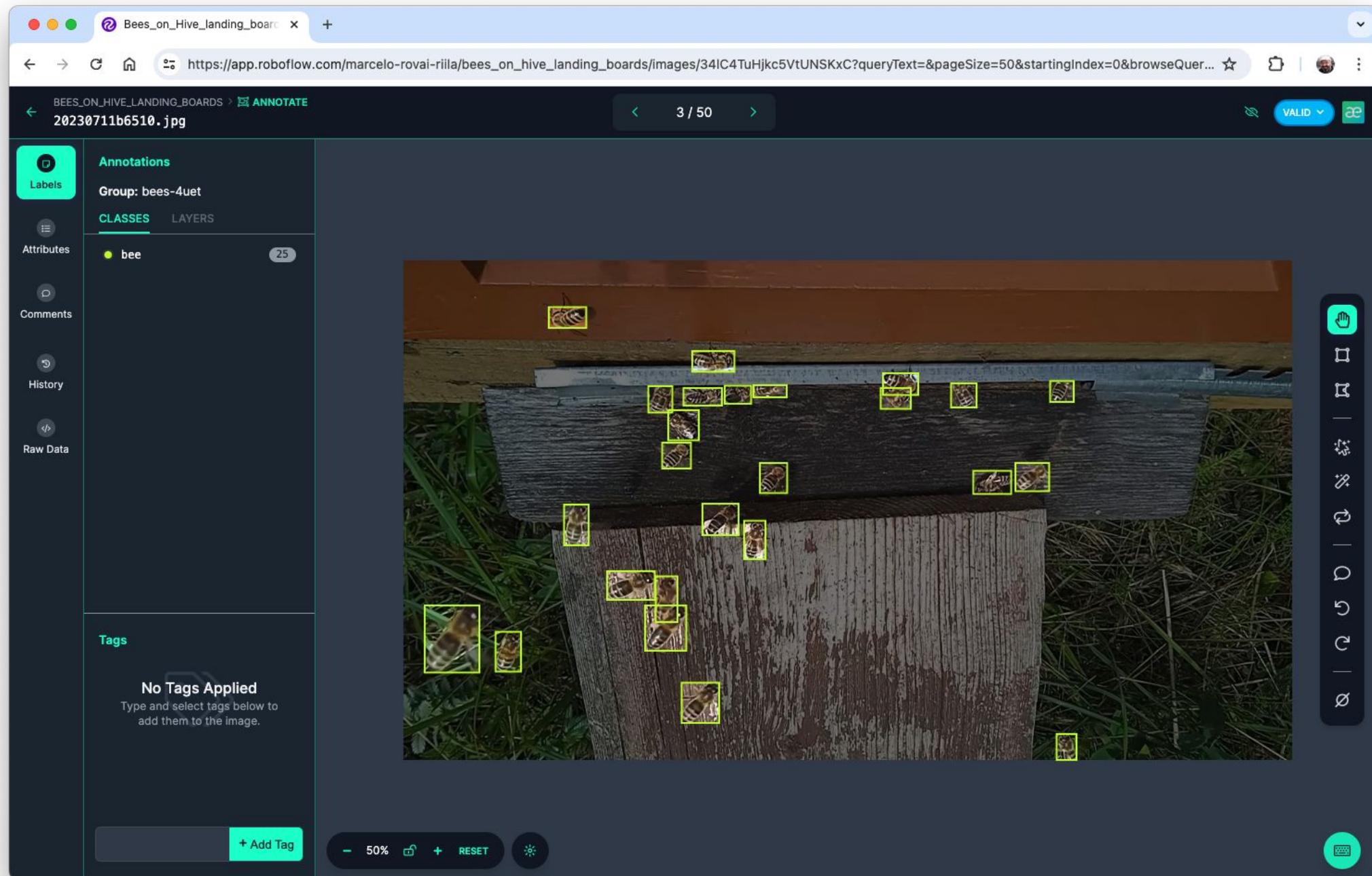
+ Add Tag - 50% + RESET

VALID ae

Hand Selection Tool

Image of a wooden beehive entrance with several bees on the landing board. Annotations are shown as yellow boxes around individual bees.

The screenshot shows a Roboflow annotation interface for a dataset named "Bees_on_Hive_landing_boards". The main view displays a photograph of a beehive entrance with multiple bees on the wooden landing board. Yellow bounding boxes have been drawn around most of the bees to identify them. An "Annotation Editor" window is open, showing the class "bee" selected. A toolbar on the right provides various annotation tools like selection, cropping, and drawing. The left sidebar includes sections for Labels, Attributes, Comments, History, and Raw Data. The bottom navigation bar includes zoom controls and a keyboard icon.



yolov8_beans_on_hive_landing_board.ipynb

File Edit View Insert Runtime Tools Help All changes saved

Comment Share Gemini

RAM Disk Gemini

Files

{x} content datasets Bees_on_Hive_landing_b... test images labels train images labels valid images labels README.dataset.txt README.roboflow.txt data.yaml

+ Code + Text

```
[ ] 1 from ultralytics import YOLO  
2  
3 from IPython.display import display, Image
```

Dataset

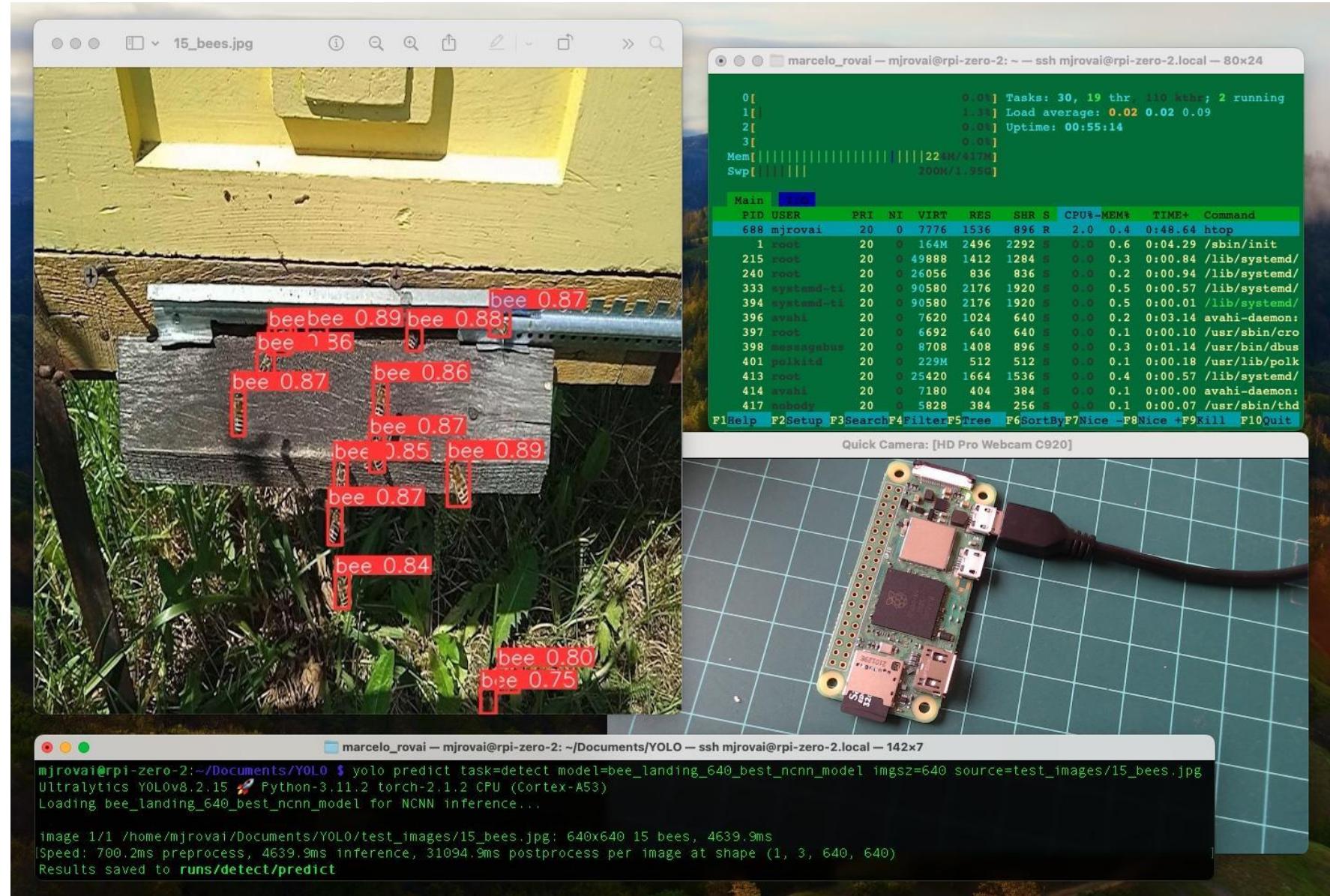
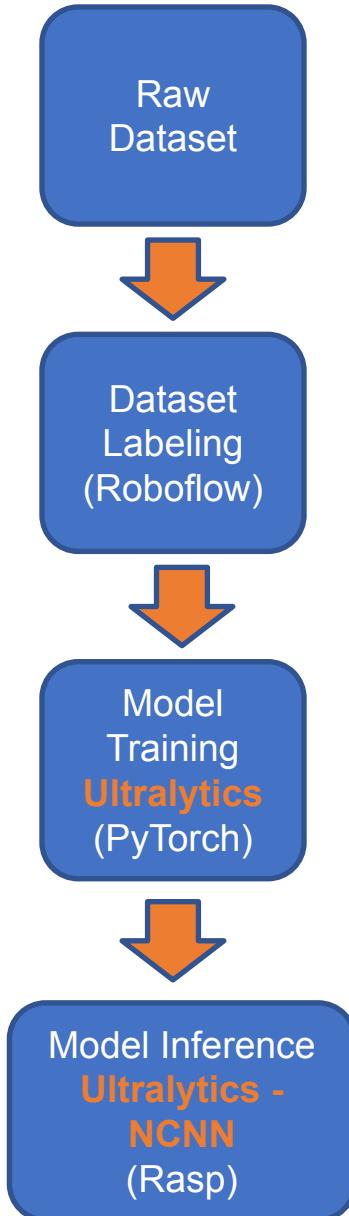
```
1 !mkdir {HOME}/datasets  
2 %cd {HOME}/datasets  
3  
4 !pip install roboflow --quiet  
5  
6 from roboflow import Roboflow  
7 rf = Roboflow(api_key="YOUR KEY HERE")  
8 project = rf.workspace("marcelo-rovai-riila").project("bees_on_hive_landing_boards")  
9 version = project.version(1)  
10 dataset = version.download("yolov8")  
11
```

```
/content/datasets
```

```
75.5/75.5 kB 3.6 MB/s eta 0:00:00  
158.3/158.3 kB 7.7 MB/s eta 0:00:00  
178.7/178.7 kB 8.3 MB/s eta 0:00:00  
58.8/58.8 kB 6.9 MB/s eta 0:00:00  
49.1/49.1 MB 16.7 MB/s eta 0:00:00  
54.5/54.5 kB 7.1 MB/s eta 0:00:00
```

```
loading Roboflow workspace...  
loading Roboflow project...  
Dependency ultralytics==8.0.196 is required but found version=8.2.23, to fix: 'pip install ultralytics==8.0.196'  
Downloading Dataset Version Zip in Bees_on_Hive_landing_boards-1 to yolov8:: 100%|██████████| 1597328/1597328 [00:09<00:00]  
Extracting Dataset Version Zip to Bees_on_Hive_landing_boards-1 in yolov8:: 100%|██████████| 32468/32468 [00:09<00:00]
```

50s completed at 8:46AM



Thanks



TINYML4D