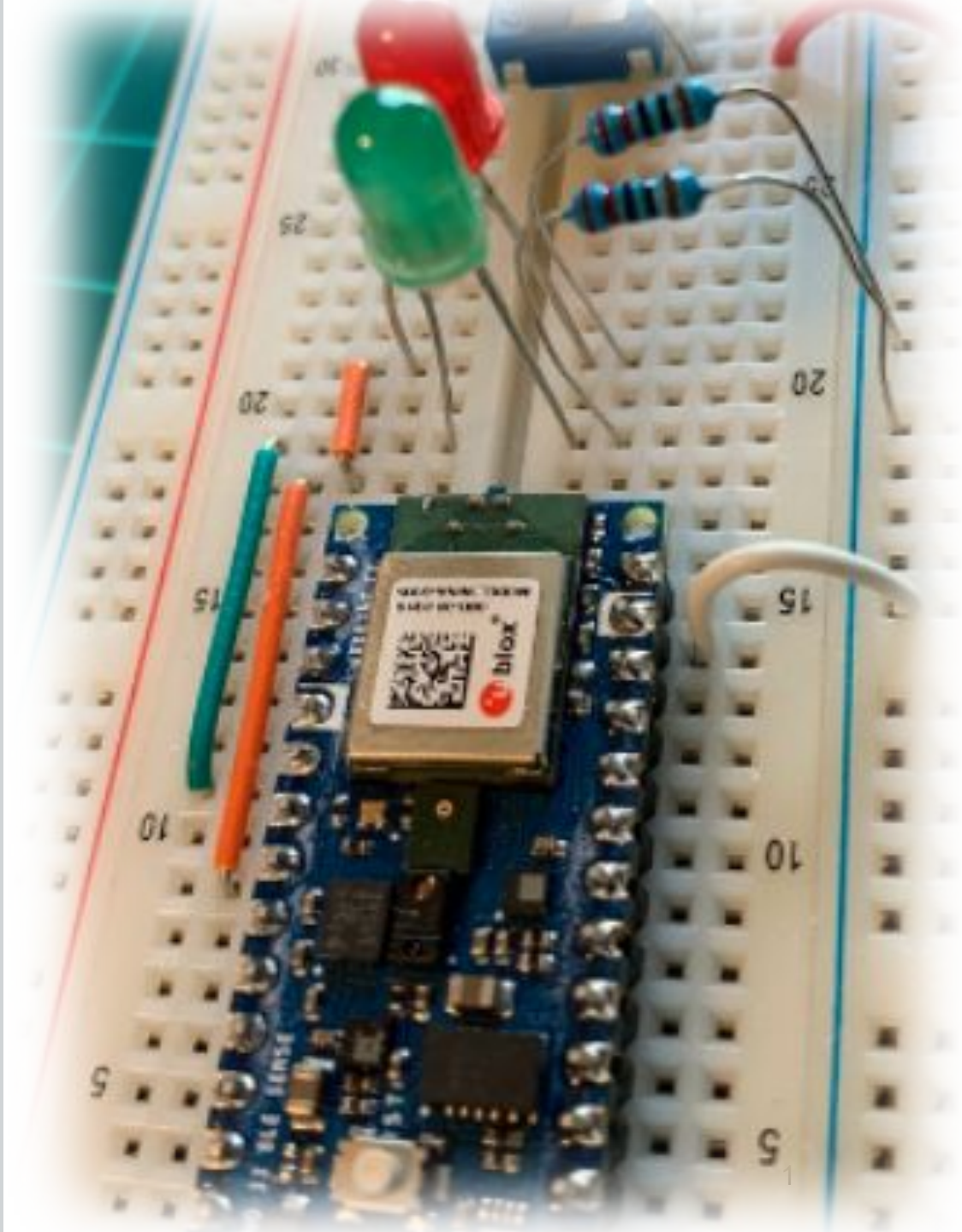
IESTI01 – TinyML

Embedded Machine Learning

12. Introduction to Edge Impulse – CNN with Cifar-10

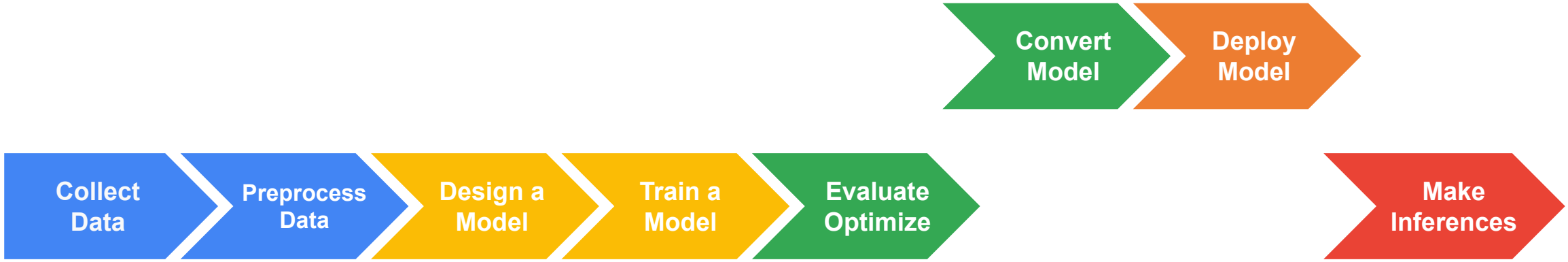


Prof. Marcelo Rovai
UNIFEI

Embedded Machine Learning (TinyML) Workflow Review

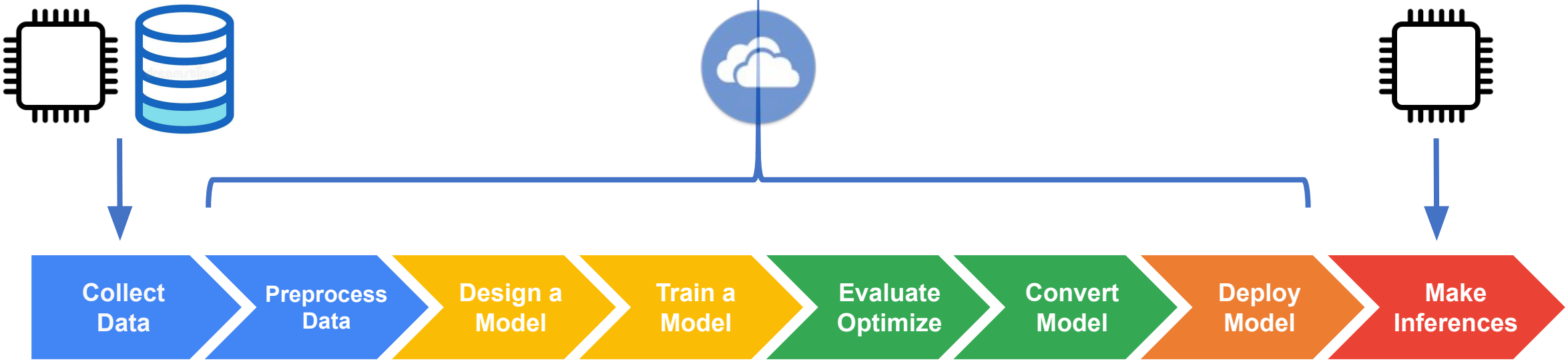
Machine Learning Workflow

Tiny Machine Learning Workflow (“What”)



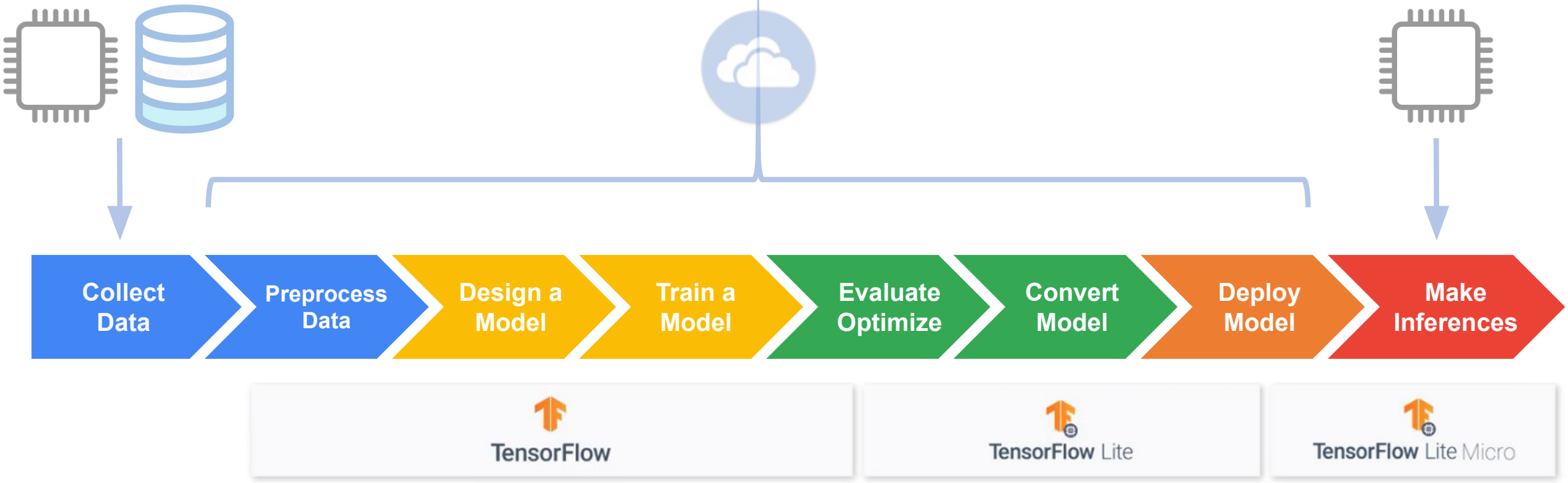
4

Tiny Machine Learning Workflow ("Where")



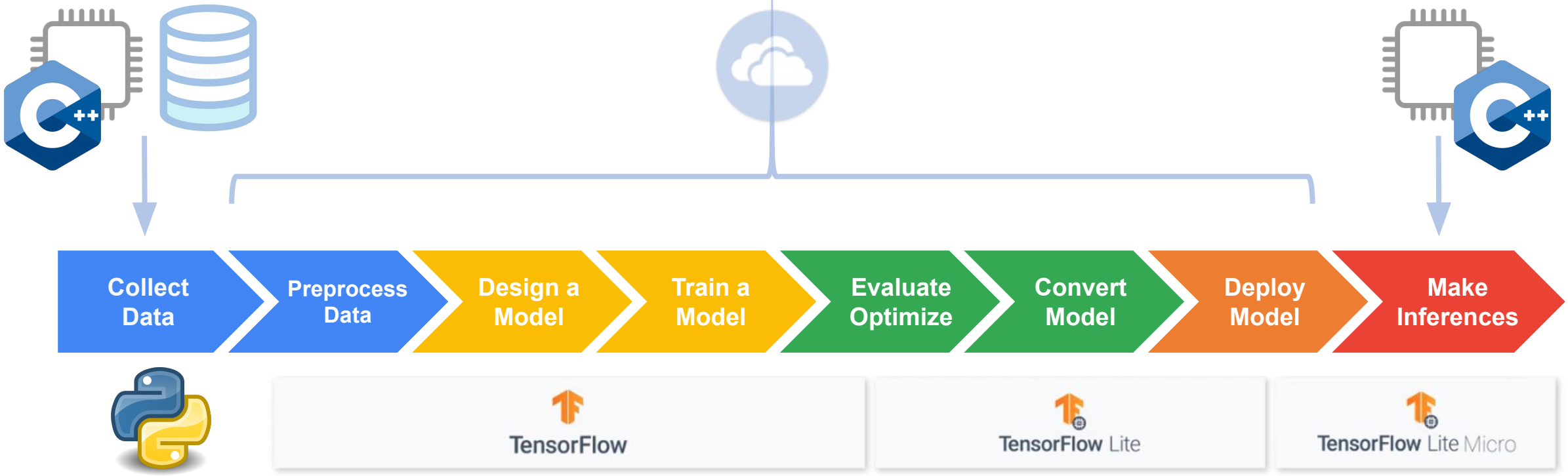
5

Machine Learning Workflow ("How")



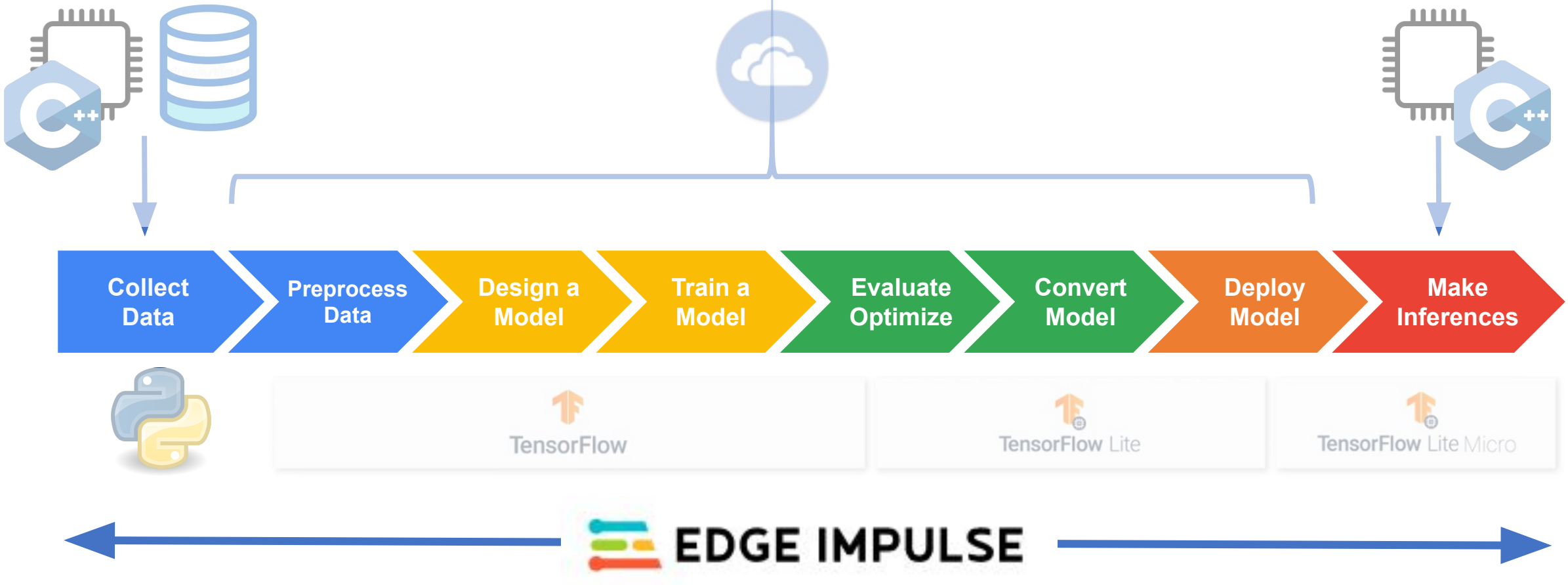
6

Machine Learning Workflow ("How")

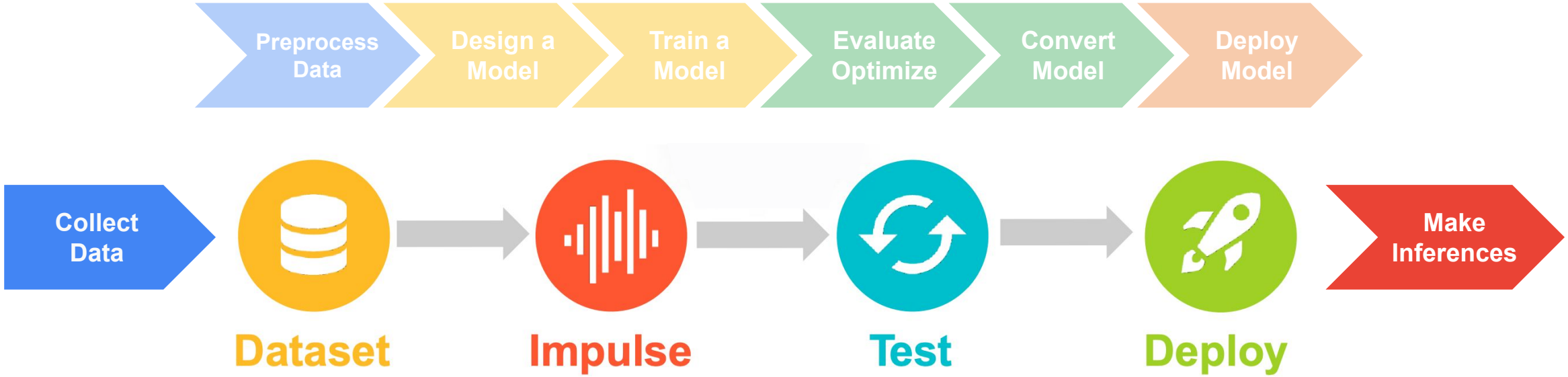


7

Machine Learning Workflow ("How")

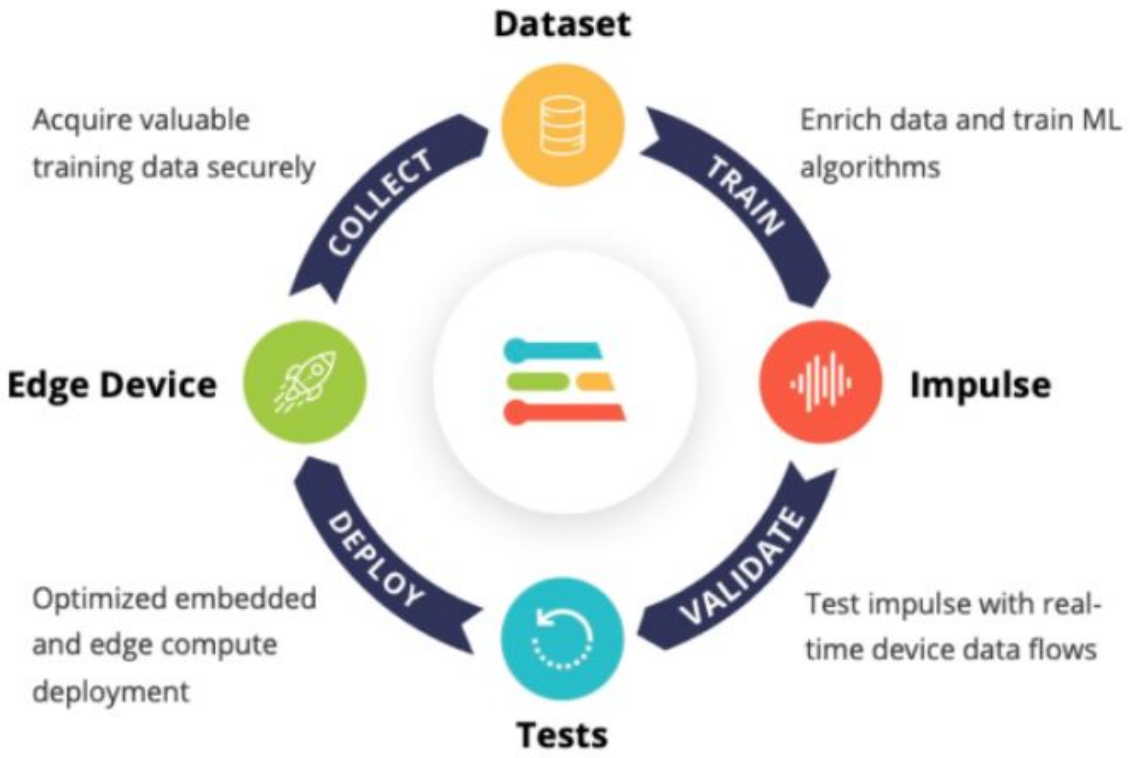


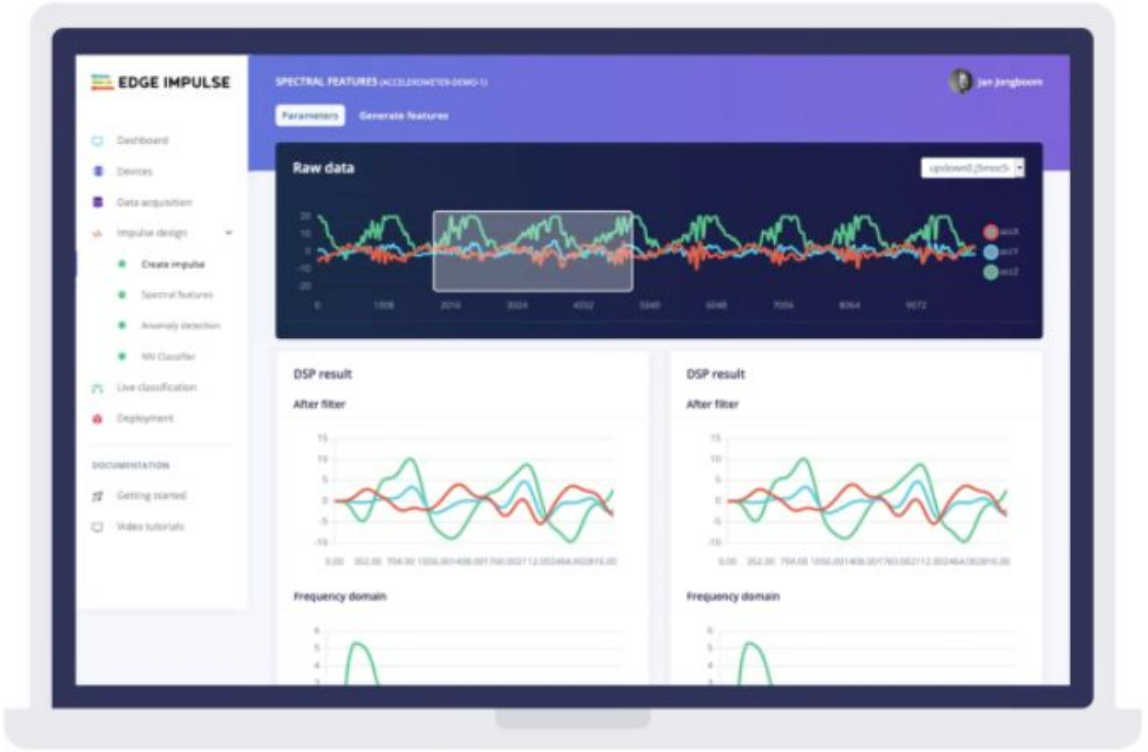
8


Preprocess Data
Design a Model
Train a Model
Evaluate Optimize
Convert Model
Deploy Model
Collect Data
Dataset
Impulse
Test
Deploy
Make Inferences

9

EI Studio - Embedded ML platform ("AutoML")



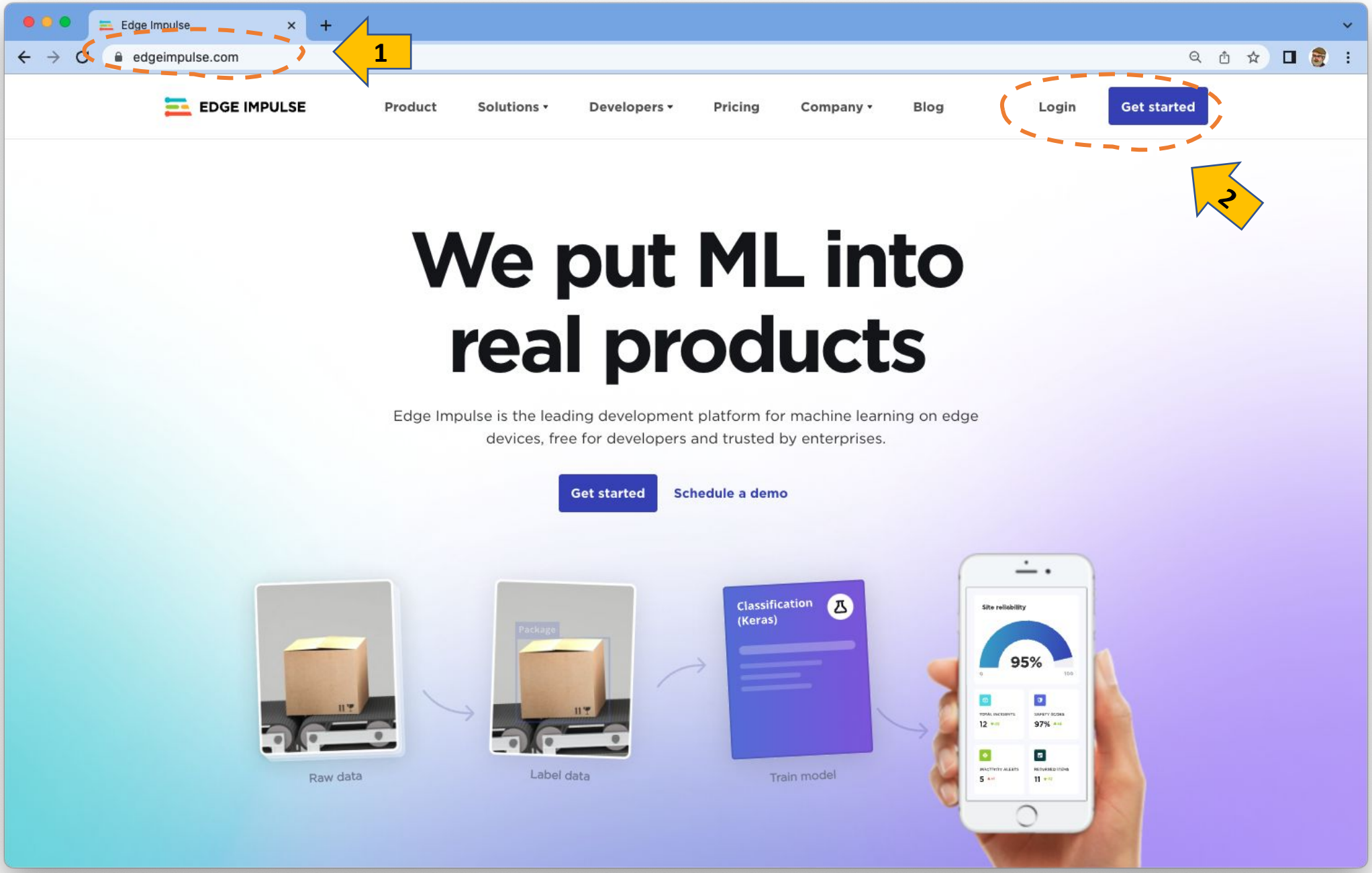


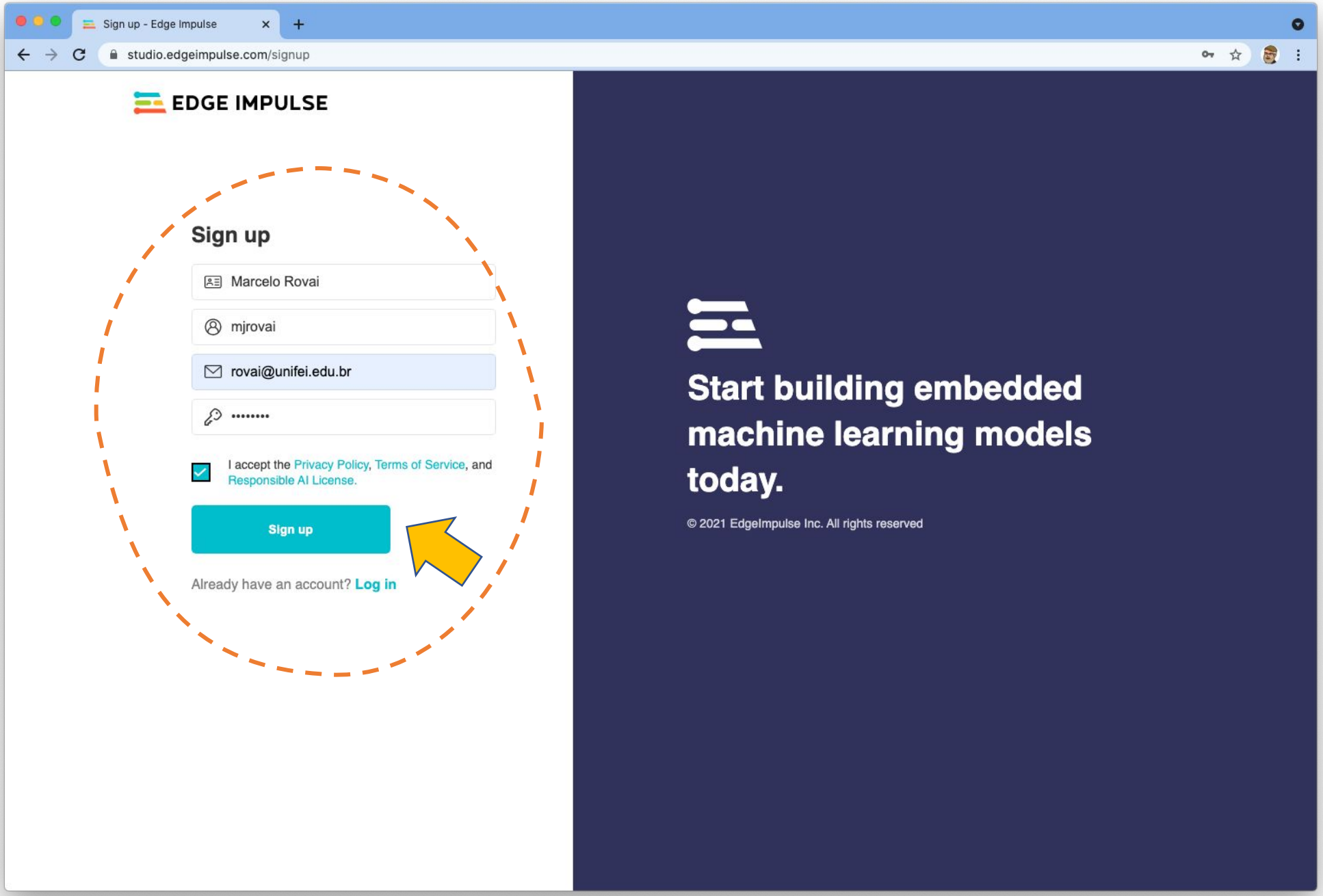
Learn more at http://edgeimpulse.com

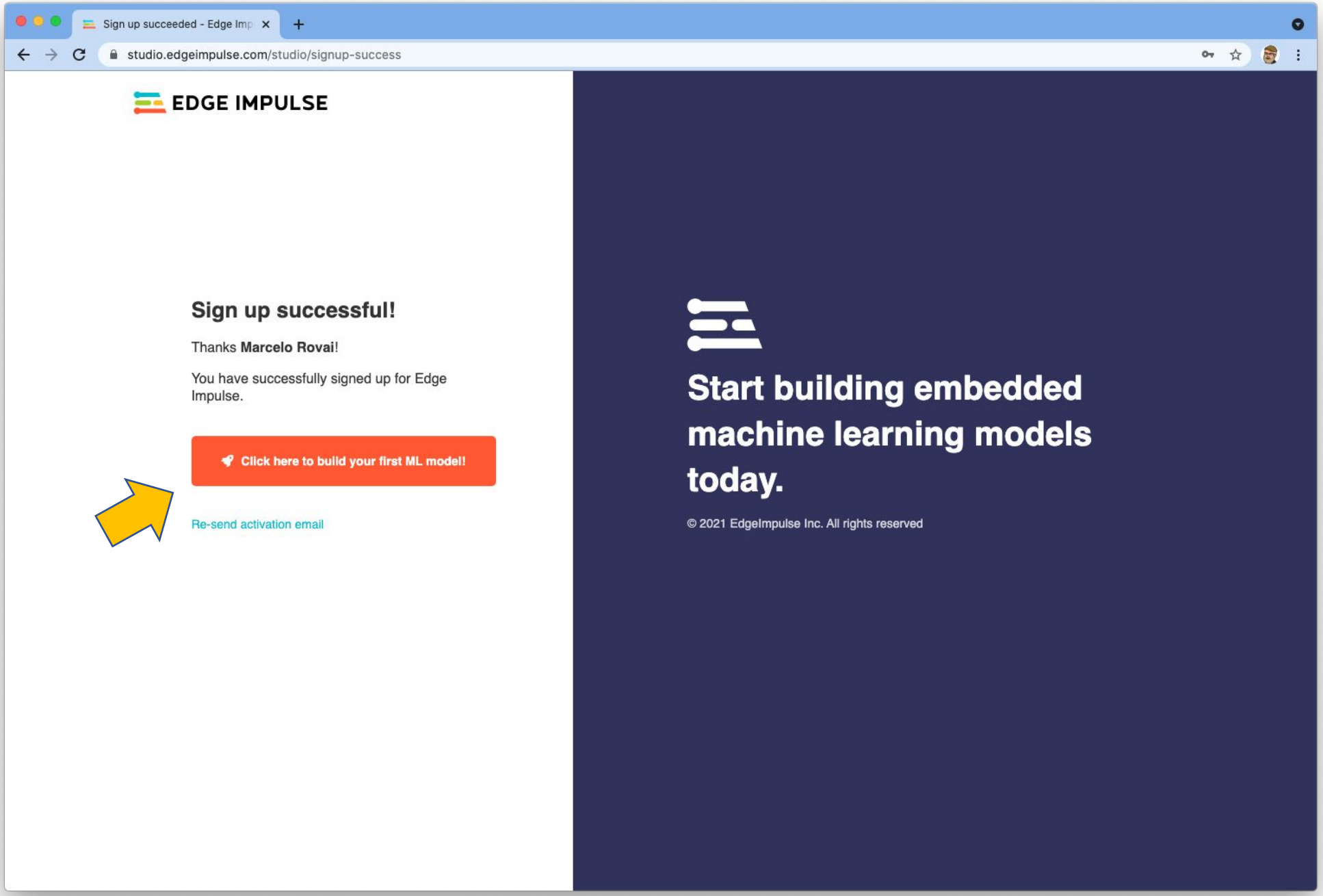
Cifar10
Edge Impulse Studio

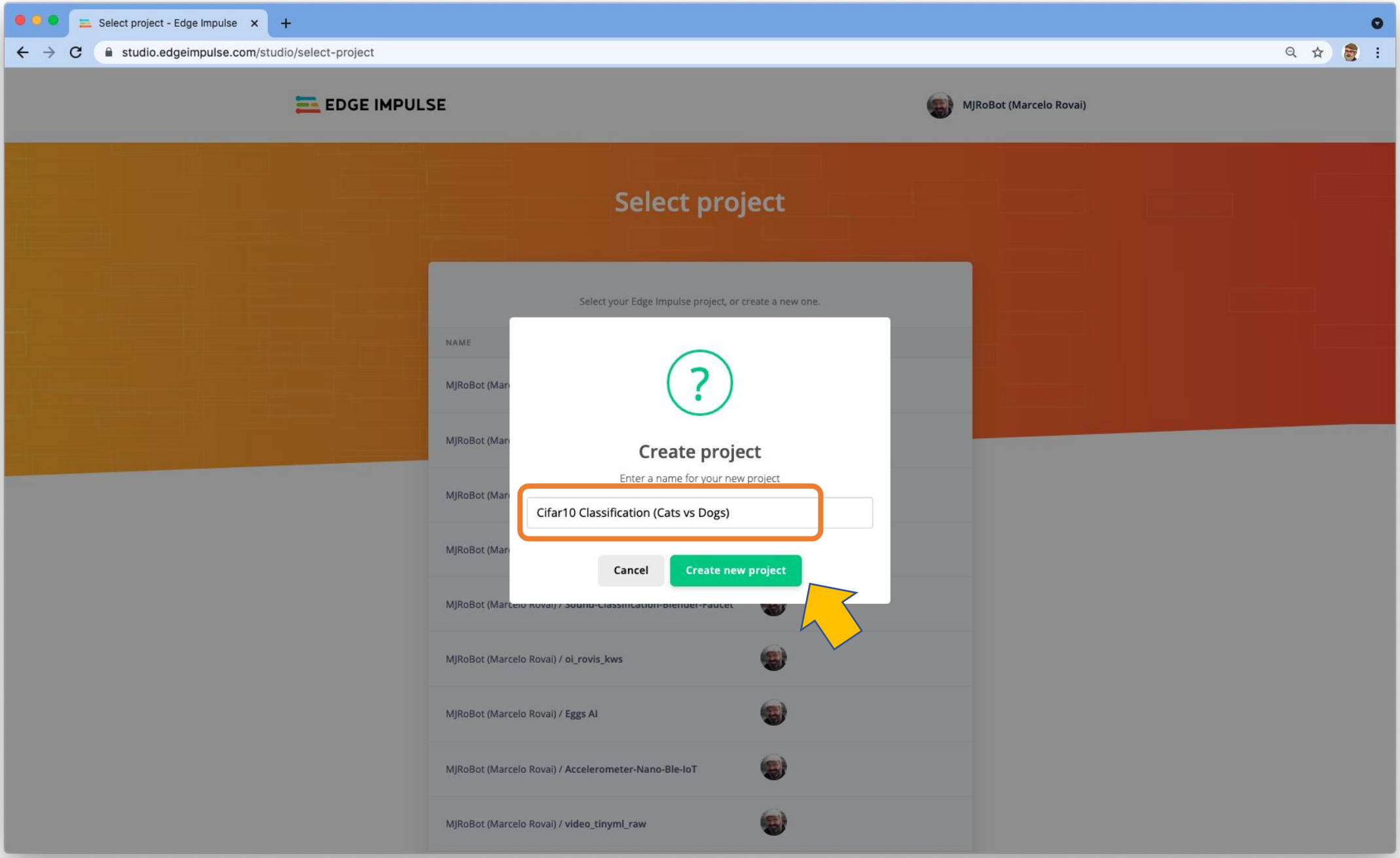
Dataset: https://github.com/YoongiKim/CIFAR-10-images

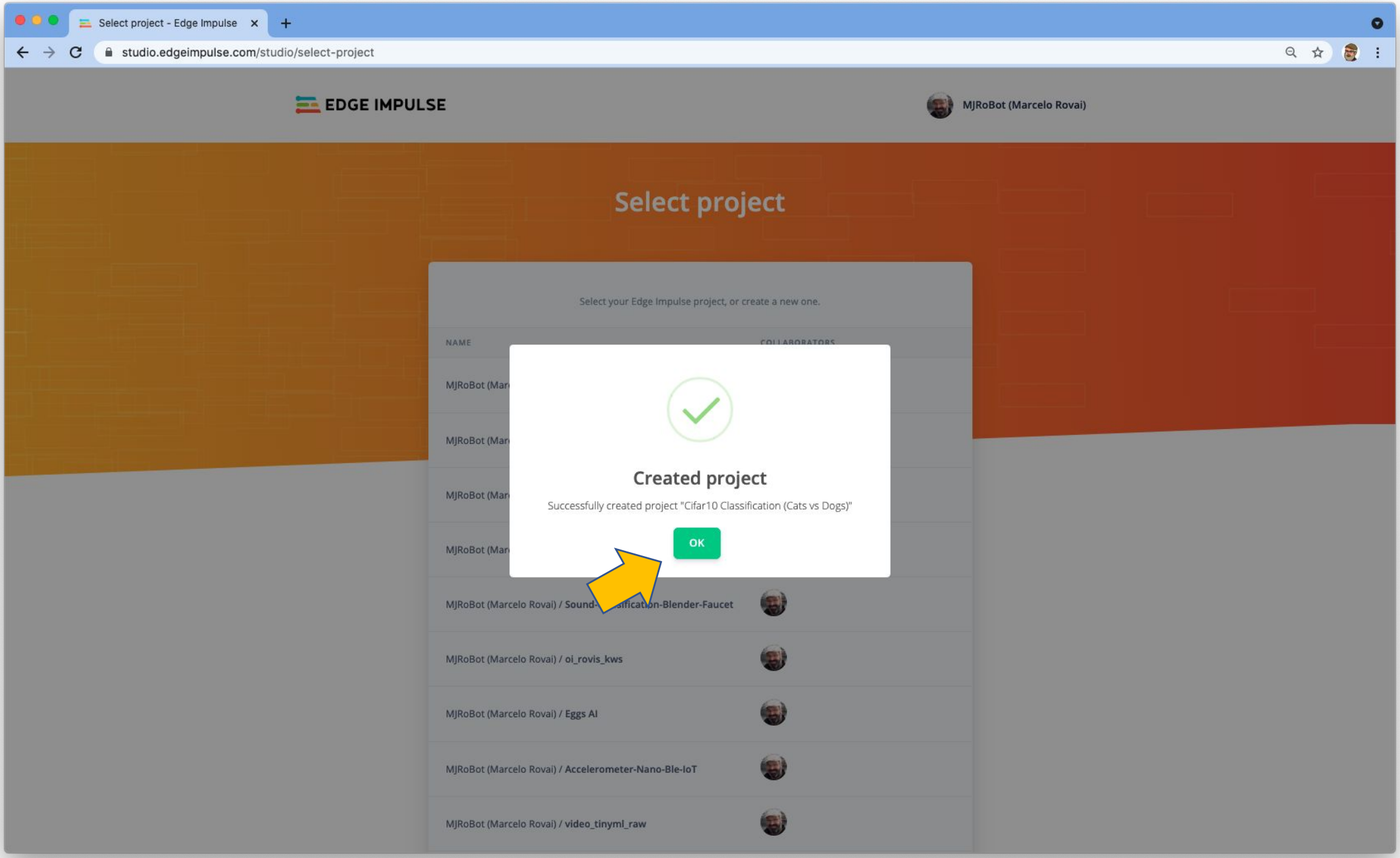
EI Studio Public Project: https://studio.edgeimpulse.com/public/51070/latest

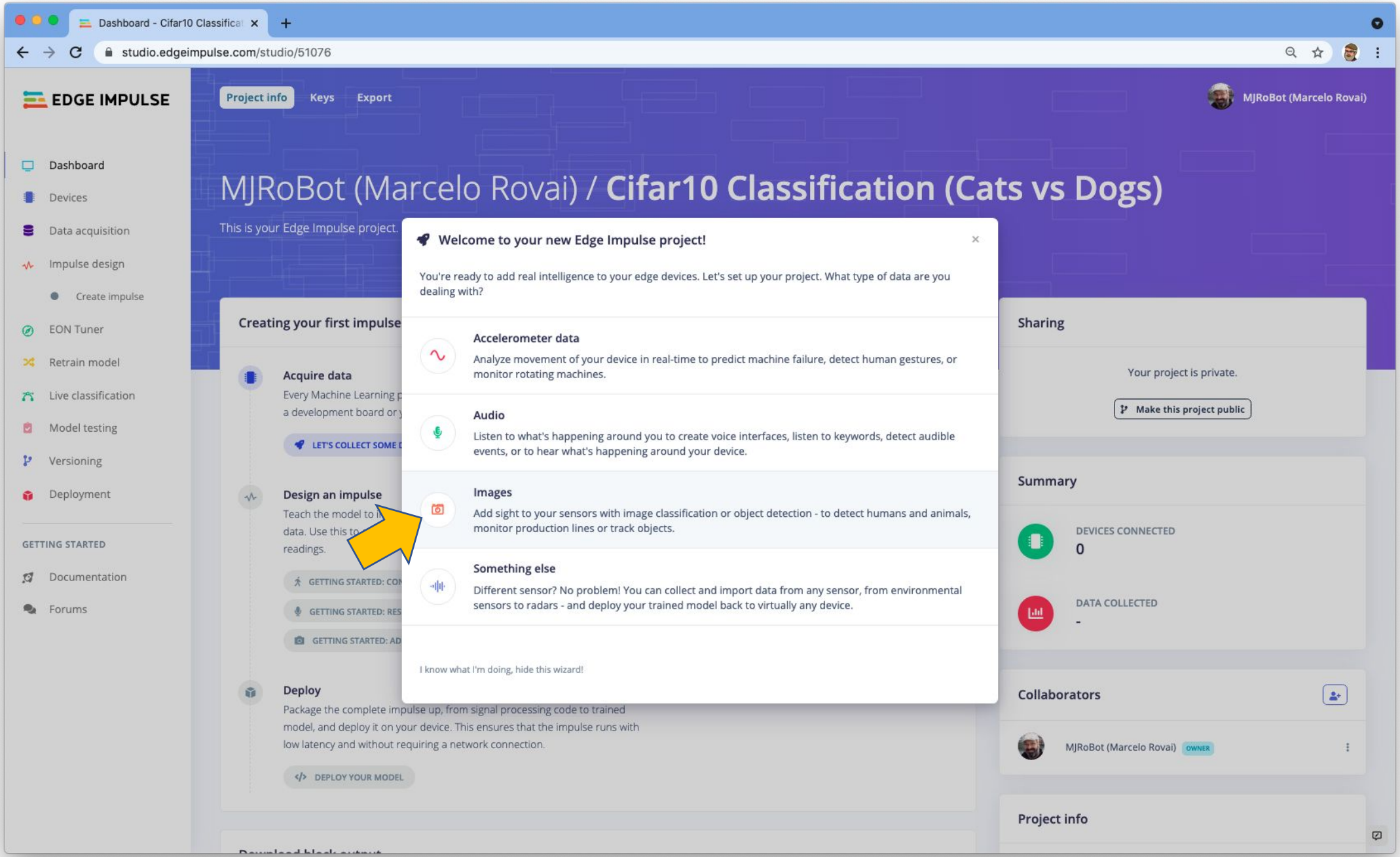

Edge Impulse
edgeimpulse.com
1
EDGE IMPULSE
Product
Solutions
Developers
Pricing
Company
Blog
Login
Get started
2
We put ML into real products
Edge Impulse is the leading development platform for machine learning on edge devices, free for developers and trusted by enterprises.
Get started
Schedule a demo
Raw data
Label data
Classification (Keras)
Train model
Site reliability
95%

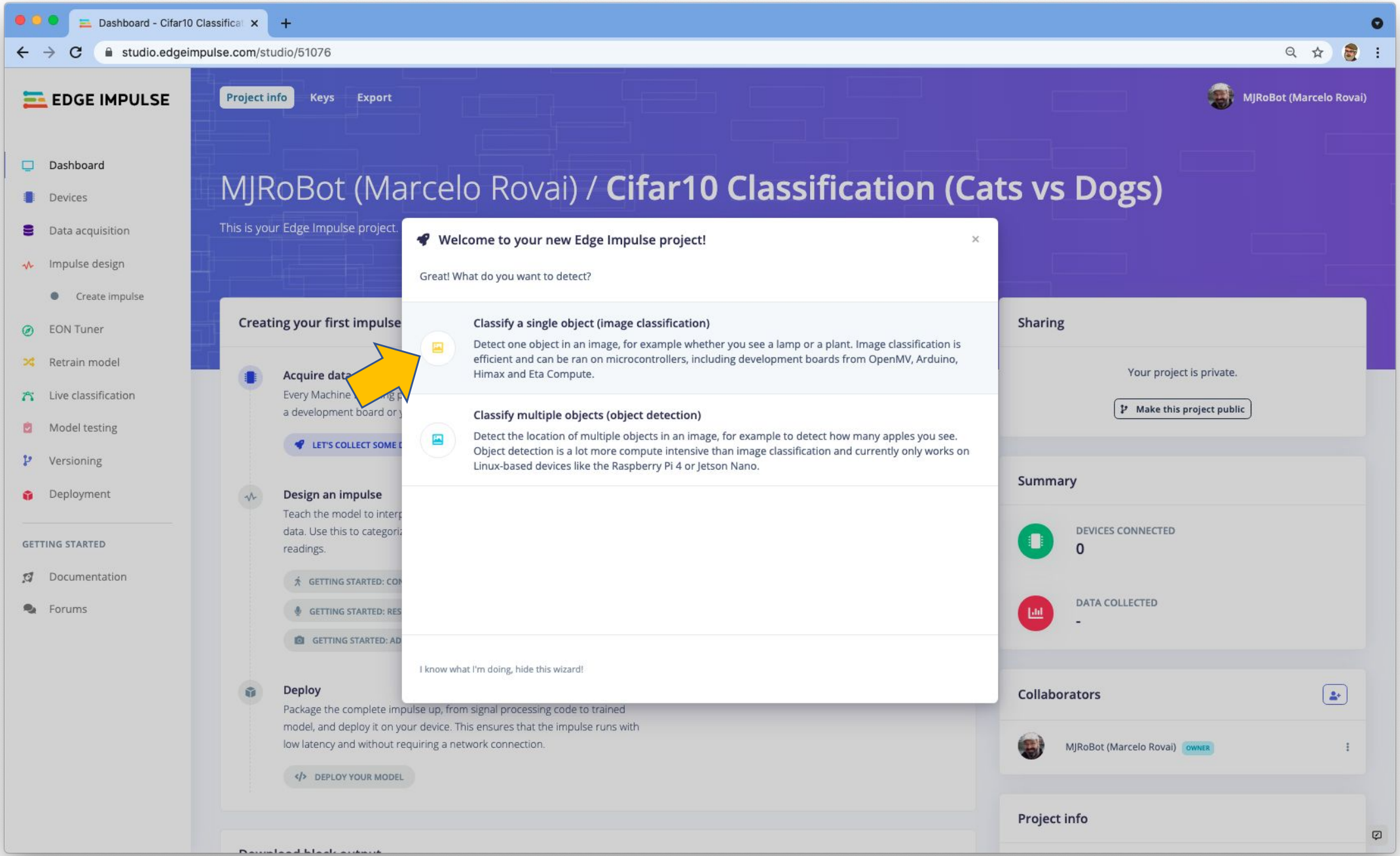

Sign up - Edge Impulse
studio.edgeimpulse.com/signup
EDGE IMPULSE
Sign up
Marcelo Rovai
mjrovai
rovai@unifei.edu.br
I accept the Privacy Policy, Terms of Service, and Responsible AI License.
Sign up
Already have an account? Log in
Start building embedded machine learning models today.
© 2021 EdgeImpulse Inc. All rights reserved

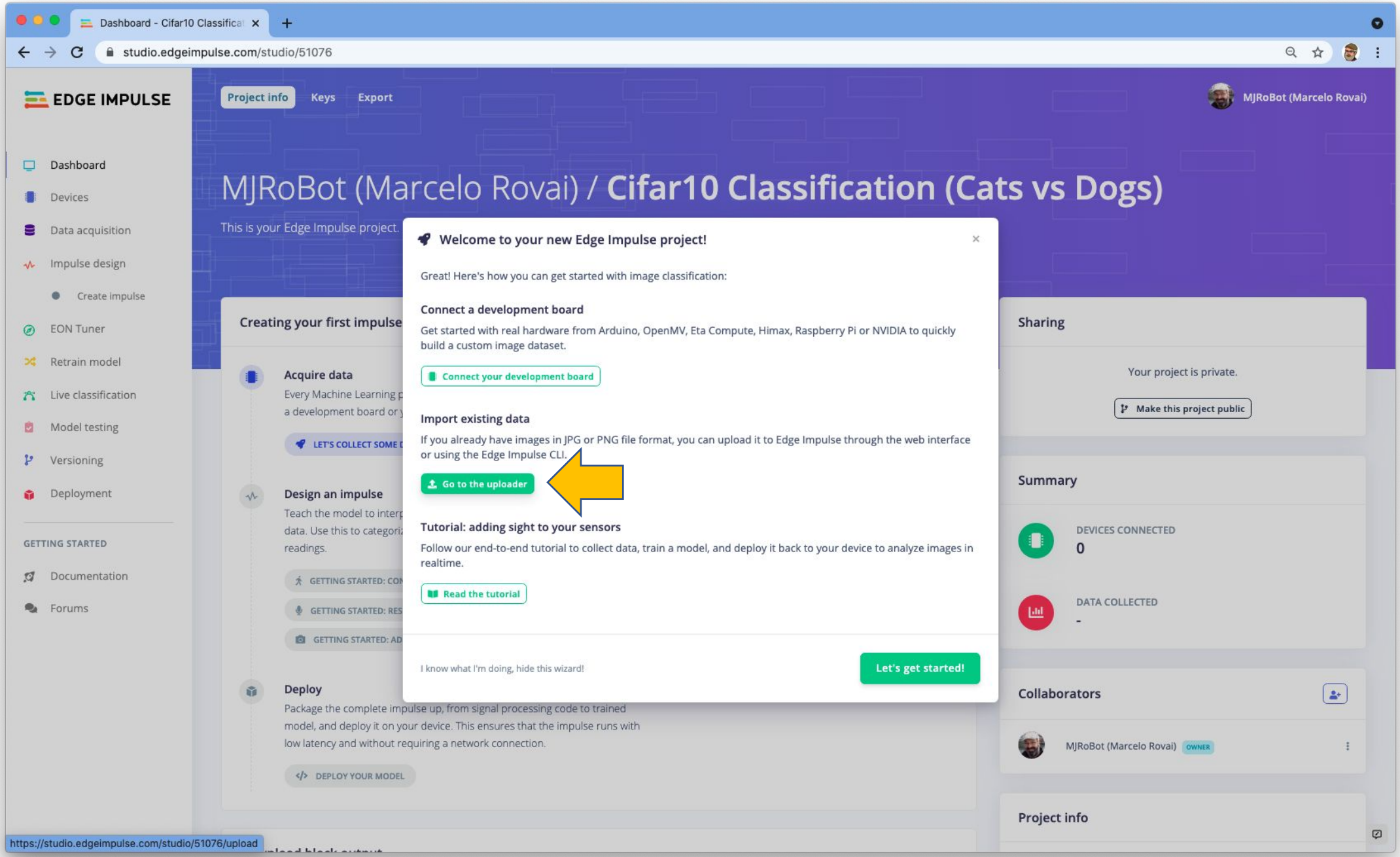

Sign up succeeded - Edge Imp
studio.edgeimpulse.com/studio/signup-success
EDGE IMPULSE
Sign up successful!
Thanks Marcelo Rovai!
You have successfully signed up for Edge Impulse.
Click here to build your first ML model!
Re-send activation email
Start building embedded machine learning models today.
© 2021 EdgeImpulse Inc. All rights reserved

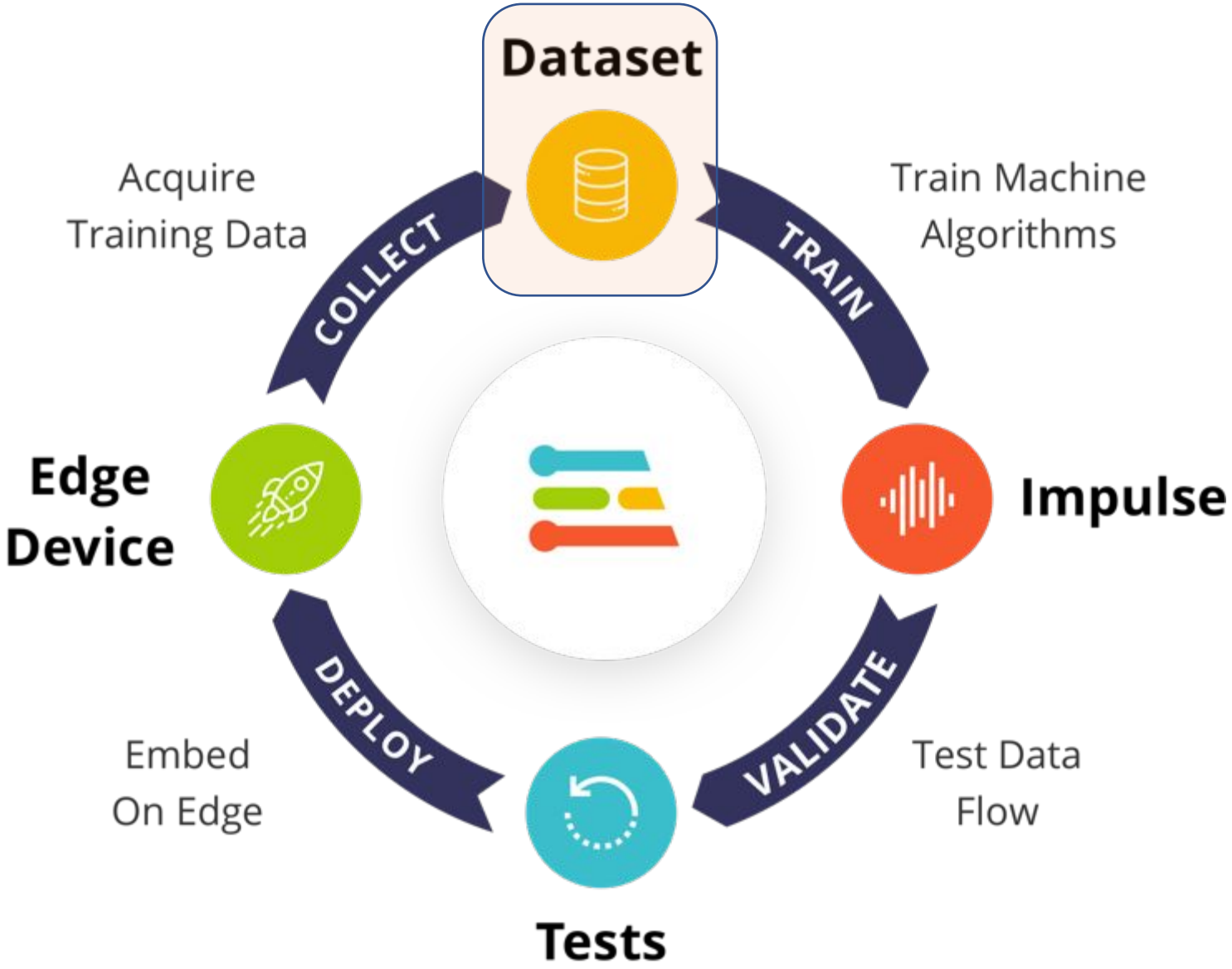

Select project - Edge Impulse
studio.edgeimpulse.com/studio/select-project
EDGE IMPULSE
MJRoBot (Marcelo Rovai)
Select project
Select your Edge Impulse project, or create a new one.
NAME
Create project
Enter a name for your new project
Cifar10 Classification (Cats vs Dogs)
Cancel
Create new project
MJRoBot (Marcelo Rovai) / oi_rovis_kws
MJRoBot (Marcelo Rovai) / Eggs AI
MJRoBot (Marcelo Rovai) / Accelerometer-Nano-Ble-IoT
MJRoBot (Marcelo Rovai) / video_tinyml_raw


Select project - Edge Impulse
studio.edgeimpulse.com/studio/select-project
EDGE IMPULSE
MJRoBot (Marcelo Rovai)
Select project
Select your Edge Impulse project, or create a new one.
NAME
COLLABORATORS
Created project
Successfully created project "Cifar10 Classification (Cats vs Dogs)"
OK
MJRoBot (Marcelo Rovai) / Sound-
sification-Blender-Faucet
MJRoBot (Marcelo Rovai) / oi_rovis_kws
MJRoBot (Marcelo Rovai) / Eggs AI
MJRoBot (Marcelo Rovai) / Accelerometer-Nano-Ble-IoT
MJRoBot (Marcelo Rovai) / video_tinyml_raw


Dashboard - Cifar10 Classifica
studio.edgeimpulse.com/studio/51076
EDGE IMPULSE
Project info
Keys
Export
MJRoBot (Marcelo Rovai)
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
EON Tuner
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
MJRoBot (Marcelo Rovai) / Cifar10 Classification (Cats vs Dogs)
This is your Edge Impulse project.
Welcome to your new Edge Impulse project!
You're ready to add real intelligence to your edge devices. Let's set up your project. What type of data are you dealing with?
Accelerometer data
Analyze movement of your device in real-time to predict machine failure, detect human gestures, or monitor rotating machines.
Audio
Listen to what's happening around you to create voice interfaces, listen to keywords, detect audible events, or to hear what's happening around your device.
Images
Add sight to your sensors with image classification or object detection - to detect humans and animals, monitor production lines or track objects.
Something else
Different sensor? No problem! You can collect and import data from any sensor, from environmental sensors to radars - and deploy your trained model back to virtually any device.
I know what I'm doing, hide this wizard!
Creating your first impulse
Acquire data
Design an impulse
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
Sharing
Your project is private.
Make this project public
Summary
DEVICES CONNECTED
0
DATA COLLECTED
-
Collaborators
MJRoBot (Marcelo Rovai)
OWNER
Project info


Dashboard - Cifar10 Classifica
studio.edgeimpulse.com/studio/51076
EDGE IMPULSE
Project info
Keys
Export
MJRoBot (Marcelo Rovai)
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
EON Tuner
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
MJRoBot (Marcelo Rovai) / Cifar10 Classification (Cats vs Dogs)
This is your Edge Impulse project.
Welcome to your new Edge Impulse project!
Great! What do you want to detect?
Classify a single object (image classification)
Detect one object in an image, for example whether you see a lamp or a plant. Image classification is efficient and can be ran on microcontrollers, including development boards from OpenMV, Arduino, Himax and Eta Compute.
Classify multiple objects (object detection)
Detect the location of multiple objects in an image, for example to detect how many apples you see. Object detection is a lot more compute intensive than image classification and currently only works on Linux-based devices like the Raspberry Pi 4 or Jetson Nano.
I know what I'm doing, hide this wizard!
Creating your first impulse
Acquire data
Design an impulse
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
Sharing
Your project is private.
Make this project public
Summary
DEVICES CONNECTED
0
DATA COLLECTED
-
Collaborators
MJRoBot (Marcelo Rovai)
OWNER
Project info

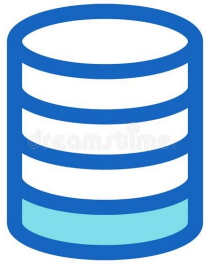

Dashboard - Cifar10 Classifica
studio.edgeimpulse.com/studio/51076
EDGE IMPULSE
Project info
Keys
Export
MJRoBot (Marcelo Rovai)
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
EON Tuner
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
MJRoBot (Marcelo Rovai) / Cifar10 Classification (Cats vs Dogs)
This is your Edge Impulse project.
Creating your first impulse
Acquire data
Design an impulse
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
Welcome to your new Edge Impulse project!
Great! Here's how you can get started with image classification:
Connect a development board
Get started with real hardware from Arduino, OpenMV, Eta Compute, Himax, Raspberry Pi or NVIDIA to quickly build a custom image dataset.
Connect your development board
Import existing data
If you already have images in JPG or PNG file format, you can upload it to Edge Impulse through the web interface or using the Edge Impulse CLI.
Go to the uploader
Tutorial: adding sight to your sensors
Follow our end-to-end tutorial to collect data, train a model, and deploy it back to your device to analyze images in realtime.
Read the tutorial
I know what I'm doing, hide this wizard!
Let's get started!
Sharing
Your project is private.
Make this project public
Summary
DEVICES CONNECTED
0
DATA COLLECTED
-
Collaborators
MJRoBot (Marcelo Rovai)
OWNER
Project info
https://studio.edgeimpulse.com/studio/51076/upload

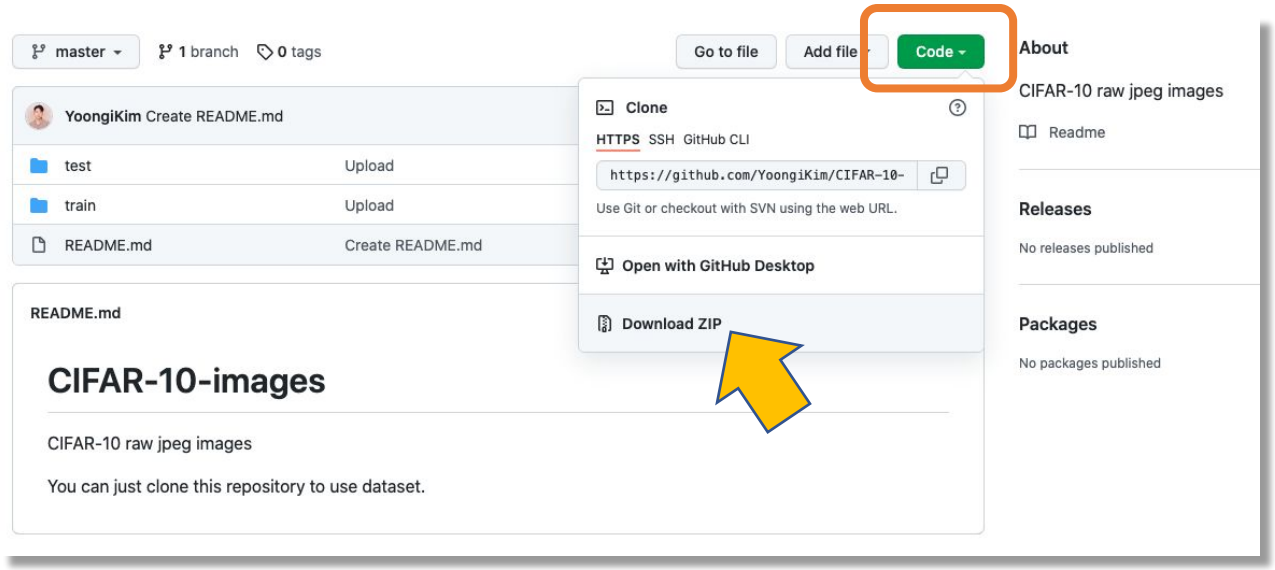


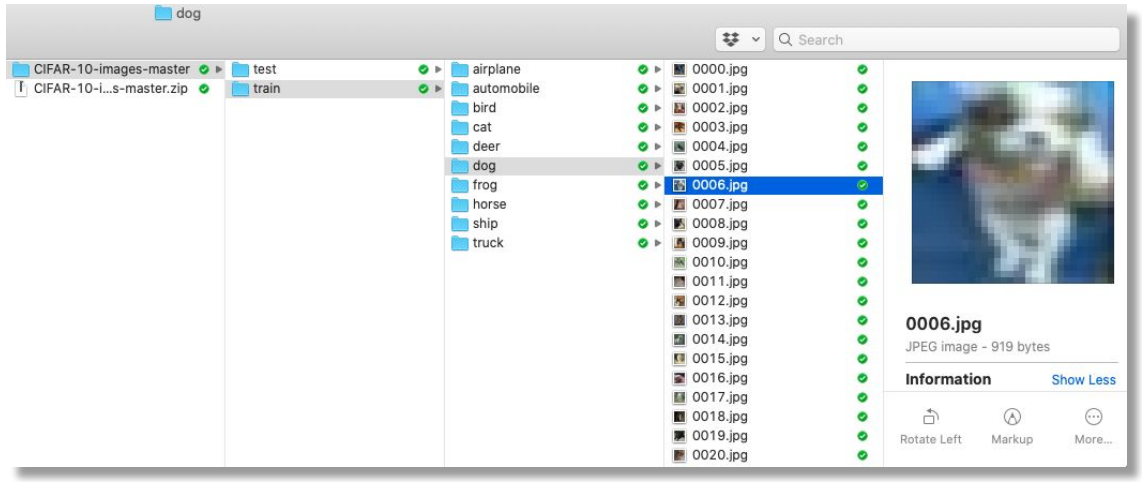
- Pre-Processing Data
- Design a Model
- Train a Model

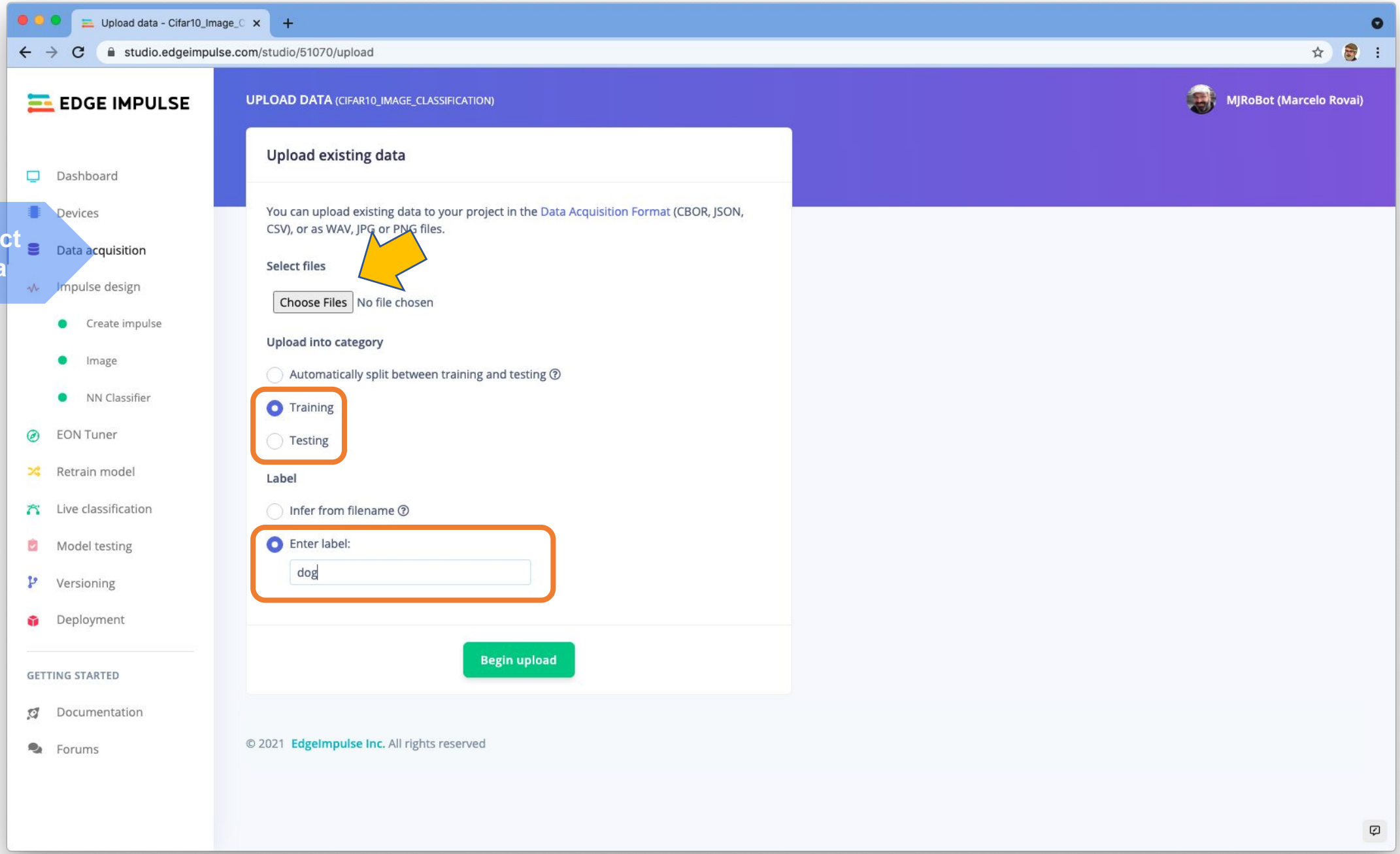
Download Dataset

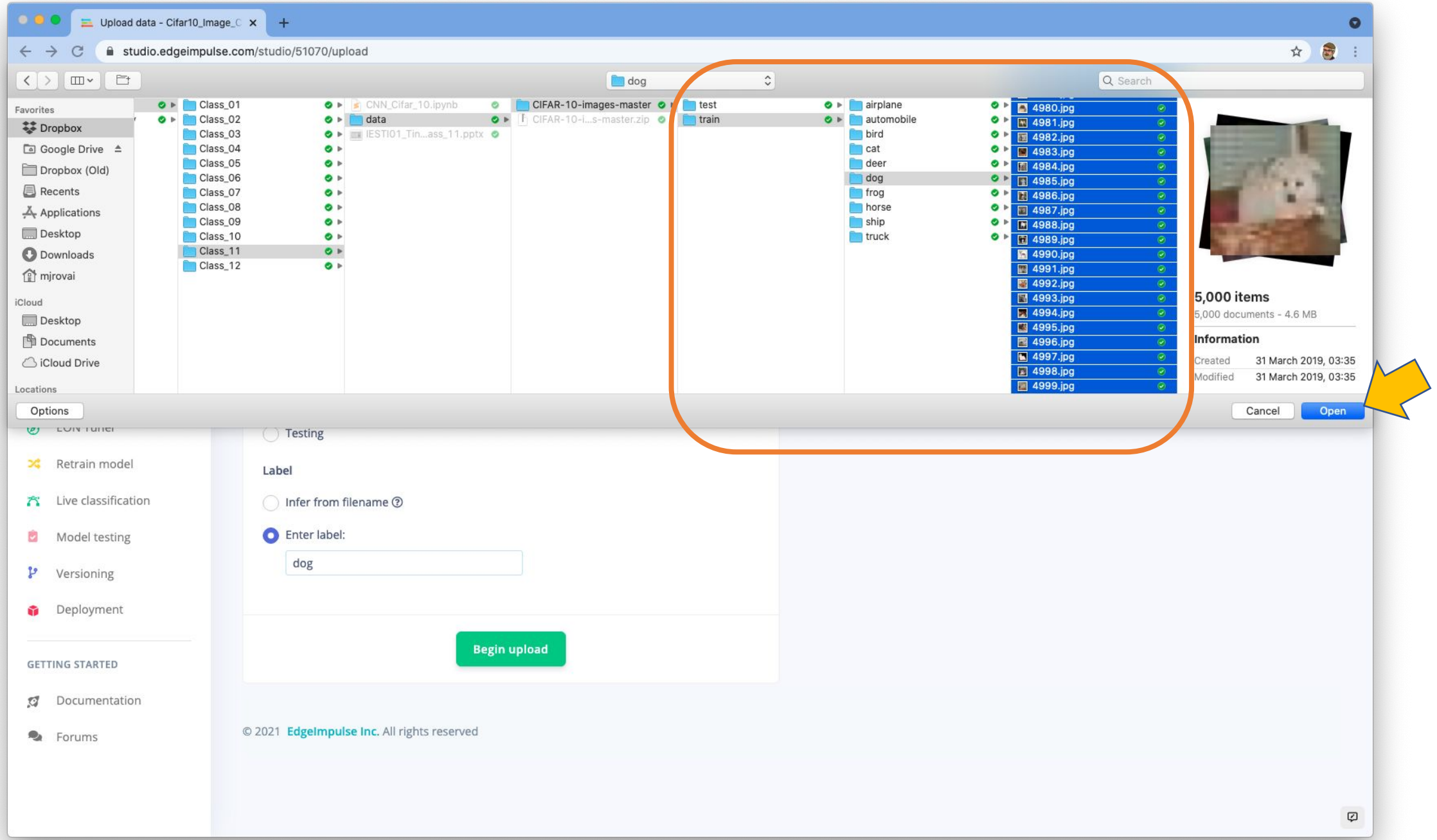
https://github.com/YoongiKim/CIFAR-10-images

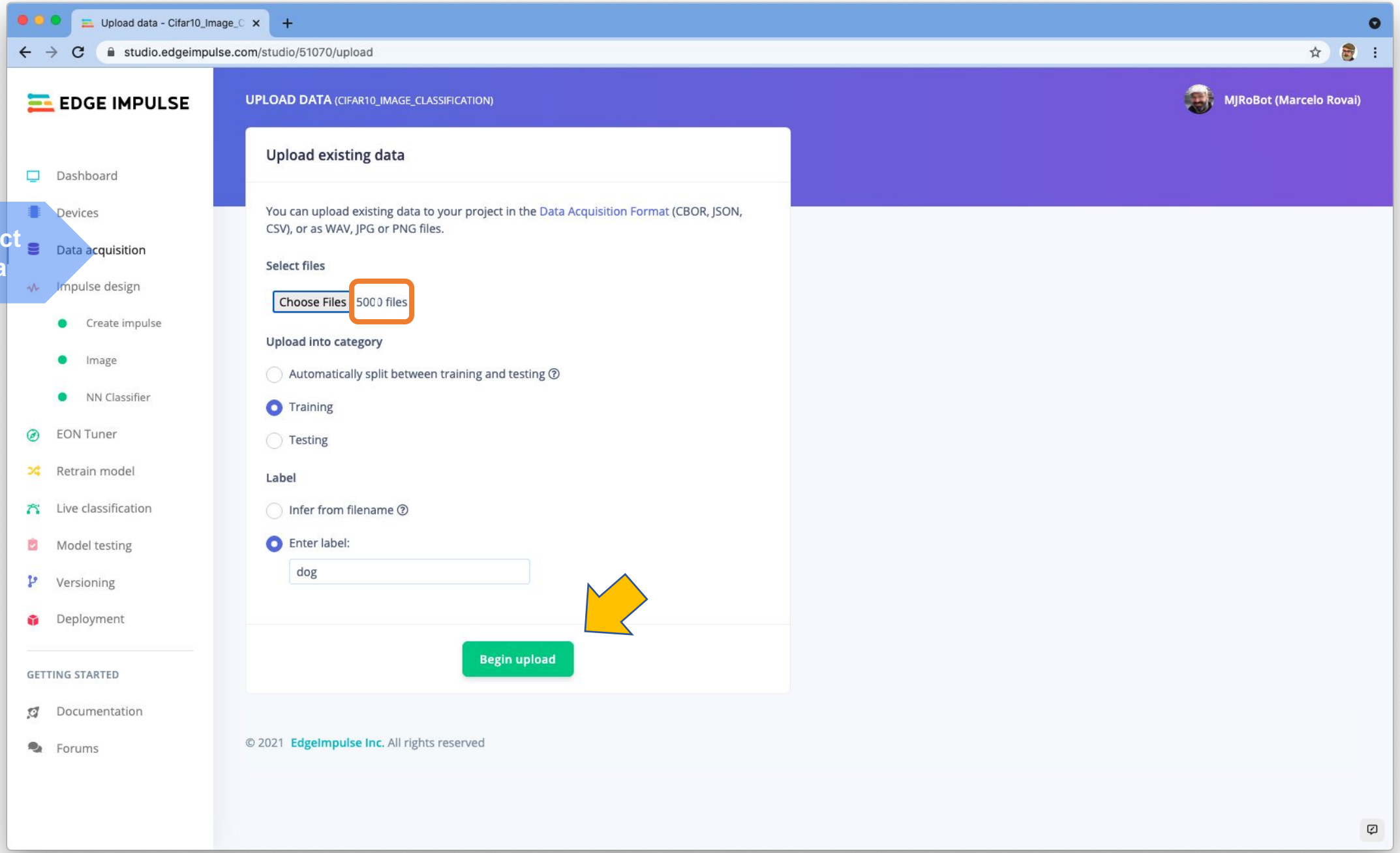




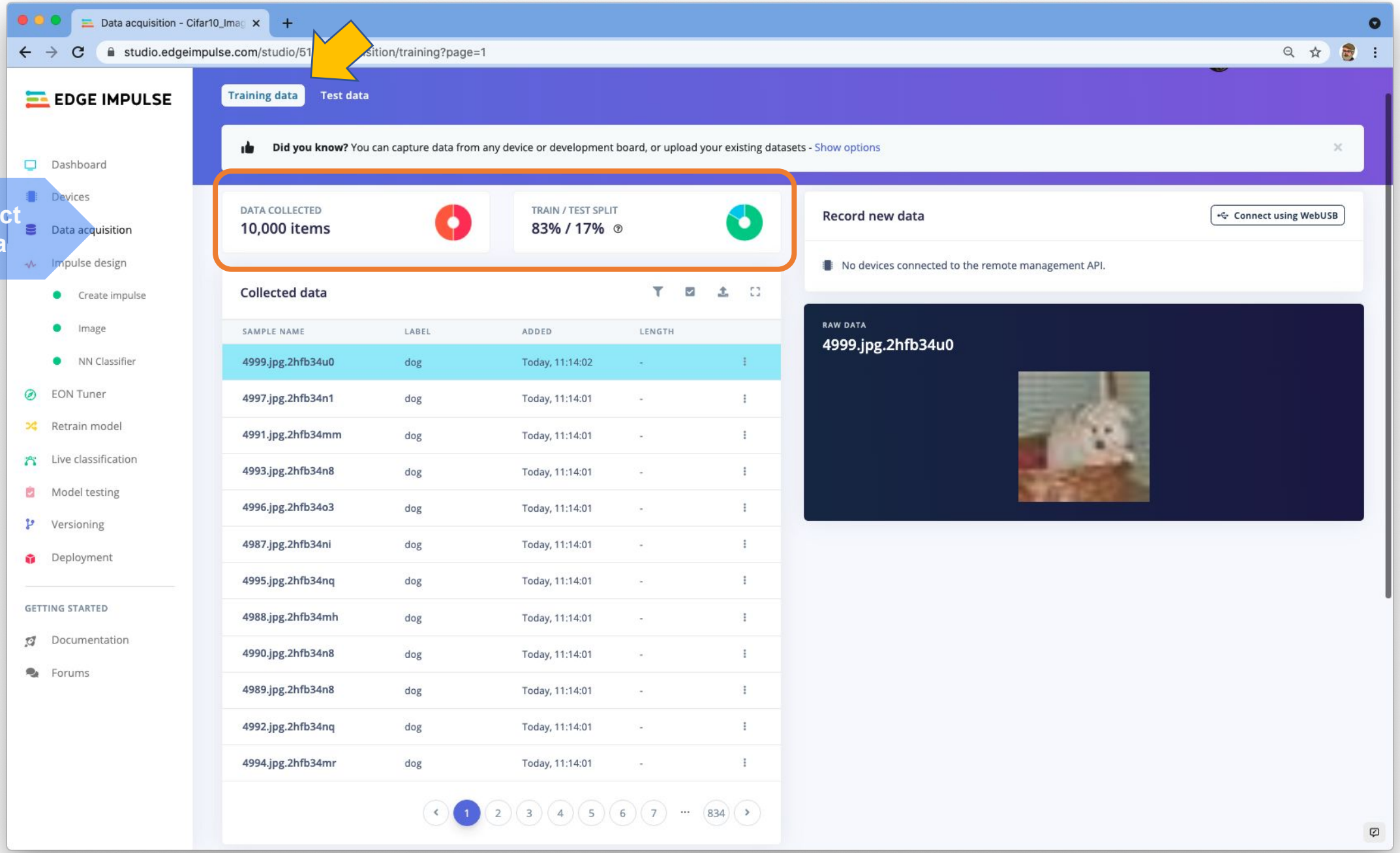


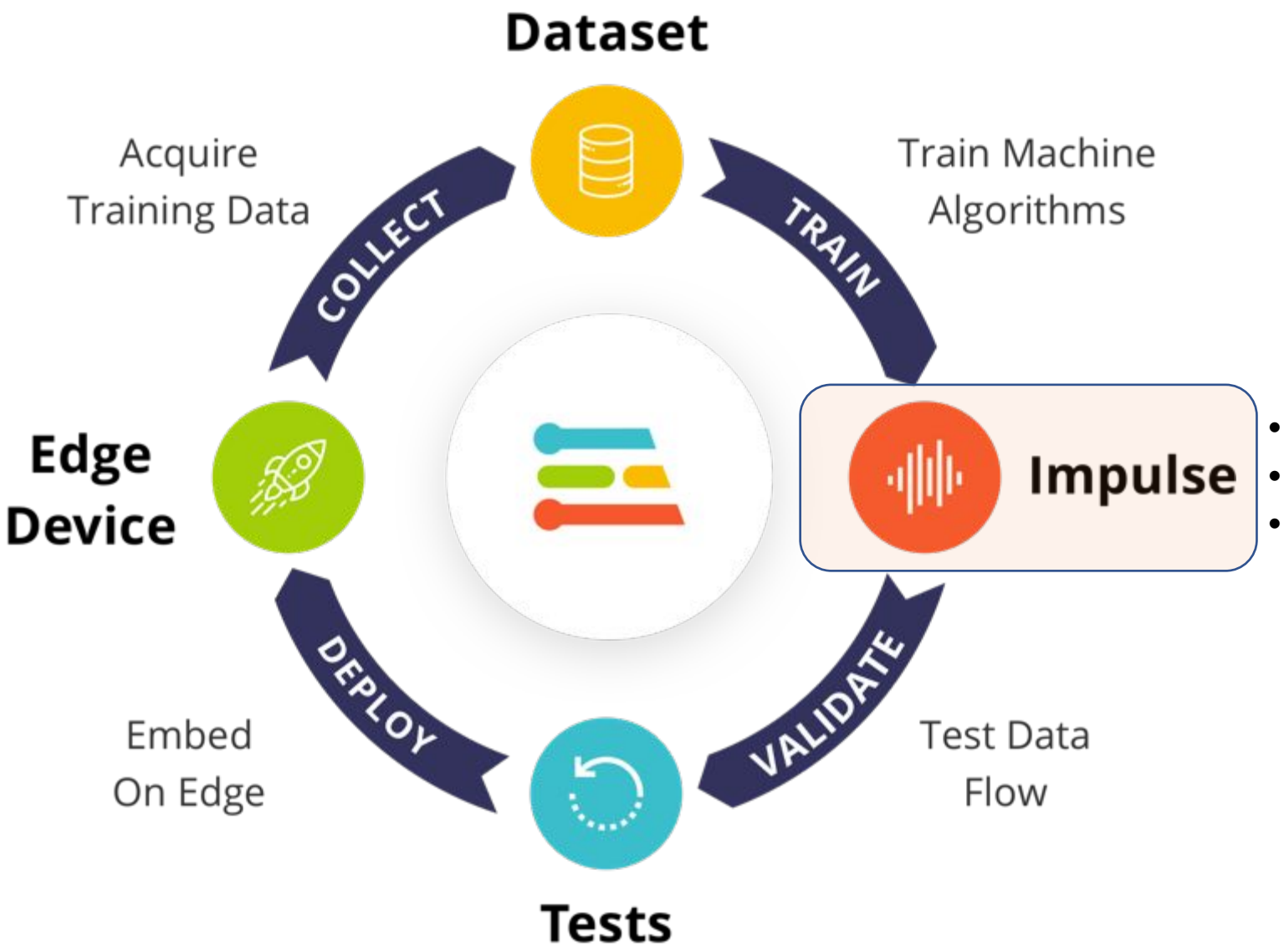

Upload data - Cifar10_Image_C
studio.edgeimpulse.com/studio/51070/upload
EDGE IMPULSE
UPLOAD DATA (CIFAR10_IMAGE_CLASSIFICATION)
MJRoBot (Marcelo Rovai)
Collect Data
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Image
NN Classifier
EON Tuner
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
Upload 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
Choose Files
No file chosen
Upload into category
Automatically split between training and testing
Training
Testing
Label
Infer from filename
Enter label:
dog
Begin upload
© 2021 EdgeImpulse Inc. All rights reserved


Upload data - Cifar10_Image_C
studio.edgeimpulse.com/studio/51070/upload
dog
Search
Favorites
Dropbox
Google Drive
Dropbox (Old)
Recents
Applications
Desktop
Downloads
mjrovai
iCloud
Desktop
Documents
iCloud Drive
Locations
Class_01
Class_02
Class_03
Class_04
Class_05
Class_06
Class_07
Class_08
Class_09
Class_10
Class_11
Class_12
CNN_Cifar_10.ipynb
data
IESTI01_Tin...ass_11.pptx
CIFAR-10-images-master
CIFAR-10-i...s-master.zip
test
train
airplane
automobile
bird
cat
deer
dog
frog
horse
ship
truck
4980.jpg
4981.jpg
4982.jpg
4983.jpg
4984.jpg
4985.jpg
4986.jpg
4987.jpg
4988.jpg
4989.jpg
4990.jpg
4991.jpg
4992.jpg
4993.jpg
4994.jpg
4995.jpg
4996.jpg
4997.jpg
4998.jpg
4999.jpg
5,000 items
5,000 documents - 4.6 MB
Information
Created 31 March 2019, 03:35
Modified 31 March 2019, 03:35
Options
Cancel
Open
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
Testing
Label
Infer from filename
Enter label:
dog
Begin upload
© 2021 EdgeImpulse Inc. All rights reserved

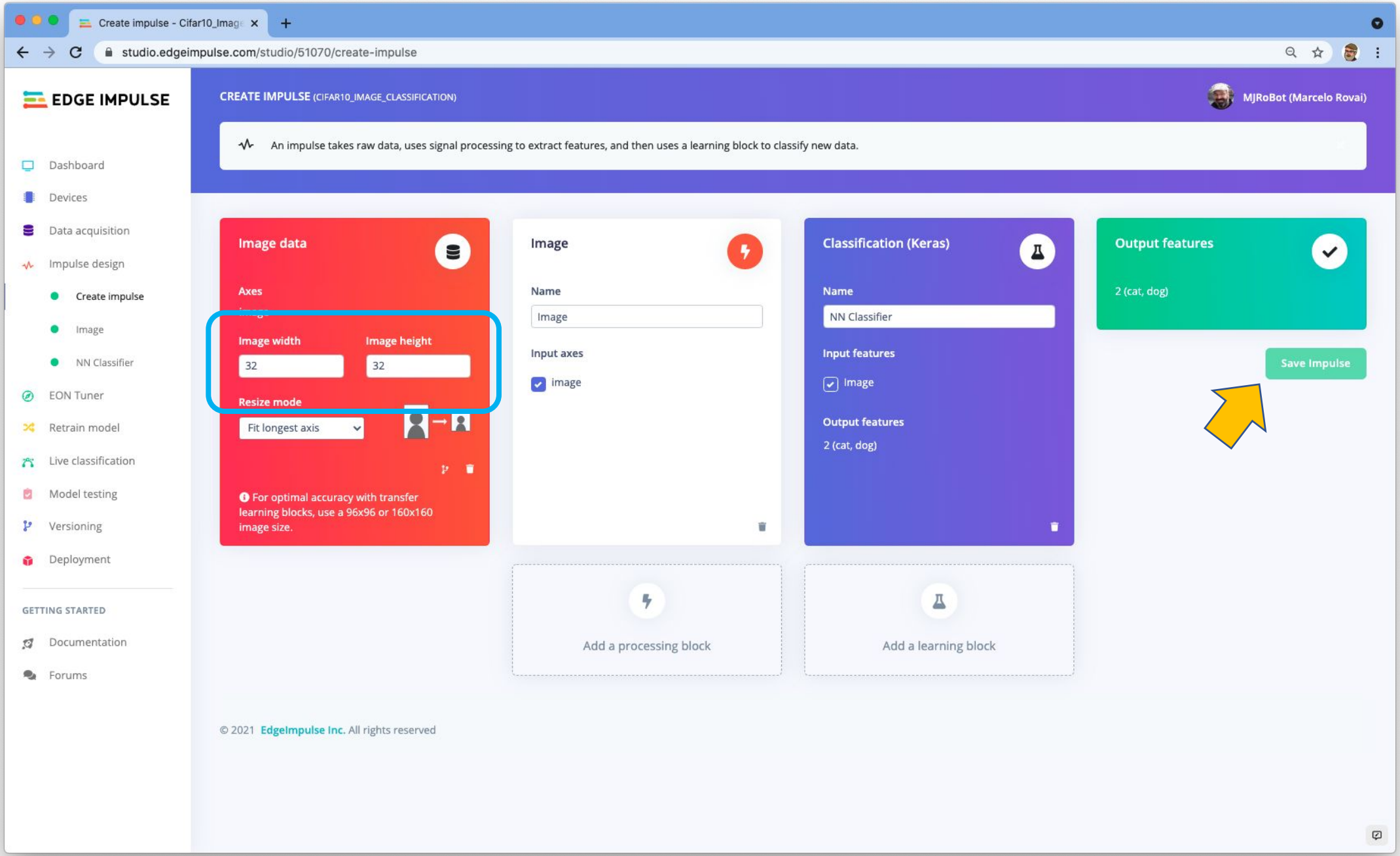


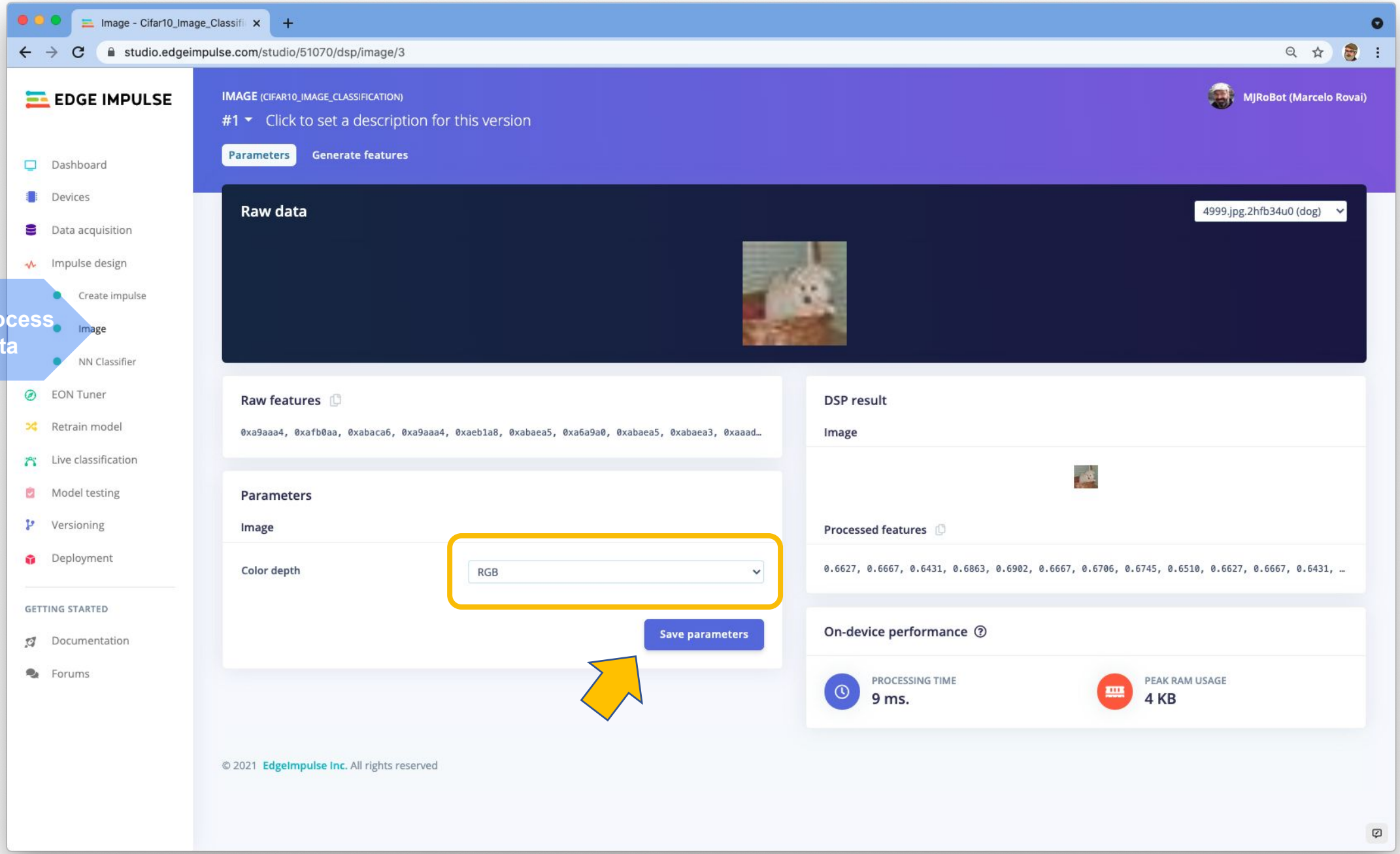
Collect Data


Data acquisition - Cifar10_Imag
studio.edgeimpulse.com/studio/51
isition/training?page=1
EDGE IMPULSE
Training data
Test data
Did you know? You can capture data from any device or development board, or upload your existing datasets - Show options
Collect Data
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
DATA COLLECTED
10,000 items
TRAIN / TEST SPLIT
83% / 17%
Record new data
Connect using WebUSB
No devices connected to the remote management API.
Collected data
SAMPLE NAME
LABEL
ADDED
LENGTH
4999.jpg.2hfb34u0 dog Today, 11:14:02 -
4997.jpg.2hfb34n1 dog Today, 11:14:01 -
4991.jpg.2hfb34mm dog Today, 11:14:01 -
4993.jpg.2hfb34n8 dog Today, 11:14:01 -
4996.jpg.2hfb34o3 dog Today, 11:14:01 -
4987.jpg.2hfb34ni dog Today, 11:14:01 -
4995.jpg.2hfb34nq dog Today, 11:14:01 -
4988.jpg.2hfb34mh dog Today, 11:14:01 -
4990.jpg.2hfb34n8 dog Today, 11:14:01 -
4989.jpg.2hfb34n8 dog Today, 11:14:01 -
4992.jpg.2hfb34nq dog Today, 11:14:01 -
4994.jpg.2hfb34mr dog Today, 11:14:01 -
1 2 3 4 5 6 7 ... 834
RAW DATA
4999.jpg.2hfb34u0



- Pre-Processing Data
- Design a Model
- Train a Model


Create impulse - Cifar10_Imag
studio.edgeimpulse.com/studio/51070/create-impulse
EDGE IMPULSE
CREATE IMPULSE (CIFAR10_IMAGE_CLASSIFICATION)
MJRoBot (Marcelo Rovai)
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
NN Classifier
EON Tuner
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
Image data
Axes
Image width
32
Image height
32
Resize mode
Fit longest axis
For optimal accuracy with transfer learning blocks, use a 96x96 or 160x160 image size.
Image
Name
Image
Input axes
image
Classification (Keras)
Name
NN Classifier
Input features
Image
Output features
2 (cat, dog)
Output features
2 (cat, dog)
Save Impulse
Add a processing block
Add a learning block
© 2021 EdgeImpulse Inc. All rights reserved



Preprocess Data

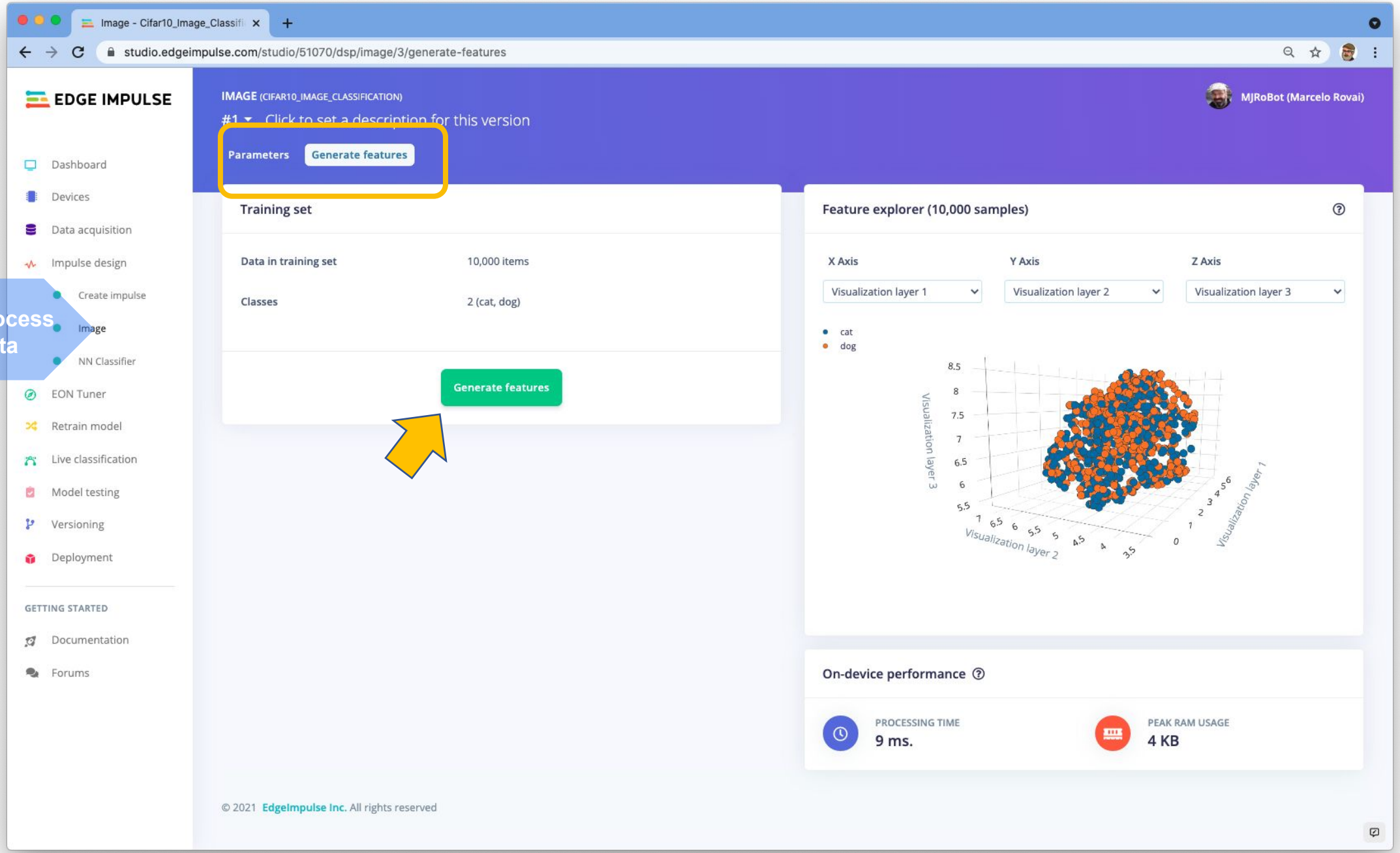
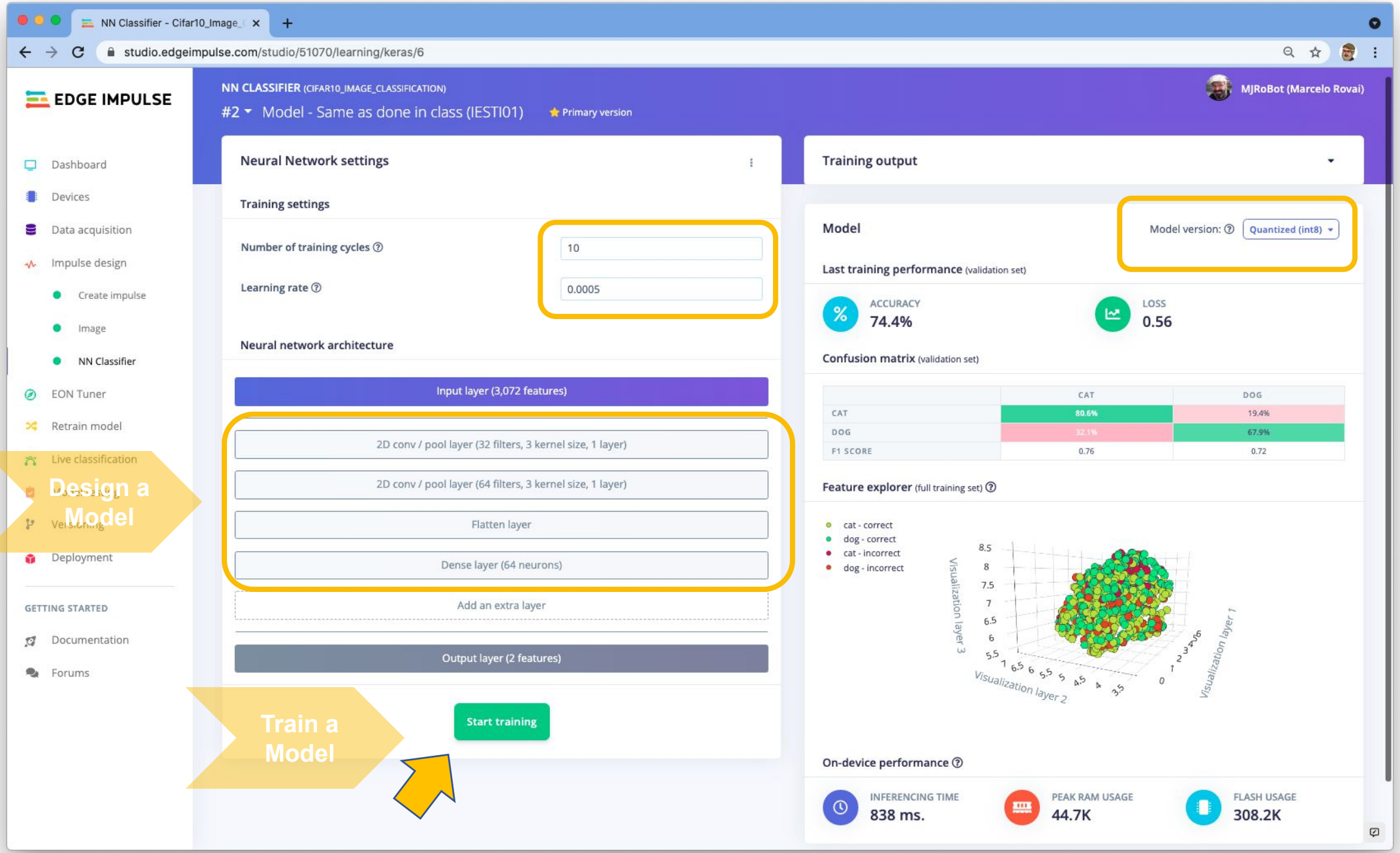
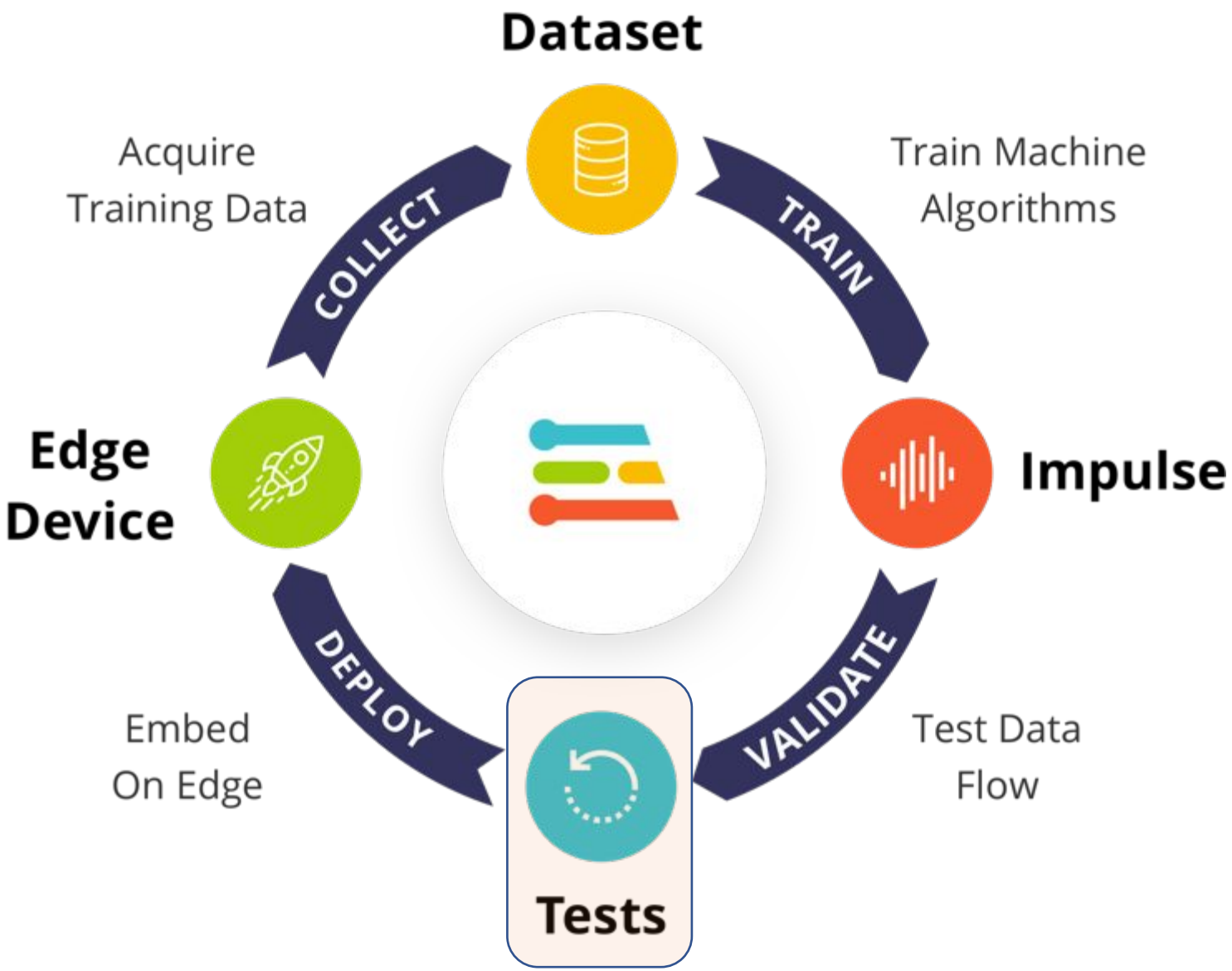
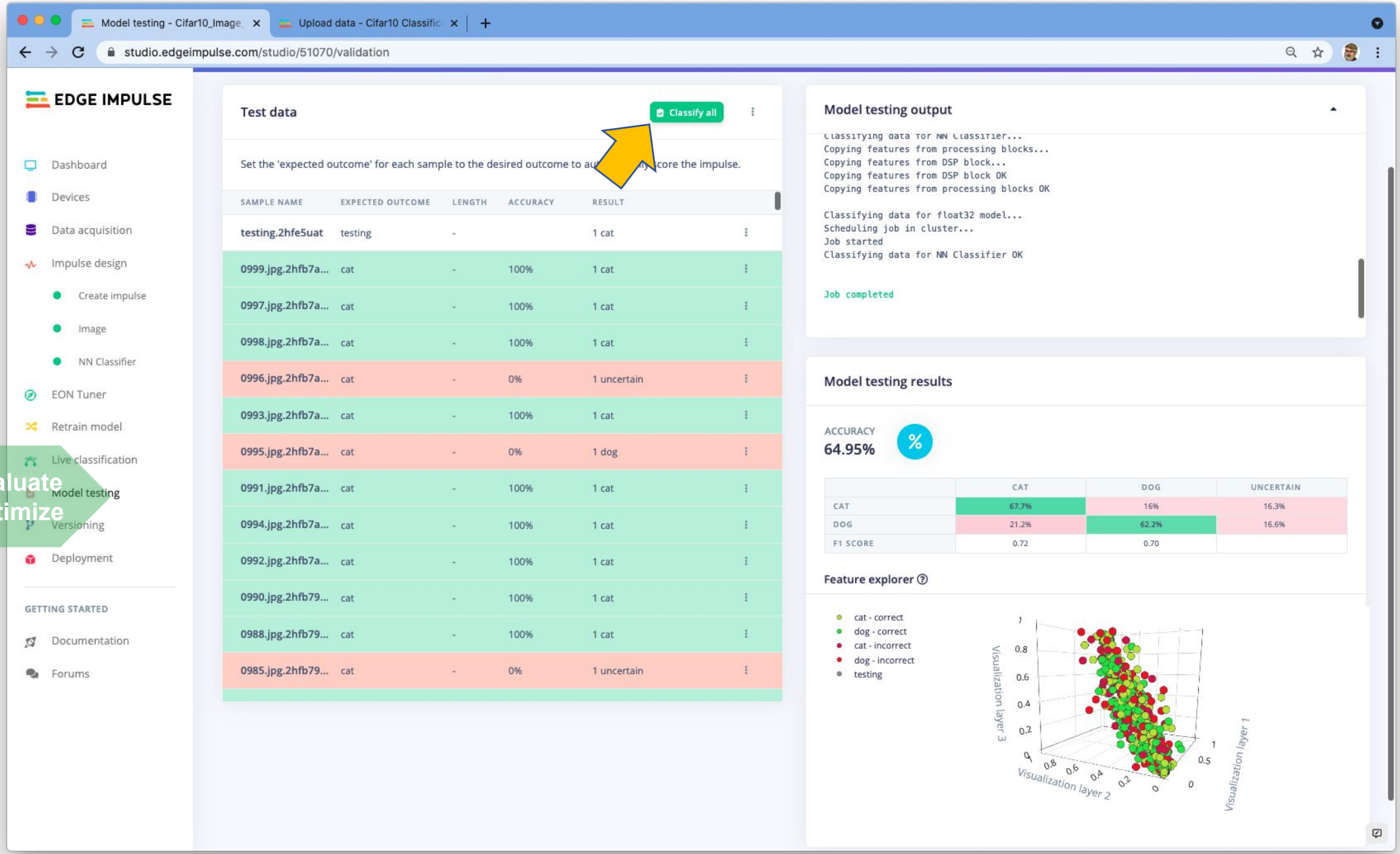


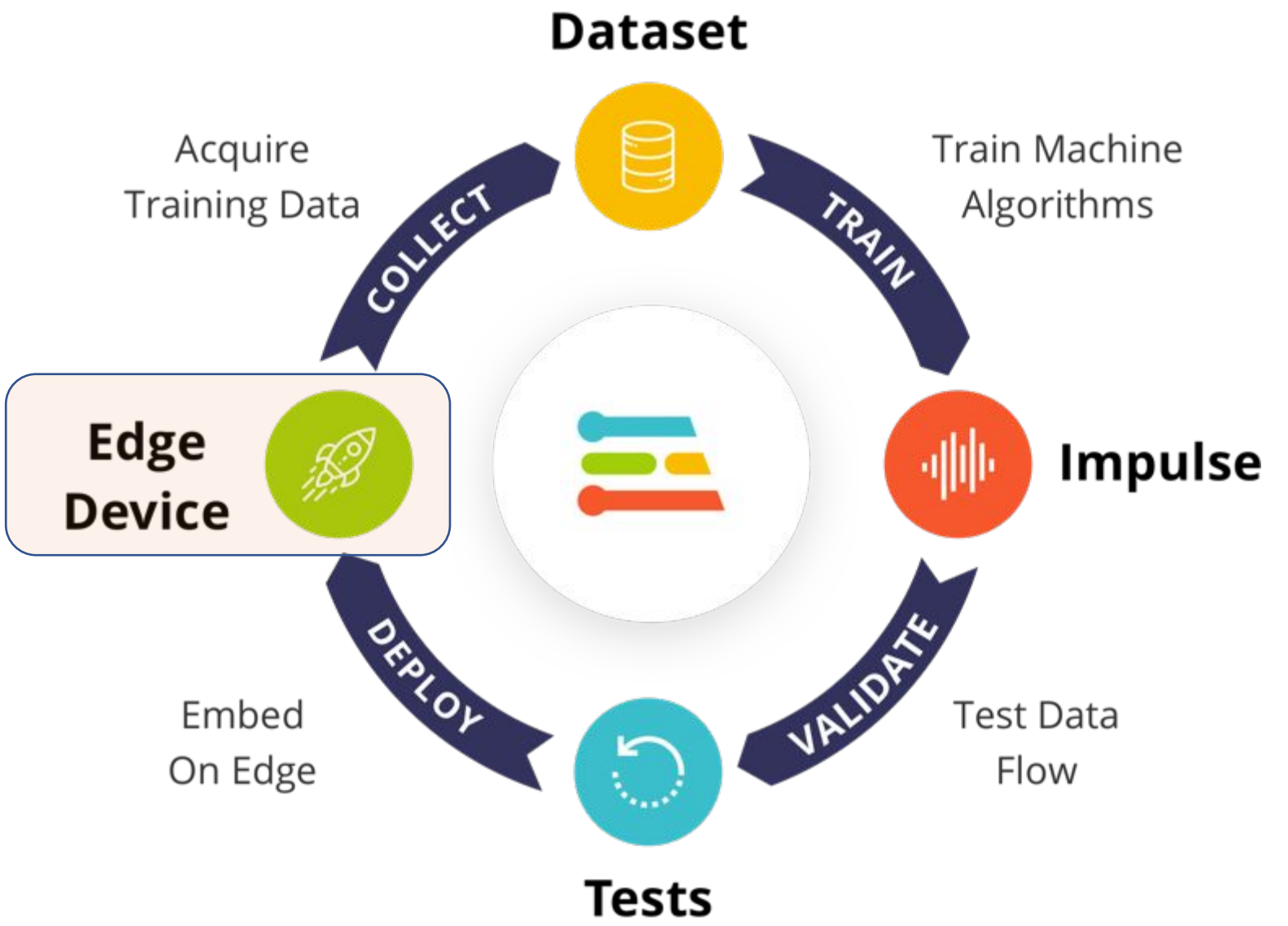
Image - Cifar10_Image_Classifi
studio.edgeimpulse.com/studio/51070/dsp/image/3/generate-features
EDGE IMPULSE
IMAGE (CIFAR10_IMAGE_CLASSIFICATION)
#1 Click to set a description for this version
MJRoBot (Marcelo Rovai)
Parameters
Generate features
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Image
NN Classifier
EON Tuner
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
Preprocess Data
Training set
Data in training set
10,000 items
Classes
2 (cat, dog)
Generate features
Feature explorer (10,000 samples)
X Axis
Y Axis
Z Axis
Visualization layer 1
Visualization layer 2
Visualization layer 3
cat
dog
On-device performance
PROCESSING TIME
9 ms.
PEAK RAM USAGE
4 KB
© 2021 EdgeImpulse Inc. All rights reserved


NN Classifier - Cifar10_Image_
studio.edgeimpulse.com/studio/51070/learning/keras/6
EDGE IMPULSE
NN CLASSIFIER (CIFAR10_IMAGE_CLASSIFICATION)
#2 Model - Same as done in class (IESTI01)
Primary version
MJRoBot (Marcelo Rovai)
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Image
NN Classifier
EON Tuner
Retrain model
Live classification
Deployment
GETTING STARTED
Documentation
Forums
Neural Network settings
Training settings
Number of training cycles
10
Learning rate
0.0005
Neural network architecture
Input layer (3,072 features)
2D conv / pool layer (32 filters, 3 kernel size, 1 layer)
2D conv / pool layer (64 filters, 3 kernel size, 1 layer)
Flatten layer
Dense layer (64 neurons)
Add an extra layer
Output layer (2 features)
Start training
Design a Model
Train a Model
Training output
Model
Model version:
Quantized (int8)
Last training performance (validation set)
ACCURACY
74.4%
LOSS
0.56
Confusion matrix (validation set)
CAT
DOG
F1 SCORE
80.6%
19.4%
32.1%
67.9%
0.76
0.72
Feature explorer (full training set)
cat - correct
dog - correct
cat - incorrect
dog - incorrect
Visualization layer 1
Visualization layer 2
Visualization layer 3
On-device performance
INFERENCING TIME
838 ms.
PEAK RAM USAGE
44.7K
FLASH USAGE
308.2K



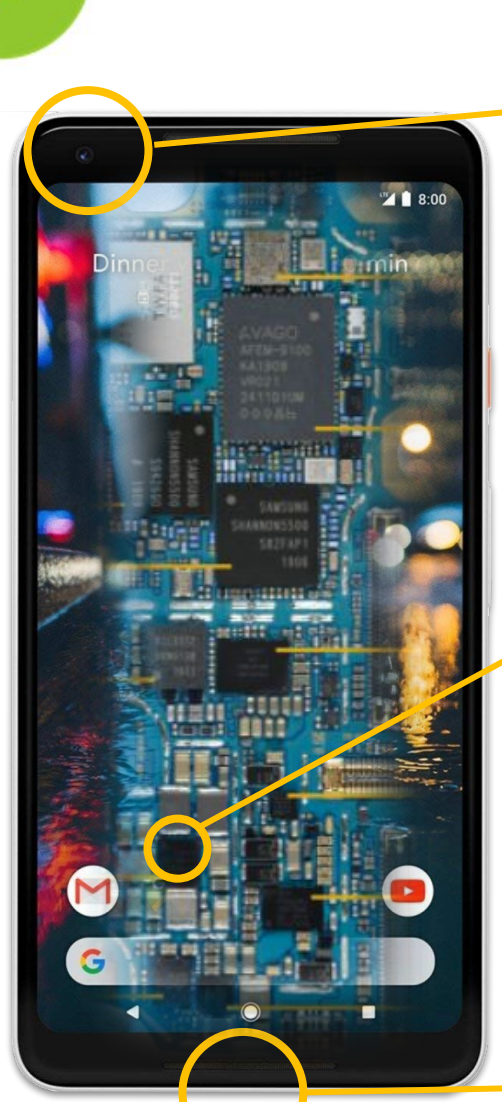
- Pre-Processing Data
- Design a Model
- Train a Model


Model testing - Cifar10_Image
Upload data - Cifar10 Classific
studio.edgeimpulse.com/studio/51070/validation
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
Test data
Classify all
Set the 'expected outcome' for each sample to the desired outcome to au
core the impulse.
SAMPLE NAME
EXPECTED OUTCOME
LENGTH
ACCURACY
RESULT
testing.2hfe5uat testing - 1 cat
0999.jpg.2hfb7a... cat - 100% 1 cat
0997.jpg.2hfb7a... cat - 100% 1 cat
0998.jpg.2hfb7a... cat - 100% 1 cat
0996.jpg.2hfb7a... cat - 0% 1 uncertain
0993.jpg.2hfb7a... cat - 100% 1 cat
0995.jpg.2hfb7a... cat - 0% 1 dog
0991.jpg.2hfb7a... cat - 100% 1 cat
0994.jpg.2hfb7a... cat - 100% 1 cat
0992.jpg.2hfb7a... cat - 100% 1 cat
0990.jpg.2hfb79... cat - 100% 1 cat
0988.jpg.2hfb79... cat - 100% 1 cat
0985.jpg.2hfb79... cat - 0% 1 uncertain
Model testing output
Classifying data for NN Classifier...
Copying features from processing blocks...
Copying features from DSP block...
Copying features from DSP block OK
Copying features from processing blocks OK
Classifying data for float32 model...
Scheduling job in cluster...
Job started
Classifying data for NN Classifier OK
Job completed
Model testing results
ACCURACY
64.95%
CAT DOG UNCERTAIN
CAT 67.7% 16% 16.3%
DOG 21.2% 62.2% 16.6%
F1 SCORE 0.72 0.70
Feature explorer
cat - correct
dog - correct
cat - incorrect
dog - incorrect
testing
Visualization layer 3
Visualization layer 2
Visualization layer 1
Evaluate
Optimize



- Pre-Processing Data
- Design a Model
- Train a Model

Edge Device & Sensors



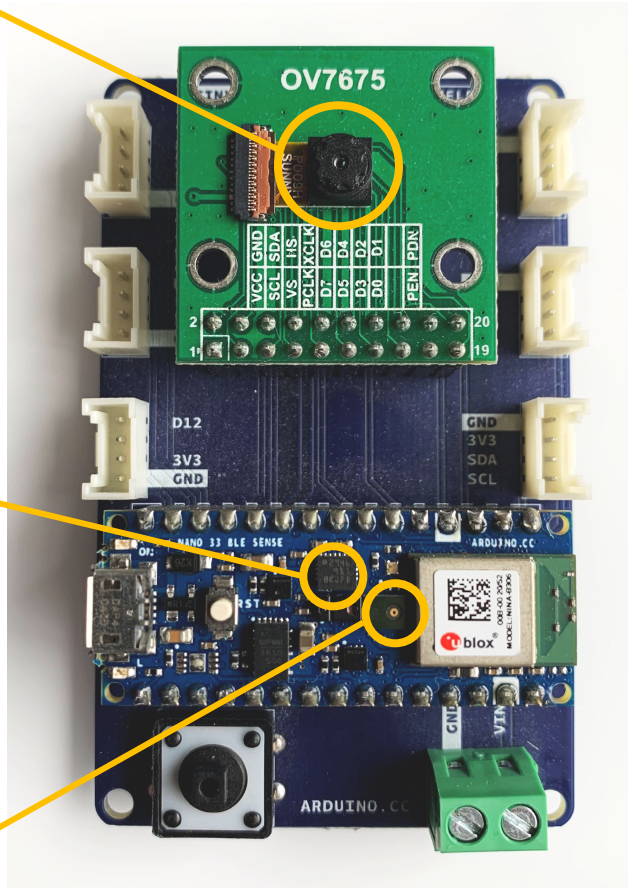
Camera

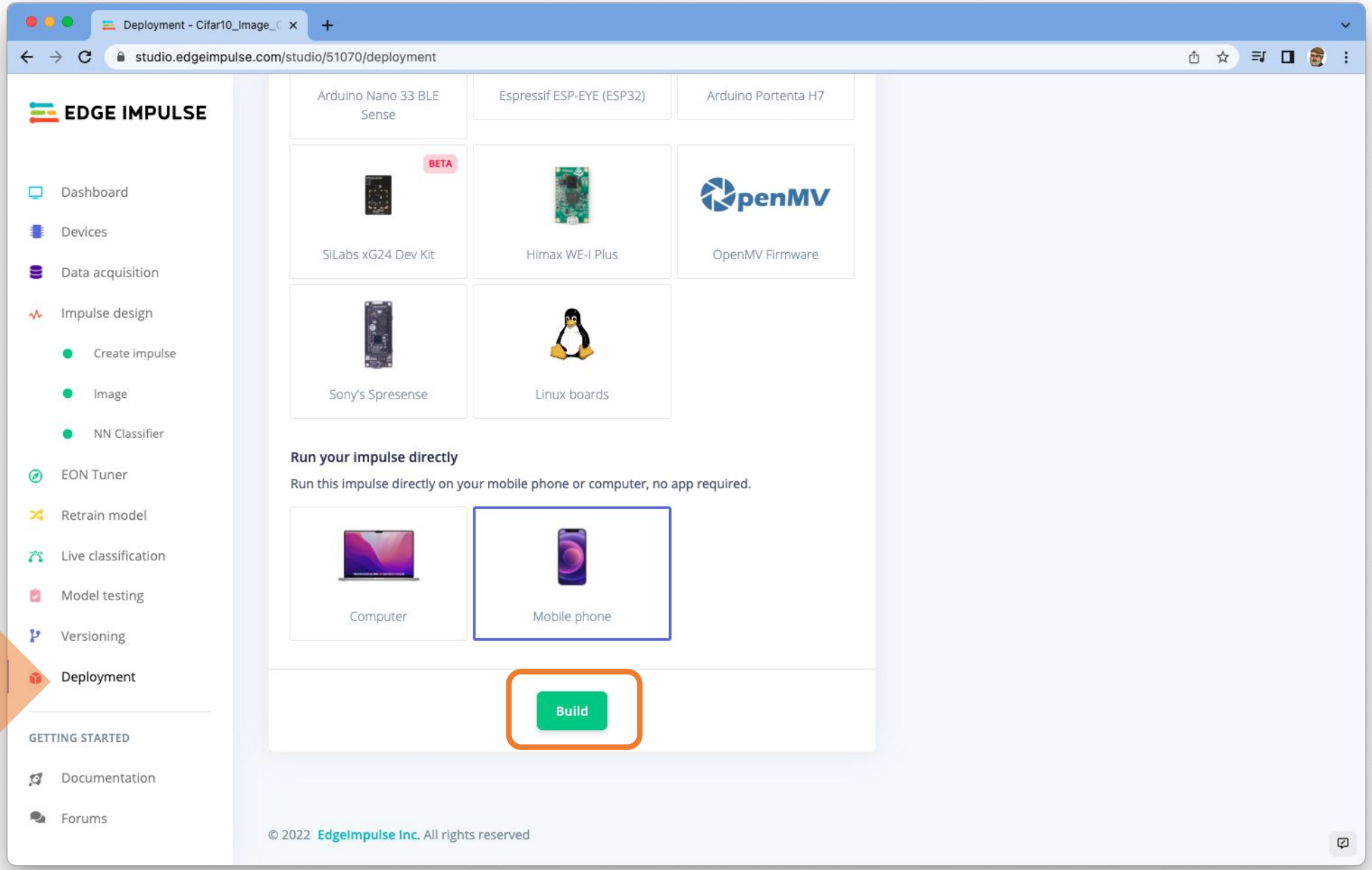
Accelerometer

Gyroscope

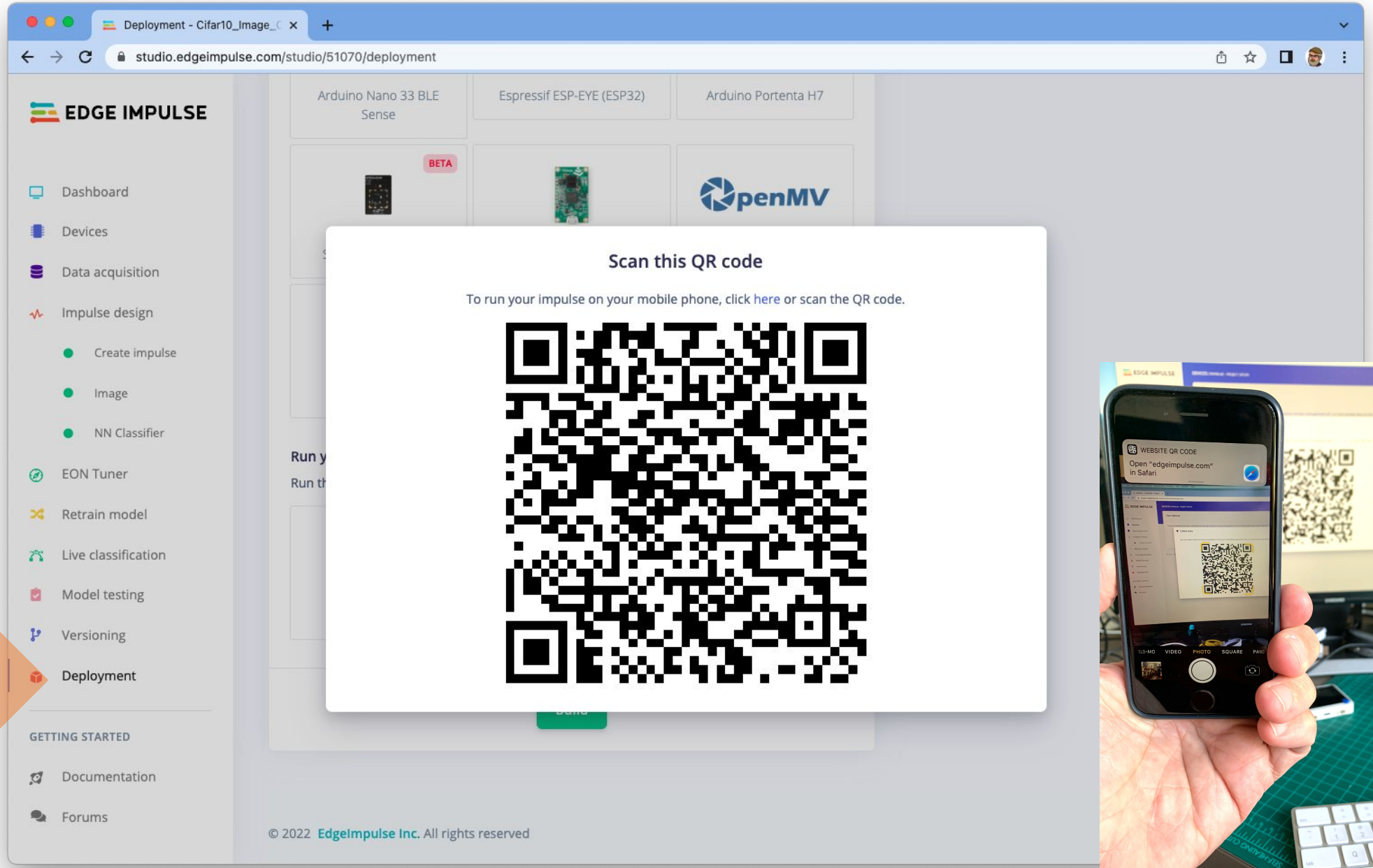
Magnetometer

Microphone



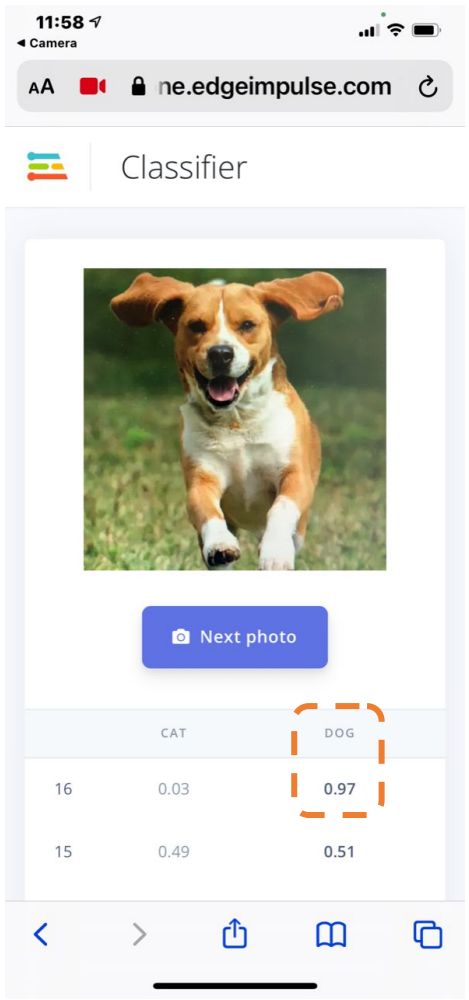


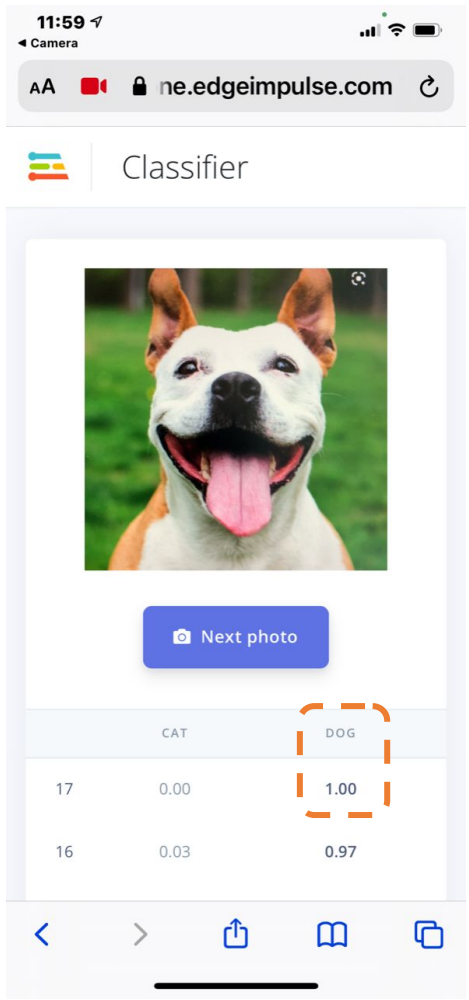
Deploy Model

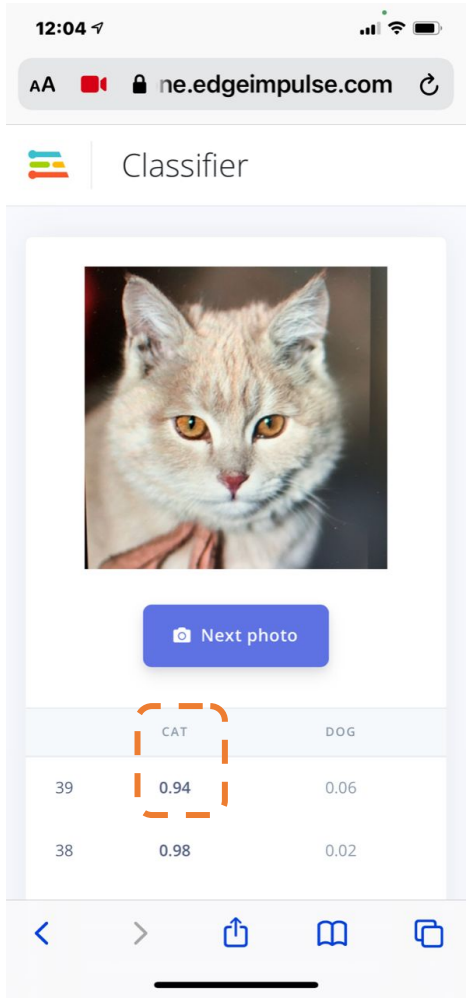


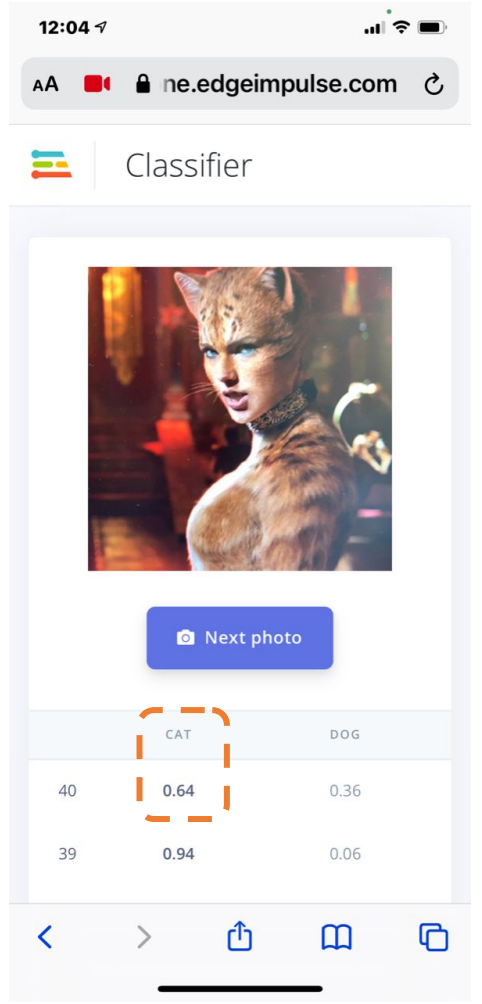
Deploy Model

Make Inferences





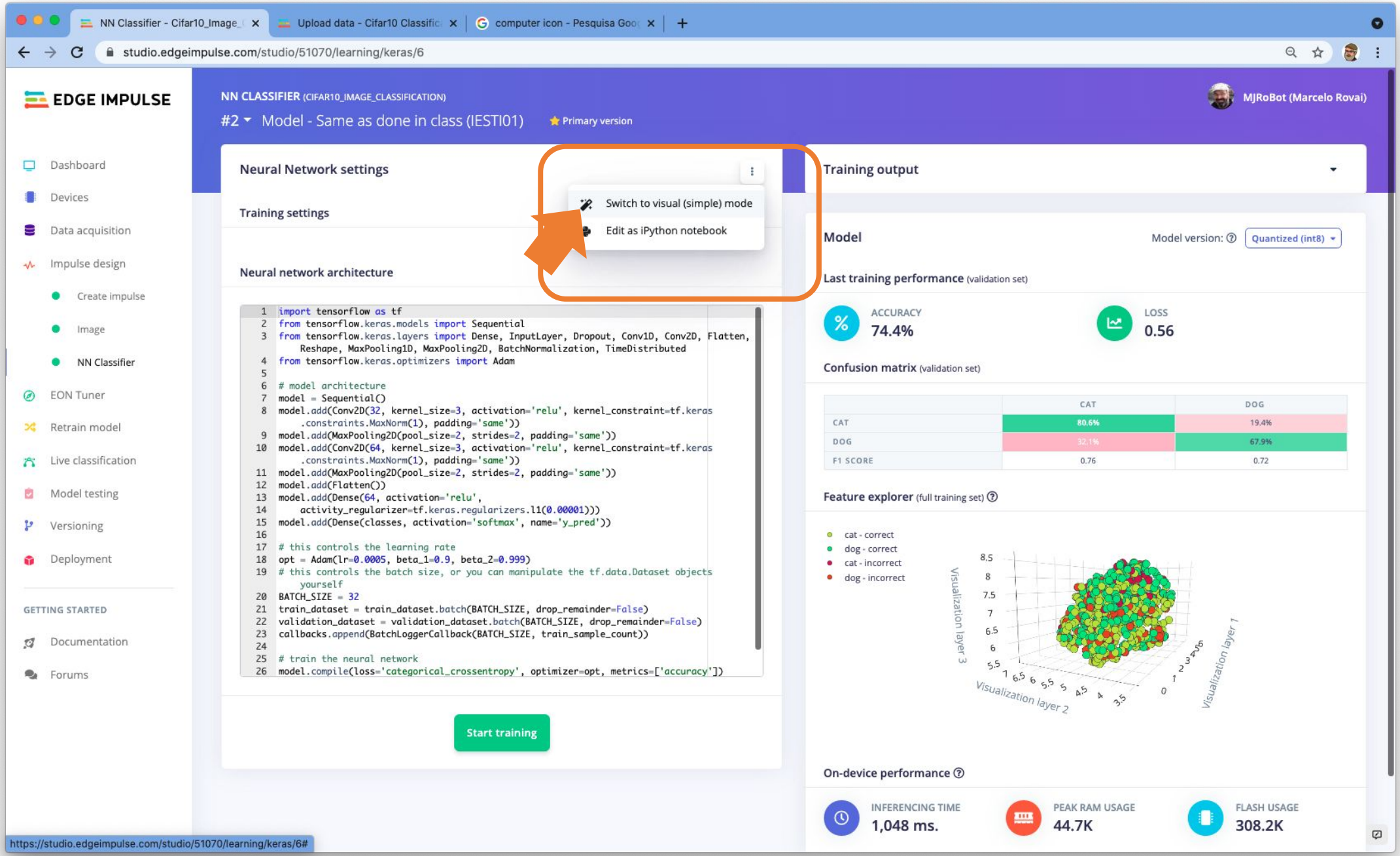


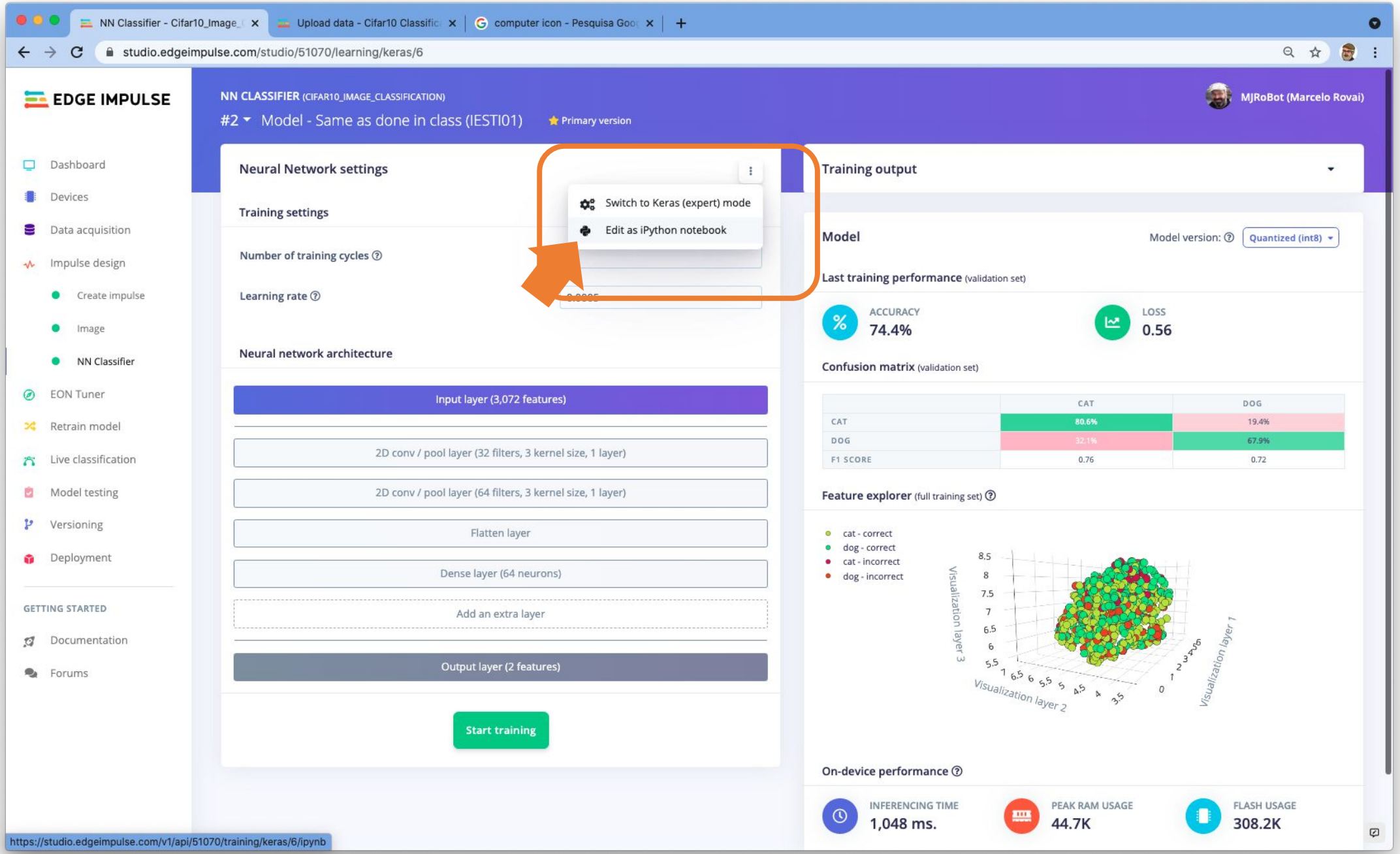


EI Studio “under the hood”

Code Time!

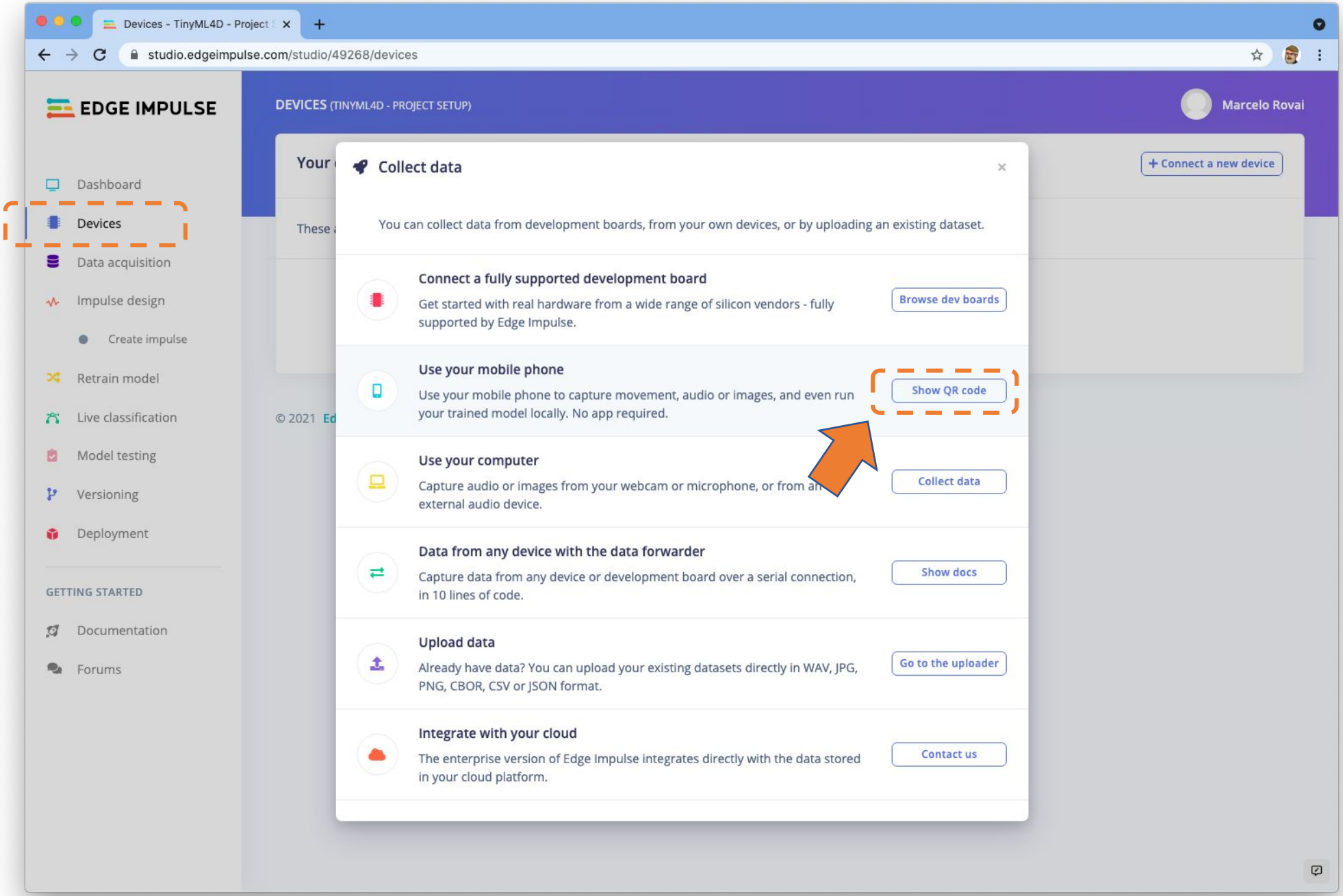
ei-cifar10_image_classification-nn-classifier-explained.ipynb

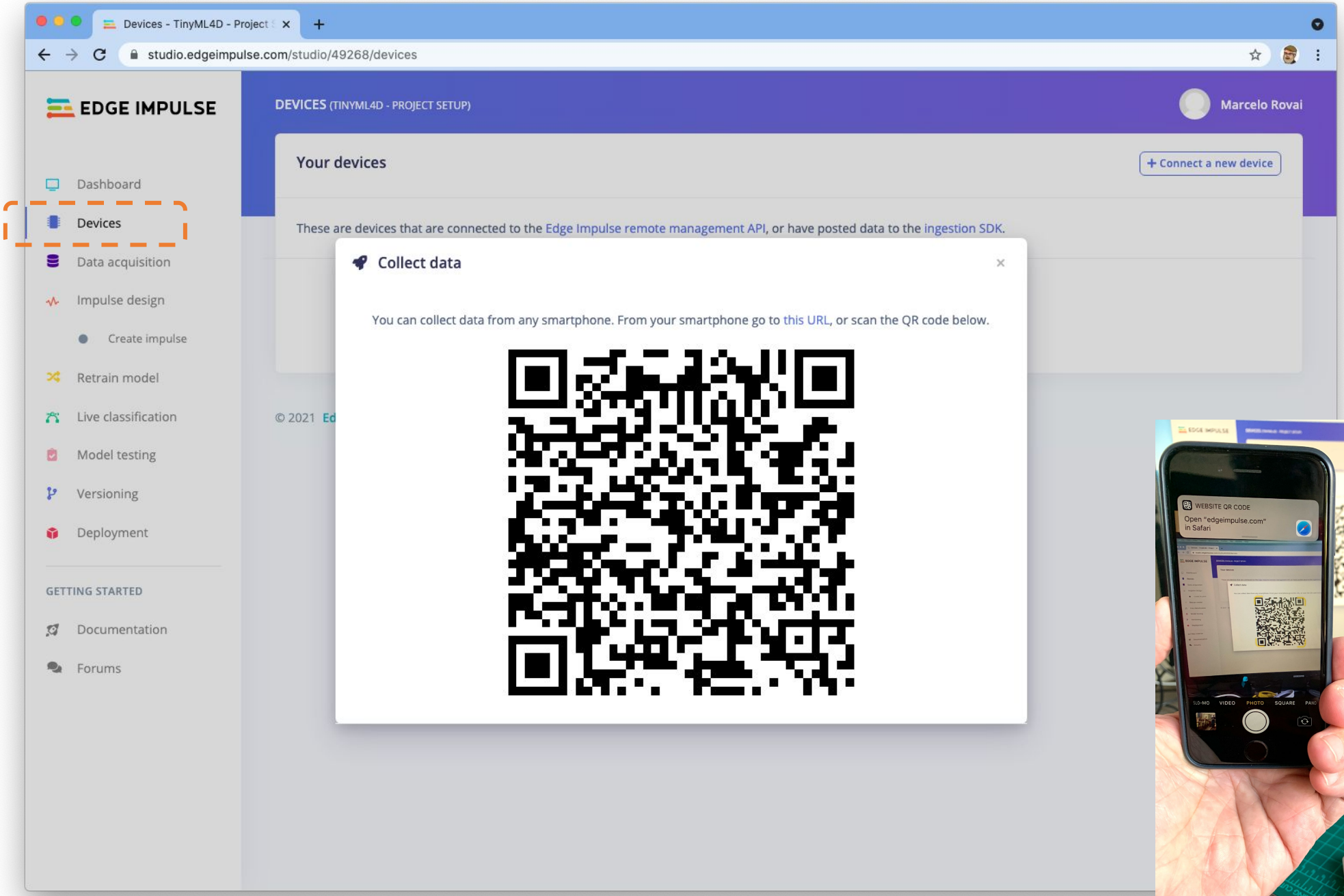

NN Classifier - Cifar10_Image_
Upload data - Cifar10 Classific
computer icon - Pesquisa Goo
studio.edgeimpulse.com/studio/51070/learning/keras/6
EDGE IMPULSE
NN CLASSIFIER (CIFAR10_IMAGE_CLASSIFICATION)
#2 Model - Same as done in class (IESTI01)
Primary version
MJRoBot (Marcelo Rovai)
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Image
NN Classifier
EON Tuner
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
Neural Network settings
Training settings
Switch to visual (simple) mode
Edit as iPython notebook
Neural network architecture
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, InputLayer, Dropout, Conv1D, Conv2D, Flatten, Reshape, MaxPooling1D, MaxPooling2D, BatchNormalization, TimeDistributed
from tensorflow.keras.optimizers import Adam
# model architecture
model = Sequential()
model.add(Conv2D(32, kernel_size=3, activation='relu', kernel_constraint=tf.keras.constraints.MaxNorm(1), padding='same'))
model.add(MaxPooling2D(pool_size=2, strides=2, padding='same'))
model.add(Conv2D(64, kernel_size=3, activation='relu', kernel_constraint=tf.keras.constraints.MaxNorm(1), padding='same'))
model.add(MaxPooling2D(pool_size=2, strides=2, padding='same'))
model.add(Flatten())
model.add(Dense(64, activation='relu', activity_regularizer=tf.keras.regularizers.l1(0.00001)))
model.add(Dense(classes, activation='softmax', name='y_pred'))
# this controls the learning rate
opt = Adam(lr=0.0005, beta_1=0.9, beta_2=0.999)
# this controls the batch size, or you can manipulate the tf.data.Dataset objects yourself
BATCH_SIZE = 32
train_dataset = train_dataset.batch(BATCH_SIZE, drop_remainder=False)
validation_dataset = validation_dataset.batch(BATCH_SIZE, drop_remainder=False)
callbacks.append(BatchLoggerCallback(BATCH_SIZE, train_sample_count))
# train the neural network
model.compile(loss='categorical_crossentropy', optimizer=opt, metrics=['accuracy'])
Start training
Training output
Model
Model version:
Quantized (int8)
Last training performance (validation set)
ACCURACY
74.4%
LOSS
0.56
Confusion matrix (validation set)
CAT
DOG
F1 SCORE
80.6%
19.4%
32.1%
67.9%
0.76
0.72
Feature explorer (full training set)
cat - correct
dog - correct
cat - incorrect
dog - incorrect
Visualization layer 1
Visualization layer 2
Visualization layer 3
On-device performance
INFERENCING TIME
1,048 ms.
PEAK RAM USAGE
44.7K
FLASH USAGE
308.2K
https://studio.edgeimpulse.com/studio/51070/learning/keras/6#


NN Classifier - Cifar10_Image_
Upload data - Cifar10 Classific
computer icon - Pesquisa Goo
studio.edgeimpulse.com/studio/51070/learning/keras/6
EDGE IMPULSE
NN CLASSIFIER (CIFAR10_IMAGE_CLASSIFICATION)
#2 Model - Same as done in class (IESTI01)
Primary version
MJRoBot (Marcelo Rovai)
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
Neural Network settings
Training settings
Number of training cycles
Learning rate
Switch to Keras (expert) mode
Edit as iPython notebook
Neural network architecture
Input layer (3,072 features)
2D conv / pool layer (32 filters, 3 kernel size, 1 layer)
2D conv / pool layer (64 filters, 3 kernel size, 1 layer)
Flatten layer
Dense layer (64 neurons)
Add an extra layer
Output layer (2 features)
Start training
Training output
Model
Model version:
Quantized (int8)
Last training performance (validation set)
ACCURACY
74.4%
LOSS
0.56
Confusion matrix (validation set)
CAT
DOG
F1 SCORE
80.6%
19.4%
32.1%
67.9%
0.76
0.72
Feature explorer (full training set)
cat - correct
dog - correct
cat - incorrect
dog - incorrect
Visualization layer 1
Visualization layer 2
Visualization layer 3
On-device performance
INFERENCING TIME
1,048 ms.
PEAK RAM USAGE
44.7K
FLASH USAGE
308.2K
https://studio.edgeimpulse.com/v1/api/51070/training/keras/6/ipynb

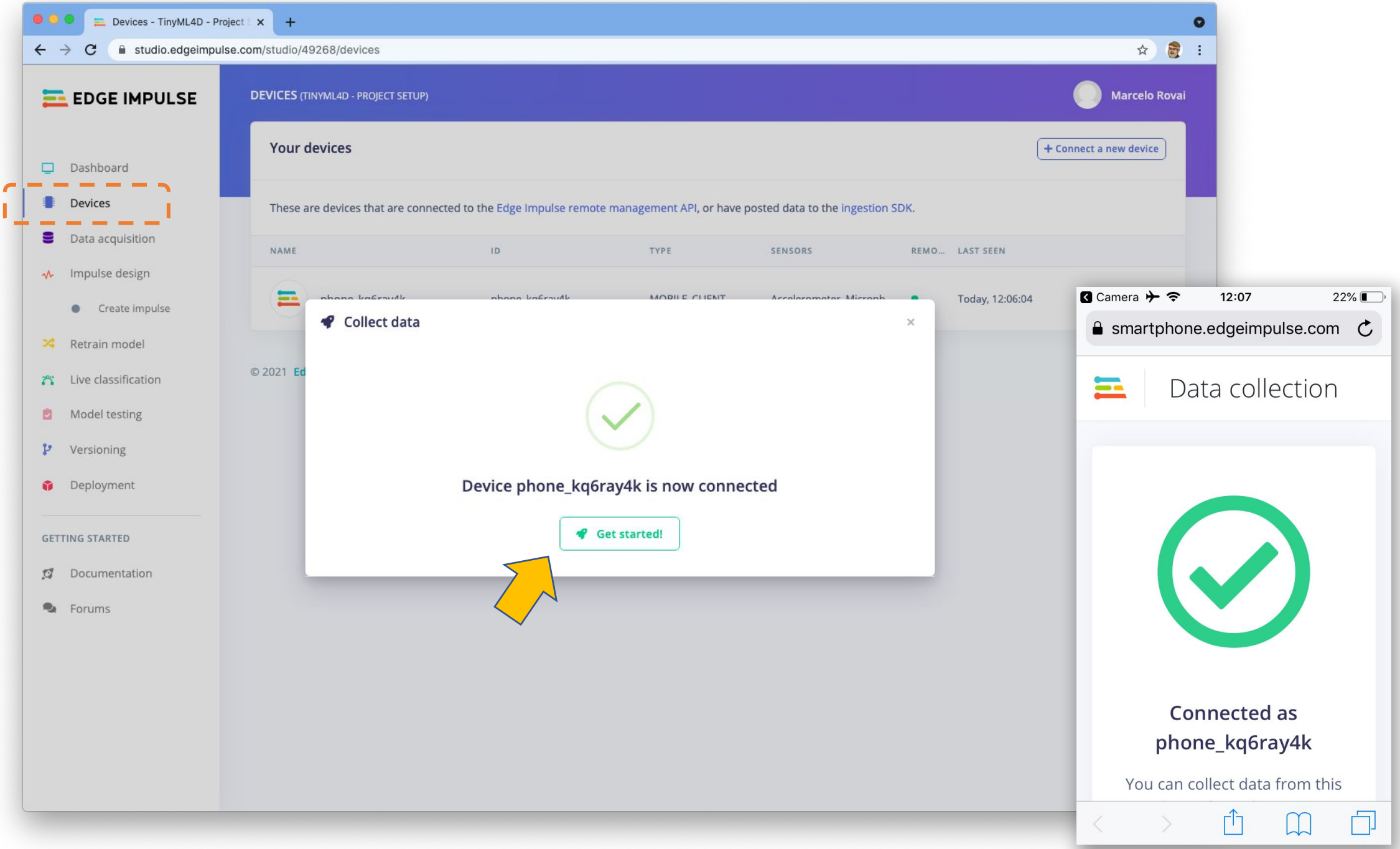
Optional

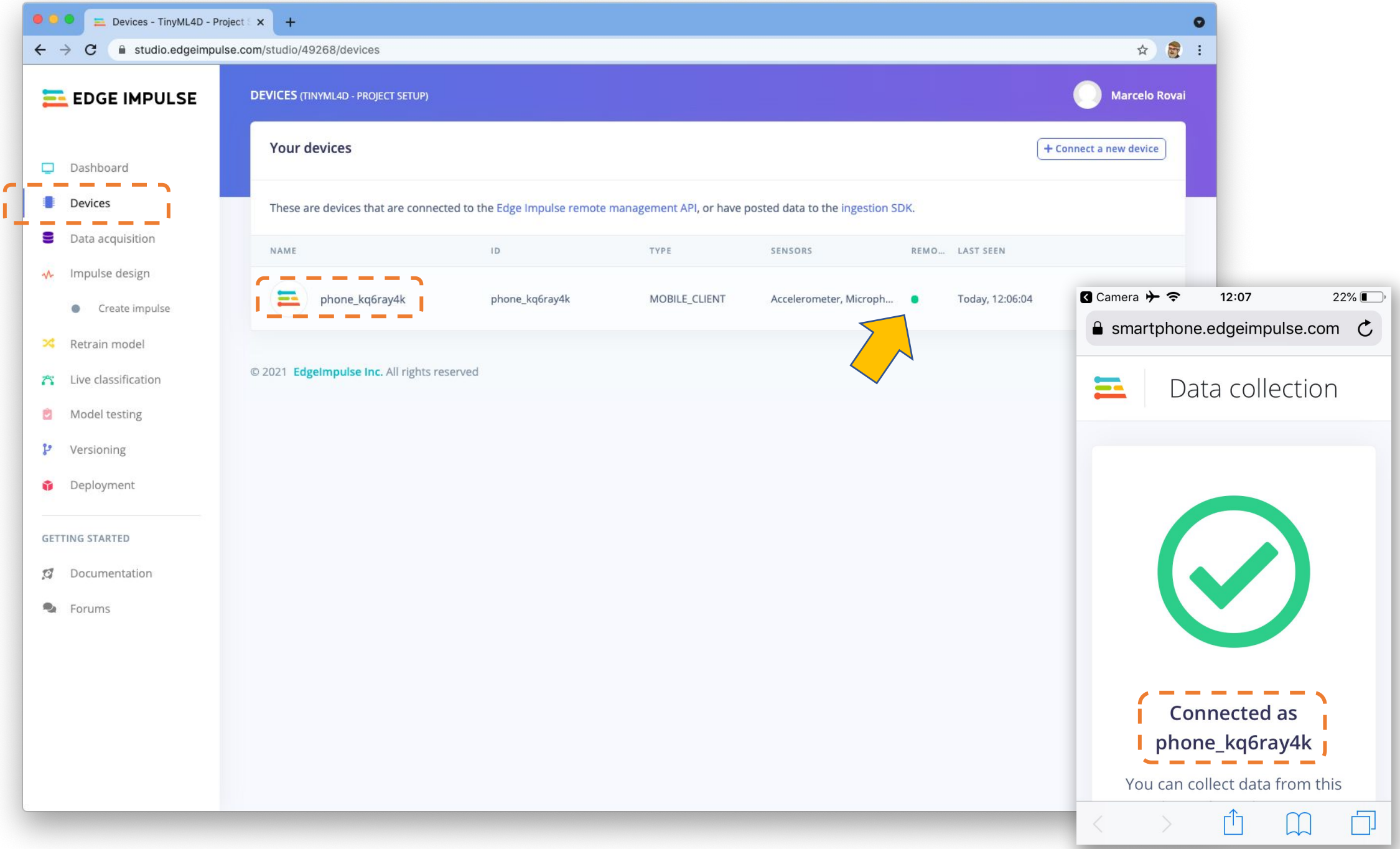
Connect device for data capture

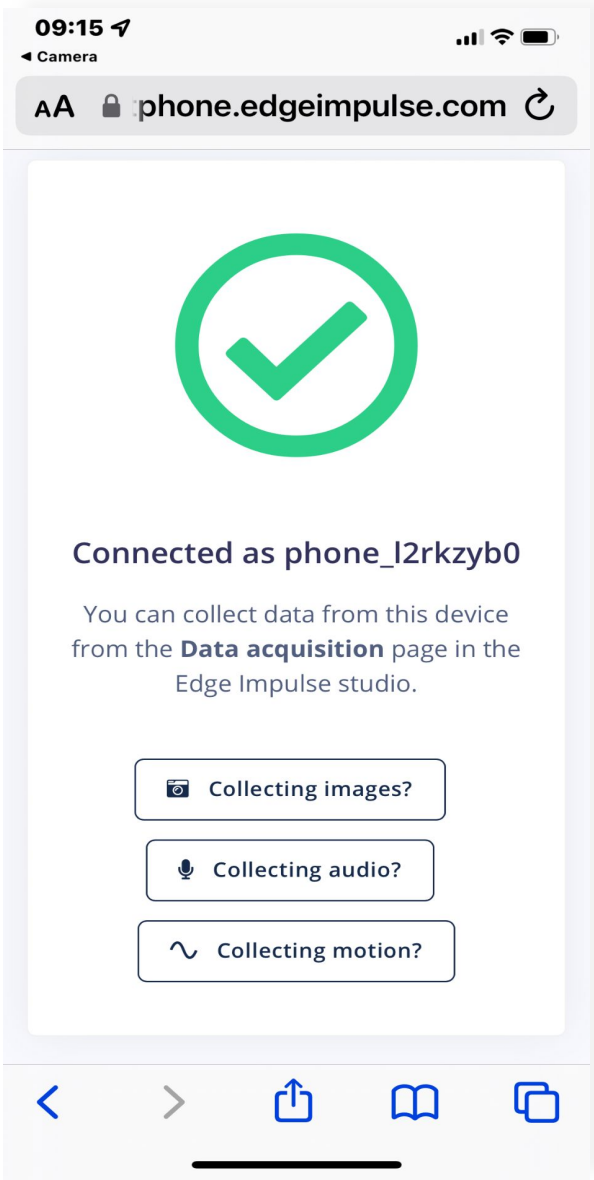

Devices - TinyML4D - Project
studio.edgeimpulse.com/studio/49268/devices
EDGE IMPULSE
DEVICES (TINYML4D - PROJECT SETUP)
Marcelo Rovai
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
+ Connect a new device
Collect data
You can collect data from development boards, from your own devices, or by uploading an existing dataset.
Connect a fully supported development board
Get started with real hardware from a wide range of silicon vendors - fully supported by Edge Impulse.
Browse dev boards
Use your mobile phone
Use your mobile phone to capture movement, audio or images, and even run your trained model locally. No app required.
Show QR code
Use your computer
Capture audio or images from your webcam or microphone, or from an external audio device.
Collect data
Data from any device with the data forwarder
Capture data from any device or development board over a serial connection, in 10 lines of code.
Show docs
Upload data
Already have data? You can upload your existing datasets directly in WAV, JPG, PNG, CBOR, CSV or JSON format.
Go to the uploader
Integrate with your cloud
The enterprise version of Edge Impulse integrates directly with the data stored in your cloud platform.
Contact us

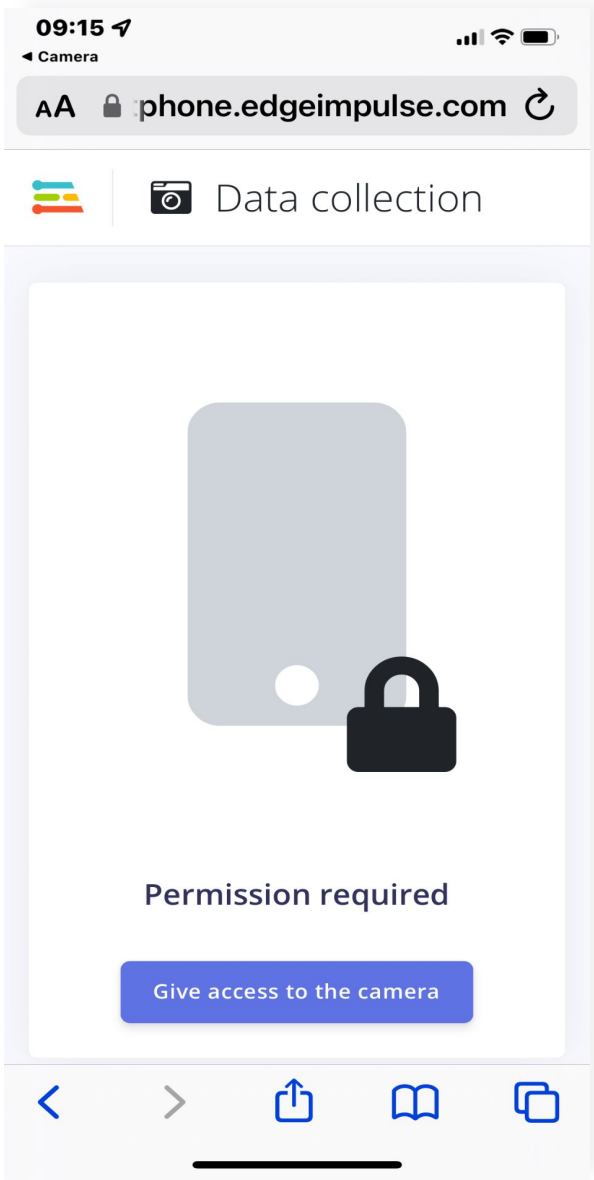

Devices - TinyML4D - Project
studio.edgeimpulse.com/studio/49268/devices
EDGE IMPULSE
DEVICES (TINYML4D - PROJECT SETUP)
Marcelo Rovai
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
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.
Collect data
You can collect data from any smartphone. From your smartphone go to this URL, or scan the QR code below.

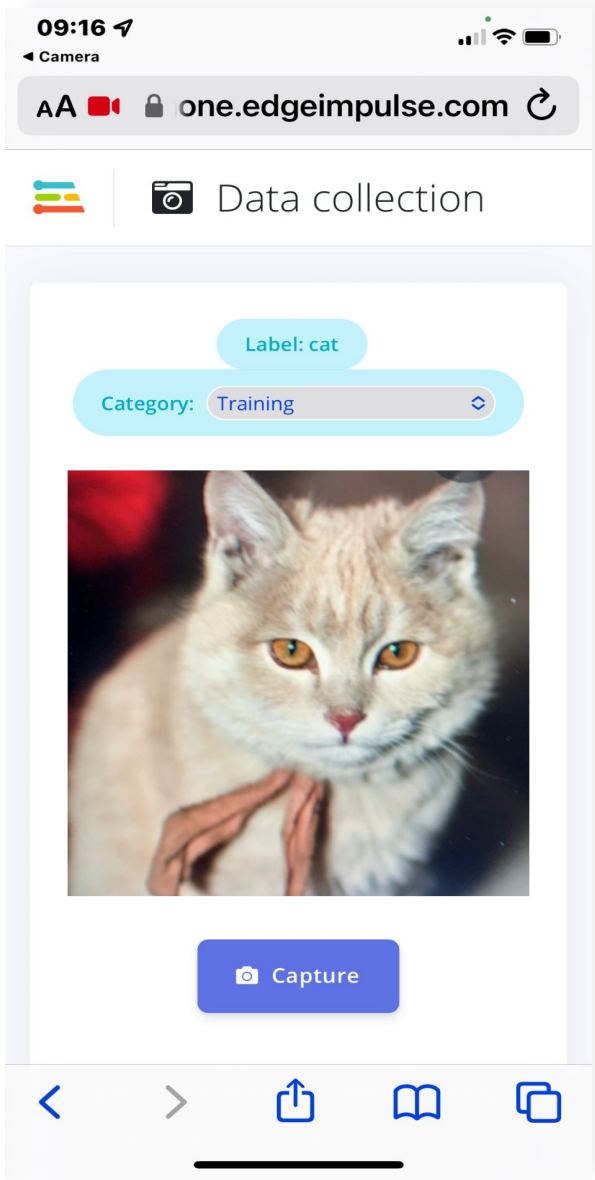

WEBSITE QR CODE
Open "edgeimpulse.com" in Safari


Devices - TinyML4D - Project
studio.edgeimpulse.com/studio/49268/devices
EDGE IMPULSE
DEVICES (TINYML4D - PROJECT SETUP)
Marcelo Rovai
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
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
REMO...
LAST SEEN
Today, 12:06:04
Collect data
Device phone_kq6ray4k is now connected
Get started!
Camera
12:07
22%
smartphone.edgeimpulse.com
Data collection
Connected as
phone_kq6ray4k
You can collect data from this


Devices - TinyML4D - Project
studio.edgeimpulse.com/studio/49268/devices
EDGE IMPULSE
DEVICES (TINYML4D - PROJECT SETUP)
Marcelo Rovai
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
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
REMO...
LAST SEEN
phone_kq6ray4k
phone_kq6ray4k
MOBILE_CLIENT
Accelerometer, Microph...
Today, 12:06:04
© 2021 EdgeImpulse Inc. All rights reserved
Camera
12:07
22%
smartphone.edgeimpulse.com
Data collection
Connected as
phone_kq6ray4k
You can collect data from this


09:15
Camera
AA
phone.edgeimpulse.com
Connected as phone_l2rkzyb0
You can collect data from this device from the Data acquisition page in the Edge Impulse studio.
Collecting images?
Collecting audio?
Collecting motion?


09:15
Camera
AA
phone.edgeimpulse.com
Data collection
Permission required
Give access to the camera


09:16
Camera
AA
one.edgeimpulse.com
Data collection
Label: cat
Category: Training
Capture

Reading Material

Main references

- Harvard School of Engineering and Applied Sciences - CS249r: Tiny Machine Learning
- Professional Certificate in Tiny Machine Learning (TinyML) – edX/Harvard
- Introduction to Embedded Machine Learning - Coursera/Edge Impulse
- Computer Vision with Embedded Machine Learning - Coursera/Edge Impulse
- Fundamentals textbook: “Deep Learning with Python” by François Chollet
- Applications & Deploy textbook: “TinyML” by Pete Warden, Daniel Situnayake
- Deploy textbook “TinyML Cookbook” by Gian Marco Iodice

I want to thank Shawn Hymel and Edge Impulse, Pete Warden and Laurence Moroney from Google, Professor Vijay Janapa Reddi and Brian Plancher from Harvard, and the rest of the TinyMLedu team for preparing the excellent material on TinyML that is the basis of this course at UNIFEI.

The IESTI01 course is part of the **TinyML4D**, an initiative to make TinyML education available to everyone globally.

Thanks

UNIFEI