Introducing schools into STEAM with birds, IoT, AI and Fablabs

FAB16 - 10th August 2021

marc@balena.io

Marc Pous

balena.io Developer Advocate

Co-Founder at thethings.iO & 1m1Labs
IoT Barcelona & IoT Munich

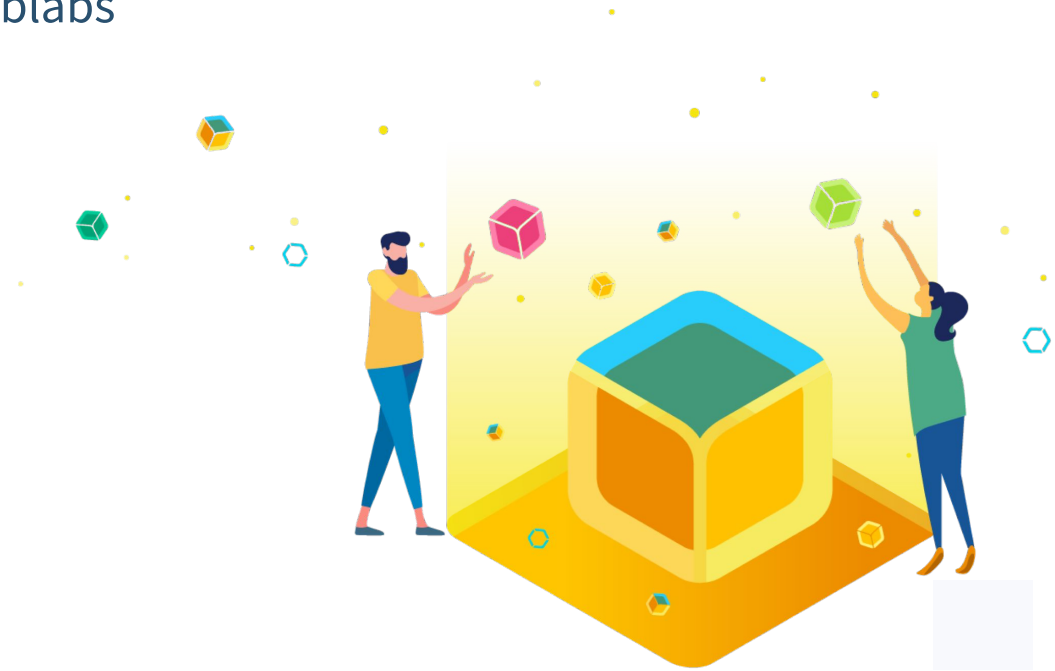
…

and father

Today

⅓ Stories about birds + AI + IoT + Fablabs

⅔ Let’s build it together



Prerequisites

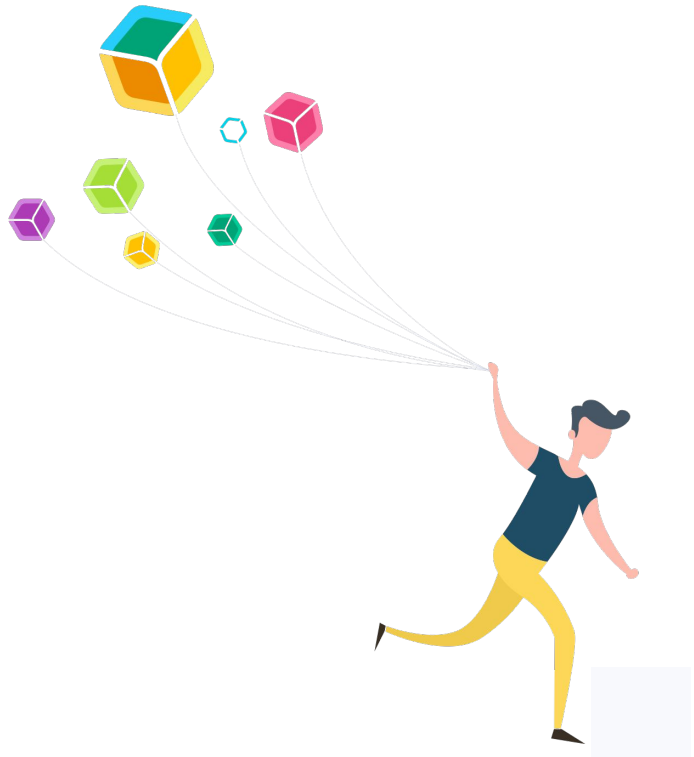
Raspberry Pi 3 / 4

USB Camera or Pi Camera

Telegram app

balenaCloud account

Edge Impulse account

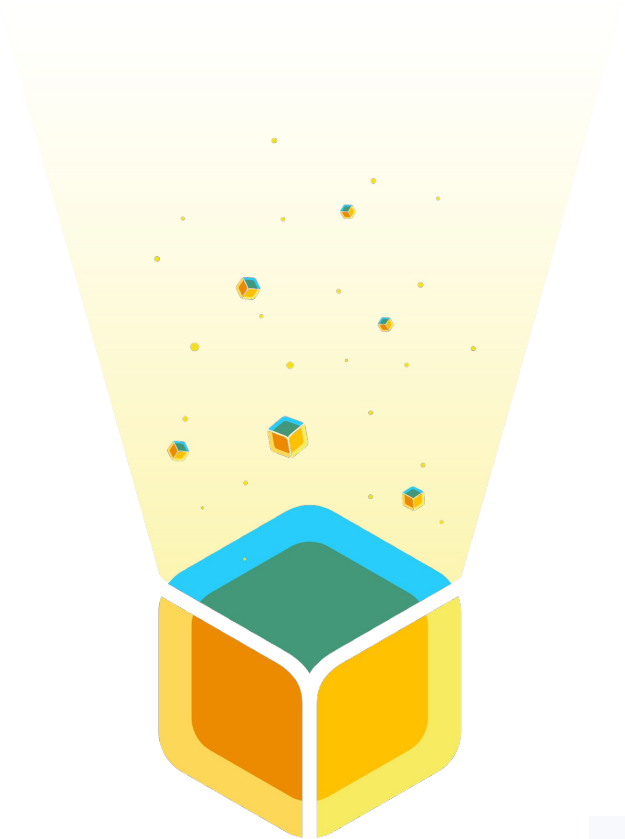


Goals

Learn about birds around us.

Introduce on IoT and AI.

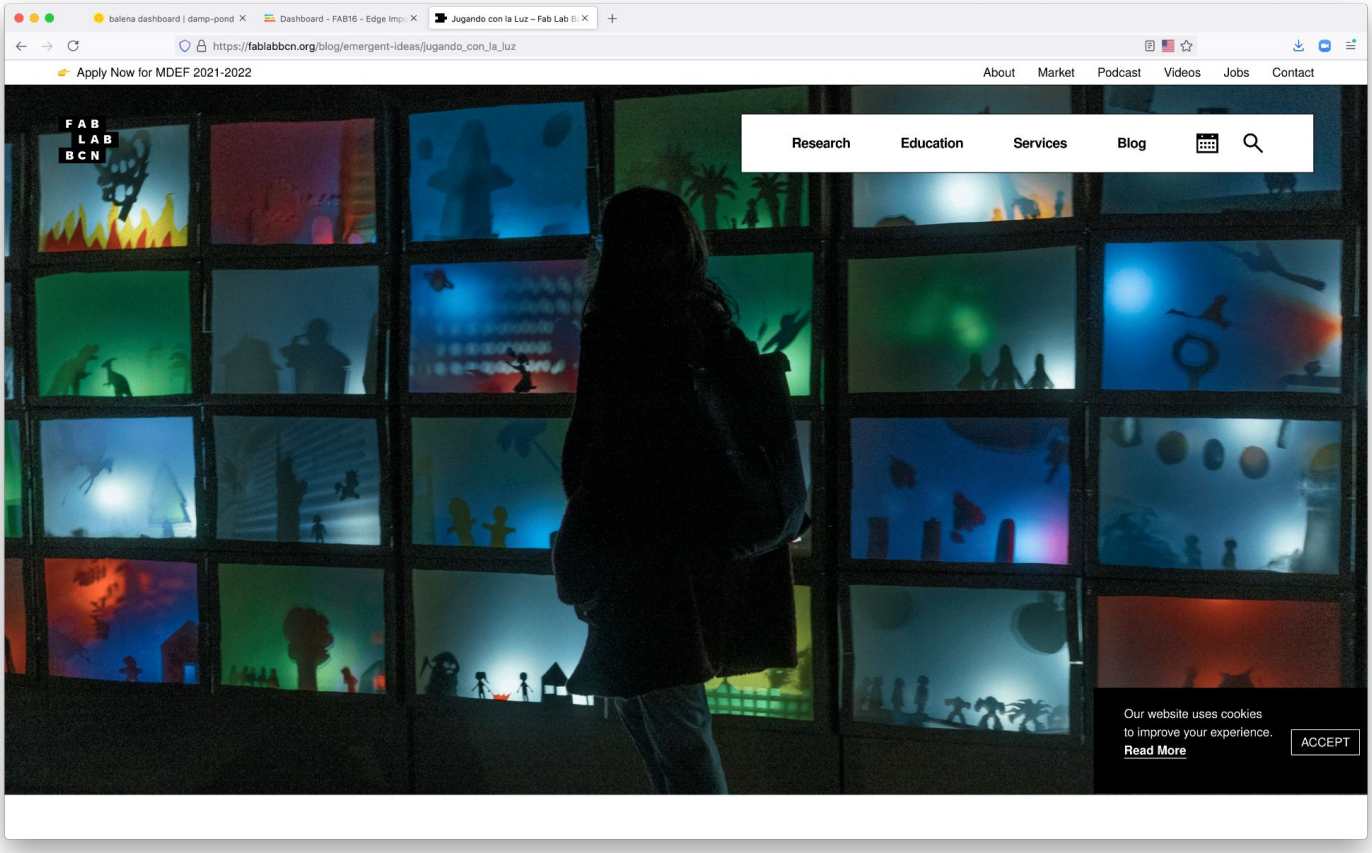
Involve the community into the project.



Let me tell you a story...


Vilallonga de Ter

Escola Sant Martí Barcelona



https://fablabbcn.org/blog/emergent-ideas/jugando_con_la_luz

https://pajarosenlanube.ibercivis.es/2020/11/09/pajaros-en-la-nube-proyecto/

Pájaros en la nube @ Escola Sant Martí Barcelona

Mapatge d'ocells de Sarrià – 25 de març

Fitxa de camp:

1 - Jardins d
2 – Can Pon
3 – Parc de J

Colom roquer

Garsa

Mallerenga carbonera

Mallerenga cuallarga

Mosquiter comú

ELS OCELLS DE LA NOSTRA ESCOLA

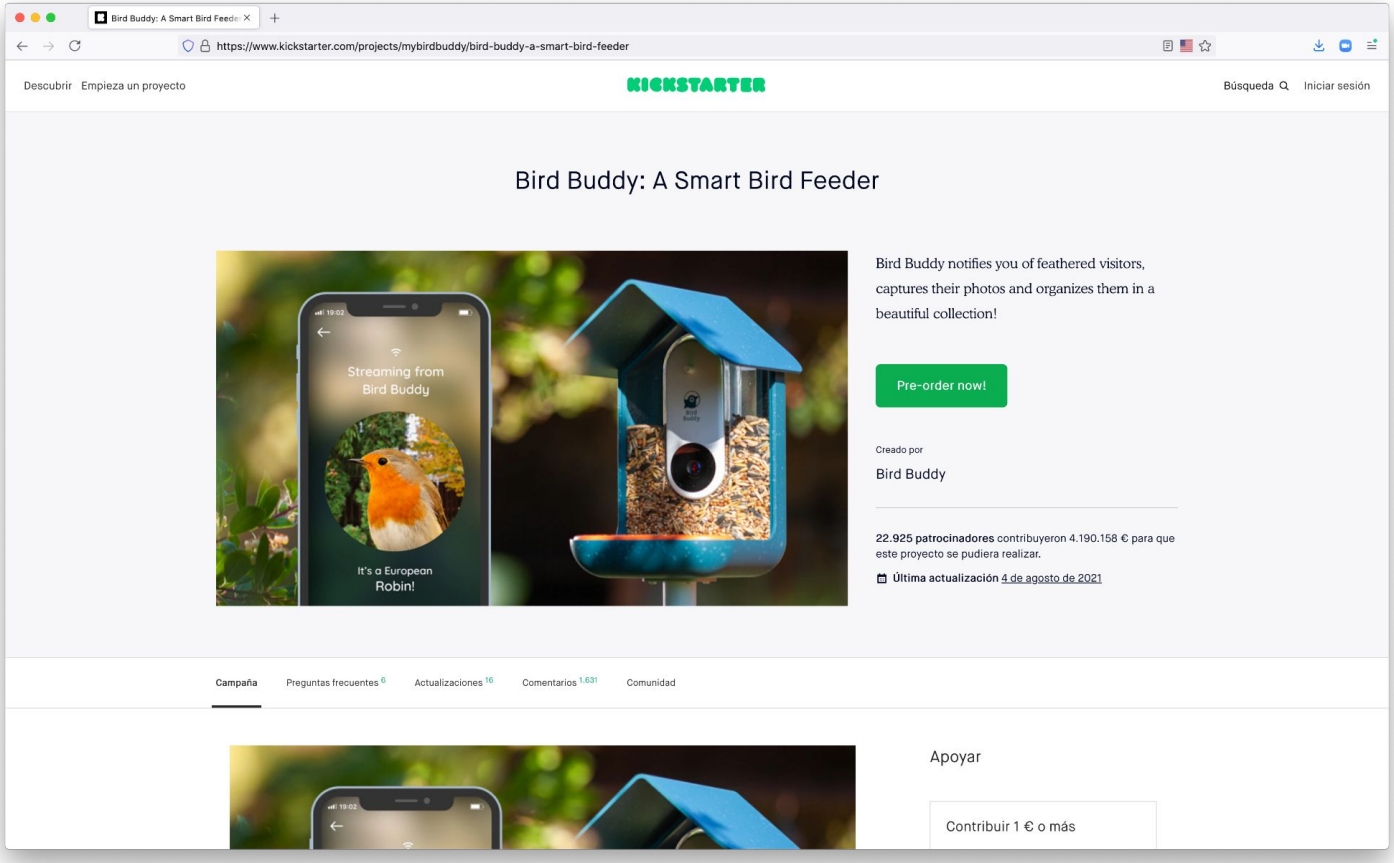
Institut Moisès Broggi

Barcelona

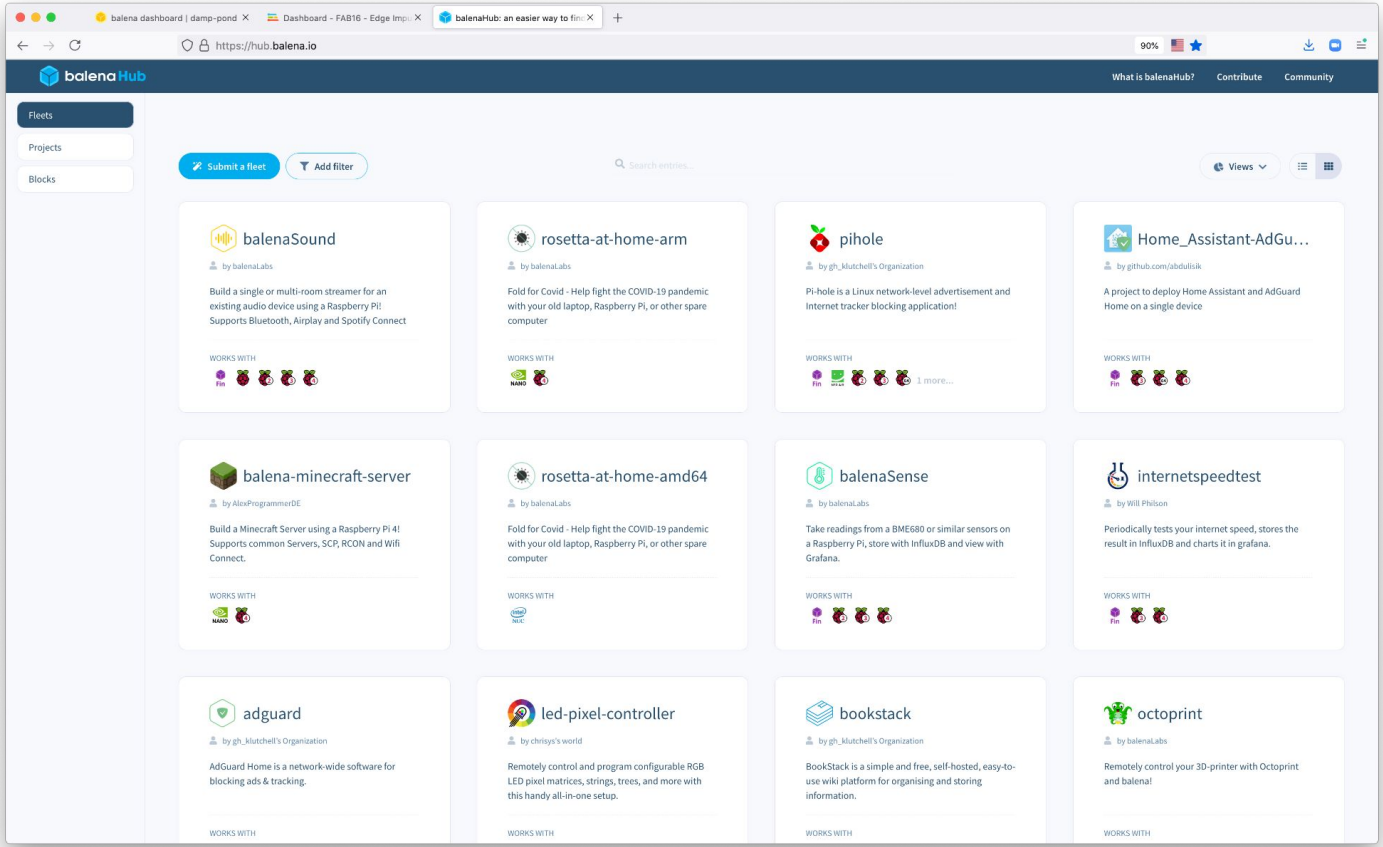
Resident
Hivernant
Estival

Il·lustracions
Àlex Mascarell

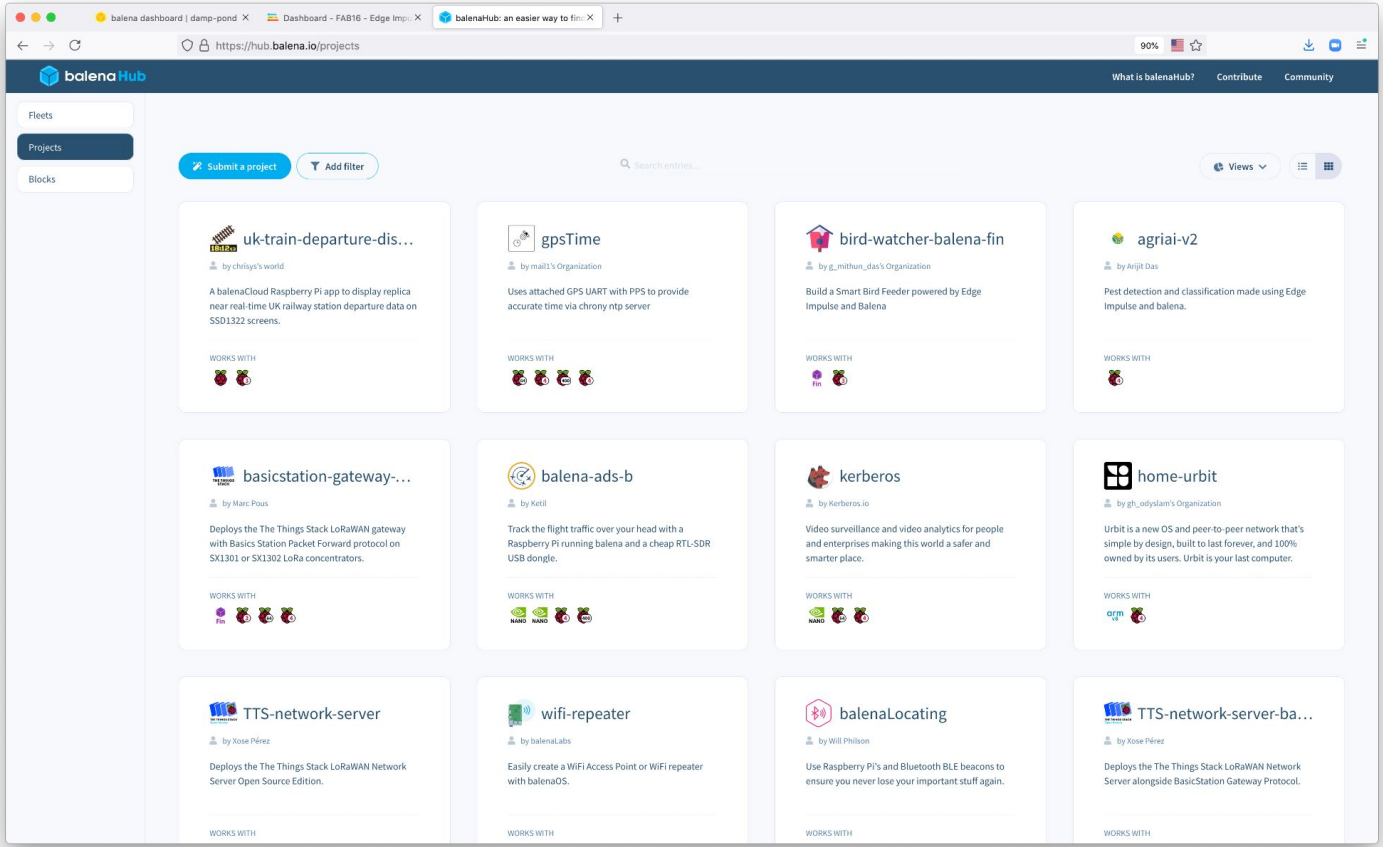
balena



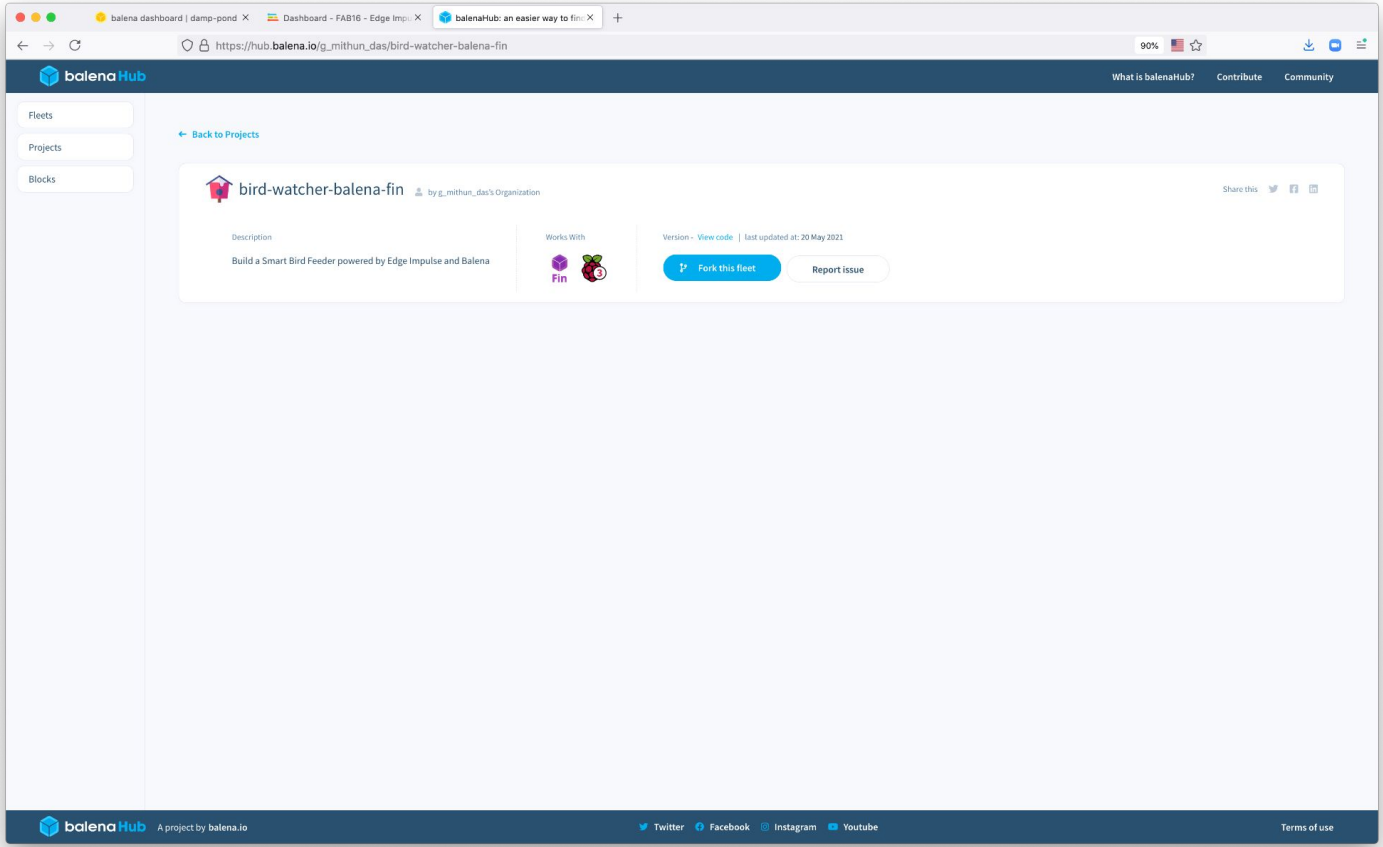
https://www.kickstarter.com/projects/mybirdbuddy/bird-buddy-a-smart-bird-feeder



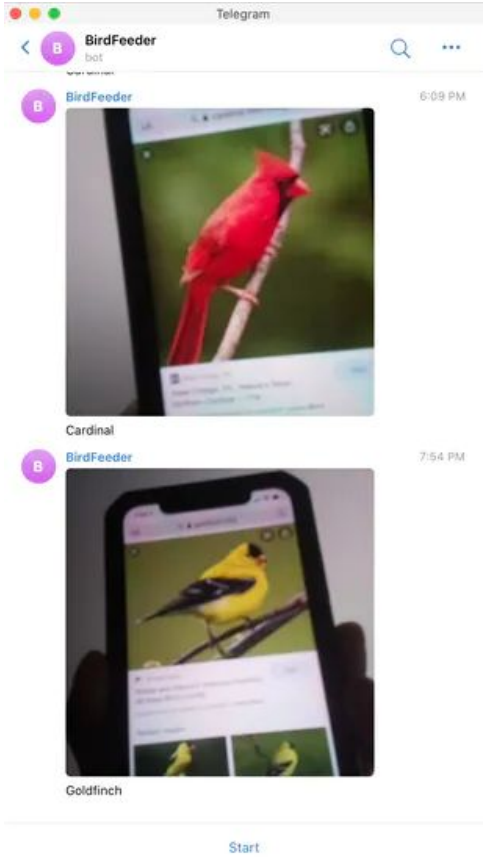
https://hub.balena.io

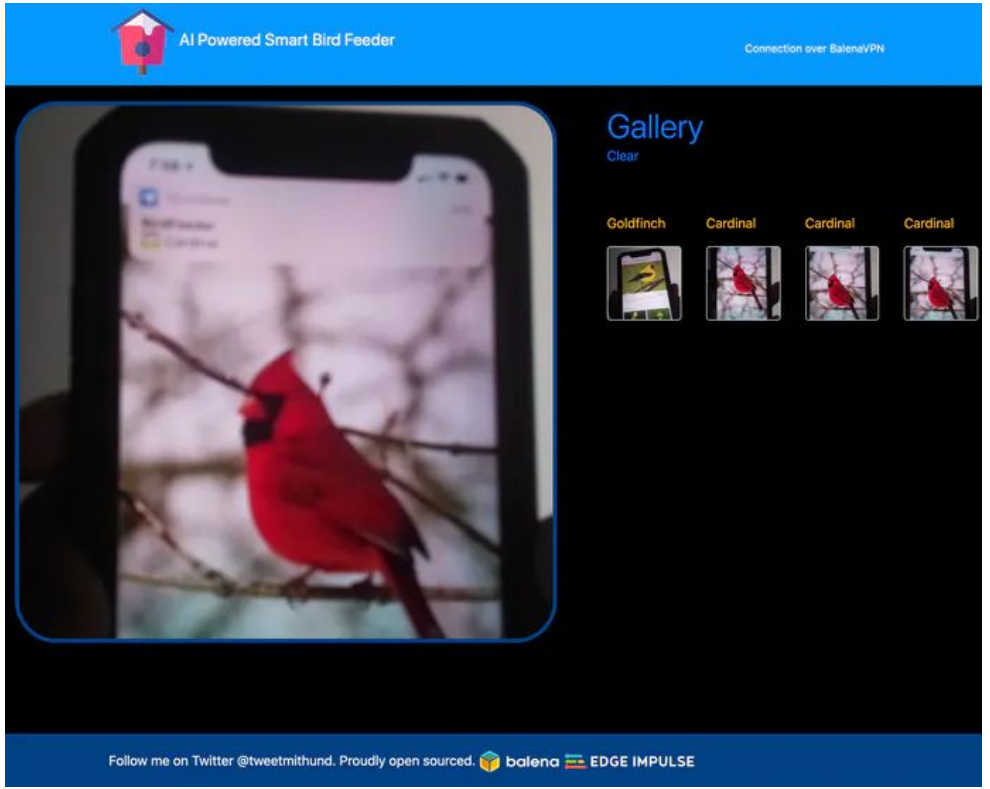


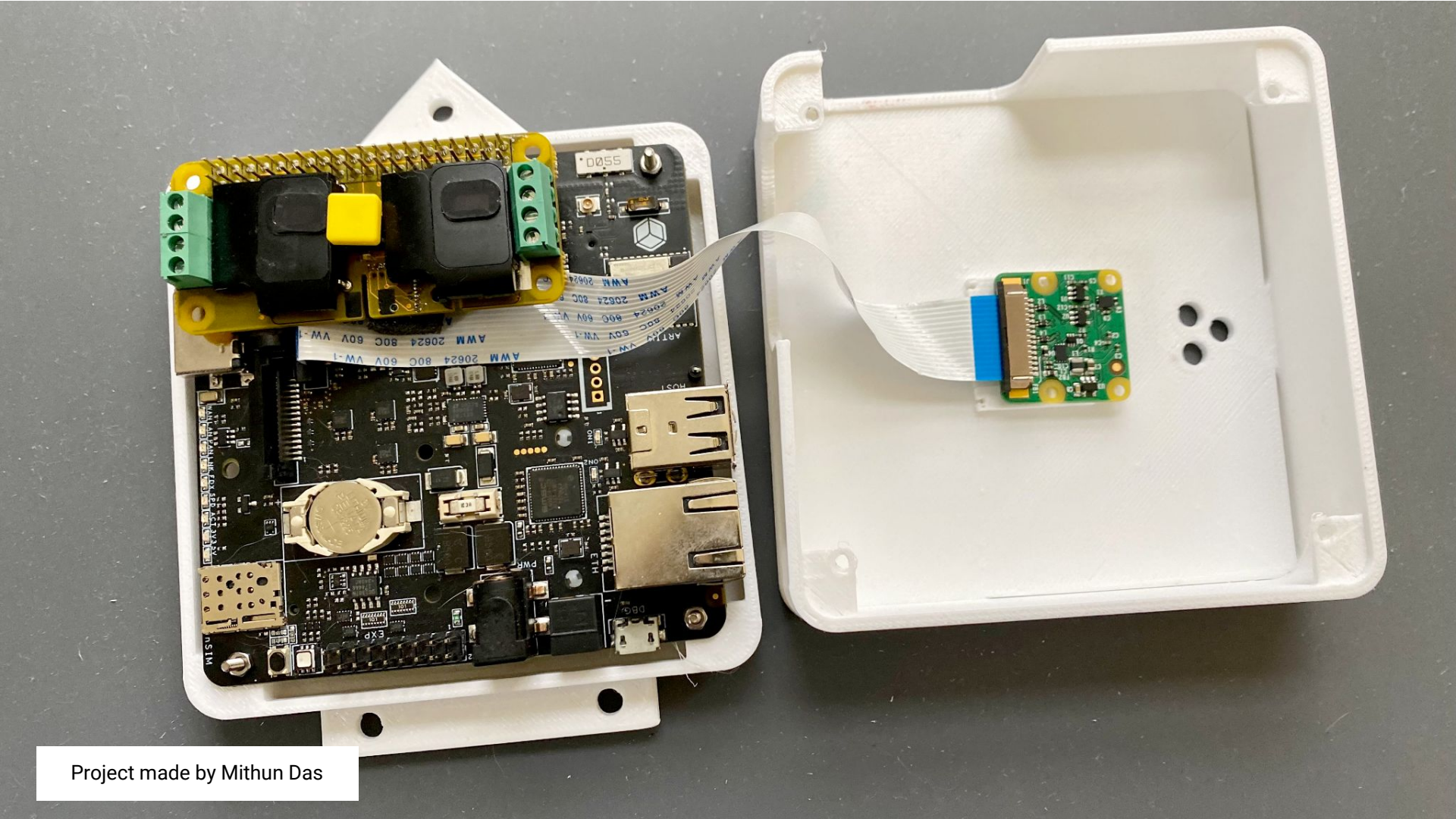
https://hub.balena.io



https://hub.balena.io


Telegram
BirdFeeder
bot
BirdFeeder
6:09 PM
Cardinal
BirdFeeder
7:54 PM
Goldfinch
Start


AI Powered Smart Bird Feeder
Connection over BalenaVPN
Gallery
Clear
Goldfinch
Cardinal
Cardinal
Cardinal
Follow me on Twitter @tweetmithund. Proudly open sourced.
balena
EDGE IMPULSE



Project made by Mithun Das

Project made by @disk91

Goals of the project

How to introduce STEAM & citizen science into schools for all?

- Learn about birds around us
  - Birds sizes, birds migration, different species, food, stations and more.

- Learn about birds around us
  - Birds sizes, birds migration, different species, food, stations and more.

- Experiment with different materials
  - Make bird feeders using 3D printing, wood, and more.

- # Learn about birds around us
  - Birds sizes, birds migration, different species, food, stations and more.

- # Experiment with different materials
  - Make bird feeders using 3D printing, wood, and more.

- # Introduce IoT+AI to children
  - Show to children how the system works and how to make it different (bird chirps detection?)
  - Make children understand that a camera sometimes is not just a camera.
  - Create a Machine Learning model to know what are the birds around them (local vs global).
  - Involve children, teachers and families into citizen science and STEAM.
  - Build communities and share knowledge.

How to build it?

Build it with me :-)

1. Prepare the camera + Raspberry Pi (or similar)
2. Train a ML model with Edge Impulse
3. Deploy the balena Fleet on the Pi
4. Make a bird feeder
5. Share it with everyone

1 Prepare the camera

Raspberry Pi

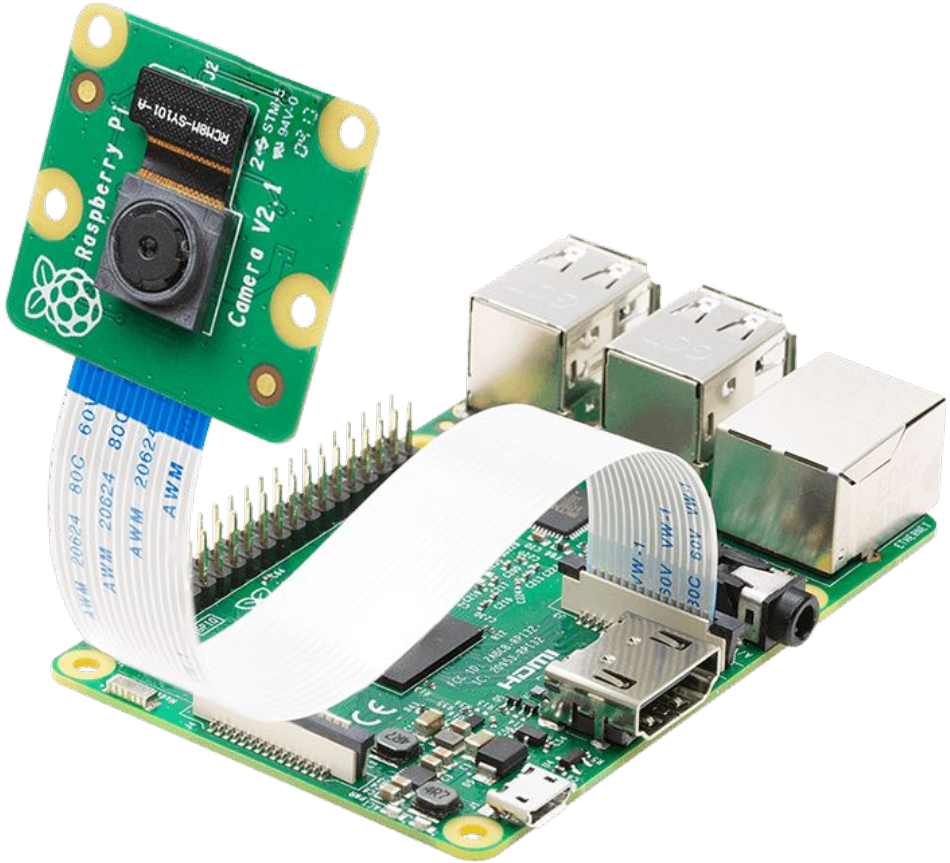
Hardware

Raspberry Pi 3 / 4 or balenaFin

USB Camera or Pi Camera

SD Card

Power Adapter



balenaCloud

Edge Impulse

balenaEtcher

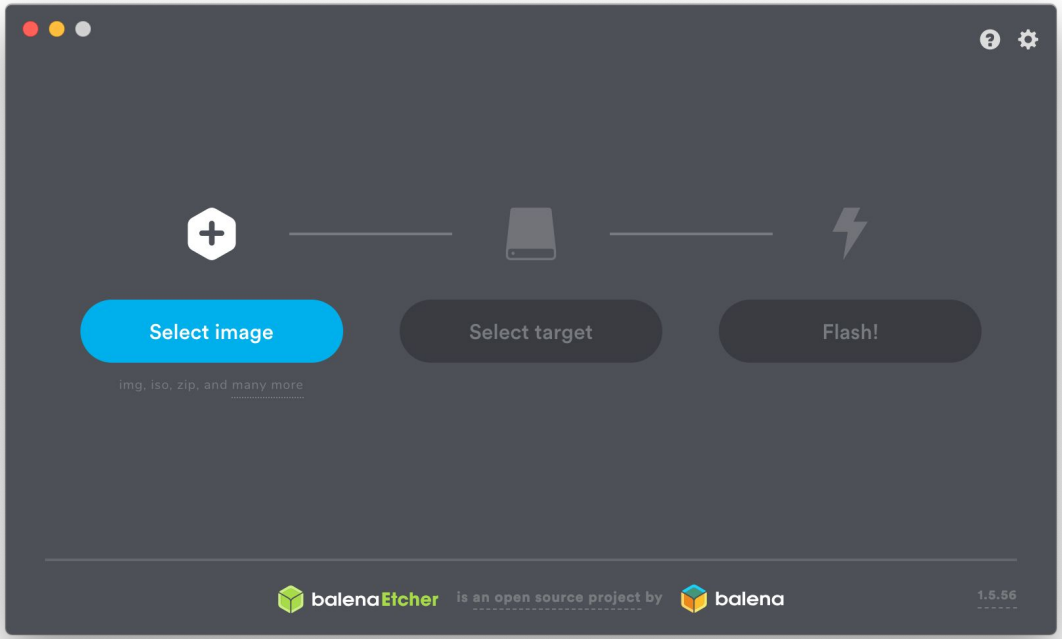
Software

balenaCloud

Edge Impulse

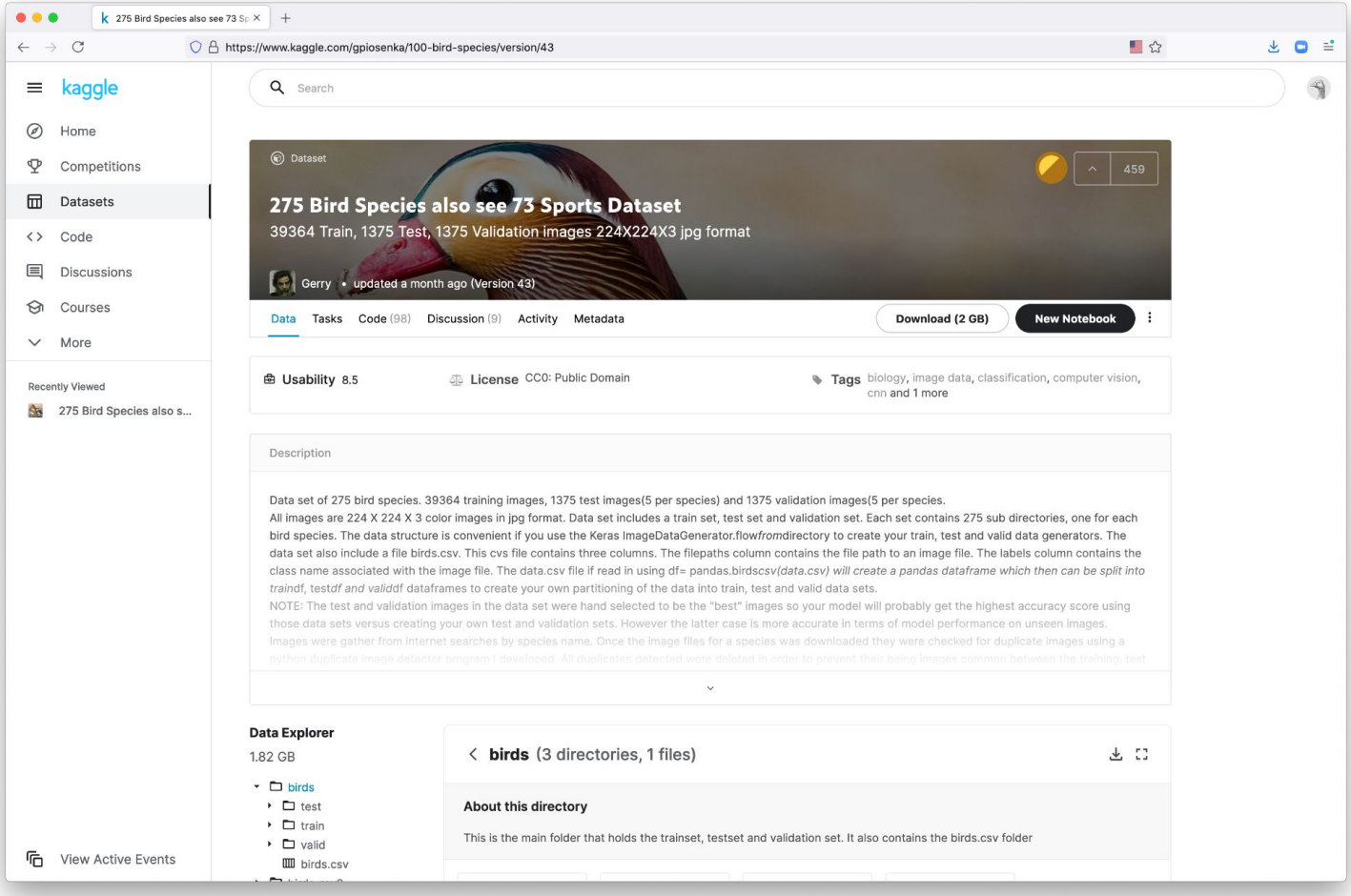
balenaEtcher

Telegram app

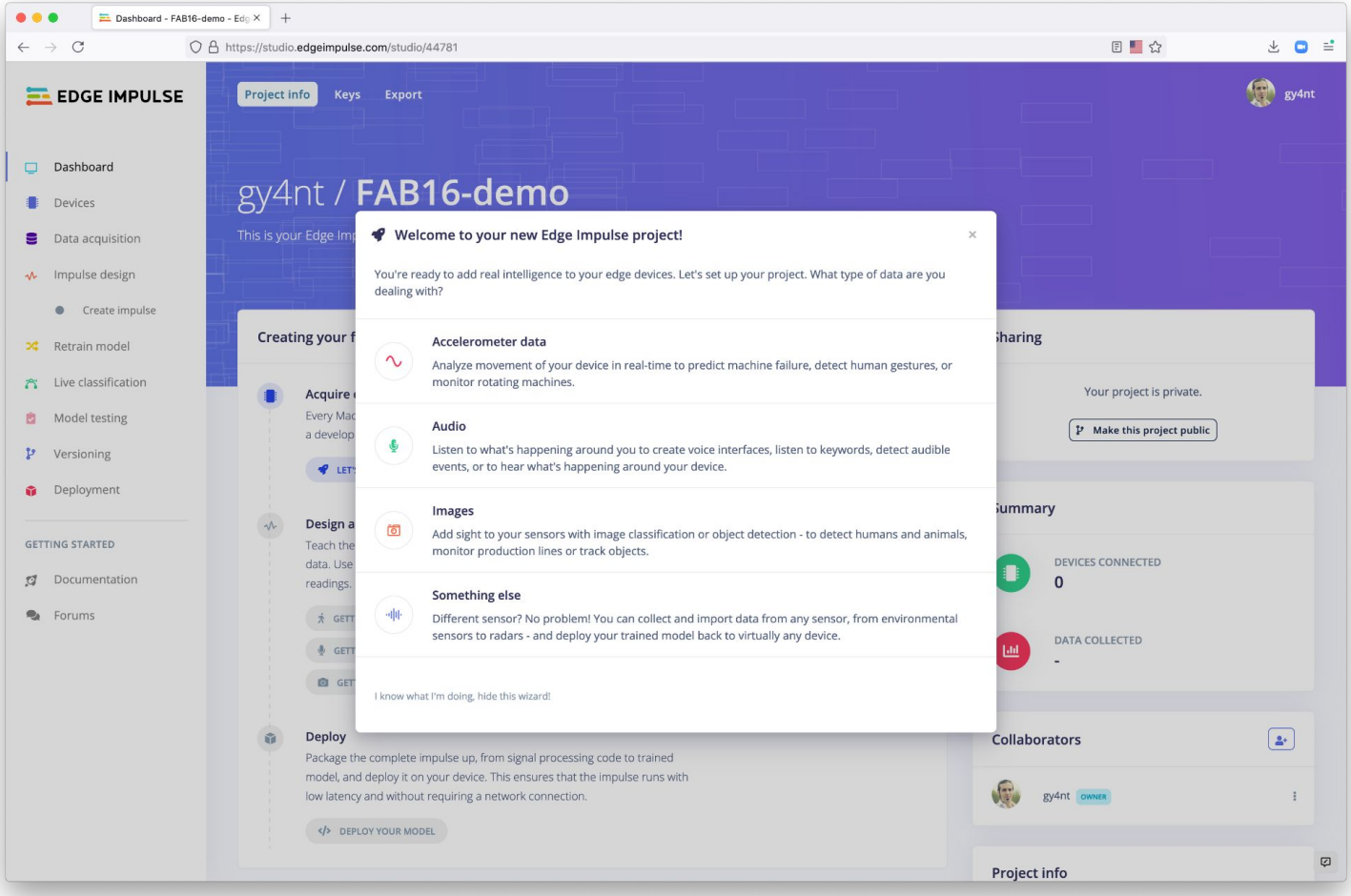


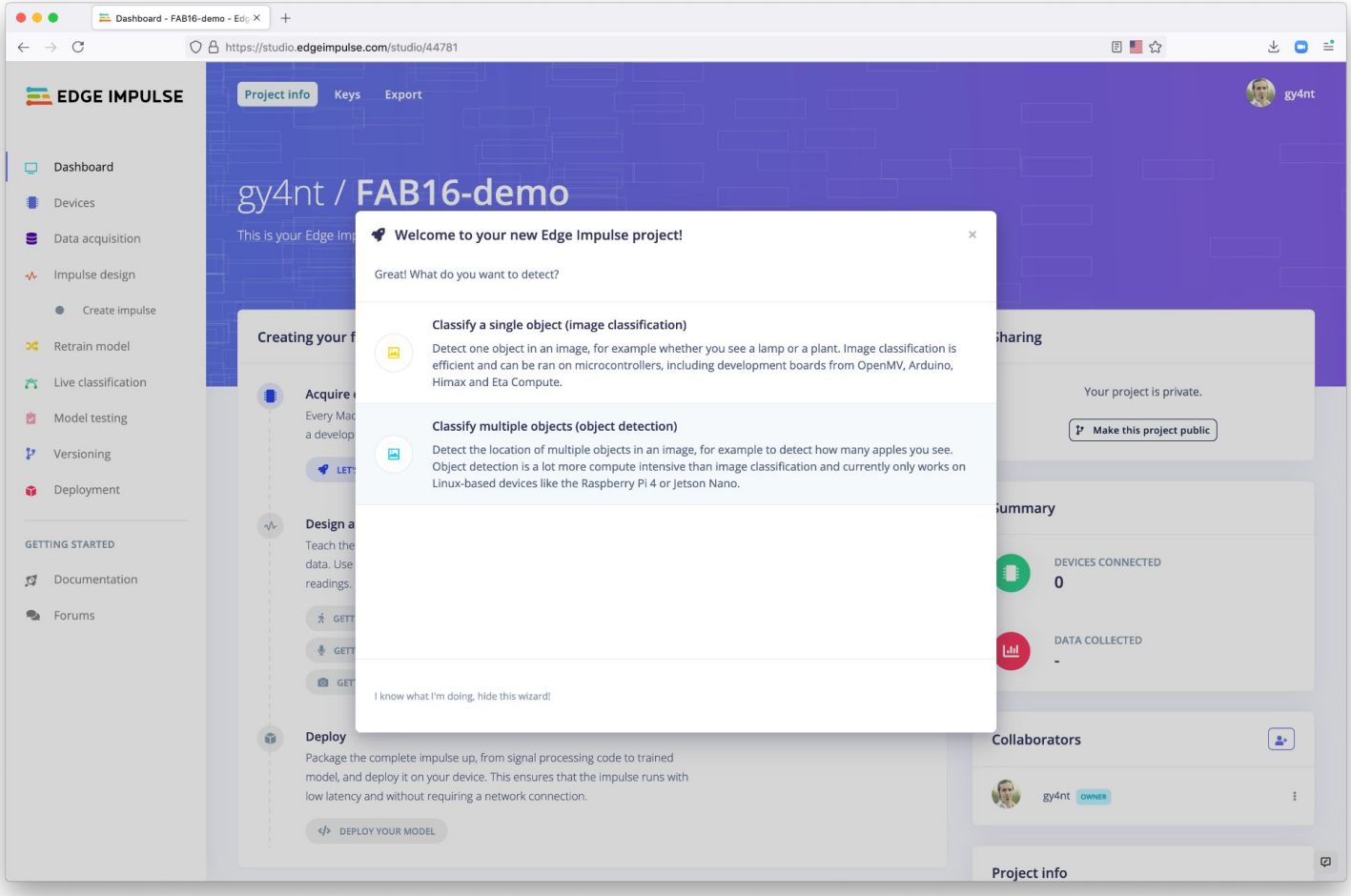
2 Train the ML model

using Edge Impulse



https://www.kaggle.com/gpiosenka/100-bird-species/version/43


Dashboard - FAB16-demo - Edg
https://studio.edgeimpulse.com/studio/44781
EDGE IMPULSE
Project info
Keys
Export
gy4nt
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
gy4nt / FAB16-demo
This is your Edge Imp
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 f
Acquire
Every Mac
a develop
LET'
Design a
Teach the
data. Use
readings.
GETT
GETT
GET
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
gy4nt
OWNER
Project info


Dashboard - FAB16-demo - Edg
https://studio.edgeimpulse.com/studio/44781
EDGE IMPULSE
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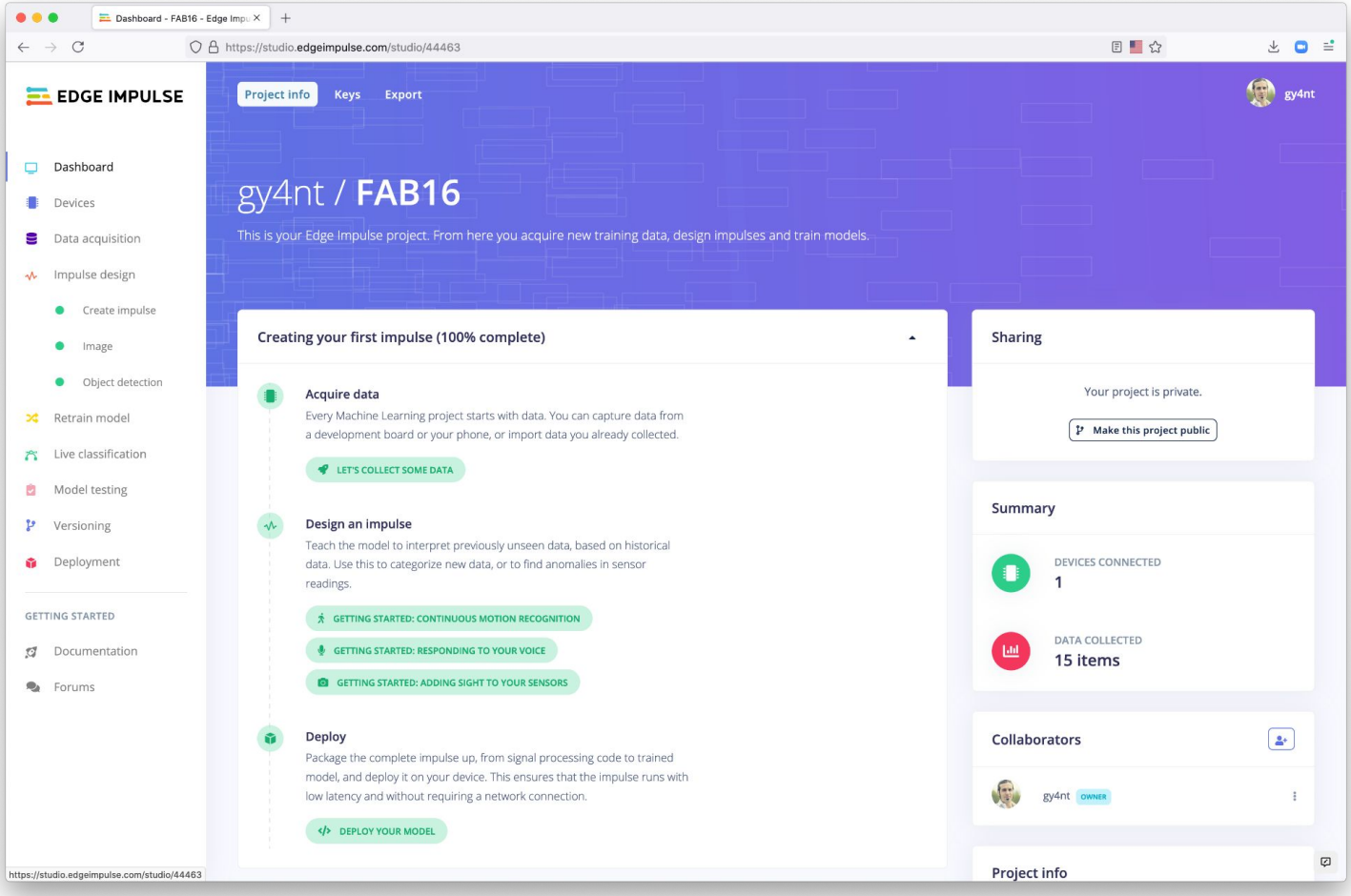
gy4nt / FAB16-demo
This is your Edge Imp
Welcome to your new Edge Impulse project!
Great! What do you want to detect?
Classify a single object (image classification)
Detect one object in an image, for example whether you see a lamp or a plant. Image classification is efficient and can be ran on microcontrollers, 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 f
Acquire
Design a
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
gy4nt
OWNER
Project info


Dashboard - FAB16 - Edge Impu
https://studio.edgeimpulse.com/studio/44463
EDGE IMPULSE
Project info
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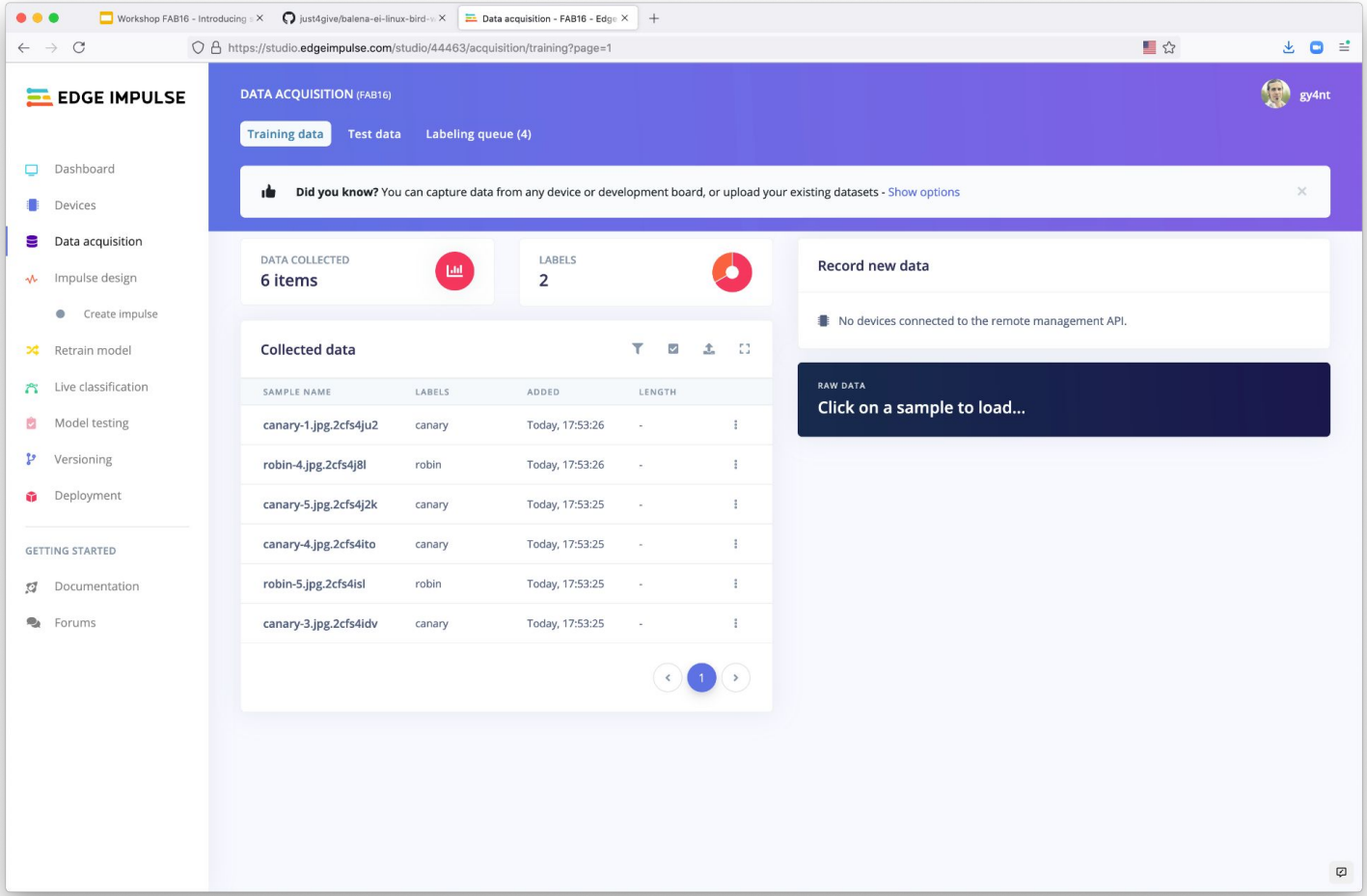
gy4nt
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Image
Object detection
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
gy4nt / FAB16
This is your Edge Impulse project. From here you acquire new training data, design impulses and train models.
Creating your first impulse (100% complete)
Acquire data
Every Machine Learning project starts with data. You can capture data from a development board or your phone, or import data you already collected.
LET'S COLLECT SOME DATA
Design an impulse
Teach the model to interpret previously unseen data, based on historical data. Use this to categorize new data, or to find anomalies in sensor readings.
GETTING STARTED: CONTINUOUS MOTION RECOGNITION
GETTING STARTED: RESPONDING TO YOUR VOICE
GETTING STARTED: ADDING SIGHT TO YOUR SENSORS
Deploy
Package the complete impulse up, from signal processing code to trained model, and deploy it on your device. This ensures that the impulse runs with low latency and without requiring a network connection.
DEPLOY YOUR MODEL
Sharing
Your project is private.
Make this project public
Summary
DEVICES CONNECTED
1
DATA COLLECTED
15 items
Collaborators
gy4nt
OWNER
Project info
https://studio.edgeimpulse.com/studio/44463


Workshop FAB16 - Introducing
just4give/balena-ei-linux-bird-v
Data acquisition - FAB16 - Edge
https://studio.edgeimpulse.com/studio/44463/acquisition/training?page=1
EDGE IMPULSE
DATA ACQUISITION (FAB16)
gy4nt
Training data
Test data
Labeling queue (4)
Did you know? You can capture data from any device or development board, or upload your existing datasets - Show options
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Retrain model
Live classification
Model testing
Versioning
Deployment
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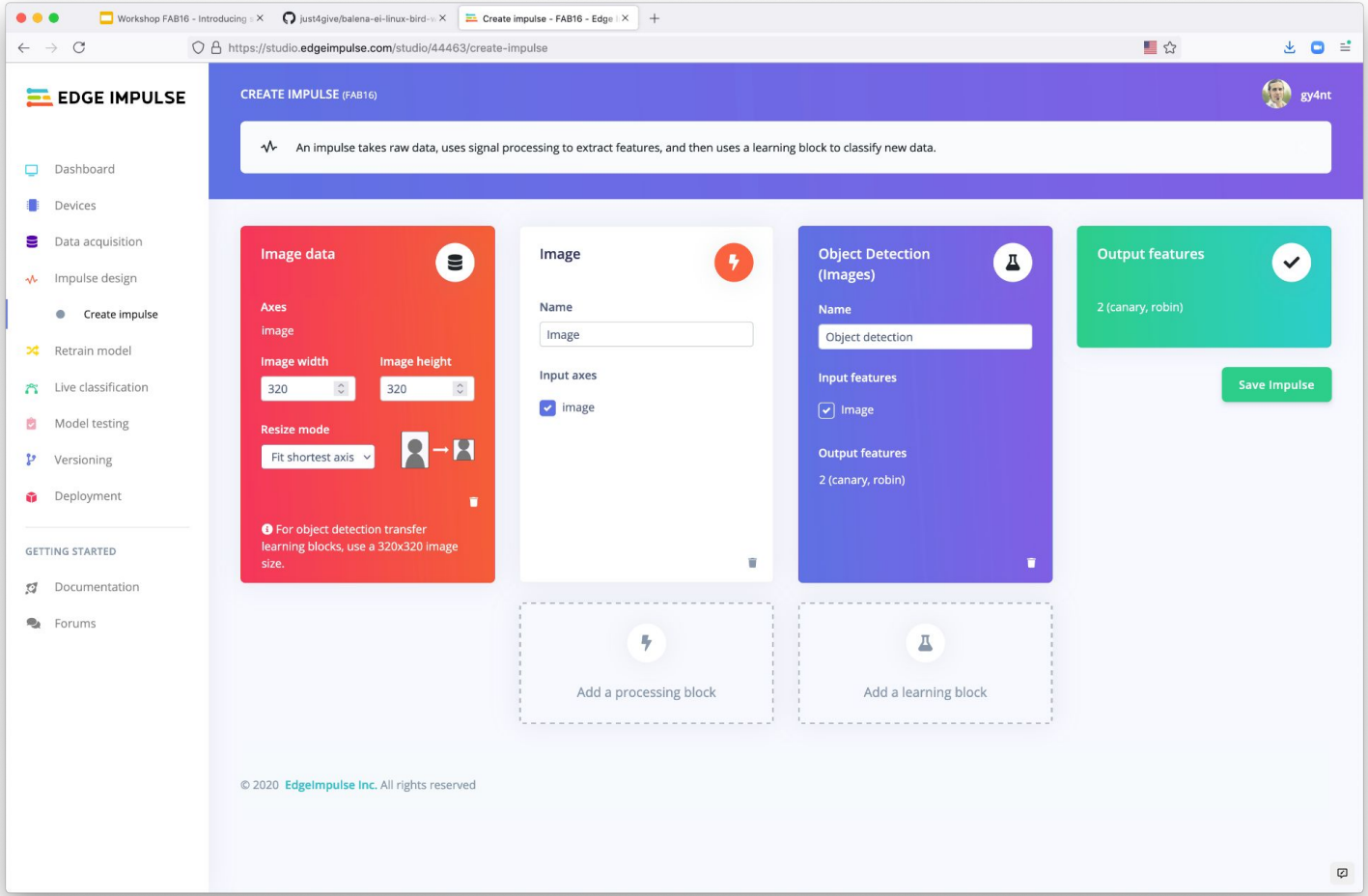
Forums
DATA COLLECTED
6 items
LABELS
2
Record new data
No devices connected to the remote management API.
Collected data
SAMPLE NAME
LABELS
ADDED
LENGTH
canary-1.jpg.2cfs4ju2 canary Today, 17:53:26 -
robin-4.jpg.2cfs4j8l robin Today, 17:53:26 -
canary-5.jpg.2cfs4j2k canary Today, 17:53:25 -
canary-4.jpg.2cfs4ito canary Today, 17:53:25 -
robin-5.jpg.2cfs4isl robin Today, 17:53:25 -
canary-3.jpg.2cfs4idv canary Today, 17:53:25 -
1
RAW DATA
Click on a sample to load...


Workshop FAB16 - Introducing
just4give/balena-ei-linux-bird-v
Create impulse - FAB16 - Edge
https://studio.edgeimpulse.com/studio/44463/create-impulse
EDGE IMPULSE
CREATE IMPULSE (FAB16)
gy4nt
An impulse takes raw data, uses signal processing to extract features, and then uses a learning block to classify new data.
Dashboard
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Create impulse
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Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
Image data
Axes
image
Image width
320
Image height
320
Resize mode
Fit shortest axis
For object detection transfer learning blocks, use a 320x320 image size.
Image
Name
Image
Input axes
image
Object Detection (Images)
Name
Object detection
Input features
Image
Output features
2 (canary, robin)
Output features
2 (canary, robin)
Save Impulse
Add a processing block
Add a learning block
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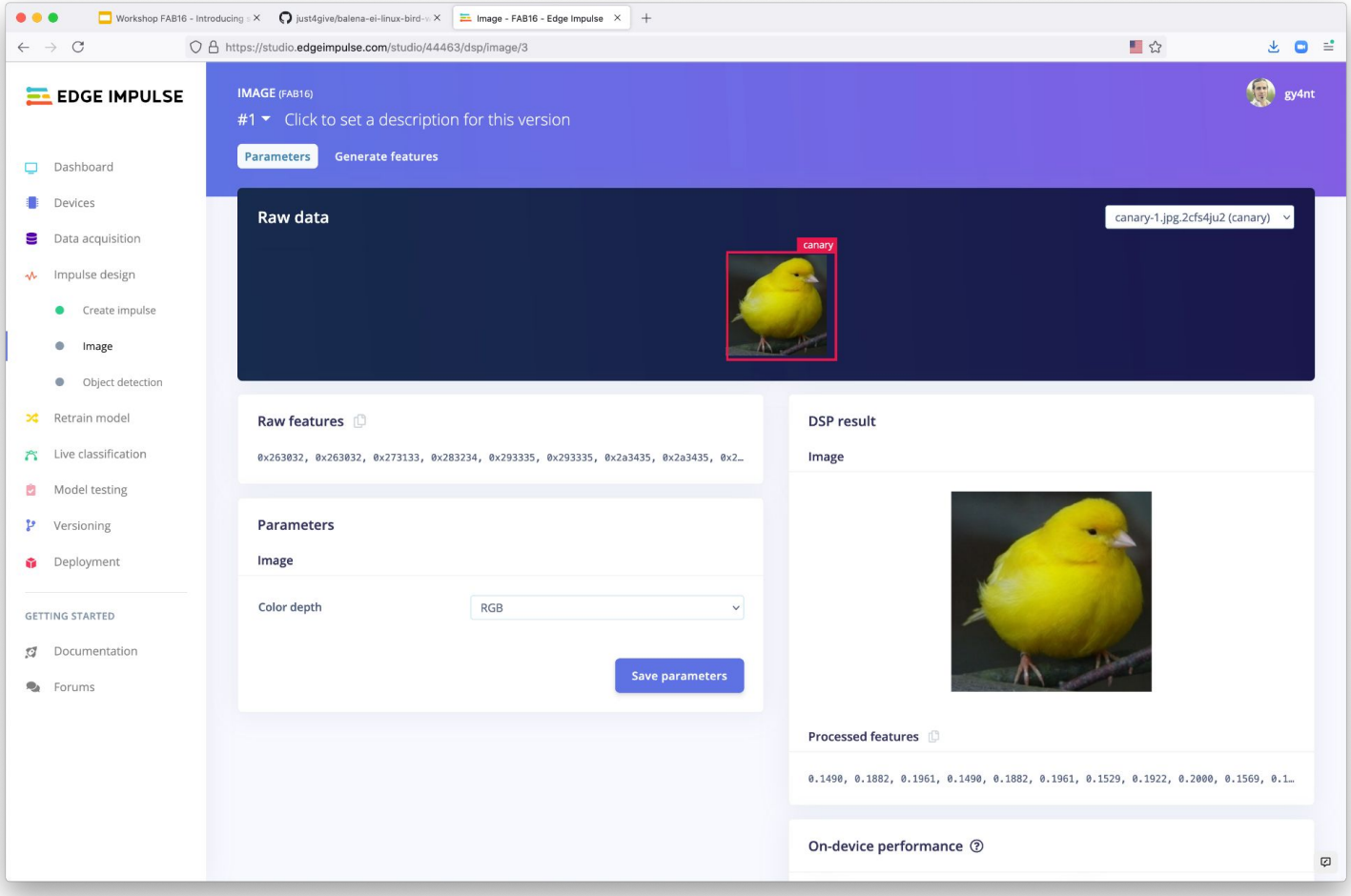
Workshop FAB16 - Introducing
just4give/balena-ei-linux-bird-v
Image - FAB16 - Edge Impulse
https://studio.edgeimpulse.com/studio/44463/dsp/image/3
EDGE IMPULSE
IMAGE (FAB16)
#1
Click to set a description for this version
gy4nt
Parameters
Generate features
Dashboard
Devices
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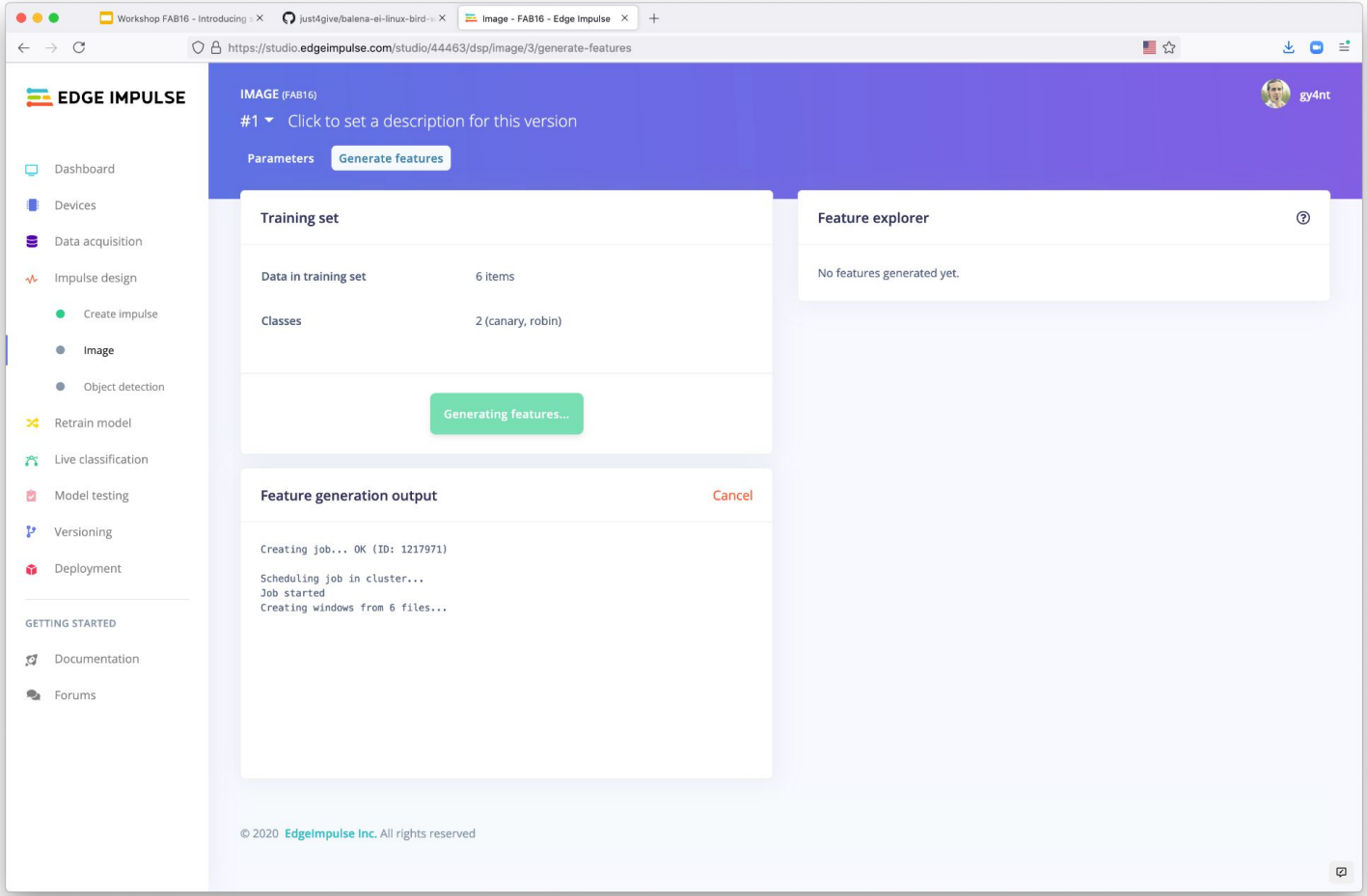
Impulse design
Create impulse
Image
Object detection
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
Raw data
canary-1.jpg.2cfs4ju2 (canary)
canary
Raw features
0x263032, 0x263032, 0x273133, 0x283234, 0x293335, 0x293335, 0x2a3435, 0x2a3435, 0x2…
Parameters
Image
Color depth
RGB
Save parameters
DSP result
Image
Processed features
0.1490, 0.1882, 0.1961, 0.1490, 0.1882, 0.1961, 0.1529, 0.1922, 0.2000, 0.1569, 0.1…
On-device performance


Workshop FAB16 - Introducing
just4give/balena-ei-linux-bird-v
Image - FAB16 - Edge Impulse
https://studio.edgeimpulse.com/studio/44463/dsp/image/3/generate-features
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Deployment
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IMAGE (FAB16)
#1
Click to set a description for this version
gy4nt
Parameters
Generate features
Training set
Data in training set
6 items
Classes
2 (canary, robin)
Generating features...
Feature explorer
No features generated yet.
Feature generation output
Cancel
Creating job... OK (ID: 1217971)
Scheduling job in cluster...
Job started
Creating windows from 6 files...
© 2020 EdgeImpulse Inc. All rights reserved

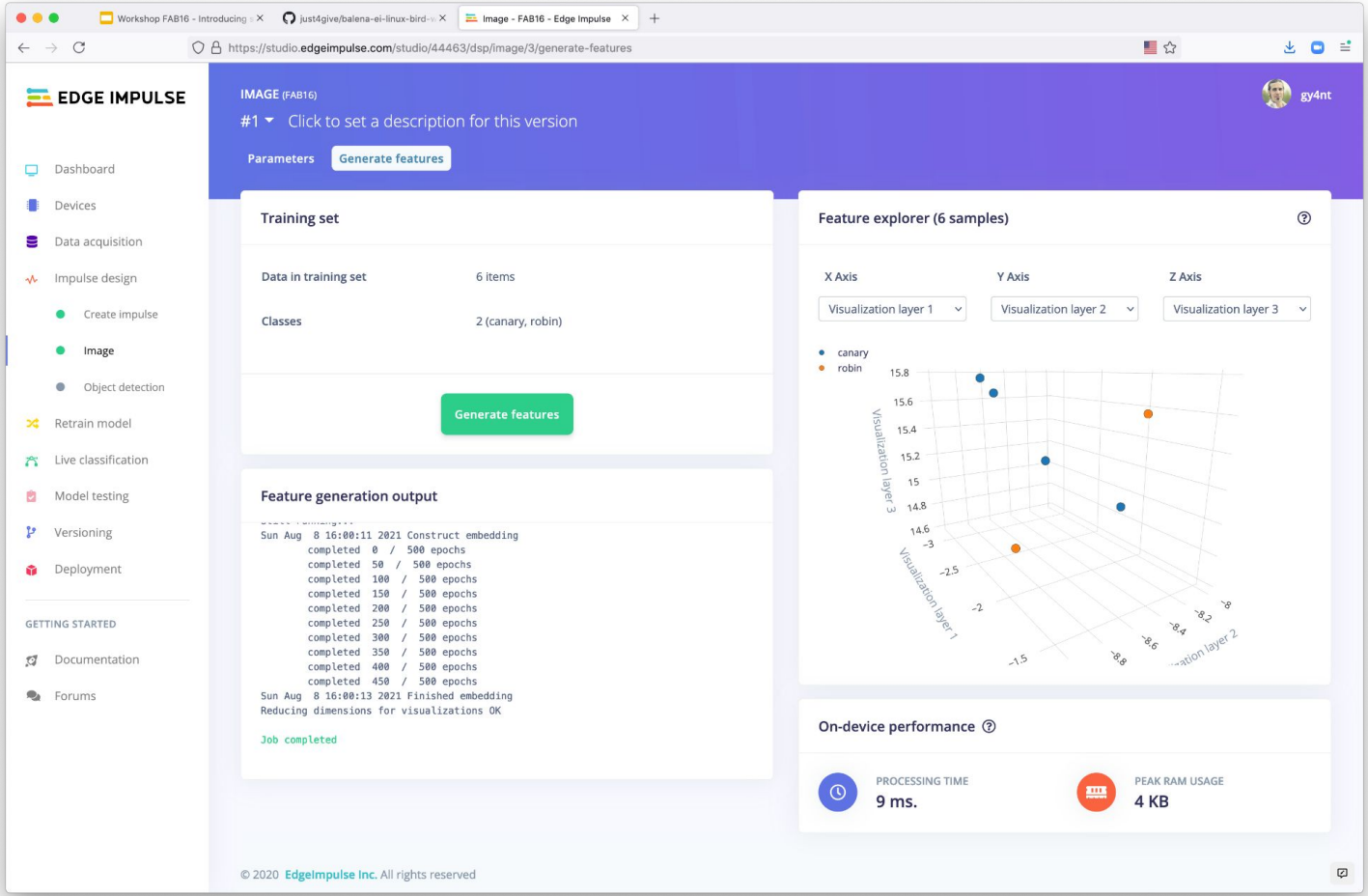
Workshop FAB16 - Introducing
just4give/balena-ei-linux-bird-v
Image - FAB16 - Edge Impulse
https://studio.edgeimpulse.com/studio/44463/dsp/image/3/generate-features
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IMAGE (FAB16)
#1
Click to set a description for this version
gy4nt
Parameters
Generate features
Training set
Data in training set
6 items
Classes
2 (canary, robin)
Generate features
Feature generation output
Sun Aug 8 16:00:11 2021 Construct embedding
completed 0 / 500 epochs
completed 50 / 500 epochs
completed 100 / 500 epochs
completed 150 / 500 epochs
completed 200 / 500 epochs
completed 250 / 500 epochs
completed 300 / 500 epochs
completed 350 / 500 epochs
completed 400 / 500 epochs
completed 450 / 500 epochs
Sun Aug 8 16:00:13 2021 Finished embedding
Reducing dimensions for visualizations OK
Job completed
Feature explorer (6 samples)
X Axis
Visualization layer 1
Y Axis
Visualization layer 2
Z Axis
Visualization layer 3
canary
robin
15.8
15.6
15.4
15.2
15
14.8
14.6
Visualization layer 3
-3
-2.5
-2
Visualization layer 1
-1.5
-8.8
-8.6
-8.4
-8.2
-8
On-device performance
PROCESSING TIME
9 ms.
PEAK RAM USAGE
4 KB
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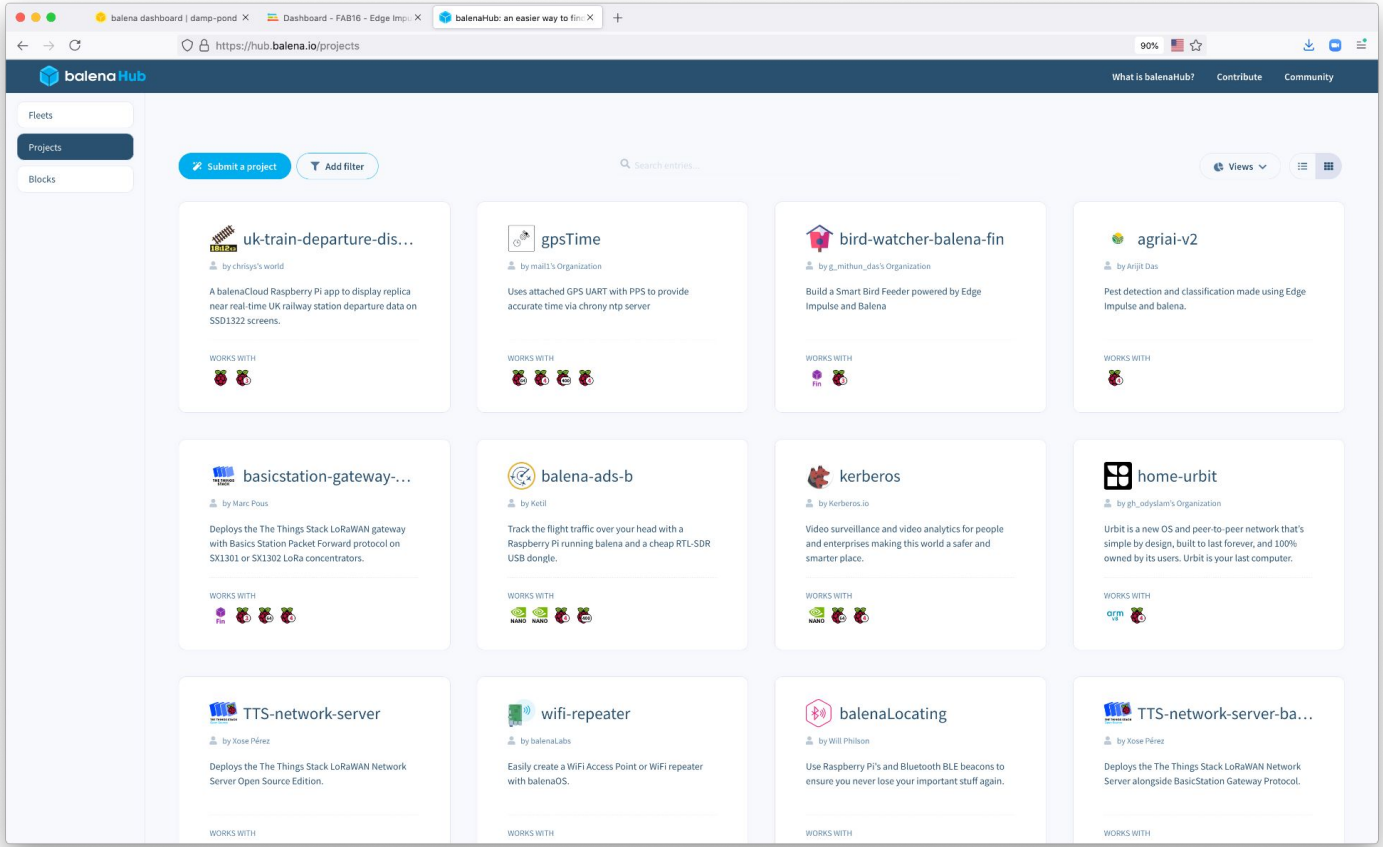
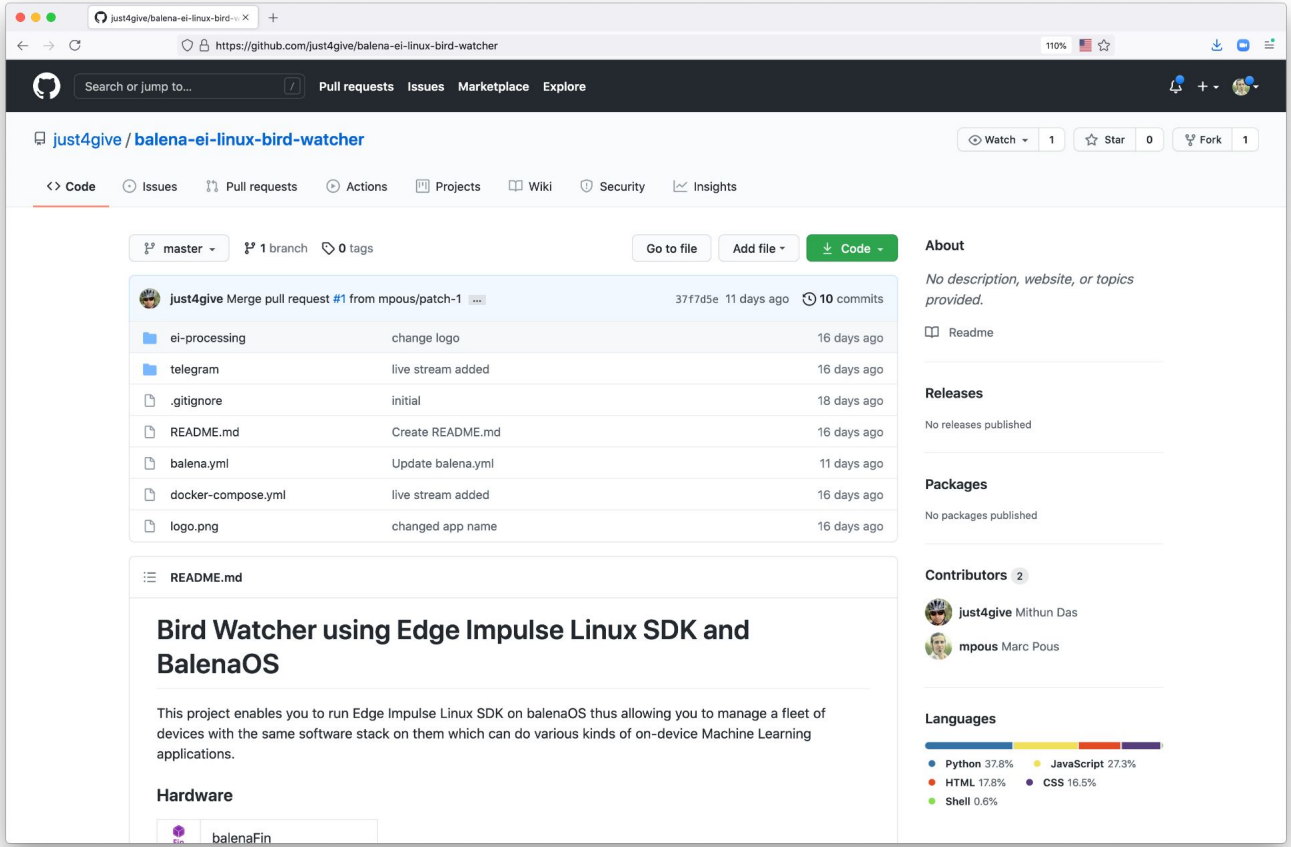
3 Deploy the balena fleet

in just one click



https://hub.balena.io



https://github.com/just4give/balena-ei-linux-bird-watcher

balena

Device Supervisor Container

User Containers

From 1 to N

balenaOS

balenaEngine

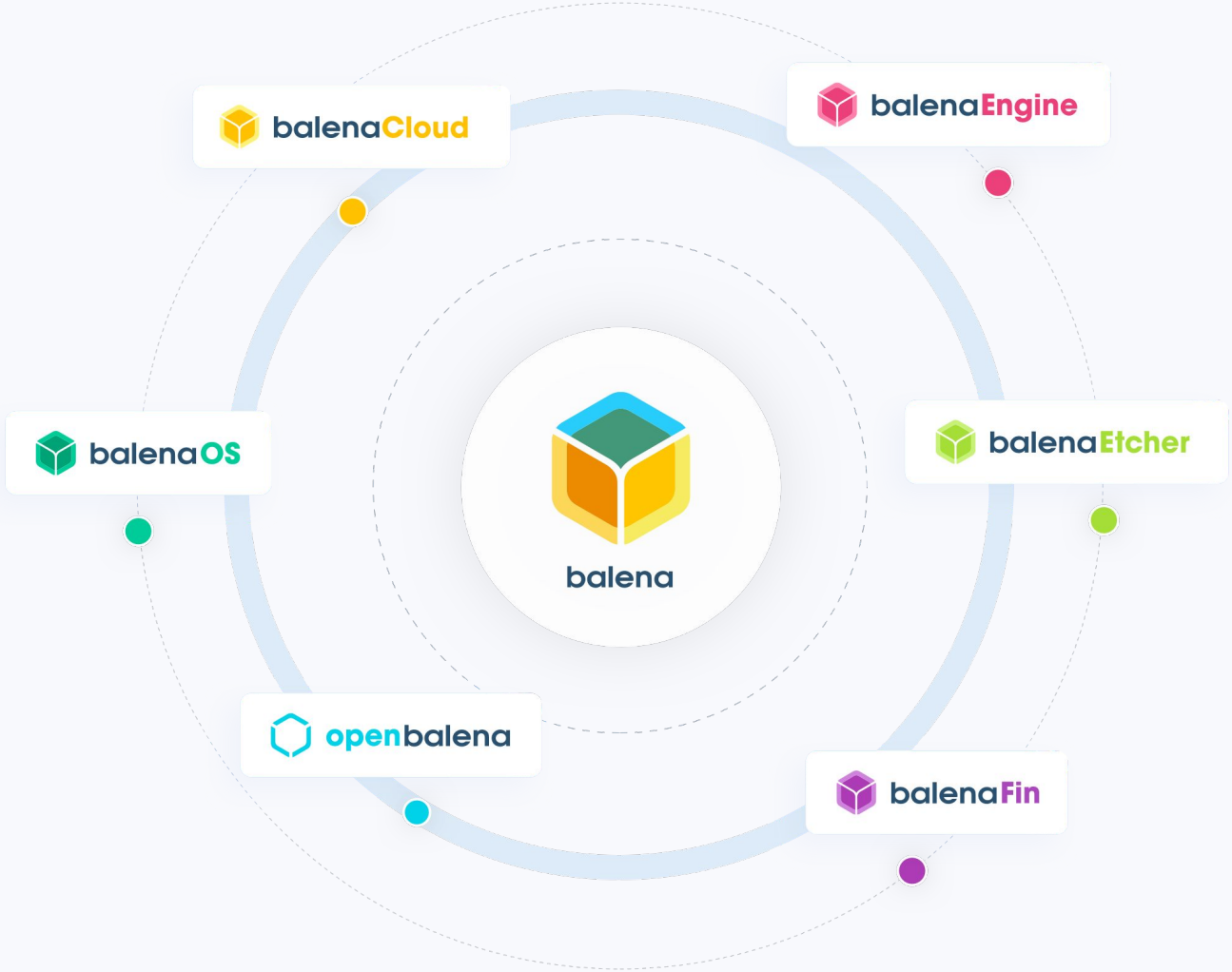
Docker-compatible, edge optimised container engine

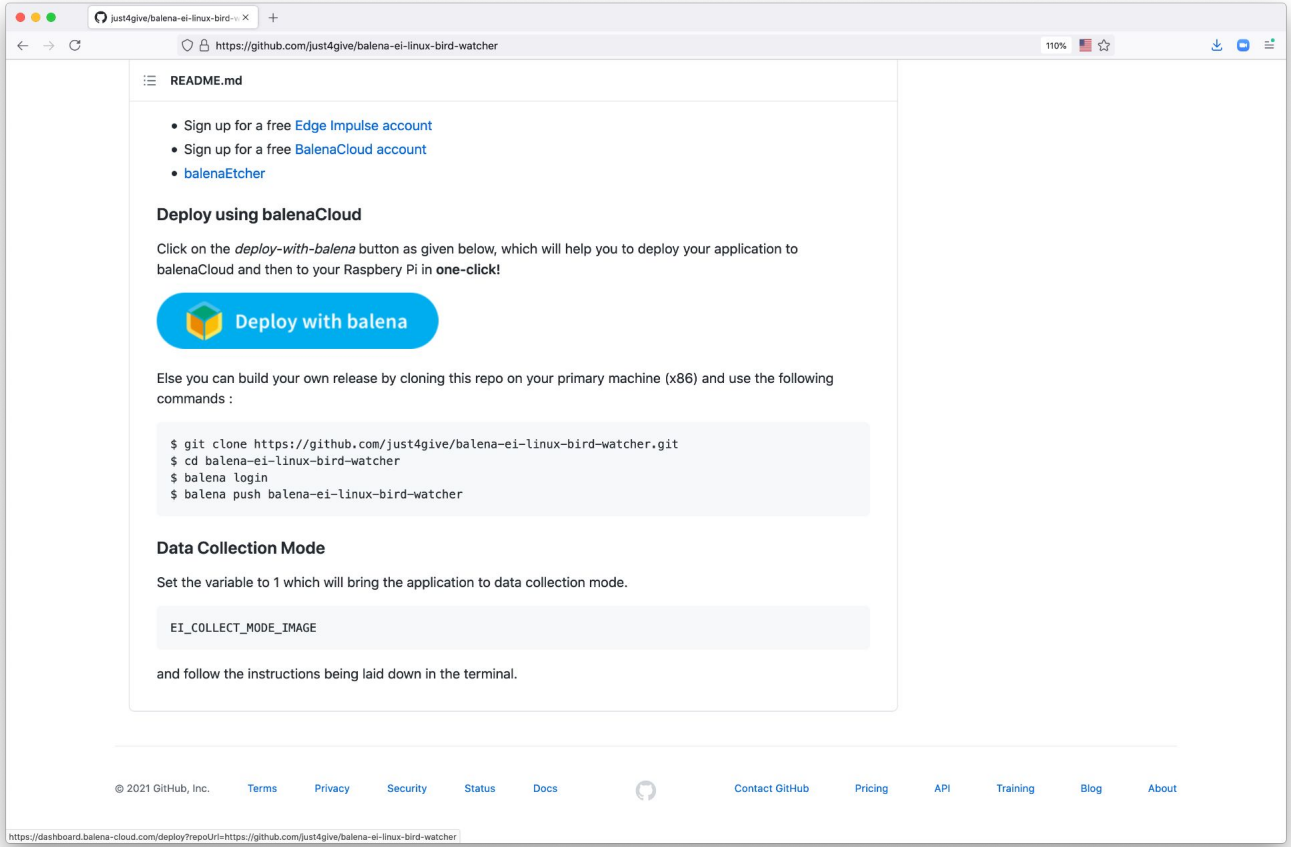
Userspace

Systemd, NetworkManager, etc.

Linux Kernel

Customised for CPU architecture & device hardware

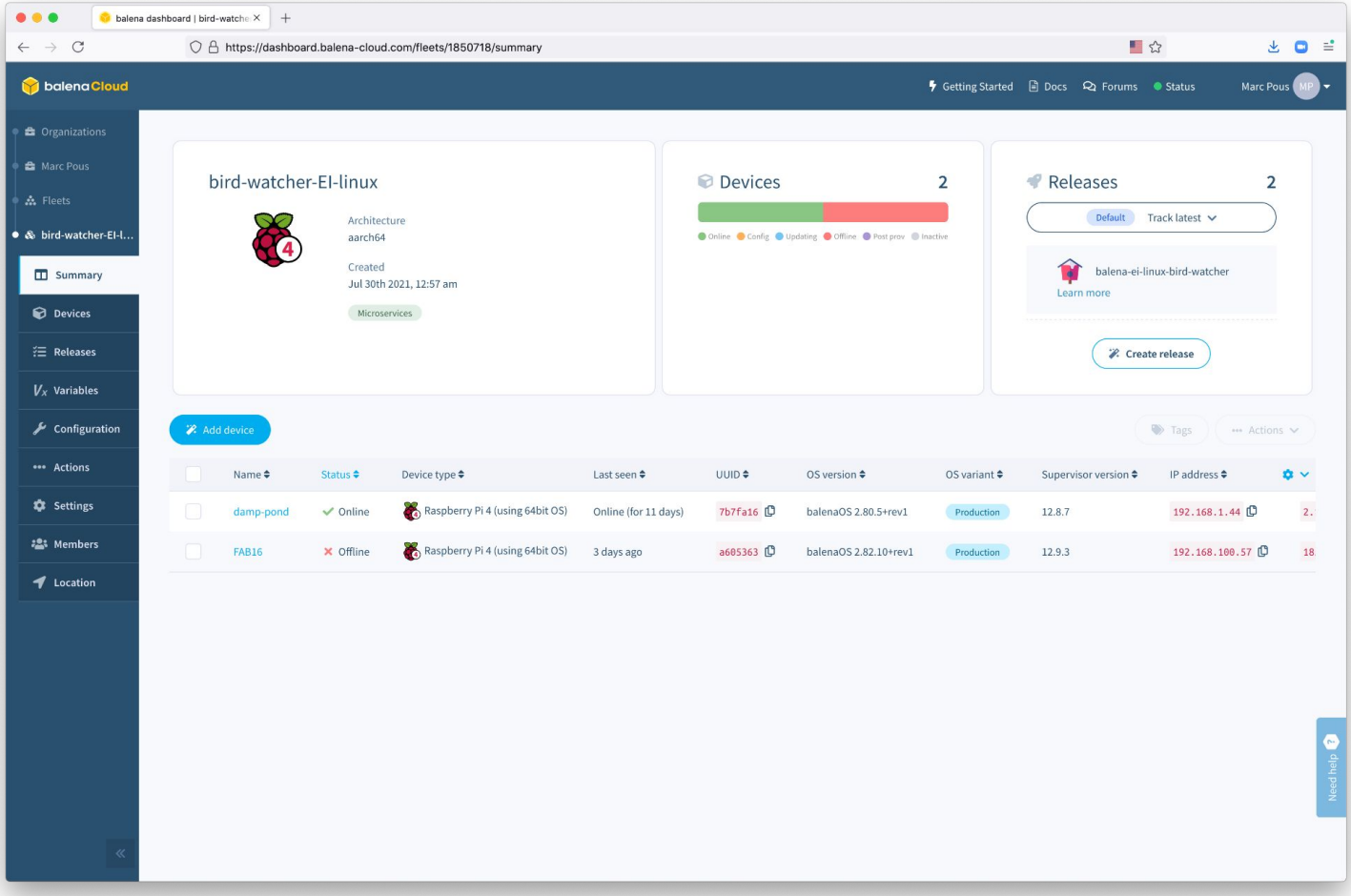

balenaCloud
balenaEngine
balenaOS
balena
balenaEtcher
openbalena
balenaFin

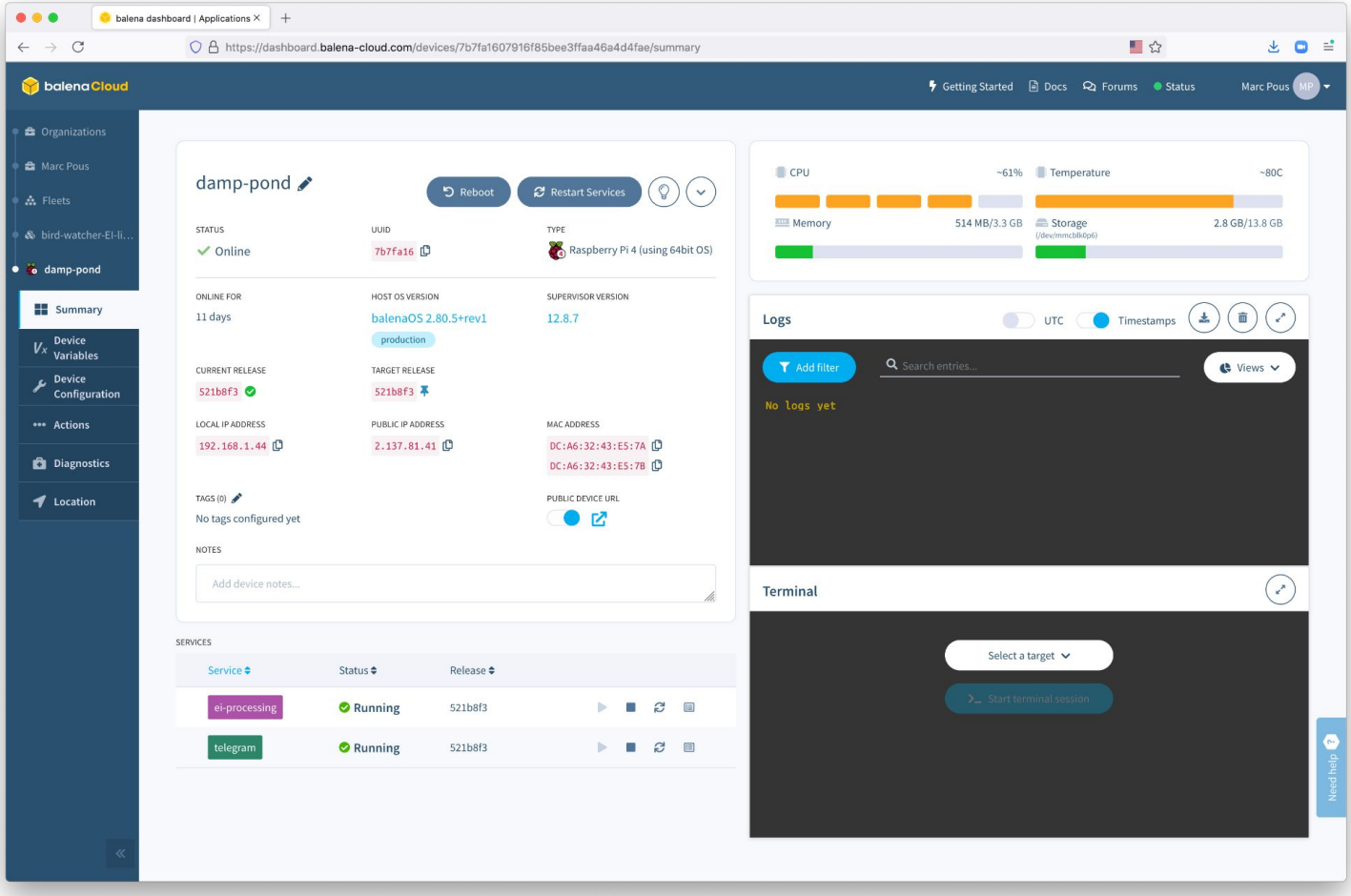


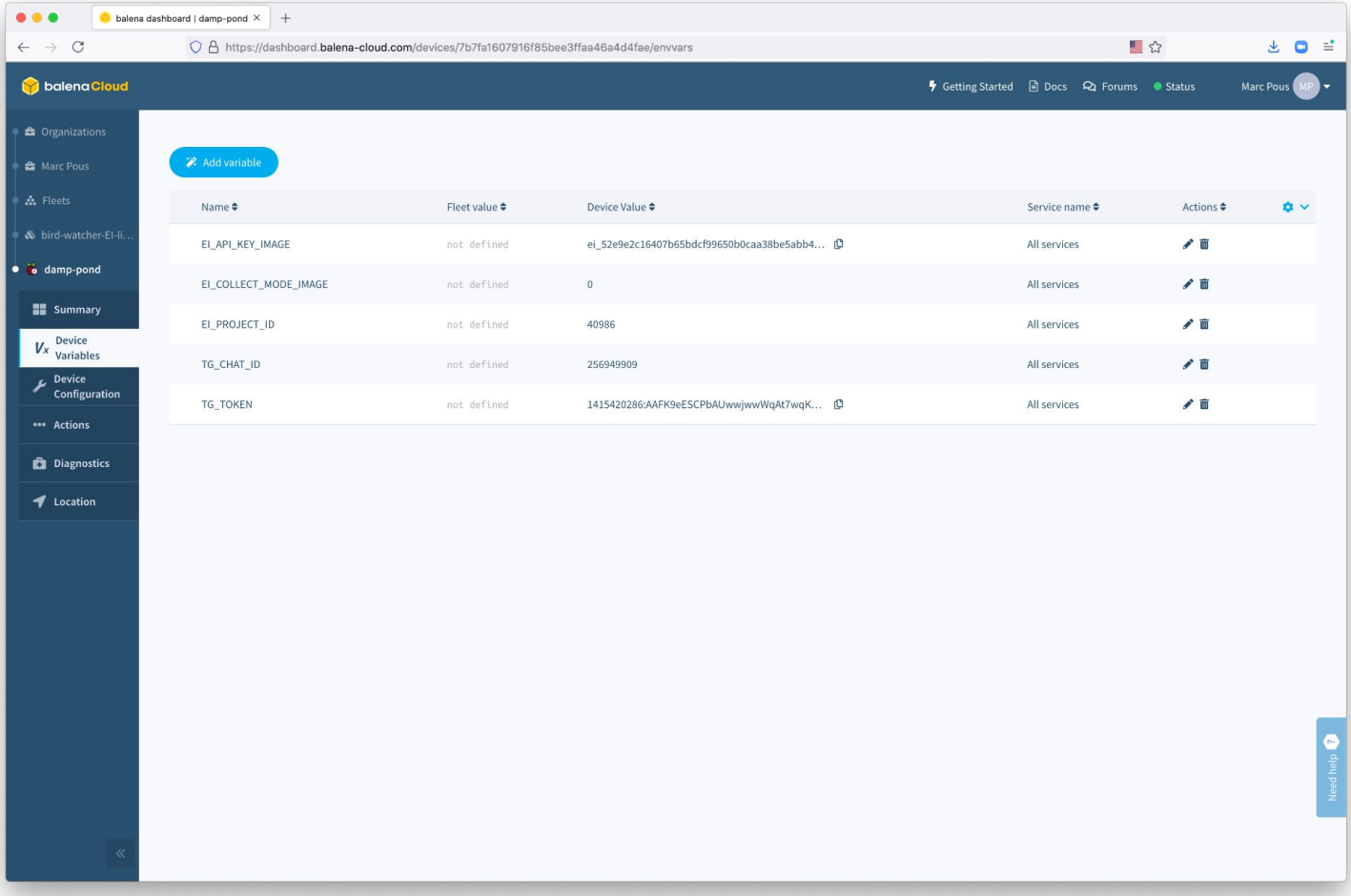
https://github.com/just4give/balena-ei-linux-bird-watcher

How it works


1
Setup your app
app created
balena Cloud
2
Flash your device
OS
Running
balena Cloud
3
Push code
$git push
balena master


balena dashboard | bird-watche
https://dashboard.balena-cloud.com/fleets/1850718/summary
balenaCloud
Getting Started
Docs
Forums
Status
Marc Pous
Organizations
Marc Pous
Fleets
bird-watcher-EI-l...
Summary
Devices
Releases
Variables
Configuration
Actions
Settings
Members
Location
bird-watcher-EI-linux
Architecture
aarch64
Created
Jul 30th 2021, 12:57 am
Microservices
Devices 2
Online Config Updating Offline Post prov Inactive
Releases 2
Default
Track latest
balena-ei-linux-bird-watcher
Learn more
Create release
Add device
Tags
Actions
Name
Status
Device type
Last seen
UUID
OS version
OS variant
Supervisor version
IP address
damp-pond
Online
Raspberry Pi 4 (using 64bit OS)
Online (for 11 days)
7b7fa16
balenaOS 2.80.5+rev1
Production
12.8.7
192.168.1.44
FAB16
Offline
Raspberry Pi 4 (using 64bit OS)
3 days ago
a605363
balenaOS 2.82.10+rev1
Production
12.9.3
192.168.100.57
Need help


balena dashboard | Applications
https://dashboard.balena-cloud.com/devices/7b7fa1607916f85bee3ffaa46a4d4fae/summary
balenaCloud
Getting Started
Docs
Forums
Status
Marc Pous
Organizations
Marc Pous
Fleets
bird-watcher-El-li...
damp-pond
Summary
Device Variables
Device Configuration
Actions
Diagnostics
Location
damp-pond
Reboot
Restart Services
STATUS
Online
UUID
7b7fa16
TYPE
Raspberry Pi 4 (using 64bit OS)
ONLINE FOR
11 days
HOST OS VERSION
balenaOS 2.80.5+rev1
production
SUPERVISOR VERSION
12.8.7
CURRENT RELEASE
521b8f3
TARGET RELEASE
521b8f3
LOCAL IP ADDRESS
192.168.1.44
PUBLIC IP ADDRESS
2.137.81.41
MAC ADDRESS
DC:A6:32:43:E5:7A
DC:A6:32:43:E5:7B
TAGS (0)
No tags configured yet
PUBLIC DEVICE URL
NOTES
Add device notes...
SERVICES
Service
Status
Release
ei-processing
Running
521b8f3
telegram
Running
521b8f3
CPU
~61%
Temperature
~80C
Memory
514 MB/3.3 GB
Storage
2.8 GB/13.8 GB
Logs
UTC
Timestamps
Add filter
Search entries...
Views
No logs yet
Terminal
Select a target
Start terminal session
Need help


balena dashboard | damp-pond
https://dashboard.balena-cloud.com/devices/7b7fa1607916f85bee3ffaa46a4d4fae/envvars
balenaCloud
Getting Started
Docs
Forums
Status
Marc Pous
Organizations
Marc Pous
Fleets
bird-watcher-EI-li...
damp-pond
Summary
Device Variables
Device Configuration
Actions
Diagnostics
Location
Add variable
Name
Fleet value
Device Value
Service name
Actions
EI_API_KEY_IMAGE
not defined
ei_52e9e2c16407b65bdcf99650b0caa38be5abb4...
All services
EI_COLLECT_MODE_IMAGE
not defined
0
All services
EI_PROJECT_ID
not defined
40986
All services
TG_CHAT_ID
not defined
256949909
All services
TG_TOKEN
not defined
1415420286:AAFK9eESCPbAUwwjwwWqAt7wqK...
All services
Need help

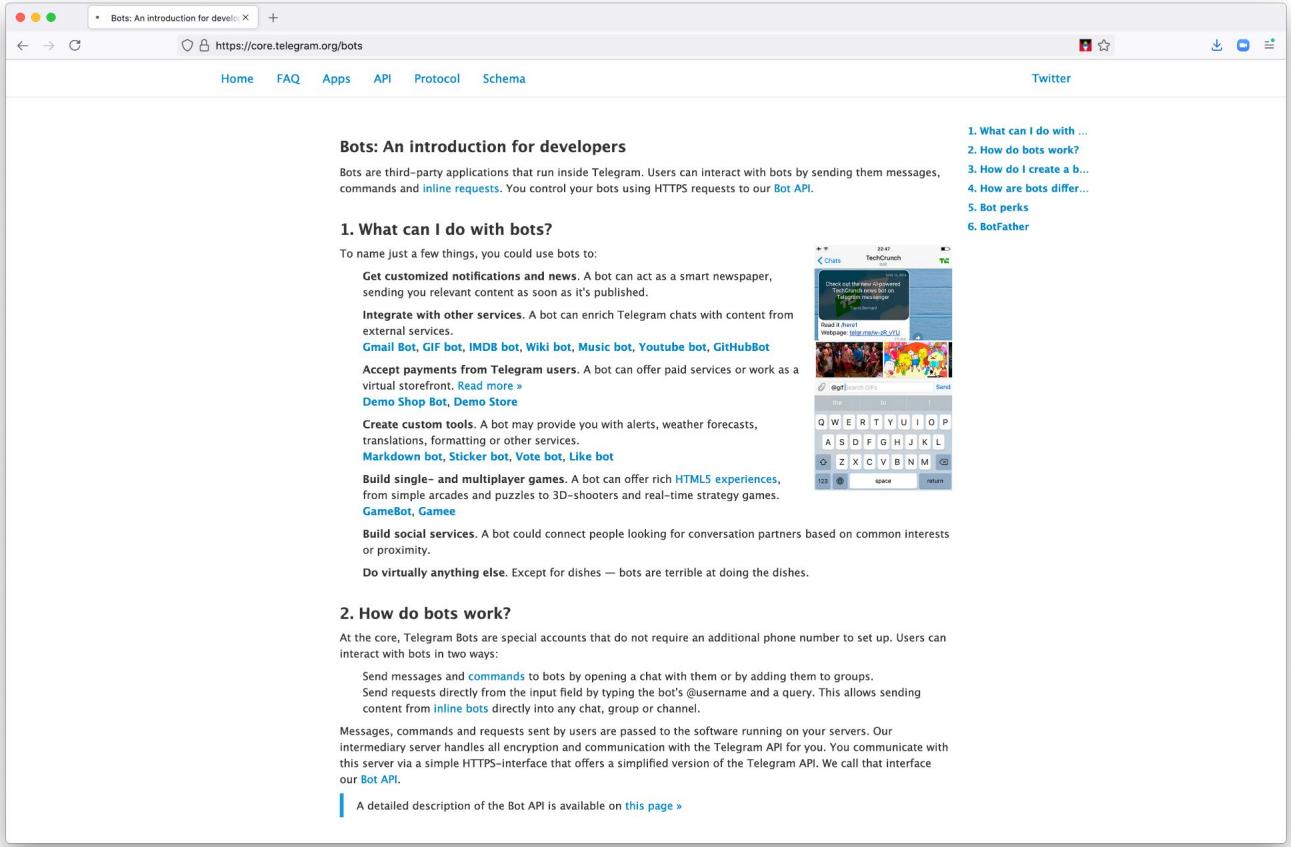
Balena Edge Impulse Cam

https://7b7fa1607916f85bee3ffaa46a4d4fae.balena-devices.com

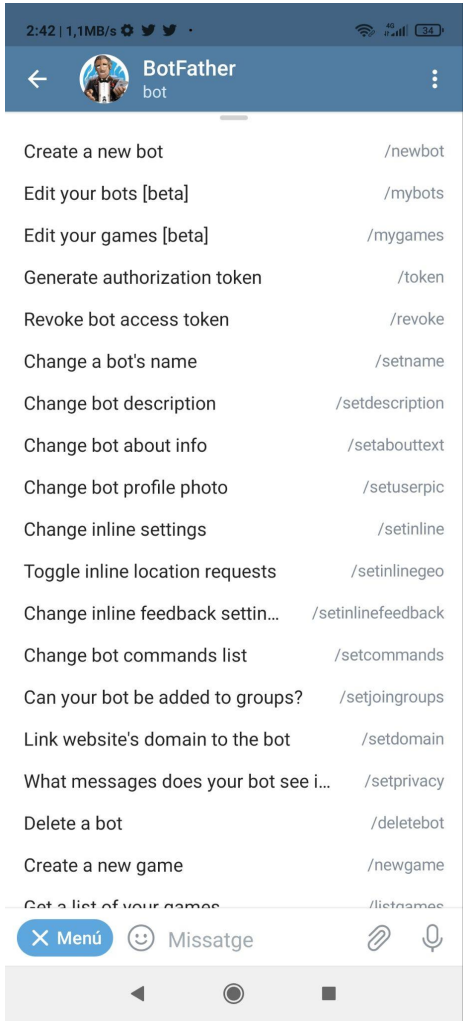
balena

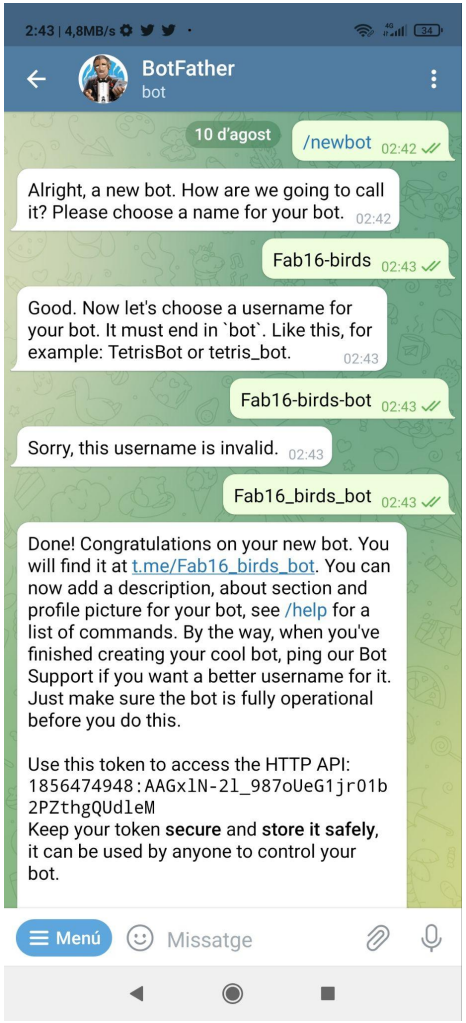
EDGE IMPULSE

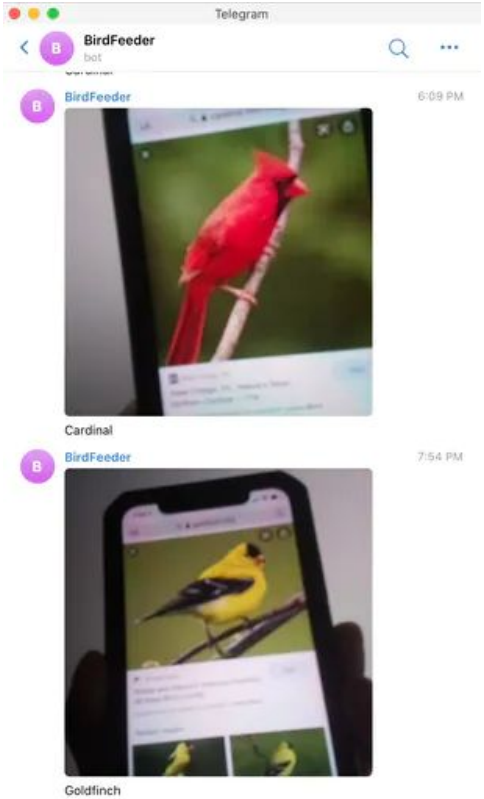
Balena Edge Impulse Cam



https://core.telegram.org/bots


2:42 | 1,1MB/s
BotFather
bot
Create a new bot /newbot
Edit your bots [beta] /mybots
Edit your games [beta] /mygames
Generate authorization token /token
Revoke bot access token /revoke
Change a bot's name /setname
Change bot description /setdescription
Change bot about info /setabouttext
Change bot profile photo /setuserpic
Change inline settings /setinline
Toggle inline location requests /setinlinegeo
Change inline feedback settin... /setinlinefeedback
Change bot commands list /setcommands
Can your bot be added to groups? /setjoingroups
Link website's domain to the bot /setdomain
What messages does your bot see i... /setprivacy
Delete a bot /deletebot
Create a new game /newgame
Menú
Missatge


2:43 | 4,8MB/s
BotFather
bot
10 d'agost
/newbot 02:42
Alright, a new bot. How are we going to call it? Please choose a name for your bot. 02:42
Fab16-birds 02:43
Good. Now let's choose a username for your bot. It must end in `bot`. Like this, for example: TetrisBot or tetris_bot. 02:43
Fab16-birds-bot 02:43
Sorry, this username is invalid. 02:43
Fab16_birds_bot 02:43
Done! Congratulations on your new bot. You will find it at t.me/Fab16_birds_bot. You can now add a description, about section and profile picture for your bot, see /help for a list of commands. By the way, when you've finished creating your cool bot, ping our Bot Support if you want a better username for it. Just make sure the bot is fully operational before you do this.
Use this token to access the HTTP API:
1856474948:AAGxlN-2l_987oUeG1jr01b2PZthgQUdleM
Keep your token secure and store it safely, it can be used by anyone to control your bot.
Menú
Missatge


Telegram
BirdFeeder
bot
BirdFeeder
6:09 PM
Cardinal
BirdFeeder
7:54 PM
Goldfinch
Start

4 Make a bird feeder

with your local Fablab

Escola Sant Martí & FabLab Barcelona

Escola Avenç

Fablab Aldeias do Xisto

5 Share it with everyone!

and inspire others

Time to install it :-)

Tree? Wall? Lessons learnt?

Time to connect with the bot

Time to share with the community,
learn and re-train the model!

Contribute on the open source project!

https://github.com/just4give/balena-ei-linux-bird-watcher

Ok! Let’s wrap-up!

Take aways

- Learn about birds/nature around us.
- Collaborate with the Fablab and involve teachers, parents and more.
- Introduce STEAM to children and collateral technologies on the experiment.
- Share with more schools and communities.

Questions?

Introducing schools into STEAM with birds, IoT, AI and Fablabs

FAB16 - 10th August 2021

marc@balena.io