Edge Impulse & ROS 2 / micro-ROS

Avi Brown

Who am I?

- Electronics engineer at a small agricultural robotics startup
- Side projects with Edge Impulse

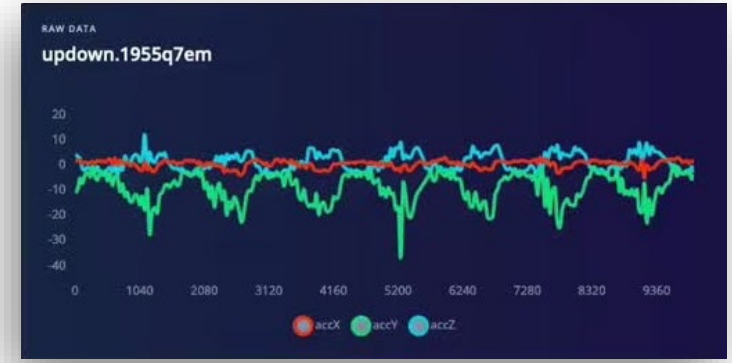
Edge Impulse: Background

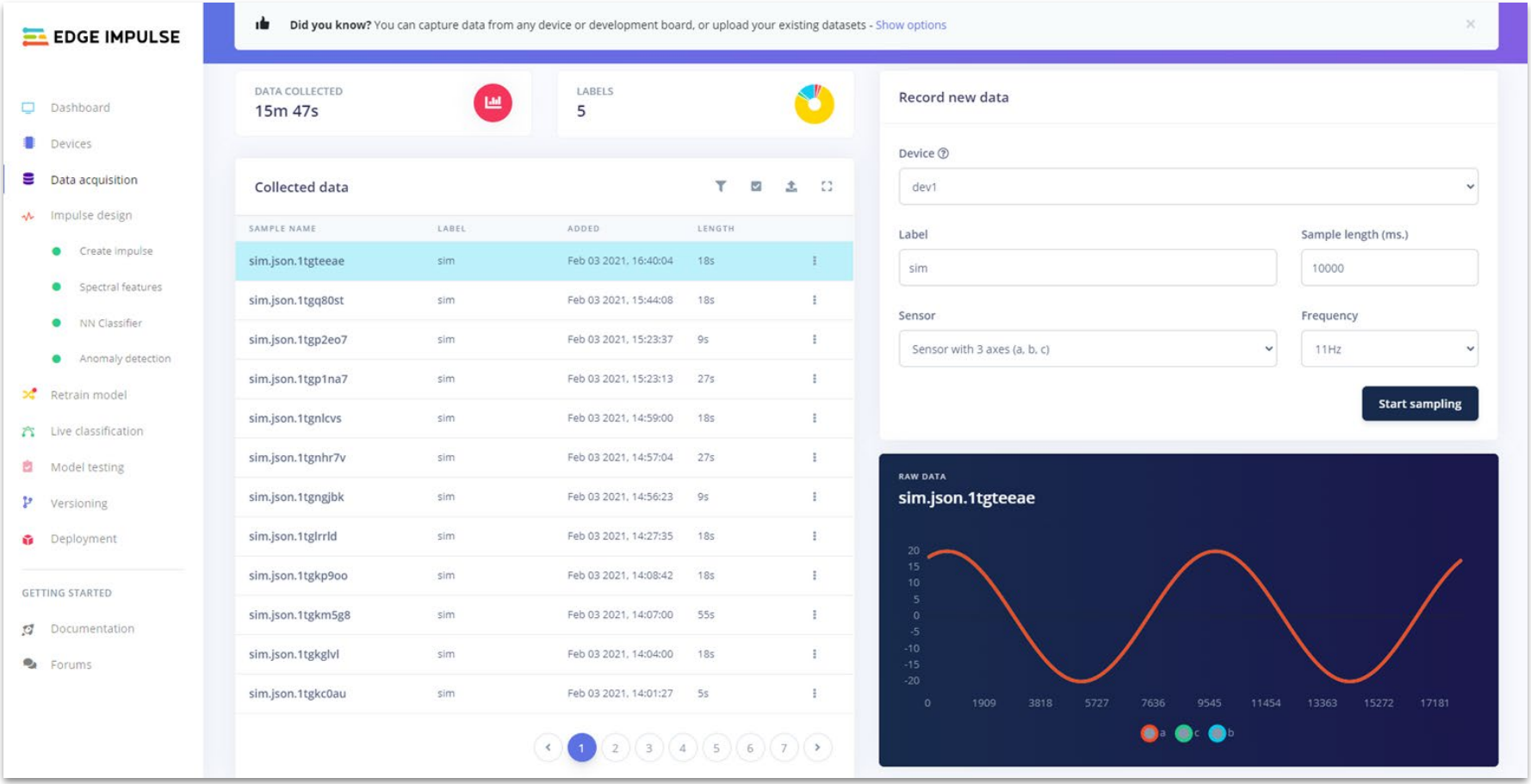
- Platform for building machine learning models for memory-constrained devices, supporting every stage of the ML cycle:
  - Data ingest / collection
  - Model design
  - DSP blocks
  - Training
  - Testing
  - Deployment

- **End result:** Open, self-contained, custom library ready for deployment on embedded devices

Data collection

- Direct file upload
  - .csv, .json, image / audio files, etc.
- **Data forwarder**
  - Print raw sensor data to serial
  - CLI tool forwards data directly to Edge Impulse suite...

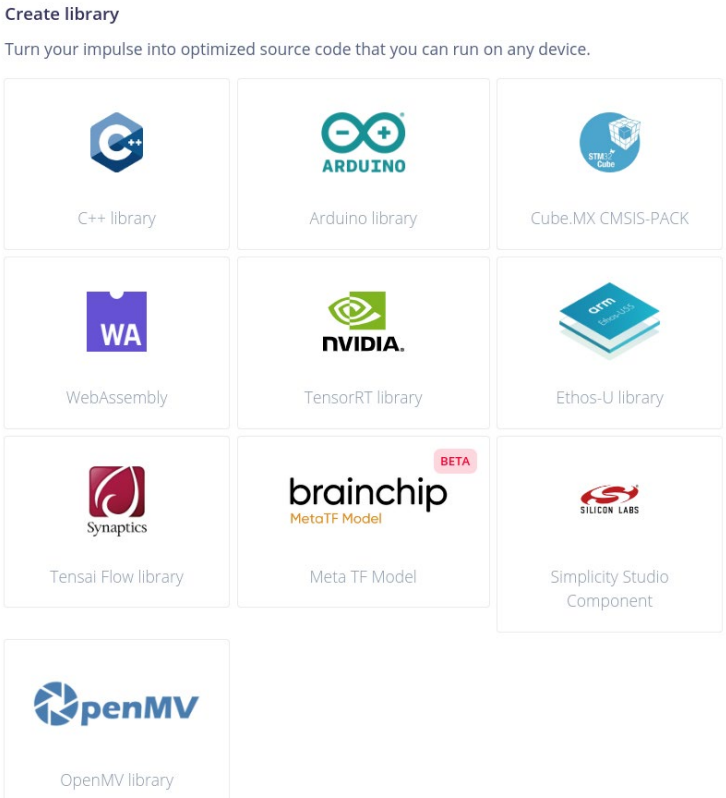



EDGE IMPULSE
Did you know? You can capture data from any device or development board, or upload your existing datasets - Show options
Dashboard
Devices
Data acquisition
Impulse design
Create impulse
Spectral features
NN Classifier
Anomaly detection
Retrain model
Live classification
Model testing
Versioning
Deployment
GETTING STARTED
Documentation
Forums
DATA COLLECTED
15m 47s
LABELS
5
Collected data
SAMPLE NAME
LABEL
ADDED
LENGTH
sim.json.1tgteeae sim Feb 03 2021, 16:40:04 18s
sim.json.1tgq80st sim Feb 03 2021, 15:44:08 18s
sim.json.1tgp2eo7 sim Feb 03 2021, 15:23:37 9s
sim.json.1tgp1na7 sim Feb 03 2021, 15:23:13 27s
sim.json.1tgnlcvs sim Feb 03 2021, 14:59:00 18s
sim.json.1tgnhr7v sim Feb 03 2021, 14:57:04 27s
sim.json.1tgngjbk sim Feb 03 2021, 14:56:23 9s
sim.json.1tglrrld sim Feb 03 2021, 14:27:35 18s
sim.json.1tgkp9oo sim Feb 03 2021, 14:08:42 18s
sim.json.1tgkm5g8 sim Feb 03 2021, 14:07:00 55s
sim.json.1tgkglvl sim Feb 03 2021, 14:04:00 18s
sim.json.1tgkc0au sim Feb 03 2021, 14:01:27 5s
1 2 3 4 5 6 7
Record new data
Device
dev1
Label
sim
Sample length (ms.)
10000
Sensor
Sensor with 3 axes (a, b, c)
Frequency
11Hz
Start sampling
RAW DATA
sim.json.1tgteeae
20 15 10 5 0 -5 -10 -15 -20
0 1909 3818 5727 7636 9545 11454 13363 15272 17181
a c b

Data exploration

- Visualize and clean up datasets

Deploy as you please...

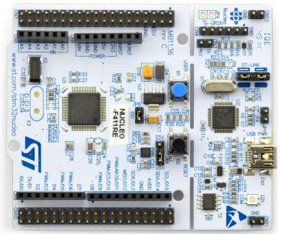


Hardware vs. capability map

Anomaly detection, sensor classification

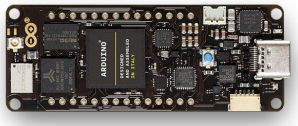
Cortex-M0+

Voice keywords, audio classification



Cortex-M4

Image classification



Cortex-M7

Object detection, complex voice processing

Cortex-A

Cortex-A + GPU

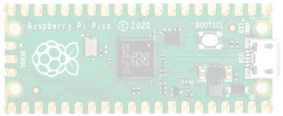
Linux SBCs

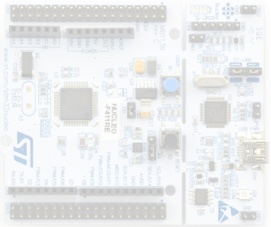
Object detection, complex voice processing

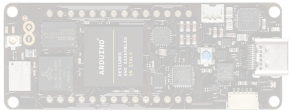
Image classification

Voice keywords, audio classification

Anomaly detection, sensor classification







Cortex-M0+

Cortex-M4

Cortex-M7

Cortex-A

Cortex-A + GPU

Existing ROS 2 + Edge Impulse integrations

- Generic ROS2 publisher + subscriber node for Edge Impulse models
  - Collect data from any sensor, pass through .eim model, publish results
- Nanosaur + ROS2 wrapper for Edge Impulse vision models
  - Raffaello Bonghi, PhD, Giovanni di Dio Bruno, MSc

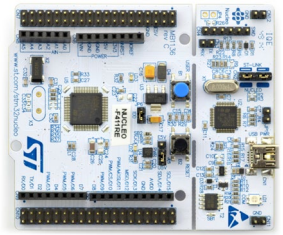
IMAGINE
EDGE IMPULSE

MCUs

Anomaly detection, sensor classification

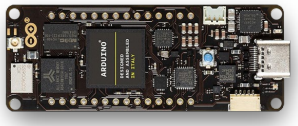
Cortex-M0+

Voice keywords, audio classification



Cortex-M4

Image classification



Cortex-M7

Object detection, complex voice processing

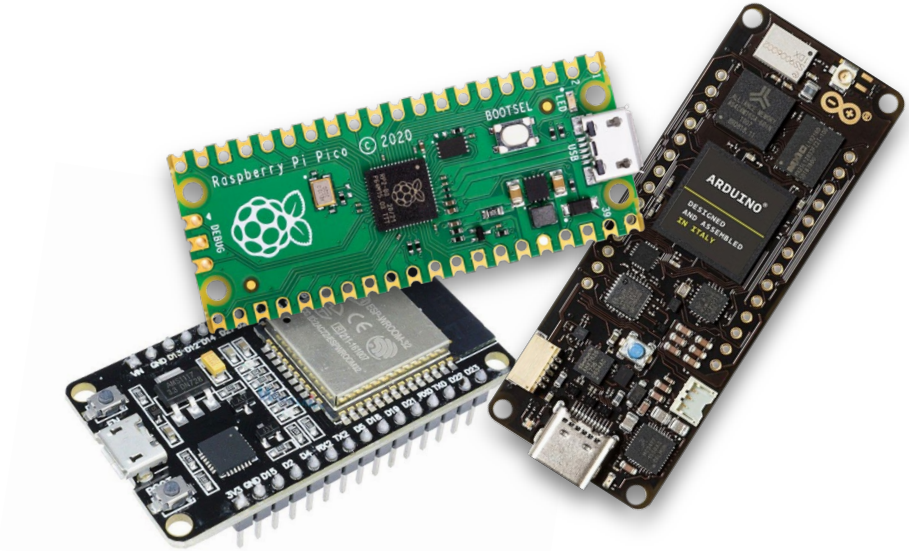
Cortex-A

Cortex-A + GPU

micro-ROS

Certain things are better handled by MCUs:

- Hardware interfacing
- Low power
- Real time tasks

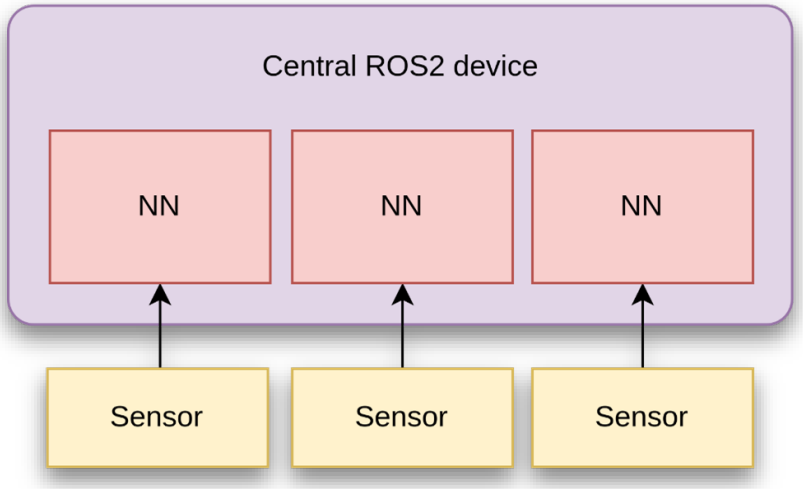


“Edge AI” in robotics

- Inferencing close to the sensor
- Offloading compute from main computer
- OAK-D by Luxonis...

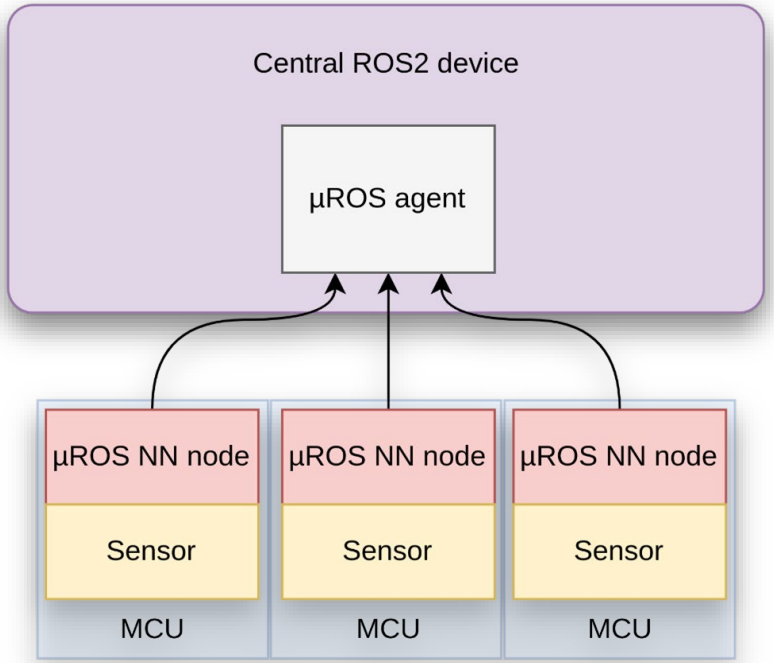
“Traditional” approach to AI in robotics

- Low cost SBCs can quickly become bogged down by multiple NNs running simultaneously



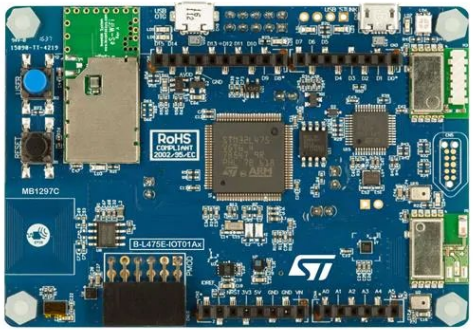
Distributed approach

- By offloading NNs to peripheral MCUs, the central computer can focus on inferences alone



Edge Impulse + micro-ROS

- Growing hardware cross-compatibility



STM32L4 Discovery kit IoT

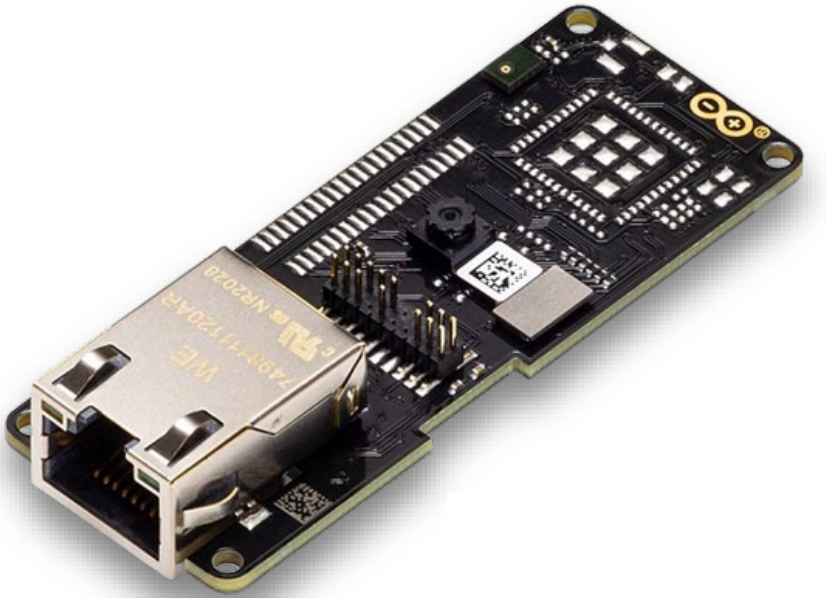
ESP32

RPi Pico

Arduino Portenta H7

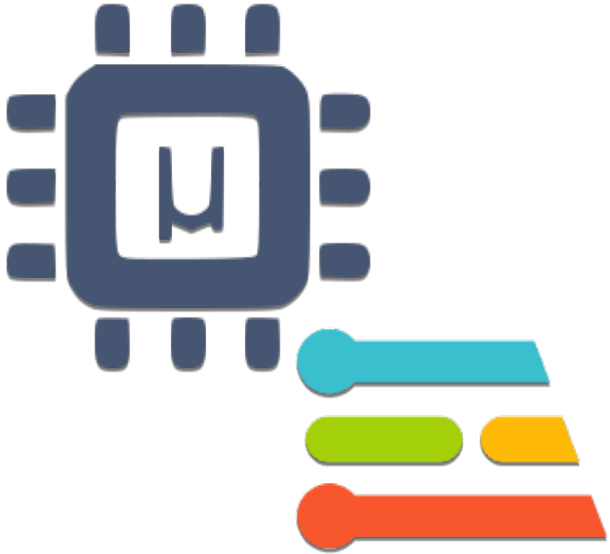
How it’s going

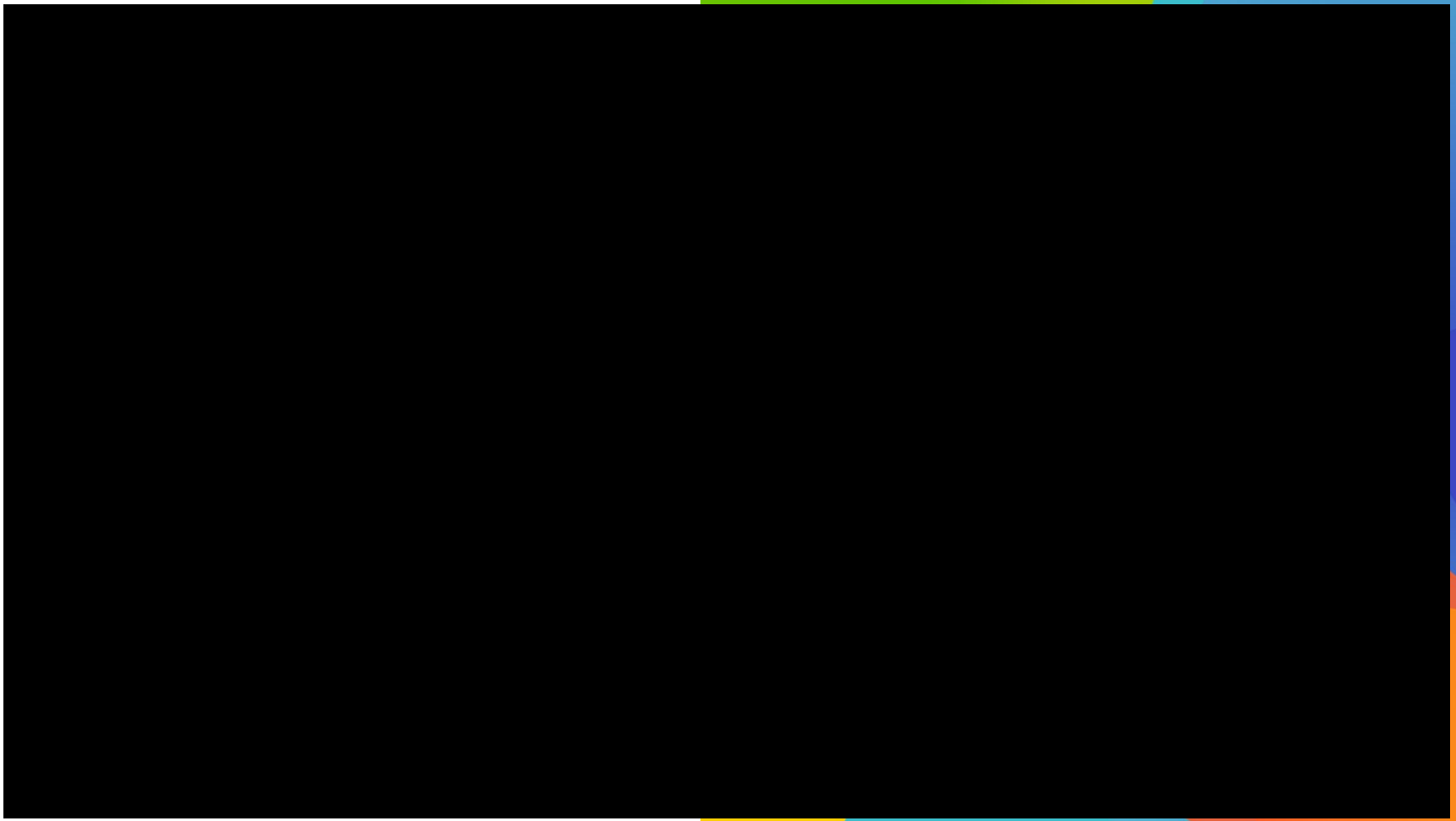
- A repo is born...
- Working examples with Portenta H7 + vision shield
- Plans for additional board support



Use cases in robotics

- Add custom “wake-words” / voice commands
- Improve robot’s situational awareness:
  - Terrain recognition
  - Environmental sensor fusion
- Predictive maintenance
  - Motor Current Signal Analysis
  - Mechanical vibration anomaly detection
- Visualisation with rviz2
  - “Markers” based on inference – groovy heatmaps?





Thank you

LinkedIn: **avi-brown**