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AIML-102

Machine Health and Condition Monitoring Using the Edge Impulse Platform

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Benefits of edge ML

Innovation

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

Privacy

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

Power

Stay operational for longer periods of time

Cost

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

Reliability

Be operational in low connectivity environments

Bandwidth & Latency

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

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Edge AI with Edge Impulse

The complete toolkit for embedded ML

Collect

Extract

Train

Test

Deploy

Dataset Management

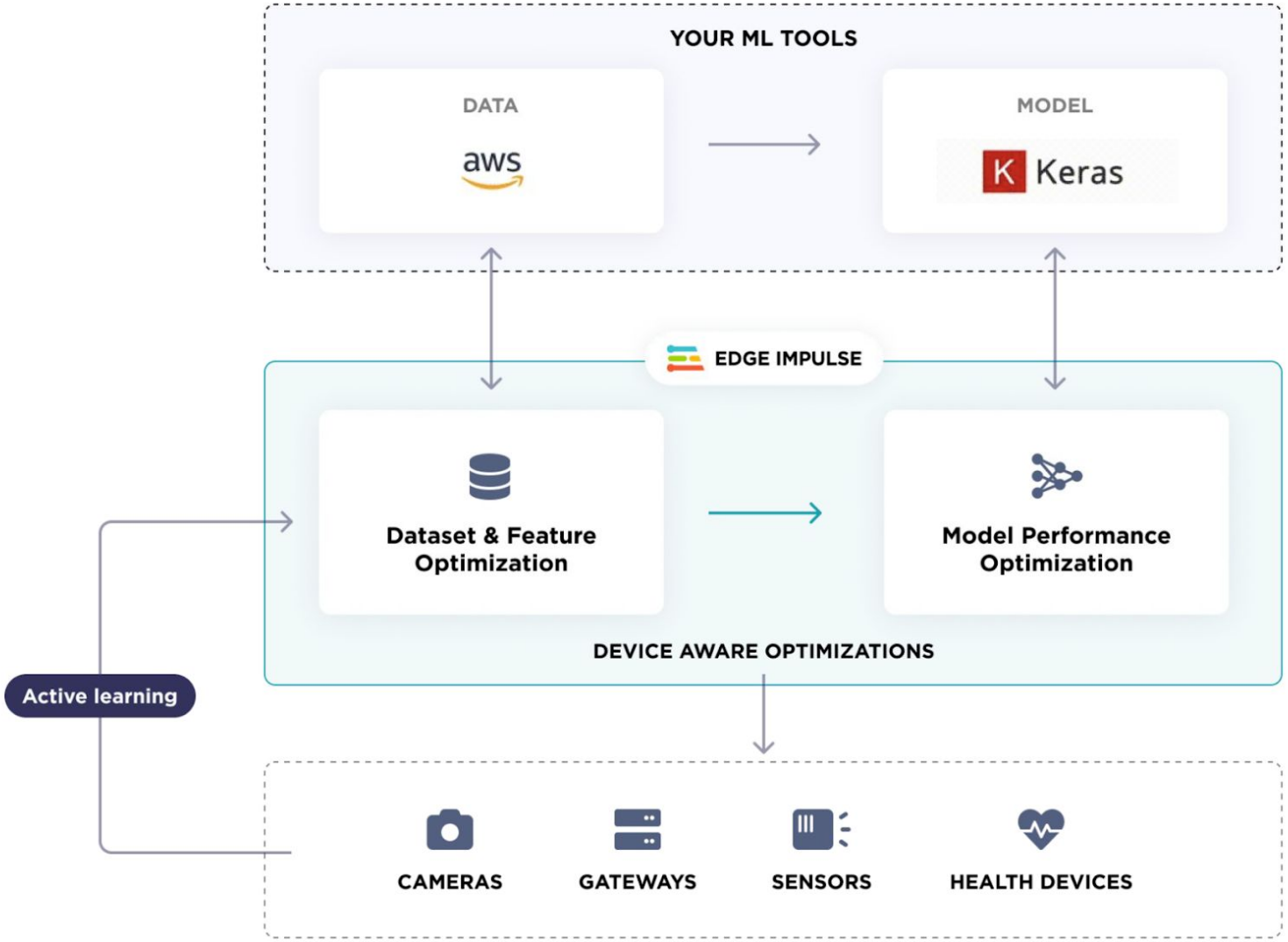
Digital Signal Processing

ML Model Development

Performance Profiling

Code Compilation

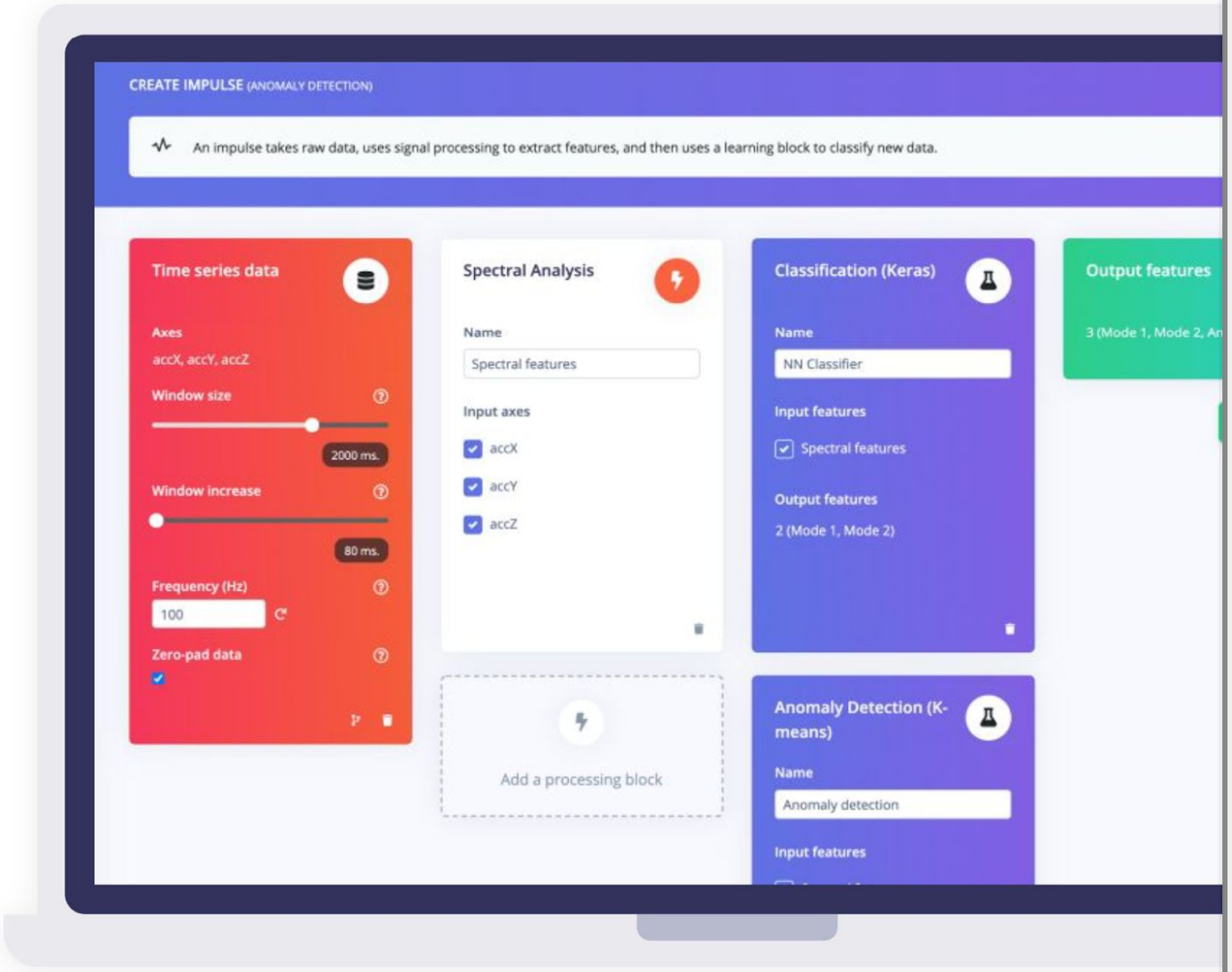
Enable edge AI for any platform



EDGE IMPULSE

Optimize AI for the edge

- Royalty-free business model, therefore no impact on BOM cost
- Your IP, stays your IP
- Total explainability, no black boxes

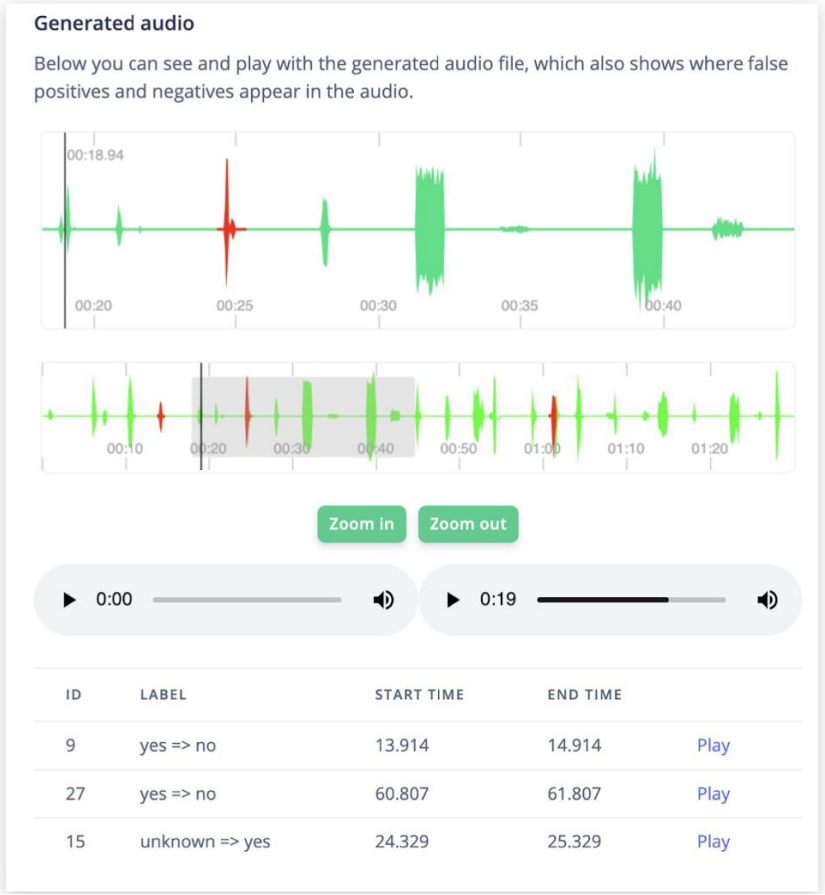


Active Learning Loop

R&D FOCUS

Active learning & continual improvement

- Simulate on-device behavior before deployment
- Assisted labelling and active learning workflows
- Model versioning and change management over time



Powering the largest edge ecosystem with MLOps

80,000+

Developers

185,000+

Projects

5,000+

Enterprises

TRUSTED BY LEADING ENTERPRISES

ŌURA ADVANTECH poly NASA SONY

Any sensor, any data, any use case

	Ultra low power	Low-end MCU	High-end MCU	NPU	MPU	GPU
	Anomaly detection	Sensor fusion classification	Audio classification	Image classification	Complex image or voice	Video classification
Memory	10kB	18kB	50kB	256kB	1MB+	1GB+
Sensor	✓	✓	✓	✓	✓	✓
Audio	✓	✓	✓	✓	✓	✓
Image			✓	✓	✓	✓
Video					✓	✓

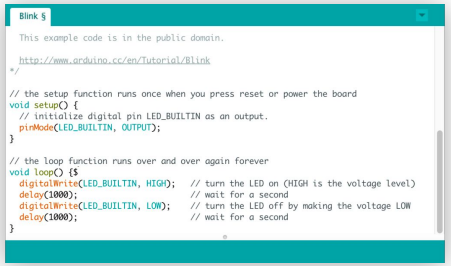
A paradigm shift

Traditional programming

Data

+

Rules



Outcomes

Adapt the rules

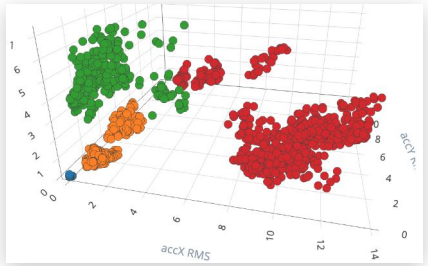
vs

Machine learning

Data

+

Outcomes



Rules

Collect more data

Machine Learning

Supervised learning

Task-driven

- Regression
- Classification
- Object detection

Unsupervised learning

Data-driven

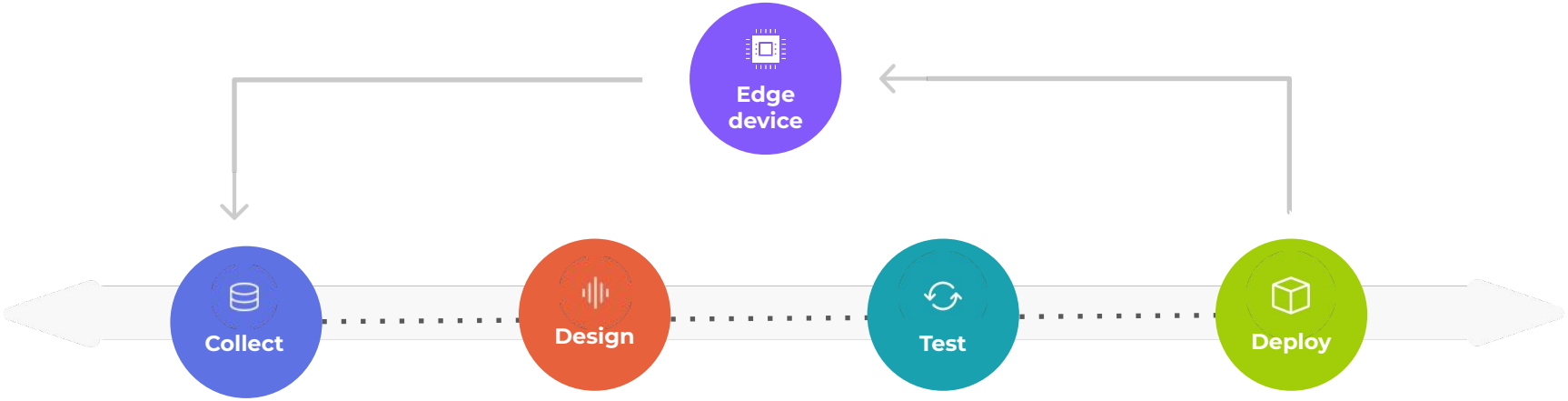
- Clustering
- Segmentation
- Anomaly detection

Reinforcement learning

Learn from experience

- Robotics
- Games
- Recommender systems

Embedded machine learning



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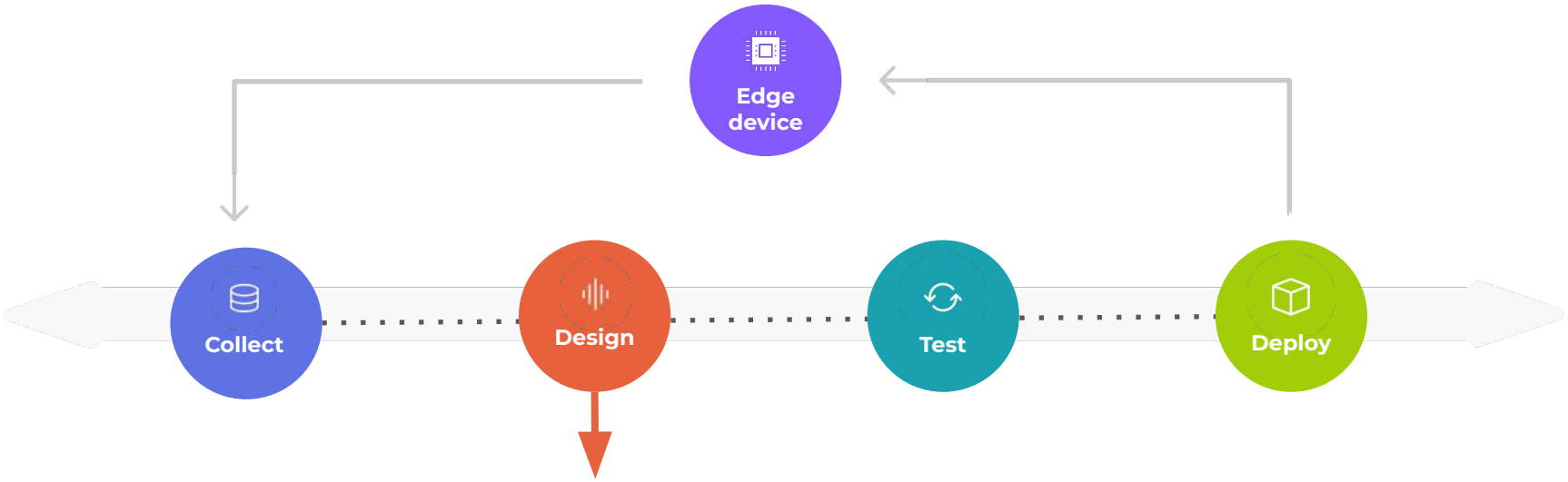
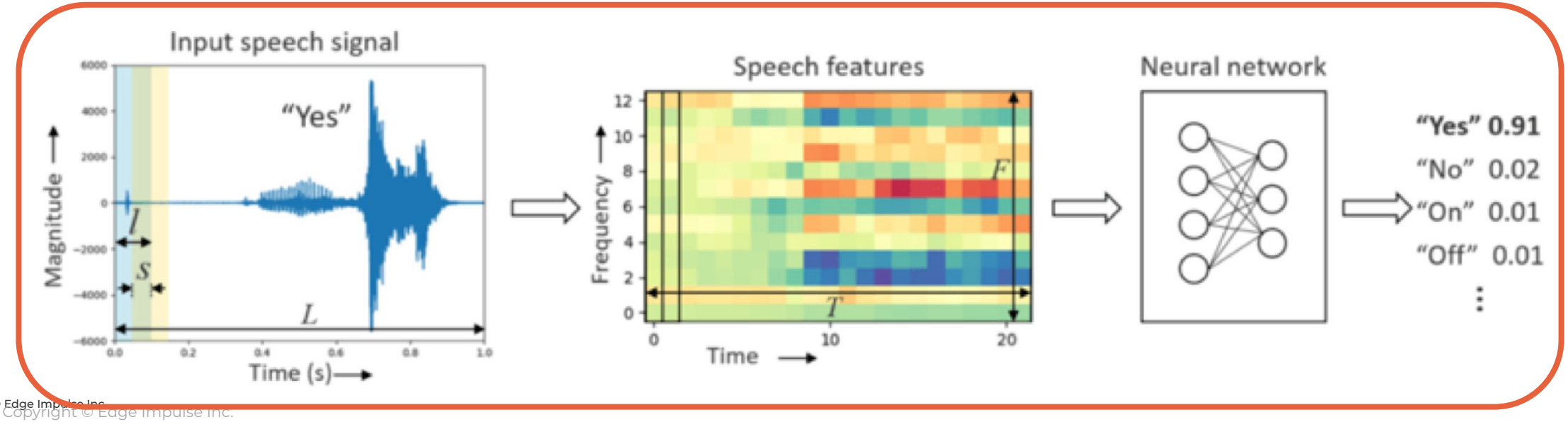
Embedded machine learning





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Studio Overview

EDGE IMPULSE

Developer-first integrated ML platform

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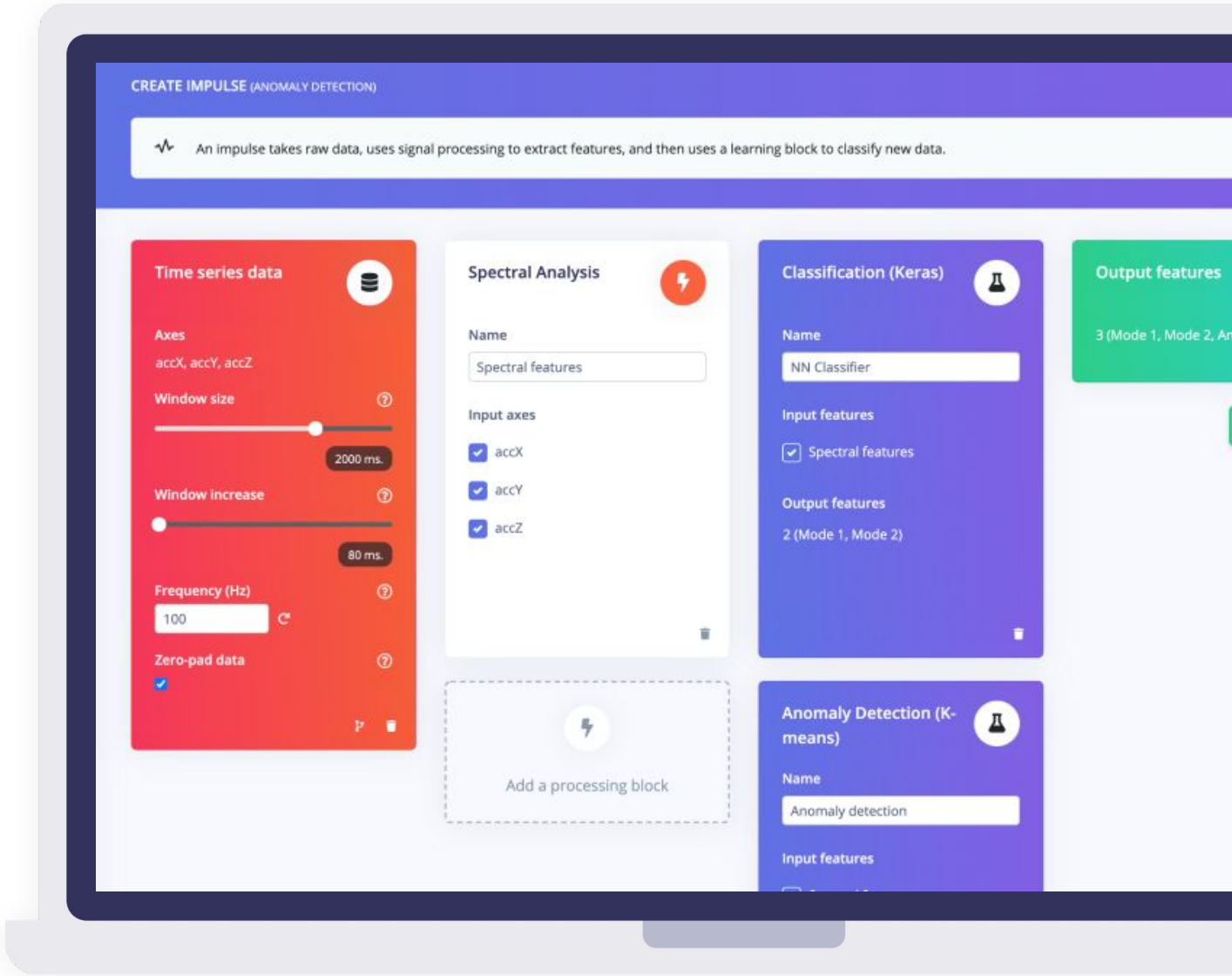
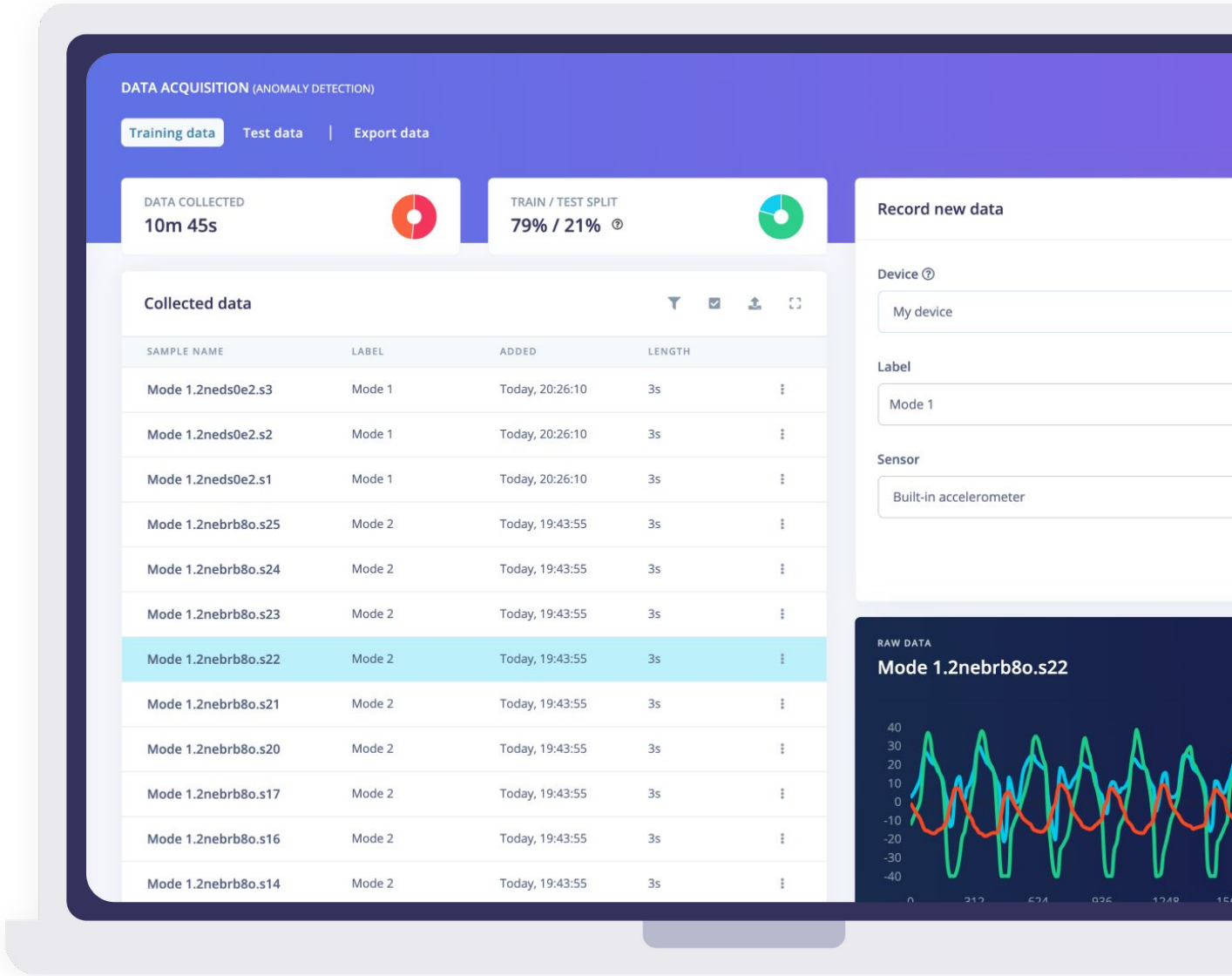


Collect

Build valuable datasets at scale

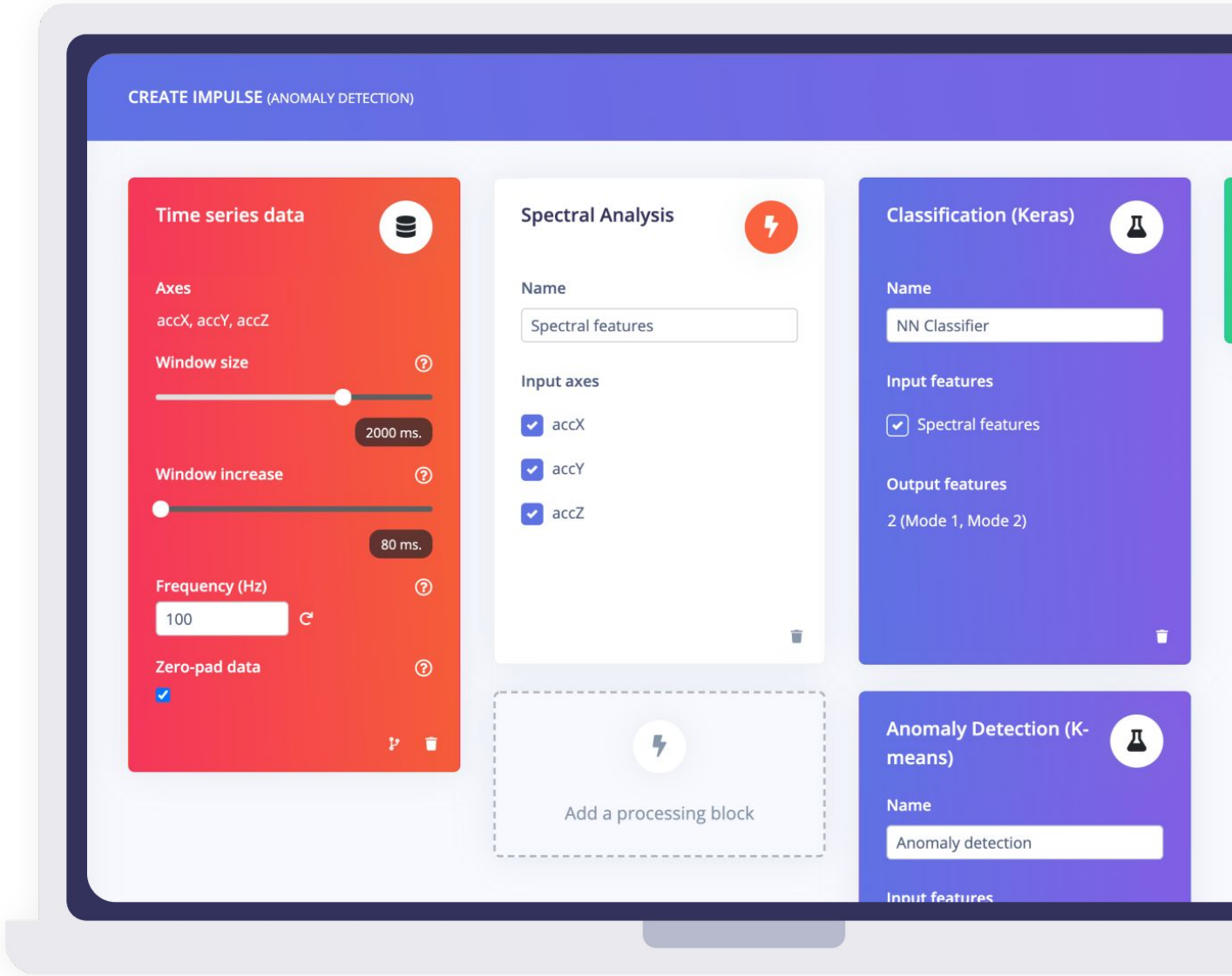
- The infrastructure ML teams need
- Auto-labeling tools
- Integrations with most widely used data science tools
- Strong data traceability and quality control
- Secure data exchange portal



Design

Advanced algorithm and ML expertise

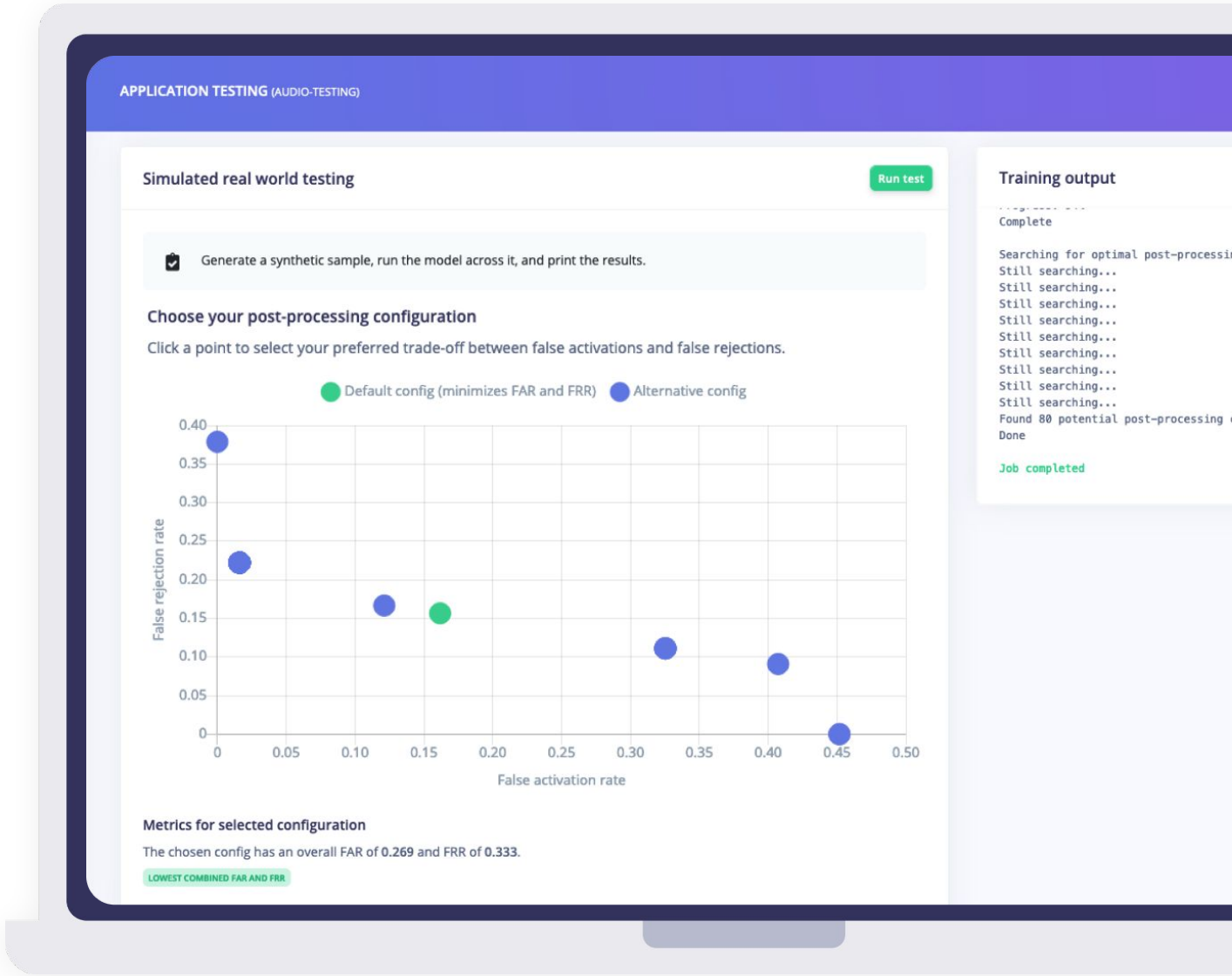
- Advanced algorithm and DSP expertise
- No black boxes
- Explainable AutoML
- Knowledge sharing and collaboration between teams



Test

Go to market faster, with confidence

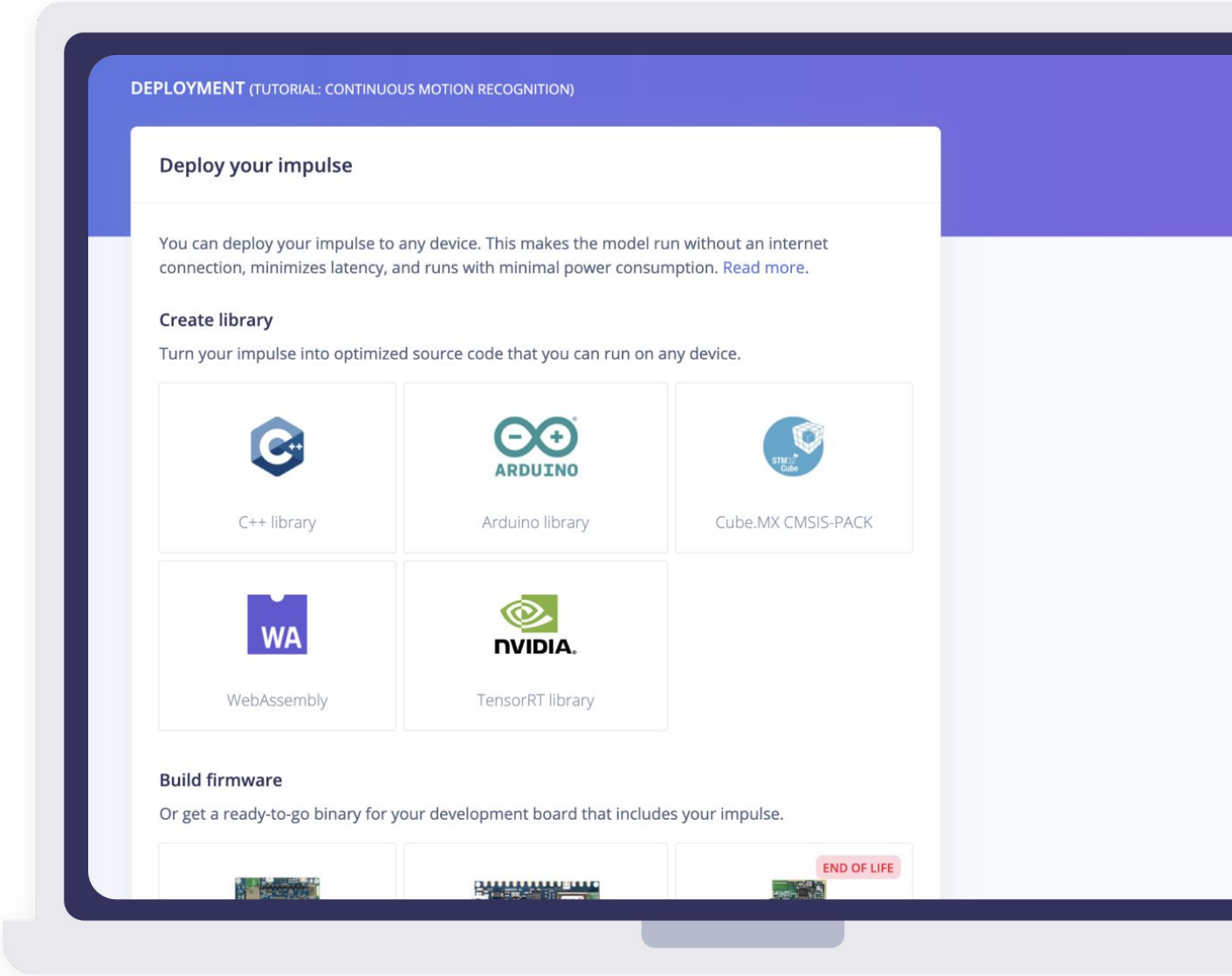
- Hardware-aware development
- Full visibility across the whole ML pipeline
- Test your development against 24hrs of real world data
- Tune the post-processing algorithm to perform optimally



Deploy

Deploy to any edge device with ease

- The largest silicon ecosystem
- Award-winning compiler
- Get access to full source code
- Full firmware integration for a number of devices
- Digital twin for performance profiling and analysis
- Enable brownfield and future greenfield



Silabs xG24 - Documentation

EDGE IMPULSE

Home Guides Projects Forum Search ⌘K

- Getting Started
- Getting Started: Next Steps
- API and SDK references
- What is embedded ML, anyway?
- Frequently asked questions

EDGE IMPULSE STUDIO

- Dashboard
- Devices
- Data sources
- Data acquisition
- Data explorer
- Impulse design
- Bring your own model (BYOM)
- Processing blocks
- Learning blocks
- EON Tuner
- Retrain model
- Live classification
- Model testing
- Performance calibration

SiLabs xG24 Dev Kit

Export as PDF

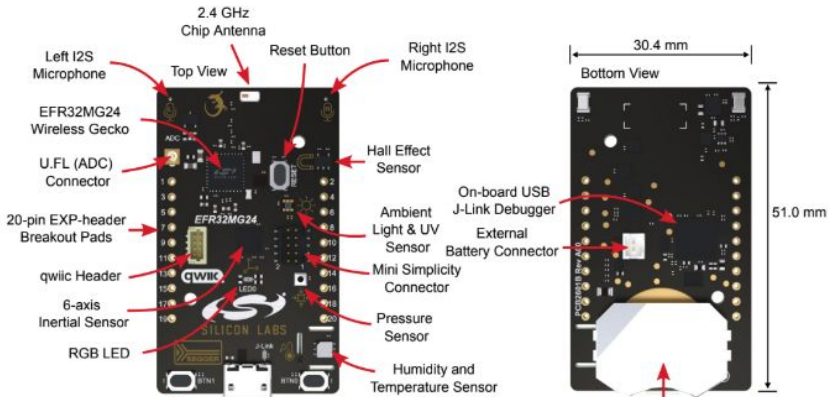
Copy link

ON THIS PAGE

- Installing dependencies
- Updating the firmware
- Connecting to Edge Impulse
- Bluetooth Demo
- Next steps: Build a machine lear...

The Silicon Labs xG24 Dev Kit (xG24-DK2601B) is a compact, feature-packed development platform built for the EFR32MG24 Cortex-M33 microcontroller. It provides the fastest path to develop and prototype wireless IoT products. This development platform supports up to +10 dBm output power and includes support for the 20-bit ADC as well as the xG24's AI/ML hardware accelerator. The platform also features a wide variety of sensors, a microphone, Bluetooth Low Energy and a battery holder - and it's fully supported by Edge Impulse! You'll be able to sample raw data as well as build and deploy trained machine learning models directly from the Edge Impulse Studio - and even stream your machine learning results over BLE to a phone.

The Edge Impulse firmware for this development board is open source and hosted on GitHub: edgeimpulse/firmware-silabs-xg24.



https://docs.edgeimpulse.com/docs/development-platforms/officially-supported-mcu-targets/silabs-xg24-devkit

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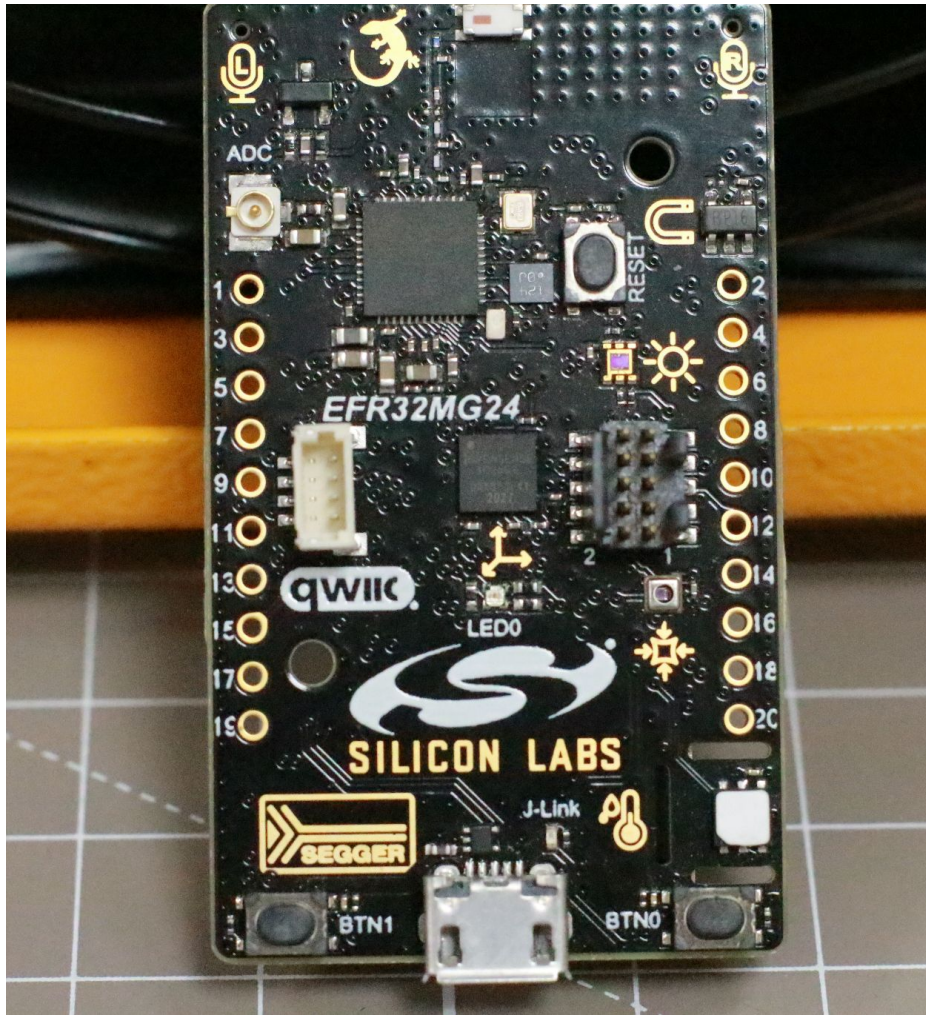
Condition Monitoring vs Predictive Maintenance

Condition Monitoring vs Predictive Maintenance

- **Condition monitoring** is the process of continuously monitoring the condition of assets in real-time to identify existing or emerging faults
- **Predictive maintenance** is a strategy that uses data analysis and modeling to predict when maintenance should be performed.

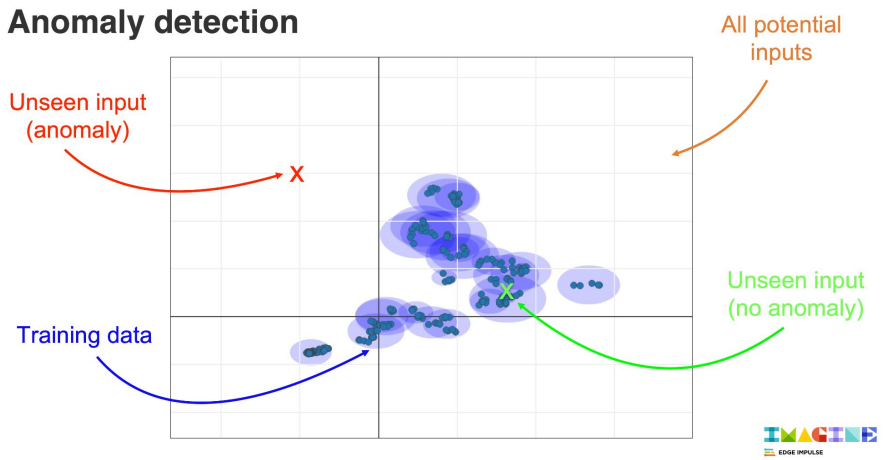


Silicon Labs xG24 placed beside a Solder Extractor Fan

Condition Monitoring - Anomaly detection

Anomaly Detection

- **Predictive maintenance can be aided by anomaly detection algorithms.**
- **Training classification models for classes where examples captured of idle states, nominal and introduced faults can build a strong base.**



Anomaly detection today

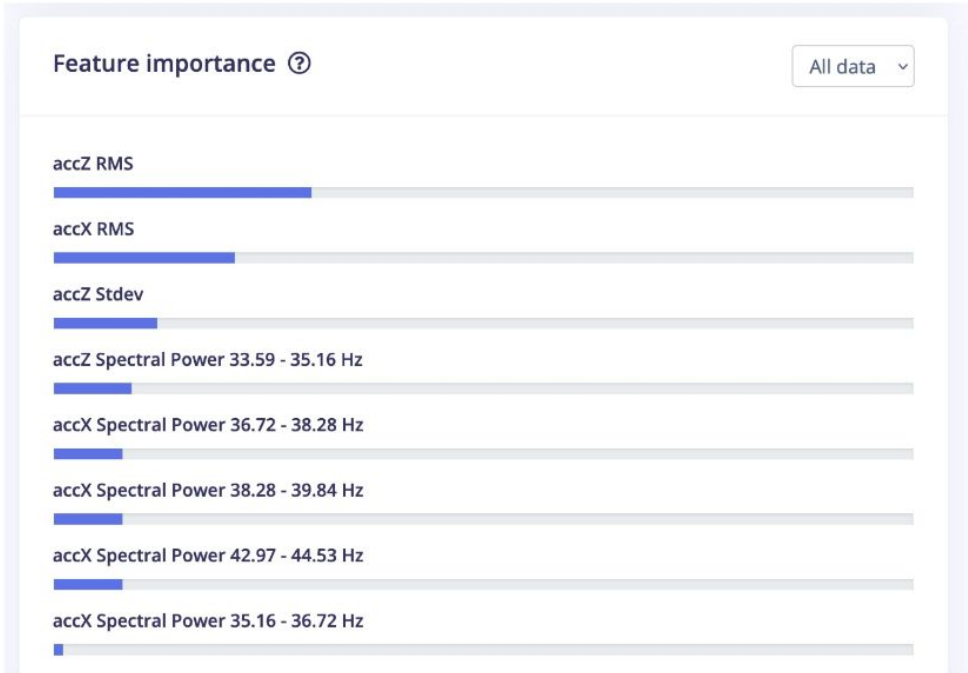
Input

↓

DSP Features

↓

Clustering algorithm



Great for basic sensor data
for which you can reason about features

IMAGINE
EDGE IMPULSE

EDGE IMPULSE

- Dashboard
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- Impulse design
  - Create impulse
  - Spectral features
  - NN Classifier
  - Anomaly detection
- EON Tuner
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- Model testing
- Performance calibration
- Versioning
- Deployment

GETTING STARTED

Training data | Test data | Data explorer | Upload data | Export data

Data explorer

The data explorer shows a complete view of all data in your project. You can clear labels through the menu on the right, and inspect or change labels by clicking on individual data items. Learn more.

Label colors: Data labels Predictions

Save changes (0 pending)

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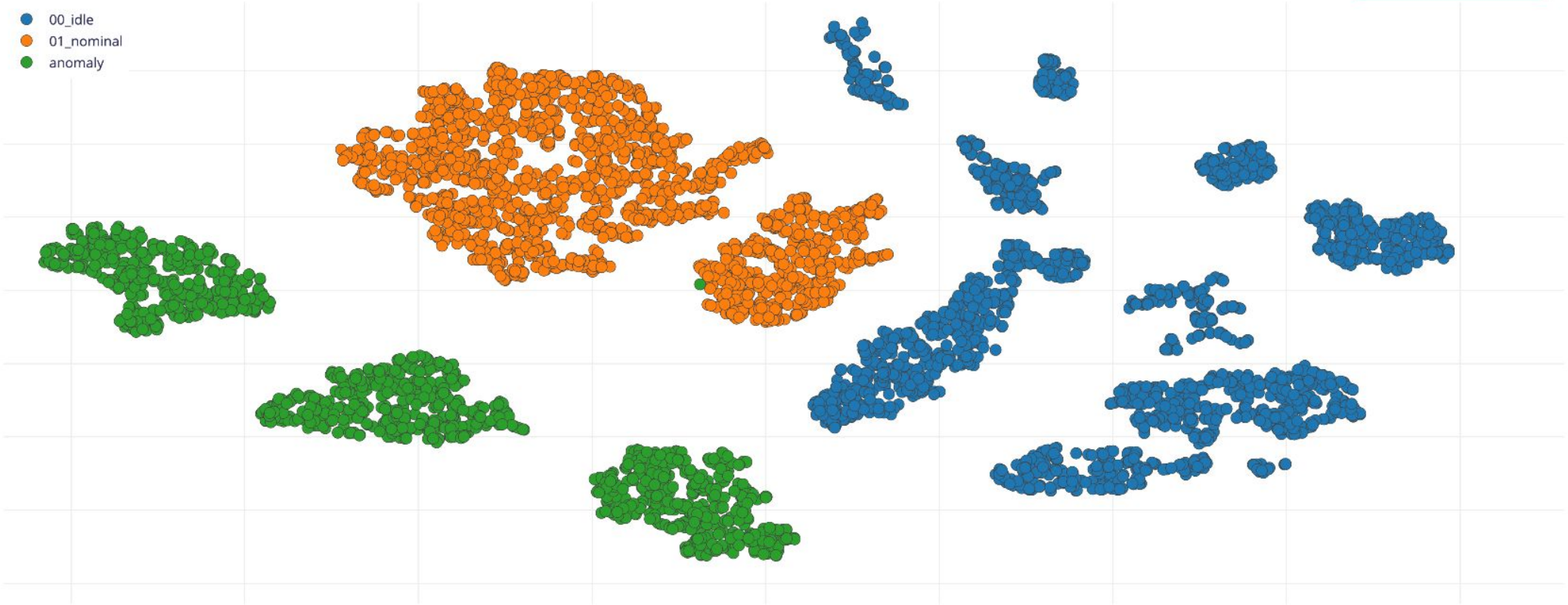

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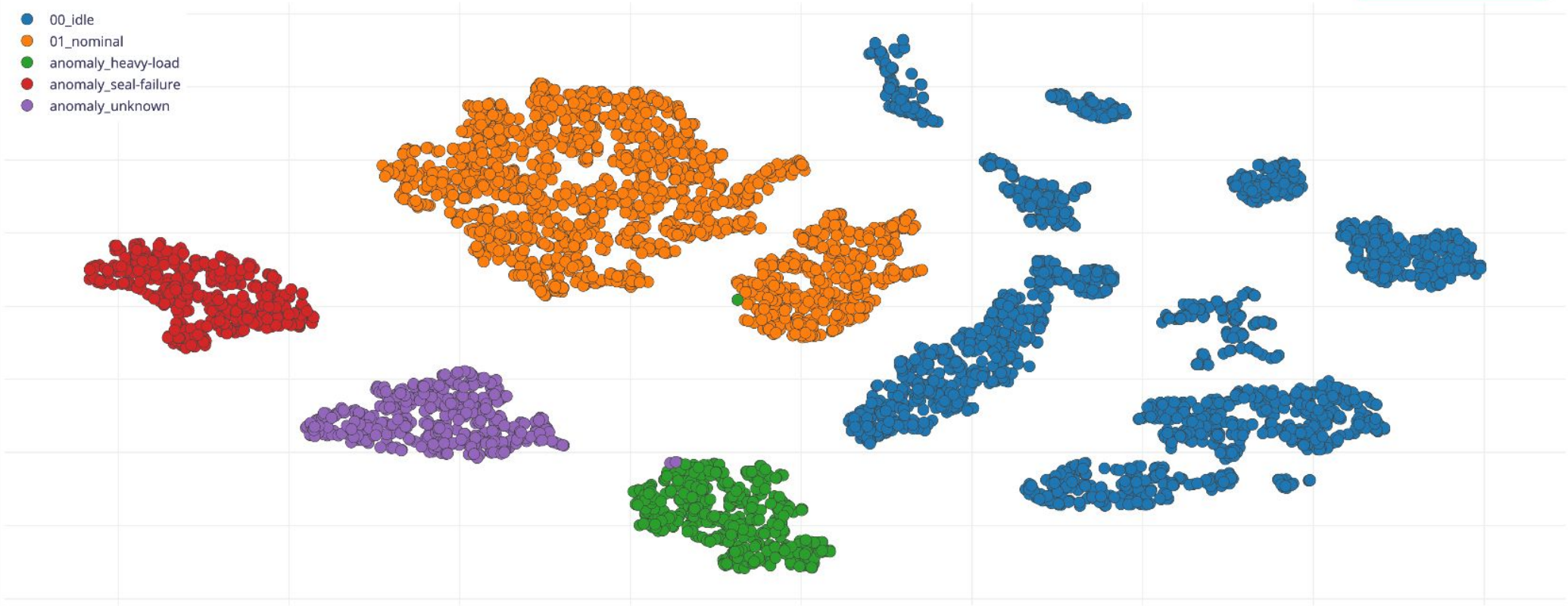
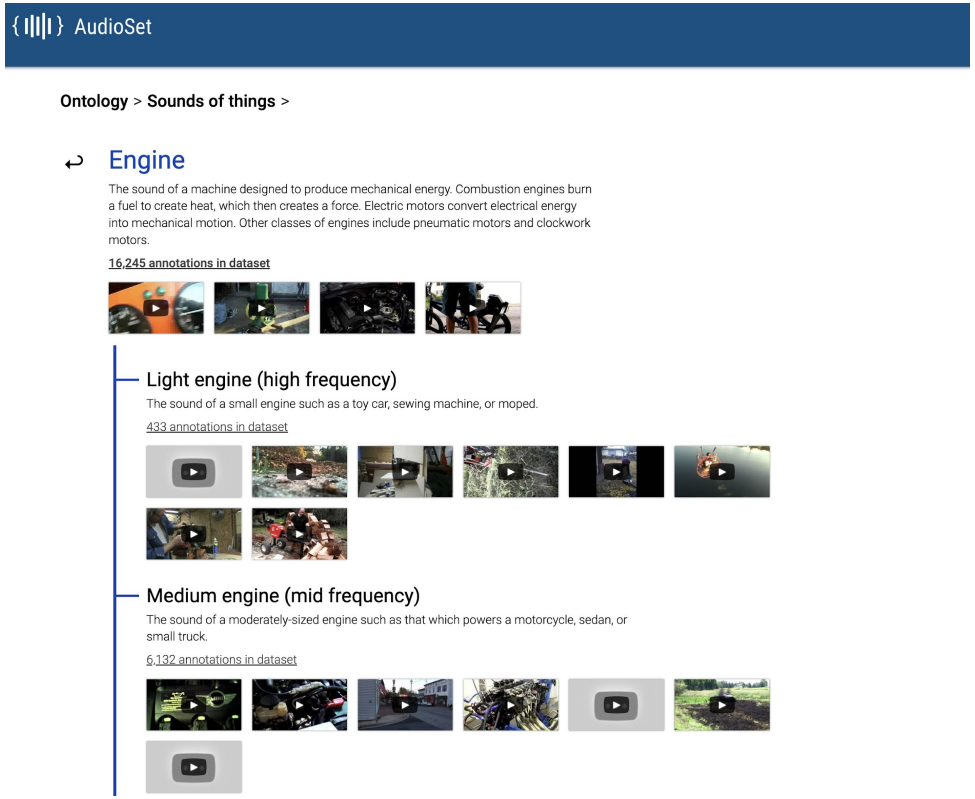


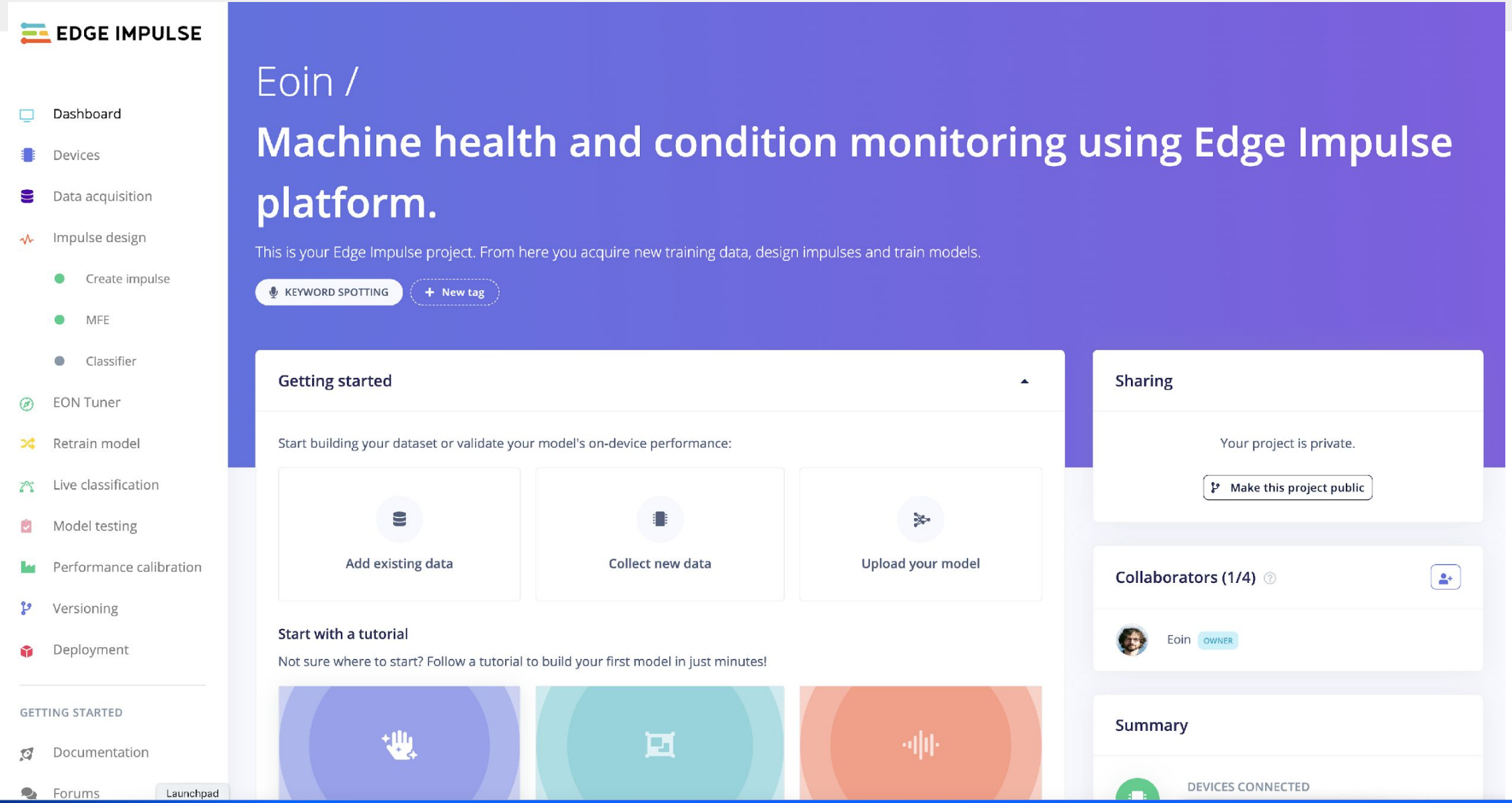
Predictive Maintenance - Transfer Learning

Audio Event Detection

- **Audio events** detected in other models can help identify similar types in another e.g. engine sounds used in the type of engine may help identify our idling one.



Public Project: Machine Health and Condition Monitoring



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Q&A

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Thank you!

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References

Documentation:

- WW23 Condition Monitoring Public Project: https://studio.edgeimpulse.com/studio/267189
- SiLabs xG24 Dev Kit: https://docs.edgeimpulse.com/docs/development-platforms/officially-supported-mcu-targets/silabs-xg24-devkit
- Feature Importance: https://docs.edgeimpulse.com/docs/edge-impulse-studio/learning-blocks/anomaly-detection#features-importance-optional
- Anomaly Detection: https://docs.edgeimpulse.com/docs/edge-impulse-studio/learning-blocks/anomaly-detection
- xG24 Firmware: https://github.com/edgeimpulse/firmware-silabs-xg24
- xG24 Workshop Notes: https://github.com/edgeimpulse/workshop-silabs-xg24-dev-kit

Tutorials:

- Advanced Anomaly Detection with Edge Impulse (Custom DSP Blocks, Feature Importance): https://www.youtube.com/watch?v=7vr4D_zlQTE
- Edge Impulse Imagine 2022: Silicon Labs MG24 Wireless SoC Demo: https://www.youtube.com/watch?v=ujMR84vlLvk
- Edge Impulse Imagine 2022: Silicon Labs Tech Talk: https://www.youtube.com/watch?v=bg9CRnWP6Co
- Silicon Labs Works With 2021: Industrial Predictive Maintenance with Embedded Machine Learning: https://www.youtube.com/watch?v=hhJN1r-sAgg