

tinyML® Talks

Enabling Ultra-low Power Machine Learning at the Edge

“Getting Started with TinyML: Train and Deploy TinyML projects with Edge Impulse”

Daniel Situnayake - Edge Impulse

[Nigerian Area Group] – January 12, 2021



www.tinyML.org



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EDGE IMPULSE



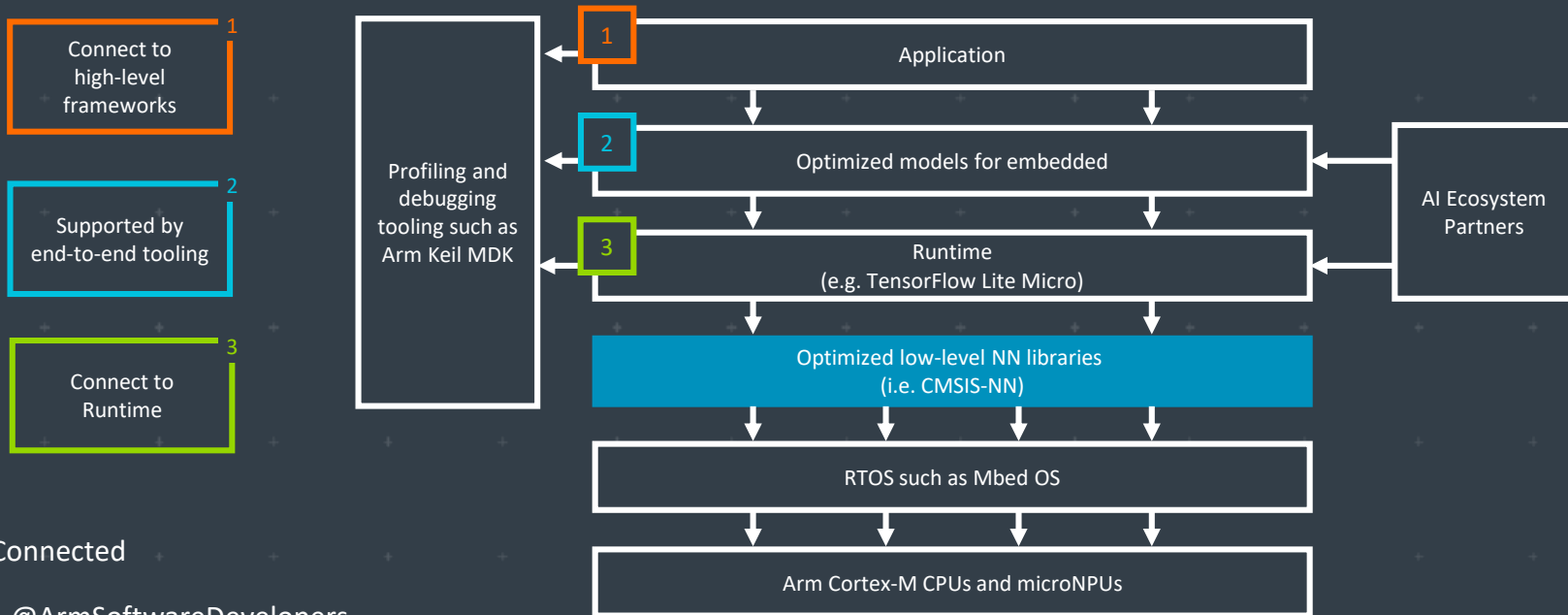
Reality AI®



SynSense

Additional Sponsorships available – contact Bette@tinyML.org for info

Arm: The Software and Hardware Foundation for tinyML



Stay Connected



@ArmSoftwareDevelopers



@ArmSoftwareDev

Resources: developer.arm.com/solutions/machine-learning-on-arm



WE USE AI TO MAKE OTHER AI FASTER, SMALLER AND MORE POWER EFFICIENT



Automatically compress SOTA models like MobileNet to <200KB with **little to no drop in accuracy** for inference on resource-limited MCUs



Reduce model optimization trial & error from weeks to days using Deeplite's **design space exploration**



Deploy more models to your device without sacrificing performance or battery life with our **easy-to-use software**

BECOME BETA USER bit.ly/testdeeplite

mobilityXlab

arm



TinyML for all developers



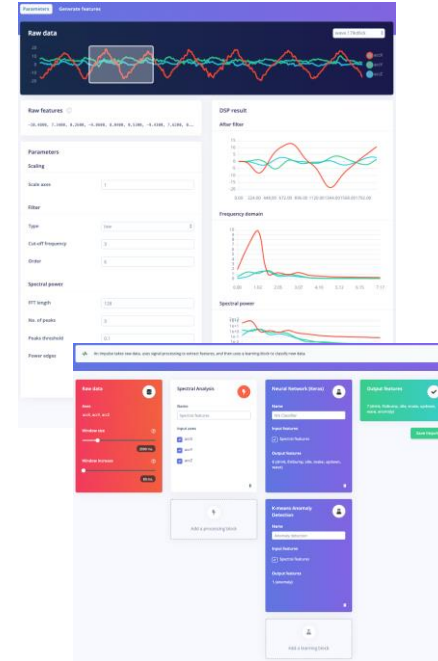
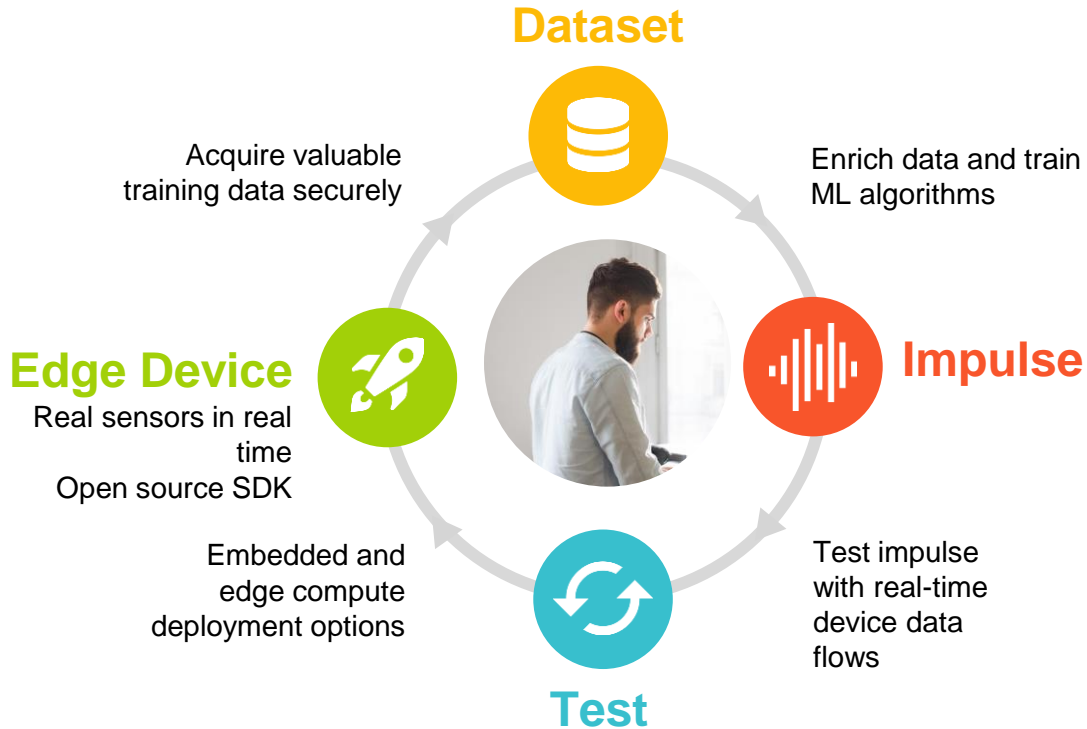
C++ library



Arduino library



WebAssembly



Maxim Integrated: Enabling Edge Intelligence

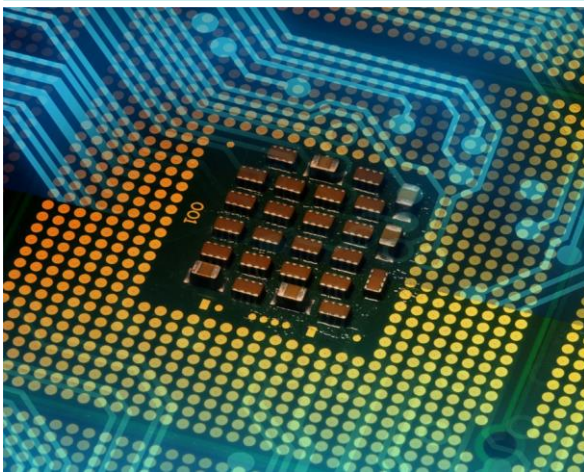
www.maximintegrated.com/ai

Sensors and Signal Conditioning



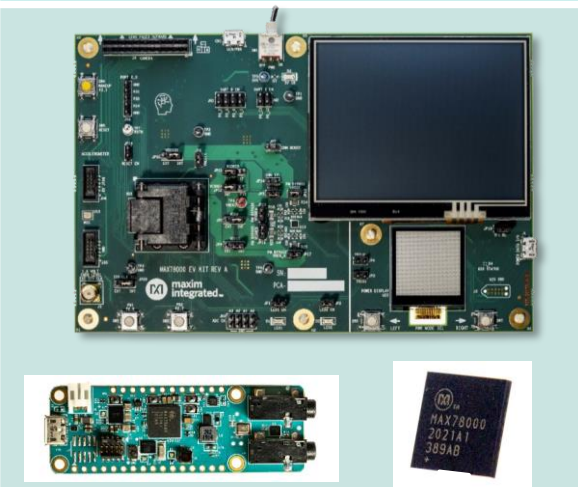
Health sensors measure PPG and ECG signals critical to understanding vital signs. Signal chain products enable measuring even the most sensitive signals.

Low Power Cortex M4 Micros



The biggest (3MB flash and 1MB SRAM) and the smallest (256KB flash and 96KB SRAM) Cortex M4 microcontrollers enable algorithms and neural networks to run at wearable power levels

Advanced AI Acceleration



The new MAX78000 implements AI inferences at over 100x lower energy than other embedded options. Now the edge can see and hear like never before.

Qeexo AutoML for Embedded AI

Automated Machine Learning Platform that builds tinyML solutions for the Edge using sensor data



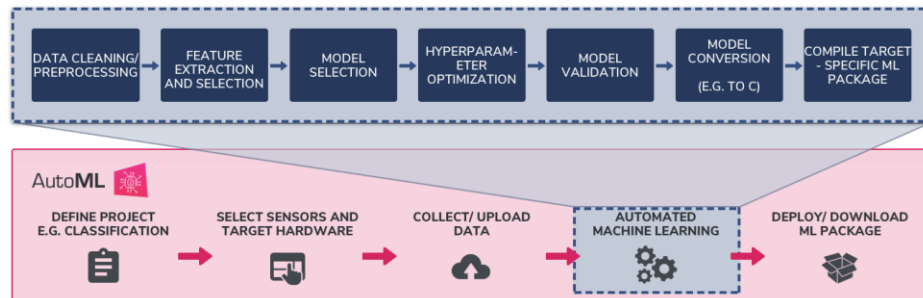
Key Features

- Wide range of ML methods: GBM, XGBoost, Random Forest, Logistic Regression, Decision Tree, SVM, CNN, RNN, CRNN, ANN, Local Outlier Factor, and Isolation Forest
- Easy-to-use interface for labeling, recording, validating, and visualizing time-series sensor data
- On-device inference optimized for low latency, low power consumption, and a small memory footprint
- Supports Arm® Cortex™- M0 to M4 class MCUs
- Automates complex and labor-intensive processes of a typical ML workflow – no coding or ML expertise required!

Target Markets/Applications

- Industrial Predictive Maintenance
- Smart Home
- Wearables
- Automotive
- Mobile
- IoT

QEEEXO AUTOML: END-TO-END MACHINE LEARNING PLATFORM



For a limited time, sign up to use Qeexo AutoML at automl.qeexo.com for FREE to bring intelligence to your devices!



is for
building products

<https://reality.ai>  info@reality.ai  [@SensorAI](https://twitter.com/SensorAI)  [Reality AI](https://www.linkedin.com/company/reality-ai)

Reality AI Tools[®] software

Automated Feature
Exploration and
Model Generation

Bill-of-Materials
Optimization

Automated Data
Assessment

Edge AI / TinyML
code for the smallest
MCUs

Reality AI solutions

Automotive sound recognition & localization

Indoor/outdoor sound event recognition

RealityCheck[™] voice anti-spoofing



SynSense

SynSense builds **ultra-low-power** (sub-mW) **sensing and inference** hardware for **embedded, mobile and edge** devices. We design systems for **real-time always-on smart sensing**, for audio, vision, IMUs, bio-signals and more.

<https://SynSense.ai>





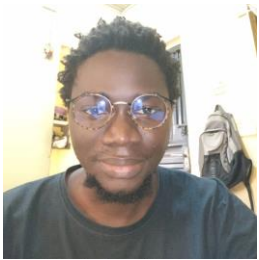
Next tinyML Talks

Date	Presenter	Topic / Title
Tuesday, January 19	Lukas Geiger Deep Learning Researcher, Plumerai	Running Binarized Neural Networks on Microcontrollers

Webcast start time is 8 am Pacific time

Please contact talks@tinymml.org if you are interested in presenting

- First TinyML Talk in Africa(Lagos, Nigeria).
- # members in the Nigerian group as of today is **216+**
- Committee members:



David Adebisi
Technical Lead,
Hankali Labs

[@David_Biyi](#)

[linkedin.com/in/david-adebiyi/](https://www.linkedin.com/in/david-adebiyi/)



George Igwegbe
Machine Learning Engineer,
Hankali Labs

[@iGeorge_i](#)

[linkedin.com/in/george-igwegbe](https://www.linkedin.com/in/george-igwegbe)



Sydney Okoroafor,
Hardware Engineer,
Hankali Labs

[@Sir_sydney_](#)

[linkedin.com/in/sydney-okoroafor](https://www.linkedin.com/in/sydney-okoroafor)



Reminders

Slides & Videos will be posted tomorrow

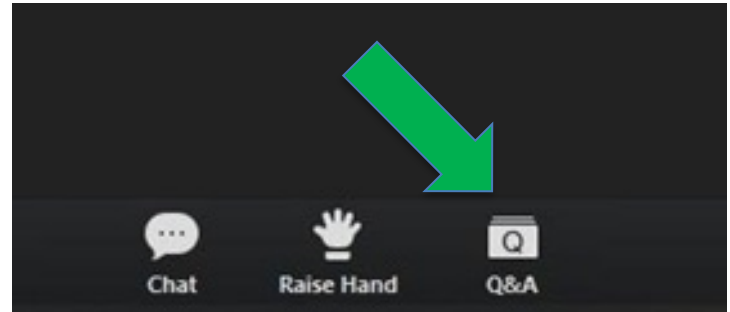


tinyml.org/forums



youtube.com/tinyml

Please use the Q&A window for your questions



Daniel Situnayake



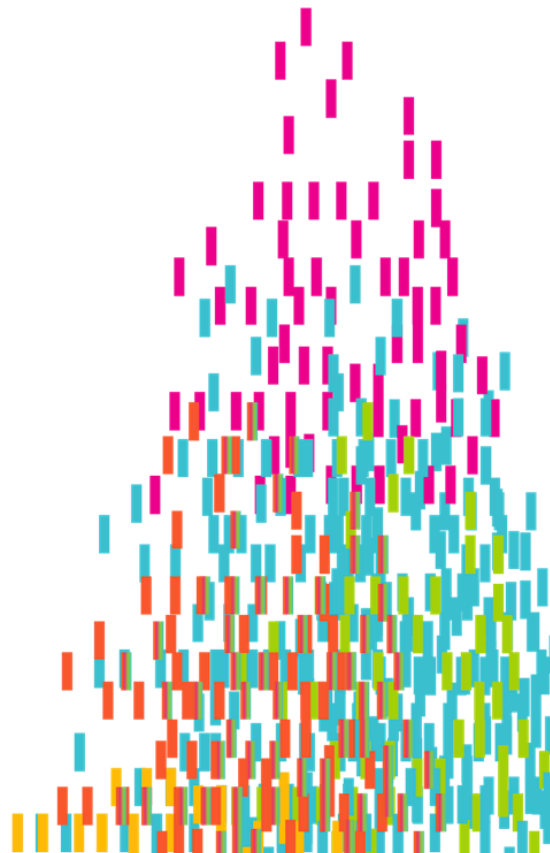
Daniel Situnayake will be teaching dozens of engineers/students/enthusiasts in Nigeria how to get started with tinyML using the Edge Impulse tool. Daniel is the Founding tinyML engineer at Edge Impulse. He's co-author of the O'Reilly book tinyML, alongside Pete Warden. He previously worked on the Tensor Flow team at Google, and he co-founded Tiny Farms Inc., deploying machine learning on industrial scale insect farms.



Getting started with tinyML

Train and deploy tinyML projects with Edge Impulse

Daniel Situnayake, Founding TinyML Engineer



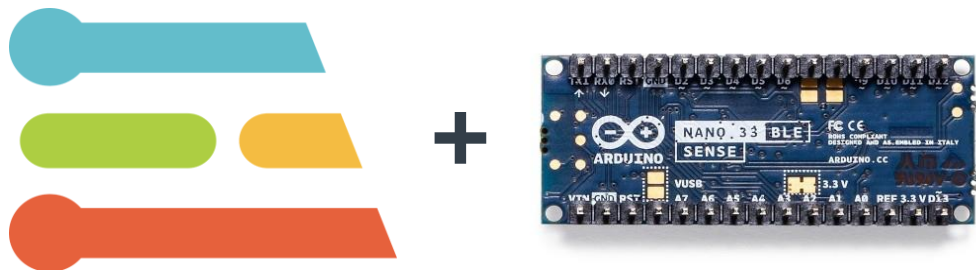
Agenda

Why is machine learning useful?

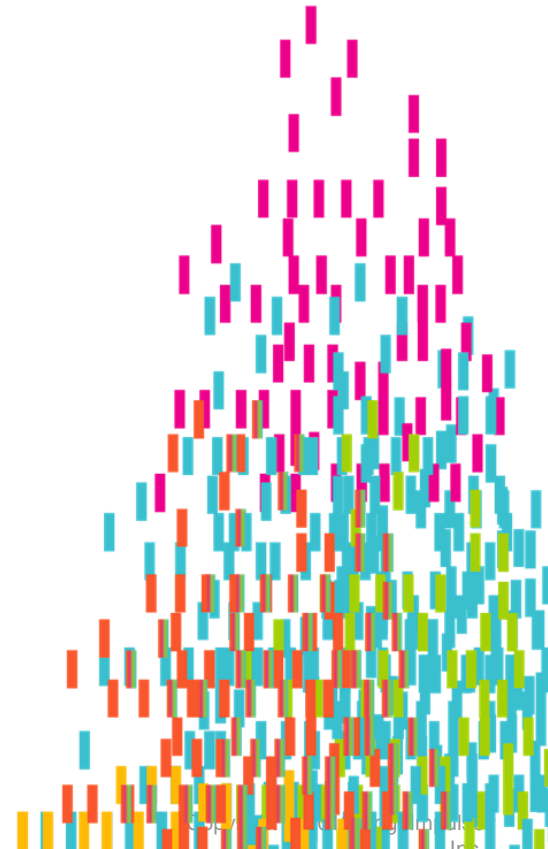
What is TinyML?

Live demo of Edge Impulse with the Arduino Nano 33 BLE Sense

Q&A



Why is machine learning useful?



Typical industrial sensor in 2020



Vibration sensor (up to 1,000 times per second)

Temperature sensor

Water & explosion proof

Can send data >10km using 25 mW power (LoRA, etc.)

Processor capable of running >20 million instructions per second



What does it do?

Once an hour:

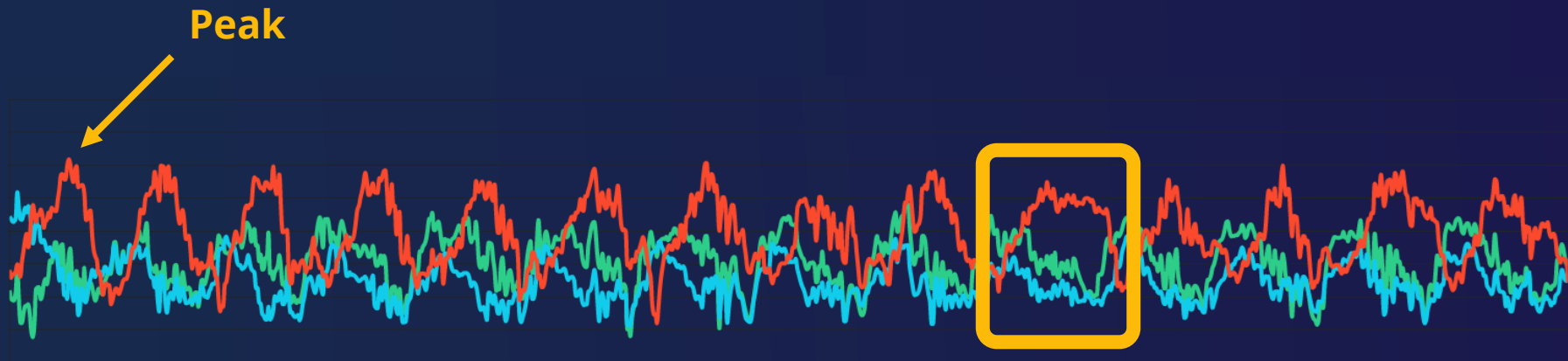
- Average motion (RMS)
- Peak motion
- Current temperature



*99% of sensor data is discarded due to cost, **bandwidth** or **power** constraints.*

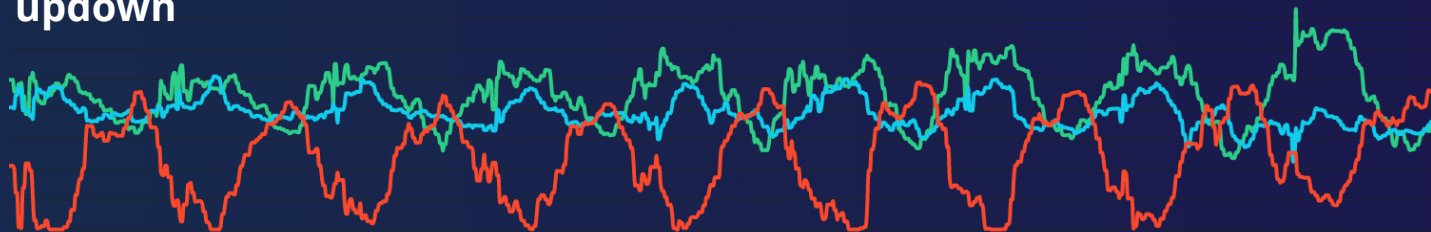


Lots of interesting events get lost



Single numbers can be misleading

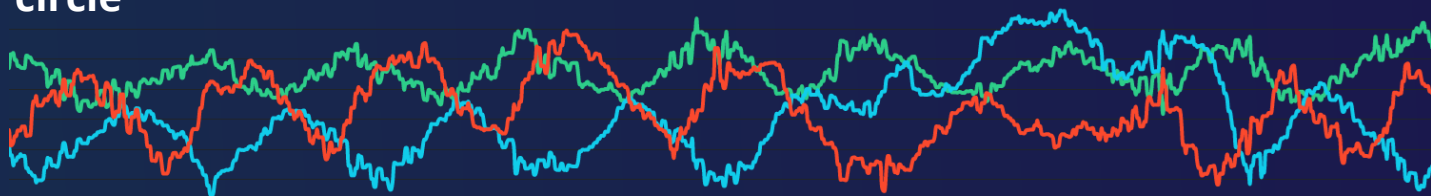
updown



avg. RMS

3.3650

circle



3.3515



On-device intelligence is the only solution



On-device intelligence is the only solution



Temperature varies in a way
that I've never seen before



Can we find patterns in our data?

Classification

What's happening right now?

Anomaly detection

Is this behavior out of the ordinary?

Forecasting

What will happen in the future?

Machine
Learning

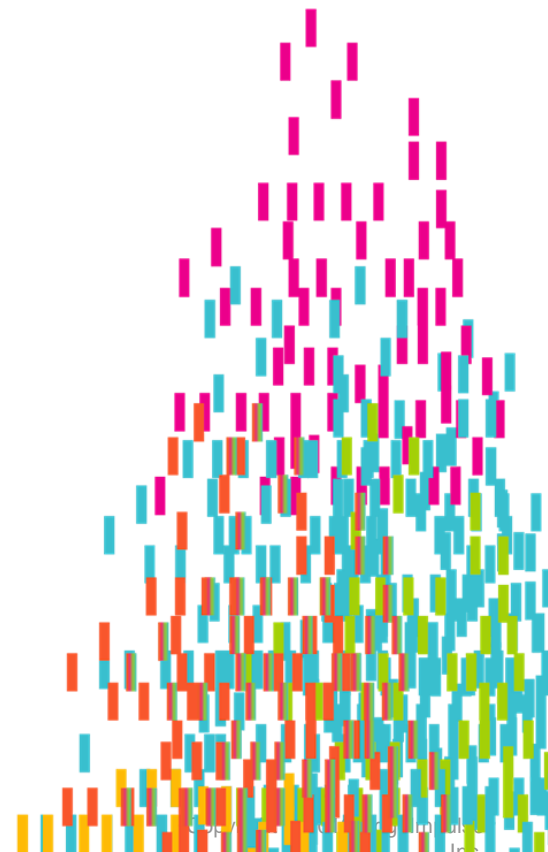




Machine learning



What is TinyML?



TinyML

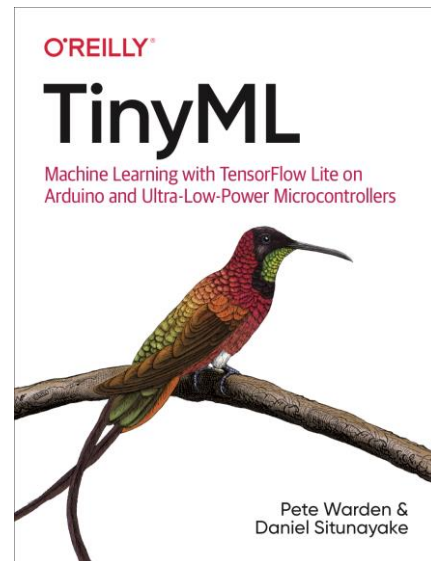
Inspired by “OK Google”

Focus on inferencing, not training

Machine learning model is just a mathematical function with lots of parameters

Accuracy vs. speed, reducing parameters, hardware optimized paths

Targeting battery-powered microcontrollers



Machine learning on the edge

Inferencing on device: typically more efficient than sending raw data over the network

Signal processing is key

Use cases with messy, high frequency data



What can we do with ML on the edge?



Recognizing sounds



Biosignal analysis



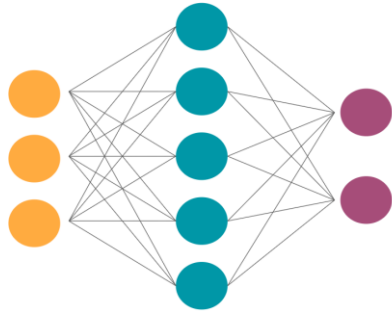
Detecting abnormal vibration



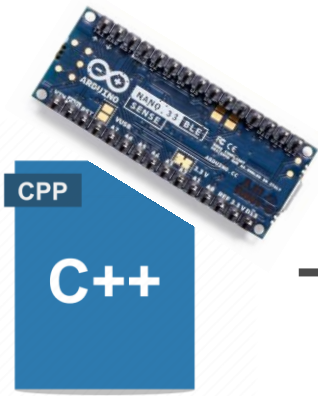
Classifying images



From model to device to cloud



Raw data
Extract meaningful features
Signal processing
Train model



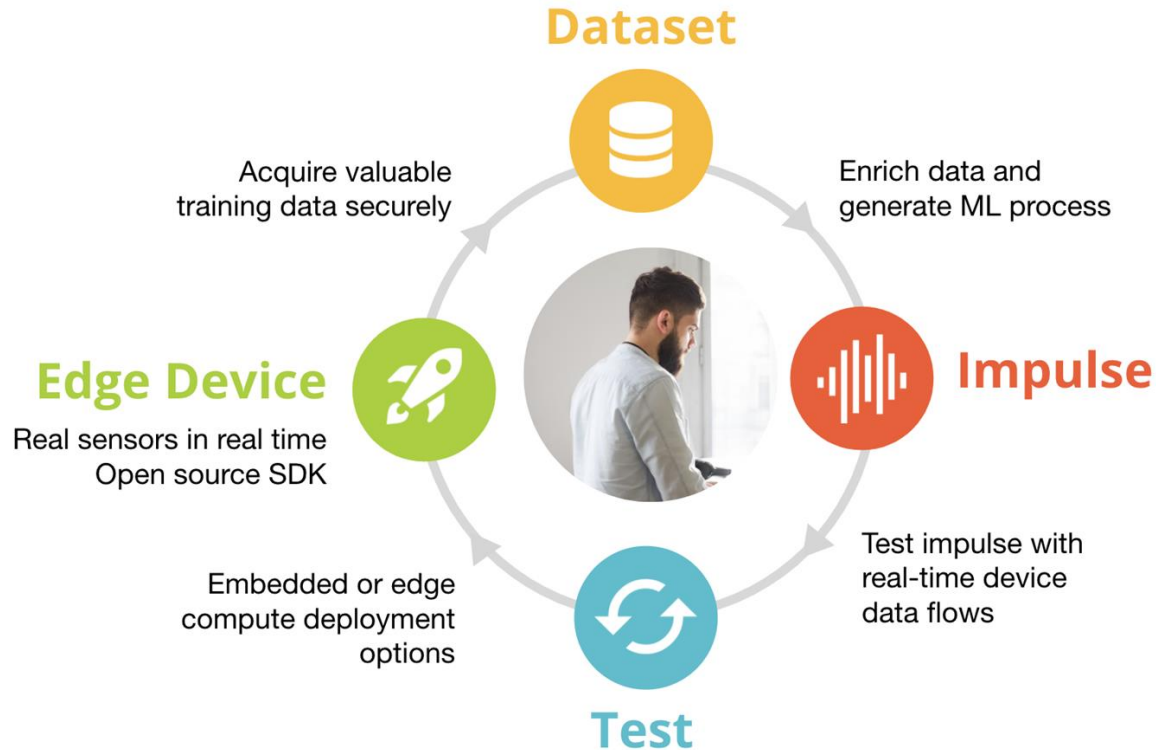
Sample sensor data
Signal processing
Run inference
Collect conclusion



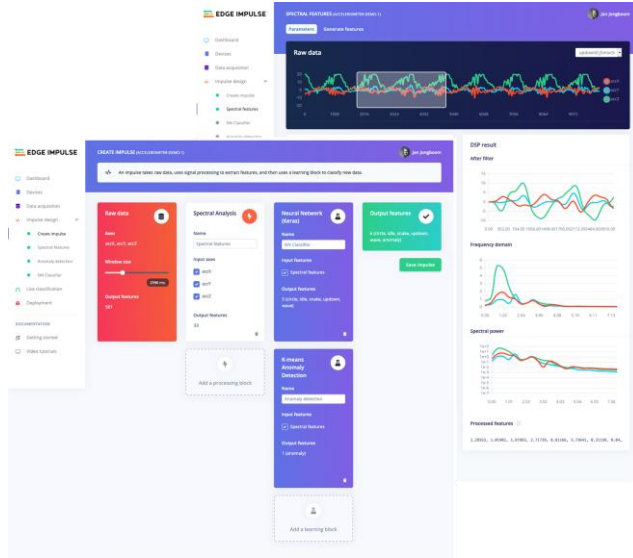
Conclusions sent to cloud



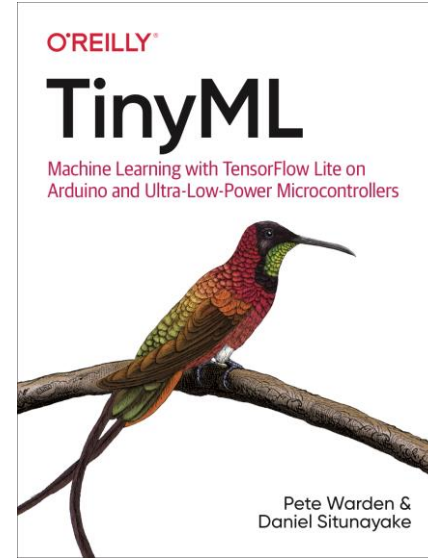
Edge Impulse - TinyML as a service



How do I get started?



edgeimpulse.com



tinymmlbook.com



Build a model in 5 minutes

Go to edgeimpulse.com, scroll down to QR code

Collect data with your phone's accelerometer, camera, or microphone

Train a machine learning model

Classify data live from your phone

Use your phone's camera or QR reader app to scan this code, and start building your tinyML model using your phone.



Demo



Recap

The ML hype is real

ML + sensors = perfect fit

Start using the remaining 99% of sensor data

edgeimpulse.com





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