tinyML® Talks

Enabling Ultra-low Power Machine Learning at the Edge

"How A Middle School Girl Solves a Real-Life Challenge Using TinyML: Gas Leak Detection"

Mithun Das - Distinguished Software Engineer, Cox Automotive

Sashrika Das - 6th Grade Student, East Lyme Middle School

March 25, 2022

www.tinyML.org

tinyML Talks Strategic Partners

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

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Fortnightly Tuesday @ 4pm GMT/8am PT

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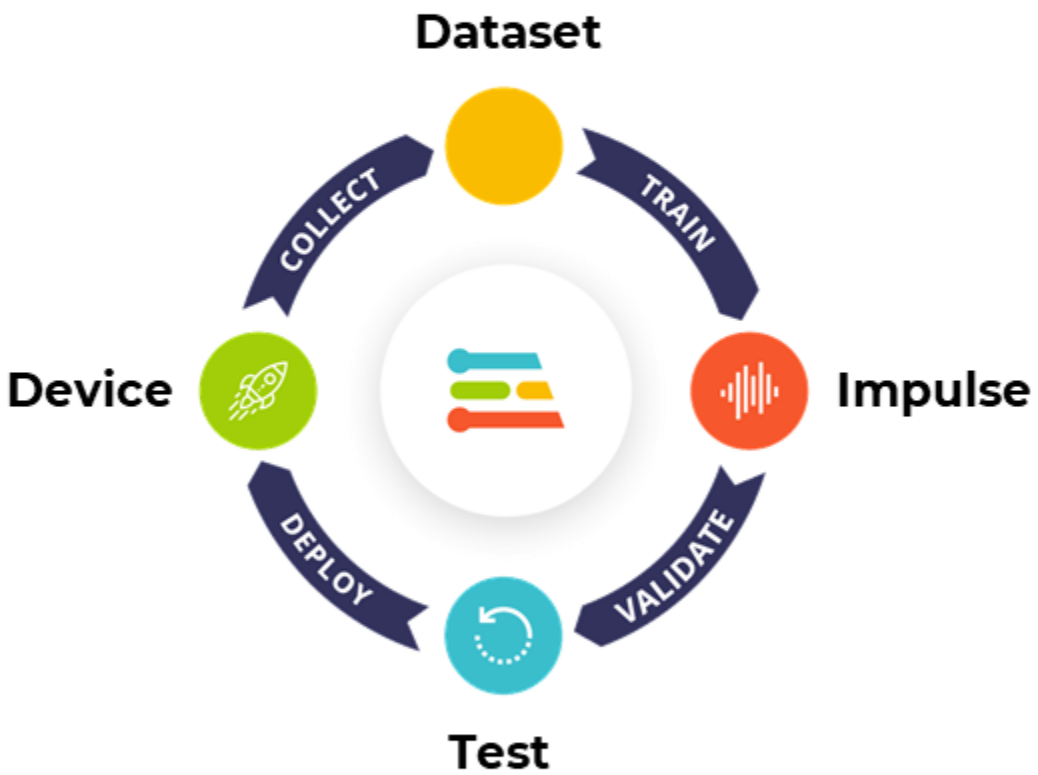
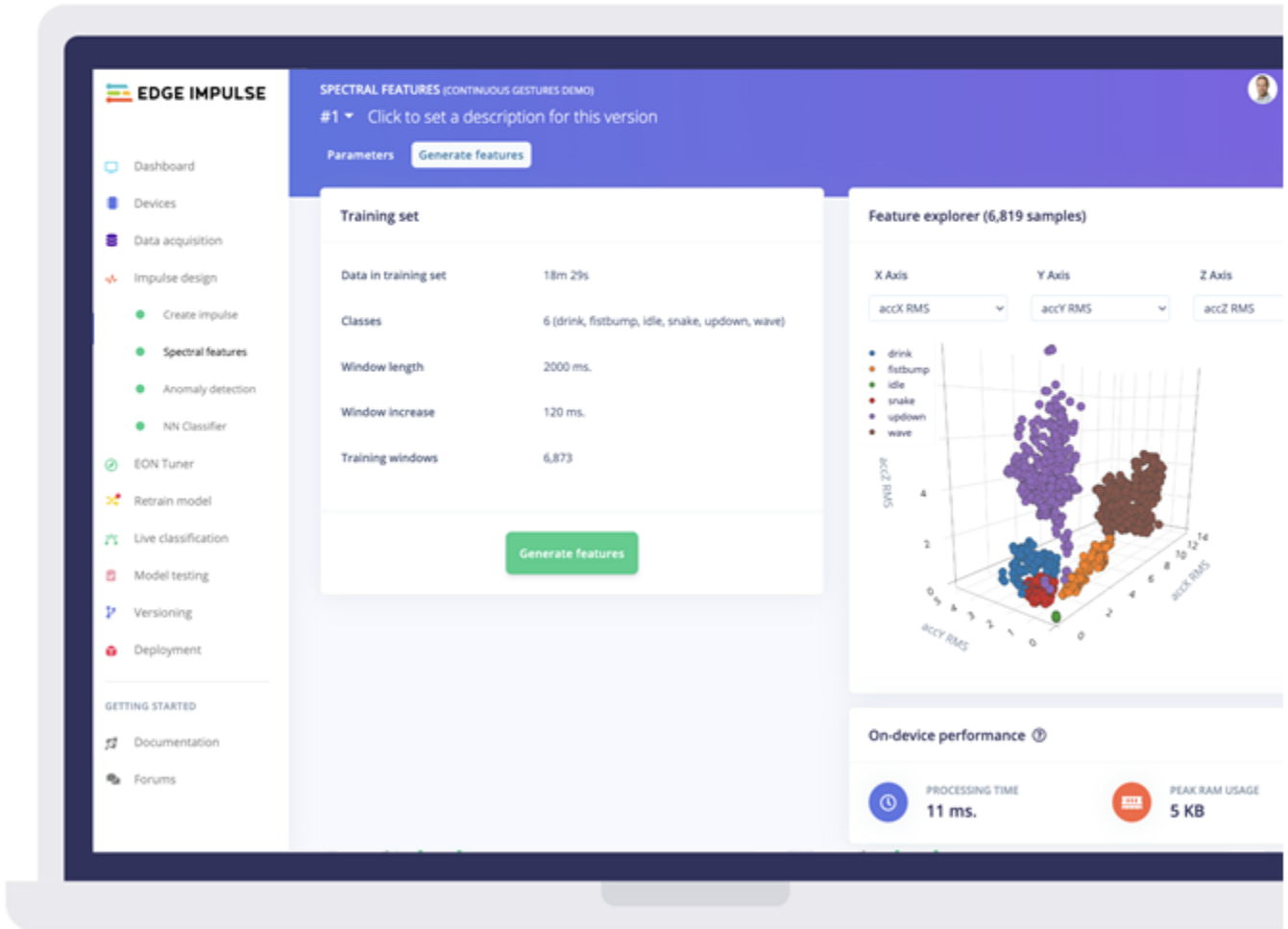
EDGE IMPULSE The leading edge ML platform



www.edgeimpulse.com



Qualcomm
AI research

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Power efficiency

Model design, compression, quantization, algorithms, efficient hardware, software tool

Personalization

Continuous learning, contextual, always-on, privacy-preserved, distributed learning

Efficient learning

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A platform to scale AI across the industry

Perception

Object detection, speech recognition, contextual fusion

Reasoning

Scene understanding, language understanding, behavior prediction

Action

Reinforcement learning for decision making

Edge cloud

Cloud

IoT/IIoT

Automotive

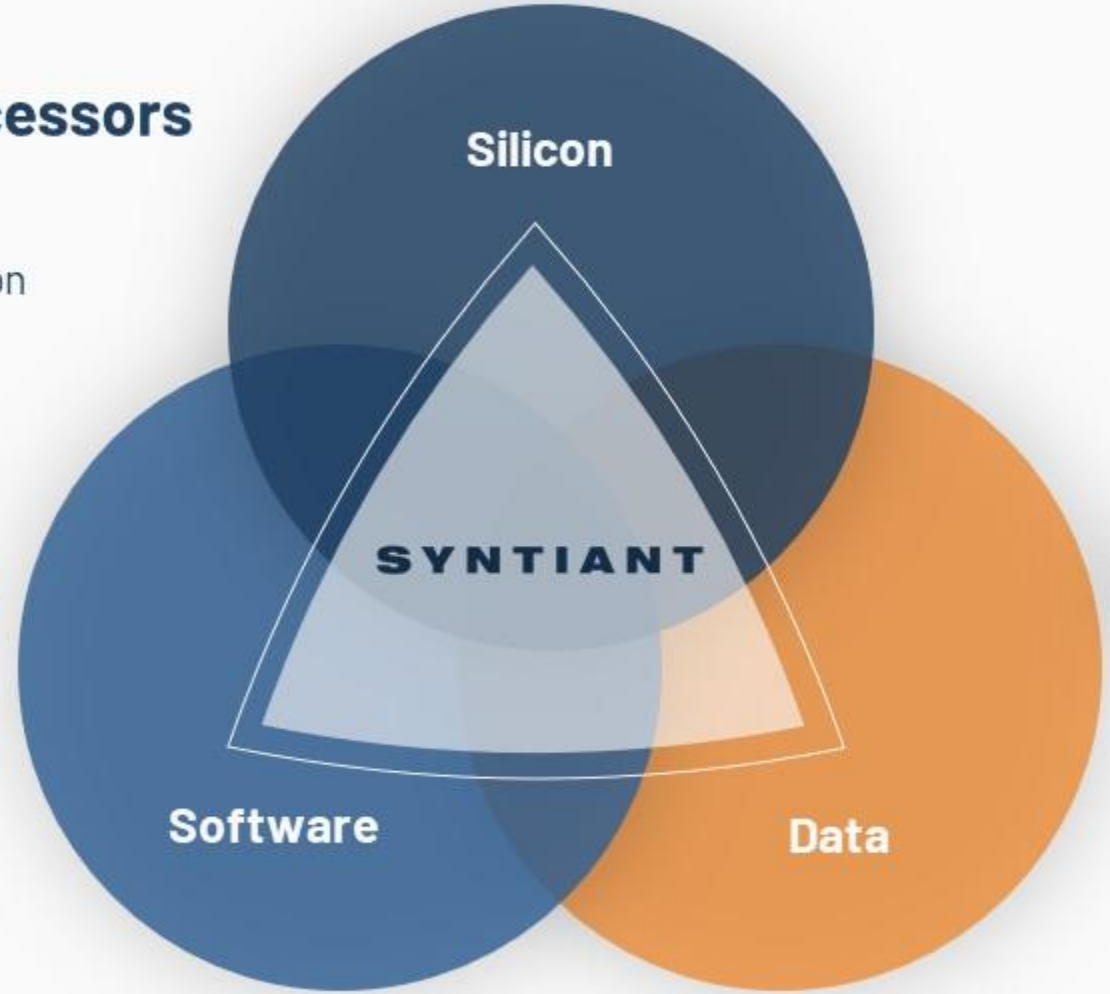
Mobile

SYNTIANT

End-to-End Deep Learning Solutions for TinyML & Edge AI

Neural Decision Processors

- At-Memory Compute
- Sustained High MAC Utilization
- Native Neural Network Processing



ML Training Pipeline

- Enables Production Quality Deep Learning Deployments

Data Platform

- Reduces Data Collection Time and Cost
- Increases Model Performance

partners@syntiant.com

www.syntiant.com

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Pre-built Edge AI sensing modules, plus tools to build your own

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Reality AI Tools® software

Build prototypes, then turn them into real products

Explain ML models and relate the function to the physics

Optimize the hardware, including sensor selection and placement

BROAD AND SCALABLE EDGE COMPUTING PORTFOLIO

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Arm ecosystem, Advanced security, Intelligent IoT

RZ — Arm®-based High-end 32 & 64-bit MPUs
High-resolution HMI, Industrial network & real-time control

RE — Arm® Cortex®-M0+ Ultra-low Power 32-bit MCUs
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Renesas Synergy™ — Arm®-based 32-bit MCUs for Qualified Platform
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Renesas Core

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AI

A broad set of high-power and energy-efficient embedded processors

Security & Safety

Comprehensive technology and support that meet the industry's stringent standards

Digital & Analog & Power Solution

Winning Combinations that combine our complementary product portfolios

Cloud Native

Cross-platforms working with partners in different verticals and organizations

BIG IDEAS FOR EVERY SPACE RENESAS

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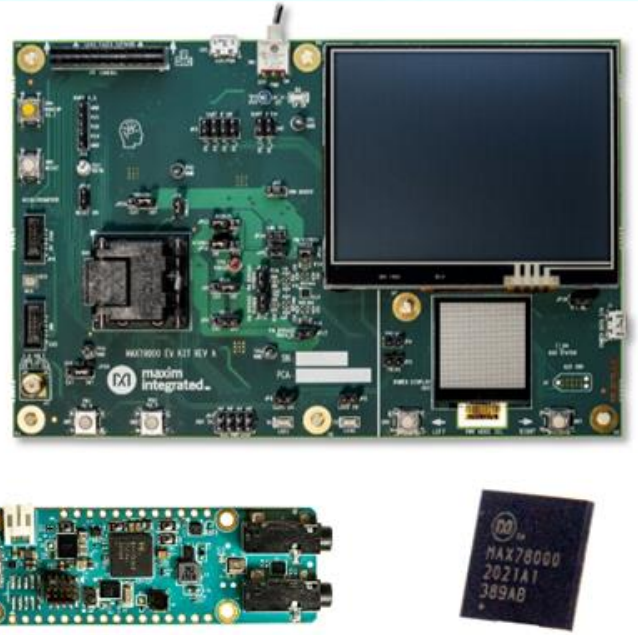
Maxim Integrated: Enabling Edge Intelligence

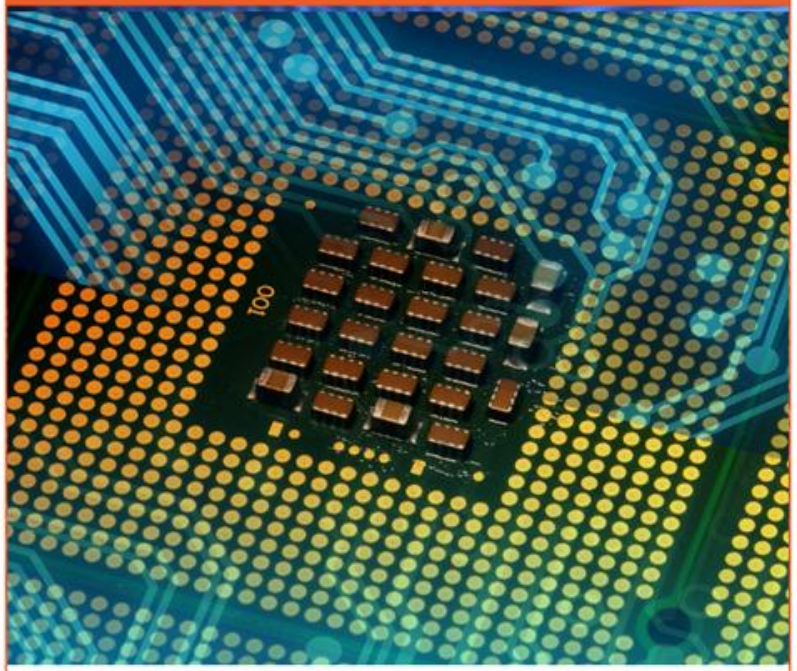
Advanced AI Acceleration IC



The new MAX78000 implements AI inferences at low energy levels, enabling complex audio and video inferencing to run on small batteries. Now the edge can see and hear like never before.

www.maximintegrated.com/MAX78000

Low Power Cortex M4 Micros



Large (3MB flash + 1MB SRAM) and small (256KB flash + 96KB SRAM, 1.6mm x 1.6mm) Cortex M4 microcontrollers enable algorithms and neural networks to run at wearable power levels.

www.maximintegrated.com/microcontrollers

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.

www.maximintegrated.com/sensors

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Latentai.com

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seeed studio

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sensiml.com

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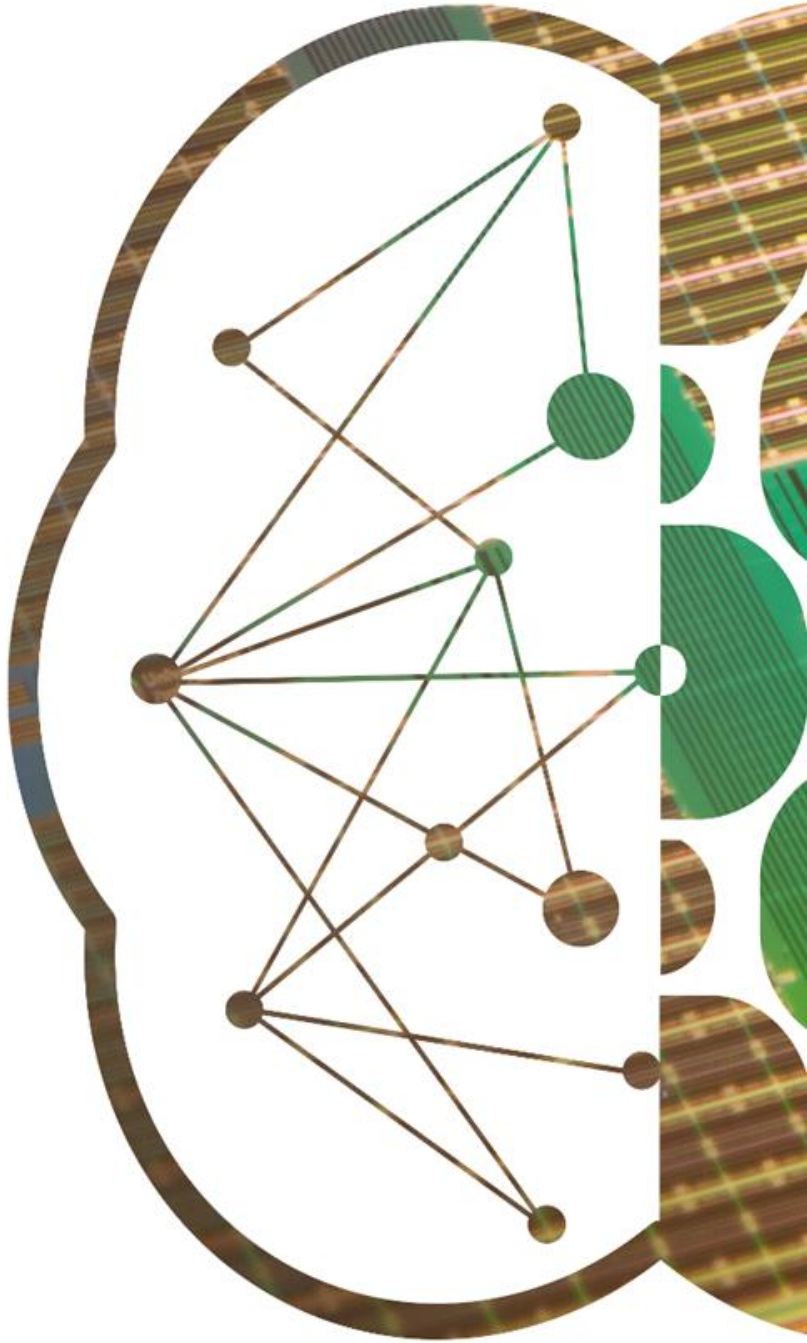
life.augmented

SynSense

SynSense builds **sensing and inference** hardware for **ultra-low-power** (sub-mW) **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



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Miniature dreams can come true…

March 28-30, 2022

Hyatt Regency San Francisco Airport

https://www.tinyml.org/event/summit-2022/

*The Best Product of the Year and the Best Innovation of the Year awards are open for nominations between **November 15 and March 14.***

tinyML Research Symposium 2022

March 28, 2022

https://www.tinyml.org/event/research-symposium-2022

More sponsorships are available: sponsorships@tinyML.org

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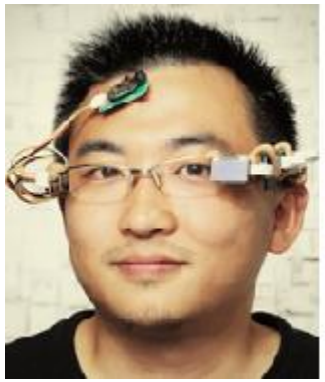
Our next tinyML Trailblazers Series

Success Stories with Eric Pan

(Founder, Seeed Studio and Chaihuo Makerspace)

LIVE ONLINE **April 6th, 2022 at 8 am PST**



TINY ML TRAILBLAZERS

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tinyML - Enabling ultra-low Power ML at the Edge

https://www.meetup.com/tinyML-Enabling-ultra-low-Power-ML-at-the-Edge/

2.7k members
&
5.7k followers

The tinyML Community

https://www.linkedin.com/groups/13694488/

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YouTube

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Next tinyML Talks

Date	Presenter	Topic / Title
Tuesday, April 5	Daniel Konegen, Embedded AI and data science engineer, Hahn-Schickard Marcus Rüb, Research assistant, Hahn-Schickard	AutoFlow - an open source Framework to automatically implement neural networks on embedded devices

Webcast start time is 9:30 am Pacific time

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

TINY ML TALKS webcast

Reminders

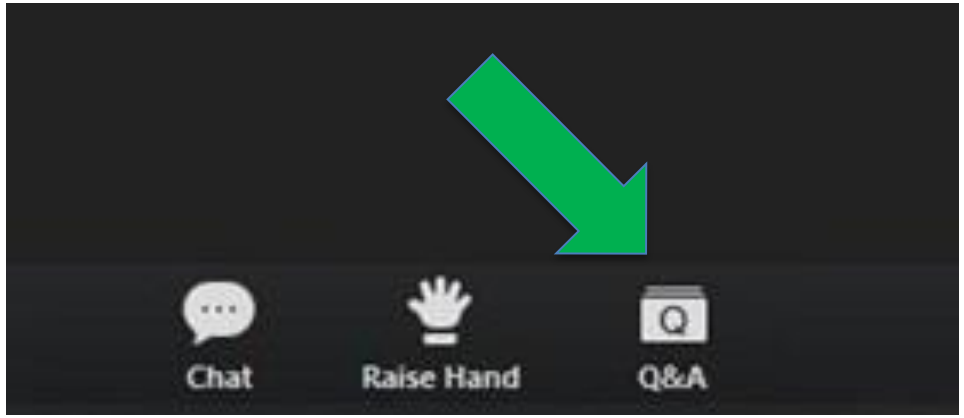
Slides & Videos will be posted tomorrow

PDF

tinyml.org/forums

youtube.com/tinyml

Please use the Q&A window for your questions



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Mithun Das

Mithun Das is a distinguished software engineer at Cox Automotive with 17 years of experience in software, ambassador at Edge Impulse & Balena. He obtained bachelors degree in “Information Technology” from IIEST, India. At Cox, innovation is in their culture which brought Mithun to the world IoT. For last 4-5 years, he has been working on IoT and ML for good. He has implemented many proof of concepts including low cost contact tracing, smart parking reducing carbon emission, saving peatlands using tinyML, smart collar for elephant, hearing substitution using haptic feedback are few of them.

TINY ML TALKS webcast

Sashrika Das

Sashrika Das is a 6th grade student at East Lyme Middle School in Connecticut, USA. She is passionate about Internet of Things and programming. She participates in virtual contests such as “The coolest project” , “do your:bit”. She has started learning tinyML recently with guidance from her parent, and created proof of concept of some of her ideas.

Gas Leak Detection

Solving real-life problem using tinyML

Why We Use Oil Tank?

- Used in boiler heating systems
- Stores diesel/propane fuel
- Used to heat up rooms and water
- Most common in older houses and apartments in Northeast of America

Cons of Using Oil Tank

- Regular maintenance required
- High repair cost
- Not monitored 24x7

Leakage from Tank

- Cracks or holes can form due to many reasons
- Unnoticed small leakage may become uncontrollable
- Posses health issues for human & pets
- May contaminate water supply
- Increase repair cost

How About Early Detection?

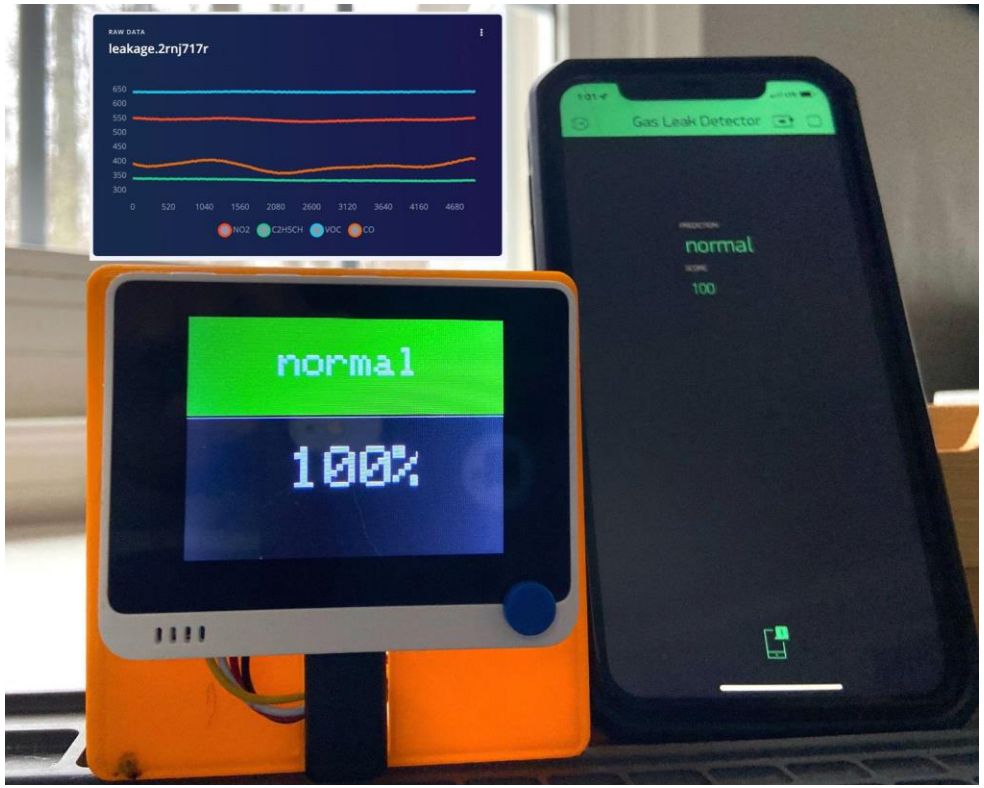
Early detection can help in :

- Reducing health issues
- Reduce risk of contamination
- Reduce repair cost

How Can We Detect?

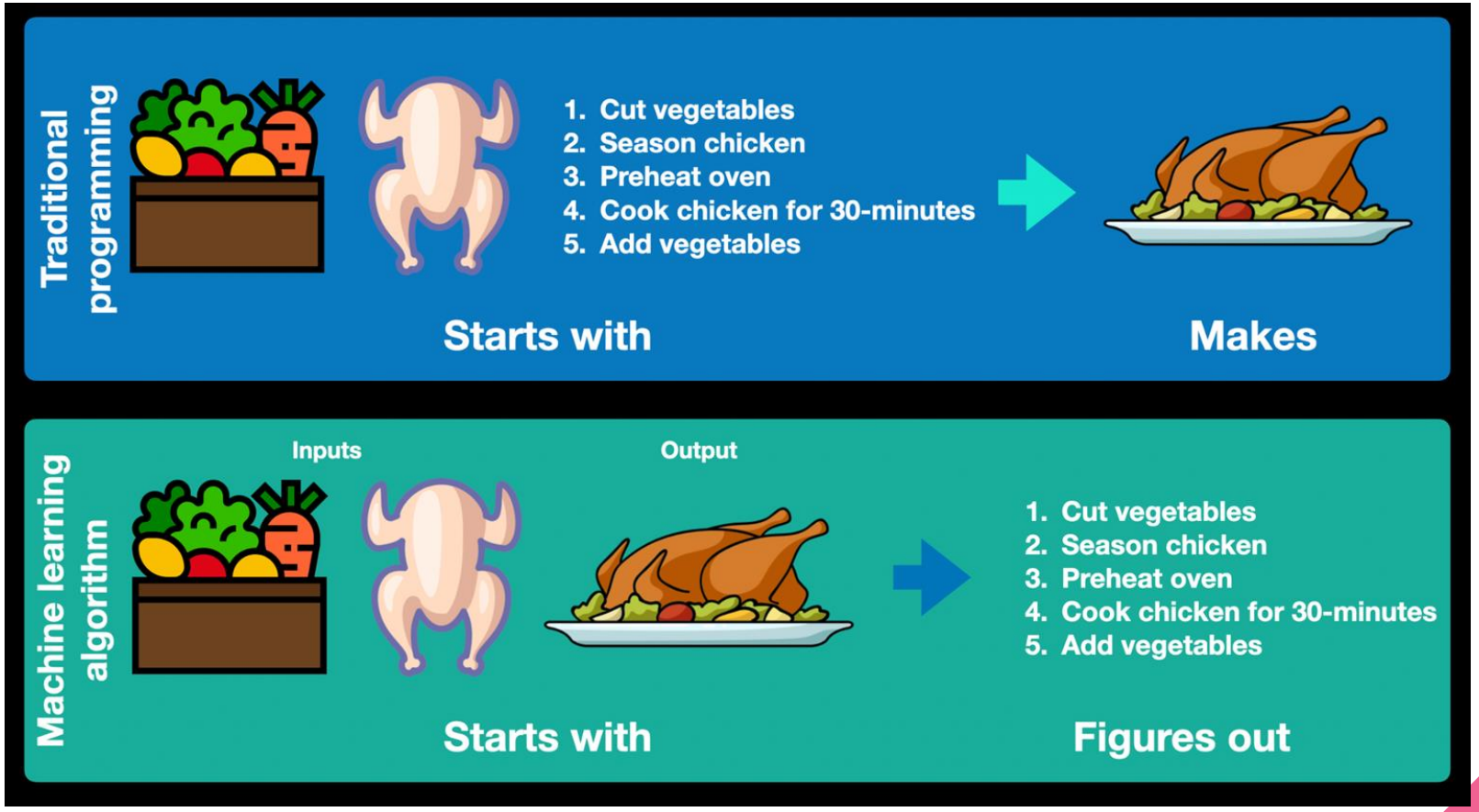
- Smell the air
- Identify if diesel or propane is in the air
- Send Text or Notification to mobile phone

Smart Oil Leak Detection



- Multichannel gas sensor collects data from air
- Microcontroller runs tinyML to classify data
- Microcontroller sends alert to Blynk when diesel is detected in the air

Why I chose ML over If-else



[Insert demo video here]

Hardwares

Seeed Wio Terminal

Grove Multichannel Gas Sensor

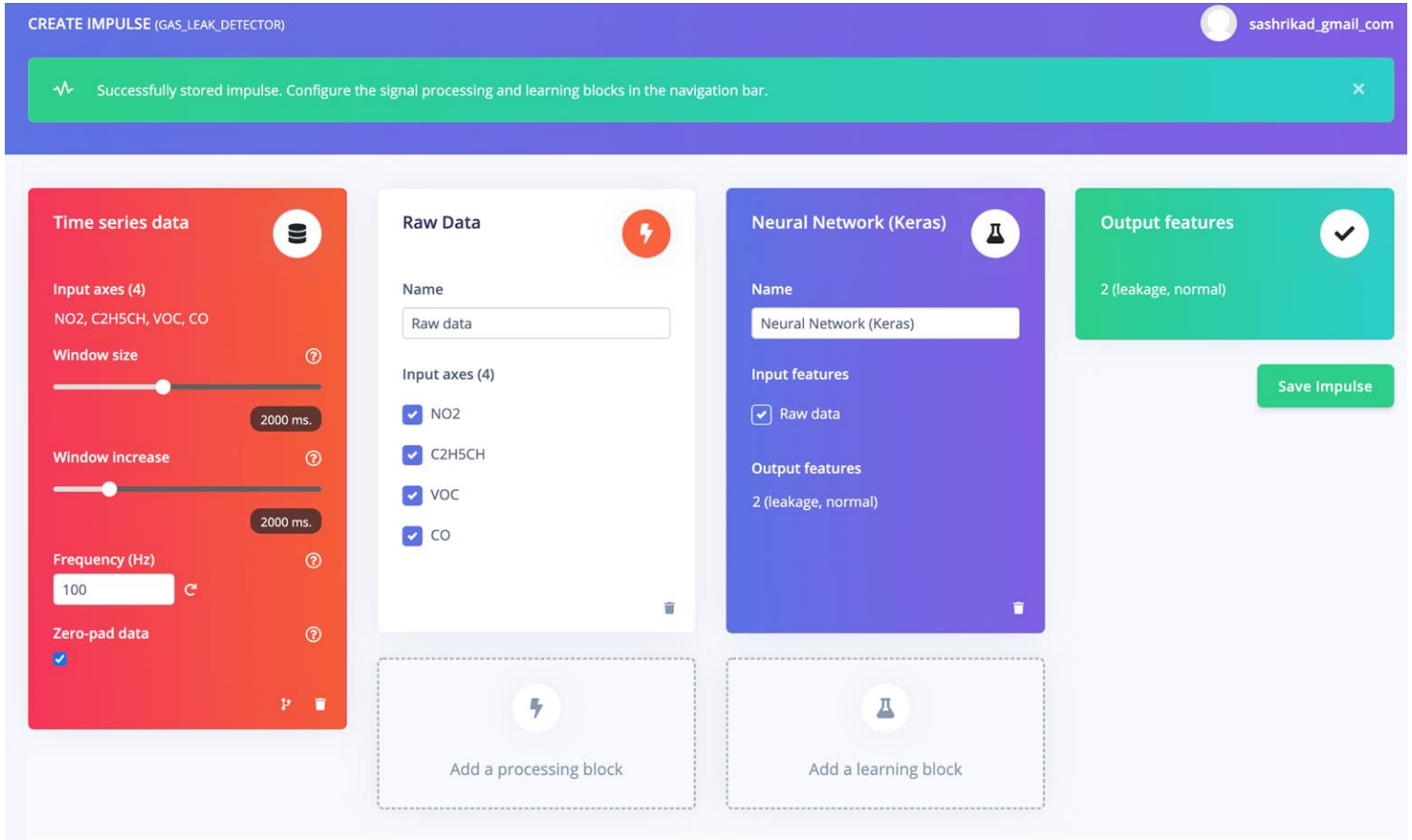
5V Mini Fan

3D printed case (optional)

Softwares

- Edge Impulse Studio
- Arduino IDE
- Blynk App

Building the model



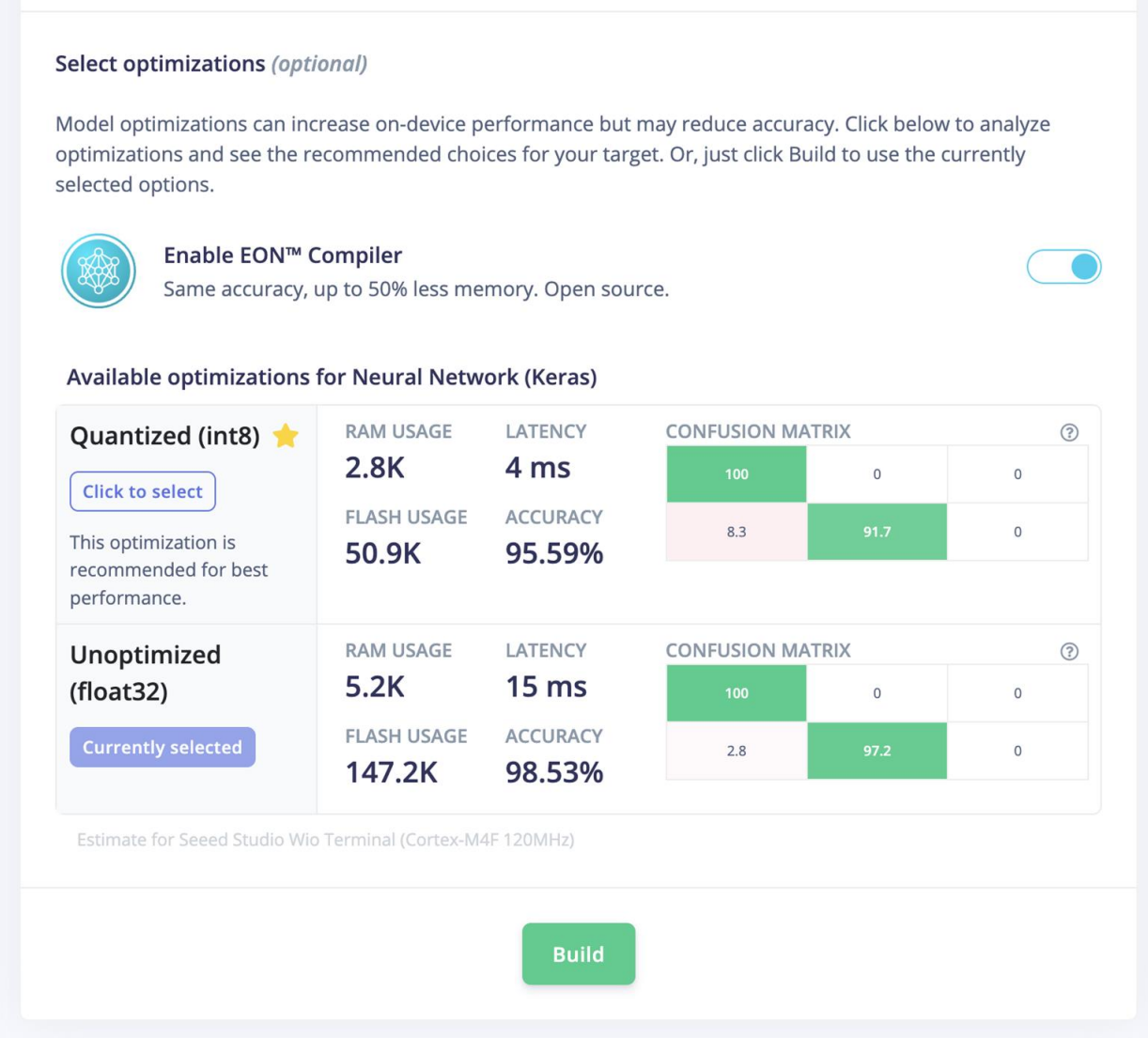
Data collection

Create Impulse

Define NN Architecture

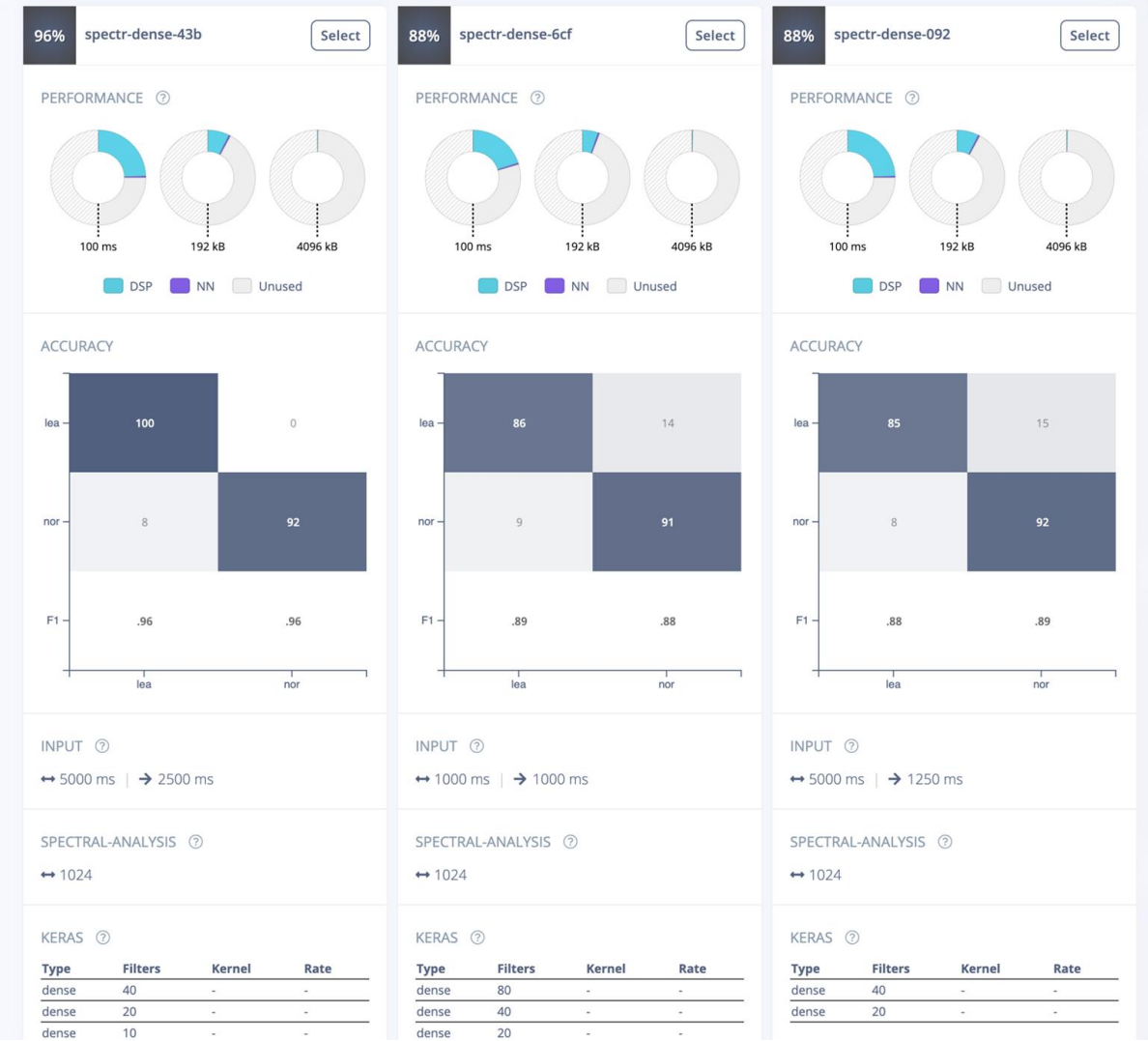
Train

Deploy TinyML on Wio Terminal



- Download the model as zip
- Import to Arduino IDE
- Upload the sketch

EON Tuner



- Raw processing had high accuracy during testing but suffered with live data
- Needed to improve the model
- EON tuner suggested Spectral analysis instead of Raw data
- Accuracy dropped during testing but performed much better with live data

Other Challenges

- Collecting wide variety of data
- Indoor vs outdoor prediction
- Initial misclassification due to other smells

Questions?

AI Thermal Camera for Safe Camping

Hardware:

- Wio Terminal
- Lorawan GPS chassis
- Batter Chassis

Software:

- Edge Impulse
- Arduino IDE
- Amazon Web Service
- Helium Console

Data Collection

```
You, 4 months ago | 1 author (You)
1   20.37,20.44,20.55,21.06,21.11,20.99,21.48,21.57,22.05,22.23,22.69,23.23,24.81,26.75,24.74,25.10,25.88,23.68,22.19,22.14,21.82,21.48,21.34,21.10,21.18,21
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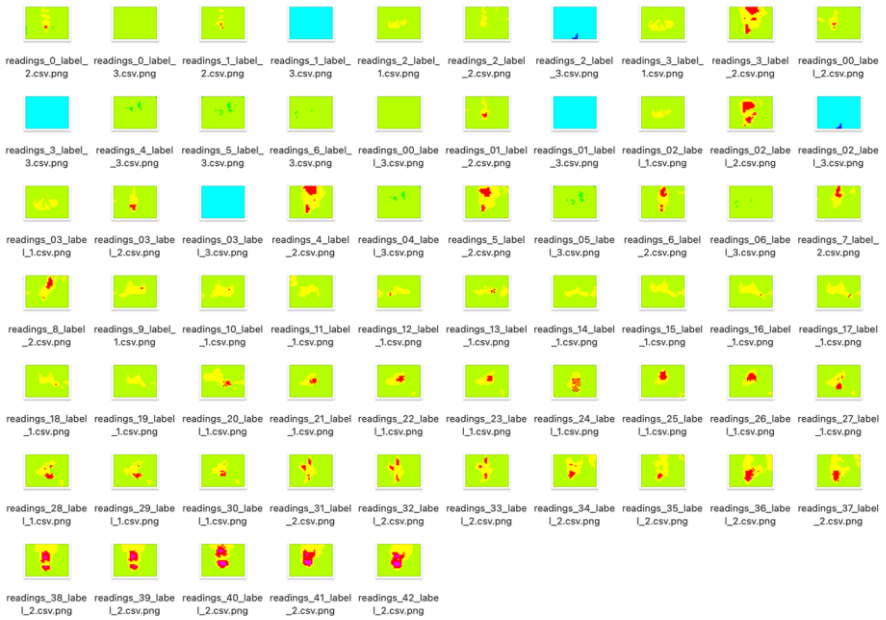
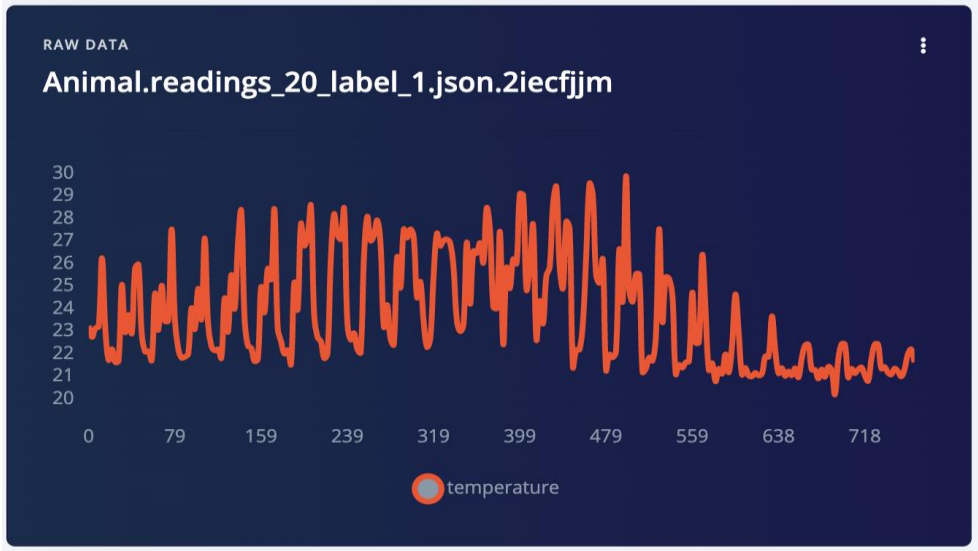
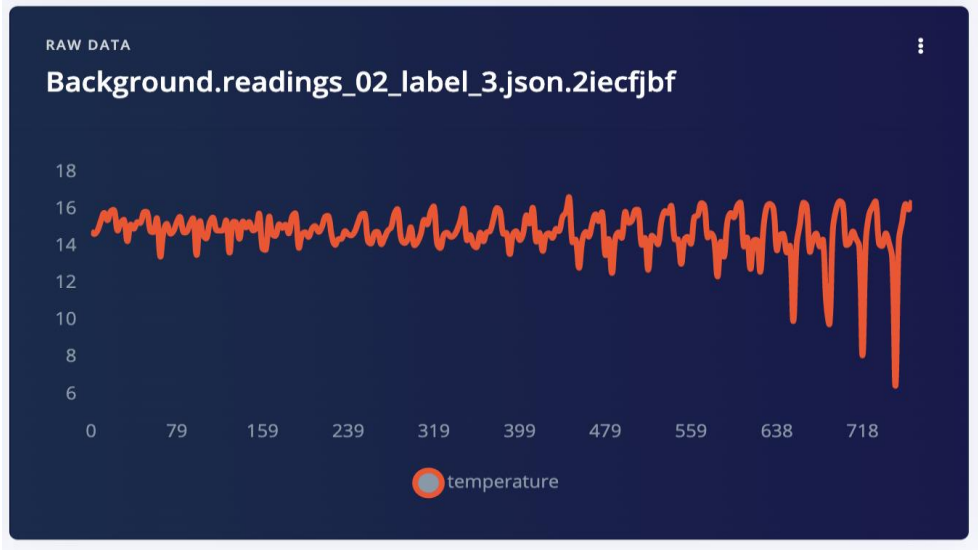


- Data collected as CSV
- CSV converted to JSON and signed by HMAC key
- Data forwarded to Edge Impulse using CLI command

https://www.hackster.io/mithun-das/ai-powered-thermal-camera-for-safe-camping-8fc887
https://www.hackster.io/mithun-das/ai-thermal-camera-for-safe-camping-seeed-helium-aws-v2-c0d28b

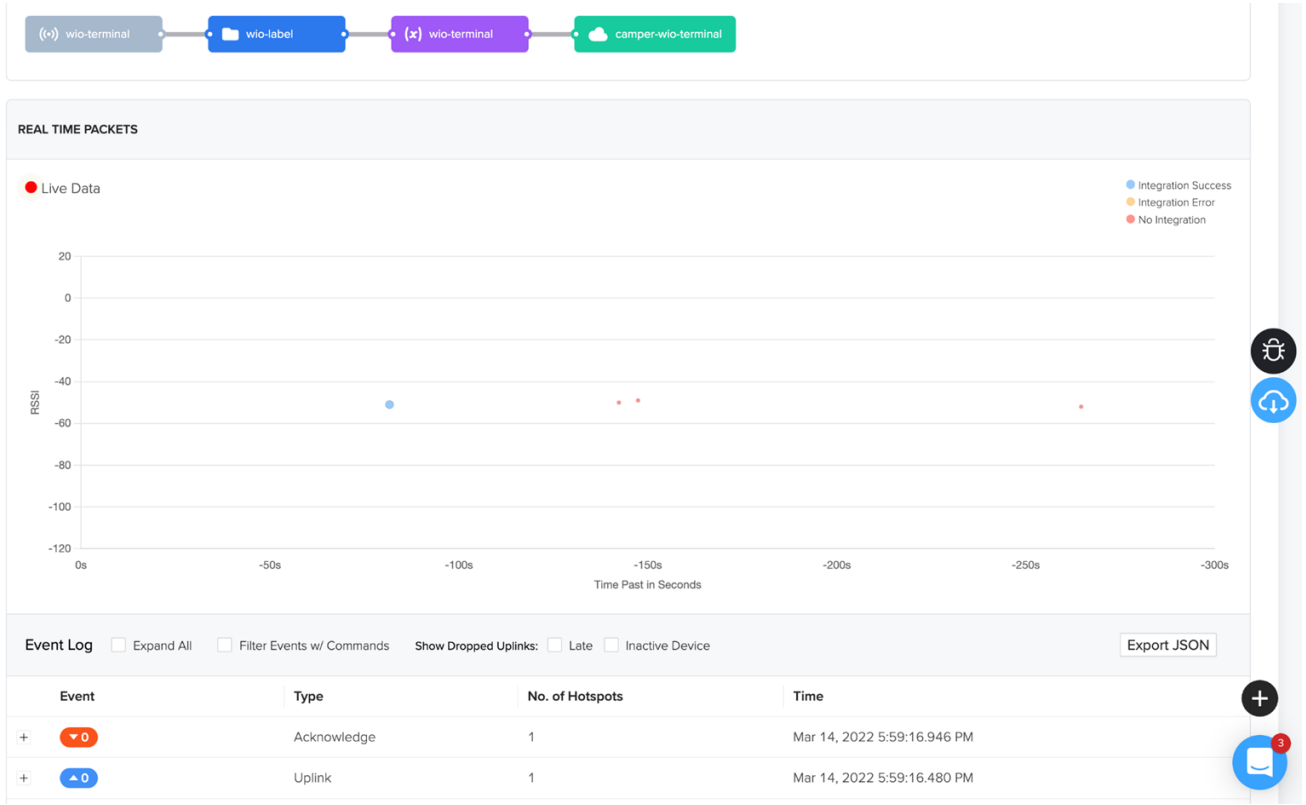
Continued…





- The IR thermal camera carries a 32x24 array of sensor value
- Data represented as 768 (32x24) discrete time series data

Integration with Helium & AWS



- Add device to helium console
- Add AWS integration
- Create AWS IoT rule
- Create lambda trigger to send message via telegram

Questions?

https://www.hackster.io/mithun-das

https://twitter.com/tweetmithund

https://www.linkedin.com/in/connectmithundas/

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