

tinyML® Talks

Enabling Ultra-low Power Machine Learning at the Edge

“Buttonless Remote Control - Reproduce on your device”

Blair Newman – CTO, Neuton.AI

Danil Zherebtsov – Head of Machine Learning & Analytics, Neuton.AI

Tamas Daranyi – Platform Product Management, Silicon Labs

October 10, 2023



www.tinyML.org



Thank you, **tinyML Strategic Partners**,
for committing to take tinyML to the next Level, together



T I N Y



TALKS
webcast

Executive Strategic Partners

Qualcomm
AI research

Advancing AI research to make efficient AI ubiquitous

Power efficiency

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

Personalization

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

Efficient learning

Robust learning through minimal data, unsupervised learning, on-device learning

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



Accelerate Your Edge Compute

SYNTIANT

Making Edge AI A Reality

www.syntiant.com

T I N Y



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Platinum Strategic Partner



**DEPLOY VISION AI
AT THE EDGE AT SCALE**

SONY



Gold Strategic Partners



AHEAD OF WHAT'S POSSIBLE™



AHEAD OF WHAT'S POSSIBLE™

Where what if
becomes what is.

Witness potential made possible at analog.com.

Build the
Future of tinyML

on **arm**



T I N Y



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EDGE IMPULSE

The Leading Development Platform for Edge ML

edgeimpulse.com

Decarbonization

Digitalization



Driving decarbonization and digitalization. Together.

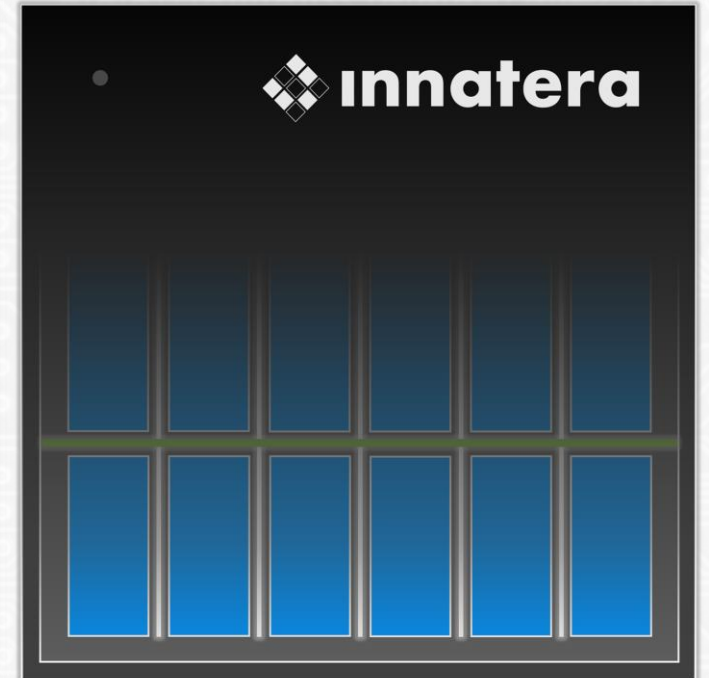
Infineon serving all target markets as
Leader in Power Systems and IoT

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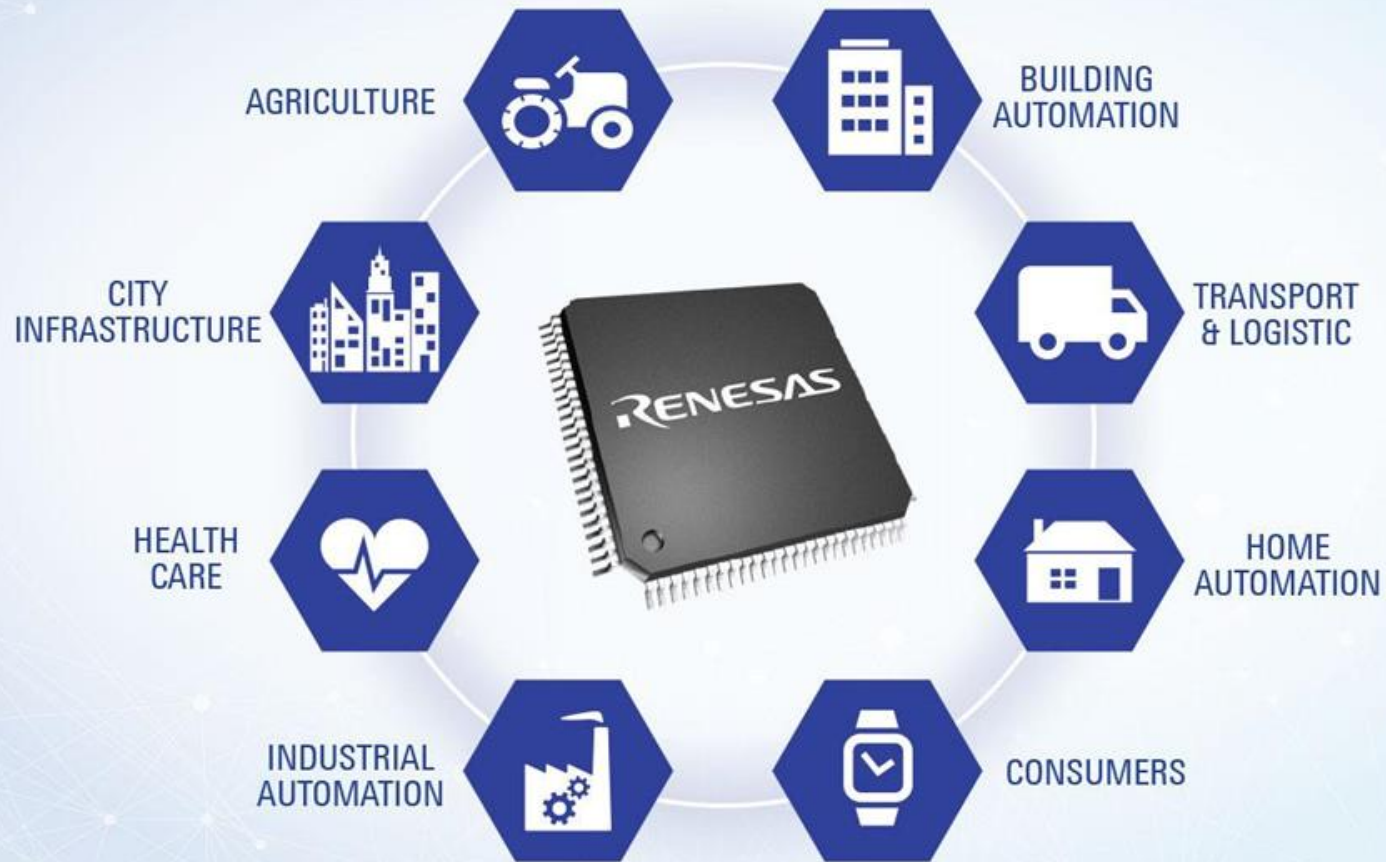


NEUROMORPHIC INTELLIGENCE FOR THE SENSOR-EDGE



www.innatera.com

Renesas is enabling the next generation of AI-powered solutions that will revolutionize every industry sector.



[renesas.com](https://www.renesas.com)



life.augmented

STMicroelectronics provides extensive solutions to make tiny Machine Learning easy

www.st.com/ai



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Silver Strategic Partners



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GREENWAVES
TECHNOLOGIES



£ Grovety Inc.



NotaAI





Join Growing tinyML Communities:



17k members in
49 Groups in 41 Countries

tinyML - Enabling ultra-low Power ML at the Edge

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



4k members
&
13k followers

The tinyML Community

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





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4.33K subscribers

10.6k subscribers, 629 videos with 384k views

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122 views · 4 days ago	262 views · 2 weeks ago	511 views · 3 weeks ago	229 views · 3 weeks ago	265 views · 3 weeks ago	286 views · 1 month ago
351 views · 1 month ago	462 views · 2 months ago	374 views · 2 months ago	133 views · 2 months ago	287 views · 2 months ago	336 views · 2 months ago
378 views · 2 months ago	214 views · 2 months ago	448 views · 2 months ago	159 views · 2 months ago	190 views · 2 months ago	545 views · 2 months ago



tinyML Asia Technical Forum

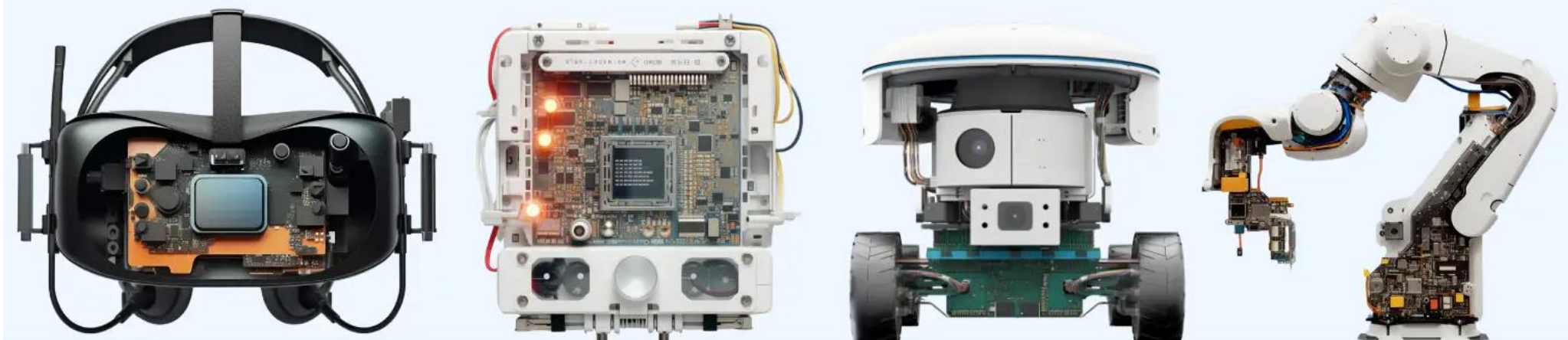
**November 16, 2023
Seoul, South Korea**



Register now
<https://www.tinyml.org/event/asia-2023/>

2023 Edge AI Technology Report

The guide to understanding the state of the art in hardware & software in Edge AI.



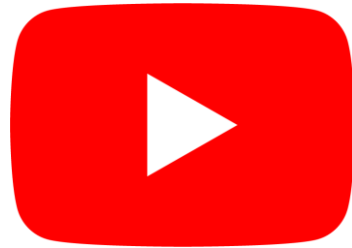


Reminders

Slides & Videos will be posted tomorrow



tinyml.org/forums



youtube.com/tinyml



Please use the Q&A window for your questions





Blair Newman



With strong tech expertise and 20+ years of leadership experience, Blair Newman provides unprecedented insights into the future of AI's development and use. As Neuton's CTO, Blair is engaged in overseeing our business solutions as well as ensuring high-quality services are delivered to our clients. Prior to Neuton, Blair held various leadership roles at T-Systems North America, a Division of Deutsche Telekom, being responsible for providing strategic direction and leadership in the areas of Dynamic Services (Cloud Computing), SAP Hosting, Application Operations, Managed Hosting and Infrastructure Services.



Danil Zherebtsov



Full-stack machine learning engineer with over 8 years of experience in the field. Before joining the Neuton team in 2018, he executed various end-to-end complex machine learning projects in multiple domains: telecom, networking, retail, manufacturing, marketing, fraud detection, oil and gas, engineering, and NLP. As a head of Machine Learning & Analytics at Neuton, Danil is working on the development of an automated TinyML platform facilitating sensor and audio data processing. Danil is an active contributor to the open-source community, with over 300,000 active users of tools featured in his repository. As an inspired writer, Danil publishes articles popularizing data science and introducing new methodologies for solving engineering tasks.



Tamas Daranyi



Tamas Daranyi, Product Manager, responsible for driving AI/ML initiatives at Silicon Labs. He holds an MSc, Electrical Engineering. He has working experience in various IoT focused projects in the past 10+ years ranging from the IoT end-node up to cloud service product development. Prior to Silicon Labs he had engineering and product management roles at GE, LogMeIn (Xively IoT) and Google Cloud IoT, CloudAI.

Buttonless Remote Control – Reproduce on your device



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CTO
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Head of Machine Learning & Analytics
Neuton.AI



Tamas Daranyi
Platform Product Management
Silicon Labs



Neutron **Tiny ML**

On-device AI features for IOT





Patented & Unique
Neural Network
Framework



No-code Tiny
AutoML Platform



Native embedding into
8-bit/
16-bit/
32-bit MCUs



End-to-end of Machine Learning
based services from data collection
to production deployment

Automatically build extremely
tiny models with minimal size
and without loss of accuracy

10 x's smaller
in comparison to other products

Recognition of dozens of gestures



Swipe Right



Double Tap



Rotation
Clockwise



Pinch



Double pinch



Swipe Left



Double Thumb



Rotation
Counter
Clockwise



Clench



Double clench

**for gesture-based interaction
for various devices**



Smart TV



Smart watch



Air conditioner

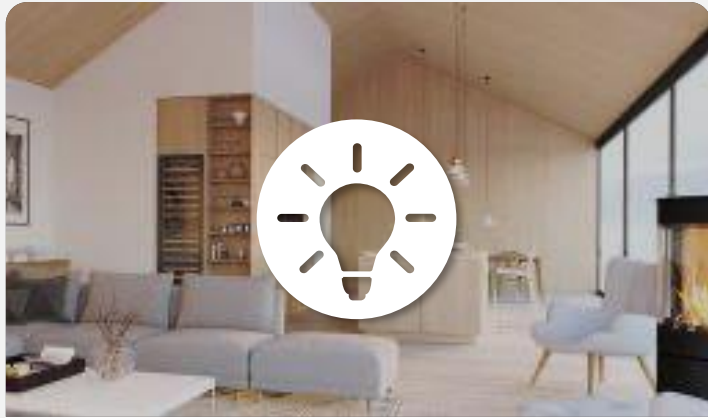


Smart rings



Smart speakers

Silicon Labs is the Market Leader in IoT



#1 provider of Smart Home IoT wireless software and silicon solutions

Unmatched breadth and depth of IoT wireless technologies

IOT LEADERSHIP



Industry Collaborations



Our product portfolio allows deployments across any device type and application

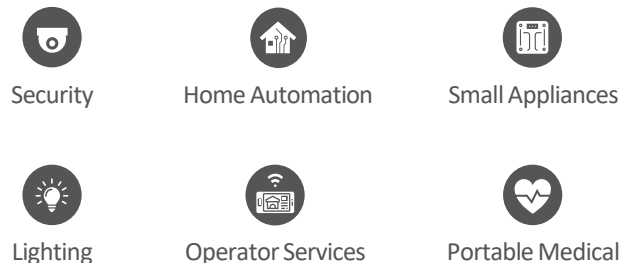


1000's of Applications



10,000's of Customers

WIRELESS PRODUCT SOLUTIONS



Silicon Labs wireless platform works with any smart home ecosystem

Actively engaged with all ecosystems helping end-device and gateway partners to market

WORKS WITH ANY ECOSYSTEM



Satisfying trends drives many applications with common care abouts



Affordable, Long-Lasting Products

Add value, are unobtrusive and economical
Optimized system and development cost
Increased battery life

Trust

Privacy protection
Brand reputation

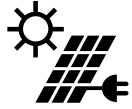
Wireless That Just Works

Connects and stays connected
Expert in adding value, not only RF

Easy Setup and Integration

Interoperability
Increased sales, reduced confusion
On-device processing

Industrial & Commercial Applications are Broad, Varied, & Durable



Energy Conversion



Smart Metering



Industrial Wearables



**Medical Asset &
Patient Monitoring**



Electric Vehicle SE



Street Lighting



Smart Buildings



Asset Tracking



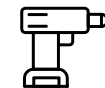
Agriculture



**Municipal
Infrastructure**



Predictive Maintenance



**Tools &
Diagnostics**

AI/ML on Silicon Labs' Wireless SoCs

EFR32 Series 2 and Wi-Fi SoCs

Higher Performance Platform

- ARM Cortex M4/M33
- Improved radio performance
- Lower power (MCU active, TX/RX)

Improved Security

- Secure Vault - Mid
- Secure Vault - High (select OPNs)

Acceleration - MVP





- AI/ML acceleration
- Faster AoA/AoD calculation
- Math library (matrix and vector ops)

AI Software

- Native support of TFLM (CMSIS and accelerated kernels)
- 3rd Party end-to-end toolchains (e.g NeutonAI platform)

All Series 2 SoCs support ML

- New: EFR32FG28 prop. radio platform

EFR32xG24	SiWx917
 	 
78MHz CortexM33 AI/ML accelerator 1.5MB / 256kB 2.4 GHz radio 20 dBm TX Power Secure Vault Low power	180MHz CortexM4 160 MHz NWP AI/ML accelerator Up to 8MB / 672kB 2.4 GHz radio 21 dBm TX Power PSA L2 Security Low power

xG24-DK2601B Developer kit

Broad Range of Sensors

- Based on EFR32MG24B310F1536IM48 2.4 GHz Wireless SoC
- 9-axis Inertial Sensor
- 2 Digital Microphones
- Pressure Sensor
- Relative Humidity and Temperature Sensor (Si7021)
- UV and Ambient Light Sensor
- Hall-effect Sensor
- CR2032 coin cell battery

Ready to demonstrate ML

- Sample applications in GSDK
- Examples on GitHub
- Examples and tutorials in MLTK
- Many sample applications and demos from solution partners (e.g. NeutonAI)
- Plug&Play Sensor extensions with Sparkfun Qwiic connector



Common Machine Learning Software and Tools on our Wireless SoC portfolio

Use cases are dependent on RAM and wireless stack



Neuton.AI & Silicon Labs in Action

Buttonless Remote Control

Tiniest Gesture Recognition Model

- 8 classes of gestures:



Swipe Right



Double Tap



Rotation
Clockwise



IDLE - no
gestures



Swipe Left



Double
Thumb

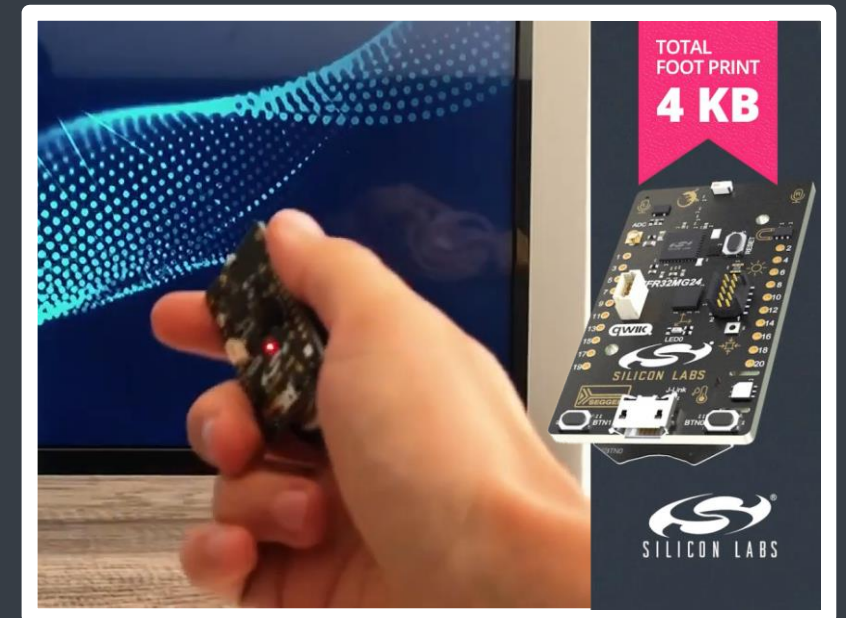


Rotation
Counter
Clockwise



Unknown
gestres

- Model Accuracy - 98,8%, 147 Weights
- Inference Time - 2.3 ms
- Total footprint - 4.2 Kb of Flash, 1.4 Kb of SRAM



<https://github.com/Neuton-tinyML/neuton-silabs-xg24-ble-remotecontrol>

Neuton's use of xG24(EFR32MG24) resources

FLASH 1536 kB	SRAM 256 kB	CPU Usage in 1 sec period
<1 %	<1 %	<1 %

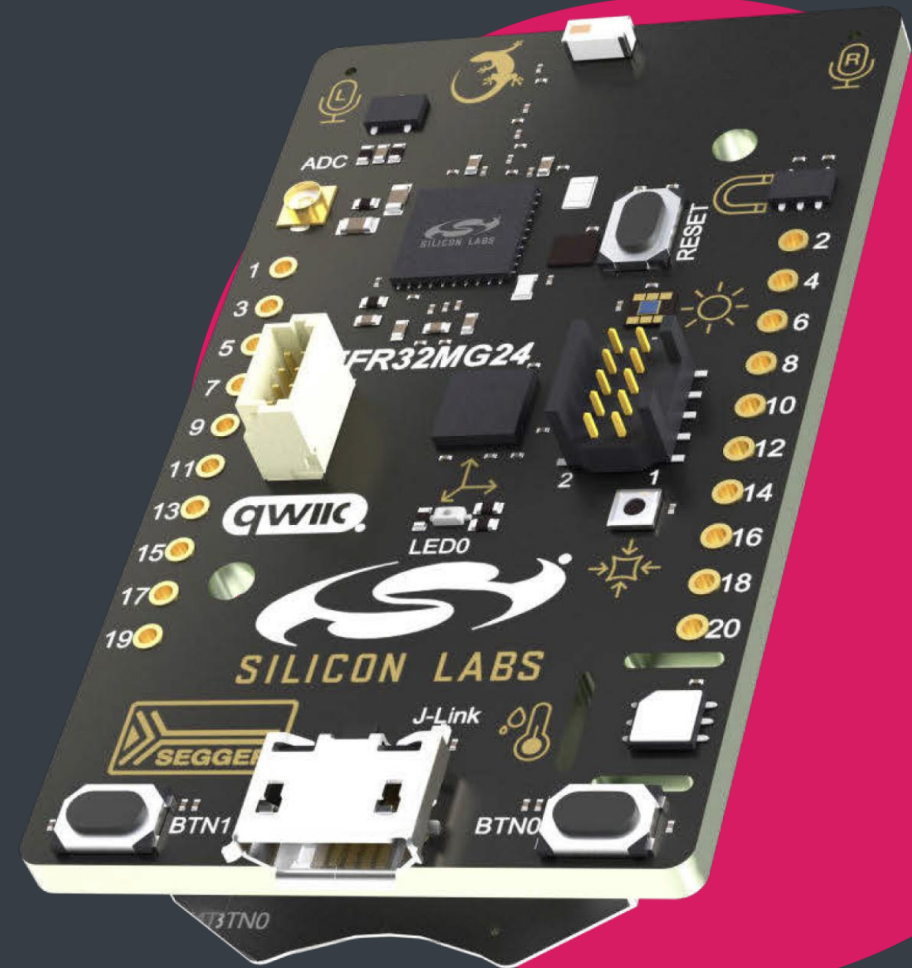
Reproduce on your device



Step by step description and ready to use project for **xG24(EFR32MG24)**

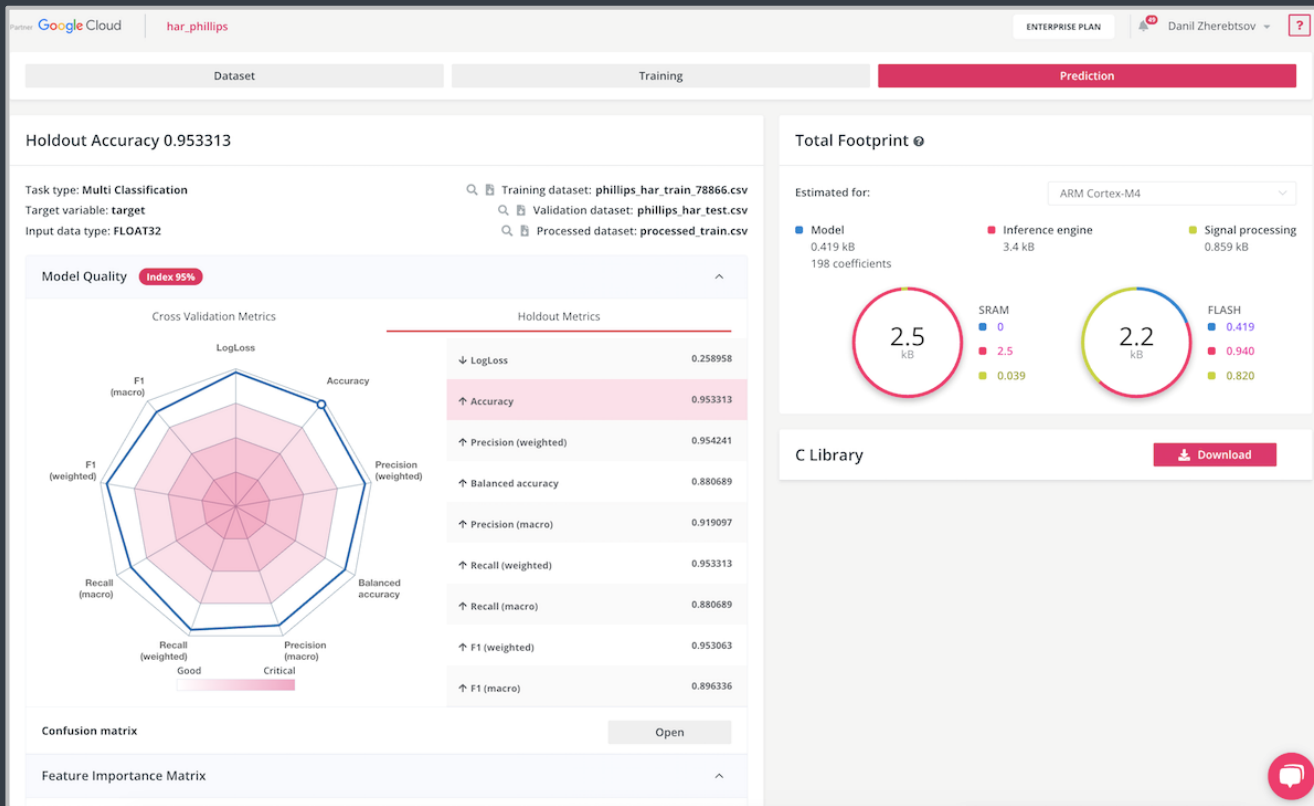


<https://github.com/Neuton-tinyML/neuton-silabs-xg24-ble-remotecontrol>



Neutron Tiny ML Platform

Automatically build extremely tiny models and embed them into any microcontroller and sensors



No-Code SaaS Solution

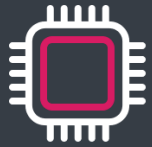


No Data Science experience required



Fully automated pipeline

Benefits of Neutron's approach



Ultra-small models for recognizing the actions, gestures, states, and human vital signs



The most energy-efficient solutions by embedding models into sensors to extend device battery life



Complete TinyML solutions with the smallest footprint, which leaves more room for business logic

On device AI features with incredibly small footprint



gesture
recognition



vital sign
determination



human-machine
Interface



human activity
recognition



machine fault
classification



asset tracking and
monitoring



Thank you!



Blair Newman
CTO
Neuton.AI



Danil Zherebtsov
Head of Machine
Learning & Analytics
Neuton.AI



Tamas Daranyi
Platform Product
Management
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Blair Newman

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