Enabling Ultra-low Power Machine Learning at the Edge

“Enabling Low Power ML at the Edge-tinyML Shenzhen Kick-off Networking Meetup”

微型机器学习分享会小组深圳首聚

Chaihuo x.factory, B622, Design Commune, Vanke Cloud City,
Dashi 2nd Road, Nanshan District, Shenzhen

January 21, 2022
tinyML Talks Strategic Partners

Additional Sponsorships available – contact Olga@tinyML.org for info
Executive Strategic Partners
Arm: The Software and Hardware Foundation for tinyML

1. Connect to high-level frameworks
   - Profiling and debugging tooling such as Arm Keil MDK

2. Supported by end-to-end tooling
   - Optimized models for embedded
     - Runtime (e.g. TensorFlow Lite Micro)

3. Connect to Runtime
   - Optimized low-level NN libraries (i.e. CMSIS-NN)
   - RTOS such as Mbed OS
   - Arm Cortex-M CPUs and microNPUs

AI Ecosystem Partners

Stay Connected

@ArmSoftwareDevelopers
@ArmSoftwareDev

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

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Dataset

Device

The leading edge ML platform

www.edgeimpulse.com

Impulse

Test

www.edgeimpulse.com
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

Perception
- Object detection, speech recognition, contextual fusion

Reasoning
- Scene understanding, language understanding, behavior prediction

Action
- Reinforcement learning for decision making

A platform to scale AI across the industry

Qualcomm AI Research is an initiative of Qualcomm Technologies, Inc.
Syntiant

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

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

partners@syntiant.com
www.syntiant.com
Platinum Strategic Partners
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
Add Advanced Sensing to your Product with Edge AI / TinyML

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

Reality AI solutions
- Prebuilt sound recognition models for indoor and outdoor use cases
- Solution for industrial anomaly detection
- Pre-built automotive solution that lets cars "see with sound"

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

https://reality.ai  info@reality.ai  @SensorAI  Reality AI
# Broad and Scalable Edge Computing Portfolio

## Microcontrollers & Microprocessors

<table>
<thead>
<tr>
<th>Core</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Arm® Core** | Arm® Cortex®-M 32-bit MCUs  
Arm ecosystem, Advanced security, Intelligent IoT  
Arm®-based High-end 32 & 64-bit MPUs  
High-resolution HMI, Industrial network & real-time control  
Arm® Cortex®-M0+ Ultra-low Power 32-bit MCUs  
Innovative process tech (SOTB), Energy harvesting |
| **Renesas Core** | Ultra-low Energy 8 & 16-bit MCUs  
Bluetooth® Low Energy, SubGHz, LoRa®-based Solutions  
High Power Efficiently 32-bit MCUs  
Motor control, Capacitive touch, Functional safety, GUI  
40nm/28nm process Automotive 32-bit MCUs  
Rich functional safety and embedded security features |

### Renesas Synergy™
- Arm®-based 32-bit MCUs for Qualified Platform  
- Qualified software and tools

### Core technologies

#### 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

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Gold Strategic Partners
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
LatentAI

Adaptive AI for the Intelligent Edge

Latentai.com
Build Smart IoT Sensor Devices From Data

SensiML pioneered TinyML software tools that auto generate AI code for the intelligent edge.

- End-to-end AI workflow
- Multi-user auto-labeling of time-series data
- Code transparency and customization at each step in the pipeline

We enable the creation of production-grade smart sensor devices.

sensiml.com
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
The Best Product of the Year and the Best Innovation of the Year awards are open for nominations between **November 15** and **February 28**.

More sponsorships are available: [sponsorships@tinyML.org](mailto:sponsorships@tinyML.org)
tinyML Trailblazers Series
Success Stories with Joel Rubino
(CEO & Co-founder of Cartesiam)

LIVE ONLINE February 2nd, 2022 at 8 am PST

Register now!
Join Growing tinyML Communities:

- tinyML - Enabling ultra-low Power ML at the Edge

- The tinyML Community
  https://www.linkedin.com/groups/13694488/

7.8k members in 42 Groups in 33 Countries

2.5k members & 4.4k followers
Subscribe to tinyML YouTube Channel for updates and notifications (including this video)

www.youtube.com/tinyML
活动流程 Event Schedule

- 19:00-19:30 签到 Check-in
- 19:30-19:40 开场 Soft Opening by Eric Pan
- 19:40-20:10 破冰环节 Ice Breaking with Self Introductions
- 20:10-20:30 冯磊：TinyML主题分享《让TinyML变得更加简单》
  “How to Make TinyML Easier” Talk by Lei Feng
- 20:30-21:00 开放讨论 Open Discussions & Mingle
- 21:00 -21:05 大合照Group Photo
破冰环节
Ice breaking with self introductions

- 姓名Name
- 公司Company
- 个人背景简介Personal Background
- 其他你想分享的内容Others Things that you would love to share
TinyML主题分享《让 TinyML变得更加简单》
“How to Make TinyML Easier” Talk

冯磊 Lei Feng
Seeed Studio 机器学习应用与技术支持负责人
让 TinyML 更加简单
降低『嵌入式机器学习』门槛的努力
大纲

- TinyML应用的门槛
- 小目标：无编程和机器学习经验也能快速上手 TinyML
- 一些有趣的收获
- 共同探索未知领域
TinyML应用的门槛
嵌入式机器学习工程化流程

1. 确定目标
2. 收集数据集
3. 设计模型架构
4. 训练模型
5. 评估模型性能
6. 获得设备可用算法
7. 算法应用

硬件设备编程能力
机器学习编程能力
硬件设备编程能力
有木有不那么难的 TinyML 应用解决方案？
EDGE IMPULSE

DEVELOPMENT BOARDS
Overview
ST B-L475E-IOT01A
Arduino Nano 33 BLE Sense
Arduino Portenta H7 + Vision shield
OpenMV Cam H7 Plus
Himax We-1 Plus
Nordic Semi nRF52840 DK
Nordic Semi nRF52840 DK
Nordic Semi nRF9160 DK
Nordic Semi Thingy91
Silabs Thunderboard Sense 2
Sony’s Sgresense
Syntiant TinyML Board
TI CC1352P Launchpad
Eta Compute ECM3532 AI Sensor
Eta Compute ECM3532 AI Vision
Raspberry Pi 4
NVIDIA Jetson Nano
Intel-based Macs
Linux x86_64
Mobile phone
Porting guide

COMMUNITY BOARDS
Seeed WiO Terminal
Agora Product Development Kit
Arduino Picoml TinyML Dev Kit
Blues Wireless Swan

EDGE IMPULSE

Model
Last training performance
ACCURACY 97.8%
LOSS 0.09

Confusion matrix

Feature explorer

On-device performance
859 ms.
297.0K
577.6K
1. 确定目标
2. 收集数据集
3. 设计模型架构
4. 训练模型
5. 评估模型性能
6. 获得设备可用算法
7. 算法应用编程与部署
80% of your images are predicted correctly, 20% incorrectly.
TinyML
无编程和机器学习经验也能快速上手
“"I have a dream"
WoTerminal

ARM Cortex-M4F core running at 120 MHz (Boost up to 200 MHz)
4 MB External Flash, 192 KB RAM
WI-FI, BT
LCD screen

板载加速度计，麦克风，蜂鸣器，microSD卡槽，光传感器和红外发射器
MicroSD Card Slot, 5-Way Switch, Programmable Buttons
Grove接口
Raspberry Pi 40-pin Compatible GPIO
Codecraft
赋予硬件灵魂的图形化编程工具

EDGE IMPULSE
4个月后.....
小白的 TinyML 现场体验活动
人工鼻子

硬件组装  数据采集  模型训练  部署和使用
单个 TOF 传感器
实现手写识别
图形化编程之嵌入式机器学习入门——用Wio Terminal玩转TinyML

Hello World of AI

WIO TERMINAL

Hello World of AI

Seeed Studio于2021年打造了一个企划：Hello World of AI，在这个企划上介绍了诸多Seeed编程工具（codecraft）之嵌入式机器学习（TinyML），并展示了如何用Wio Terminal进行嵌入式机器学习的程序。TinkerGen（由Seeed公司开发的编程）和Seeed Studio的数字化产品能够很好地为TinyML编程。在2021年7月，Seeed Studio宣布推出了Wio Terminal和TinyML工具，并在GitHub上开源了TinyML。为了能够更轻松地用在嵌入式机器学习的程序开发中，我们进一步在GitHub上开源了整个程序。
Seeed Studio 的 TinyML 图形编程平台“Codecraft”入围 2022 年 BETT 奖
才刚刚开始

Just started.
Some tinyML topics for open discussions

- ML vs tinyML
- 微型机器学习 vs 嵌入式机器学习？
- 你的 tinyML 的初识和渊源？
- tinyML 有哪些局限？
- tinyML 深圳系列活动：
  - 1）线上 vs 线下？
  - 2）最想获得什么？
Join Growing tinyML Communities
欢迎加入全球tinyML在线社区:

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

7.7k members in
43 Groups in 33 Countries
33个国家43个小组
7700+活跃成员
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