Create IoT Edge AI Code for 32-bit Down to 8-Bit MCUs
TinyML Asia Conference 2021

Chris Rogers, CEO/Founder SensiML
November 3, 2021
AutoML Meets TinyML

No Data Science Required

Expertise

ML Programming & Data Science

Cloud Compute

AutoML

Cloud AI Frameworks

TensorFlow

PC Clients

TinyML

Edge AI

TensorFlow Lite

Hardware

Gateway / Edge Server

32-bit Microcontrollers

8/16-bit MCUs

Microchip PIC / SAM / AVR

Industry First: ML for 16-bit and 8-bit MCUs
Problems with Cloud Processing for IoT Applications

“Dumb” IoT Sensor

IoT Sensor Device (ex. Smart Home Security Sensor)

Network Congestion / Bandwidth
Wireless Power Consumption
Data Security / Privacy
Network Failure / Outages
Round Trip Latency
Benefits from ML Processing at the IoT Edge

- Network Conveys Only Events
- Less RF TX, Longer Battery Life
- Sensor Data Stays Local
- Network Independent Insight
- Local Processing Speed

IoT Sensor Device (ex. Smart Home Security Sensor)
ML at the IoT Edge: From Mere Sensor to Smart Device

Physical Sensors

- Sound
- Motion
- Vibration
- Pressure
- Current

IoT Edge ML

Signal Processing + Machine Learning Classification

Meaningful Event Detection

Copyright © 2021 SensiML Corporation. All rights reserved.
AutoML: Making ML Technology Easier to Implement

ML the Hard Way

ML Made Simple and Efficient

Tools that use machine learning to create machine learning models in turn
Using AutoML IoT Edge Tools

A Mind Shift From Explicit Coding to Training by Example
Rapid Data-Driven Modeling and Code Generation

- Raw Signal Capture
- Data Insight Labeling
- Algorithm Generation
- Firmware Code Generation
- Test, Validation, and Support

Data Capture Lab
Analytics Studio
Test App
The Key to AutoML Success: Well-Labeled Datasets

- Predictive models nearly always use ‘train-by-example’ supervised ML
- Example data combined with ground truth labels
- Most common ML failure: Poorly Constructed Datasets
- Garbage In = Garbage Out

So Why Is So Little Attention Spent Improving Dataset Labeling?
SensiML Brings ML Ops to TinyML Data Engineering

Data Capture Lab Application

- Multi-User Collaboration
- Metadata Annotation
- Data Labeling
- Video Annotation
- Session and Versioning Management
- Auto Segmentation and Triggering
The SensiML Difference

Ultra-Compact ML Code Down to 8-bit MCUs
SensiML Edge AI Scalability

Example: Microchip Technology Platforms

Map Sensors

Label Data

Data Capture Lab

Analytics Studio

Build Model

Knowledge Pack
• Ready-to-run Binary
• Linkable Library
• Full Source

Generate Code and Test

32-bit
SAMD21

16-bit
PIC24F

8-bit
AVR-DA

Copyright © 2021 SensiML Corporation. All rights reserved.
Application Demo: Gesture Recognition

IMU-Based Gestures

- Figure Eight
- Up-Down
- Idle
- Wave
- Wheel
- Unknown

Resulting SensiML Model

- <20 kB Flash
- 5.1 kB RAM
- 9ms Inference Time
- 99% Accuracy

Microchip SAMD21 ML Evaluation Kit with Bosch IMU (EV45Y33A)
Optimized Models Via Pre-Processing + Classification

Runtime On-Device Sensor Processing

**Raw Sensor Data**
- Time-series
- Digital or ADC sources
- <1Hz to 1MHz
- 1-to-many channels
- Mixed sensor types

**Signal Pre-Processing**
- Filtering
- Downsampling
- Averaging
- Vector magnitude
- Scaling
- Normalization

**Event Triggering**
- Threshold
- Sliding window
- Peak detect

**Feature Transformation**
- Fully automated selection
- Library of 80+ feature transforms
- Option for manual tuning
- Custom features

**Classification**
- Classic ML (SVM, distance, trees)
- Hierarchical models
- Neural Network (TensorFlow Lite)
- Fully automated or manual tuning

**Meaningful Insight**
- Ordinal class value
- Interim feature vector
- Associated raw data buffer
Taking a Broader View on ML Models

- **Neural Networks**
  Ex: CNN, RNN, QNN

- **Distance-Based Classifiers**
  Ex: SVM, kNN, RBF

- **Tree-Based Classifiers**
  Ex: Random Forest, Boosted, Bonsai
Have a Smart IoT Application in Mind?
Odds Are Good SensiML Has Enabled Something Similar
Additional Info and Resources

• Free Community Edition Download
• SensiML Plan Comparison
• Application and Solution Briefs
• Sample Application Datasets

https://sensiml.com
Email us: info@sensiml.com