

# tinyML<sup>®</sup> EMEA

*Enabling Ultra-low Power Machine Learning at the Edge*

## tinyML EMEA Technical Forum 2021 Proceedings

June 7 – 10, 2021

Virtual Event



[www.tinyML.org](http://www.tinyML.org)

# ECG Analyzer

powered by

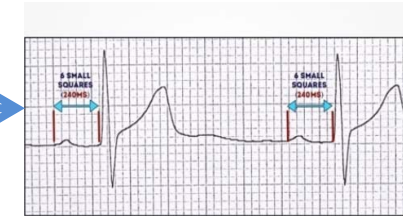


Author: **Manivannan Sivan**

T I N Y



Atrial Fibrillation

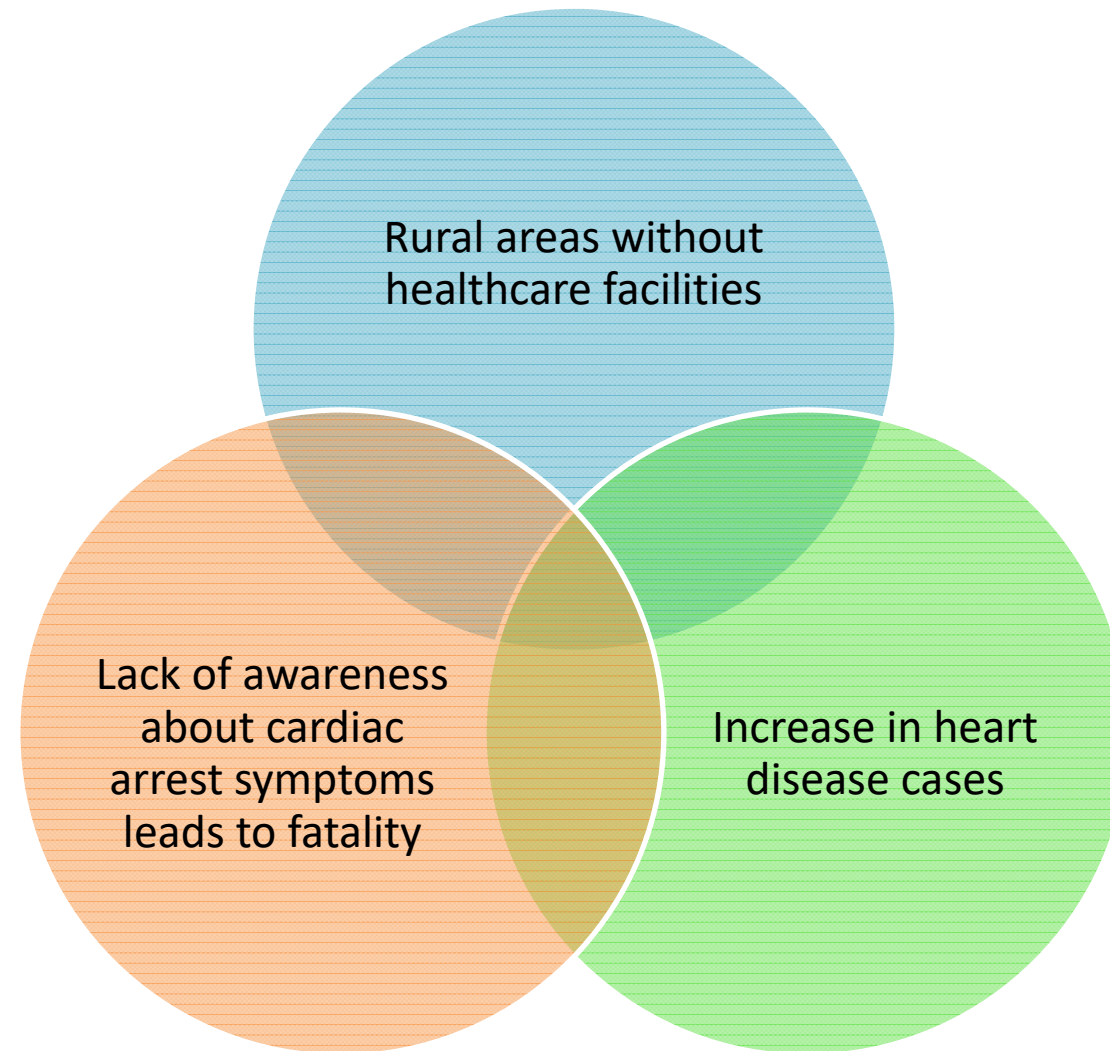


First Degree Heart block



Normal

# Increase in Fatality due to heart problems



# Present ECG Analyzer machines in market and its features

- Present IoT Medical device sends bulk ECG data to the mobile/server and analysis is done in high processor / mobile App
- Computer based application which receives signals from ECG device and analyze the ECG patterns
- All the ECG analyzing device has dependency on Internet or high processing computers/ Mobile application.



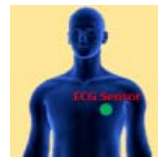


# Technology contribution

- ECG Analyzer powered by Edge Impulse will analyze the ECG data without any dependency on the Internet.
- Latency is lowest compared to IoT devices
- A 15Kb Rom - ECG Analyzing TinyML model can run on any TinyML supported microcontrollers.
- The device will analyze ECG patterns and classify into Normal, Atrial Fibrillation and First-Degree heart block



# Architecture



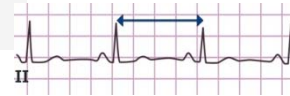
AD8232

Analog



Arduino Nano 33 BLE

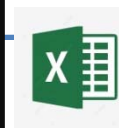
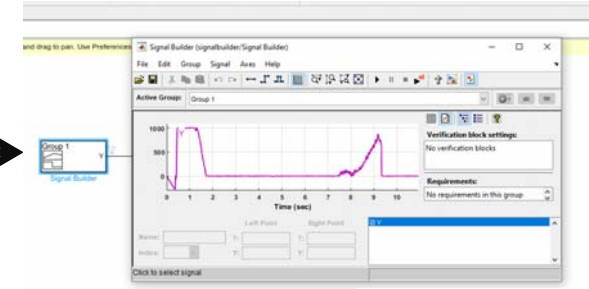
Serial monitor



Normal ECG

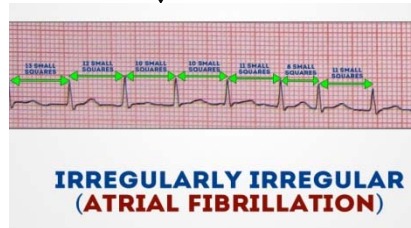
Simulation

Matlab Signal builder



Datasets

Different ECG Data patterns

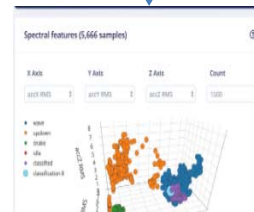


1<sup>st</sup> degree heart block



Normal ECG

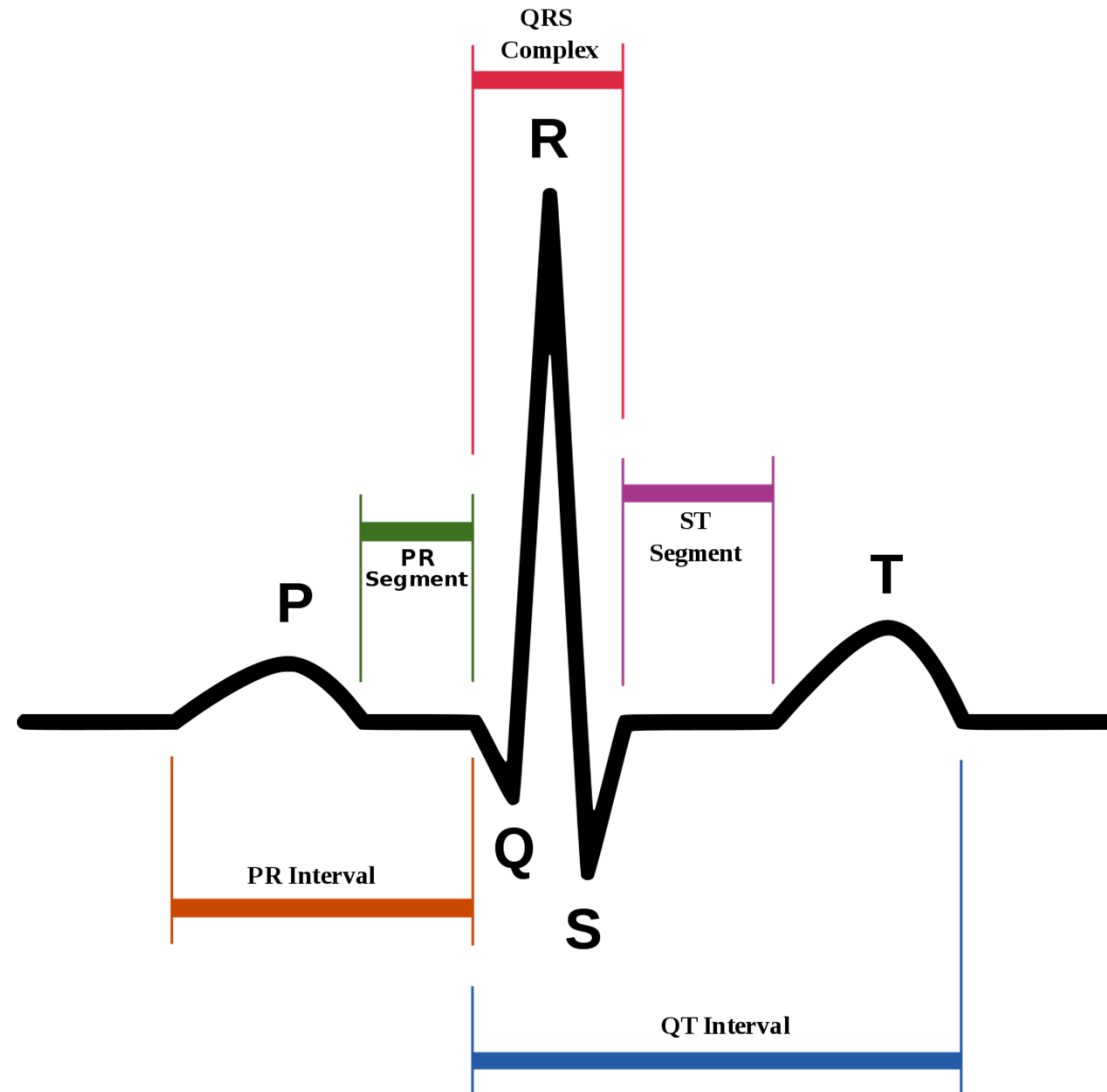
ML Training

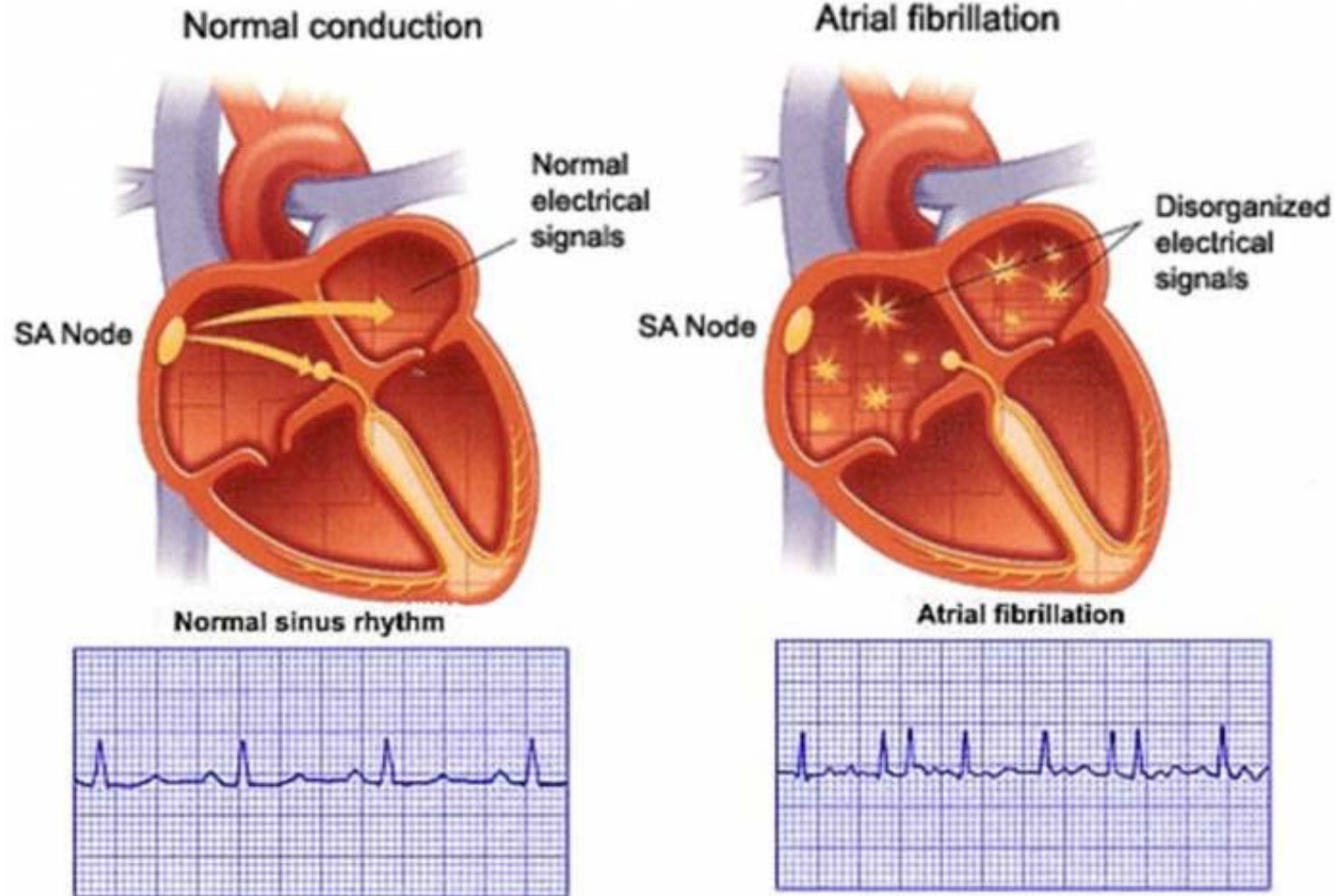


ECG Analyzer



# ECG Wave

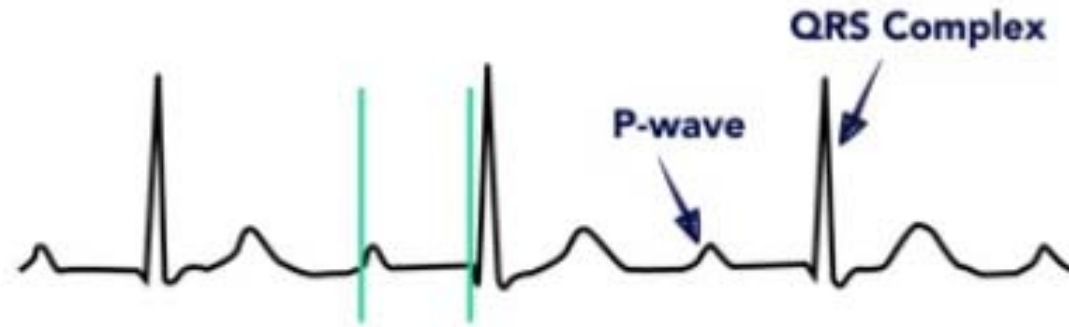
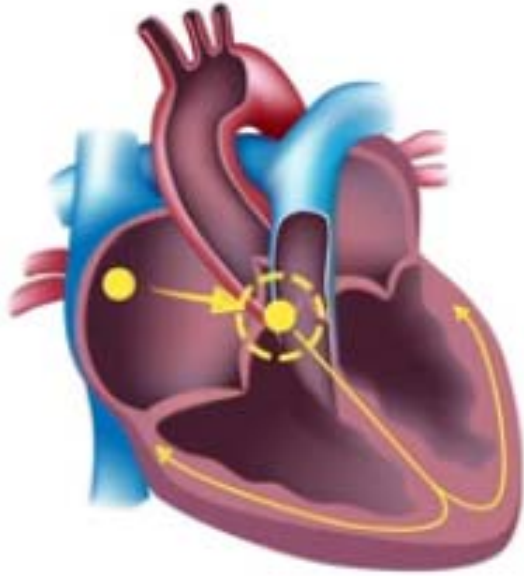




## Complications

- If a clot breaks off, enters the bloodstream and enters into the brain, it will cause stroke. About 15–20 percent of people who have strokes have this heart arrhythmia.
- Heart failure – Heart loses the capacity to pump the required amount of blood





## First Degree AV Block

Long PR Interval  
> 200 ms

### Complications

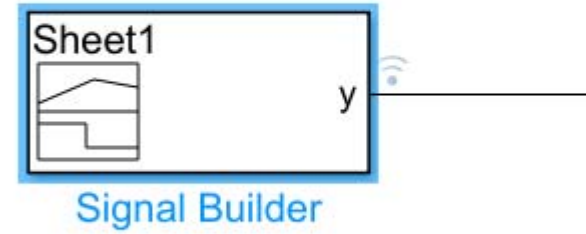
- First-degree AV block may be at an increased risk of Atrial fibrillation Heart failure

# Simulating different ECG patterns using Matlab signal builder

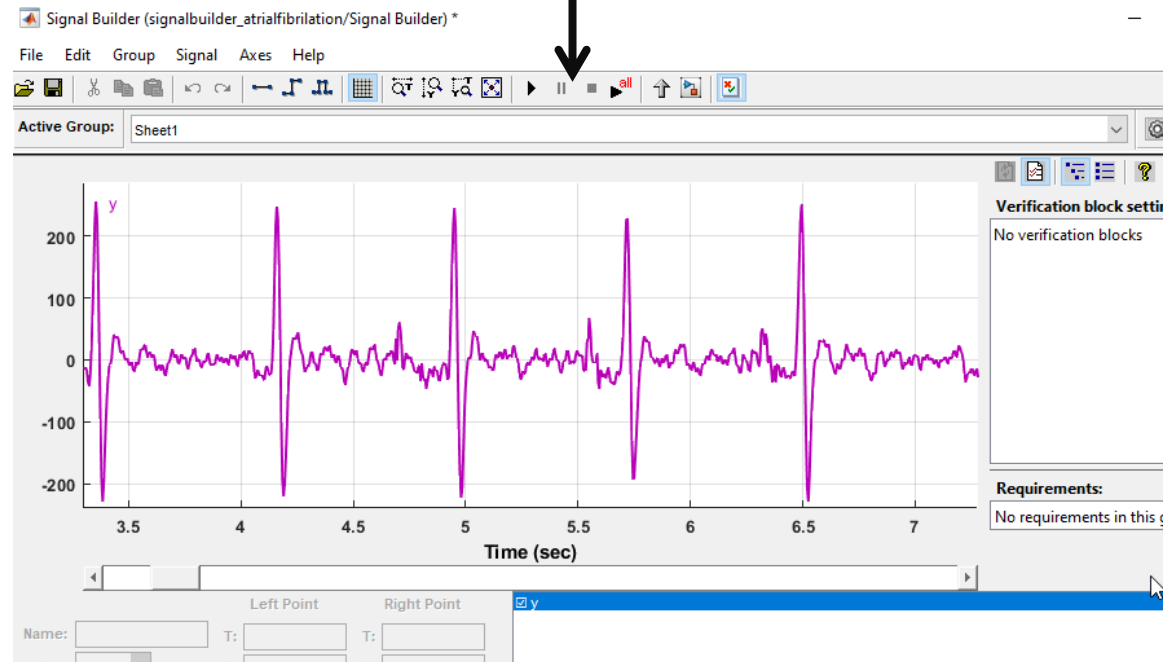


K211				
	A	B	C	D
1	T	Y		
2	0.005	-3		
3	0.01	2		
4	0.015	6		
5	0.02	4		
6	0.025	0		
7	0.03	8		
8	0.035	15		
9	0.04	8		
10	0.045	2		
11	0.05	5		
12	0.055	4		

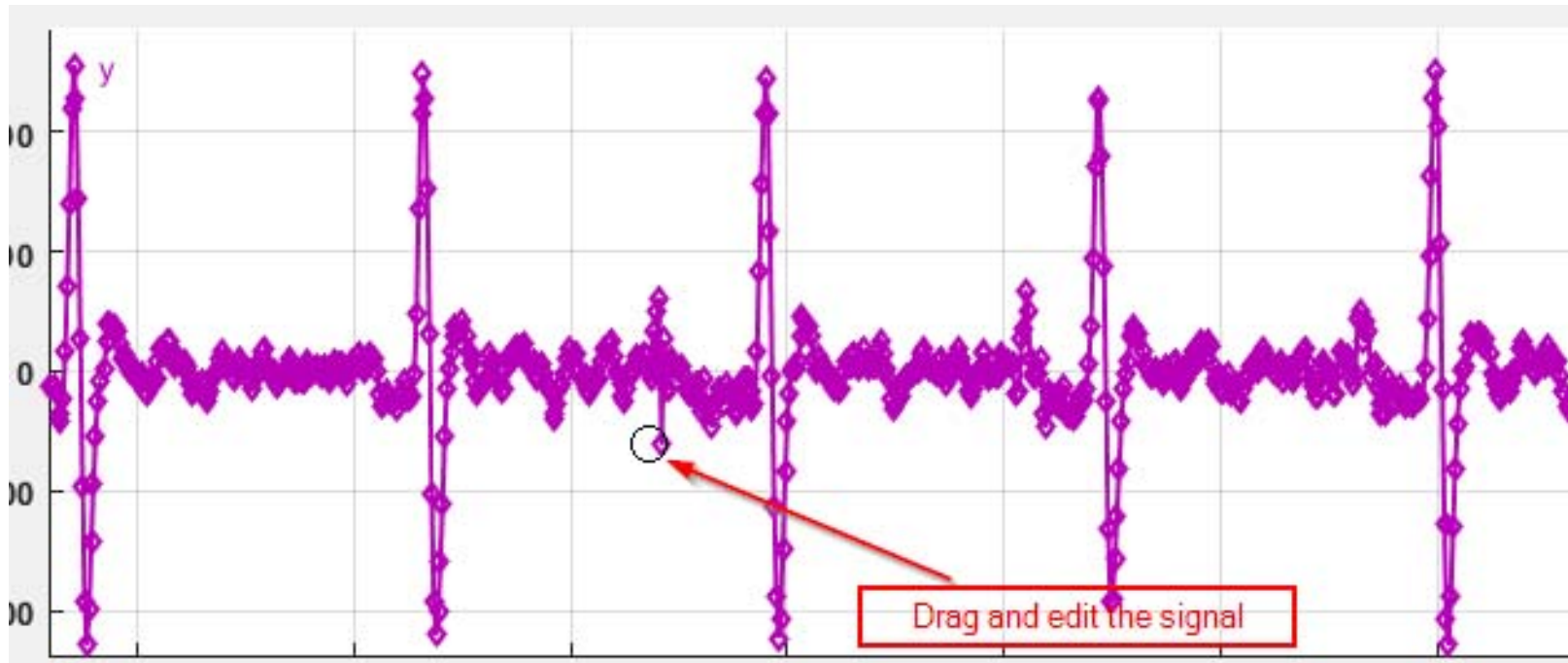
ECG Data



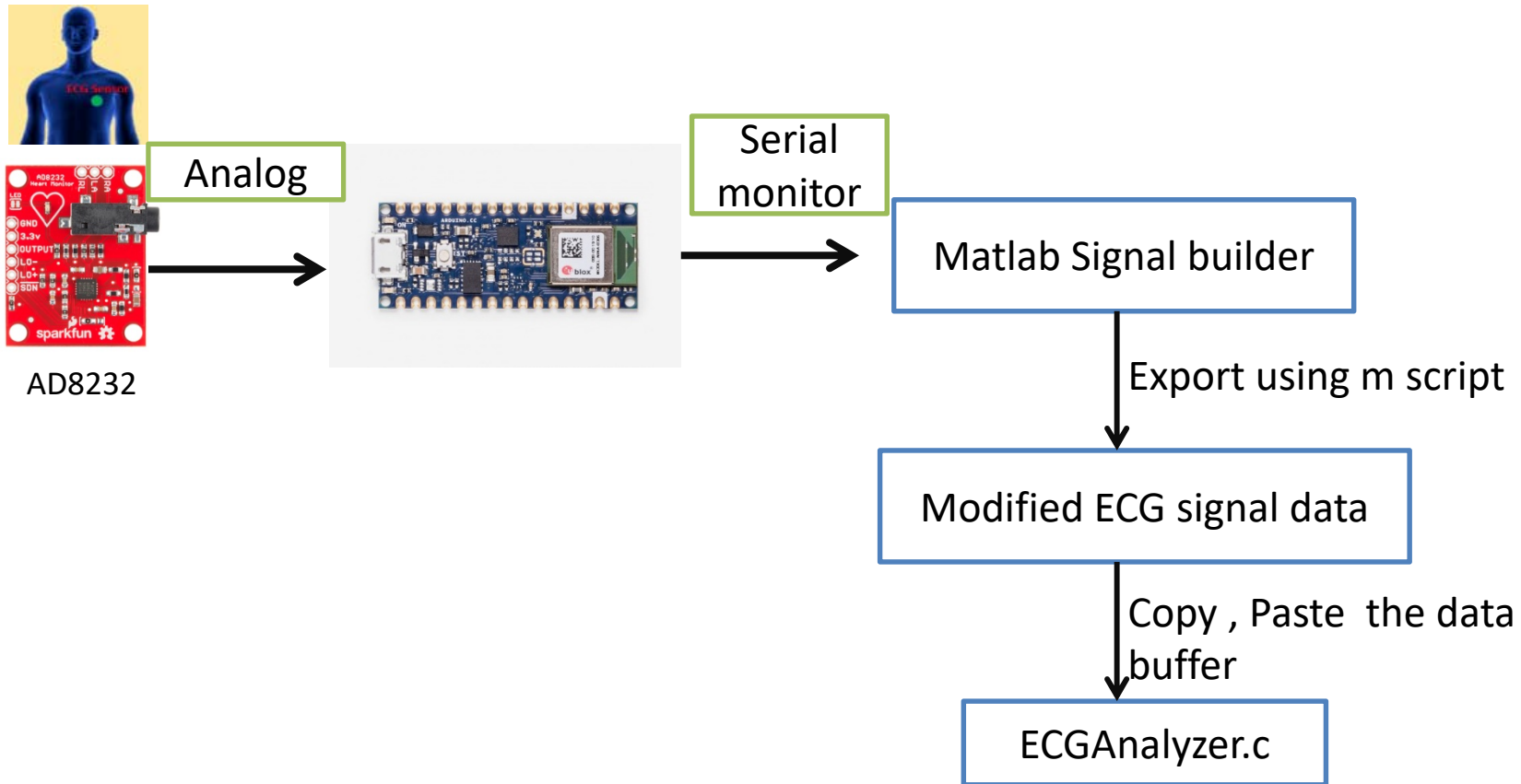
Load Excel data



## Editing the ECG signals

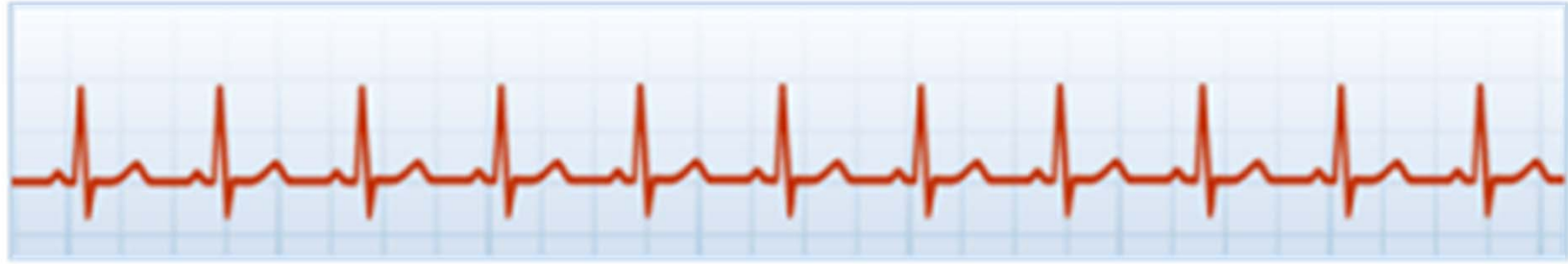




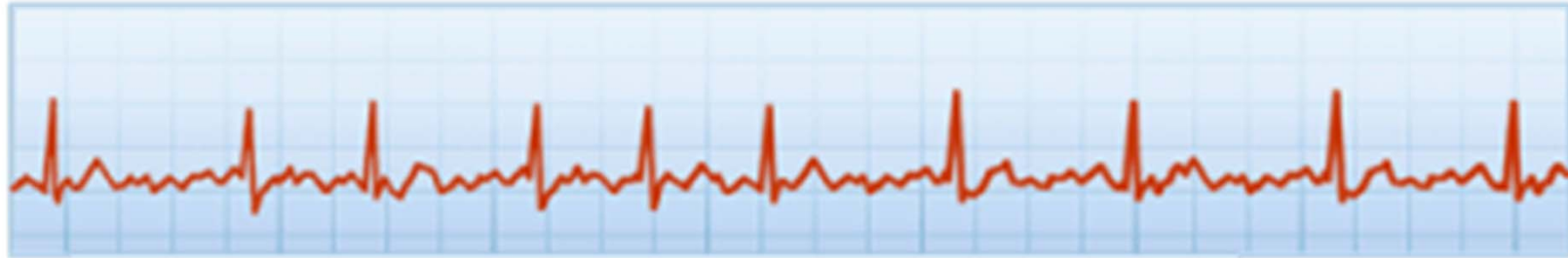


# Challenge in Improving Prediction Accuracy

Normal



Atrial Fibrillation



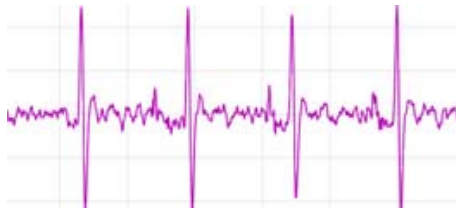
AV Block1



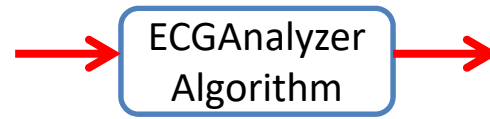
# Converting human observations into a new signal



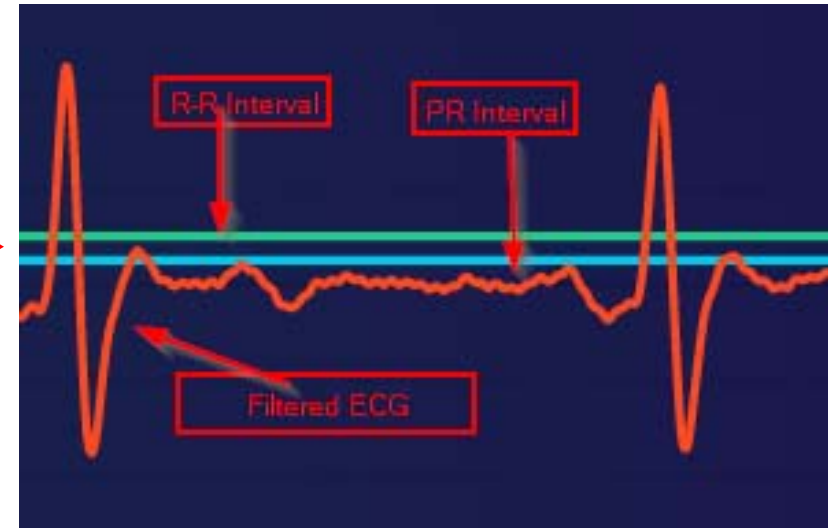
When a doctor or Trained person try to analyze the ECG graph, They will be counting the small boxes between R to R wave, P to R interval and write it down the counts in the graph or memories it for calculation.



Filtered ECG



Signal processing





Condition	Human Observation	ECG Analyzer datasets
Normal	observes boxes in graph and find no deviations	R-R Interval value: 100 PR Interval value:50
Atrial Fibrillation	Observation: Boxes count in <i>graph varies</i> between two <i>R R intervals</i>	R-R Interval value: -100 PR Interval value:50
First-Degree Heart Block	Observation: Boxes count in graph between <i>P to R</i> indicates <i>&gt;200ms</i>	R-R Interval value: 100 PR Interval value: -50



# Normal ECG



# Atrial Fibrillation

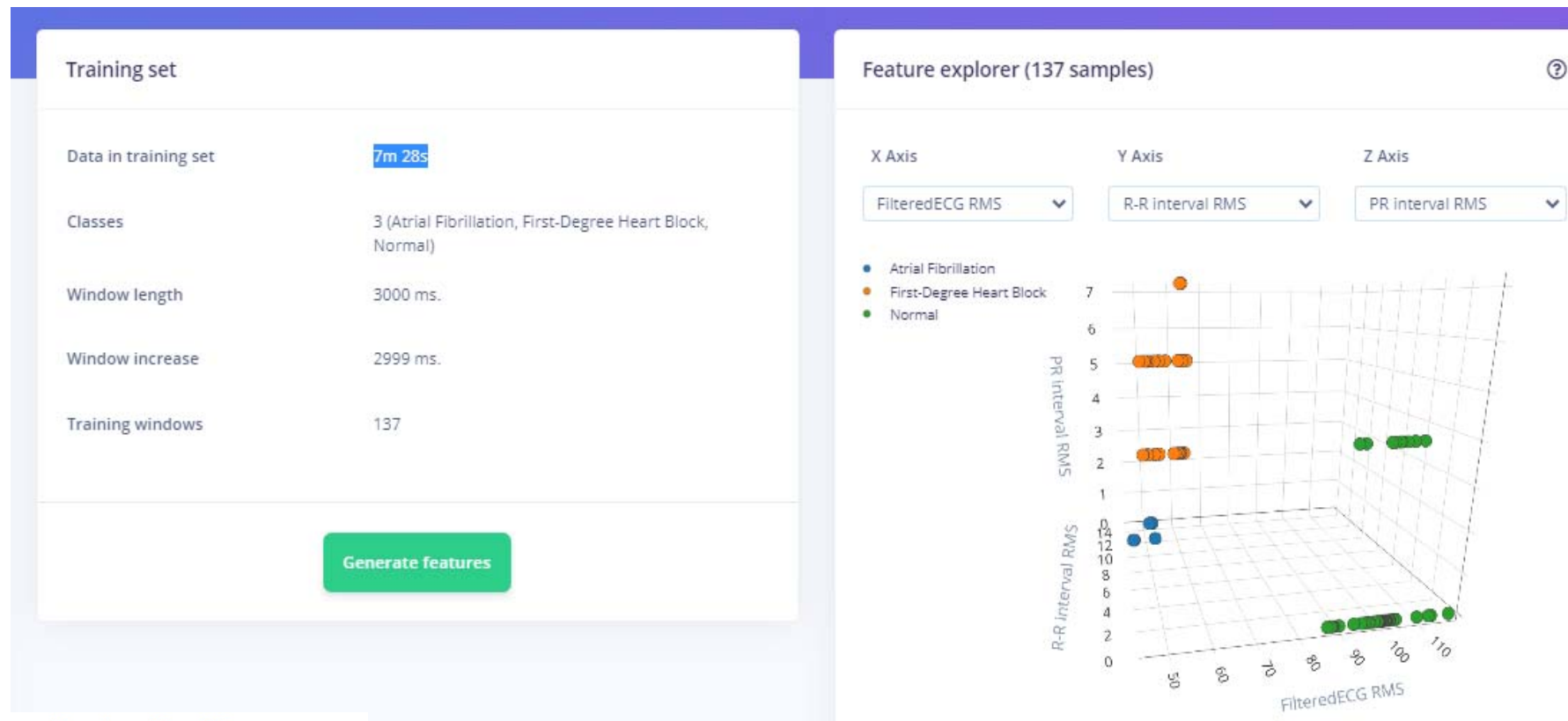


# First-Degree Heart Block

Split sample 'First-Degree Heart Block.json.1v95k3g3.s2'

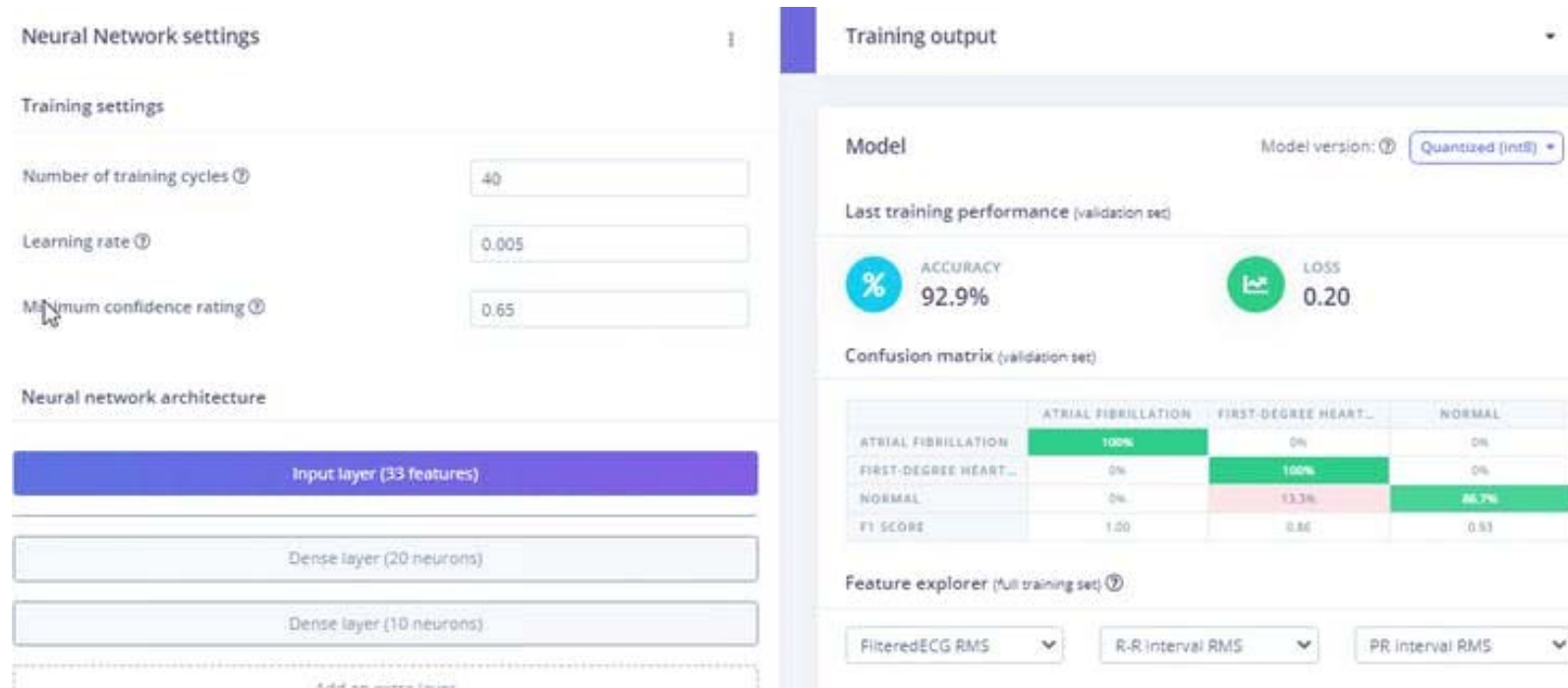


# Training Datasets

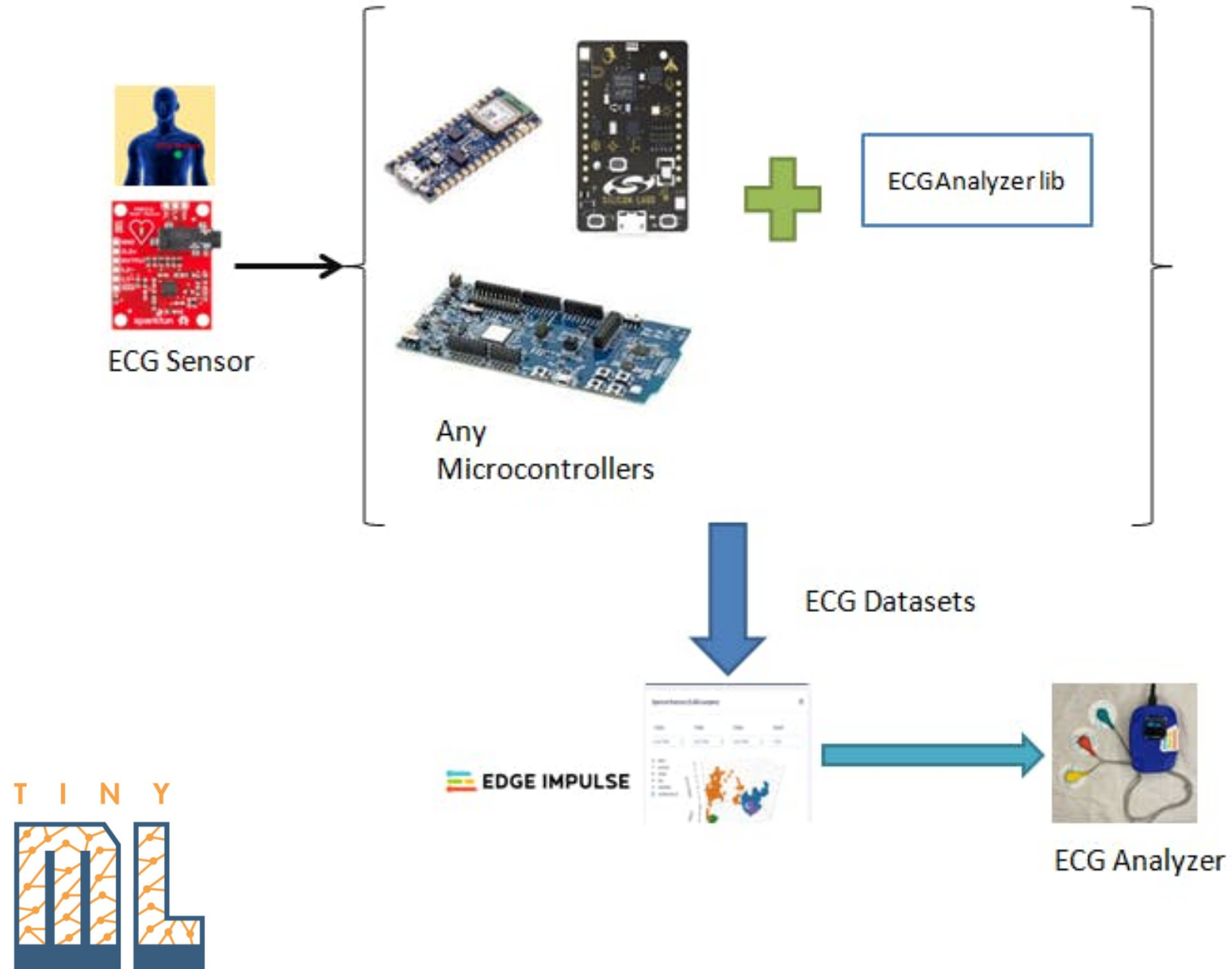




# Outcome



# Library Portability



# 1 Minute 30seconds Demo session



# Premier Sponsor





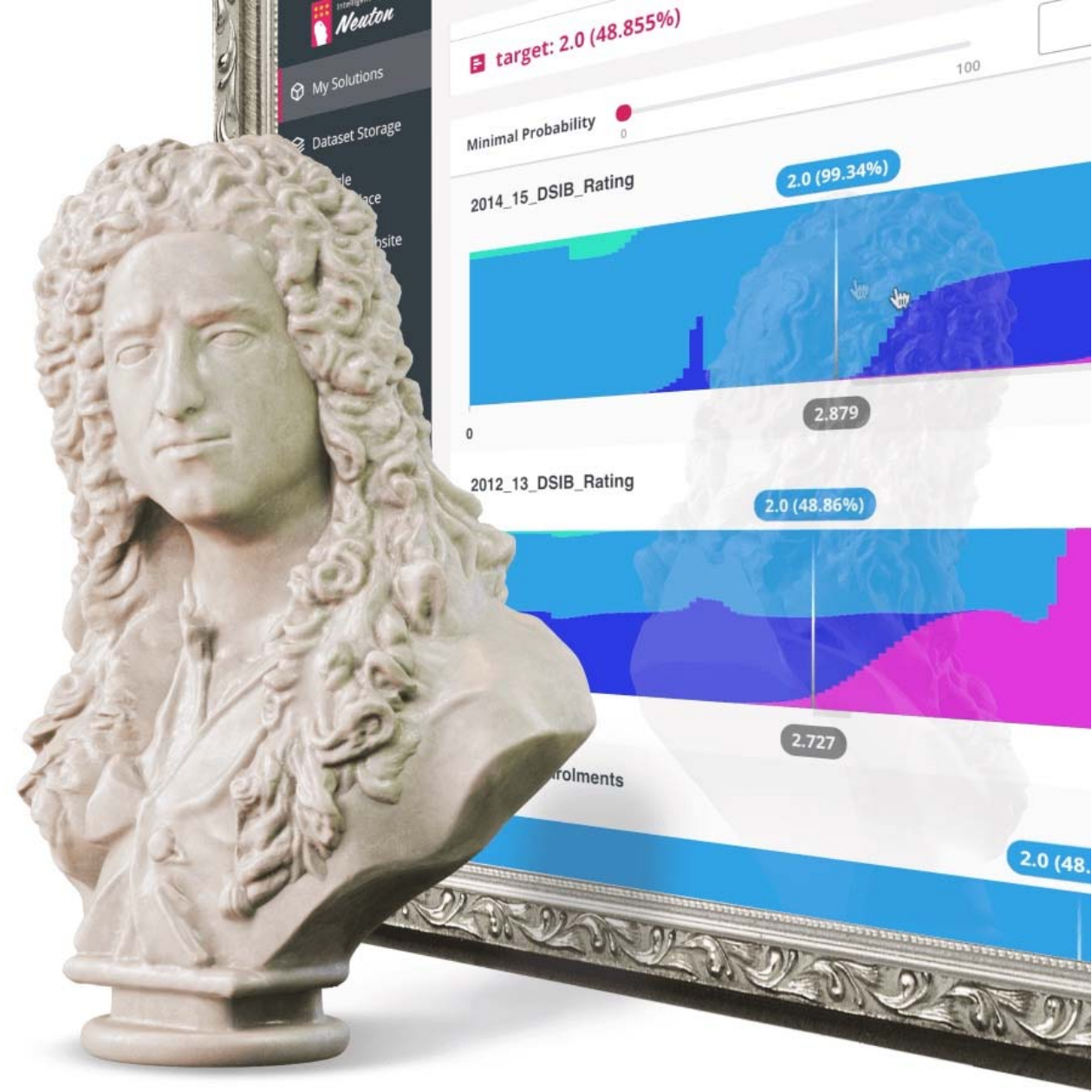
# Automated TinyML

Zero-code SaaS solution

**Create tiny models, ready for embedding,  
in just a few clicks!**

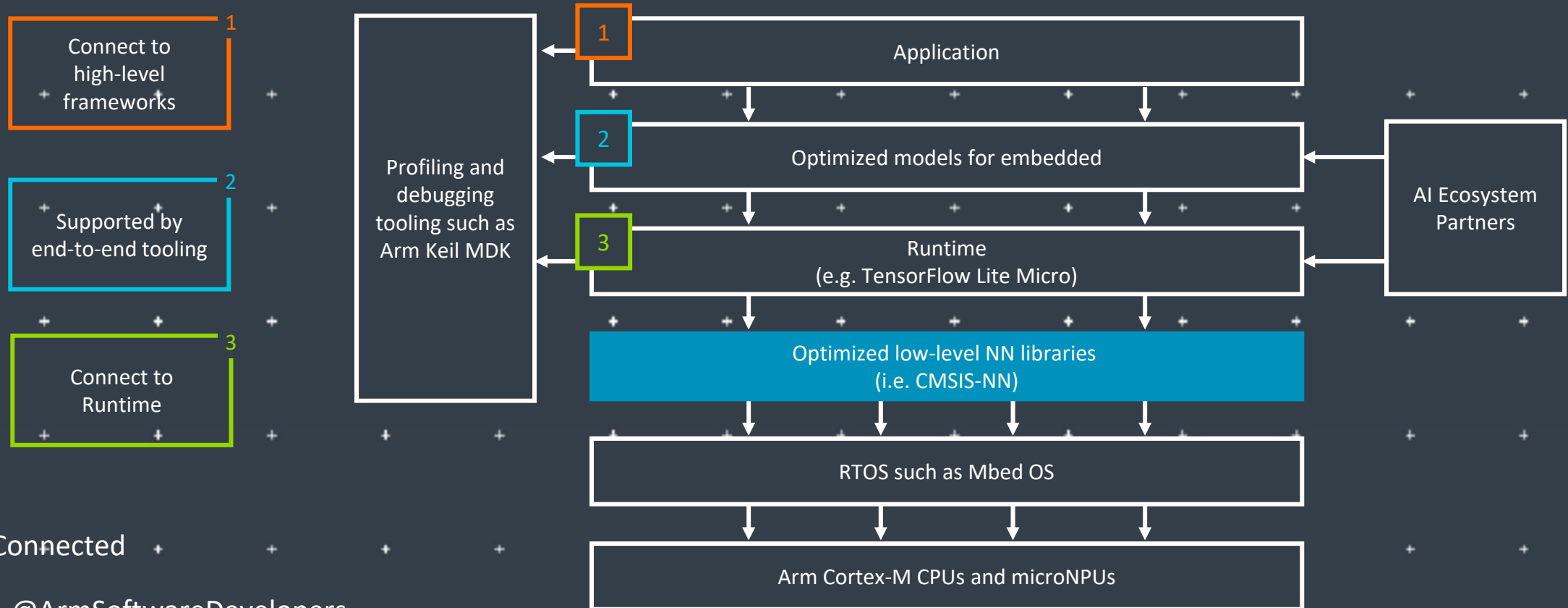
Compare the benchmarks of our compact models to those of TensorFlow and other leading neural network frameworks.

***Build Fast. Build Once. Never Compromise.***



# Executive Sponsors

# Arm: The Software and Hardware Foundation for tinyML



Stay Connected



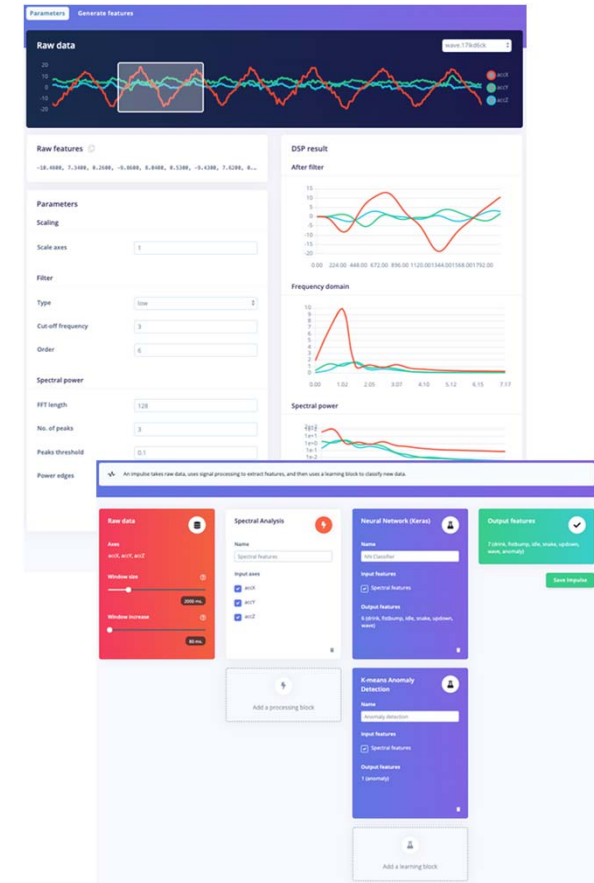
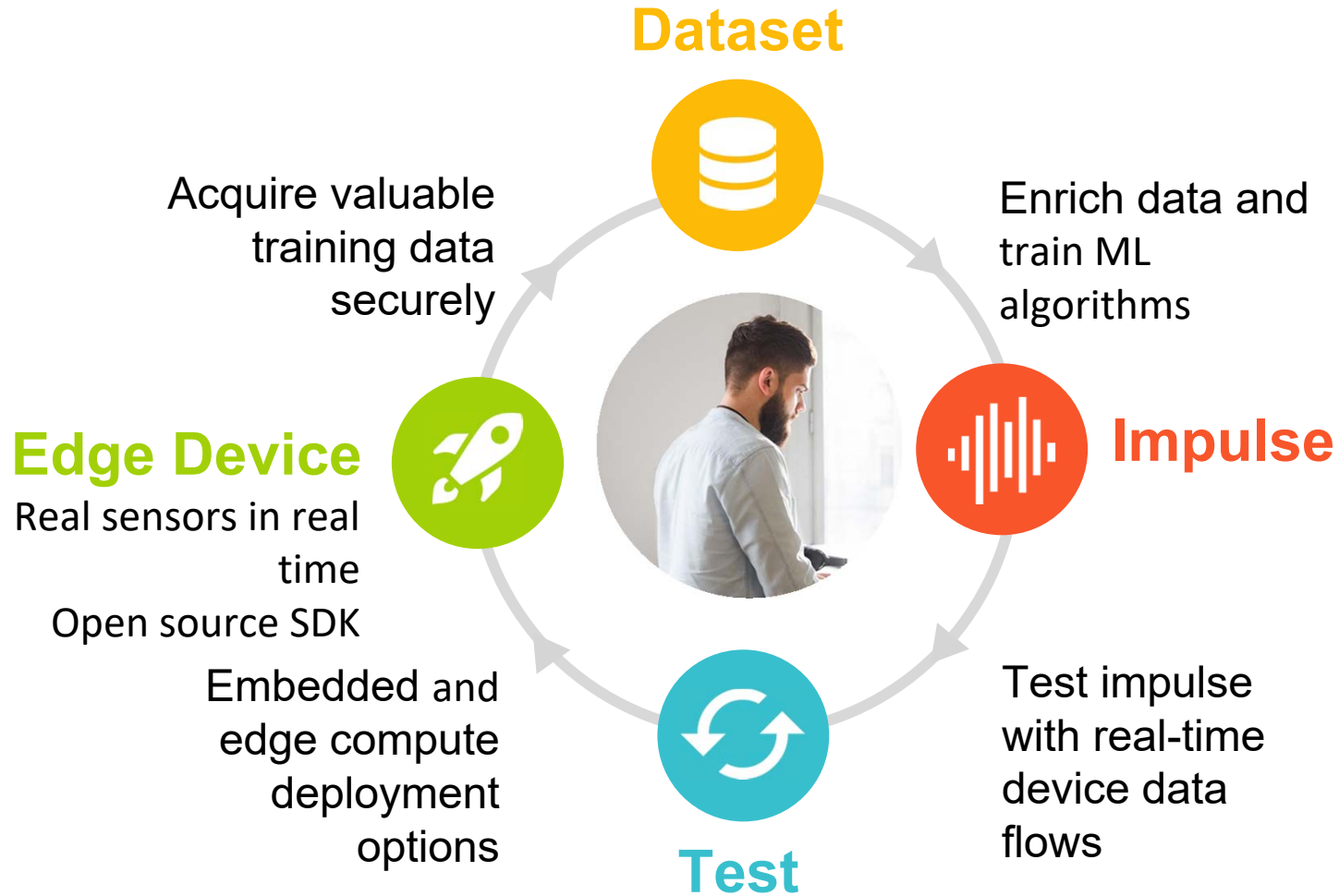
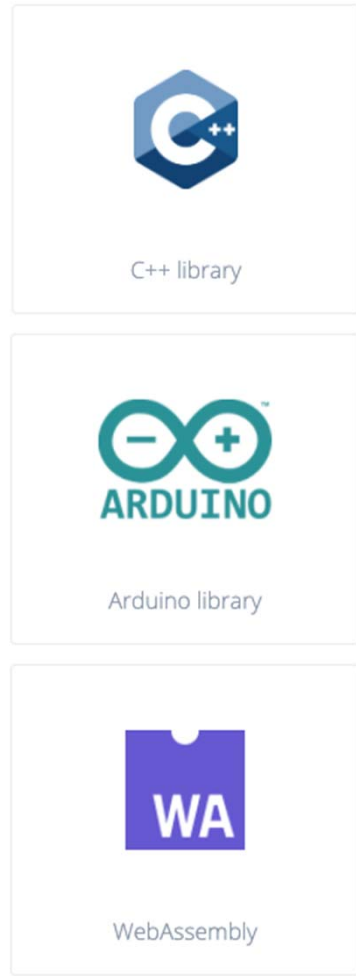
@ArmSoftwareDevelopers



@ArmSoftwareDev

Resources: [developer.arm.com/solutions/machine-learning-on-arm](https://developer.arm.com/solutions/machine-learning-on-arm)

# TinyML for all developers



[www.edgeimpulse.com](http://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

## 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



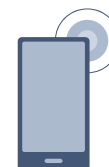
Cloud



IoT/IIoT



Automotive



Mobile

# SYNTIANT

[Syntiant Corp.](#) is moving artificial intelligence and machine learning from the cloud to edge devices. Syntiant's chip solutions merge deep learning with semiconductor design to produce ultra-low-power, high performance, deep neural network processors. These network processors enable always-on applications in battery-powered devices, such as smartphones, smart speakers, earbuds, hearing aids, and laptops. Syntiant's Neural Decision Processors™ offer wake word, command word, and event detection in a chip for always-on voice and sensor applications.

Founded in 2017 and headquartered in Irvine, California, the company is backed by Amazon, Applied Materials, Atlantic Bridge Capital, Bosch, Intel Capital, Microsoft, Motorola, and others. Syntiant was recently named a [CES® 2021 Best of Innovation Awards Honoree](#), [shipped over 10M units worldwide](#), and [unveiled the NDP120](#) part of the NDP10x family of inference engines for low-power applications.

[www.syntiant.com](http://www.syntiant.com)



@Syntiantcorp



# Platinum Sponsors



Part of your life. Part of tomorrow.

[www.infineon.com](http://www.infineon.com)



# Reality AI<sup>®</sup>

## Add Advanced Sensing to your Product with Edge AI / TinyML

<https://reality.ai>



[info@reality.ai](mailto:info@reality.ai)



[@SensorAI](https://twitter.com/SensorAI)



[Reality AI](#)

## 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<sup>®</sup> 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

# Gold Sponsors



# LatentAI

## Adaptive AI for the Intelligent Edge

[Latentai.com](https://latent.ai)



# 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

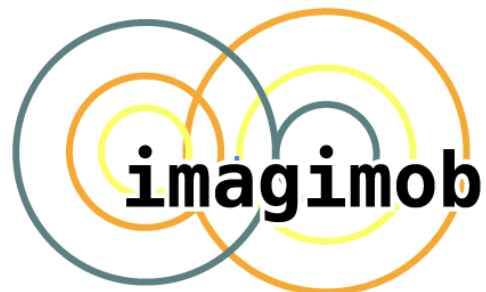
We enable the creation of production-grade smart sensor devices.



[sensiml.com](https://sensiml.com)



# Silver Sponsors



# Copyright Notice

The presentation(s) in this publication comprise the proceedings of tinyML® EMEA Technical Forum 2021. The content reflects the opinion of the authors and their respective companies. This version of the presentation may differ from the version that was presented at tinyML EMEA. The inclusion of presentations in this publication does not constitute an endorsement by tinyML Foundation or the sponsors.

There is no copyright protection claimed by this publication. However, each presentation is the work of the authors and their respective companies and may contain copyrighted material. As such, it is strongly encouraged that any use reflect proper acknowledgement to the appropriate source. Any questions regarding the use of any materials presented should be directed to the author(s) or their companies.

tinyML is a registered trademark of the tinyML Foundation.

[www.tinyML.org](http://www.tinyML.org)