

# tinyML<sup>®</sup> EMEA

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

## tinyML EMEA Technical Forum 2021 Proceedings

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Virtual Event



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

# Deeply embedded ML based radar hand gesture recognition

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Lead Principle System Architect



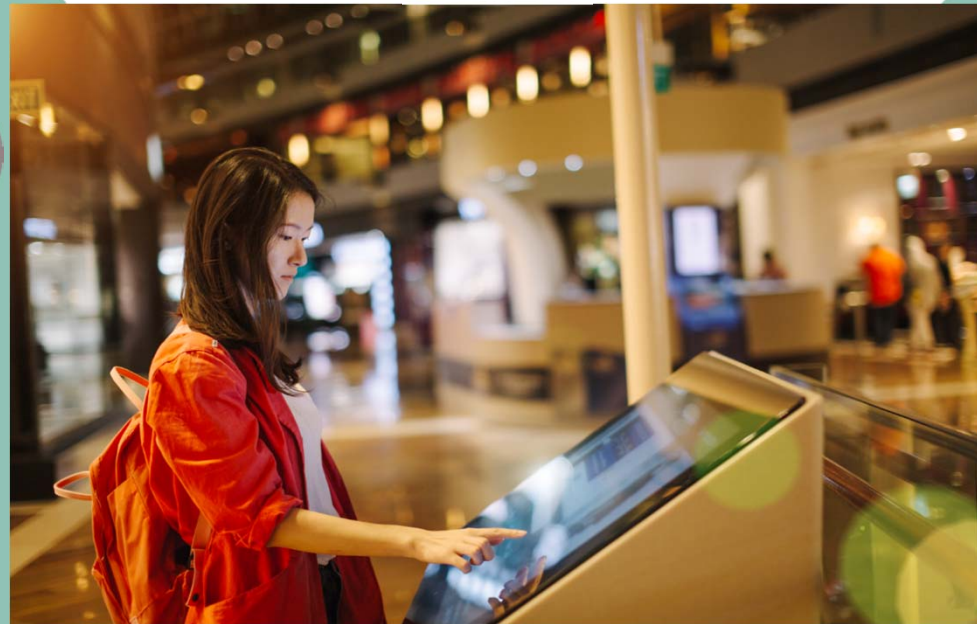
# Radar Gesture Sensing – A new way to interact with machines



Touch screens are everywhere



It is difficult to disinfect touchscreens constantly



80% consider Unhygienic\*



50% avoid interaction\*

Touch screens at public spaces are a health hazard



Alternate HMI involving e.g. speech and vision do not work due to background noise and privacy



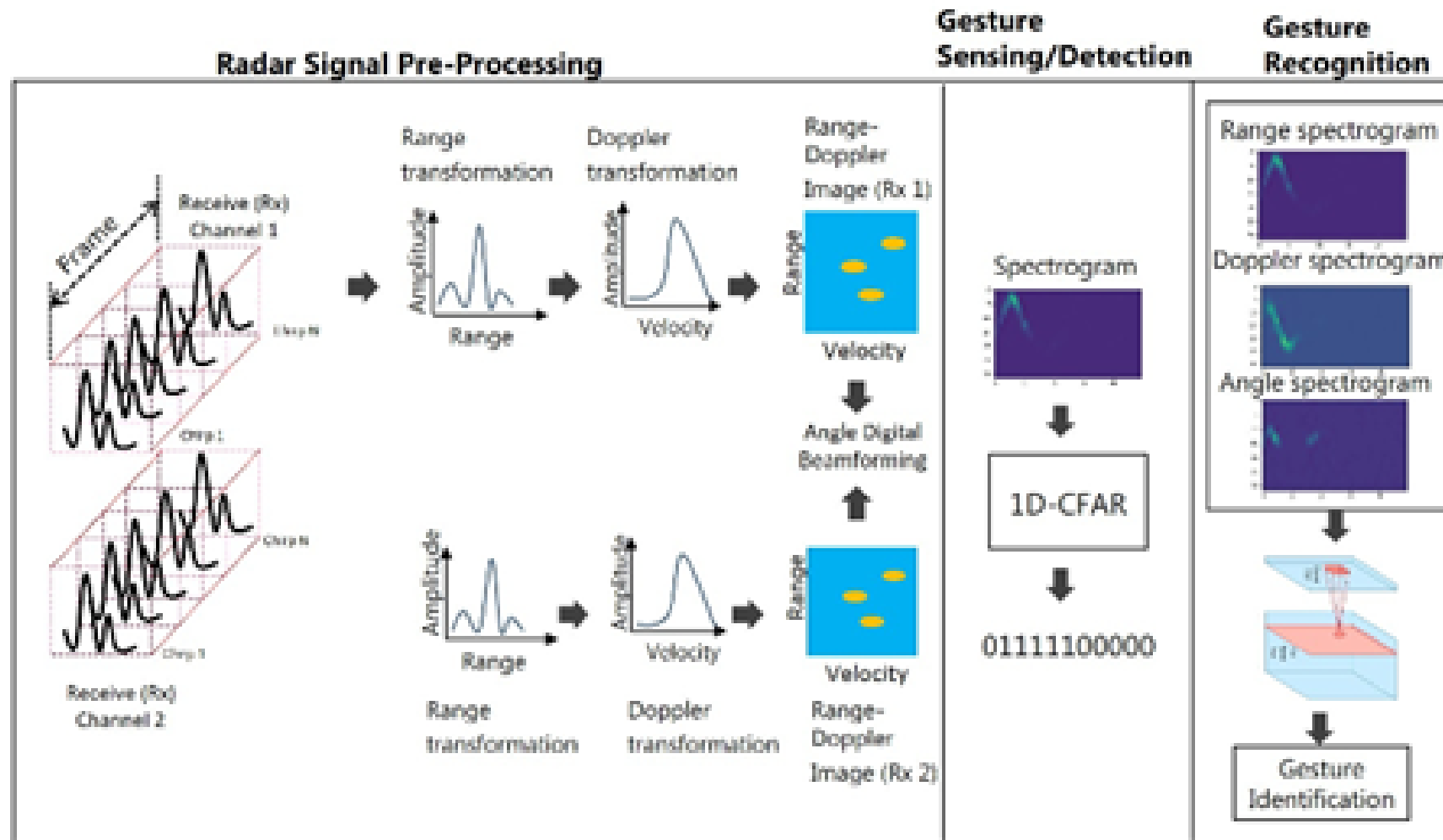
\* <https://www.ultraleap.com/company/news/resources/public-touchscreens-whitepaper/>

# Demo Features

- › detect and classify 3 different gestures
  - right swipe
  - left swipe
  - waving pattern
- › signal the detected gesture using a LED on the board
- › reject unknown gestures
- › Tiny Memory footprint: ~200kBytes
- › Little compute load: 70 % on an Cortex-M4 Processor @ 150Mhz
- › 90 % Classification accuracy in presence of unknown gestures

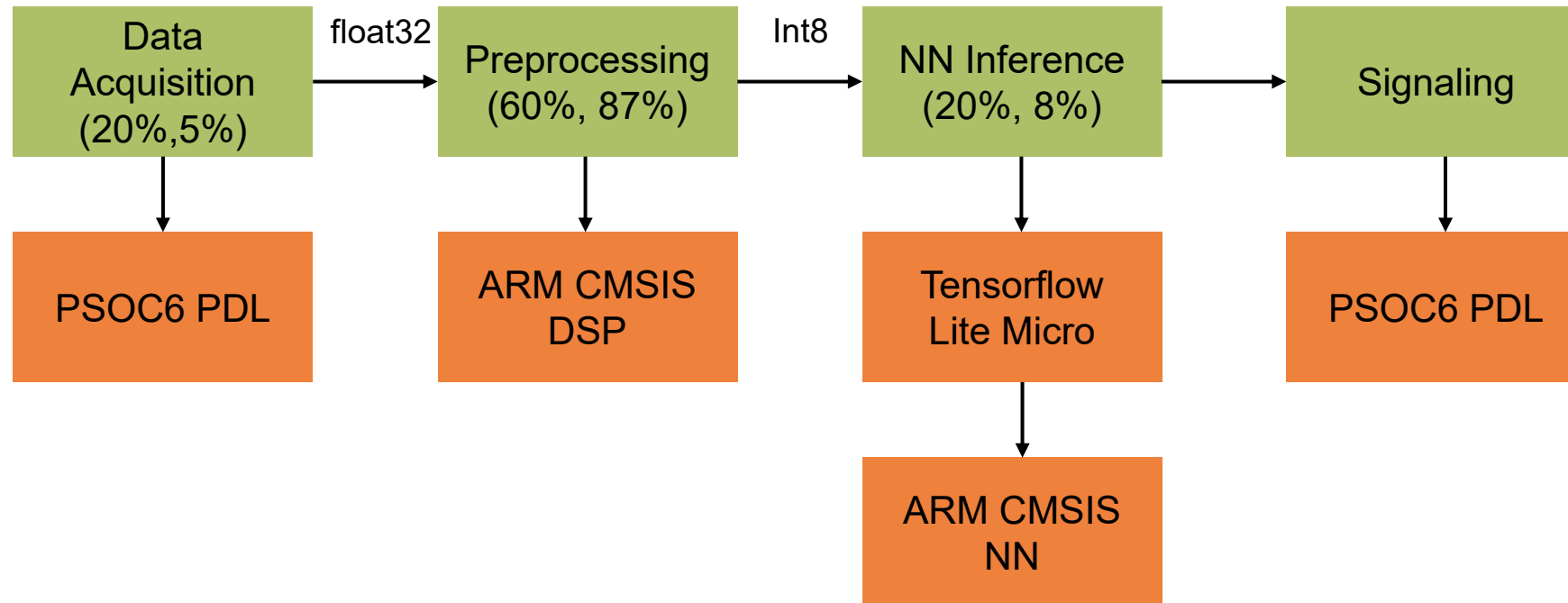


# Algorithm Overview



Source: Deep Learning Applications of Short-Range Radars, Avik Santra, Souvik Hazra

# Algorithm Blocks, Used Libraries and Resource Breakdown (Memory, Compute)



## Conclusion

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- › Radar Sensors are well suited for future human machine interfaces
- › Small neural networks are capable to classify radar sensor outputs efficiently
- › Preprocessing performance is still a major concern on today's microcontrollers

# Team and Contributions

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- › PMM RFS SSG
  - Demo Application, Network Architecture, Dataset (Avik Santra, Souvik Hazra)
  - PSOC6 Form factor Board and Sample Firmware (Peter Breitling and Team)
  
- › Stefan Gerstendoerfer (DES SDF SCS)
  - Modus Toolbox integration
  
- › Manuel Loew, Philipp Fuchs (PMM SIS SWT)
  - AI Edge Library (Preprocessing and NN Inference)
  
- › Stephan Schoenfeldt (PMM SIS SCE)
  - Neural Network optimization, quantization and training
  - End to End Application development



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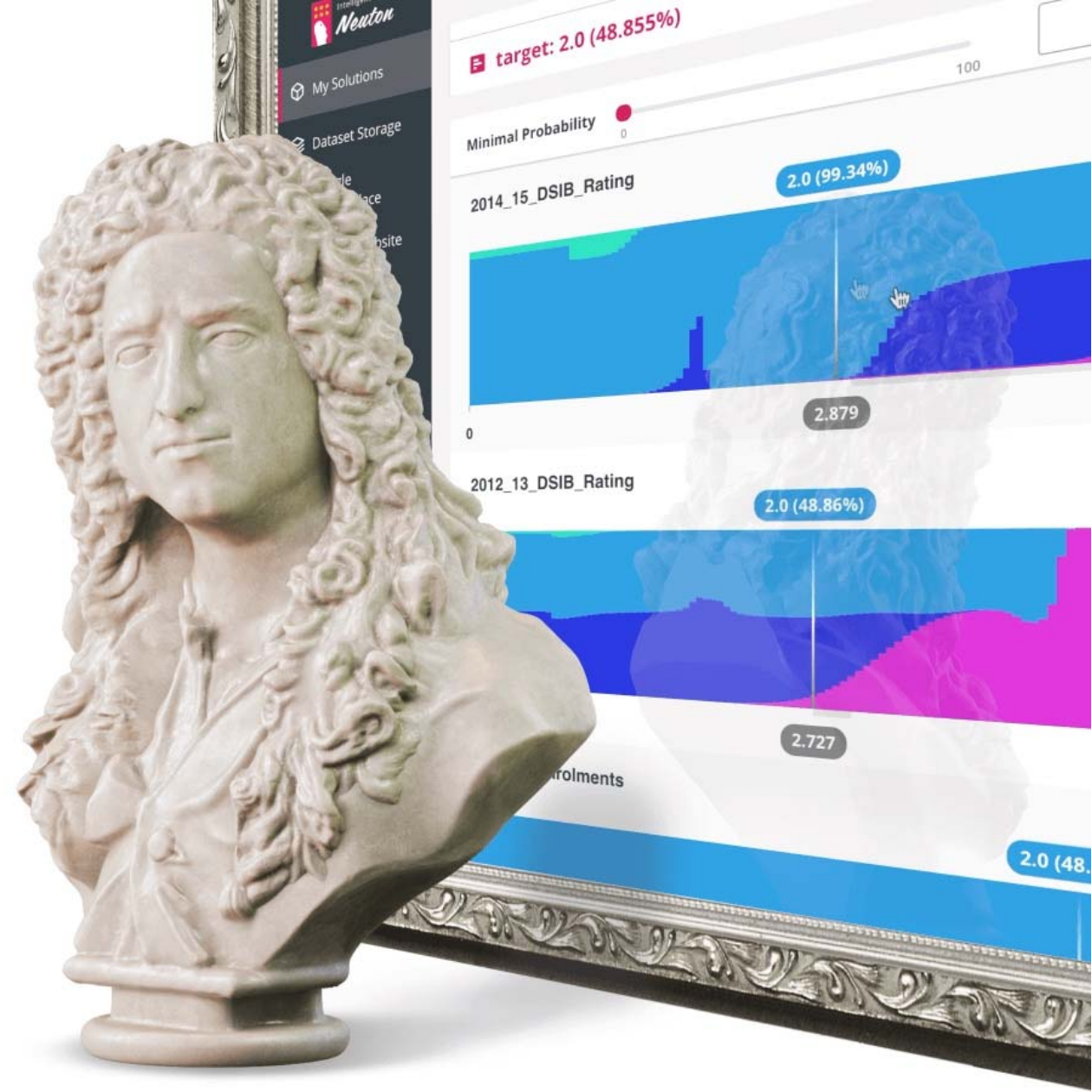
# Automated TinyML

Zero-code SaaS solution

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

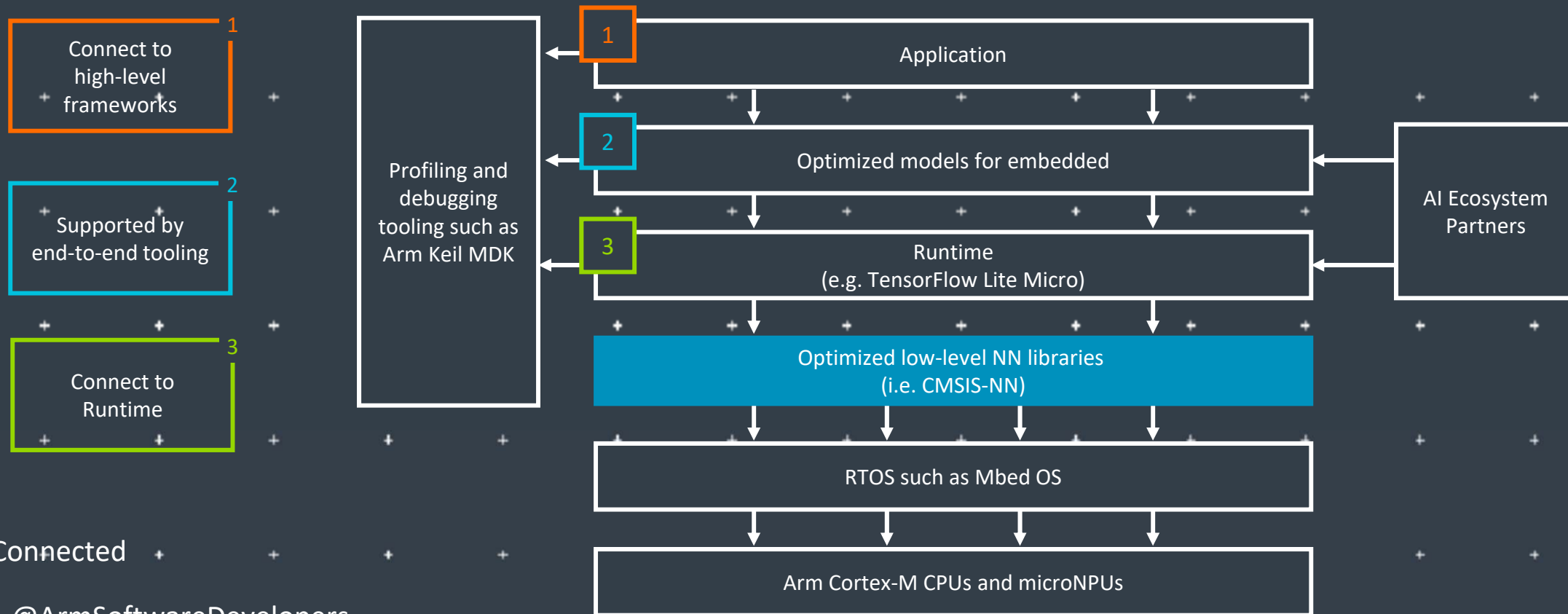
Compare the benchmarks of our compact models to those of TensorFlow and other leading neural network frameworks.

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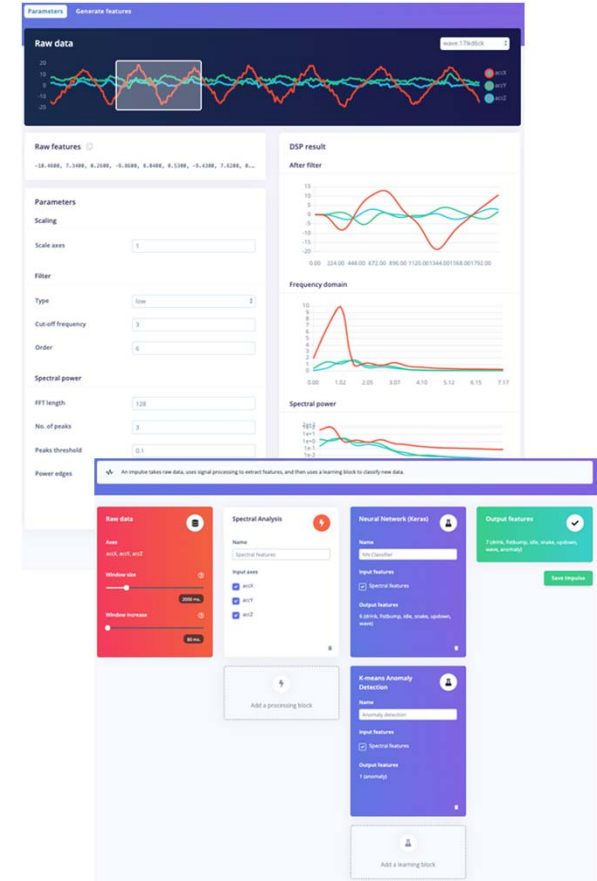
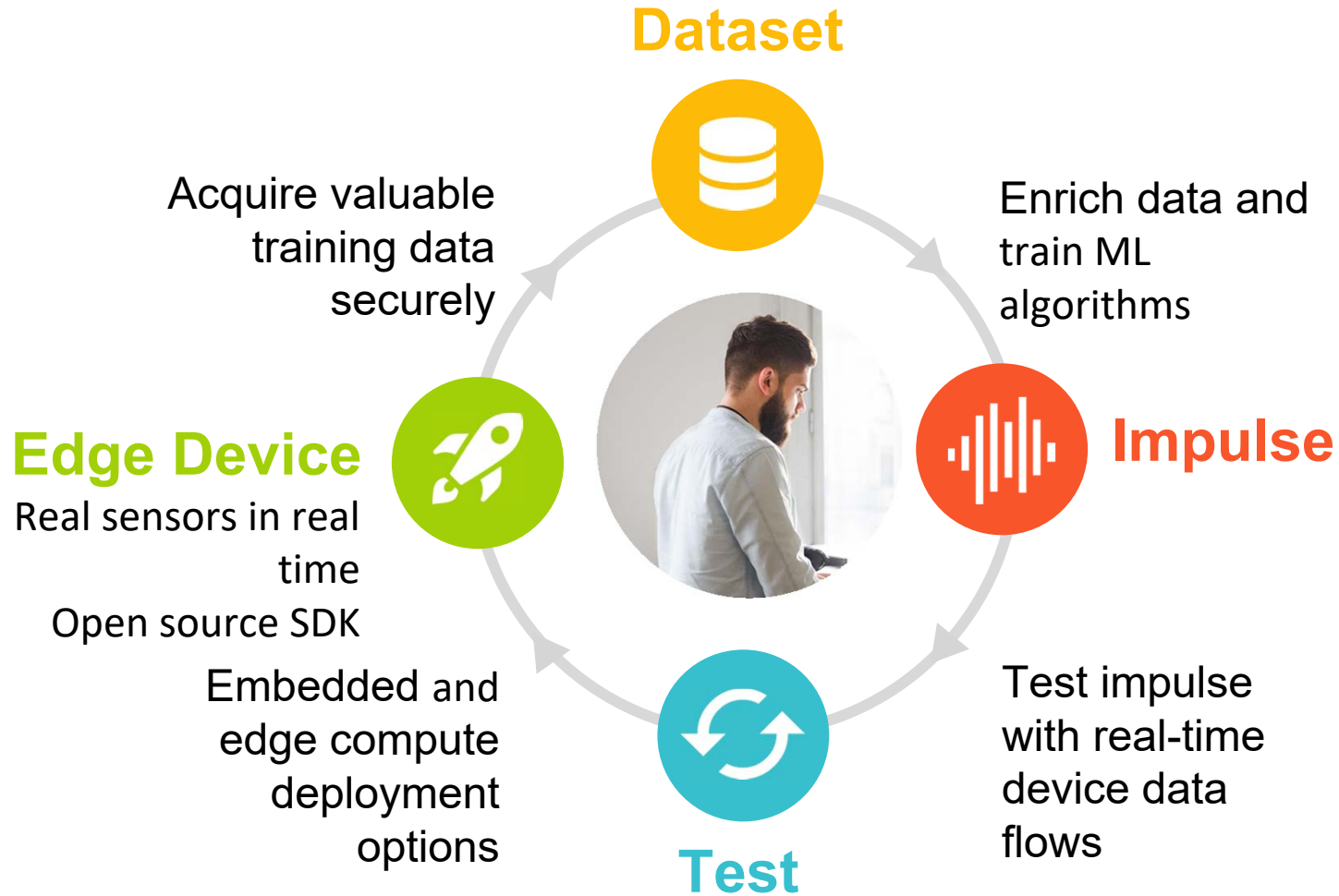
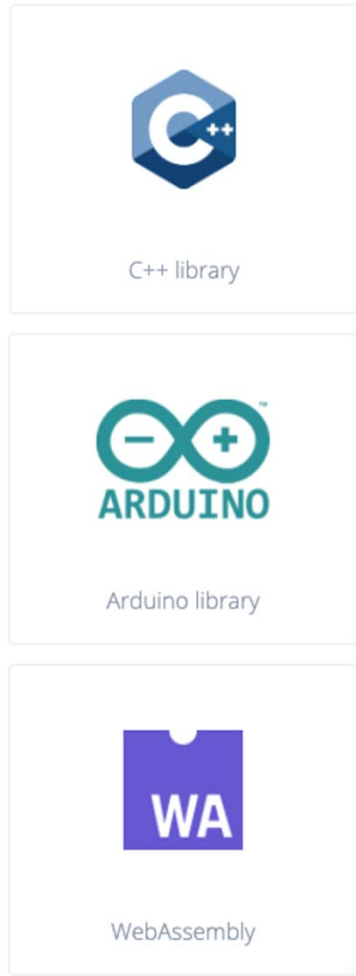
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Resources: [developer.arm.com/solutions/machine-learning-on-arm](https://developer.arm.com/solutions/machine-learning-on-arm)

# TinyML for all developers



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

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hardware, software tool

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contextual, always-on,  
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## Efficient learning

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unsupervised learning,  
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## A platform to scale AI across the industry



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understanding, behavior prediction



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Edge cloud



Cloud



IoT/IIoT



Automotive



Mobile

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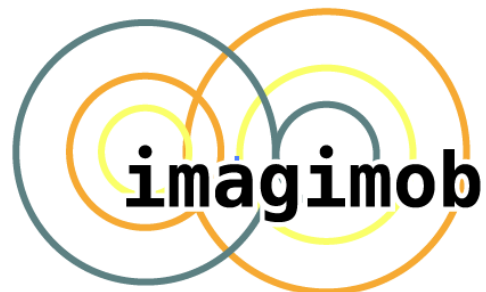
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