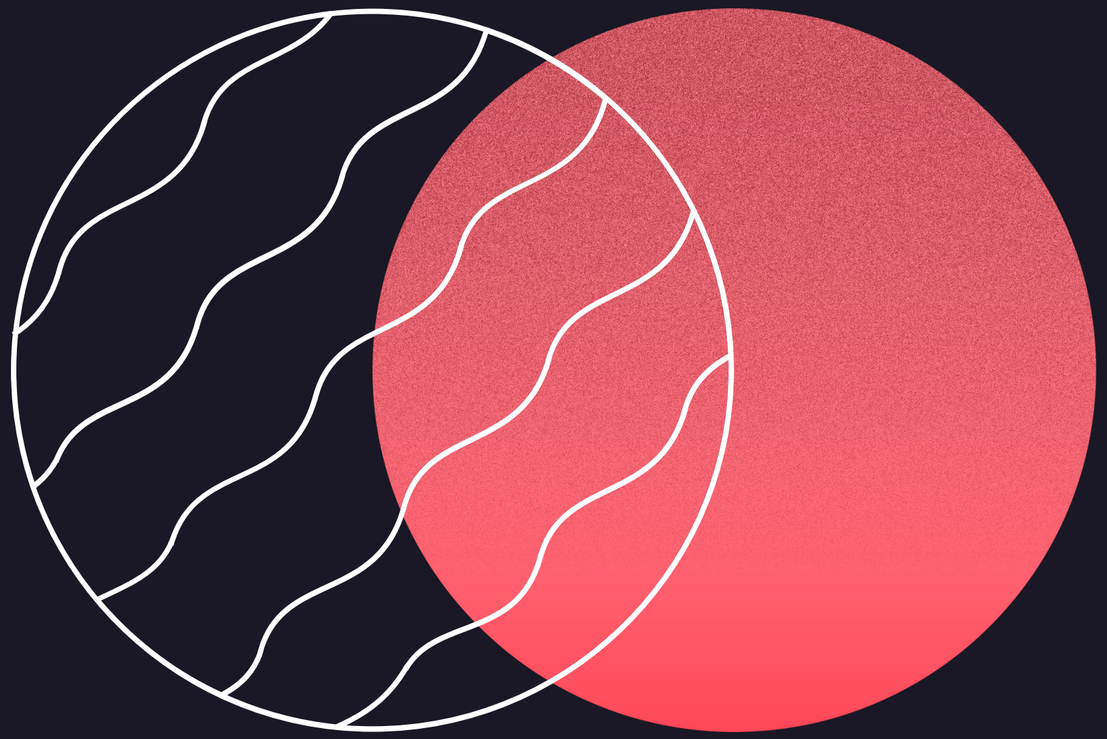
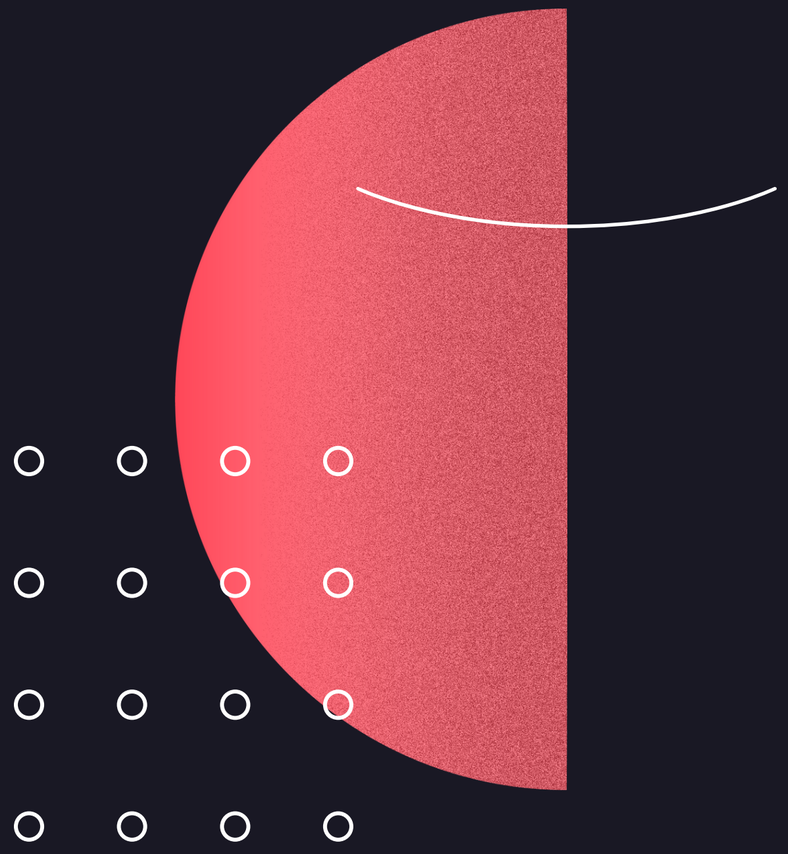


TinyML

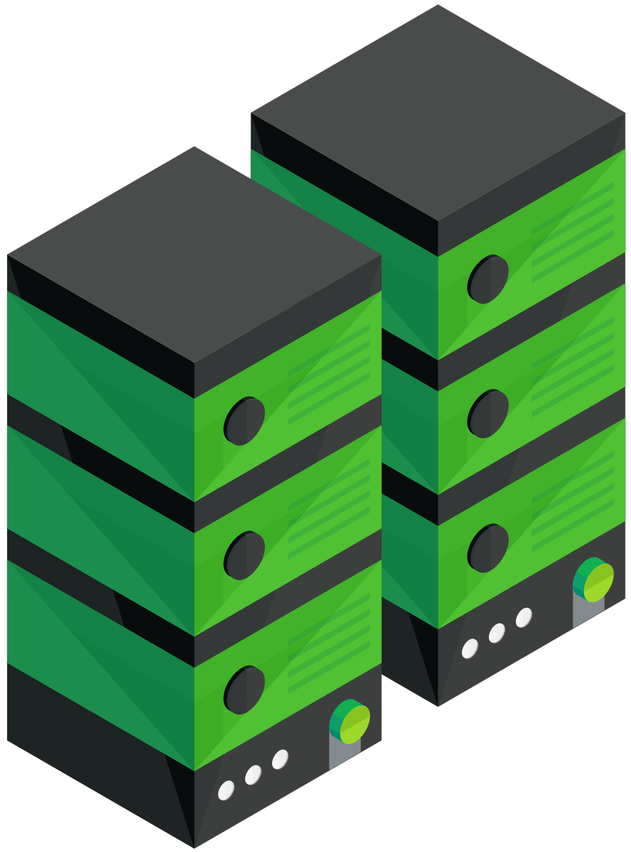
Machine Learning meets Embedded Systems

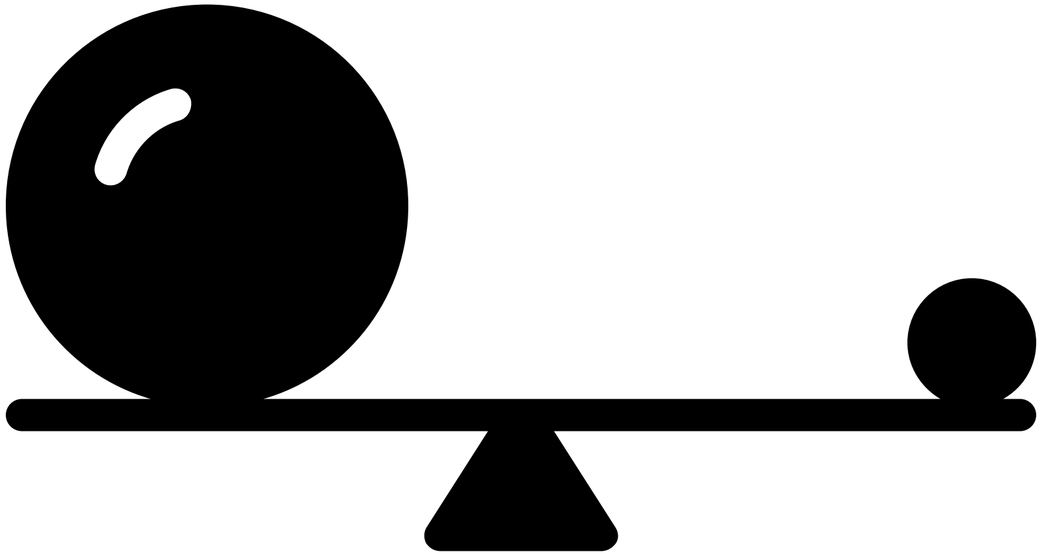
Machine Learning is Everywhere.



Training Machine Learning models is computationally expensive.

But running Inference is also expensive





BIGGER IS NOT ALWAYS BETTER

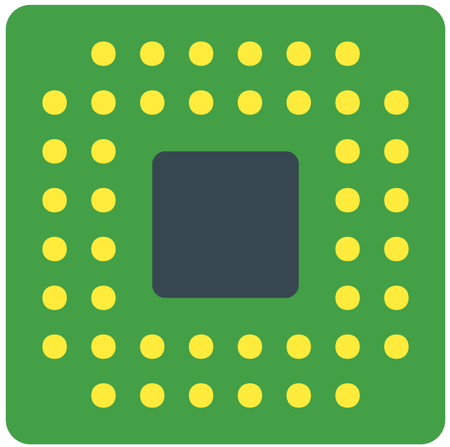
What is TinyML?

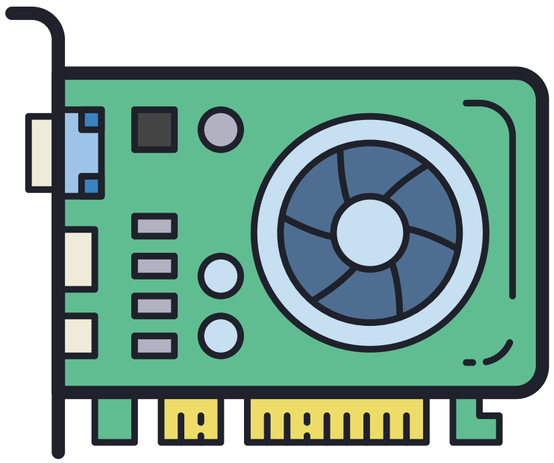
TinyML is a field of study in Machine Learning and Embedded Systems that explores the types of models you can run on small, low-powered devices like microcontrollers. It enables low-latency, low power and low bandwidth model inference at edge devices.

POWER CONSUMPTION

A typical desktop CPU consumes between 65W to 85W of power.

A typical desktop GPU consumes anywhere between 200W to 500W of power

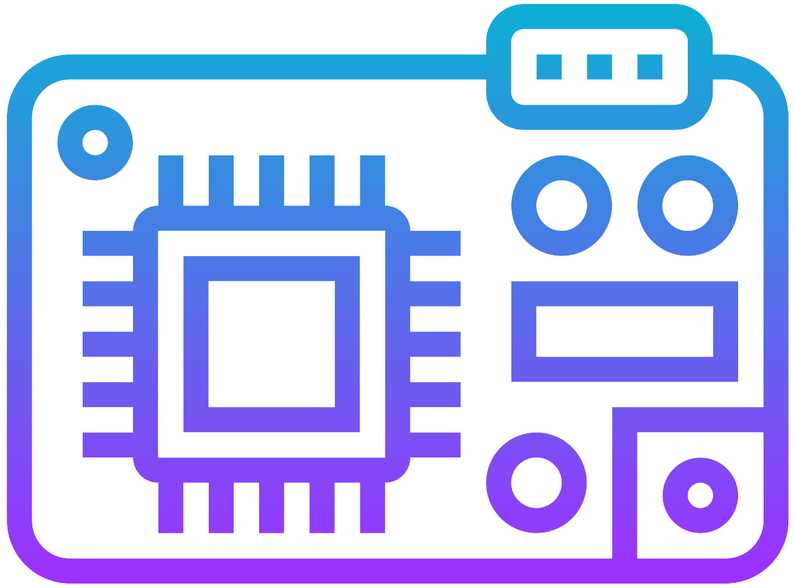




POWER CONSUMPTION

On the contrary, a microcontroller consumes power in the order of milliwatts or microwatts.

This low power consumption enables the TinyML devices to run unplugged on batteries for weeks, months, and in some cases, even years, while running ML applications on edge.



LATENCY

ML models deployed on cloud needs a reliable internet connection to work properly.

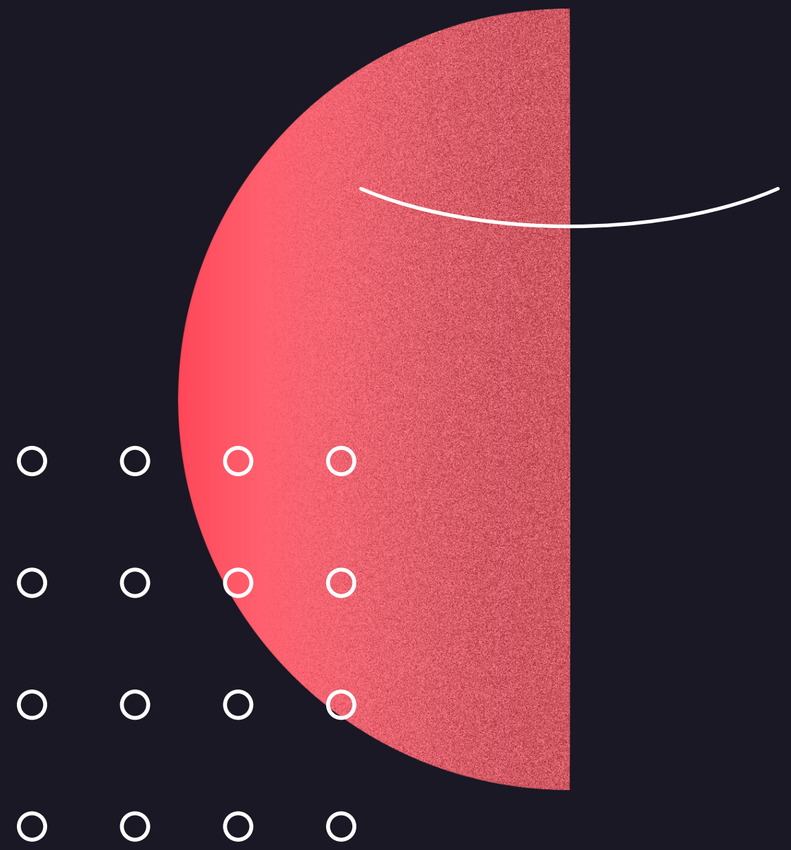
On the other hand, TinyML models are run on the edge. Hence, they don't need an internet connection to perform model inference.

The Future of ML is Tiny and Bright

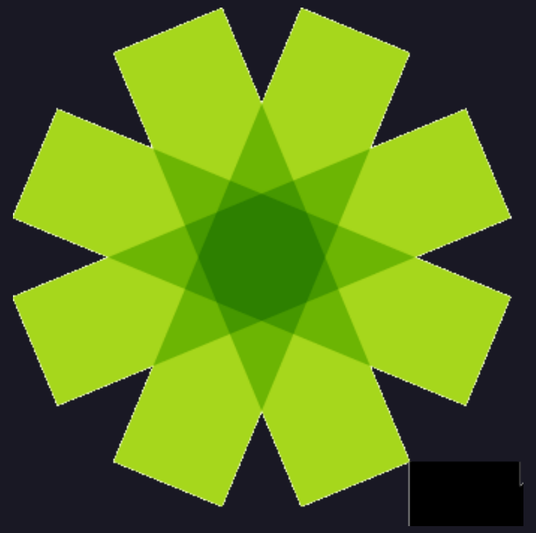
ADVANTAGES OF TINYML

- Low Power Consumption
- Low Latency
- Low Bandwidth
- Privacy

Applications of TinyML



Industrial Predictive Maintenance



Ping Services

Applications of TinyML

Healthcare

The Solar Scare Mosquito Project

Applications of TinyML

Agriculture

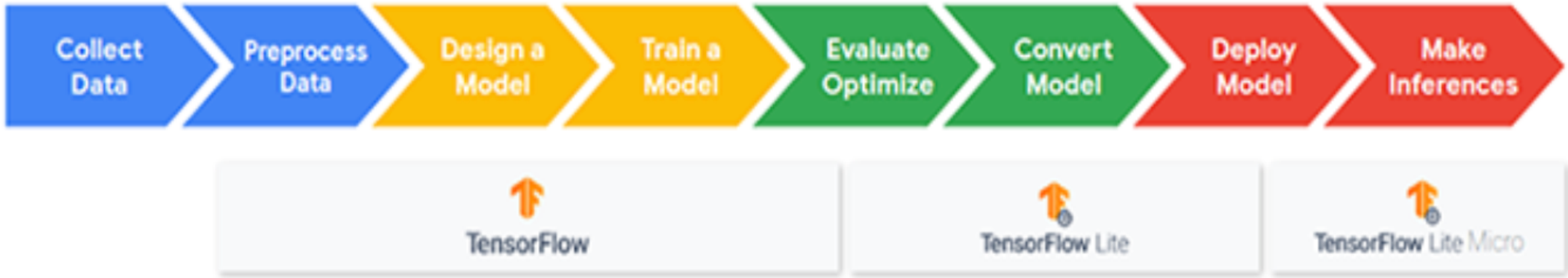
Nuru App

Applications of TinyML

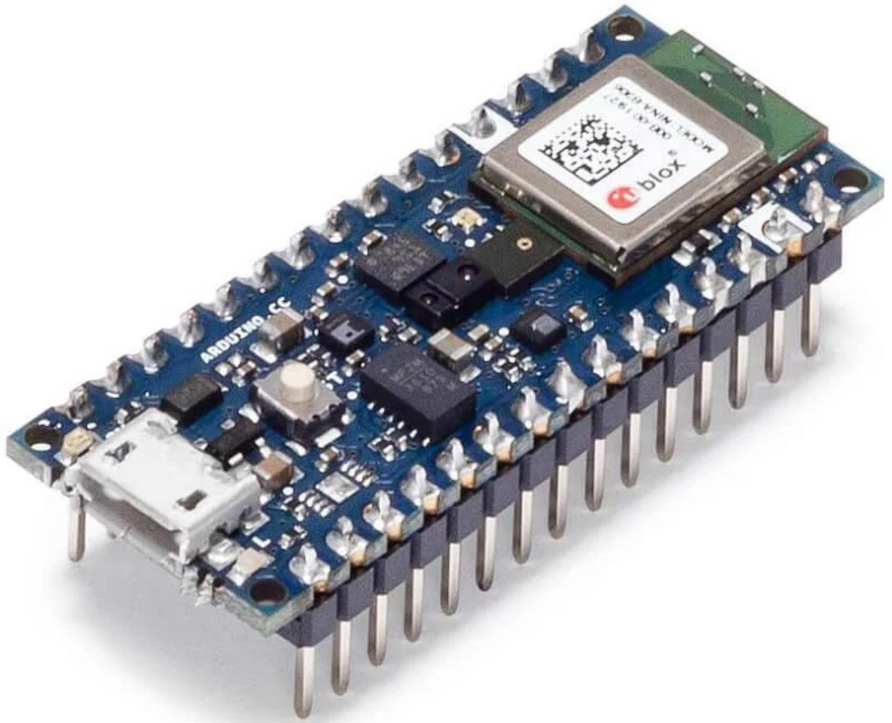
Ocean Life Conservation

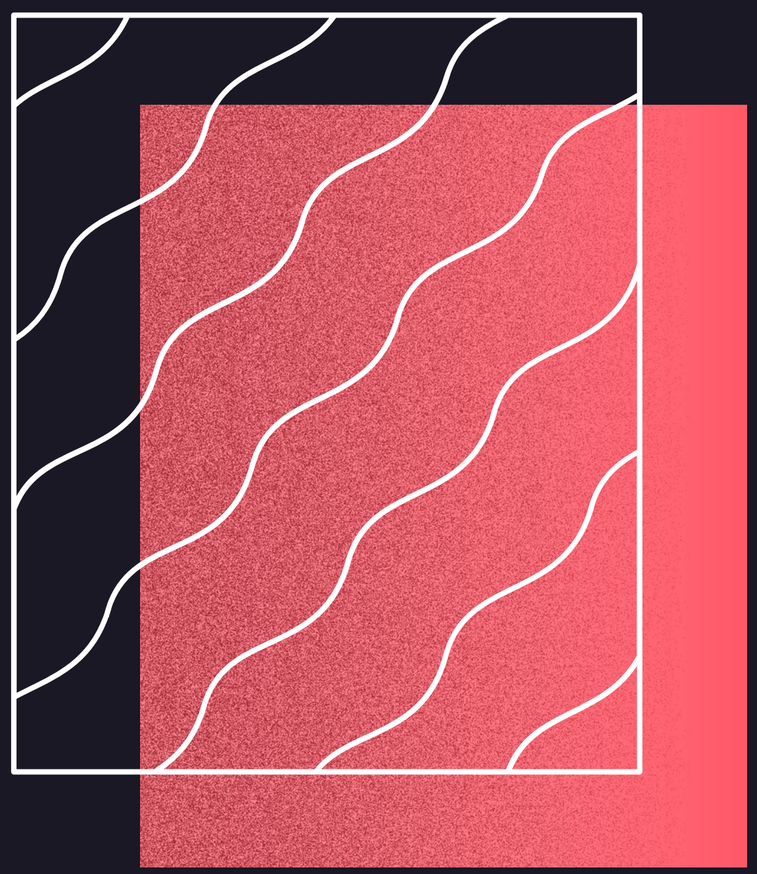
Real-time whale path detection

How do we do it?



How do we do it?





ARDUINO NANO 33 BLE SENSE

- Microcontroller - nRF52840
- Operating Voltage - 3.3V
- Clock Speed - 64MHz
- CPU Flash Memory - 1MB
- SRAM - 256KB
- Digital I/O Pins - 14

Sensors in Arduino Nano 33 BLE Sense

- 9 axis inertial sensor
- Humidity and temperature sensor
- Barometric sensor
- Microphone
- Gesture, proximity, light colour and light intensity sensor

TINYML ON ARDUINO NANO 33 BLE

Cheap

Low-Powered

Easily Accessible

TensorFlow Lite

Arduino IDE

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board.

Cartesiam NanoEdge

IDE + runtime for TinyML model development

Unlocking training and inferencing directly on the edge

OctoML Octomizer

Model optimizer

Taking larger ML models and effectively reducing their size to run on MCUs

Neuropilot-Micro

Runtime fully optimized for the MT3620

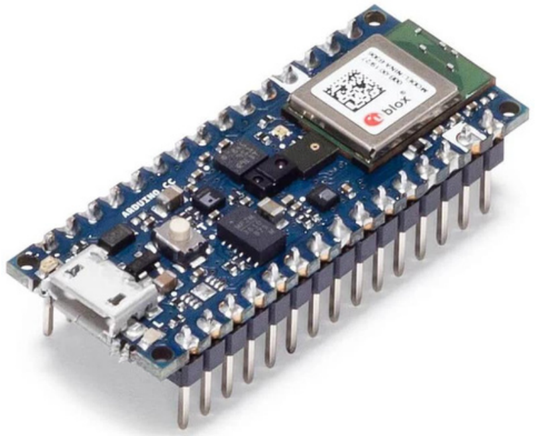
Taking full advantage of hardware acceleration, on-chip memory and dual-core architecture of the MCU

EDGE IMPULSE

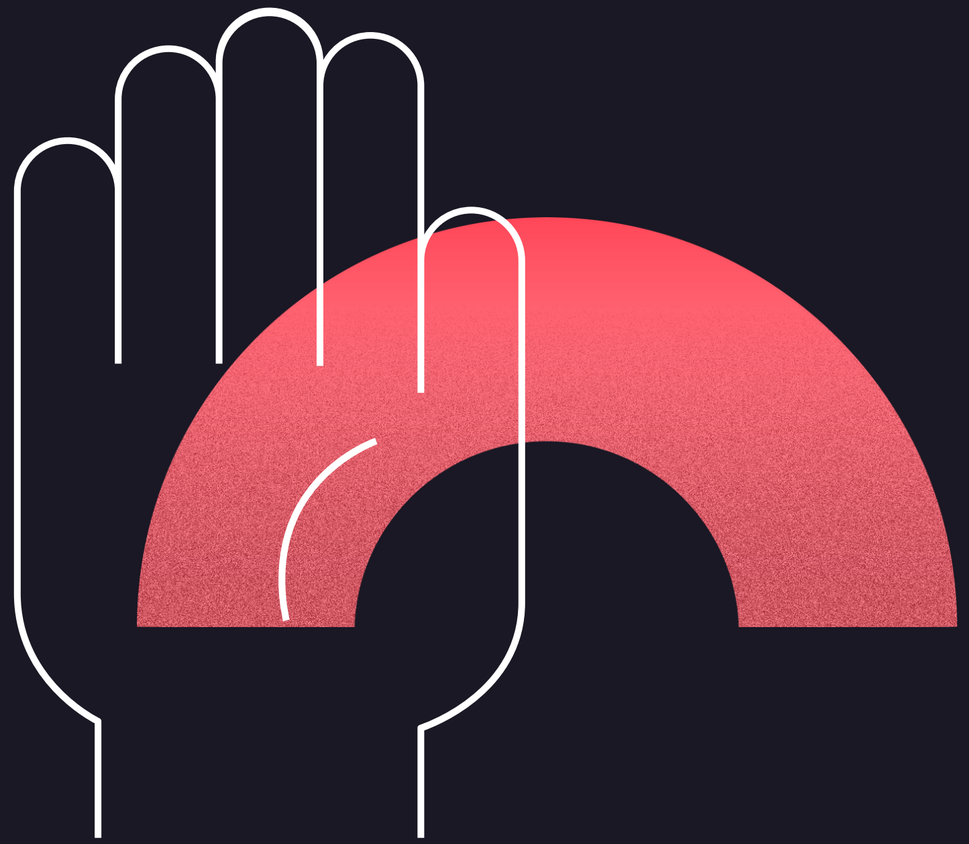
IDE for TinyML model development

Focusing on ease of use for the TinyML novice up through expert users and even collaborative, enterprise teams

How is this better than a Raspberry Pi or an Nvidia Jetsaon



VS



QUESTIONS?

DEMO

Hello World in TinyML

Magic Wand

Micro Speech

Chainsaw Detection

THANKS!

/arunkumar-l

/CleanPegasus

/CleanPegasus