Tiny ML

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Collaborations:

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European Network on High Performance and Embedded Architecture and Compilation

Pakistan Supercomputing Center

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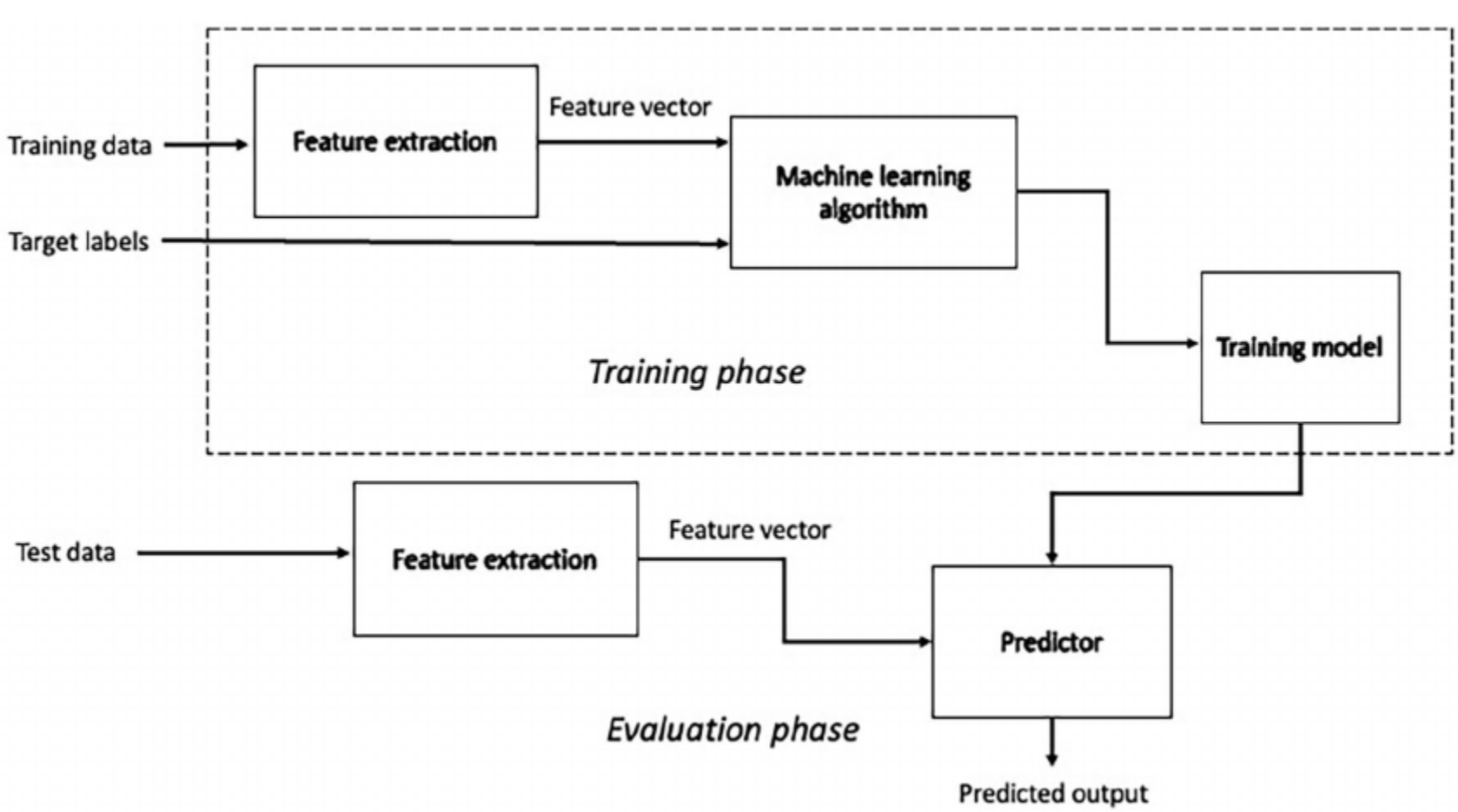
Supervised ML



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What is TinyML

- The usual definition is running machine learning on embedded devices at an average of less than one milliwatt in power.
- This power requirement is important because it allows unattended devices on batteries or energy harvesting.
- Here we'll stretch the definition temporarily to include MCUs that use 10's of mWs, since they're easier to work with and widely available

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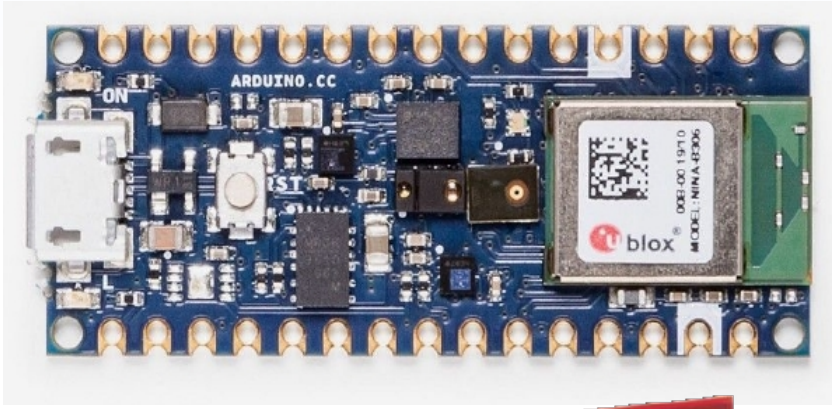
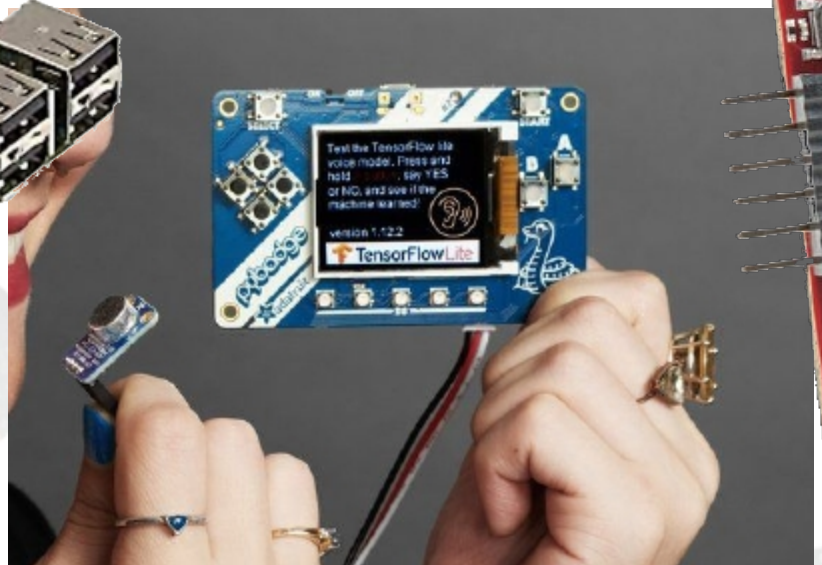
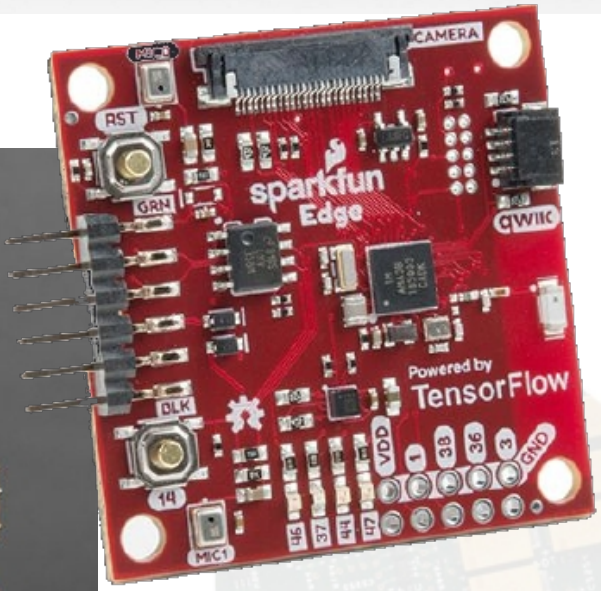
Targeted Hardware

Single Board Computer (SBC)
Low Performance
Low Power
Low Cost







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Software Development Framework

- tensorflow.org/lite/microcontrollers!
  - It fits in less than 20KB of binary footprint, and has no operating system, malloc/free or C library dependencies, so it can run on bare metal.
- github.com/uTensor/uTensor
- edgeimpulse.com
- cartesiam.ai
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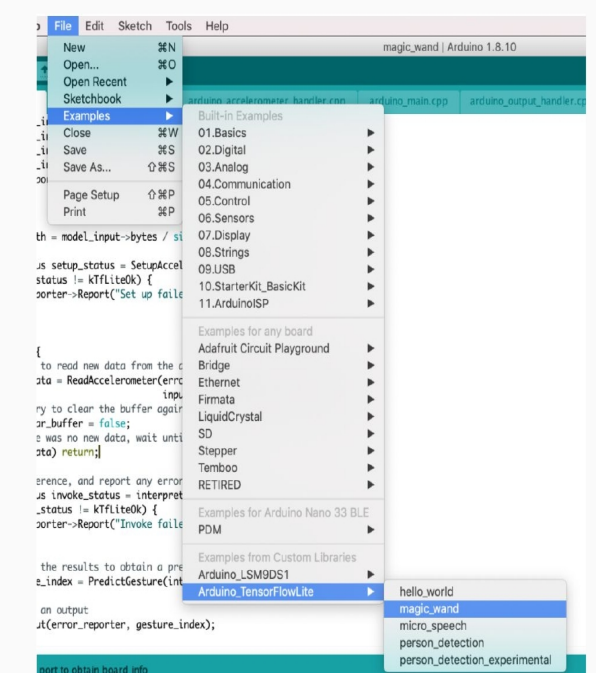

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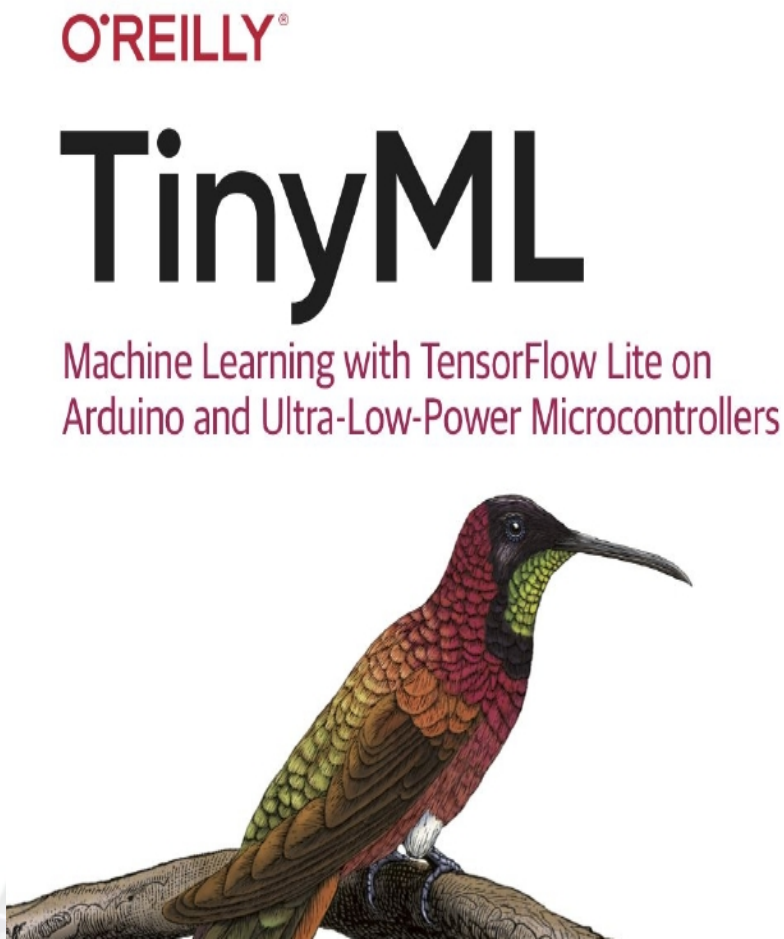
Data and Literature



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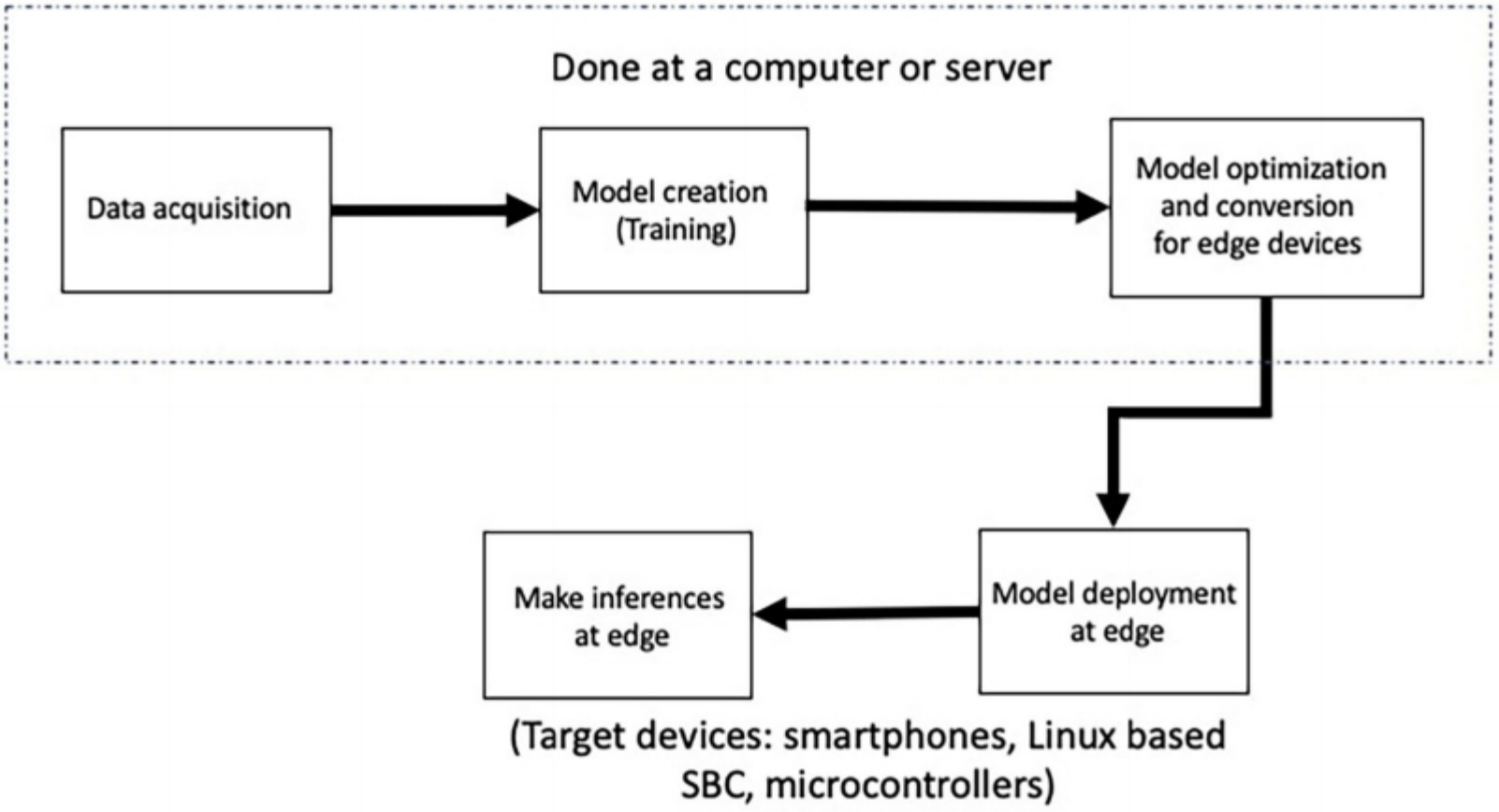
TinyML Model Deployment



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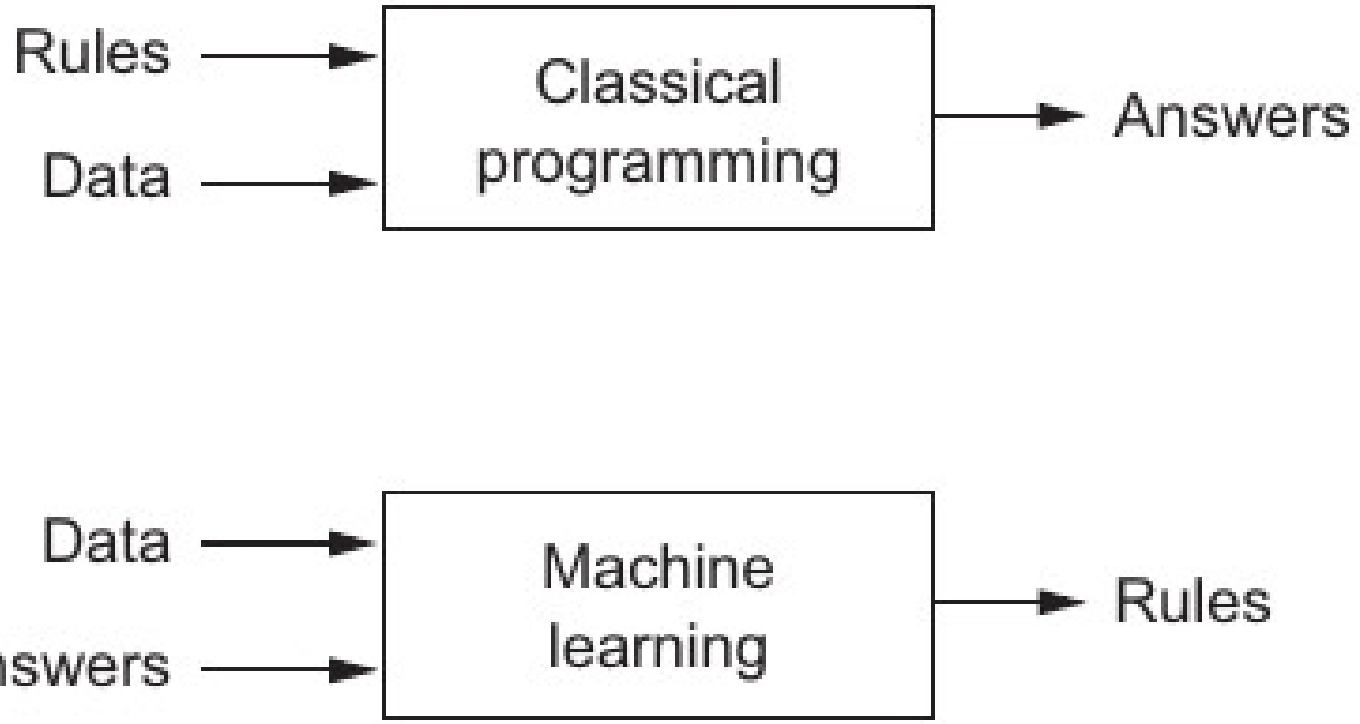
Conventional VS ML Programming



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Applications

- Keyword Spotting:
- Gesture Recognition:
- Anomaly Detection in Sensor Data:
- Health Monitoring:
- Object Detection in Edge Cameras:
- Industrial IoT (IIoT) Applications:
- Environmental Monitoring:

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Solvers and Models

- Utensor
- CMSIS-NN (Cortex Microcontroller Software Interface Standard - Neural Network):
- TensorFlow Lite for Microcontrollers:
- EdgeML:
- MicroML

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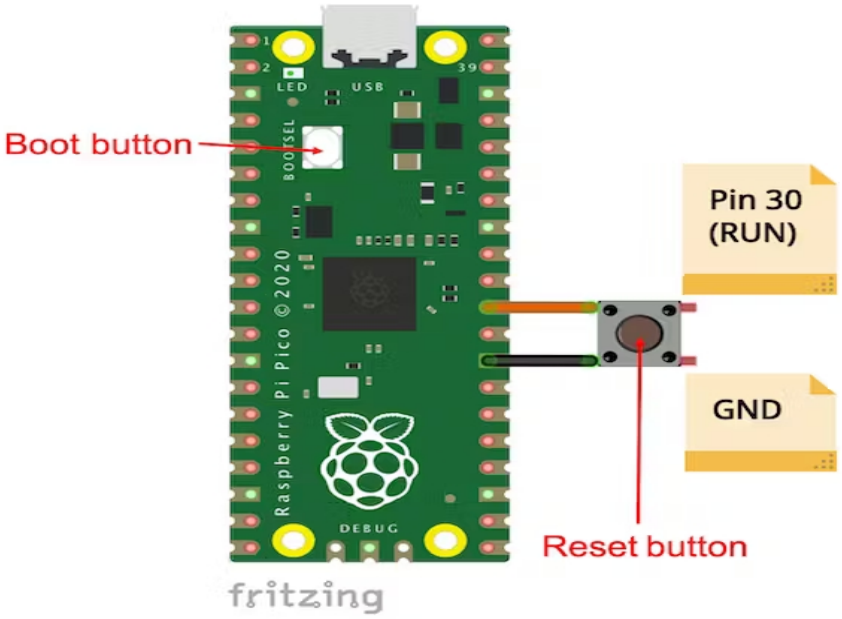
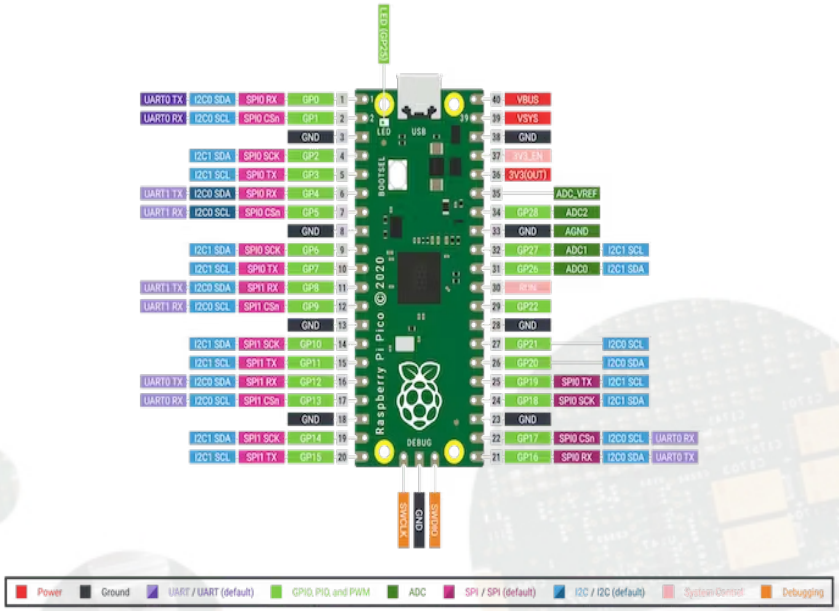
Example

- Micro RaspperyPi





- https://github.com/ShawnHymel/tinyml-example-anomaly-detection

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First Neural Network

- import tensorflow as tf
- import numpy as np
- from tensorflow import keras
-
- # define a neural network with one neuron
- model = tf.keras.Sequential([keras.layers.Dense(units=1, input_shape=[1])])
-
- # use stochastic gradient descent for optimization and
- # the mean squared error loss function
- model.compile(optimizer='sgd', loss='mean_squared_error')
-
- # define some training data (xs as inputs and ys as outputs)
- xs = np.array([-4.0, -2.0, 2.0, 4.0, 6.0, 8.0], dtype=float)
- ys = np.array([-3.0, -1.0, 1.0, 3.0, 5.0, 7.0], dtype=float)
-
-
- # fit the model to the data (aka train the model)
- model.fit(xs, ys, epochs=300)
-
- print(model.predict([20.0]))

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