

Tiny ML Tassadaq Hussain Professor Namal University Director Centre for AI and Big Data

Collaborations:

Barcelona Supercomputing Center Barcelona, Spain European Network on High Performance and Embedded Architecture and Compilation Pakistan Supercomputing Center





Supervised ML



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



Targeted Hardware

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





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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Data and Literature

O'REILLY[®] TinyML

Machine Learning with TensorFlow Lite on Arduino and Ultra-Low-Power Microcontrollers



TinyML Model Deployment



Conventional VS ML Programming





Applications

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

Solvers and Models

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

Example

Micro RaspperyPi





 https://github.com/ShawnHymel/tinymlexample-anomaly-detection



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]))