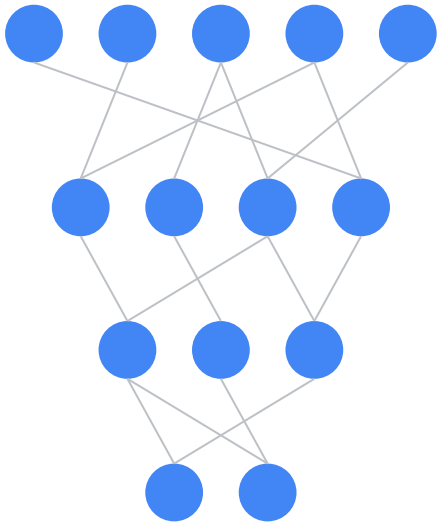
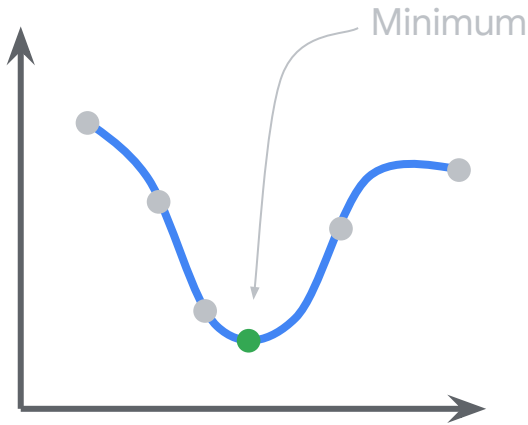
Preview of TinyML Applications

Acoustic Sensors
Ultrasonic, **Microphones**, Geophones, Vibrometers

Image Sensors
Thermal, **Image**

Motion Sensors
Gyroscope, Radar, **Accelerometer**





TinyML Application Areas

Home

Office

Industry

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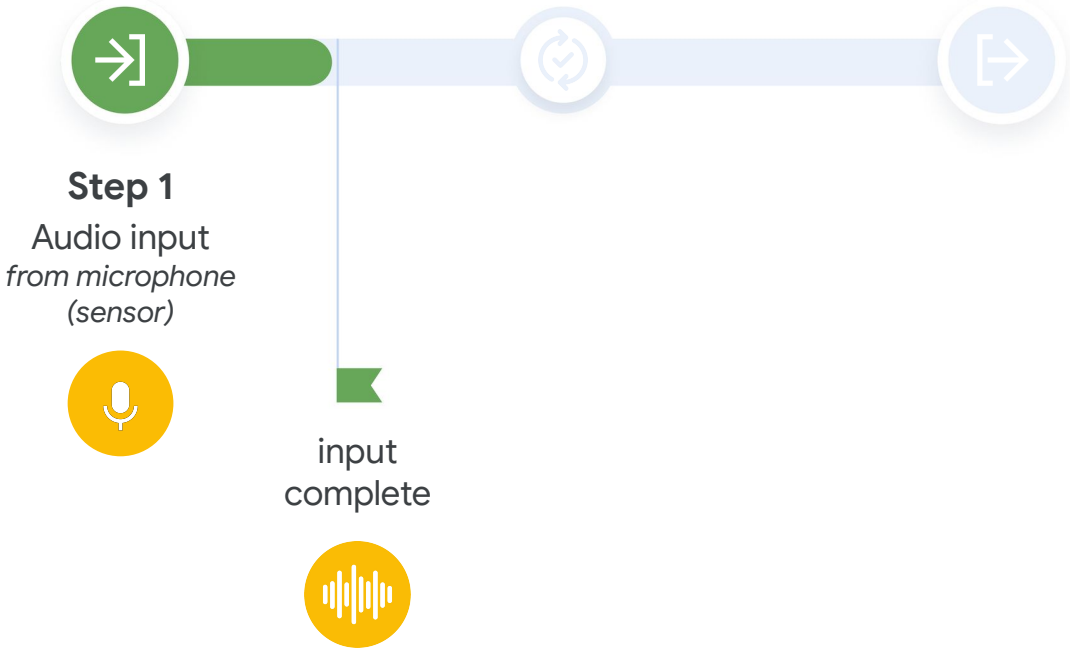
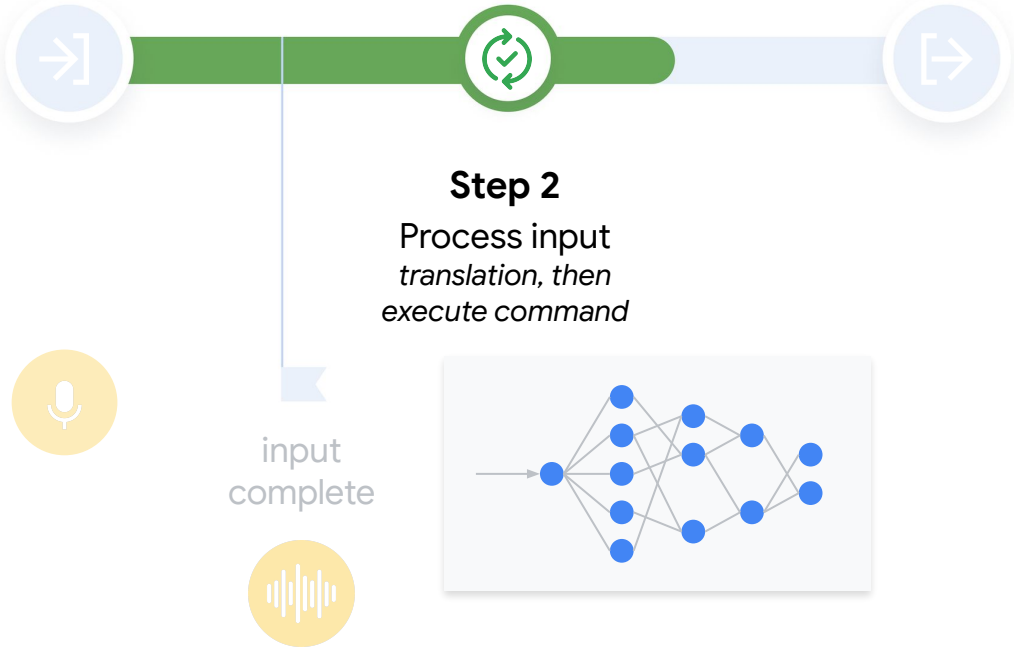
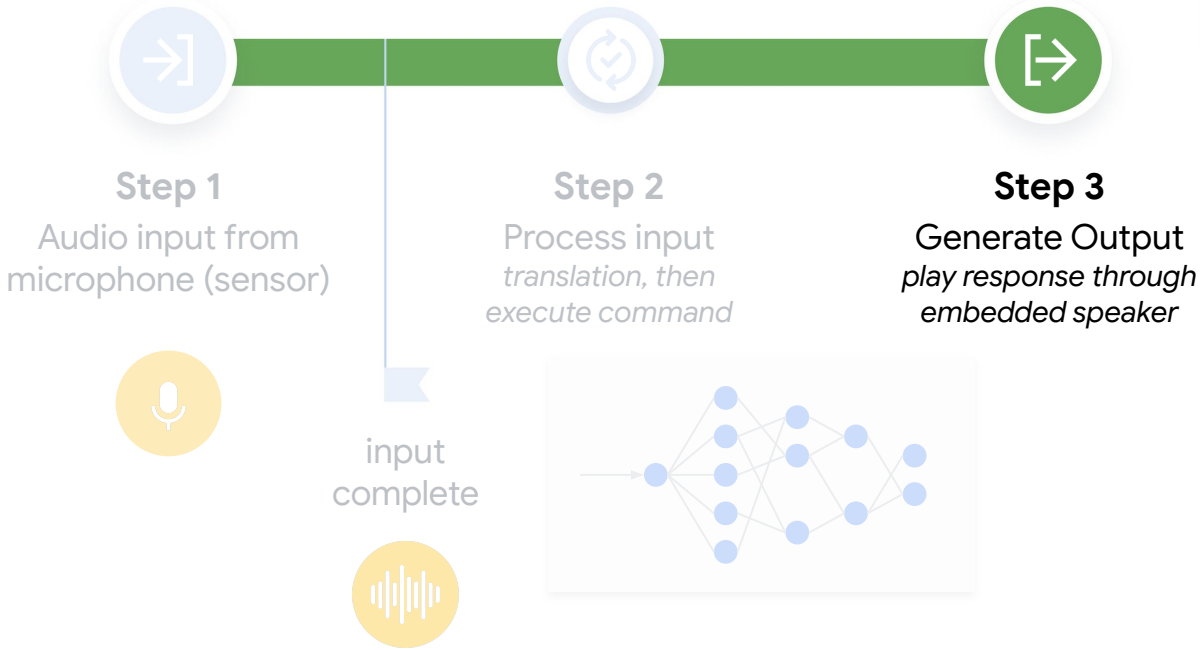
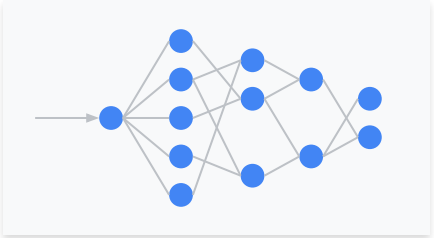
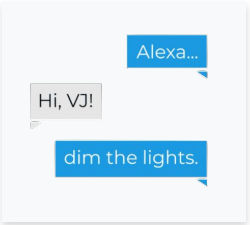
Keyword Spotting


Step 1
Audio input
from microphone
(sensor)
input
complete


Step 2
Process input
translation, then
execute command
input
complete


Alexa...
Hi, VJ!
dim the lights.
Step 1
Audio input from microphone (sensor)
Step 2
Process input
translation, then execute command
Step 3
Generate Output
play response through embedded speaker
input complete




Alexa...
Hi, VJ!
dim the lights.

Questions

- How do we **capture** the data to feed into the neural network?
- How do you **design** the neural network to take in the speech signal?
- What **dataset** does the neural network need to be trained?
- How do we **pre-process** the data for neural network inference?
- How do you **post-process** the neural network output?
- How do you make sure there is no **bias** in the dataset?
- How do you **deploy** this on the microcontroller?

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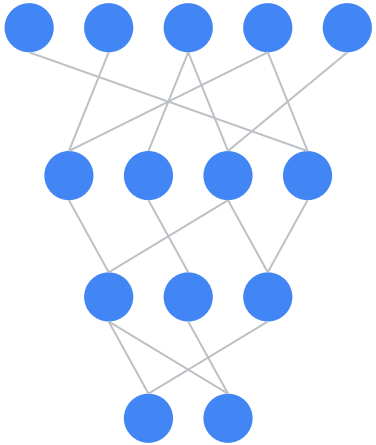
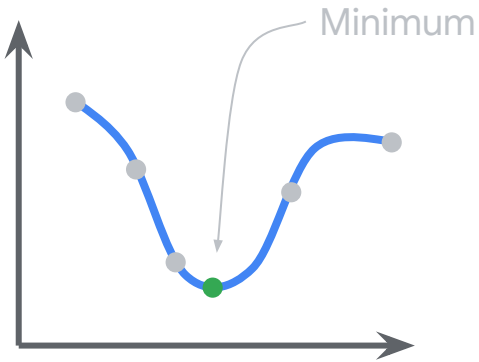
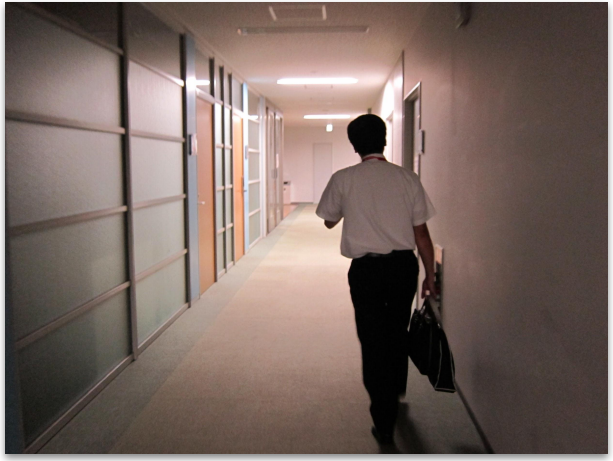
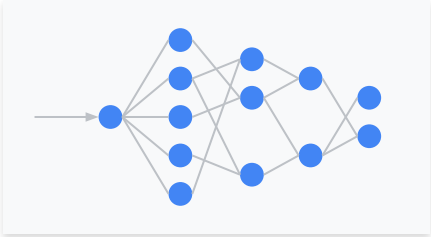
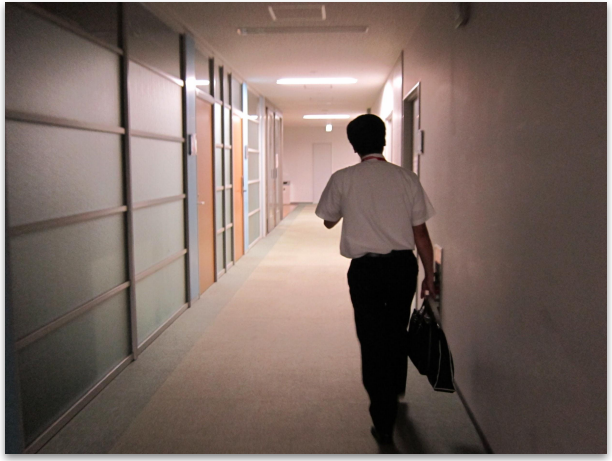
Image Sensors
Thermal, **Image**

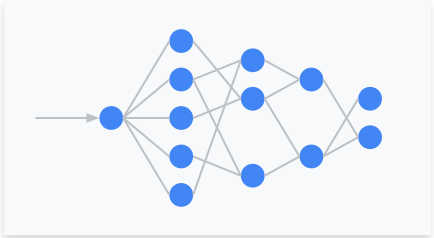


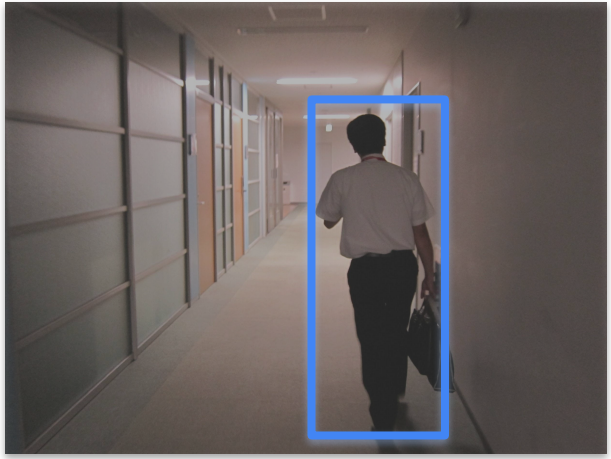






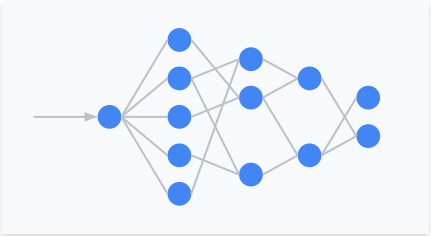






ML Model Evolution

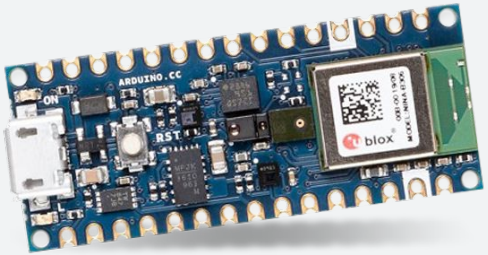
- **MobileNet** (2015)
  - ***MobileNetv1***
    - 70.6% accuracy
    - 16.9MB in size



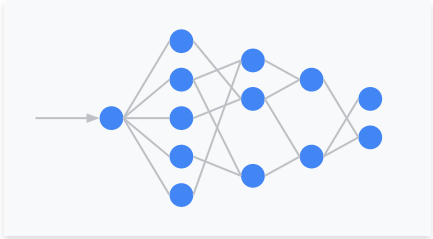
Source: S. Bianco, R. Cadene, L. Celona, and P. Napoletano, "Benchmark analysis of representative deep neural network architectures," *IEEE Access*, vol. 6, pp. 64 270–64 277, 2018

Problem

Our board (in your kit for Course 3) only has **256KB** of RAM (memory) yet ***MobileNetv1*** needs **16.9MB**!



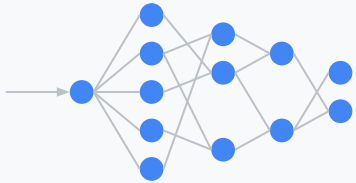
How do we engineer a **TinyML** vision network?



Think:

- Compute **operations**
- Operator **numerics**
- **Compression** methods (e.g., pruning, quantization)

What is the **end-to-end** workflow?



Questions

- How do we **capture** the data to feed into the neural network?
- How do you **design** the neural network to take in the image?
- What **dataset** does the neural network need to be trained?
- How do we **pre-process** the data for neural network inference?
- How do you **post-process** the neural network output?
- How do you make sure there is no **bias** in the dataset?
- How do you **deploy** this on the microcontroller?
- *How do we ensure that the neural network is **resilient**?*
- *How do we get the neural network to **train faster**?*

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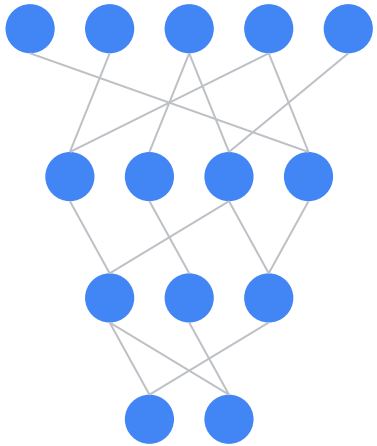

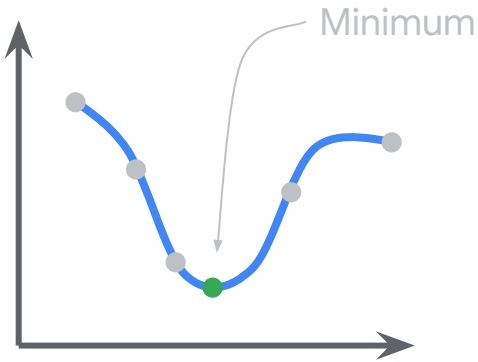

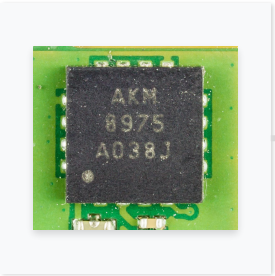
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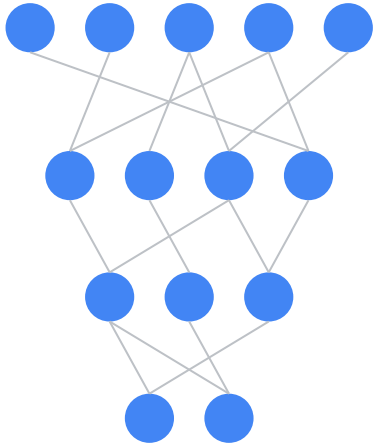
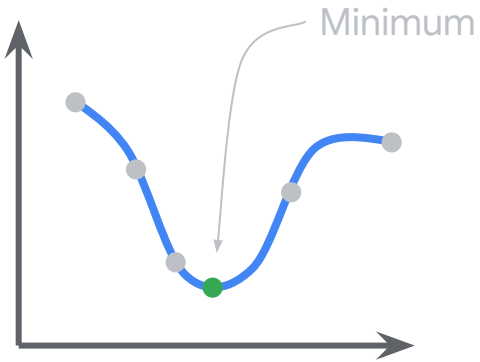
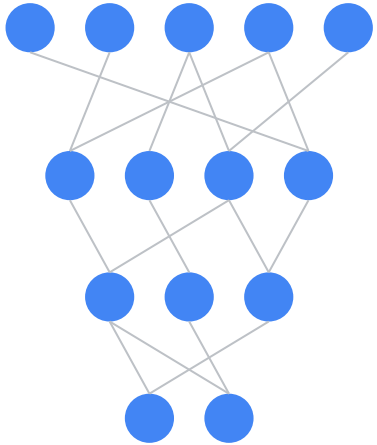
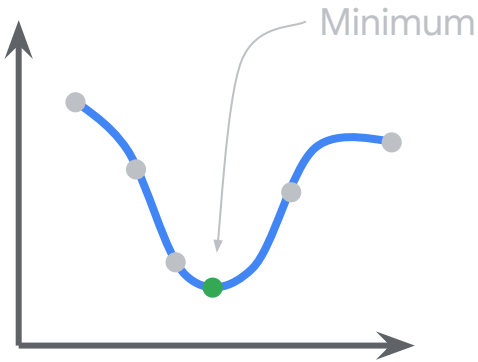



Minimum

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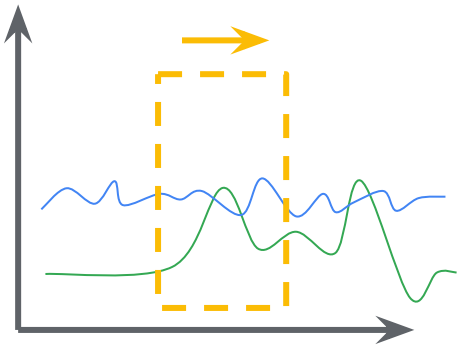

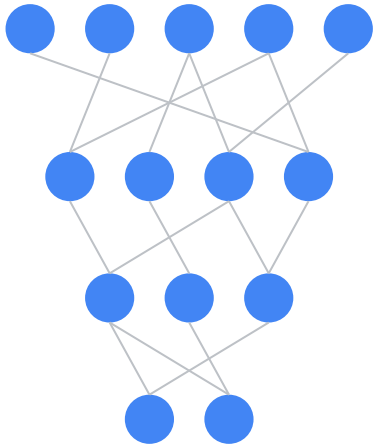

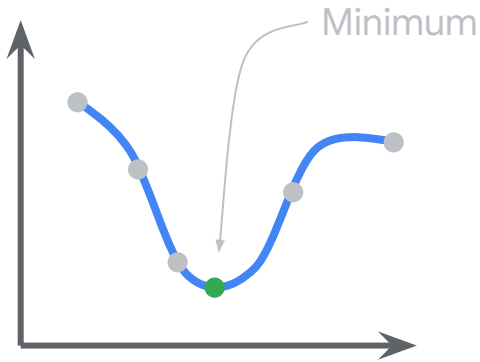
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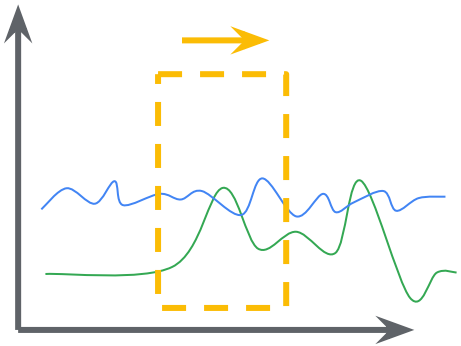
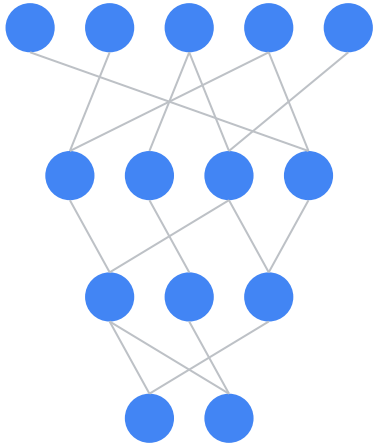
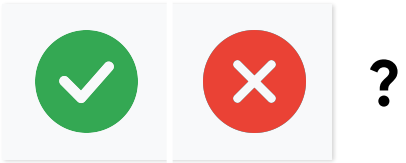
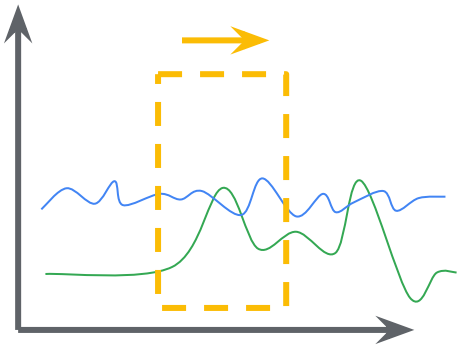
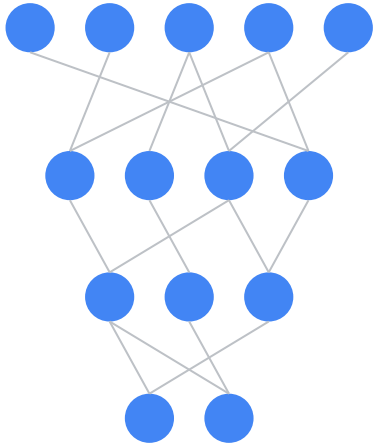
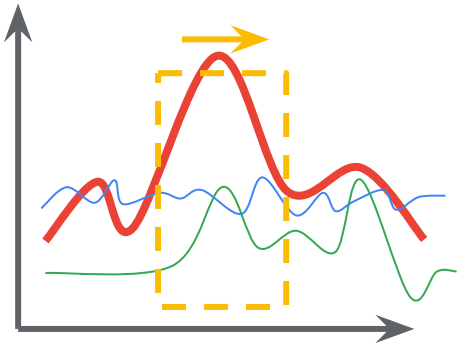


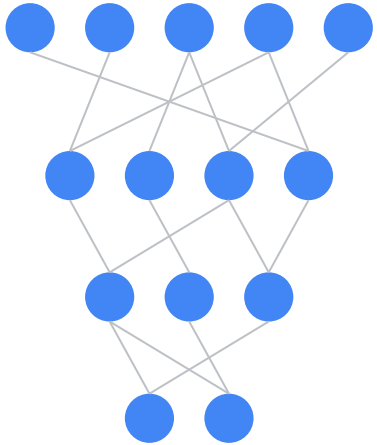


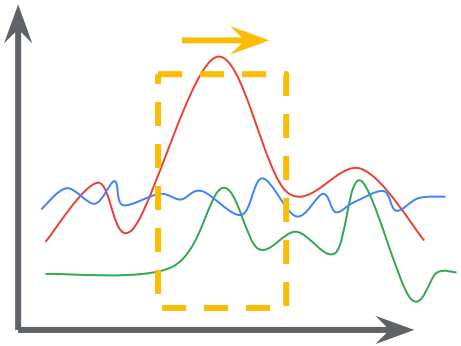


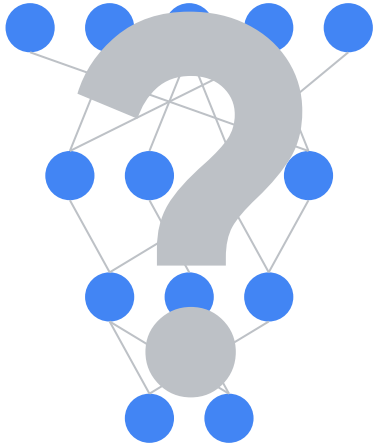


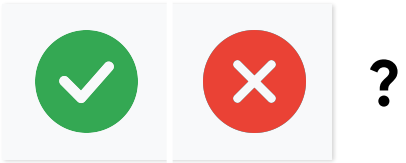




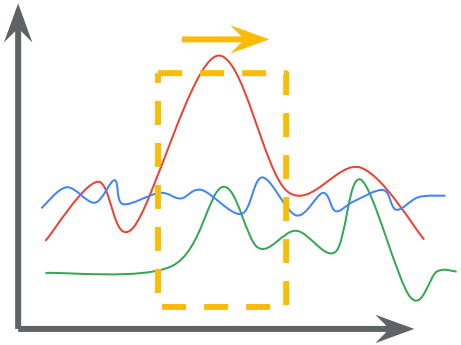


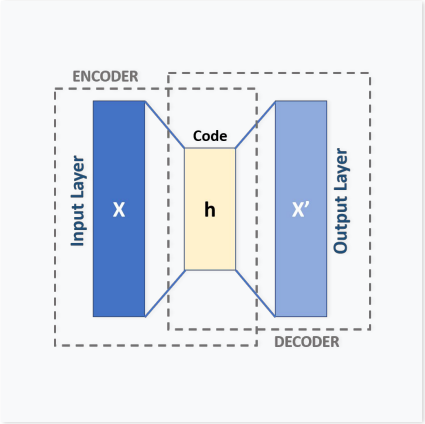






Autoencoder





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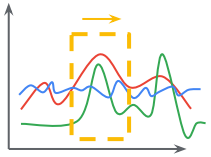
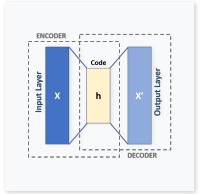
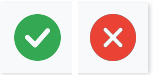
Questions







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- *How do we **capture** the **time-series** data to feed into the neural network?*
- How do we **pre-process** the data for neural network inference?
- *How do you **design** the **autoencoder** neural network?*
- What **dataset** does the neural network need to be trained?
- How do you **post-process** the neural network output?
- How do you make sure there is no **bias** in the dataset?
- How do you **deploy** this on the microcontroller?