

Machine Learning for Embedded Software Engineers

Class 1: Introduction to Machine Learning

April 22, 2019
Jacob Beningo

Course Overview

Topics:

- **Introduction to Machine Learning**
- Machine Learning Architectures for Embedded Systems
- Machine Learning Applications: Vision and Speech
- Machine Vision with OpenMV
- Near Real-time Machine Learning using Coral

The Lecturer – Jacob Beningo



Jacob Beningo

Principal Consultant



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EDN : Embedded Basics

ARM Connected Community

Consulting

- Advising
- Coaching
- Content
- Consulting
- Training

www.beningo.com

Jacobs CEC Courses

CEC 2013 – 2015

Fundamentals of Embedded Software (2013)

Mastering the Software Design Cycle (2014)

Python for Embedded Systems(2014)

Software Architecture Design (2014)

Baremetal C (2015)

Mastering the ARM Cortex-M Processor (2015)

Writing Portable and Robust Firmware in C (2015)

Design Patterns and the Internet (2015)

CEC 2016 - 2017

Bootloader Design for MCUs (2016)

Rapid Prototyping w/ Micro Python (2016)

Debugging (2016)

Professional Firmware (2016)

API's and HAL's February 2017

Baremetal to RTOS April 2017

Designing IoT Sensor Nodes July 2017

From C to C++ October 2017

CEC 2018

Connecting Edge Devices (March 2018)

Building an IoT Connected PLC (April 2018)

Securing IoT Devices using Arm TrustZone (Nov 2018)

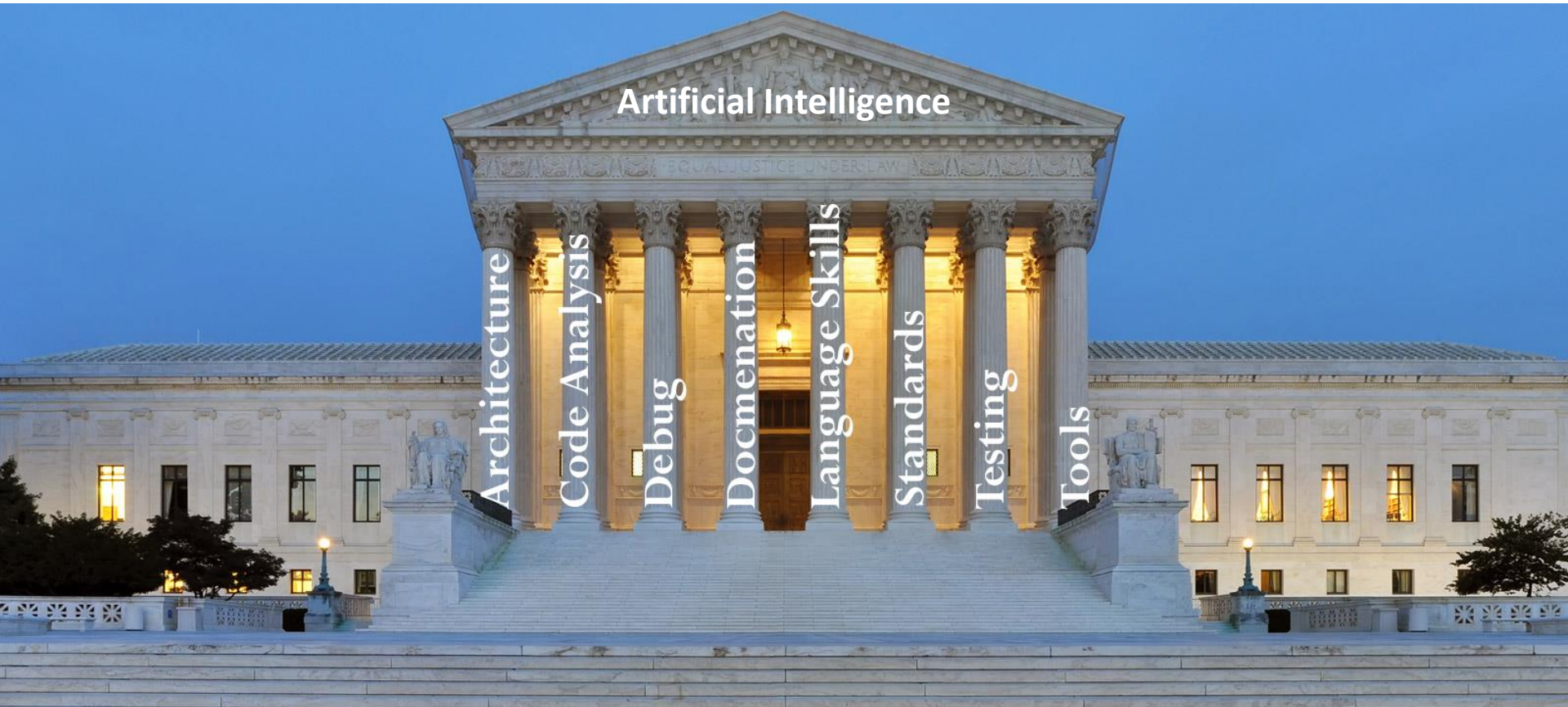
Minimizing Defects (Dec 2018)

CEC 2019

Machine Learning for Embedded (April 2019)

Minimizing Defects (Dec 2018)

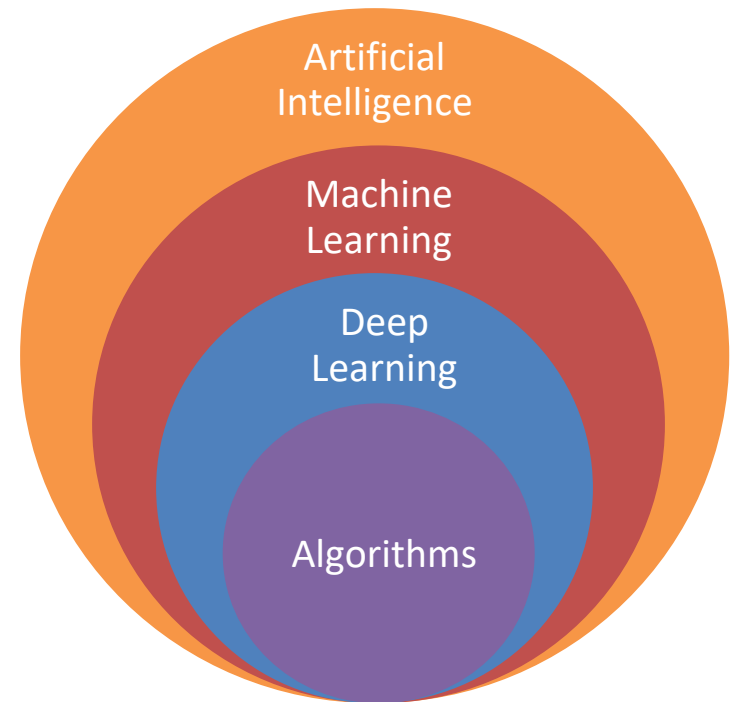
Introduction



Designing Intelligent Systems – Machine Learning

“Machine learning is a field of computer science that often uses statistical techniques to give computers the ability to ‘learn’ with data, without being explicitly programmed”

Wikipedia



Designing Intelligent Systems – Machine Learning

Why do we need intelligent systems?

- To solve problems that are not easy for humans to code for
- To scale system behaviors and results based on new data and situations
- To perform tasks that are easy for a human but traditionally difficult for computers
- To decrease system costs in certain applications
- Because it's cool and cutting edge

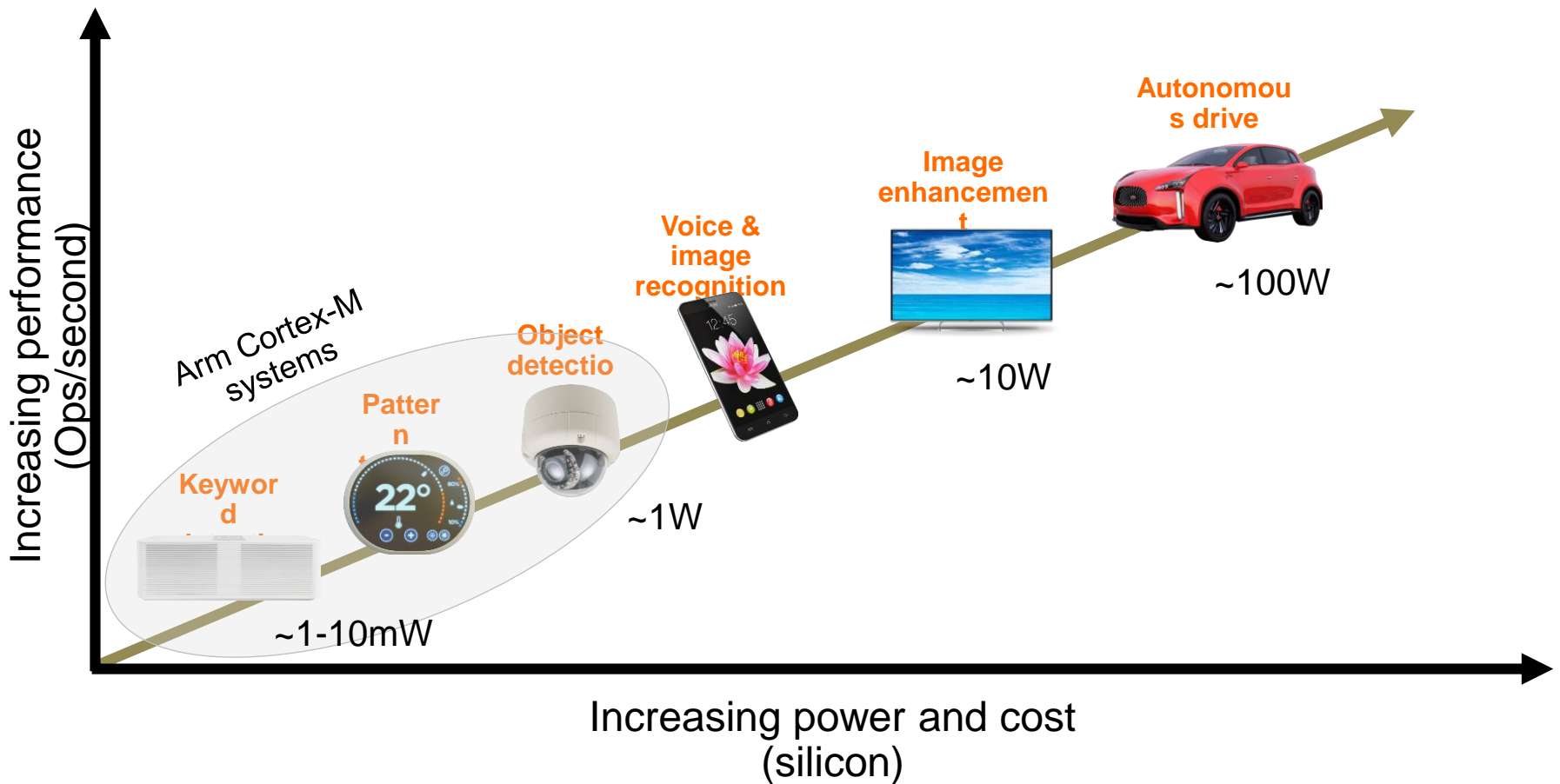
Designing Intelligent Systems – Machine Learning

What can machine learning be used for?

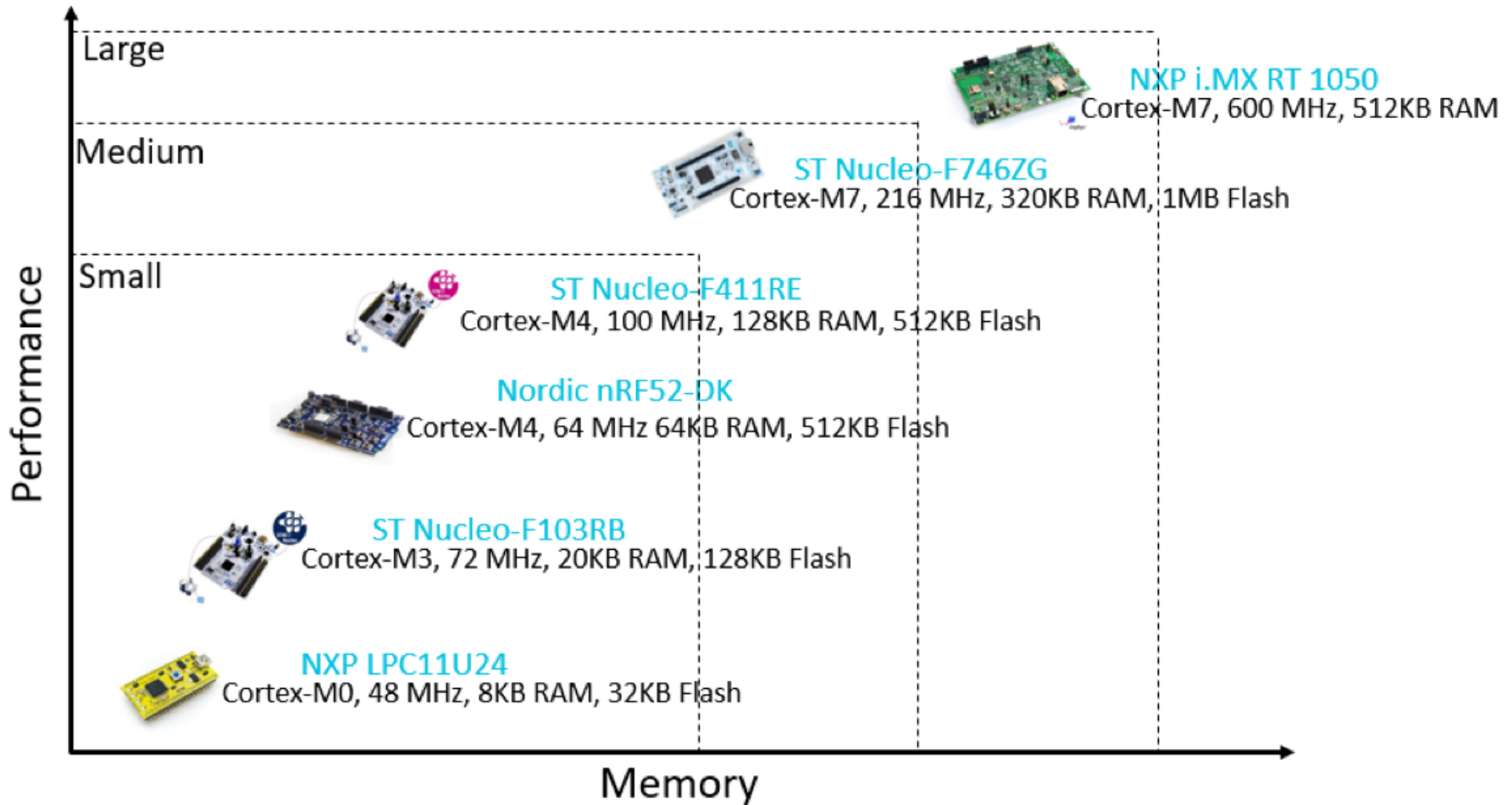
- Image recognition
- Speech and audio processing
- Language processing
- Robotics
- Bioinformatics
- Chemistry
- Video Games
- Search



Range of “Edge” Applications



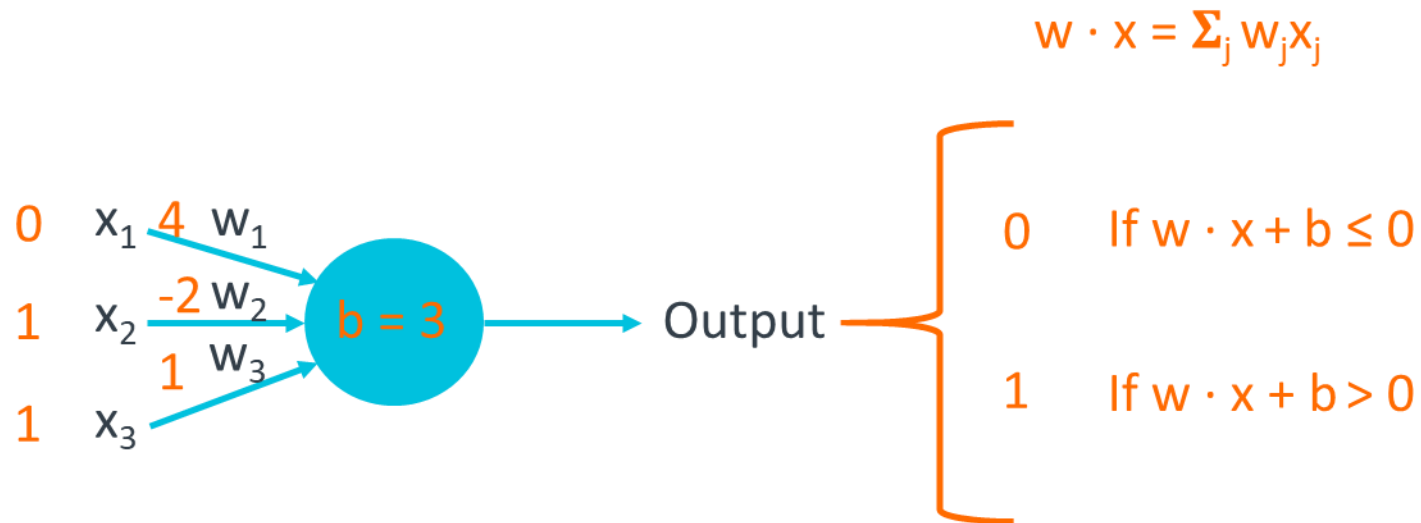
Understand the Context: Cortex-M based Platforms



More boards at:
<https://os.mbed.com/platforms/>

Machine Learning Basics – Deep Learning

Perceptron Neuron

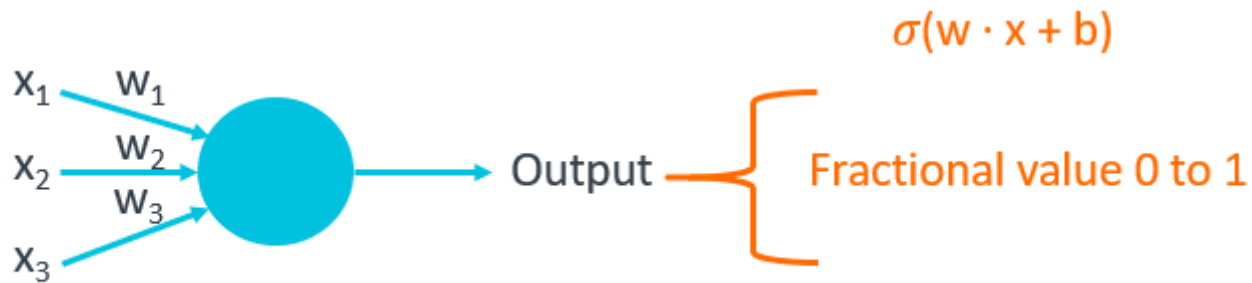


$$w \cdot x = (0 * 4) + (1 * -2) + (1 * 1) = -1$$

$$w \cdot x + b = -1 + 3 = 2 > 0$$

Machine Learning Basics – Deep Learning

Sigmoid Neuron

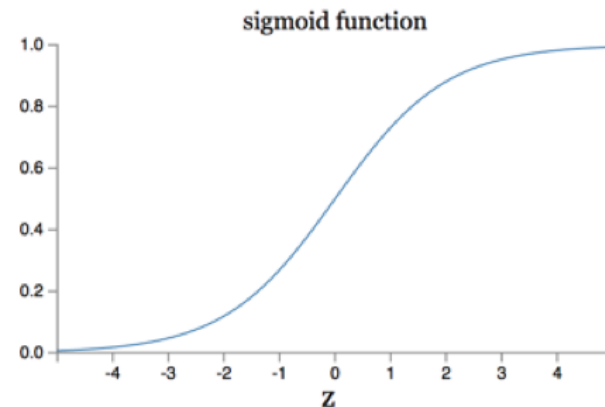
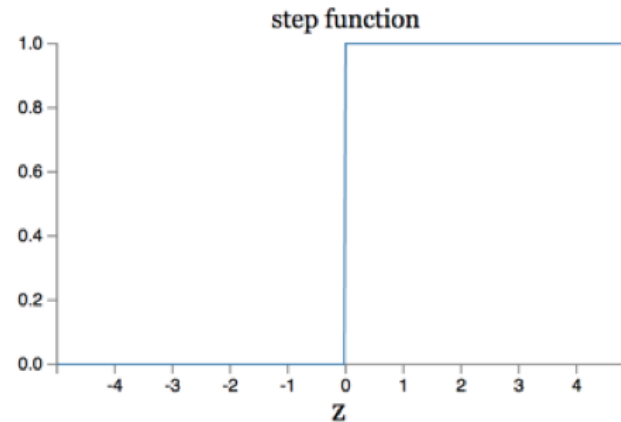


Machine Learning Basics – Deep Learning

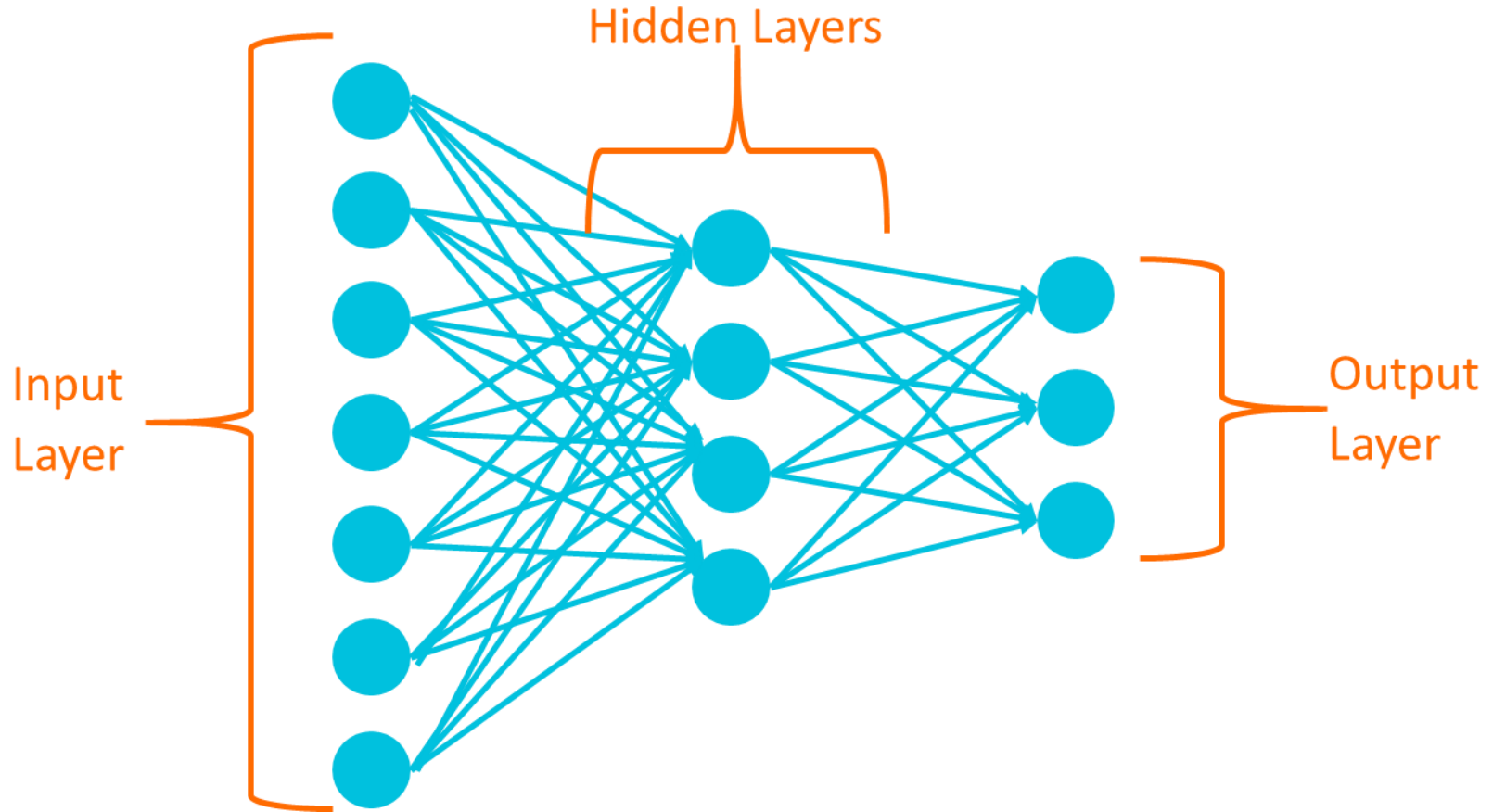
The Sigmoid Function

$$\sigma(z) \equiv \frac{1}{1 + e^{-z}}$$

$$\frac{1}{1 + \exp(-\sum_j w_j x_j - b)}$$



Machine Learning Basics – Deep Learning



Resources

- <https://www.youtube.com/watch?v=aircAruvnKk>
- <https://www.youtube.com/watch?v=IHZwWFHWa-w>
- <https://www.youtube.com/watch?v=llg3gGewQ5U>
- <https://www.youtube.com/watch?v=tleHLnjs5U8>

Additional Resources

- Download Course Material for
 - C/C++ Doxygen Templates
 - Example source code
 - Blog
 - YouTube Videos
- Embedded Bytes Newsletter
 - <http://bit.ly/1BAHYXm>



From www.beningo.com under

- Blog > CEC – Machine Learning for Embedded Software Engineers