Navigating the Fragmented Machine Learning Ecosystem for Hardware Devices

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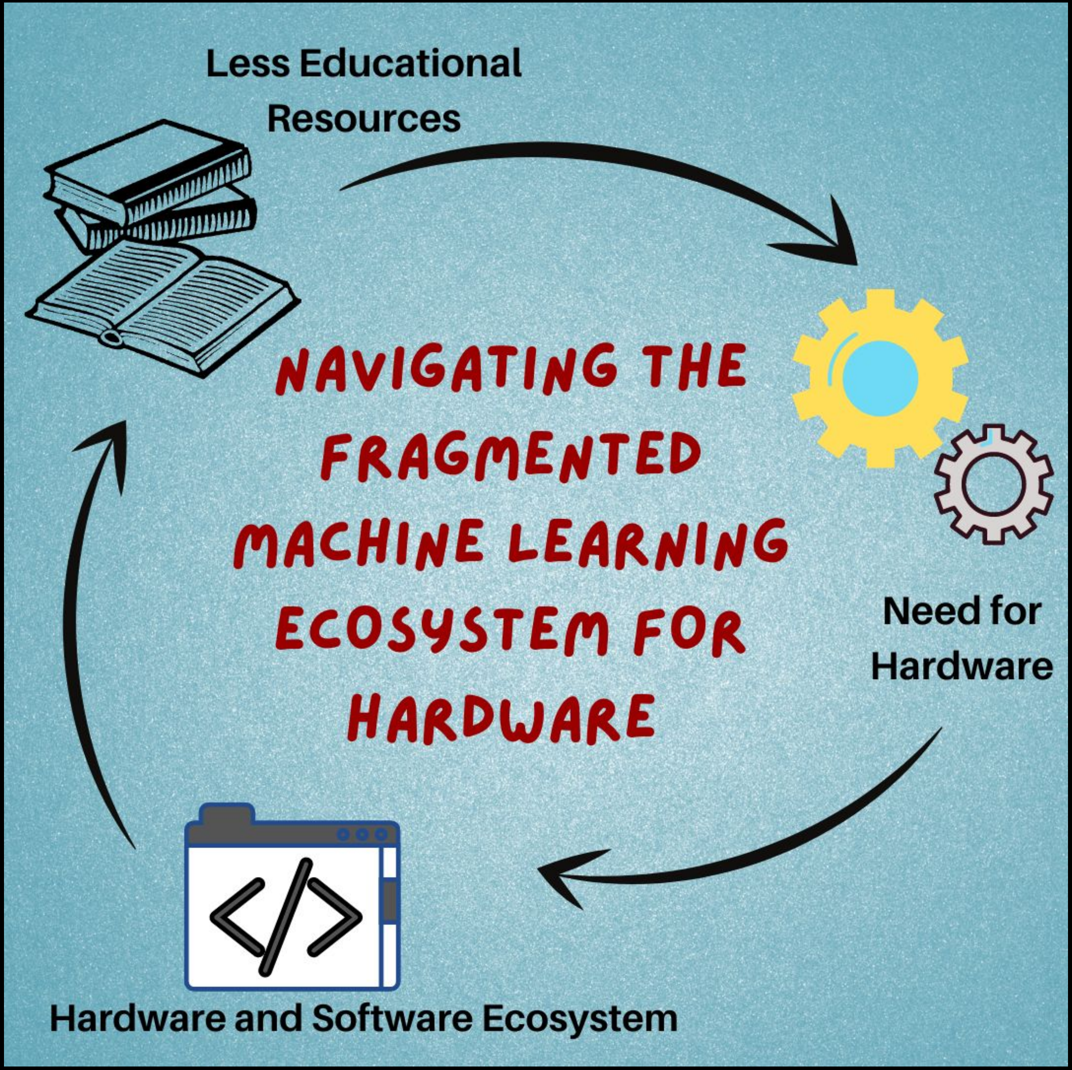


NAVIGATING THE FRAGMENTED MACHINE LEARNING ECOSYSTEM FOR HARDWARE

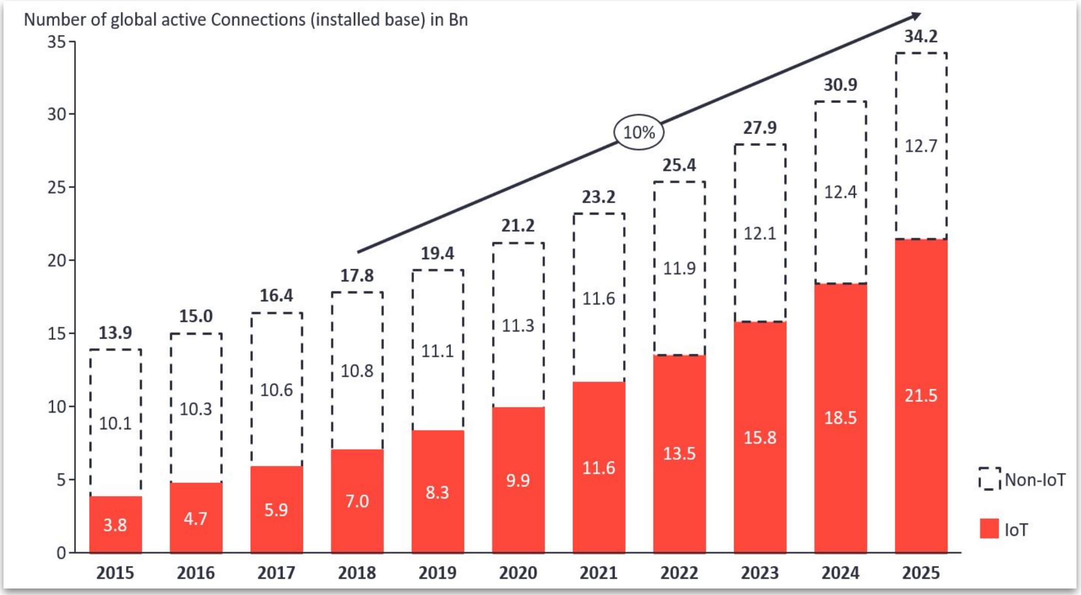
Less Educational Resources

Need for Hardware

Hardware and Software Ecosystem

Internet of Things

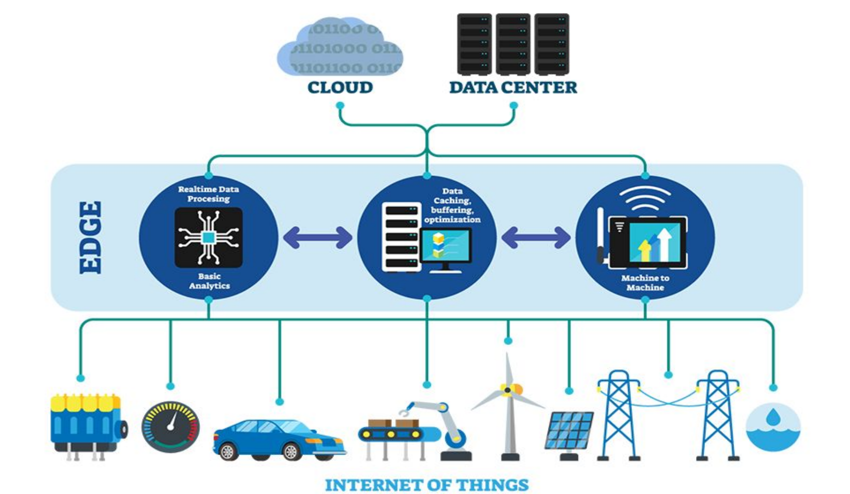
- IoT devices have a microcontroller and sensors
- They can collect and transfer data, as well as perform simple tasks
- IoT devices have become popular over the last few years
- They are used as smart home and fitness devices, but are also being used in industrial settings
- However **99% of IoT sensor data is discarded**



State of IoT; iot-analytics.com

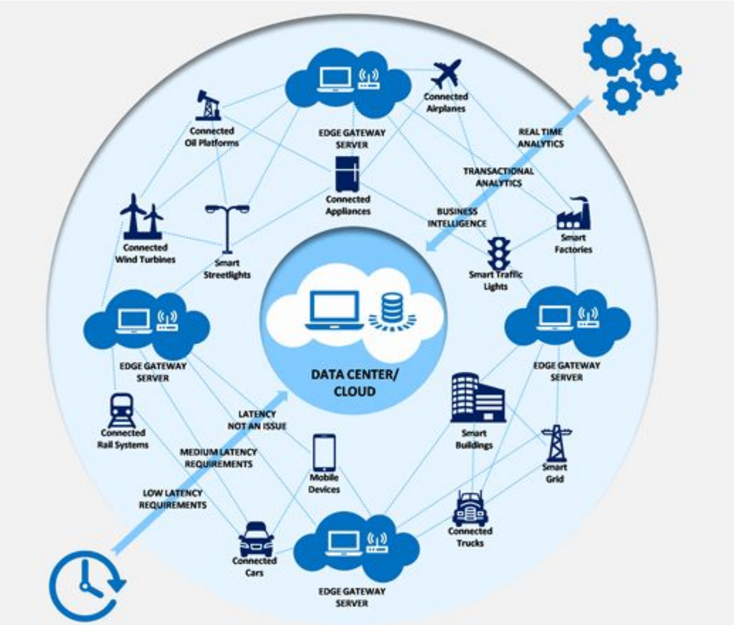
Internet of Things and Edge Computing

- Most DL models are deployed on cloud servers
- Running models closer to where the data is being generated is called edge computing



Edge Computing Use Cases; innovationatwork.ieee.org

Edge Computing



1– Increase in IoT devices causes an increase in cloud dependency

2-Need edge devices which have their own data centres

3-The computing that is performed in those data centers is Edge computing

4- Application: Security Cameras, Self Driving Cars

Advantages of Edge Computing

- Reduced Latency
- Reduced Internet Bandwidth
- Increased Security
- Reduction in Dependence on Cloud Services

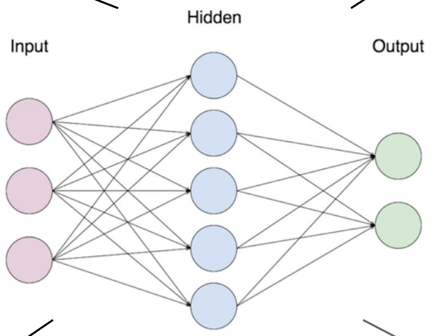
Edge Computing Hardware

- **Microprocessors**
  - General Purpose
  - More Powerful
  - Consume More Power
- **Microcontrollers**
  - For Simpler Tasks
  - Less Computationally Powerful
  - Consumes Less Power
- **Accelerators**
  - Specialised for one task
  - Smaller and more power efficient
  - Computationally powerful, but can only perform a specific task

Need for Edge Computing Algorithms

<u>Power constraints:</u> Neural networks require massive amount of computational power and energy to execute on CPU and GPUs

<u>Composed of Floating Point Values:</u> Neural Networks are generally trained to preserve accuracy and not speed



<u>Memory Constraints:</u> Laptops and PC come with at least 4GB of RAM whereas Raspberry Pi 3 has 1GB of RAM

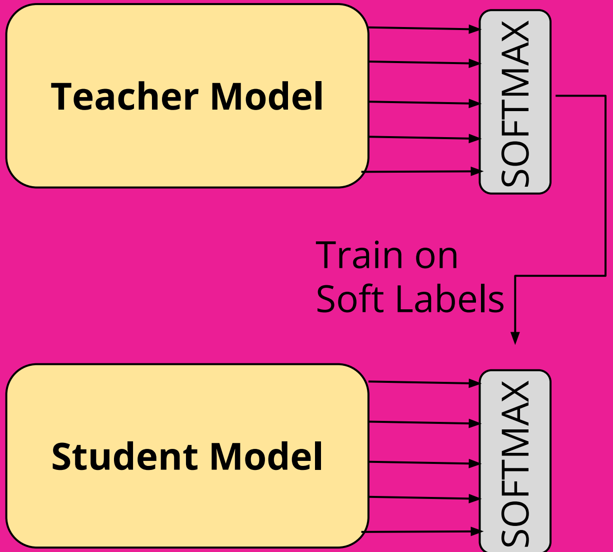
<u>Inference Efficiency:</u> We need model that takes less time for inference

Edge Computing Frameworks

- TensorFlow Lite
  - Quantization
  - Pruning
  - Weight Clustering
  - Support for EdgeTPU
- OpenVINO
  - Quantization
  - Intermediate Representations
  - Support for NCS and other Intel Hardware
- Others
  - ONNX
  - PyTorch
  - DeepStream

Knowledge Distillation

- Works by transferring the knowledge learned by a large teacher model to a smaller student model
- The student model is easier to execute
- The student model can be trained with unlabelled data
- Student models can often achieve similar or more accuracy than the teacher



Teacher Model
SOFTMAX
Train on Soft Labels
Student Model
SOFTMAX