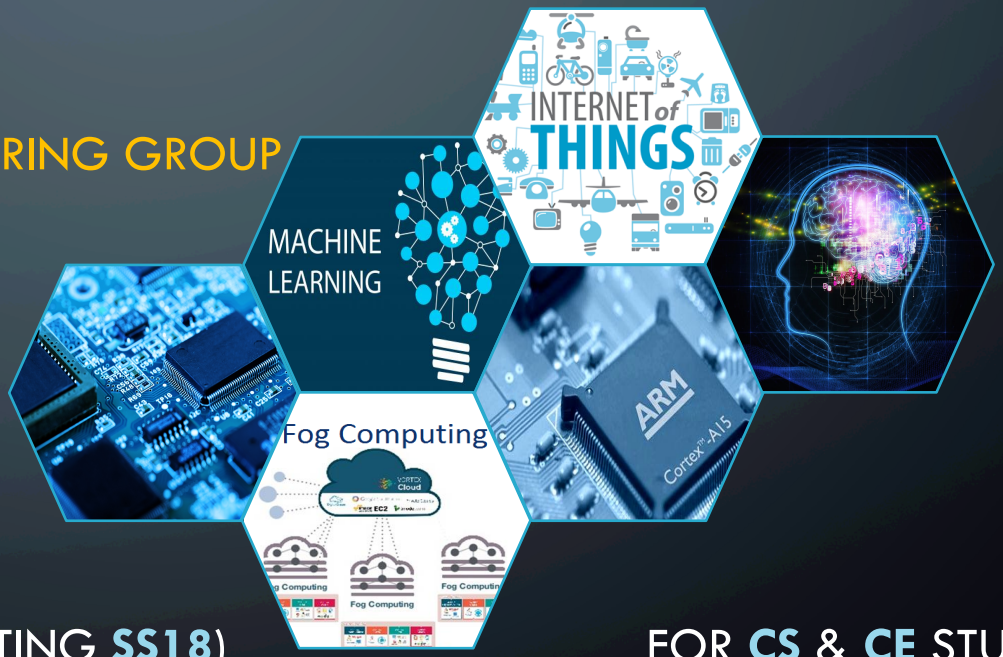
EML: EMBEDDED MACHINE LEARNING

COMPUTER ENGINEERING GROUP



PROJECT GROUP (STARTING **SS18**)

FOR **CS** & **CE** STUDENTS

MARKET TRENDS – AI, ML, IOT

Emerging Systems of Intelligence

Artificial Intelligence (AI), Machine Learning (ML)

By 2019, 75% of enterprise and ISV development will include AI or ML (IDC)

Internet-of-Things (IoT), Edge Computing

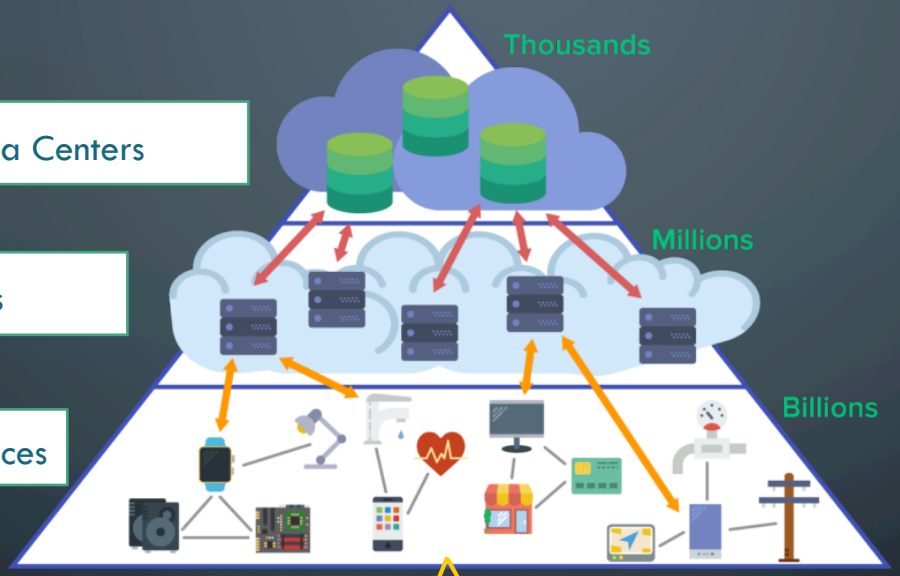
By 2020, 5.6 billion enterprise and government IoT devices connected to an edge solution (BI)

EMBEDDED MACHINE LEARNING = ML @ EDGE

Cloud | Data Centers

Fog | Nodes

Edge | Devices



Computational capacity

Real-time computing, security

How to set up machine learning for edge targets?

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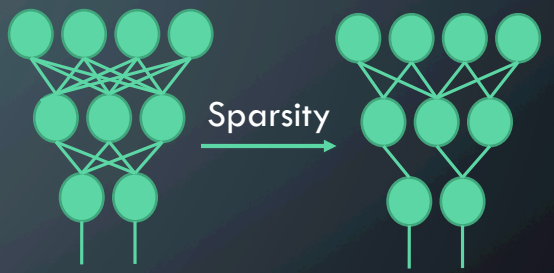
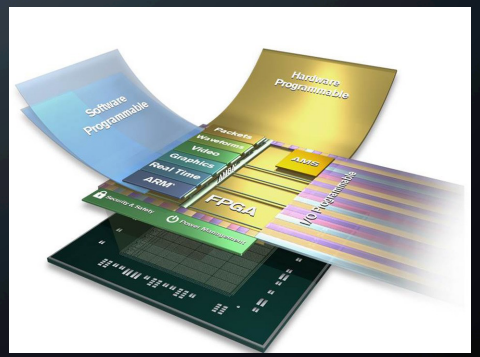
How to cope with limited budgets on energy & hardware?

RESEARCH APPROACHES

- Develop/modify ML techniques to be able to cope with resource limitations
  - Approximate Neural Networks (NN), k-Nearest Neighbour
    - Example: **sparse NNs** vastly reduce the amount of computations in testing phase

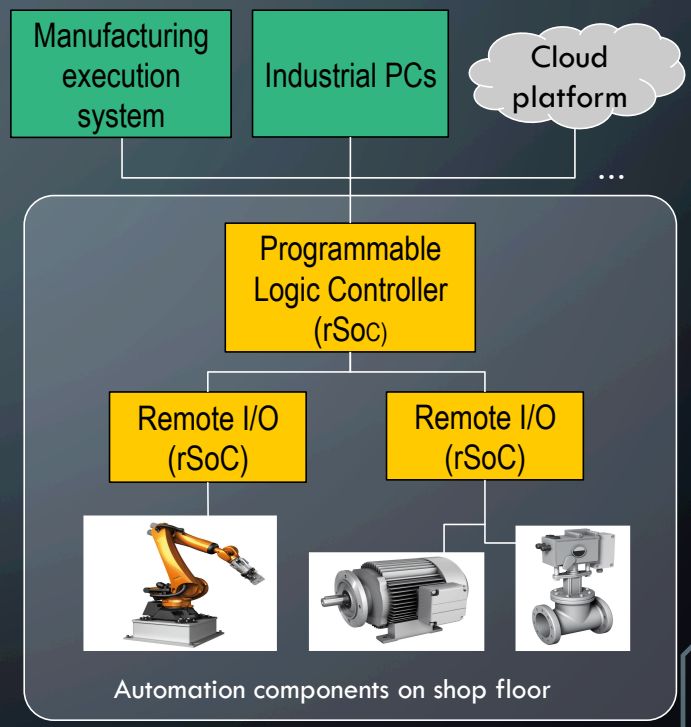


- Develop accelerators optimized for specific ML algorithms
  - Accelerators for NN, Random Markov Fields
    - Edge device: **Reconfigurable System-on-Chip (rSoC)** Xilinx UltraScale+MPSoC: quad core ARM A53 + dual core ARM R5 + Mali GPU + reconfigurable hardware + memory + peripherals



INDUSTRIAL COOPERATION WITH Weidmüller

- Industrial analytics @ edge
  - Use existing production data for machine learning
  - Maximization of up-time and productivity
  - Predictive maintenance and anomaly detection
- Challenges
  - Increasing data volume from heterogeneous sources (smart machines, sensors, IoT-devices…)
  - Demand for low latency signal processing
  - Cloud-based processing often not an option



PROJECT GROUP **EML** - **GOALS**

- Develop approximated machine learning techniques and algorithms
  - Approximations in both software and hardware
- Implement and evaluate techniques on a modern system-on-chip
  - Embedded platform with ARM CPU cores and reconfigurable logic
- Demonstrate performance for real industrial datasets
  - In cooperation with Weidmüller Interface GmbH
- Evaluate the resiliency of the proposed techniques
  - Test under worse (corner) conditions

PROJECT GROUP **EML**

What you should bring with you

- Interest in embedded system design (software or hardware)
- Interest in machine learning techniques
- Basic experience with programming embedded processors and/or FPGAs is a plus

What you will gain

- Knowledge about architectures and tools for systems-on-chip
- Practical experience in embedded system design and machine learning algorithms
- Expertise in the emerging field embedded machine learning (resource constrained algorithms), experience in edge computing for intelligent systems

QUESTIONS?

- Today after the presentations
- Contact supervisors
  - Hassan Mohammadi hgm@mail.upb.de
  - Marco Platzner platzner@upb.de
- https://cs.uni-paderborn.de/ceg/teaching/student-projects/project-groups/pg-eml