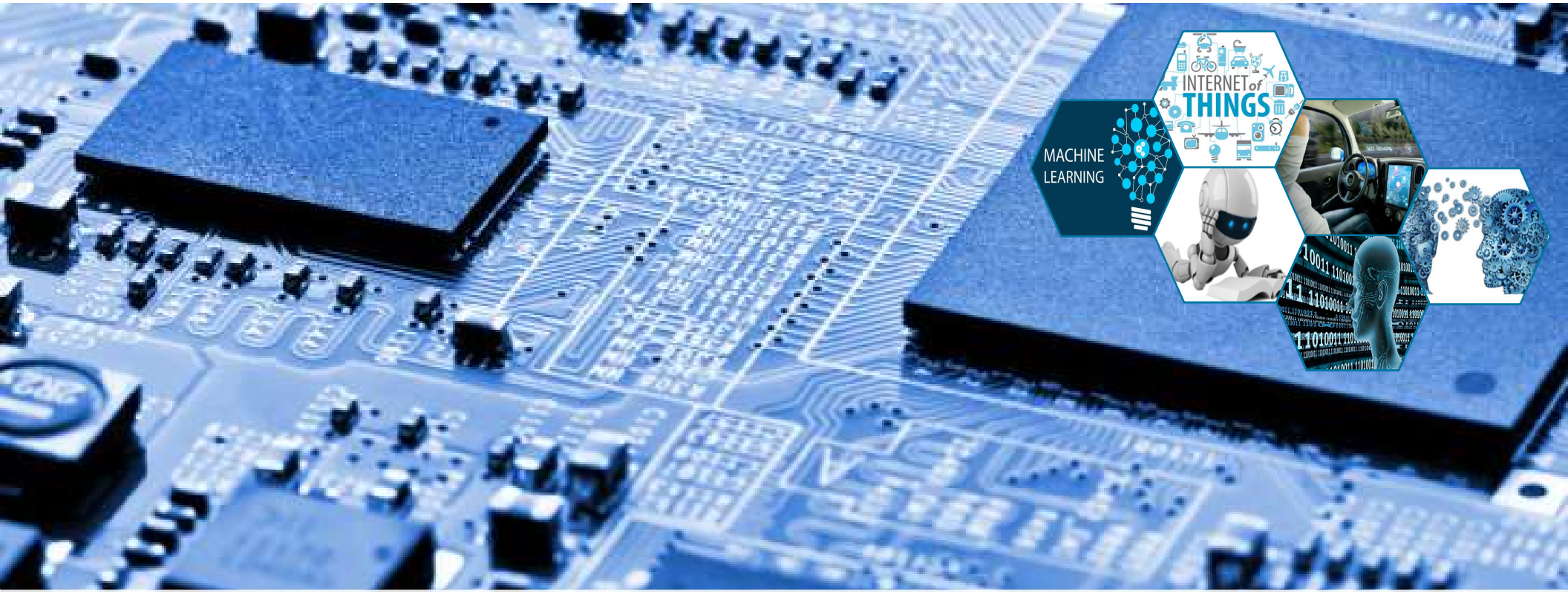
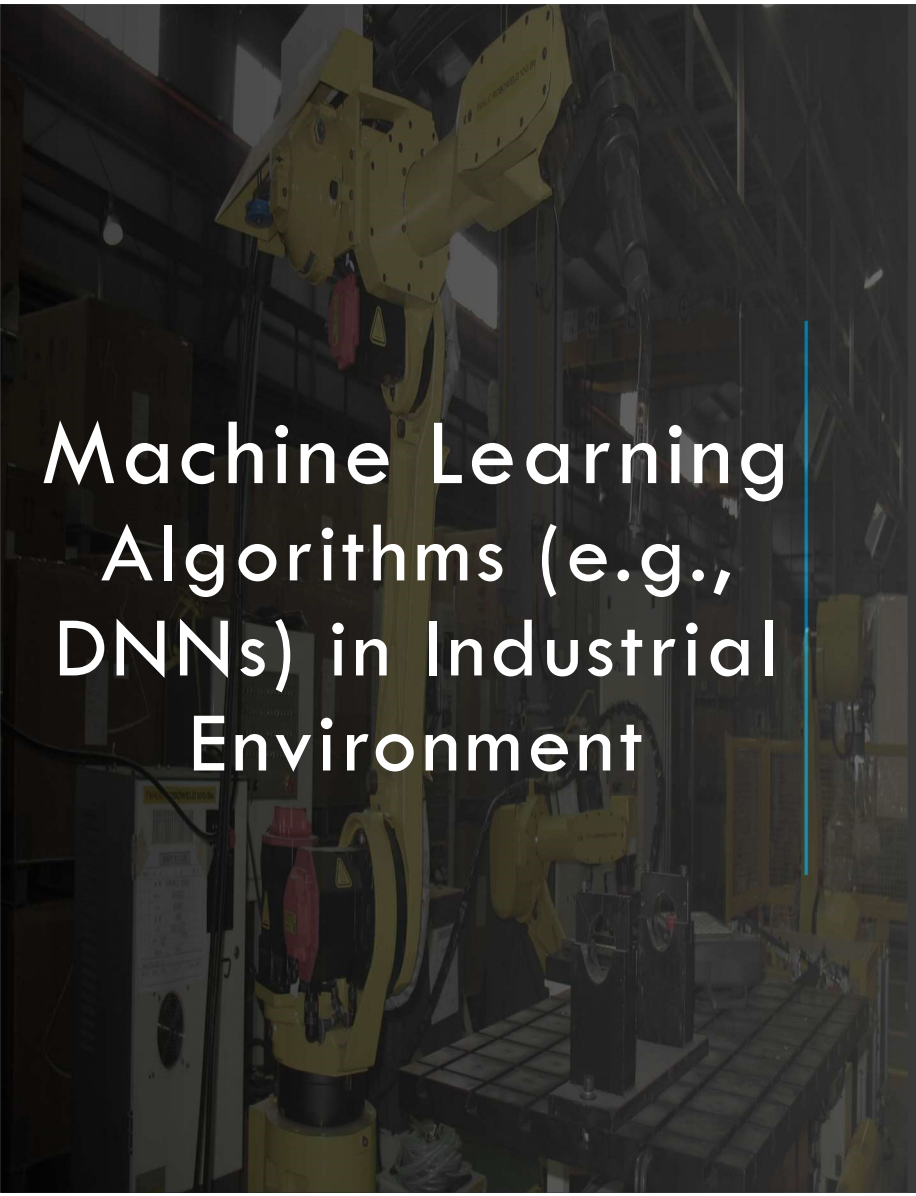


EML II:
EMBEDDED MACHINE LEARNING II

Project group (staring SS19)
for CS & CE students

CEG group
Paderborn University



Machine Learning Algorithms (e.g., DNNs) in Industrial Environment

Common tasks

- Quality insurance
- System monitoring
- Anomaly detection (AD)

DNNs in embedded system

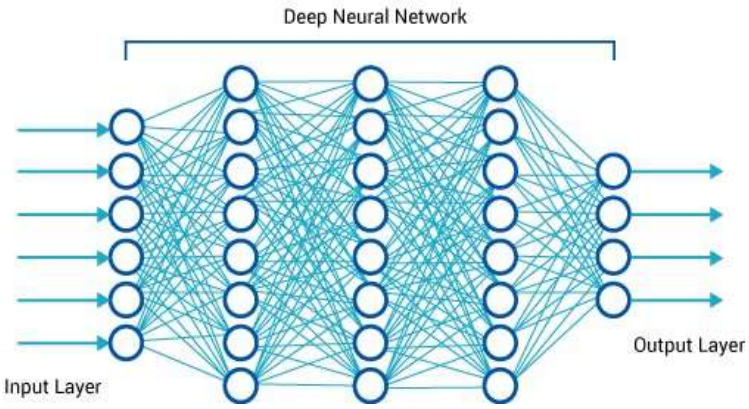
- Superior results over other ML algorithms
- Computationally challenging tasks

Challenge: Reduce complexity?

- Systematic approach needed

EML CHALLENGES – A CASE STUDY (POWER CONSUMPTION)

- Energy cost per 32b operation in a 45nm technology
  - 3*pJ* for multiplication
  - 640*pJ* for off-chip memory access
  - Running a 1-billion connection NN @ 30*Hz*
    - 30*Hz* * 1G * 640*pJ* = 19.2W



impossible

PROJECT GROUP EML II - 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 platforms with ARM CPU cores and reconfigurable logic

Demonstrate performance for real industrial datasets

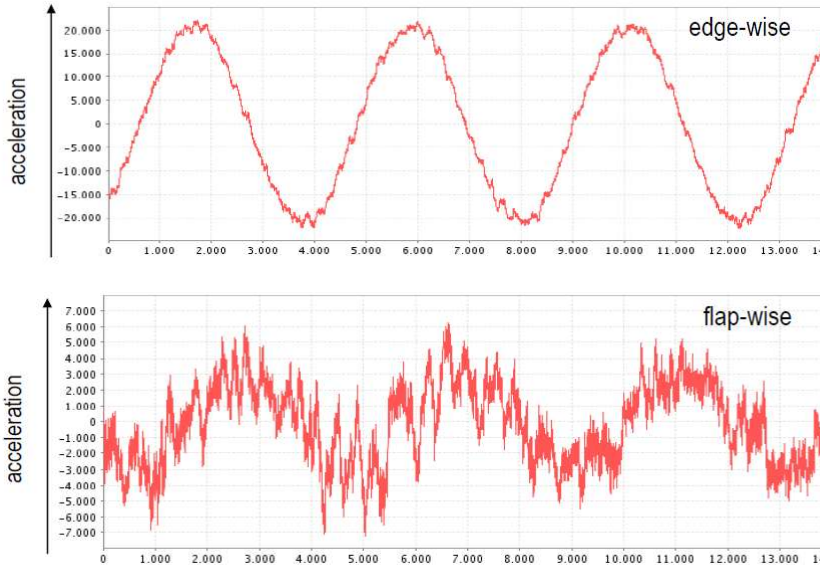
- In cooperation with Weidmüller Interface GmbH

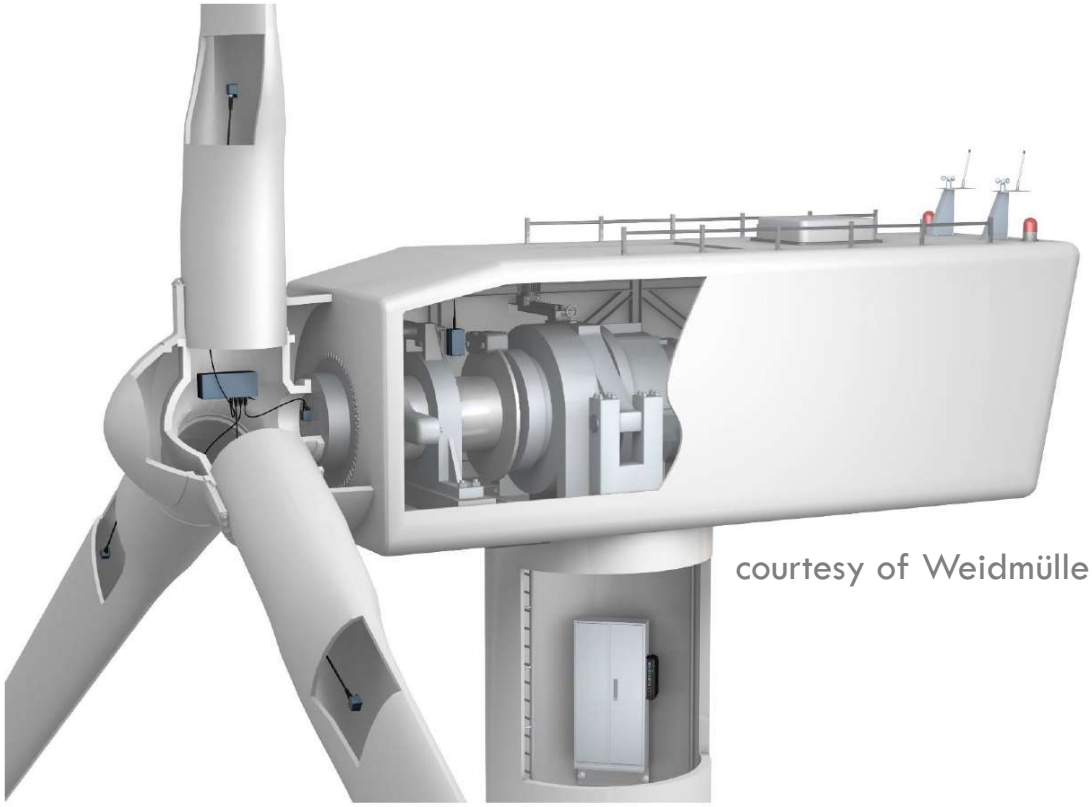
Evaluate the resiliency of the proposed techniques

- Test under worse (corner) conditions

SAMPLE PROBLEMS – AD IN A WIND TURBINE

Rotor blade sensors malfunction detection





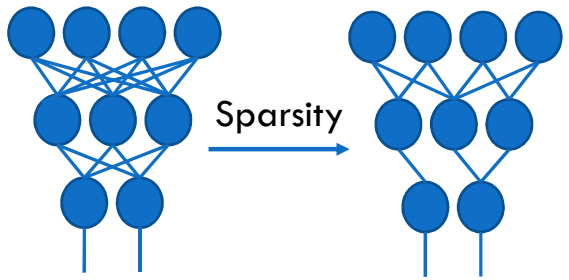
courtesy of Weidmüller

RESEARCH APPROACH

Develop or modify ML techniques to be able to cope with resource limitations (e.g., energy)

- Approximate DNN, SVN, KNN, Bagging, …

Ex.: **sparse DNNs** which vastly reduce the amount of computations in inference phase



Develop optimized accelerators for specific ML algorithms

- Accelerators for NNs and RMFs

PROJECT GROUP EML II

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 working with real datasets

QUESTIONS?

Today after the presentations

Contact supervisors

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- Prof. Dr. Marco Platzner platzner@upb.de

https://cs.uni-paderborn.de/ceg/teaching/courses/ss-2019/pg-eml/

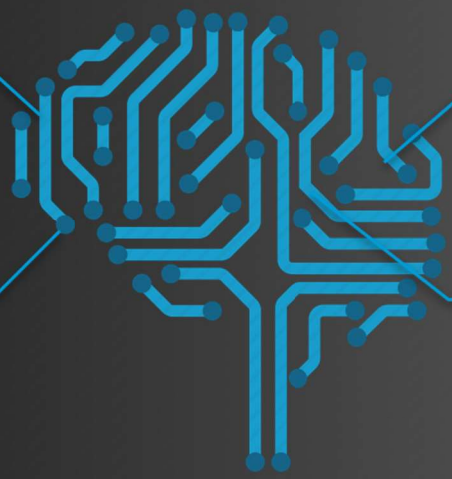
IOT SOLUTIONS - EMERGING SYSTEM OF INTELLIGENCE

Big data era

44 Zettabyte by 2020 (IDC)

Cloud services

Cheap, scalable computing



Embedded devices

212 B connected devices by 2020 (IDC)

Algorithm and libraries

Open source, easy to use, available in several programming languages

Enormous potential for embedded machine learning using edge devices