Unleashing the Power of Machine Learning for Operational Excellence:

Opportunities and Challenges

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Machine Learning in Industry

Industry 4.0, Logistics

Intelligent Power Management

Autonomous Driving
Hidden Treasures of Data

Proliferation of sensors and processing technologies

Optimize processes, identify anomalies, control

Large amounts of data

Data carries actionable information
AI-Driven Interpretation and Control

- Automated Control + Algorithm
- Model + Algorithm
- Actionable Information
Why is Machine Learning Promising?

- **Traditional model construction**
  - Engineers build models.
  - Use domain knowledge.

- **Complex domains ➔ complex models**
  - Expensive development process.
  - Impossible to understand all relevant aspects.

- **Expensive to incorporate changes**
Why is Machine Learning Promising?

Traditional Machine Learning
- Automatically distill a model from data.
- Engineers prepare features.
- Engineers manage the learning process: Inductive bias, representations.

Deep learning
- Automatically distill a model from data.
- Automated feature extraction ➔ less engineering.
- Engineers manage the learning process.
Challenges in Industrial Applications

Industry ➔ mission critical applications
- The outcomes of ML have a critical impact on the processes.

How do we know a distilled model is adequate?
- Naïve black-box testing is increasingly expensive as the modelling complexity grows (exponential).
- Continuous learning: is the system evolution OK?

A successful ML solution from one application is usually not suitable for other applications!
- Theory: “No free lunch theorem”, “Ugly duckling theorem”.

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Way Forward

- **Scientific advances**
  - Improved understanding of the ML processes.

- **ML-compatible engineering processes**
  - The engineering processes must be based on sound mathematical principles.

- **Competences: training engineers in ML basics**
  - Understand the *Math* behind ML ➔ avoid pitfalls, maximise the benefits.
Summary

| ML is a critical enabler of advanced industrial solutions |
| John van den Dobbelsteen: Computer assisted process management in the operating room |

| ML introduces new engineering challenges ➔ adapt engineering processes |
| Michael Borth: Here There Be Dragons |
THANK YOU...