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Unleashing the Power of Machine Learning for Operational Excellence:

Opportunities and Challenges

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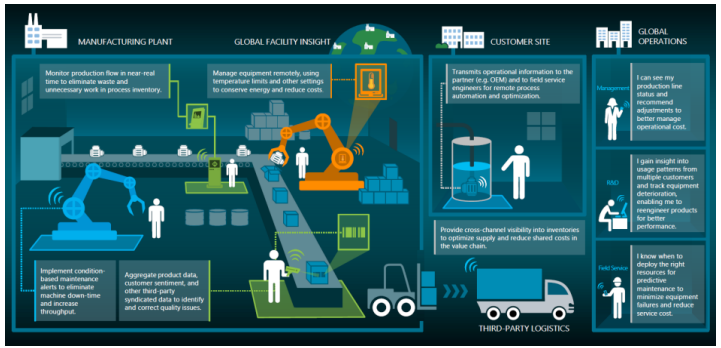
Machine Learning in Industry

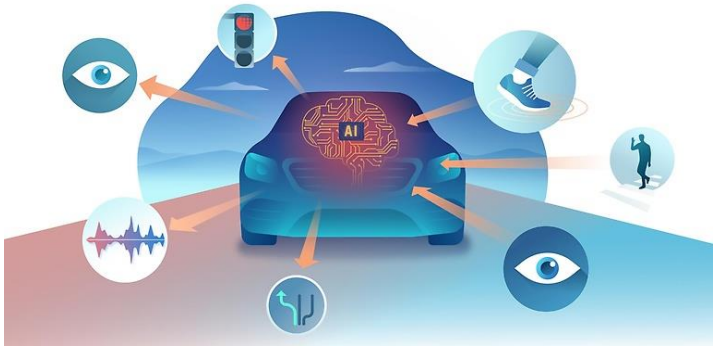
Industry 4.0, Logistics



Intelligent Power Management

Photo Courtesy American Public Power Associations

Autonomous Driving



Graphics Courtesy Daimler

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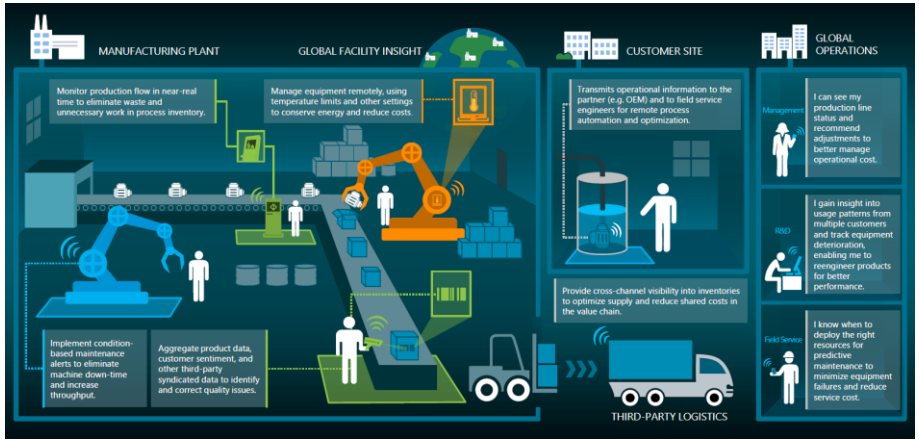
Hidden Treasures of Data

Proliferation of sensors and processing technologies



Large amounts of data

Data carries actionable information

Optimize processes, identify anomalies, control

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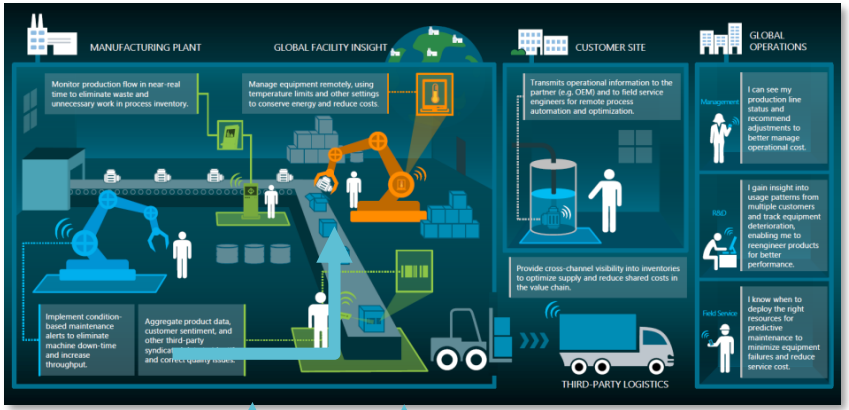
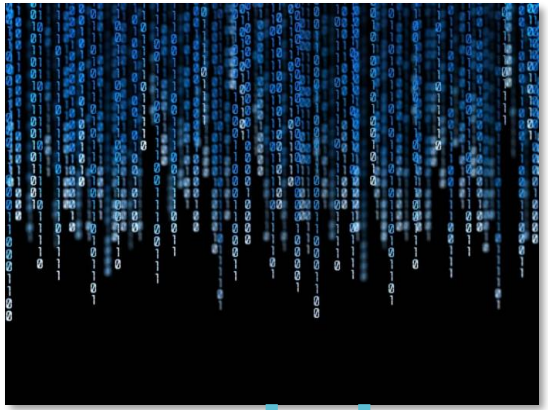
AI-Driven Interpretation and Control





Actionable Information

Model + Algorithm

Automated Control

Model + Algorithm

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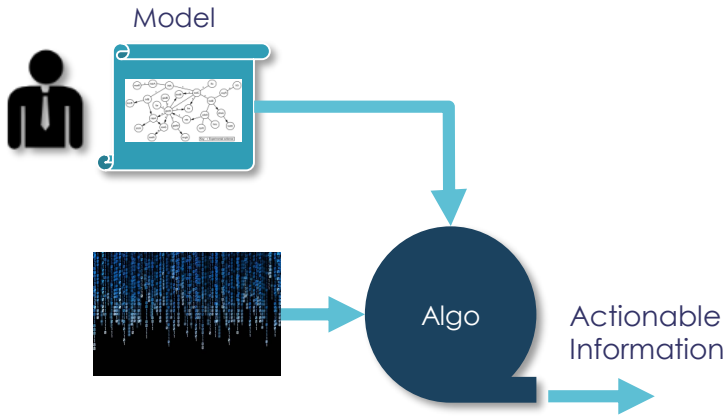
Why is Machine Learning Promising?



Traditional model construction

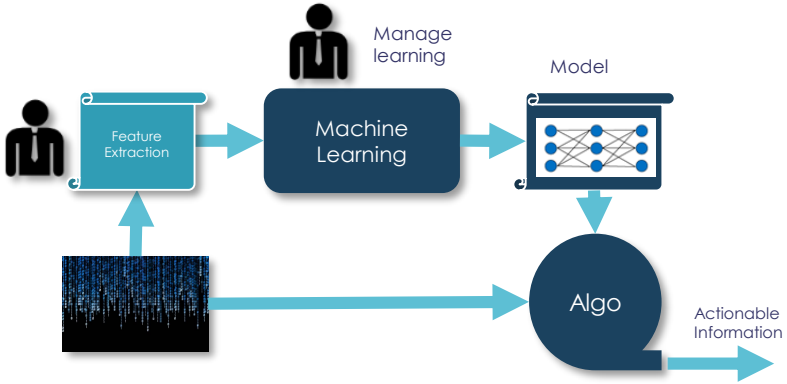
- Engineers build models.
- Use domain knowledge.

Complex domains ➔ complex models

- Expensive development process.
- Impossible to understand all relevant aspects.

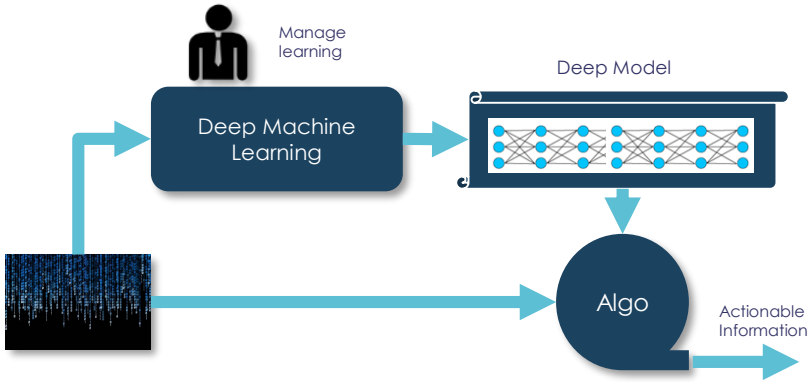
Expensive to incorporate changes

Why is Machine Learning Promising?



Traditional Machine Learning

- Automatically distil a model from data.
- Engineers prepare features.
- Engineers manage the learning process: Inductive bias, representations.



Deep learning

- Automatically distil a model from data.
- Automated feature extraction ➔ less engineering.
- Engineers manage the learning process.

Challenges in Industrial Applications

Industry ➔ mission critical applications

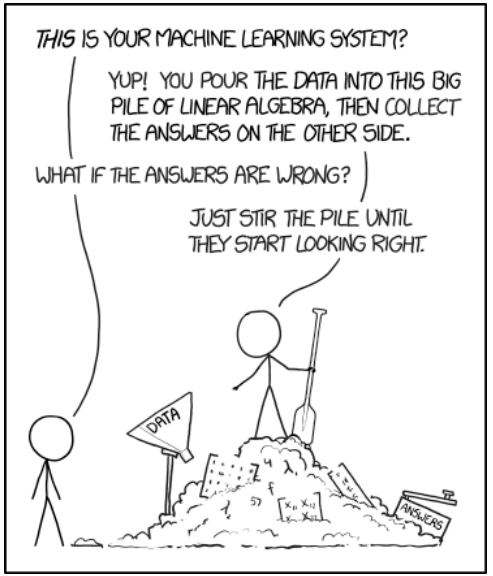
- The outcomes of ML have a critical impact on the processes.

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!

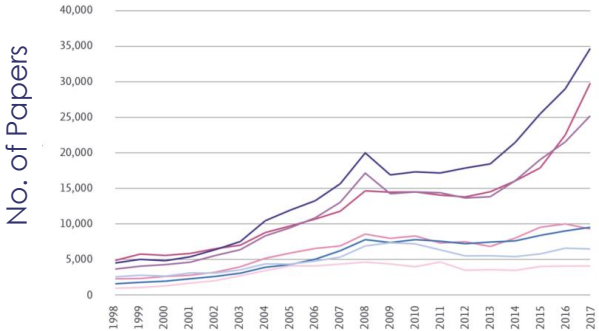
- Theory: “No free lunch theorem”, “Ugly duckling theorem”.



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…