New perspectives in production control: situation-aware decision making with machine learning approaches

by

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STC-O: Short technical presentations
Session on special discussion topic of revival of artificial intelligence (AI)

Manufacturing and data science: status quo and top trends

- Industrial digitalization is on the hype cycle peak
- Academia: new insights partner for enterprises
- AI and ML: the data scientist's ultimate assistants
- Industrial IT: still behind the innovative needs
  - Relational data is still the most common
  - Problems with „dirty data"
  - Lack of experts

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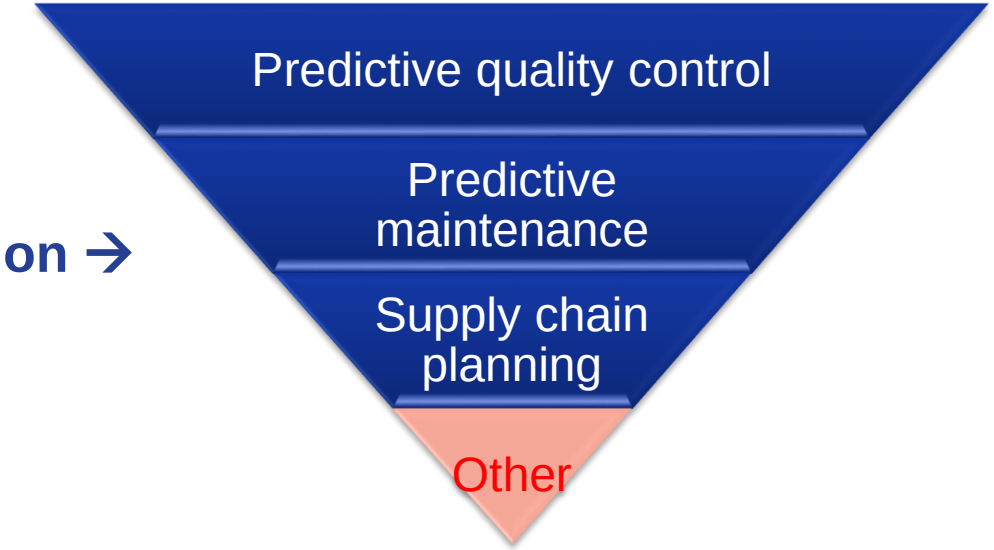
ML in production →



D. Gyulai, A. Pfeiffer, V. Gallina: *New perspective in production control: Situation-aware decision making with machine learning approaches*
CIRP General Assembly 2018 Tokyo, Japan; STC-O short technical presentation

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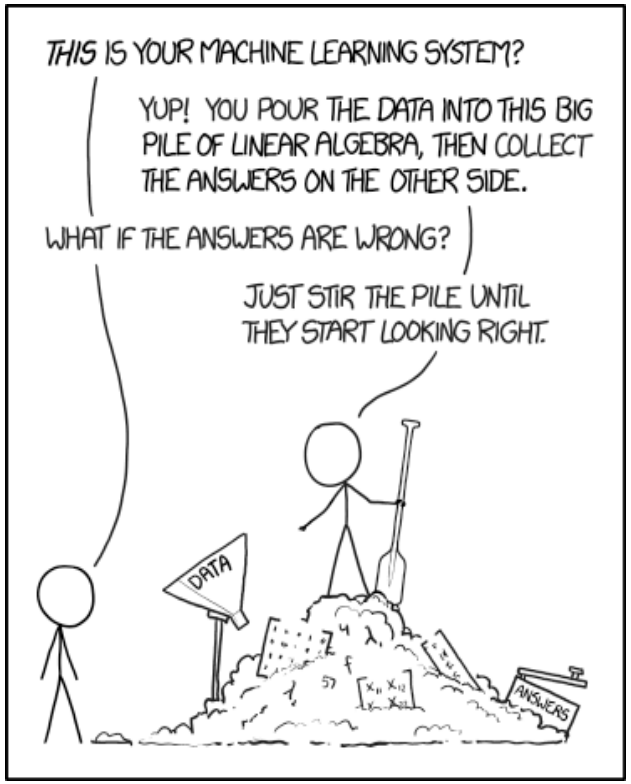
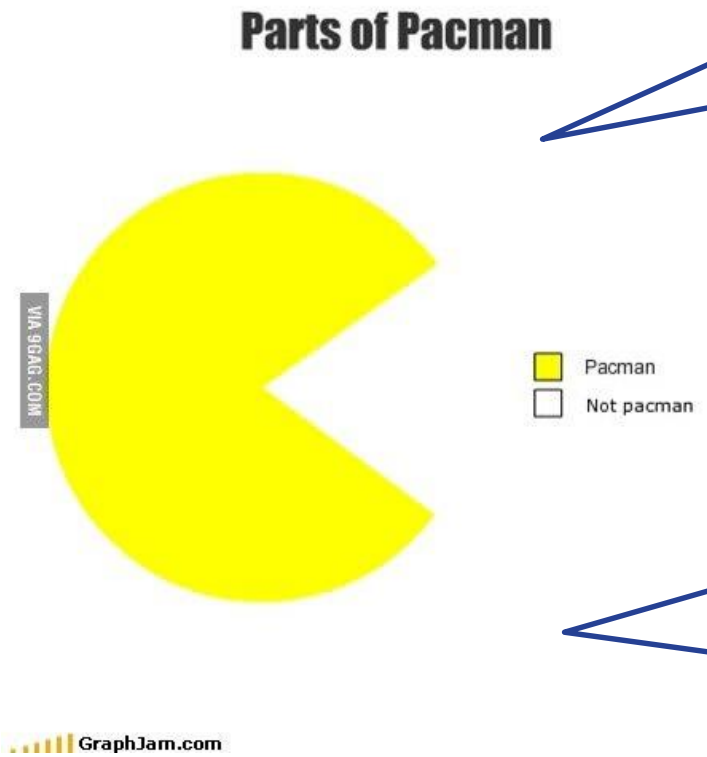
Barriers and challenges of applying ML in production

- Wrong questions → wrong answers
- Garbage in → garbage out
- Improper use of tools, use of improper tools



David Robinson
Chief Data Scientist at DataCamp



*„Multi-factor productivity has been stagnant for the last decade due to **separation of operations (OT) and information technology (IT)**"*
[Nonaka, 2017]

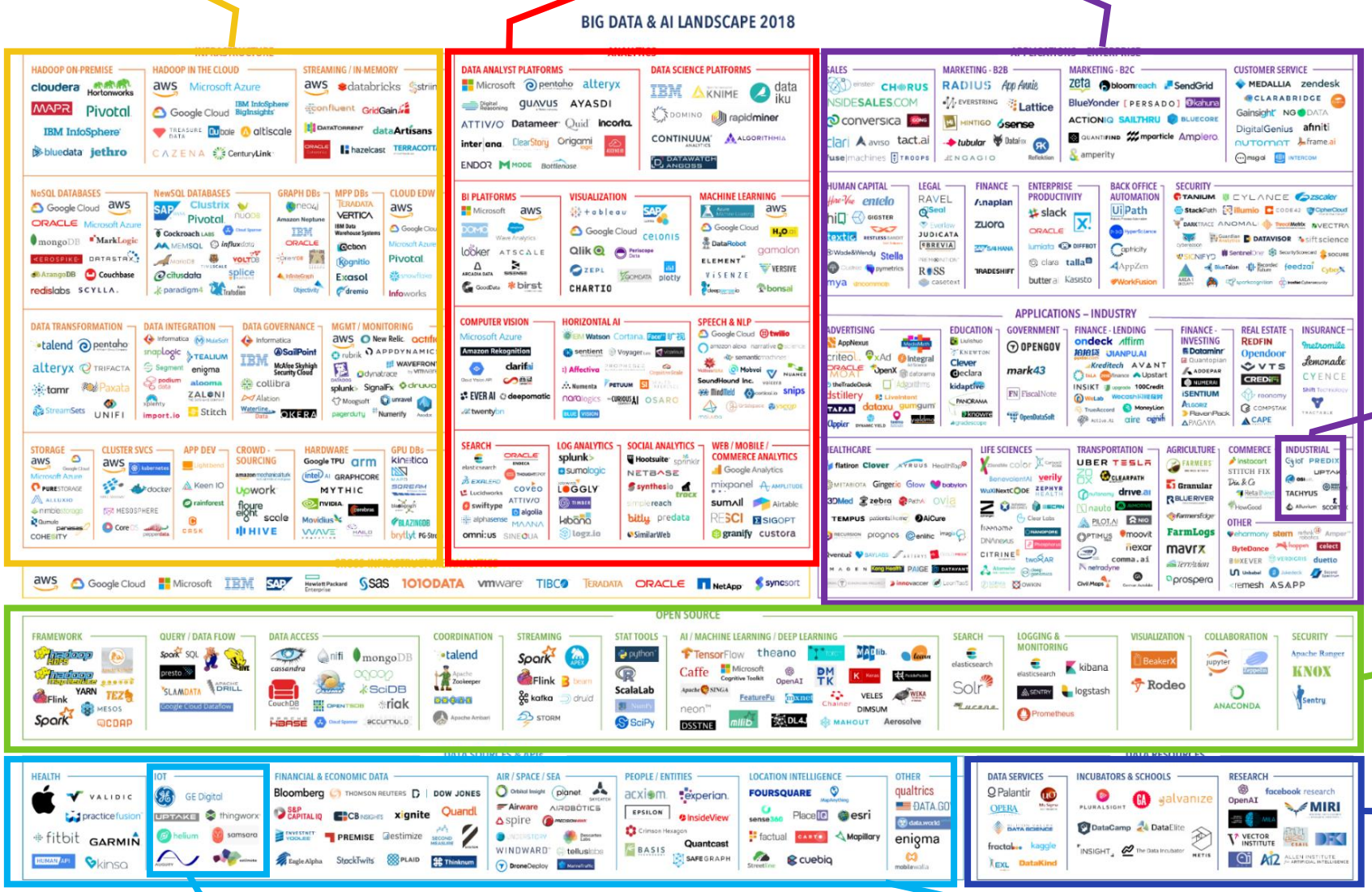
*„I began to imagine how incredibly frustrating it would be if I were **a decision maker for a manufacturing company** and I knew that we needed to act fast to **kick off an Industrial Internet project** but couldn't be certain about the **quality of information out there.**"*
[Chu, 2016]

Tools and technologies: great opportunities

Infrastructure

Analytics

Applications - Enterprise



Industrial

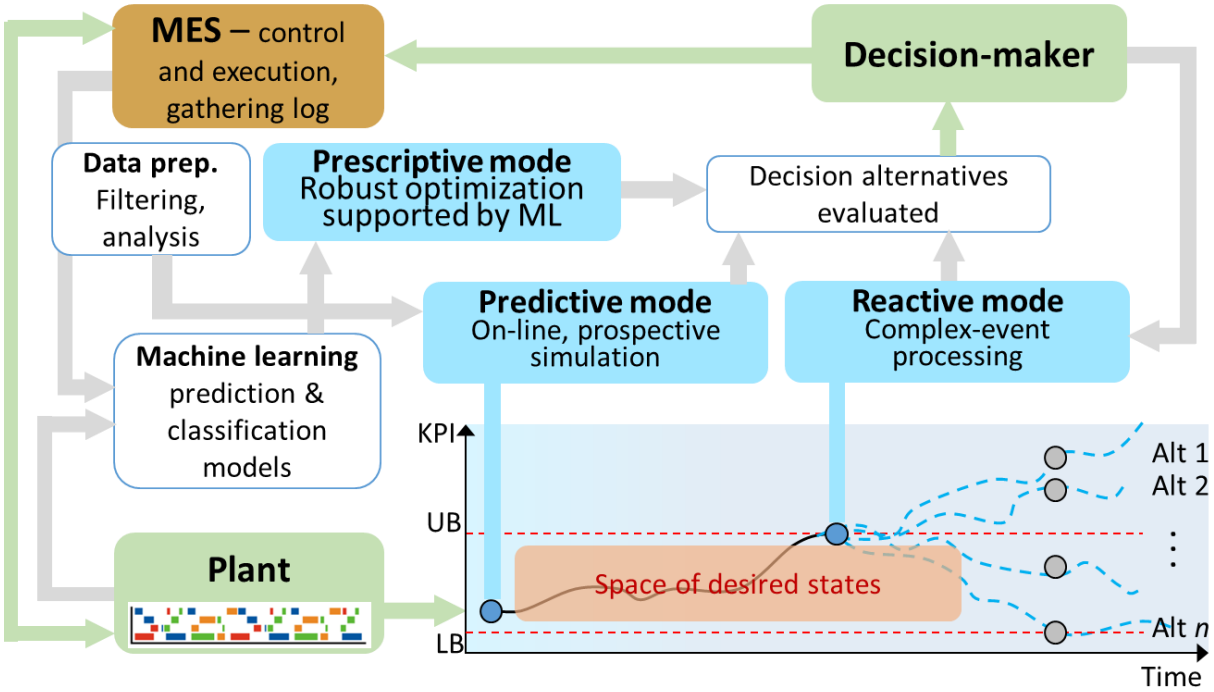
Open Source

Data Resources

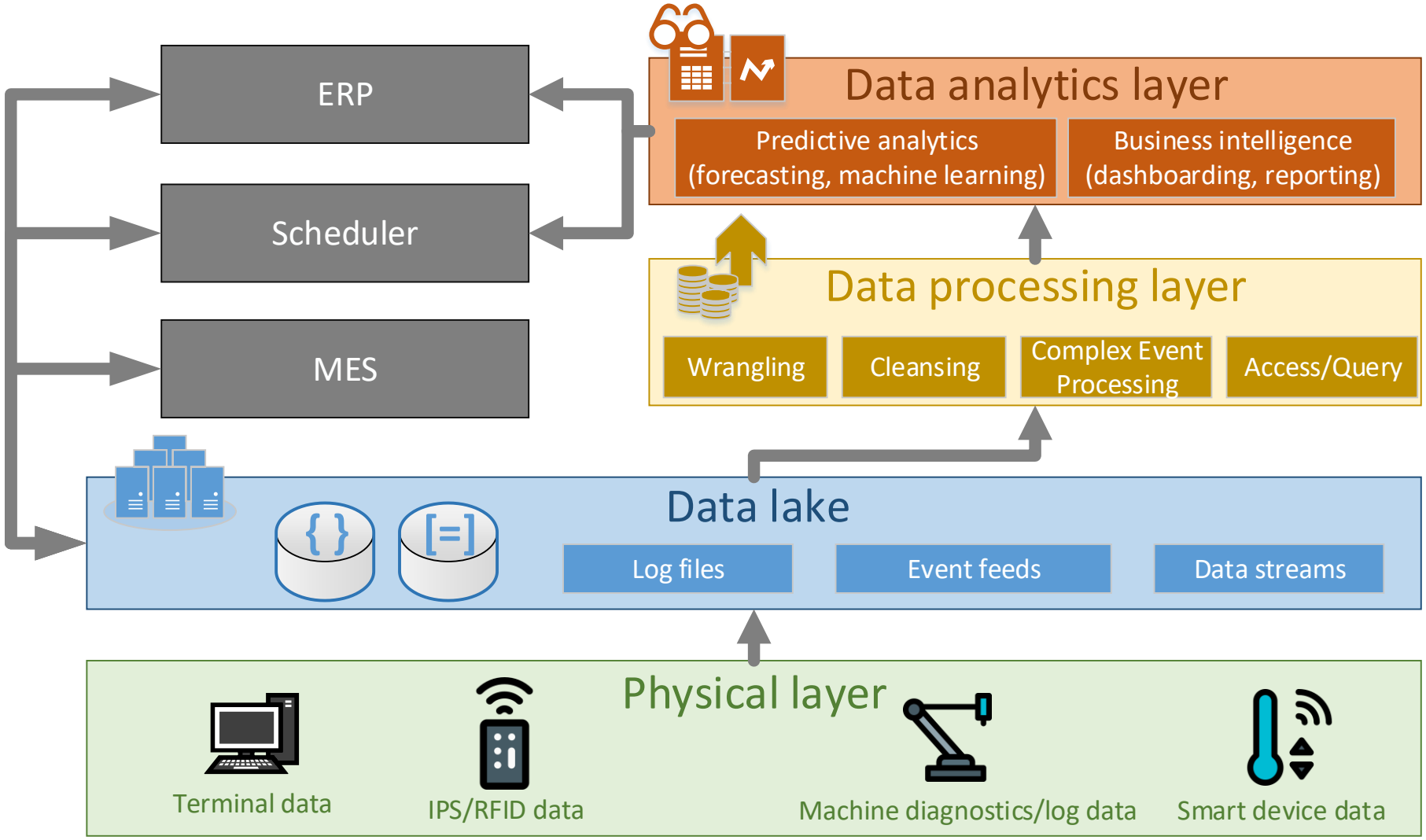
Data Sources and APIs

ML in PPC: towards situation-aware control

- Current lack of tight link between ML/analytics and decision making
- Situation-awareness
  1. Identify desired and/or avoidable situations
  2. Prescribe next best action or set of actions
  3. A combination of optimization, simulation and data analytics tools
     a) Predictive: Applying simulation-based optimization
     b) Reactive: Applying real-time data in e.g., complex-event processing
     c) Prescriptive: (Robust) optimization and decision making enabled by machine learning and data analytics
- New element**: prescriptive scheduling with enabled by machine learning**



A situation-aware control architecture



See also:

- [Frazzon, 2018]
- [Zhong, 2018]

Machine learning pipeline for PPC

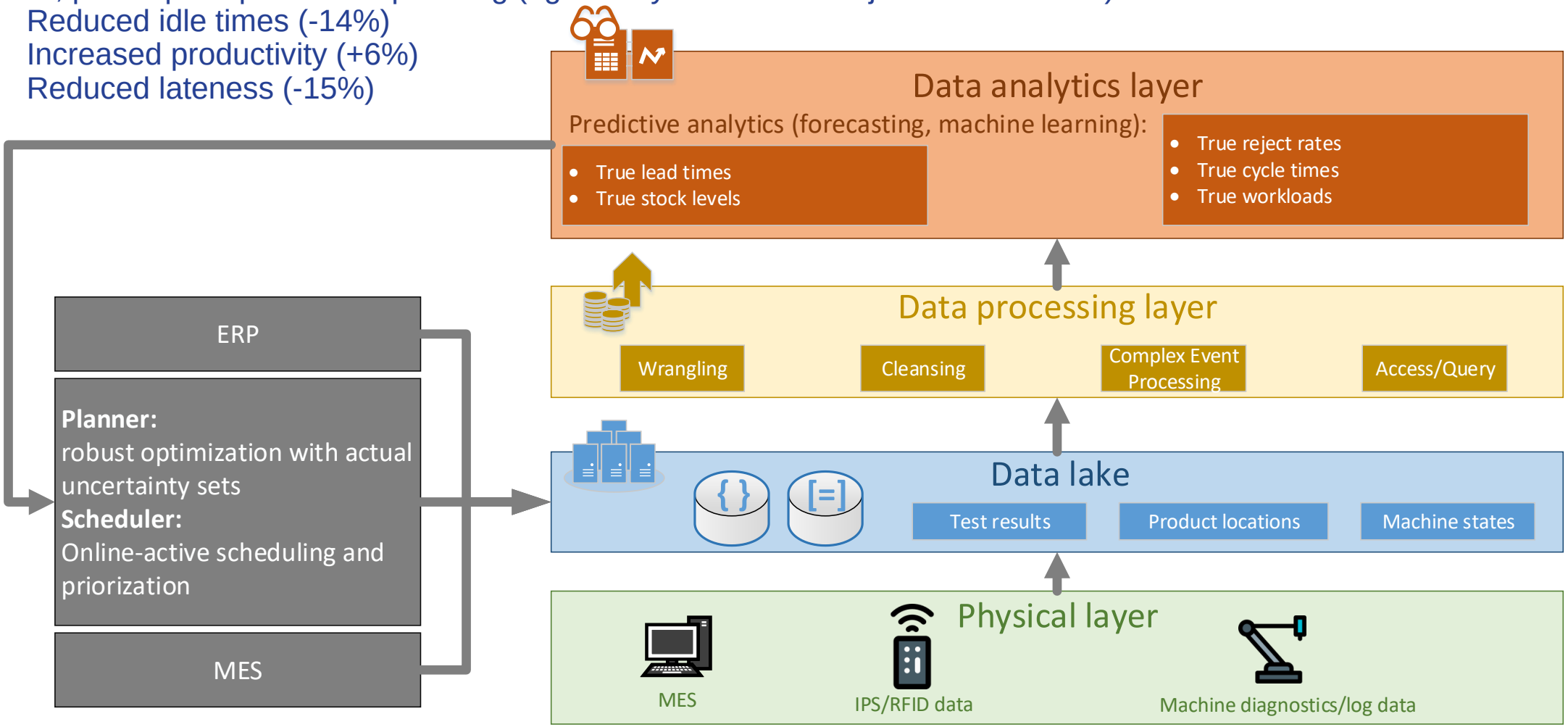
1. Access requested data „from the lake” (machine log, job status’, ERP)
2. Prepare, filter and transform (unstructured)
3. Parse structured & unstructured data

4. Train regression model(s)

5. Fine tune of model parameters
   - Data mining: simulation model settings, e.g. stochastic parameters
   - Machine learning
     - Inject constraints to optimization models
     - Predict numeric parameters based on given input (e.g. job completion as APS module)
     - Predict uncertain parameters of robust optimization models

Application results

- Accurate lead-time prediction for priorization (>90%)
- Robust, prescriptive production planning (against cycle time and reject rate variance)
  - Reduced idle times (-14%)
  - Increased productivity (+6%)
  - Reduced lateness (-15%)



Thank you for your attention!

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Related own works

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