THE VALUE OF DATA SCIENCE STANDARDS IN MANUFACTURING ANALYTICS

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Data science standards in manufacturing analytics
Outline

- Bosch's dual role in advanced manufacturing/Industry 4.0
- The need for standards in predictive analytics
- Case study in the use of PMML at Bosch
- How to improve existing standards?

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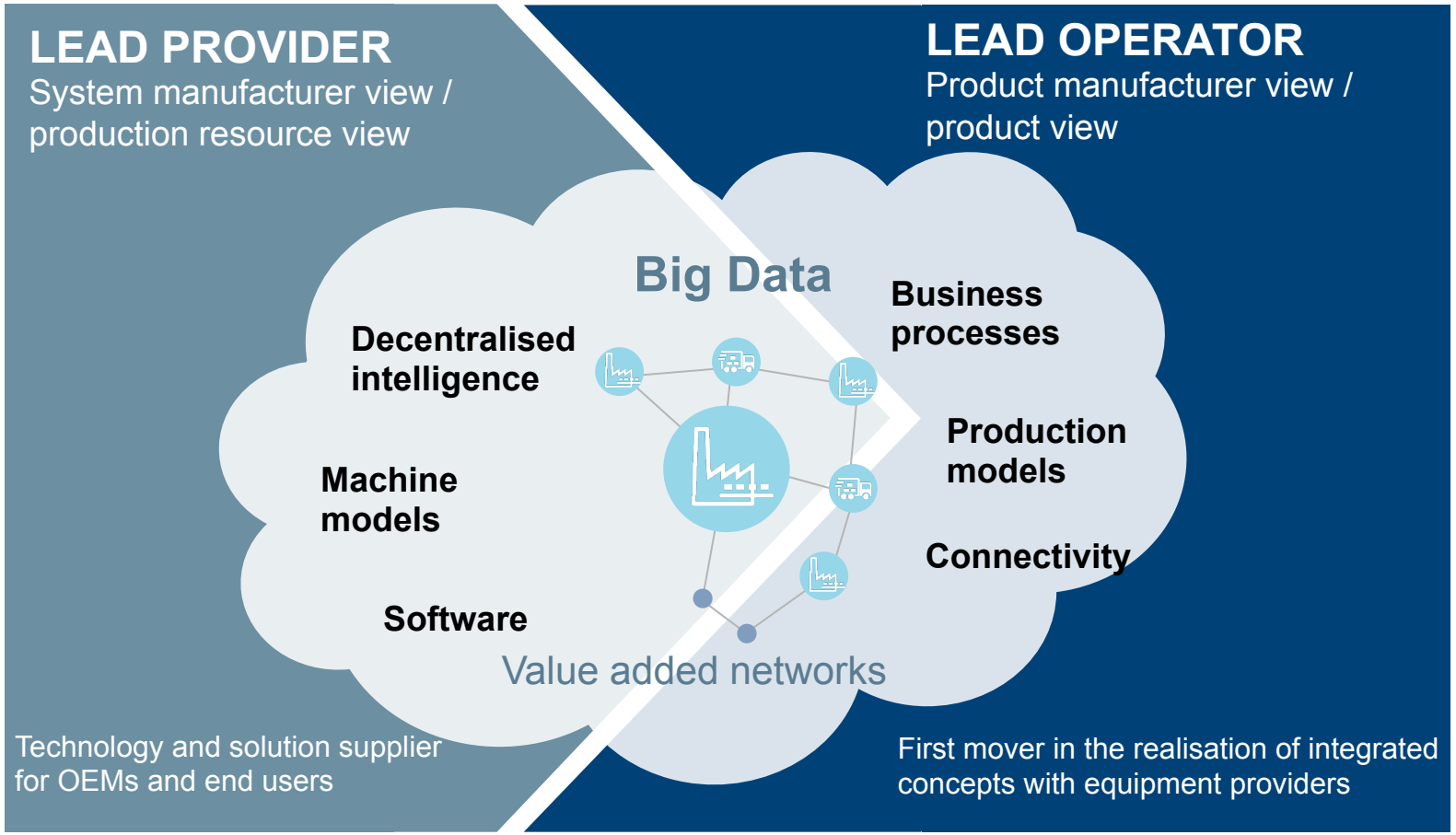
Two perspectives for Bosch on Industry 4.0



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The need for standards in predictive analytics

- **Bosch's interest in Standards for Manufacturing Analytics**
  - As an user/operator
    - Vendor independence
      - » Interoperability and Standardization of data collection, storage, retrieval, and presentation
      - » Data-driven verification and validation for improving efficiency and quicker scaling
      - » Use of best practices and standards to improve quality and traceability
      - » Model auditing and update
  - As a provider
    - Interoperability and Standardization
    - Sharing of success stories and best practices
    - Drive adoption of data-driven modeling, V&V
      - » Bosch is a leading participant in ASME's initiative on **verification and validation** for advanced manufacturing
    - Creation of neutral testbeds and certification agencies

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Join the manufacturing analytics community

- **Predictive Modeling in Manufacturing Analytics Challenge**
  - Kaggle Competition to be launched on August 17th, 2016
  - Focus on improving product quality as a binary classification problem (0.6% in one class)
    - 1 year of a product manufactured in large volumes and probably in your car
    - Complete assembly and testing data
    - 3 million samples, 4000 features,
  - Public testbed for manufacturing data science innovation
- **IEEE Big Data for Advanced Manufacturing Special Symposium**

  2016 IEEE International Conference on Big Data

  Dec 5 – Dec 8 2016 @Washington D.C., USA

  http://cci.drexel.edu/bigdata/bigdata2016/SpecialSymposium.html

  August 31, 2016: Results due for the manufacturing data challenge

  Sept 20, 2016: Due date for full symposium papers submission

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Analytics success stories in manufacturing

Test and Calibration Time Reduction

- Prediction of test results
- Prediction of calibration parameters

Scrap Costs Reduction

- Early prediction from process parameters
- Descriptive analytics for root-cause analysis

Warranty Cost Reduction

Prediction of field failures from

- Test and process data
- Cross-value stream analysis

Yield Improvement

- Benchmark analysis across lines and plants
- Pin-point possible root causes for performance bottlenecks (OEE, cycle time)

Predictive Maintenance

- Identify top failure causes
- Predict component failures to avoid unscheduled machine down-times

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Case Study: Test Time Reduction

Business Objective:

Reduce test and calibration time in the production of mobile hydraulic pumps

Impact

***35% reduction** in test and calibration time via accurate prediction of calibration and test results*

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Case Study: Test Time Reduction

Layout of the assembly line

Problem:
Bottleneck Test Benches

Approach:

1) Identify candidate tests for removal
2) Identify test '**groups**' run in parallel
3) Use **feature selection** methods to identify **least important** test measurements.
4) Remove least important test measurements (saving test time)
5) Train a predictive model to predict test outcome from remaining measurements.

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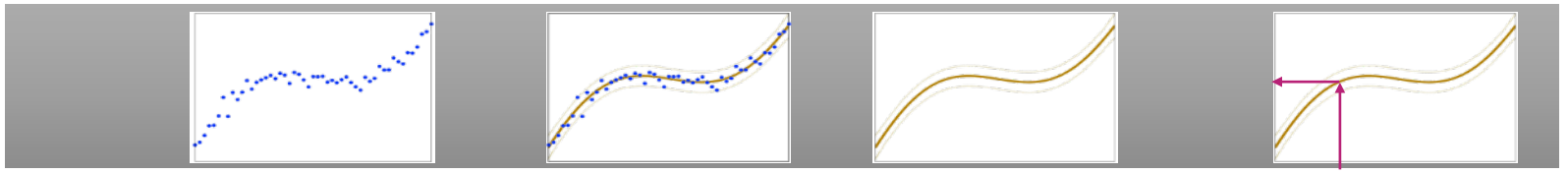
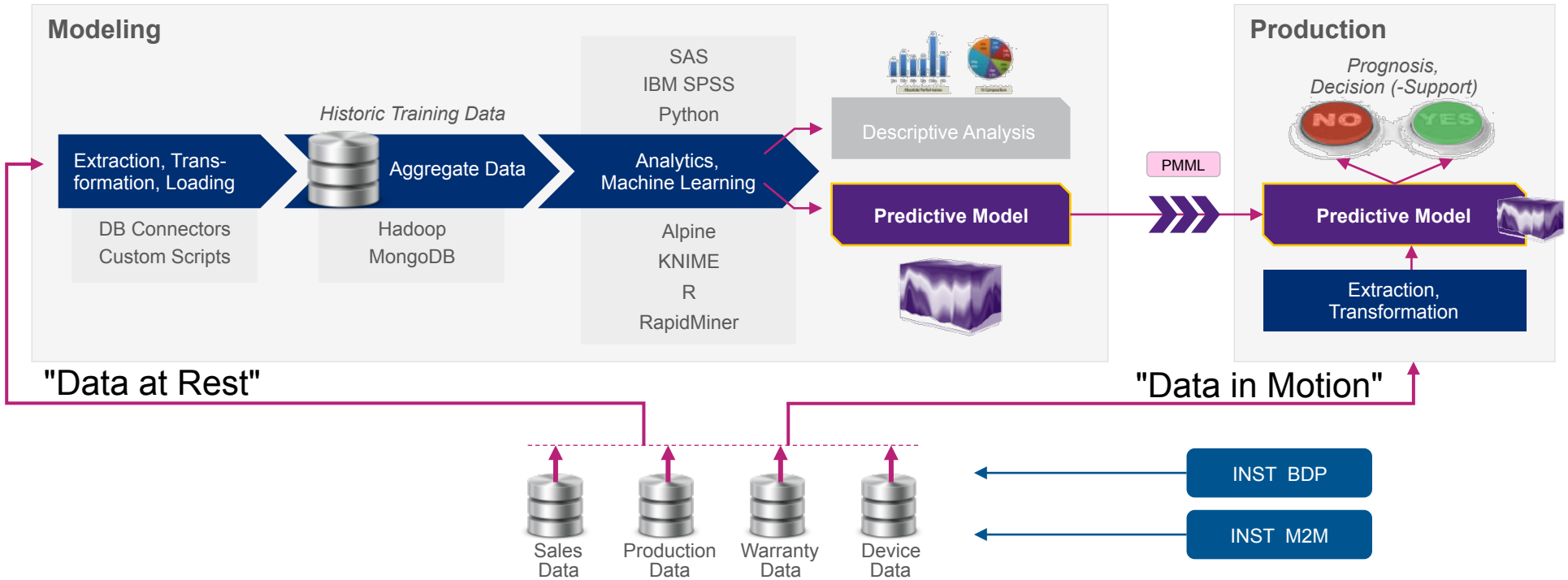
Our analytics information workflow





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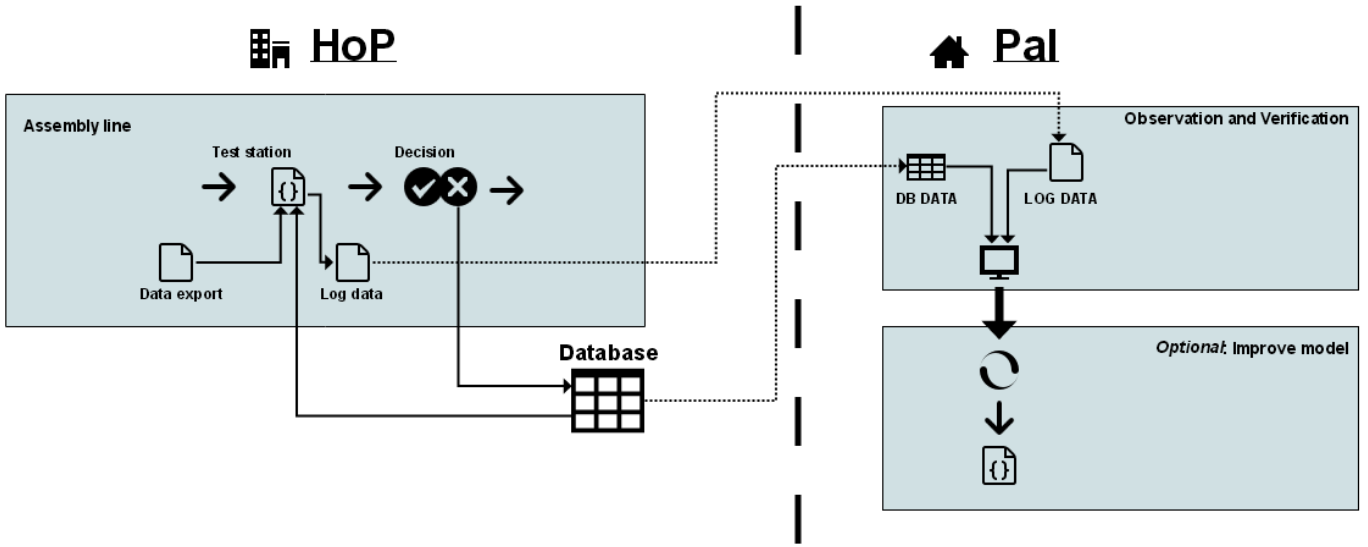
Deployment using PMML

- Model (Boosted Trees) developed in R
- Implementation time ~1 month
  - Proposed a client-server architecture using the PMML implementation by ADAPA
  - No installation required at the client



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Alternatives to PMML use

- Deployment using R-server
  - Not robust enough for continuous and low latency deployment
  - Additional memory overhead for low cost machines in manufacturing
  - Need to create scoring logs
- End-to-end deployment using other freeware or commercial analytics software
  - Local installation required
  - Need to recreate solutions
  - Learning overhead for data scientists
  - Licensing costs

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Summary of first impressions in using PMML

- Vendor independence
- Freedom of development tools for the data scientist

- Each vendor implements PMML differently
- Model coverage is limited
  - Adapa had to be extended in our application; many thanks to Zementis for a quick response
- Commercial solutions have better support, but come at a higher cost

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How to improve existing standards?

- Certification of compliance by DMG
- Keep up with the innovation in modeling paradigms
- Standards have to cover the complete analytical workflow
  - ETL
  - Model creation
  - Model deployment
  - Validation
  - Interpretation and uncertainty quantification
  - Versioning and traceability
- Consideration of development and deployment environments