IMPROVING THE MONITORING OF OFFSHORE WIND POWER PLANTS BY INTEGRATING CONTEXTUAL INFORMATION FROM LIFECYCLE RECORDS

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AGENDA

– Motivation

– Data Analysis Approaches
  1. SCADA Client
  2. Intelligent Data Monitor
  3. Integrated Digital Life Cycle Record

– Conclusion
MOTIVATION

- **Machine learning** in the wind industry with promising results

- Mostly **focussing on SCADA data** (exclusively)

- Open challenges in practice
  - High quality annotated data sets needed
  - False alarm rates
  - Distributed context information leading to high efforts for operators
QUESTION OF INTEREST

- How can we increase the practical impact of machine learning algorithms for plant monitoring and operation in practice?

- Working packages
  - Providing knowledge context to algorithms
  - Providing knowledge context to users
  - User experience
DATA ANALYSIS APPROACHES

SCADA CLIENT

SCADA

Data

Operator

Trading

DMS
ERP
WFMS
...
Weather
Forecast
Context

Icons: FontAwesome; Source: own figure
DATA ANALYSIS APPROACHES

INTELLIGENT DATA MONITOR

SCADA 1

Data Monitoring 2

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DATA INTELLIGENT DATA MONITOR

FEATURES

- **High-performant and intelligent** data analysis and prediction

- **Interactive** dashboards

- **Notifications** linked to anomaly data

- **Real-time data** support
INTELLIGENT DATA MONITOR

CHALLENGES

- Not every change is caused by a defect
  - Hardware (sensor) upgrades lead to different measurements
  - Previously unseen or seasonal behaviour
  - Firmware or parameter updates lead to different turbine behaviour

- Notify only, if “not yet known”, ignore subsequent and in progress defects

- Prioritize the impact on current and future power production
DATA ANALYSIS APPROACHES

SYSTEM INTEGRATION

1. SCADA
2. Data Monitoring
3. DMS, ERP, WFMS, Weather Forecast, Context

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DATA ANALYSIS APPROACHES

SYSTEM INTEGRATION

1. SCADA
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SYSTEM INTEGRATION

- System integration enables
  
  - Automatic creation of monitoring rules
  
  - Improvements on SCADA messages and sensor anomaly interpretation
  
  - Predictions based on plant history for predictive maintenance
SYSTEM INTEGRATION

AUTOMATIC CREATION OF MONITORING RULES

- Component **structure** from ERP
  - Parameterise physical models
- **Component semantics of RDS-PP®**: e.g. different types of “container”
  = MDK30 CM011 “hydraulic oil tank” / can run empty
  = MDK30 CL011 “hydraulic oil drip pan” / can spill over
- **Component master data and specification**
  - eCl@ss 36-03-01-04 “tank (closed)”: 
  - Property: 0173-1#02-BAA138#005 (nominal volume)
  - Format: float (number);
  - Unit: litre
SYSTEM INTEGRATION

CONTEXT INFORMATION FOR SCADA MESSAGES AND SENSOR ANOMALY INTERPRETATION

- Integrate WFMS or DMS

- Use *wiring diagrams* to reason about dependant sensors
  - Enable anomaly classification
  - Improve user experience

- Use maintenance or incident *reports*
  - Detect *component exchange* or *software updates*
  - List of “*known incidents*” to suppress notifications
DATA ANALYSIS APPROACHES

SYSTEM INTEGRATION

icons: FontAwesome; Source: own figure

1. SCADA
2. Data Monitoring
3. Lifecycle Record
4. Weather forecast

Context
LIFECYCLE RECORD

ACCORDING TO GERMAN STANDARD DIN 77005-1

- Contains for each object every related documented information throughout the whole lifecycle in chronological order
- Broad normative (international) basis

- Key properties
  - Different types of information including relationships
  - Strict reference to the object
  - Recording lifecycle and lifetime
  - Contextual extensions through views

Source: DIN 77005-1:2018-09
LIFECYCLE RECORD

REFERENCE FRAMEWORK

- Normative specifications (and more)
  - Information model
  - Adoption and extension according to individual needs

Source: own figure, see also DIN 77005-1:2018-09
LIFECYCLE RECORD AND DATA MONITORING

BENEFITS AND POTENTIALS

- **Single point of integration** providing inter-connected information
  - Complete incident work logs and changes including *related information*

- Enables
  - **Triggering** data monitor after structural changes to *update models*
  - Extraction and **learning** of *incident patterns* for prediction
  - **Similarity search** in plant histories (e.g. other turbines in the park)
  - Knowledge linkage for anomaly **classification**
CONCLUSION

- Different **maturity levels** of Data Analysis Approaches
- **Importance of contextual information** to
  - Automatically create and maintain monitoring rules
  - Interpret SCADA messages and sensor anomalies
  - Enable history based predictions
- Lifecycle record provides **common information model**

High quality lifecycle record as annotated dataset (e.g. for supervised learning) to empower machine learning in practice.
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PROJECT GRANTS

SCADS DRESDEN/LEIPZIG

- Competence Center for Scalable Data Services and Solutions Dresden/Leipzig

Specialists from computer & domain sciences
Focal point for new research activities
Collaborative big data research
THANK YOU

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