KNIME in Production

Development and deployment of reusable models for the Industrial Internet
Bosch Group

Four business sectors

**Mobility Solutions**
One of the world’s largest suppliers of automotive technology

**Industrial Technology**
Leading in drive and control technology, packaging, and process technology

**Energy and Building Technology**
Leading manufacturer of security technology
Market leader of energy-efficient heating products and hot-water solutions

**Consumer Goods**
Leading supplier of power tools and accessories
Leading supplier of household appliances
Industrial Internet / Industry 4.0

Challenges in Manufacturing

**Severe Restrictions**
- Closed networks
- Security standards
- Constrained devices

**Demanding Requirements**
- Real-time scoring
- Millisecond response time
- High availability
Industrial Internet / Industry 4.0
Market Situation and Need

Industry 4.0 software solutions in use

- 56% yes
- 44% no

- 72% Monitoring of machine data
- 70% Monitoring of process/quality data
- 58% Monitoring/control of logistics processes

Improving KPIs in the manufacturing environment

Costs of maintenance & repair

- 66% Failure costs
- 60% Production output
- 50% Logistic costs
- 31% Direct labor costs
- 30% Inventory
- 12% Fixed costs from investments
- 9% Indirect labor costs

Production output KPI

- 77% OEE: Technical downtime
- 62% OEE: Performance losses
- 44% OEE: Organizational downtime
- 32% OEE: Quality losses
- 31% OEE: Changeover losses
- 23% Plan occupancy time

Source: Industry 4.0 Market Survey
Bosch Software Innovations, 09/2015
Industrial Internet / Industry 4.0

Bosch Sites around the World

- **Americas:** 15 manufacturing sites in 3 countries
- **Europe:** 51 manufacturing sites in 19 countries
- **Asia Pacific and Africa:** 40 manufacturing sites in 11 countries

**Bosch Location**

**Data Mining Services**
Industrial Internet / Industry 4.0

Use Cases
Visualization

**X Charting**

- Get a first glimpse on the data at hand using a set of standardized charts/reports
- Starting point for further analysis
- Encourages collaboration between stakeholders
Visualization

X Charting

Production metrics
Visualization

X Charting

Feature extraction
Visualization

X Charting

Manufacturing specific functions
**Agility**

Predicting Spatter in Resistance Spot Welding

- **Goal:** Predict when hot metal will “spatter” from a weld before it happens
- Use data provided by the weld controller
- Have many different welding programs (types of weld)

**Rexroth PS 6000**

- Initial preparation of welding time-series measurements performed in KNIME
- “First Shot” analysis also performed in KNIME
- Exports of cleaned data from KNIME used for final, complex analysis
- Final models predicted a large fraction of spatters for particular welding programs with few false positives

Spatter occurs here, when the voltage drops
Agility

Exploratory Analytics

Visual Analysis
Statistics
Feature Extraction
Feature Creation
Model Building
Reuse

Problem Description

- Data transformations use domain knowledge. Much effort is spent in implementation of this domain knowledge.
- Identical transformations are needed during both model creation and execution.
- Transformations form a function hierarchy.
Reuse

Our Approach

1. Develop new pre-processing function
2. Add function to library
3. Define hierarchy of transformations
4. Build & score models
5. Deploy best performing solution

Parse hierarchy and generate JAR
Reuse

Creating Transformation Models

1. New node type „Transformation Function“
2. Design KNIME workflow using “Transformation Function” nodes
3. Configure mapping of KNIME table columns to function arguments
4. Parse KNIME workflow & create transformation model
Reuse

Putting it all together

1. Upload a suitable driver together with JAR to Analytics Environment
2. Upload a suitable driver together with JAR to Production Environment
3. Deploy PMML model to Scoring Engine
Reuse

Standards based deployment with PMML – “Model once, deploy anywhere”
Summary

Swiss Army KNIME

- **Ease of use** facilitates collaboration between different stakeholders
- **Perfect match for exploratory analytics** approaches thanks to community and integration nodes
- **Openness and extensibility** allows for application to a broad range of use cases.
Thank you for your attention!

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