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# Siemens enables Digitalization:
Human-in-the-Loop Control Processes

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Data Analytics and Artificial Intelligence, Trondheim

New business models in the internet age are disrupting complete markets

From bookstore to e-book

From record store to streaming

From Yellow Pages to marketplace

From taxi to ride-sharing

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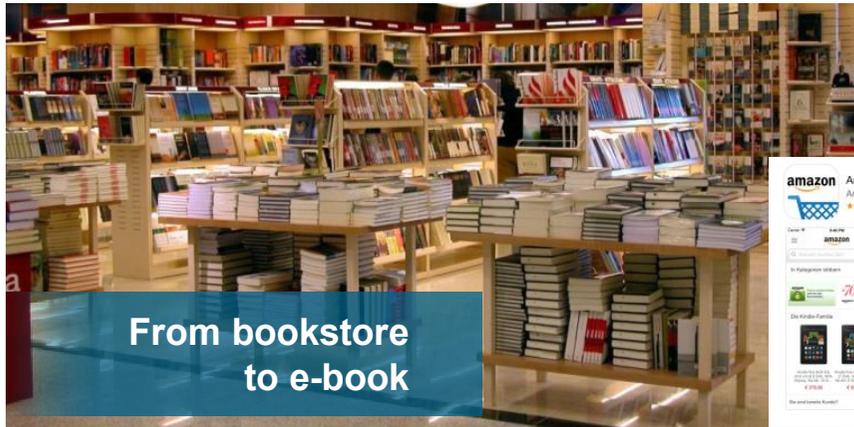
Industries are changing as well

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From manual machine configuration…

… to virtual commissioning

From fixed maintenance intervals…

… to predictive maintenance

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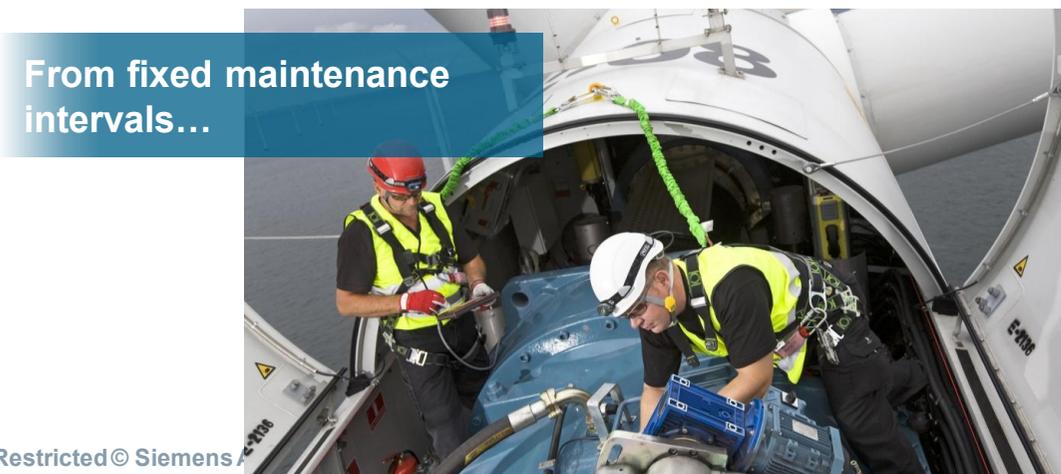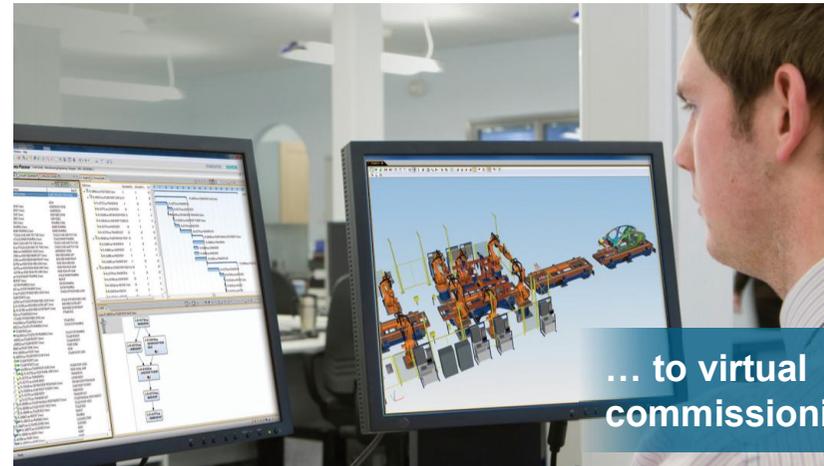
Artificial Intelligence encompasses a variety of technologies – integration is crucial

Analytics/Method-oriented perspective:

- Classification
- Regression
- Forecasting
- Controlling
- Optimization

Knowledge Representation
(e.g., Knowledge graph / Ontology)

Reasoning

Agent technologies

Planning Optimization
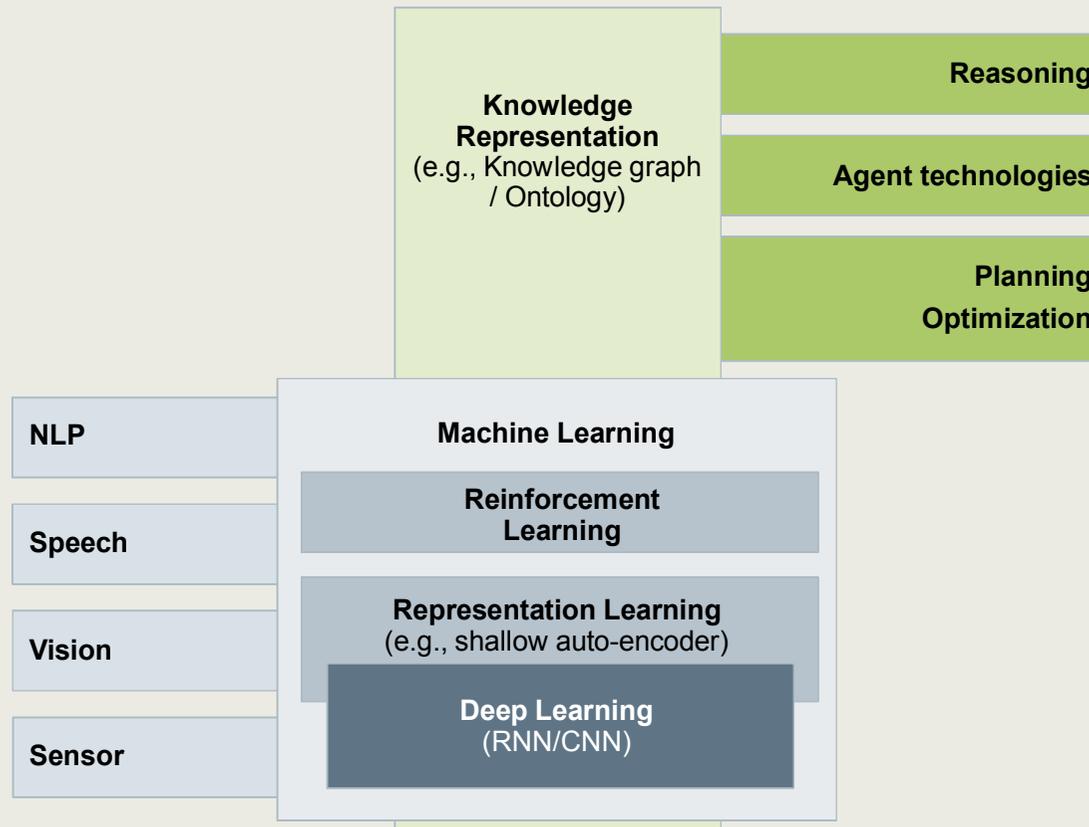
Decision/Action-oriented perspective:

- Perception
- Cognition
- Decision

NLP

Speech

Vision

Sensor

Machine Learning

Reinforcement Learning

Representation Learning
(e.g., shallow auto-encoder)

Deep Learning
(RNN/CNN)

Connecting industrial knowledge (sources)

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Data Sources

Static aspects

R&D data

Engineering data

Plant data

Dynamic aspects

Service data

Monitoring data
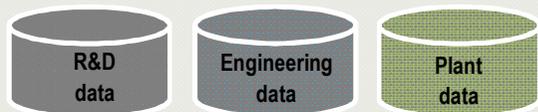
Relational Learning (e.g. via Tensor Factorization)
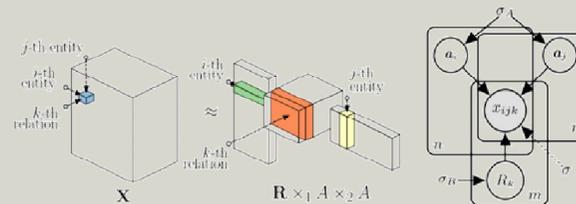
Tresp, Nickel. Tensor Factorization for Multi-Relational Learning, ECML, 2013

Information extraction
(e.g. Natural Language Processing)

Pattern Sequence Mining (e.g. via PrefixSpan)

Build in-depth prefixes

ROOT

A

Not frequent

AA

AB

Not frequent

AAA   AAB   AAC   ABA   ABB
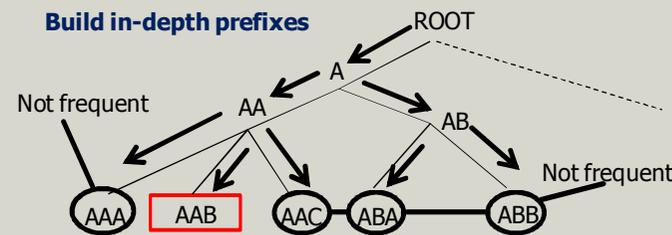
Industrial Knowledge Graph

Knowledge fusion into one coherent semantic model

Examples for automated graph construction

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Enable intuitive end-user access to industrial data

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Data Sources

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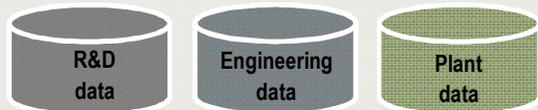
Industrial Knowledge Graph

Ontology-based Data Access

Normal start?

Query

Analytics

SAP HANA

FL FUZZY LOGIX

TERADATA ASTER

R

TIBCO

KNIME

python

examples

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Knowledge-Graph driven Analytics
Why? Where? How? Example?

BSX-TC3562-XE01	
BSX-TMP12A-XE01	DC1, DB X1, TY2
BSX-TICCFB1-XE01	

Analytics

MS-XC255-X12	
BSX-TC3562-XE01	DC2, DB X2, TY2
BSX-TC3562-XE01	

Analytics

MRR-T8901-8462	DC2, DB X2, TY2
CRR-M8393-9272	
"Ignitor on"	DC2, DB X2, TY4

Analytics

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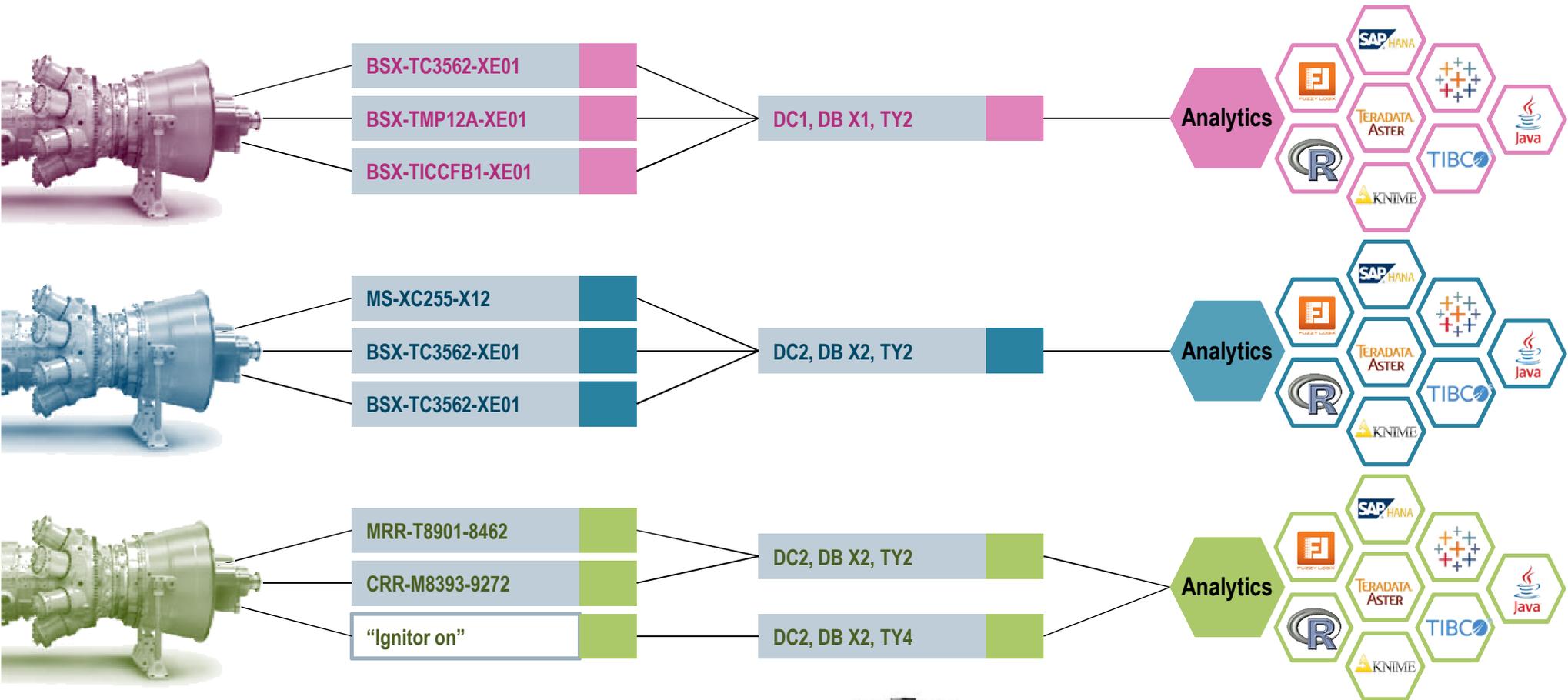
Example of the Out-of-box Data Analytics Tools

A

amount of digitalized knowledge

Health Check for CERN

5 Deep Learning & Natural Language Processing

4 Data-driven Methods & Machine Learning

3 Rule-based Analysis & Complex Event Processing

System data

2 Physics-based Models

1 Basic & Dedicated Calculations

Knowledge Graph

Report   Part   Location   Part   OEM   SIEMENS

Digitalized expert knowledge

Implicit expert knowledge

degree of Artificial Intelligence **B**

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Demo Introduction:
Semi-Supervised Annotation via Smart Pen Application

Data Acquisition

Semantic Representation

Intelligent User Interface

- Human (e.g. technician) provides data by hand-written
- Context information is provide by circling in a graphical representation
- intelligent handwriting recognition by using related taxonomies

Semantic Model

- establishes the basis for seamless data integration across system borders, applications, locations, etc.
- Through semantic labeling of data, data can be easily reused and combined
- external knowledge, such as external knowledge model can be integrated

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Demo Introduction: Semantic Modeling establishes means for seamless data integration across plants and workflows

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WHAT is it?

Semantic Models formally define the structure of a plant as well as the underlying processes and workflows

HOW to develop?

-manual editing of semantic models

- automated bootstrapping of models (e.g. from TIA, COMOS)

-Reuse of models developed by the communities

VALUE ADD

- Seamless data integration and exchange across system borders, locations & companies

- Important foundation for semi-automatic data acquisition via a Smart Pen application and associated applications

Engineering

Operations

Plant Design

Semantic Model Manager*)

Manual Editing / Modeling

| Bootstrapping | Alignment |

Semantic Knowledge Base
(incl. consistency check, versioning)

Maintenance & Service
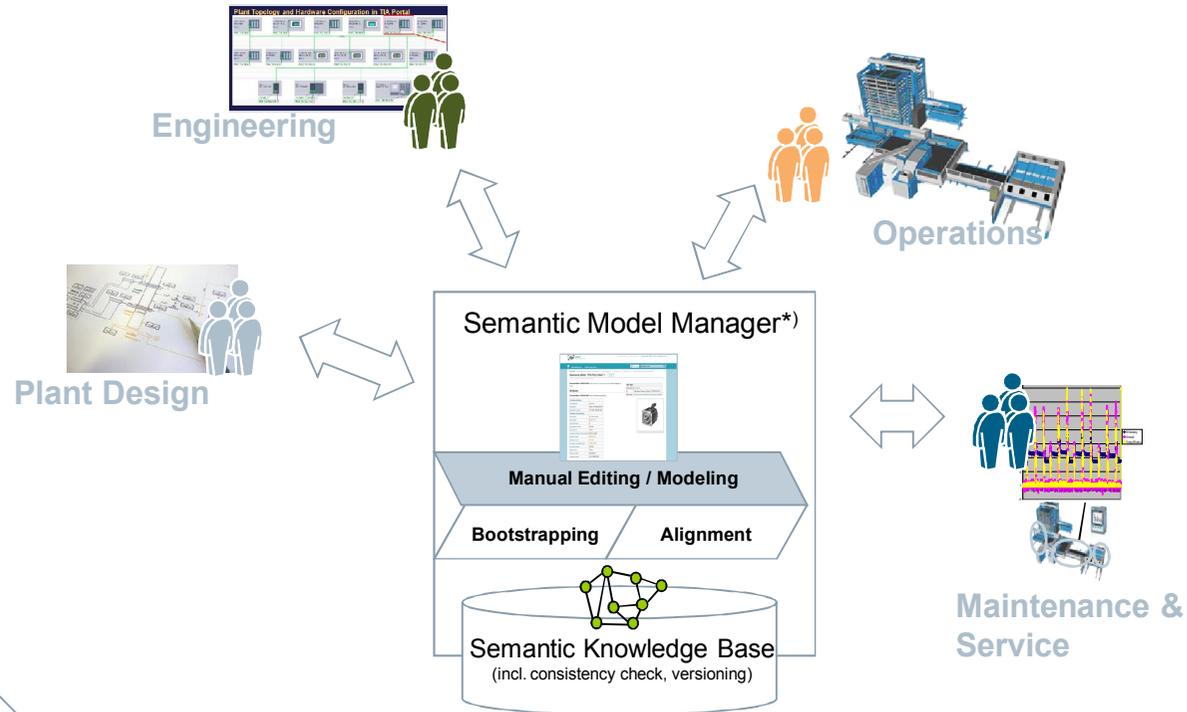
*)Deployable on PLCs, server and/or cloud

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Demo Introduction: Overview Architecture

metaphacts / protégé

Domain Modeling

Instance Base

SMARTFACTORIES SERVER

Handwriting Recognition

Gesture Interpretation

Center Device

Camunda BPM

Maintenance Model BPMN

The Demo itself:
Semi-Supervised Annotation via Smart Pen Application

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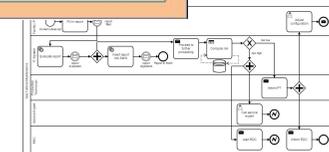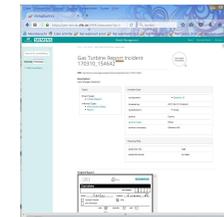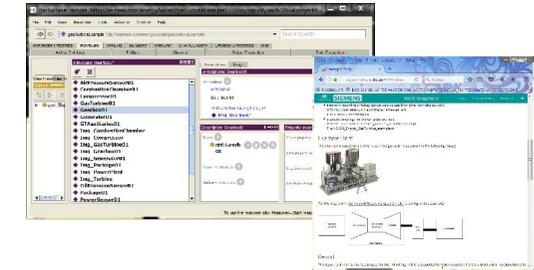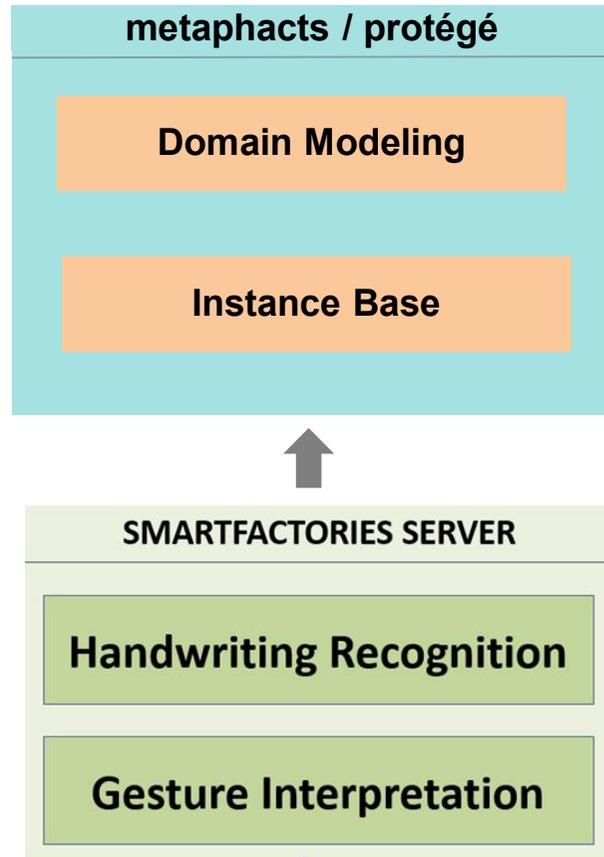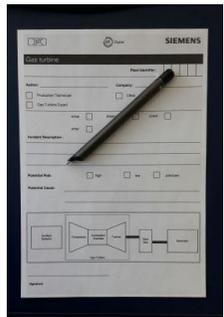
Contact page

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