A Semantic Architecture for Industry 4.0
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Industry 4.0

• Technologies and concepts of value chain organization which draws together Cyber-Physical Systems, the Internet of Things and the Internet of Services.
  • AKA « the fourth industrial revolution »
• Can be seen as an engineering eco-system, where
  • processes govern themselves,
  • smart products take corrective actions to avoid damages,
  • individual parts are automatically replenished, and
  • raw parts and production machines enter into a dialogue in order to optimise manufacturing processes.
One possible architecture

Taken from Toro’s « A perspective on Knowledge Based and Intelligent systems implementation in Industrie 4.0 »
Joint use of Semantics and « Big Data »

- Use of Semantic Technologies
- Development of semantically enhanced cyber-physical systems

- « Big Data » coming from sensors
- This information needs to be converted into knowledge for further use and exploitation

Taken from Toro’s « A perspective on Knowledge Based and Intelligent systems implementation in Industrie 4.0 »
The Role of Big Data

- Big data is high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization (Gartner, 2012)
  - Explain inconsistent component performance and availability
  - Implement predictive manufacturing
  - ...
The Role of Semantic Technologies

• But ... **what are semantic technologies?**

• **Semantics** is the study of meaning
  • Central to the study of communication (a crucial factor in social organization)
  • Central to the study of the human mind - thought processes, cognition, conceptualization –
Some things we know

• Consider
  • *The small blue circle is in front of the square.*
  • *The square is behind the small blue circle.*
• We are capable of verifying that both sentences are **true** in this particular situation.
• This is because we know what the world must be like in order for these sentences to be true.

Taken from Assimakopoulo's course on Semantics (University of Malta)
Some things we know

• Now consider: *She drove past the bank*

• This sentence then can mean more than one thing (it is **ambiguous**).
• This seems to be related to our knowledge of what *bank* denotes.

Taken from Assimakopoulou's course on Semantics (University of Malta)
Some things we know

• Finally, consider:
  1. *John murdered the president.*
  2. *The president is dead.*

• We also know that sentence two follows from sentence 1 (technically: sentence 1 *entails* sentence 2 or sentence 2 is a *consequence of* sentence 1)

• In this particular case, it seems to be related to the meaning of *murder.*
Knowledge and Semantic Engineering

• Knowledge and Semantic Engineering proposes
  • concepts, methods and techniques
  • to model, formalize or acquire knowledge
  • with the aim of capitalization, implementation or management in the broadest sense of the terms.
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Development of Intelligent Semantic Systems
Intelligent Semantic Systems

• Software capable of reproducing the cognitive mechanisms of an expert in a particular field.
  → Capable of answering questions, by performing reasoning from known facts and rules.

• Particularly suitable for decision support.
Why use semantics in an industrial context?

- To share common understanding of the structure of information among people or software agents
- To enable reuse of domain knowledge
- To make domain assumptions explicit
- To separate domain knowledge from the operational knowledge
- To capitalize experience knowledge
- To be able to make decisions in different contexts
Specific scientific challenges in HALFbACK

• The use of both inductive and deductive techniques to make sense of data and to gain new insights.

• The joint use of semantics and of data-mining algorithms to improve the quality of the interpretation of huge amounts of data and foster data retrieval, reuse, and integration.
  • Top-down engineered ontologies and logical inferencing play a key role in providing the vocabularies for querying data,
  • Machine learning techniques will enable the linkage of these data.
Specific scientific challenges in HALFbACk

- The HALFbACk system will first learn higher-level features, expressed as logical axioms from data (coming from sensors, measurements of the characteristics of the final products, machine statistics, and so)

- It will then use these higher level features for non-trivial deductive inferences (the optimized prediction of maintenance or the need to use the broker to shift the production).
Questions or Comments?

Thank you !!!