Applying ISO 15926 to drilling control systems

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Outline

- AutoConRig
  - Autonomous drilling control systems
  - Challenges
  - Agents
- Applying ISO 15926 to AutoConRig

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The AutoConRig project

- Founded by NFR
- The main objective is to analyse, develop and test an (agent based) autonomous and semi-automated drilling control system
- Enable real plug-and-play control connection between any approved control party – and a drilling rigs drilling machine
- Need
  - Standard for communication with the drilling machineries

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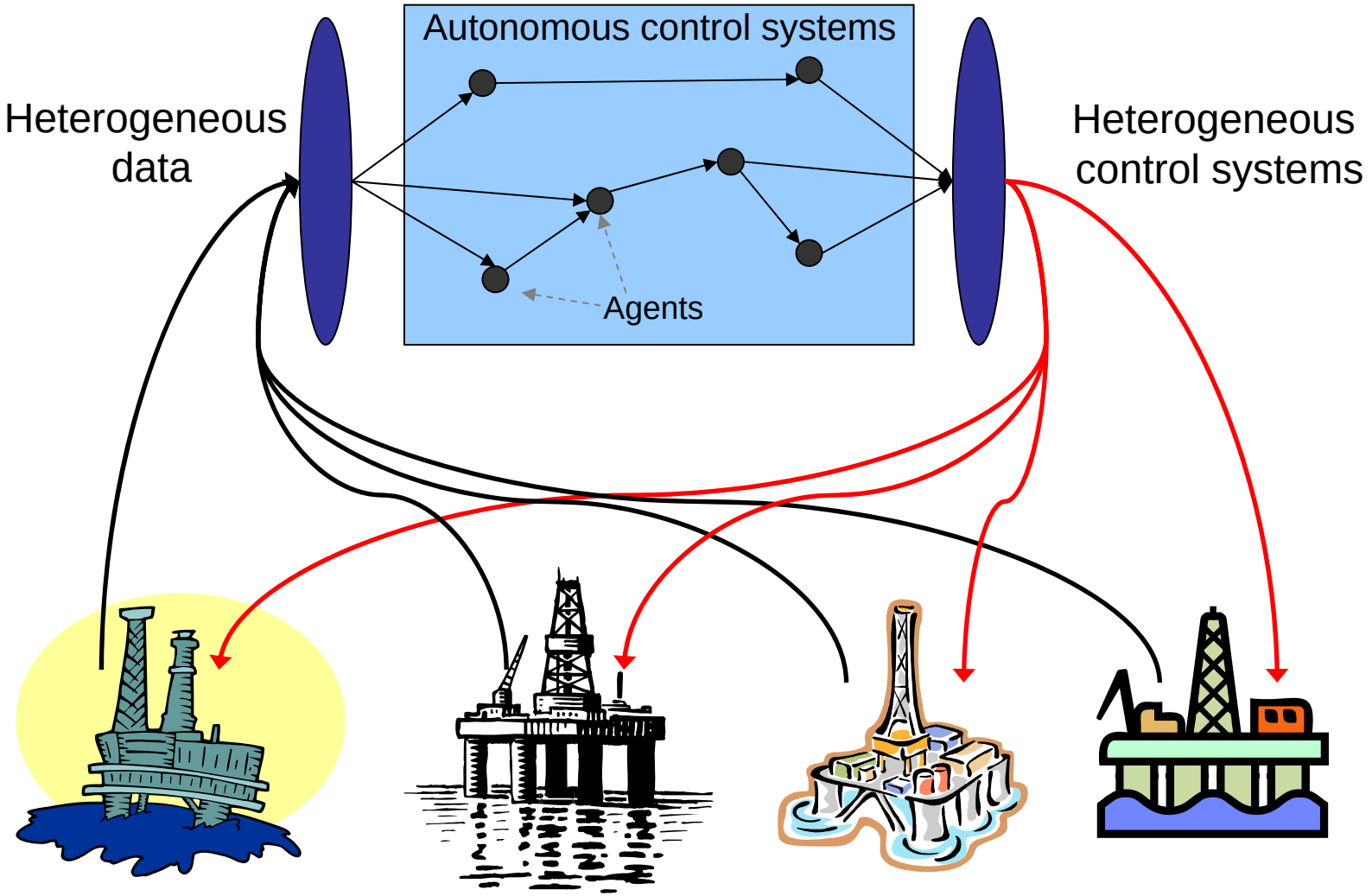
Autonomous Drilling Control Systems



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Deliverables

- Standard for communicating with the drilling machineries (based on extensions and use of ISO 15926) including :
  - Service Oriented Architecture (SOA) of new standard for high-level drilling control
  - The OPC standard for real-time drilling control
  - Ontology for Integrated Drilling Control
  - A demonstration will be run in eLAD with virtual machines.
- Automation of tripping sequences for:
  - Normal tripping operations
  - Management of circulation during tripping sequences.
  - Management of unexpected events during tripping sequences
- Agent-oriented architecture for semi-autonomous control system:
  - Agent platform and communication language (adopted from other projects)
  - Decision-making plans for tripping operations
- A demonstration of the resulting software architecture and automation in the eLAD laboratory using virtual machines (draw-work, mud-pumps, top-drive, power-slips, starracker and iron rough neck)
- A demonstration on the full scale drilling rig Ullrigg with both normal operation and unexpected events.

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Agents

- An agent is a computer system that is situated in some environment, and that is capable of autonomous actions in this environment in order to meet its designed objectives
- An intelligent agent has flexible, autonomous behaviour, in which it reacts to its environment appropriately and may take initiatives to meet its goals

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Characteristics of Intelligent Agents

- Environment awareness
  - sense the environment
  - their actions affect it
- Autonomous
  - have some sort of free will and are independent
  - Decide for themselves what to do and with whom to cooperate
- Proactive
  - Have a goal which they take actions to pursue
- Reactive
  - Can react to changes in the environment when necessary
- Social
  - Communicate, negotiate, and collaborate with other agents
- Flexible
  - Have several ways to achieve a goal
- Robust
  - Can recover from failure

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Multi-Agent systems

- Cooperative or competitive
- Characteristics
  - Each agent has incomplete information of capabilities to solve the problem
  - There is no global system control
  - Data is decentralised
  - Computation is asynchronous

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Challenges

- Need an unified understanding of concepts and how they are related
  - With minimal encoding bias → the conceptualization should not depend on a particular symbol-level encoding [gruber95]
- Need data that can be interpreted and processed by the agents

→Semantic technologies and ISO 15926 can provide this…

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Applying ISO 15926 to AutoConRig

- Drilling-specific standards:
  - WITSML
  - AKSIO
  - ISO 13628
  - IADC
  - TRAC-ID
  - Control systems (OPC & ISA88)
- Have to design:
  - A vocabulary for the standard
  - A method to map data/information to and from the standard
- Challenge:
  - Where do the domain ontology end and the business specific rules begin?

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ISO 15926 as an intermediary

- The industry show reluctance against applying ISO 15926
  - They find it difficult to understand and use
  - Do not see the reason to apply it
- Need a clear specification on how it is meant to be used
  - How/why?
  - What role should ISO 15926 play in the integration process?

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What does ISO 15926 provide?

- A methodology for designing ontologies
- An upper, abstract ontology
- Common terminologies
- Templates for designing ontologies

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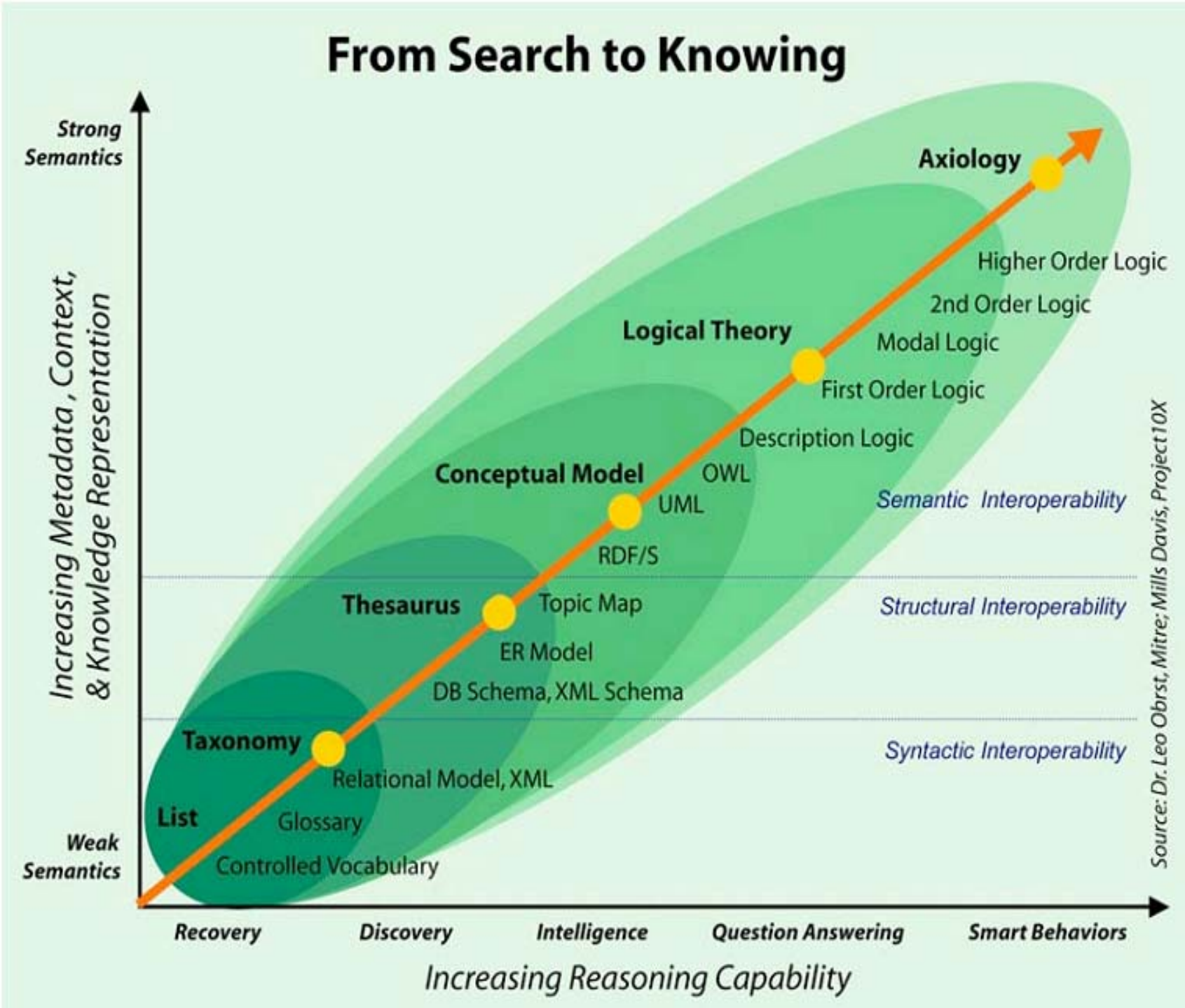

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From terminologies to an ontology

- Common terminologies/vocabulary (E.g. RDL)
  - Easy to se the relation between concepts in different systems and domains
  - Just static structures used for knowledge references
  - Describe the kinds of entities in the world
  - Excellent starting point for ontology structuring
  - Do not show the relation between different consepts
  - Do not support reasoning
- An overall ontology for the whole domain
  - Describe, in addition, how the entities are related
  - Allow knowledge inference and reasoning
  - Can also be used as a reference data library
  - Represent content rather than just data
  - Capture a share understanding of a domain of interest
  - Contain no ambiguities
  - (Provide a formal and machine manipulability model of the domain)

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Ontology

- Should provide the needs of a maximally large number of users, but at the same time be manageable
- Large ontologies
  - Impractical to handle → not used
  - Can not satisfy all the needs at the same time
- Small ontologies
  - Tend to be to narrow
  - Lose the ability of cross-domain integration

→ We need several ontologies that embrace the different sub-domains

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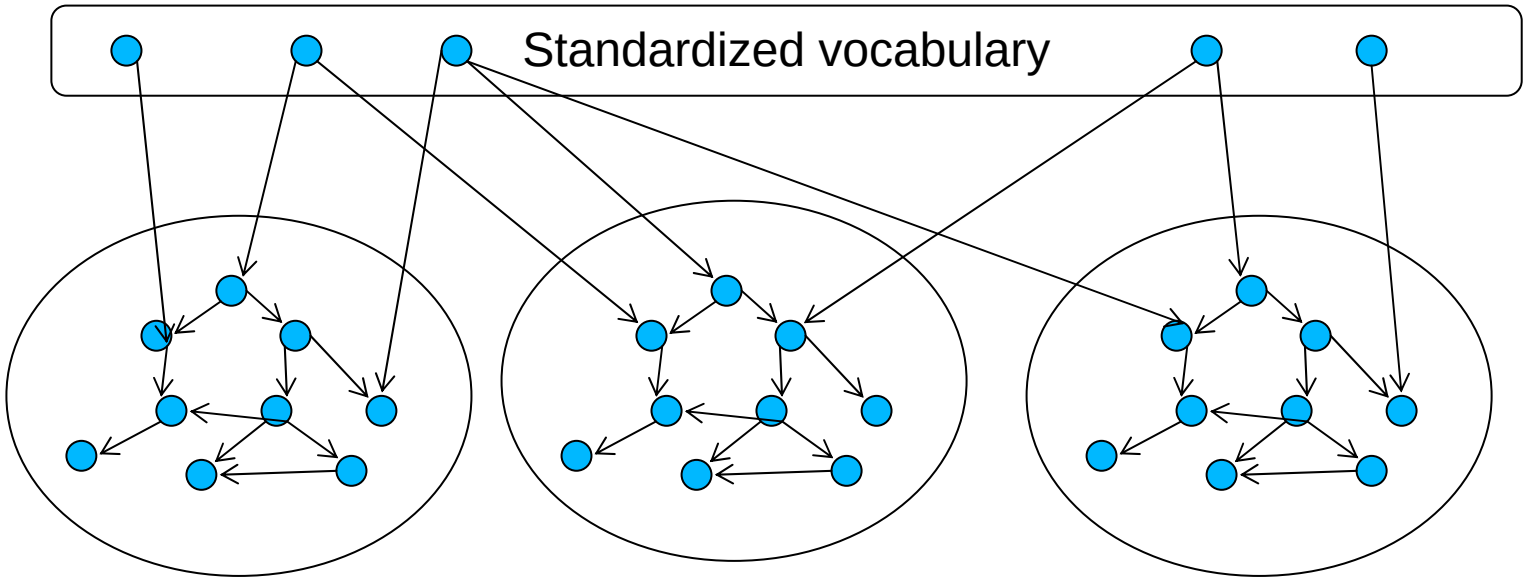

Need mapping mechanisms