Ontology Summit 2015
Internet of Things:
Toward Smart Networked Systems and Societies

Symposium – April 13, 2015
Track C: Decision Making in Different Domains

Co-Champions
Mike Bennett, Michael Grüninger

Track C Decision Making in Different Domains

From the Summit theme:

Identify a methodology for development of terminologies for multimodal data (or ontologies), developing appropriate ontologies, developing testing methods for these ontologies, demonstrating interoperability for selected domains (e.g., healthcare, situational awareness), and using these ontologies in decision making.

Track C Mission

To explore several approaches to automated inference in applications ranging from complex event processing and situation awareness to manufacturing.

Identify key problems in IoT which require (or would benefit from) automated reasoning (motivating scenarios for ontologies in IoT)

- Decision Support
- Integration and interoperability of devices (interactions among smart objects)

Address the challenges for these applications

- role of ontology languages (expressiveness/tractability)
- are existing ontologies adequate for supporting these applications?
- scalability of approaches to semantic integration and automated reasoning

Speakers – Session 1

- Ontology Based Information Centric Tactical Edge Networking, Joseph Kopena (Bellerophon Mobile)
- From Semantic Complex Event Processing to and Ubiquitous Pragmatic Web 4.0, Adrian Paschke (Freie Universitaet Berlin)
- Process Ontologies for Smart Objects in Manufacturing, Michael Grüninger (University of Toronto)
- Situation Awareness and Decision Making, Ken Baclawski (Northeastern University)

Speakers – Session 2

- An Ontological Framework for Decision Support. Marco Rospocher (Fondazione Bruno Kessler)
- Decision Making in IBM Watson Question Answering, Bill Murdock (IBM Watson Research Center)
- The Role of Ontologies in Building Automation, Matthew Giannini (SkyFoundry)

Case Studies

- Military Situation Awareness (Kopena)
- Enterprise Decision Management (Paschke)
- Manufacturing (Grüninger)
- Healthcare (Baclawski)
- Cloud Services (Baclawski)
- Customer Service (Baclawski)
- Financial Services (Baclawski)
- Environment (Marco Rospocher)
- Jeopardy-Style Question Answering (William Murdoch)
- Building Automation (Matthew Giannini)

Insights/Lessons Learned

- A little semantics goes a long way (Kopena)
  - Potential stakeholders primarily interested in basic taxonomies
- Fairly difficult to get developers without KR experience up to speed (Kopena)
  - Project apps didn't get to point of utilizing capabilities for collaboration, versioning, etc., offered by the underlying model

Insights / Lessons Learned

- Project Challenges
  - Determining relevance
  - Security considerations
  - Testing effort
  - Human v non human inputs
  - Handling Uncertainty
- Architectural Considerations
  - Networking architectures – Information centric, peer to peer
  - Queries optimization / distribution
  - Use of Rules

Insights/Lessons Learned

- Evaluation of KR systems is extremely difficult (Kopena)
  - Performance is non-trivial but fairly straightforward
    - Sidenote: What's hard for network may not be hard for KR, & vice versa
  - Testing actual effectiveness and value requires complex yet realistic scenarios, revolves around metrics that are difficult to quantify
- SPARQL and RDF model aren't quite the right tools for this task (Kopena)
  - SPARQL great for querying the KB, less ideal for fetching objects
    - Apps want all the metadata about content, resulting in massive queries
  - RDF+SPARQL cumbersome when working with dynamic data

Insights/Lessons Learned

- Automated reasoning is difficult! (Grüninger)
  - Some queries could not be answered in the time limit.
  - Approaches are necessary for dealing with this problem.
- Trade-offs
  - Reasoning complexity versus real time processing trade-offs
  - Axiom types v usefulness / applicability to task
- Semantic Issues
  - Observation versus Subject (topic v type hierarchies?)
  - Use of Concept Lattice
  - Sequencing – how to represent
- Tools and Languages
  - Alternatives to SPARQL / RDF?
  - Pragmatic Web v Schema.org
  - Logic translations; other tooling questions

Insights/Lessons Learned

- Manufacturing processes are complex. (Grüninger)
  - Objects flow through a sequence of processes, and at any point in a process plan, there are multiple activities that can possibly occur next.
  - Process plans may also be nondeterministic.
  - A first-order process ontology can be used to create smart objects that can reason about the manufacturing processes in which the object participates.
  - Eventually, smart items could be dynamically self-routed through the various process plans.

Insights/Lessons Learned

- Complex event processing can benefit from semantics (Paschke)
  - Event data becomes declarative knowledge while conforming to an underlying formal semantics
  - Reasoning over situations and states by event processing agents
  - Better understanding of the relationships between events
  - Declarative knowledge-based processing of events and reactions to situations
- The Pragmatic Web consists of the tools, practices and theories describing why and how people use information. (Paschke)
  - In contrast to the Syntactic Web and Semantic Web the Pragmatic Web is not only about form or meaning of information, but about interaction which brings about e.g. understanding and commitments. [www.pragmaticweb.info]

Insights/Lessons Learned

Decision Making in Question Answering (William Murdoch)

- Choosing the answer to a question
  - IBM Watson generates many candidate answers
  - For each answer, how confident are we that the answer is right?

- Deciding whether to answer at all
  - Based on how confident we are that the answer is right
  - Based on cost/benefit of right answers and wrong answers

- Deciding how many answers to provide

- Deciding whether to hedge

Insights/Lessons Learned

Question Answering vs Decision Making

- Question Answering presumes that there is a unique correct answer to a question and the purpose of decision support is to find the answer.

- Decision-making can be regarded as the cognitive process resulting in the selection of a belief or a course of action among several alternative possibilities. [ref: Wikipedia]
  In such a process, there is no unique answer or even necessarily a correct answer that one could verify.

- Question Answering and Decision Making have much in common but a system designed for one may not be suitable for the other without some effort.

Insights/Lessons Learned

- Conceptual model of semantics provides considerable lift in building services (Giannini)
  - Addresses common problems with HVAC etc. components (boiler on-boarding etc.)
  - Energy, sensor etc. concepts
- Did not use formal logic based language for this
  - Opportunity to re-frame the semantics in formal logic based notation
  - Would then be interoperable with other standard ontologies

Vision of the future of the Web (from Paschke)