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Sharing Resources to Advance Research and Education through Cyber-infrastructure

Towards an Ontology Development Methodology for Interdisciplinary Researh Group Collaborations

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Abstract

Interdisciplinary research (IDR) collaboration can be defined as the process of integrating experts' knowledge, perspectives, and resources to advance scientific discovery. These collaborations, however, introduce a new set of "culture" barriers as participating experts are trained to communicate in discipline-specific languages, theories and research practices. We propose that building a common knowledge base using ontologies can provide a starting point for **interdisciplinary knowledge exchange, negotiation, and integration**. This paper introduces a methodology that extends previous work in collaborative ontology development, and integrates learning strategies, such as concept maps, to enhance interdisciplinary research practices.

Introduction

Collaborative work in an interdisciplinary setting introduces a different set of "cultural" barriers [1,2]. We address the challenges that come from integrating disparate disciplinary perspectives using **semantic data models** and processes, and incorporating **learning theories** to support both information exchange and acquisition. Our hypothesis is that by combining semantic methods (e.g. ontology development) with learning practices (e.g. concept map development) we can facilitate the knowledge negotiation process in IDR teams [3,4,9].

Background

Ontologies are used to explicitly specify a shared conceptualization of a domain in the world [6]. Knowledge represented in ontologies can later be shared and reused among scientists with common research interests to provide formal logics and automated reasoning to support decision-making, data integration, and question answering for future collaborations [5].
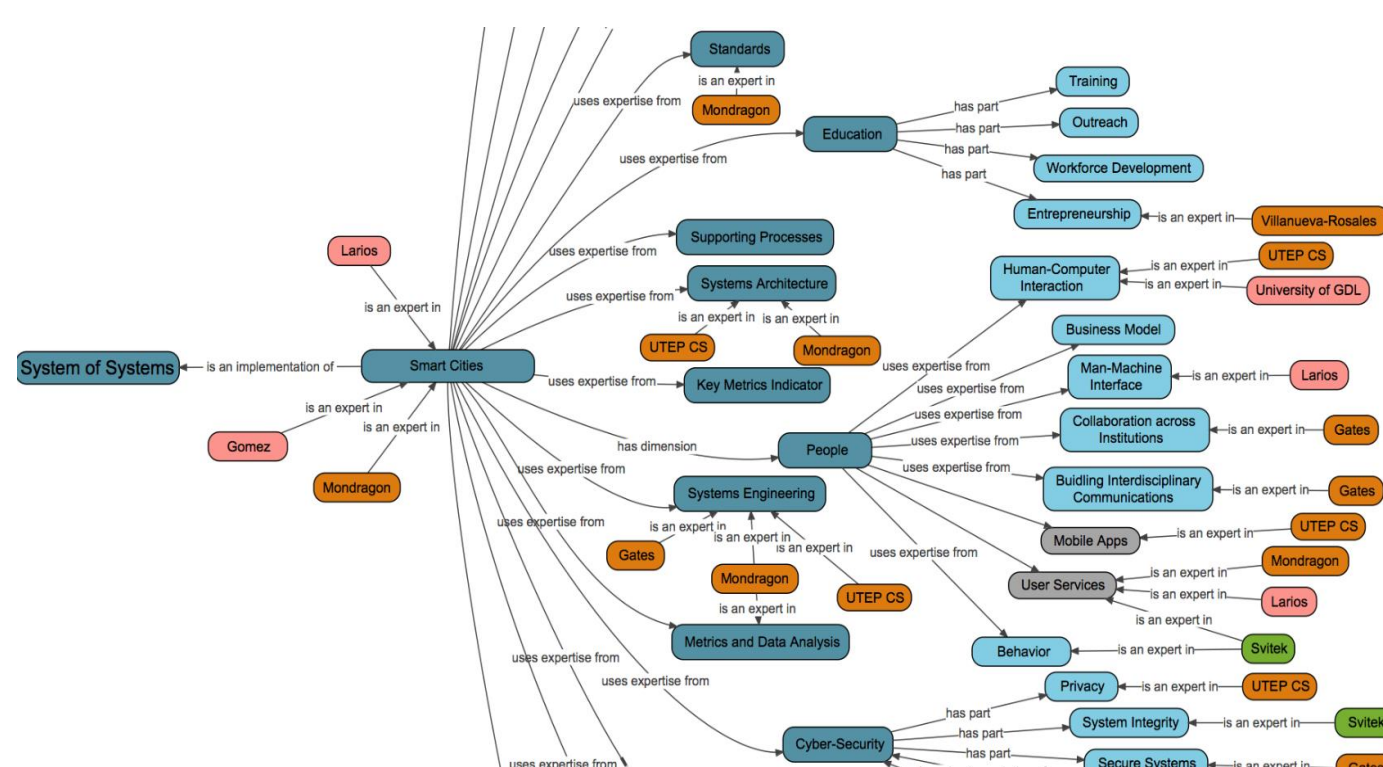

Figure 1. Sample of concept map developed with Smart Cities group.

The types of interactions proposed in this methodology use efficient collaborative learning strategies [6,7] that include: **scaffolding, externalizing self-reasoning, explaining and justifying opinions**, among others. This is accomplished by conducting a series of workshops with the team, where participants engage in structured tasks to externalize, share, and discuss their knowledge in ways purposely designed to incorporate the above learning strategies.

Methodology

Our approach extends previous work by developing well-defined solutions to support the inherent learning process.

Figure 2. Smart Cities group collaboration in GDL.

1. **Problem Gestation.** Explicitly state (and annotate) the scope and goals to enable envisioning the purpose and design outcomes of the initial ontology.
2. **Expert Knowledge Elicitation.** Participants separate into smaller groups to define relevant concepts and their relationships.
3. **Knowledge Discovery and Negotiation.** Clusters of terms are created. This process yields a common vocabulary, visually represented as a draft **concept map**[8].
4. **Concept Formalization.** Classes and properties in the ontology are created by mapping concepts and relationships. Data already identified in the previous steps is mapped into instances of the ontology.
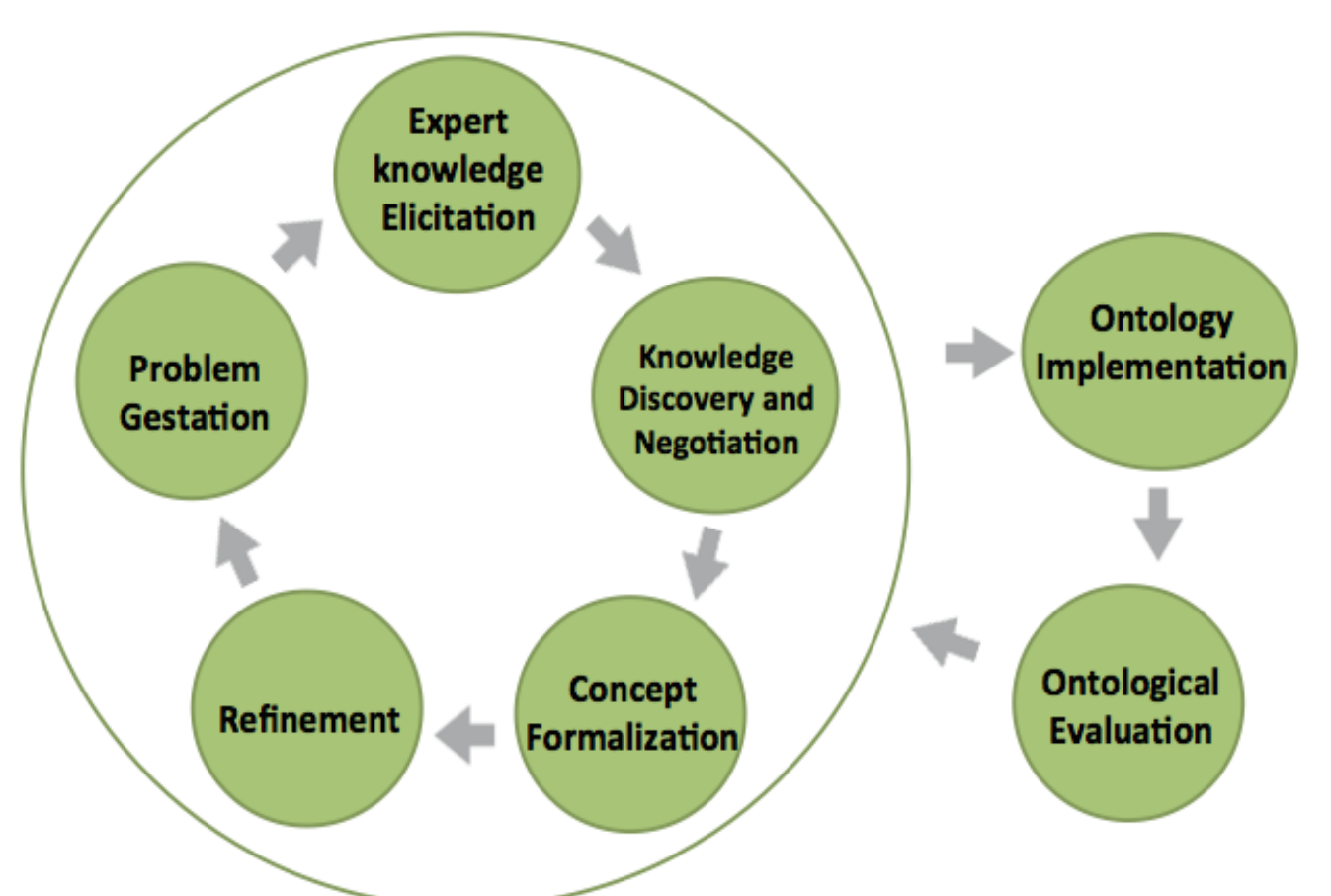5. **Refinement.** Develop use cases and extend or modify the ontology.

Figure 2. Summary of methodology as a highly iterative process. Stages with more IDR group participation enclosed in circle.

Future Work

- Explore the advantages and limitations of ontologies to represent individual and shared mental models.
- Explore the translation of mental models (researcher's knowledge) to formal models (domain ontologies.
- Investigate and evaluate how these interdisciplinary ontologies facilitate data integration and/or analyses to answer specific scientific questions defined by IDR team.
- Conclude research work with a wider variety of IDR groups.

Conclusions

- Preliminary results indicate that the use of conceptual maps has facilitated communication across team members.
- Shared understanding across disciplines and knowledge negotiation is a necessary precursor to development of formal ontologies and collaborative work.
- Methodologies such as the one proposed here can aid to overcome the barriers found in IDR group settings.

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