Designing and Building Semantic Technologies for Cloud-based Applications

Eric Little, PhD
NYU Polytechnic School of Engineering, New York University

Room 42 (UD) and Lab 6 (PN)
November 4th and 6th 2014 at 14.30

Cloud computing has grown in popularity over the past several years and now controls a large portion of many of our current information systems across numerous domains of interest such as in national defense, bioinformatics, healthcare or energy industries. At an increasing rate, data in large enterprises is being sought after to perform advanced analytics to help solve problems for a multitude of users. However, many legacy computing systems are highly stovepiped and do not provide an adequate means for querying across an enterprise, even where cloud computing is being applied. Instead, multiple queries must be generated that only solve portions of the problem space to be analyzed. Semantics can help this problem by providing complex logical models (in the form of ontologies) that integrate data at the conceptual level. The graphs created provide a high level of inter-connectivity and provide a robust means to query advanced types of information. However, scalability has been a problem traditionally with these types of semantic systems because graph computing across hundreds to thousands of nodes and edges is difficult and often presents intractable computational problems. Cloud computing has helped solve the scalability problem through the use of vitualized machines, data indices, multi-node data threading, etc., but cloud computing in and of itself does not provide the type of complexity necessary for intelligent data integration.

This seminar will show that these problems can be addressed by building layered formal ontologies within cloud-based computational frameworks to allow for advanced kinds of analytics to be performed over a variety of domains of interest. We will examine the following areas in this seminar:

- What are formal ontologies? How do they differ from basic data models? What is the role of metaphysics in designing them for large-scale applications? What are some examples of these currently being utilized?
    - Students will learn about upper ontology models and what to consider when building them
- What types of cloud computing environments currently exist? What is the difference between these types of architectures and which ones are most useful for what applications. How is cloud computing different from grid computing or basic SOA architectures?

    - Students will learn about different cloud types (utility cloud, data cloud, public cloud, private cloud, etc.) as well as types of components in cloud computing SAAS, PAAS & IAAS).
- What is the role of Reasoning in semantic systems? How can semantics be used for analytics? What is the difference between logic-based reasoning and mathematically-based analytics approaches? Can these 2 areas be synthesized into a common type of solution? I will provide some current research results on this topic.
    - Students will be introduced to logical reasoning (Sentential Logic (Aristotelean Square of Opposition), Symbolic Logic, Description Logic, First Order Logic) and statistical reasoning (Baysian, etc.) and demonstrations on how these can be used together.
- What are the challenges with graphs – particularly in terms of graph-matching and graph heuristics? What is the difference between graph matching using logic and graph matching using methematics? How do we treat "fuzzy" or inexact matches
    - Students will learn some principles of graph theory, graph matching, graph association and the problems in understanding entities when merging graphs of different types.
- What are some "best practices" for the development and execution of formal ontologies in cloud systems? Where have there been successes and failures? What are some of the hurdles to overcome? Who are the team members and areas of expertise needed?
    - Students will learn some methods for implementing semantics in various application domains and will learn certain pitfalls to avoid.

BIO for Eric Little, PhD:

Eric Little is Adjunct Professor at the NYU Polytechnic School of Engineering, New York University and VP and Chief Scientist at Modus Operandi in Melbourne, FL. He received a Ph.D. in Philosophy and Cognitive Science in 2002 from the University at Buffalo, State University of New York. His Post-Doctoral Fellowship at the University at Buffalo's Department of Industrial Engineering (2002-2004) focused on developing ontologies for multisource information fusion applications. Dr. Little then spent several years (2004-2009) as Assistant Professor of Doctoral Studies in Health Policy & Education and Director of the Center for Ontology and Interdisciplinary Studies at D'Youville College in Buffalo, NY, during which time he also owned his own consulting company. He left academia in 2009 to work as Chief Knowledge Engineer at the Computer Task Group (CTG) and later as Director of Information Management at Orbis Technologies (2010). In 2014 he became Adjunct Professor at the NYU Polytechnic School of Engineering, New York University.

His areas of specialization are: ontology, semantics, knowledge management, cognitive science, philosophy of neuroscience, phenomenology and organizational theory. Dr. Little has designed and helped to implement formal ontologies for use in various applied domains including: biomedicine, medical device manufacturing, medical fraud, waste and abuse detection, pharmaceuticals, medical management, threat prediction/mitigation, disaster management, national defense/intelligence, steel production and petrochemicals. He has published in the areas of cognitive science, ontology, information fusion, and human factors engineering. He has delivered lectures on ontology, philosophy, biomedicine, and cognitive science at numerous locations in Germany, Canada, Italy, United Kingdom and throughout the U.S.