Conceptual Ontology Engineering Tutorial

Michael G. BENNETT

mbennett@hypercube.co.uk
Hypercube Limited, London, England

Abstract: Conceptual modeling as defined within the discipline of software development is the exercise of creating computationally independent model artifacts against which to develop and validate logical and physical model design artifacts. The art of conceptual modeling is one that requires a clear understanding of the notion of a concept and an appreciation of the nature of concepts as distinct from words, labels or database element names. One powerful type of conceptual model is the 'ontology' where ontology is understood to be a formal specification of a conceptualization. The word 'ontology' is broadly used to cover a number of such specifications. The goal of this tutorial is to present a formal framework within which to understand these distinctions and to introduce techniques by which attendees may be able to develop ontologies that may serve as conceptual models, focusing on the less technical (and often overlooked) aspects of such ontology development, specifically the ability to appreciate concepts and to model these within the logical formalisms used in ontology development.

Keywords: Ontology, conceptual model, development lifecycle, concept, knowledge representation, top level ontology.

1.Introduction

This tutorial sets out the basic principles of concept modeling, situating these kinds of models within a broader modeling framework that includes logical models, ontologies for reasoning applications and so on. Attendees will learn how to frame this kind of ontology artifact, how to think in terms of concepts and how to define these in formal logic. The bulk of this tutorial focuses on conceptual issues: understanding concepts, classification theory and powertypes, the use of formal logics in ontology development and issues relating to terminology and vocabulary. Attendees will learn ontology development techniques such as the use of upper ontologies to provide disambiguation of similar concepts and how these abstractions address common data problems. Specific examples of upper and cross-domain ontologies are covered in depth, including contextually defined concepts (roles etc.), event and process modeling, contracts and transactions. The course concludes by identifying the range of ways in which conceptual ontologies may be used in various practical deployment architectures and how to use or extend popular ontologies such as the Financial Industry business Ontology (FIBO), with examples. No prior knowledge of ontology modeling is required.

This tutorial is intended to describe conceptual ontology modeling techniques and concerns. It does not cover the technical details of modeling ontologies in RDF and OWL but is intended to provide the groundwork for such work. Those who are interested in implementing RDF and OWL models for applications may wish to complement the learning from this tutorial with a comprehensive course in OWL based modeling.

1.1.Intended Outcomes

By the end of this tutorial attendees should be able to create their own conceptual ontologies and understand how the use of ontologies as conceptual models can enhance software development and cut integration costs. Attendees will also understand how to derive technical artifacts from these for data integration and model driven development, as well as pragmatic, operational ontologies for semantically enabled reporting and inference processing applications.

1.2.Intended Audience

This tutorial is aimed at anyone interested in data modeling, knowledge representation and systems development, including students, researchers, data architects and business analysts. It is relevant to anyone exploring the use of formal ontologies for a range of different application areas, particularly in emerging technology areas such as micro-finance, distributed ledger technology (AKA Blockchain), big data, machine learning and the Internet of Things (IoT). No prior knowledge of ontology modeling or standards is required. Some basic knowledge of information technology is assumed, including familiarity with the technology development lifecycle, but no prior knowledge of any language for programming, databases or modeling is assumed.

2.Outline of the Tutorial

Introduction: Concepts and words; the data development lifecycle; use of computationally independent models. Introducing ontology: a conceptual model for data and beyond.

Modeling Semantics: principles of semantic modeling, illustrated with a rolling example. Defining concepts. Classification and taxonomy, properties, the differentiating characteristics of concepts; understanding formal logic and set theory. Formal semantics basics – representation of classes, properties and logical restrictions.

Conceptual Issues: Anatomy of a Concept; words, concepts and lexical space. Homonyms, heteronyms and some strange habits of words. Concepts without words. Different approaches to formal semantics.

Classification principles: kinds of taxonomy; subsumption based taxonomies; faceted classification; powertypes and kinds of individuals.

Introducing Data: Distinguishing things from data about things; semantic 'truth-makers' versus data; real things that are data; establishing data applicability (semantic distance) for a given type of ontology; datatype properties in ontologies; information kinds and the use of a 'values' ontology.

Top Level Ontologies (TLOs) and Cross Domain Ontologies: Why top level ontology? Understanding existing top level ontologies and standards. Semantic

abstraction and re-use; dimensions of a top level ontology. Some popular top level ontologies. Things defined by their context; things that happen; other partitioning considerations. Realism versus concept-centric ontology.

TLOs In Depth: Contextual Things Deep dive session on things in roles and other contextual matter. Different conceptualization options for roles and relators. Examples of these using customer and counterparty data modeling issues.

TLOs In Depth: Things that Happen Deep dive session on continuant and occurrent things (endurants and perdurants). Classifying kinds of occurrent. Different conceptualization options for things that ought to happen or might happen. The semantics of plans and risks. Modeling business processes as ontology.

Recommended Mid-level Ontologies: Authoritative Sources of Meaning: identifying meaningful published concept definitions and adapting these into the ontology framework using TLO (with examples). The REA ontology for transactions; LKIF and other legal ontologies; ontologies for business process and other common problem areas.

Conceptual Ontology Development: Framing 'Simplest kind of Thing' concepts (archetypes); top down, bottom up and middle out ontology development; the use of the 'wire frame' upper ontology for pragmatic conceptual ontology development.

Putting it to Work: Business concept ontologies versus application ontologies. Introducing the Financial Industry Business Ontology (FIBO™) Standard. Putting these to use: mapping, reporting, inference processing, Blockchain, graph analytics, machine learning, legal and regulatory (RegTech) and novel finance and micro-finance opportunities (FinTech). Styles of ontology for different ontology uses (with examples). Getting to there: a roadmap for ontological maturity.