Ontology-based Enterprise Modeling for Human and Machine Interpretation

Prof. Knut Hinkelmann

For latest material see: http://knut.hinkelmann.ch/lectures/nemo2019

NEXT GENERATION ENTERPRISE MODELLING IN THE DIGITAL TRANSFORMATION AGE

6th Edition in the NEMO Summer School Series July 15th - July 26th, 2019
University of Vienna - Austria
About Me

- Head of MSc in Business Information Systems
- Research Associate at University of Pretoria
- Visiting Professor at University of Camerino

FHNW – University of Applied Sciences and Arts Northwestern Switzerland
Why are we here?

I ♥ Modeling
Models

not what we are dealing with
Enterprise Modeling

[Diagram showing enterprise modeling processes and flowcharts]

---

[Diagram showing enterprise system architecture and integration]

---

[Diagram showing enterprise software systems, such as CRM and ERP, and their integration]

---

[Diagram showing enterprise data flow and management structures]
Learning Goal

- Domain-specific Modeling
  - Appropriate for decision making and knowledge exchange between humans
  - Appropriate for automated analysis and decision making
  - Adaptable for specific requirements
Models

- A Model is a reproduction of a relevant part of reality which contains the essential aspects to be investigated.

- Relevance depends on the
  - purpose (also called concern or goal)
  - stakeholders
Why Modeling: Dealing with Complexity and Change

■ If the object you want to create or change is simple, then you can do it directly.

■ For complex systems that are likely to change over time, you need a model.

■ Without explicit modeling there is a high risk that the implementation is not what is intended

(John Zachmann, 2012)
Business Value of Modeling

- Communication between people
- Knowledge management and reuse
- Analysis of a business situation
- Decision Making
  - Training and learning
  - Persuasion and selling
  - Compliance management
  - Development of software requirements
  - Direct execution in software engines

Based on (Bridgeland & Zahavi 2010)
Models

- There can be different kinds of models
  - textual model
  - graphical model
  - conceptual models
  - mathematical model
  - physical model

\[ E = m \ c^2 \]
In the business process for health insurance, first the application data are captured by the clerk. Then the risk assessment is made by the underwriter. Depending on the risk score, the clerk determines the premiums and sends the policy or the application is rejected.

- Is the rejection of the application a task or an event?
- Which tasks are executed in parallel?
In the business process for health insurance, first the application data are captured by the clerk. Then the underwriter makes the risk assessment. Depending on the risk score, the clerk determines the premiums and sends the policy or the application is rejected.

- Is the rejection of the application a task or an event?
- Which tasks are executed in parallel?
Models

- Models are not mere pictures; rather, they
  - provide a precise, meaningful description that can be visualized in different ways for different stakeholders;
  - can also be used to analyze the impact of changes, cost, risk, security, compliance and other relevant KPIs.

http://blog.bizzdesign.com/how-to-not-fail-when-implementing-strategy
Process Analysis

■ What is wrong with this process model?
■ Can the tasks (1) and (2) be executed in parallel?
Example: Alignment of Business and IT

Business-IT alignment is a dynamic state in which a business organization is able to use information technology effectively to achieve business objectives.

Typical questions and principles:

♦ Which processes are affected by the replacement of an application?
♦ Which applications share data?
♦ Which services can be provided as cloud services?
♦ Each function should be realized exactly once
♦ Why did we decide to customize this application?
Example: Application Architecture

- What are problems of this situation with respect to data management?
- How could an architecture look like to deal with this problem?
Managing Shared Data

- Master Data Management ensures that there is a «single source of truth» for shared data
Ontology-based Metamodelling
**Human Problem Solving**

Communication/
Analysis/
Decision Making

**Models**

**Reality**

**Knowledge**

human-interpretable models
Automated Analysis / Decision Making

Analysis / Decision Making

Models

machine-interpretable models

Reality

application
Human and Machine Interpretation

Models

Reality

Knowledge

application

human interpretable

machine interpretable

Human and Machine Interpretation
Definition of syntax and (type) semantics

Notations

Classes

Model

Meta²-model layer

Metamodel layer

Model layer

Linguistic metamodelling: syntax, structure, type semantics
Humans and machines should «know» the meaning of the modeling objects:

→ Enterprise Ontology
Semantic Lifting

Knowledge

human interpretable

machine interpretable

data ontology rules

Models

Reality

NEMO 2019
linguistic metamodelling: syntax, structure, type semantics

tonological metamodelling (lifting): explication of type semantics

Ontology

Semantics definition: commonly accepted ontology
Example: Business Process as a Service

human interpretation
informal and semi-formal

machine interpretation
formal

BPaaS Modelling Environment

Meta model

Models

Workflow Process

BPaaS Ontology

Classes/Rules

Triple Store Repository

Inference

Smart Business and IT in the Cloud Alignment

semantic alignment

semantic annotations

transformation and mapping
Objective

Models + Knowledge

Ontology-based Models
(human- and machine-interpretable)

Reality
Ontology-based Metamodelling

meta²-model layer

meta²-model (e.g. GraphRep)

notation

structure, semantics

metamodel layer

model layer

model (e.g. RDFS 3.0)
Example

Functionality

Non-functional requirements

All Concepts are defined in the Ontology
ArchIMEO Enterprise Ontology

Enterprise Upper Ontology (Archimate)

includes

Top-level Ontology (TOL)

Enterprise Meta Ontology (ArchIMEO)

includes

APQC Ontology

extends

Functional Description Ontology

includes

Bpaas Ontology
Application Example for Ontology-based Metamodel

Cloud Service Selection

Functionality

- APQC category that reflect the functional requirement:
  type to search *

- Action that reflect the functional requirement:
  type to search *

- Object that reflect the functional requirement:
  type to search *

Non-functional requirements

- Select your preferred payment plan:
  - Prepaid Annual Plan
  - Try Free First
  - Customizable Plan
  - Monthly Fee
  - None

- Monthly Availability in %:
  Insert your value here *
Agile Meta-Modeling
Example: Customization in Archimate

- One single concept for Actors
  
- Objective: Distinguish between human and organisation unit
  
  - Name
    
  - Stereotyping

Semantics only for human, not machine-interpretable
Ensure a precise shared interpretation of new modeling constructs to both humans and machines
Change of Metamodel

Time-consuming engineering effort!
Integration of Meta-modeling and Modeling: On-the-fly Modeling Language Adaptation

Name of the parent class

Name for the new modeling construct

Create New Modeling construct and store in the ontology

Graphical notation to be shown in palette and canvas
Ontologies

Palette Ontology (PO)
- po:PaletteConstruct (44)
  - po:PaletteConnector (2)
  - po:PaletteElement (42)
    - po:Activity
    - po:CloseTransferCaseRecord
    - po:ConfirmTransfer
    - po:DataInput
    - po:DataObject

Modeling Language Ontology (MLO)
- lo:ModelingLanguageConstruct (502)
  - lo:ModelingElement (500)
    - bpmn:Artifact (4)
    - bpmn:FlowObject
    - ...
  - lo:ModelingRelation (2)
    - archi:Relationships
    - bpmn:ConnectingObject (1)
    - bpmn:FlowElementContainer

Domain Ontology (DO)
- apqc:AmericanProductivityAndQualityCenter
- fbpmo:FunctionalBusinessProcessDescription
  - fbpmo:Activity
  - fbpmo:Object
  - top:TopLevelElements (22)
    - top:Event (7)
    - top:Location (15)
    - top:Time
    - ...

includes
Agile and Ontology-Aided Modeling Environment (AOAME)

Models + Knowledge

Ontology-based Models (human- and machine-interpretable)

Reality
Thanks to …

Emanuele Laurenzi
Charuta Pande