The Unified Foundational Ontology with Applications to Agent-Oriented Modeling

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Foundational Ontology and Conceptual Modeling

Conceptual modeling should be based on a suitable foundational ontology
Conceptual Modeling

Agent Modeling, Business Process Modeling, Enterprise Modeling seen from a Conceptual Perspective
Unified Foundational Ontology

- **UFO-A**: Endurants and Core Categories
- **UFO-B**: Perdurants (Process, Event, Chronoids, Situations, ...)
- **UFO-C**: Social and Intentional Entities (Agent, Action, Commitment, Belief, Perception, ...)

Qualia and Quality Dimensions

Substance Universal

Apple

Extension

Substance (apple a)

Quality Universal

Weight

Extension

Quality (weight w of apple a)

Quality Dimension

Weight Dimension

0

represented by

Weight Values

w

Qualia (value of weight w in this quality dimension)
Quality Domains

- Certain quality dimensions are integral in the sense that one cannot assign an object a value on one dimension without giving it a value on the other (e.g., hue, saturation and brightness)
- Dimensions that are not integral are said to be separable (e.g. size and hue)
- A quality domain is a set of integral dimensions that are separable from all other dimensions. Example, the color quality domain
UFO-A (2/2)

Entity

Individual

Type

Endurant Type

Relation

Substance Type

Moment Type

Formal Relation

Material Relation

Substance Kind

Substance Role

Relator Type
UFO-B

Diagram showing the relationship between State, Pre-state, Post-state, Event, Atomic Event, and Complex Event.
An Ontological Approach to Integrate AO Modeling Languages

Tropos
Requirements-Driven
Development for Agent Software

AORML
The Agent-Object Relationship Modeling Language
Tropos + AORML = ARKnowD

- Agent-oriented Recipe for Knowledge management system Development (ARKnowD)
- Applies Tropos for requirements analysis and AORML for system design.
- Proposes an emphasis on the domain analysis in order to guarantee that an appropriate solution for the given problem is found.
- Provides a transformation method between Tropos & AORML, facilitating the tasks of the analyst/designer, and can also be automated.
The Method

Domain Conceptualization

Domain Ontology ↔ Metamodel

Language
Evaluation Criteria

- **Lucidity**: each construct of a language should represent at most one entity of the conceptualization.
- **Soundness**: a language should represent solely the entities of the domain conceptualization.
- **Laconicity**: a language should have at maximum one construct to represent each phenomenon in the domain of discourse.
- **Completeness**: a language should have at least one construct to cover each concept of the domain conceptualization.
Lack of Laconicity & Unsoundness

UFO-C

Tropos Metamodel
Incompleteness and Missing Lucidity

Diagram:

- A1: Having free new system releases
- A2: Having employees availability information
- A3: Setting up a meeting with department’s personnel
- B1: Having free new system releases
- B2: Having employees availability information
- B3: Setting up a meeting with department’s personnel
Dependencies, Delegations & Acquisition

- **Dependee** depends on the **Depender**
- **Delegator** delegates to the **Delegatee**
- **Acquisitor** acquires from the **Aquisittee**

**Diagram:**
- **Goal Dependency:**
- **Plan Dependency:**
- **Resource Dependency:**
- **Goal Delegation:**
- **Plan Delegation:**
- **Resource Acquisition:**
Missing Lucidity

Legend

- agent
- object
- \( \rightarrow \) refers to

Diagram:

- Institution: ITBE Library
- Artificial: LeSys
- Organizes: Book
- Borrow: Borrower
- Borrrows: Book
ARKnowD Transformations

Early Requirements

Late Requirements

Architectural Design

Detailed Design

Transformation

provideDocument

provideExplanation

noAvailableArtifact
A Case Study

Demonstrating the Transformation from Tropos to AORML
Tropos Actor Diagram
Tropos Goal Diagram
AOR Interaction Sequence Diagram
Implementation
XMI file representing AOR AD

Transformation

Tropos Actor Diagram
Conclusions

• We have presented the Unified Foundational Ontology (UFO) and how it can be used as a foundation for conceptual modeling languages, in general, and agent-oriented modeling languages, in particular.

• A foundational ontology serves multiple purposes concerning agent-oriented modeling languages:
  – Clarifying the concepts used in the area.
  – Supporting the evaluation and adjustment of the applied notations.
  – Guiding the transformation between concepts of one language to the other.

• Here, we exemplified this with the evaluation and integration of Tropos and AORML.

• The ontology developed here is a work in progress. Specifically, we aim at extending the ontology (e.g. including the concepts of softgoal and contribution).