Investigating the Role of Ontologies in Computer Simulation

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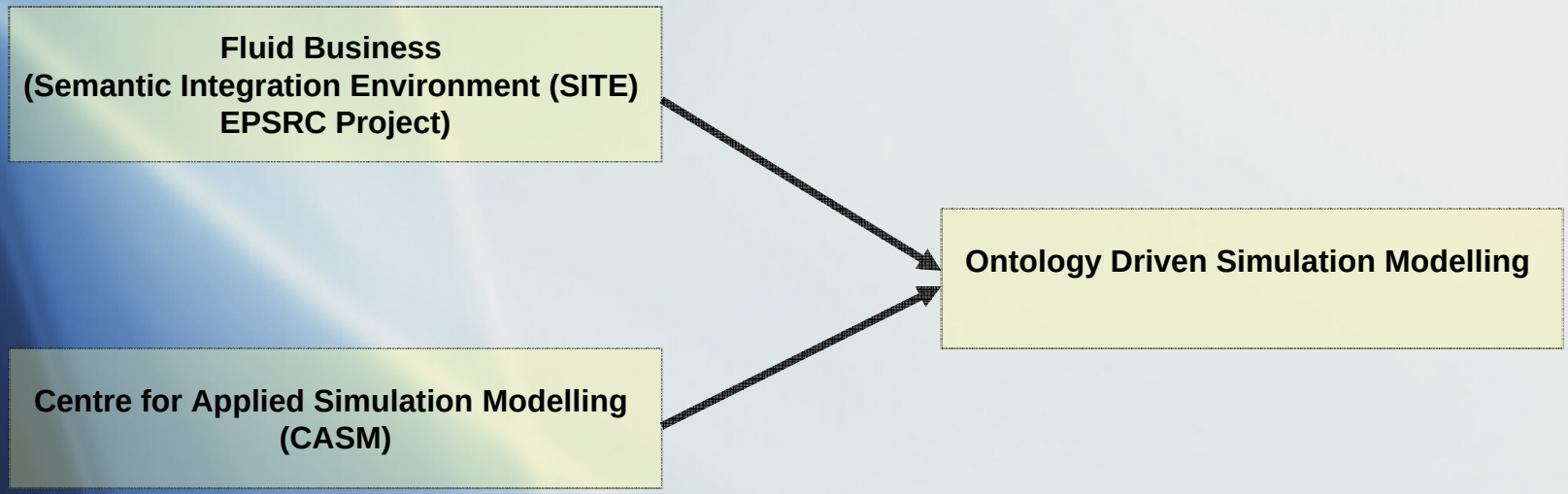
Overview

- Background
- Ontologies and semantic modelling
- Deriving semantic content
- Ontologies and simulation
- Future work

Background


Fluid Business
(Semantic Integration Environment (SITE)
EPSRC Project)
Centre for Applied Simulation Modelling
(CASM)
Ontology Driven Simulation Modelling

Ontologies and Semantics

- Ontology is a term originally coined by philosophers to refer to the study of being or what exists
- In computer science ontology has been adopted by the Artificial Intelligence (AI) community as a means to produce shared conceptual models
- More recently the Semantic Web community is applying the outcomes of the work carried out in AI, however research continues

Definition of Ontology

- A couple of definitions help to clarify what is meant by ontology:
  - Formal specification of a shared conceptualisation (Gruber 1993)
  - The set of things that a system or theory commits to existing (Lowe 1996)
- Hence,
  - Formal model of shared knowledge
  - Mapping to things that exist (ontological commitments)
  - Such mapping identifies the meaning or semantics of model representations

Deriving Semantic Content

- Ontology development and evolution requires method
- Ontologies should be grounded by empirical data
  - Data contained in models (software, simulation, etc.)
  - This serves as a means for ensuring a certain level of confidence of how the ontological representations map to the real world (system)
  - Ontologies can be derived from the interpretation and semantic improvement of existing models
- A semantic transformation process underlies the derivation of semantic content from existing models

Semantic Transformation: An Example Applied to Web Services

- The table summarises the main phases of a semantic transformation process applied to descriptions of web services.

Activities	Description	Input Artifacts	Output Artifacts
Service interpretation	A service description is broken down into its fundamental parts (e.g., name, input and output parameters). Each part is interpreted in order to represent its ontic commitment.	▪ Web service descriptions (e.g., WSDL code)	▪ Individual service ontic commitment models
Concept scoping	The concepts represented in the service ontic commitment models are either mapped to pre-existing ontologies or assigned to newly developed ones.	▪ Service ontic commitment models ▪ Domain ontologies	▪ Objects incorporated or mapped to ontological domain models
Harmonization	Services are represented within ontological models and related to other domain objects.	▪ Service ontic commitment models ▪ Domain ontologies	▪ Extended or specialized domain ontology ▪ Service ontology

Ontologies and Simulation

- The development of ontologies for simulation modelling is difficult (Miller and Baramidze 2005) :
  - Simulation models are not domain limited
  - Founded on mathematics, probability and statistics which need to be rigorous (in this case ontologies should serve as a foundation)

Ontologies and Simulation

- The Discrete-event Modelling Ontology (DeMO) provides a precise vocabulary for simulation (Miller and Baramidze 2005)
- The DESC ontology provides a language for simulation components (referencing the domain in which they reside)
- Transforming Simulation Components (SC) in a DESC/DeMO based ontology provides an improved platform for component selection and integration

Research in Progress

- The work being carried out at Brunel is aimed at:
  - Deriving semantic content from existing simulation models
  - Representing such content in domain ontologies
  - Enabling reuse of simulation models and interoperability between COTS simulation packages

Further Work

- Our work is progressing in the following interrelated directions
  - Semantic discovery for simulation modelling
    - Adaptation and specialisation of the semantic transformation process to simulation models
    - Discovery of extendible semantic models for simulation
  - Service-oriented simulation (SOS)
    - Based on the ontological models discovered
    - Methodologies for SOS
    - Architectures for SOS