Defining Abstraction

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Motivation

- To understand the many guises of abstraction
- To relate the notions of abstraction in many domains

What Do We Gain

- Enable correct communication between modellers about abstraction
- Enables one to enhance modelling tools to support correct reasoning about abstraction
  - Handle element approximations
  - Make explicit the assumptions made
  - Get insights into how effects of approximations and abstractions propagate during compositions

Process

1. Terminology
2. Taxonomy
3. Ontology
4. Systematic literature review
5. Use above to enhance tools

Examples of Abstraction

- Measuring current over a piece of metal in the real world
  - How is this transformed into a model?
- Approximation of a model
  - How does this change the properties we can prove on the model?

Examples of Abstraction

- Creating a Modelica class that represents a resistor
  - Does this accurately represent the real world?
- Creating an AND symbol which represents a circuit diagram
  - Is information hidden or lost?
  - How do the properties of this model change when we change domains/paradigms

Examples of Abstraction

- Classifying a model using linguistic/ontological relationship
  - Is abstraction the same on the linguistic side as the ontological side?

Defining Underlying Terms

- We want to classify abstraction along the following dimensions
  1. Formalism
  2. Representation
  3. Properties

Formalism

- Change in formalism and change in abstraction level are often found combined
- How to decouple these?

Properties

Key to our understanding of abstraction
Based on the *information* contained in a model M.
Different *questions* (properties) $P = I(M)$ which can be asked concerning the model.
These questions either result in true or false.

Abstraction and its opposite, *refinement* are
relative to a non-empty set of questions (properties) P.

- M_1 is an *abstraction* of M_2 with respect to P if
  for all $p \in P$: $M_1 \models p \Rightarrow M_2 \models p$.
  This is written $M_1 \sqsupseteq_P M_2$.
- M_1 is said to be a *refinement* of M_2 with respect to P if
  M_2 is an *abstraction* of M_1 with respect to P.
  This is written $M_1 \sqsubseteq_P M_2$.

Properties

- When we abstract, we can still satisfy some properties
- We might be able to satisfy new properties
- Some properties cannot be satisfied any more
- Of course, we have to select the ‘interesting’ properties

Future Work

- Connect terms like:
  - System
  - Environment
  - Properties
  - Experiments
  - Process
  - Change of domain, multi-domain
  - Change of formalisms
  - Concept
  - Feature
- Define the intention of the abstractions on the formalism, representation, and properties of the model