AI and model integration

Ideas for the (near) future

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Do standards solve the problem?

- The actual reusability of model components is limited
- Model components are framework dependent
- A great deal of hidden knowledge is required to use models
- Integrated models are as good as our mental models are

There is a fundamental underlying problem

- Software handles only numbers
  - Model components are poor incarnations of much richer systems
  - Modelling assumptions are not encoded in software implementations
- Consequences: misuses and abuses

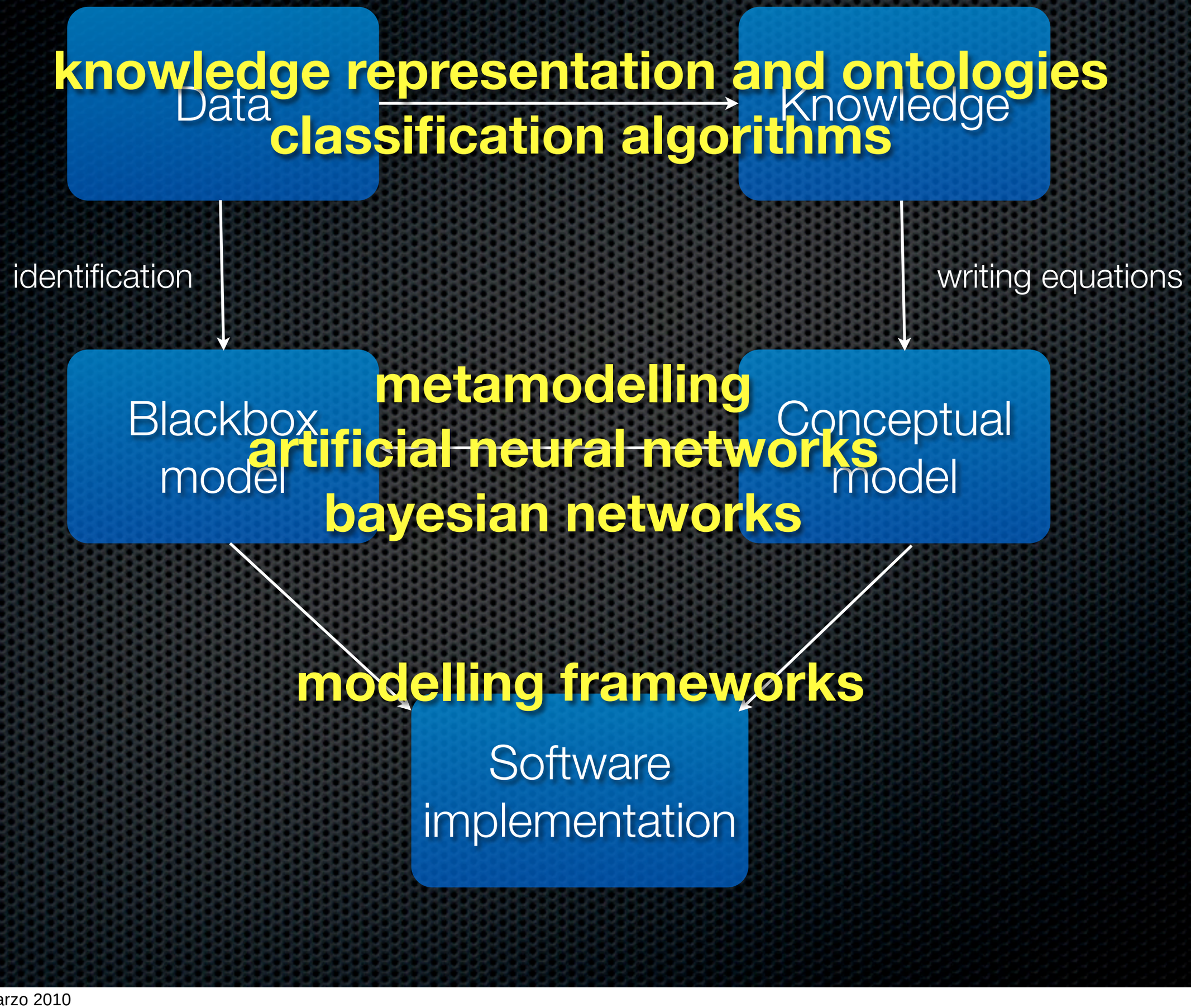
Knowledge is power

- We need to make explicit the knowledge in models
- We can formally describe the main concepts of a modelling domain and their relationships
- We can apply automated reasoning
- We can understand which model can do what, when and where, and we can ask the model to explain why

How to get there

- A step-by-step approach
  - develop knowledge bases to be shared
  - offer models as services accessible on the Net
  - more and deeper info in models and data: tag existing resources
  - automate search, discovery and linking
  - develop reasoning tools and algorithms

The role of AI: examples


Data
knowledge representation and ontologies
classification algorithms
Knowledge
identification
writing equations
Blackbox model
metamodelling
artificial neural networks
bayesian networks
Conceptual model
modelling frameworks
Software implementation

Model implementation

simulation

computes

scenarios / sensitivity analyses

uses

optimisation

computes

Policies

Algorithm

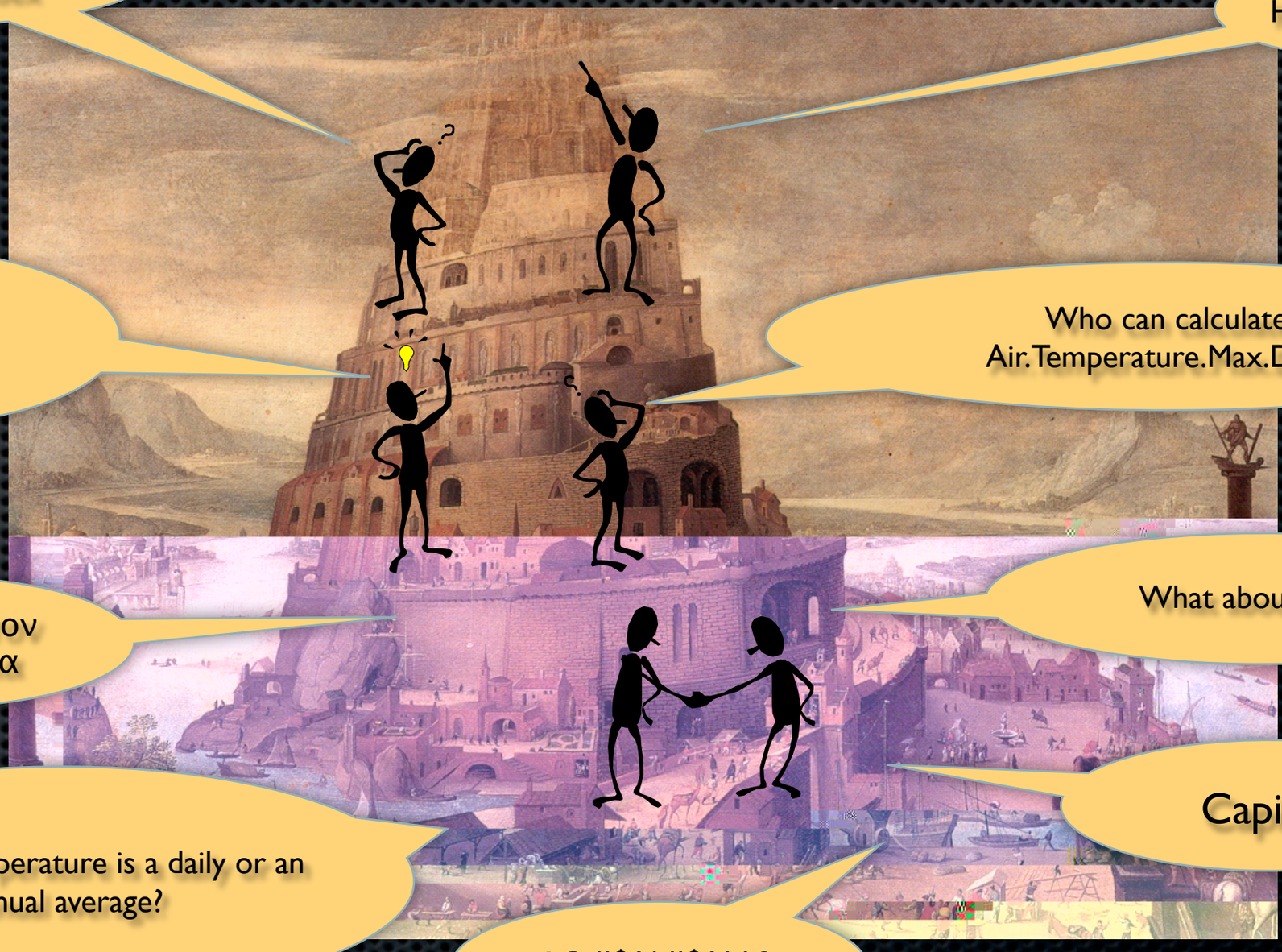
agent based computing

reinforcement learning

neurodynamic programming

metaheuristics

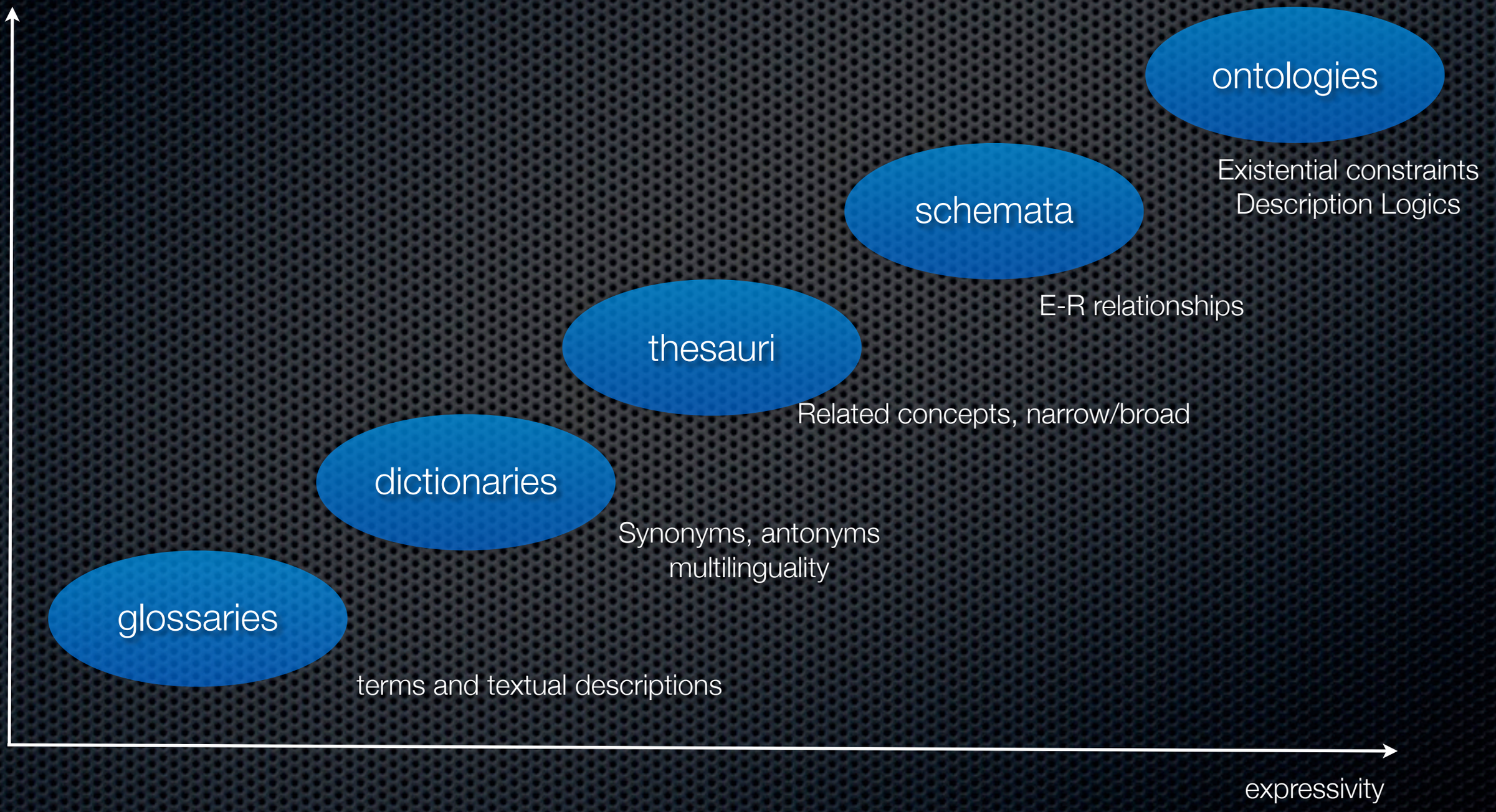
Knoweldge-based model integration



It is not a Babel, but still...

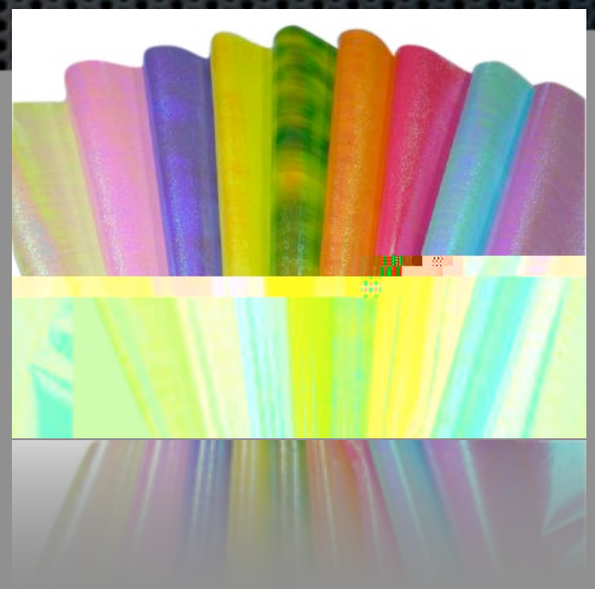
- A shared dictionary for model inputs and outputs
  - Not just common naming conventions
    - Not just “meta-data”
- A common reference that aims to:
  - build a shared view on systems modeled
  - identify unclear “spots”
  - integrate our models in a sound way

Domain modeling



Semantically rich interfaces

- Ontologies = wrapping paper
- The Model Interface Ontology
  - encapsulates modeler's knowledge (perception) of the model interface
  - in a declarative fashion

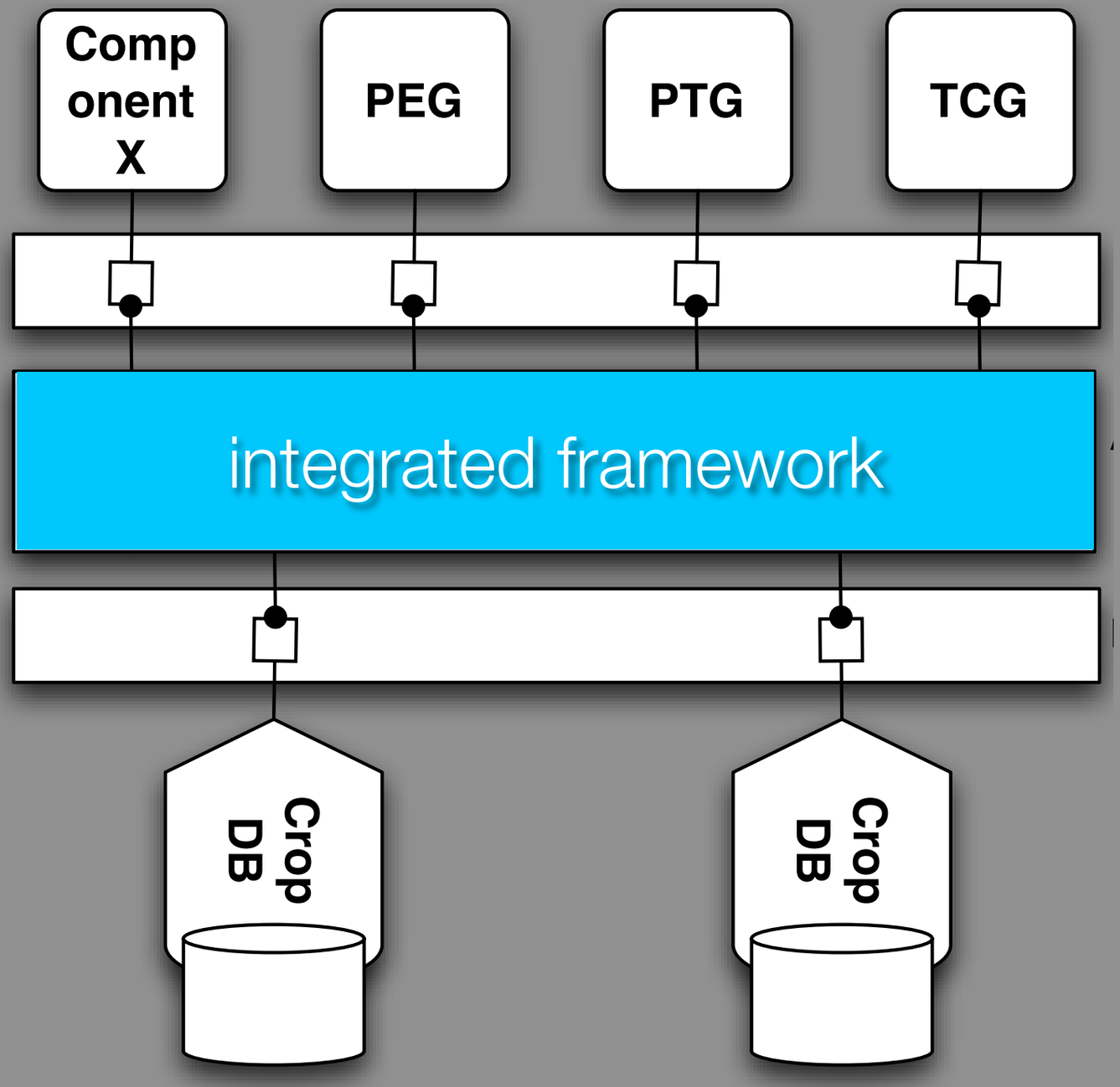


- Example: a model interface for continuous system simulation
  - exposes both stocks (states) and flows (rates of inputs and outputs)
  - is accessed by a simulation engine (for the numerical integration)

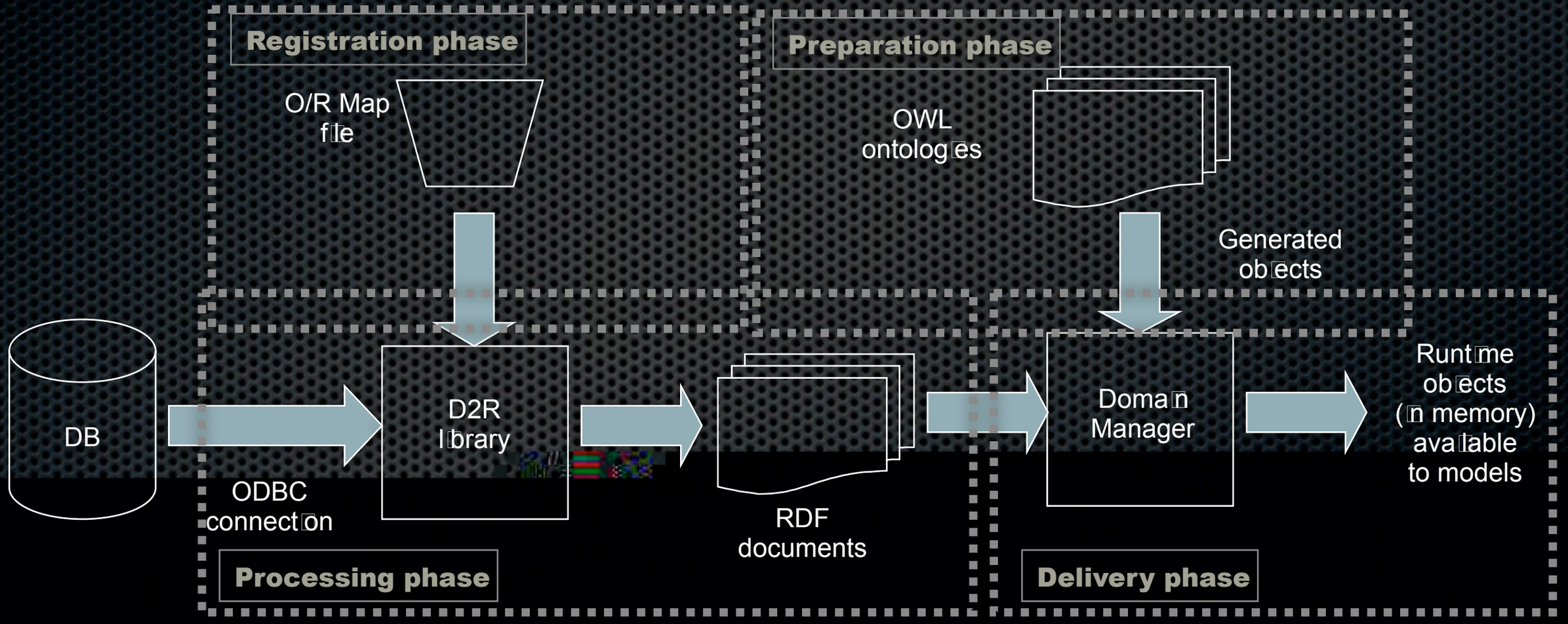
A E Rizzoli, M Donatelli, I N Athanasiadis, F Villa, D Huber (2008) **Semantic links in integrated modelling frameworks**. Mathematics and Computers in Simulation 78 p. 412-423

Models annotated - problem solved?

Workflow execution (a)



KM as an intermediate



Workflow execution (b)

A Semantic-Rich Development Architecture