Knowledge Organization Systems for Semantic Models

Bob Allen

THE NORFOLK WEEKLY NEWS.

NORFOLK, NEBRASKA, THURSDAY, MAY 10, 1900.

POPULISTS IN SESSION

Convention Begins Its Work at Sioux Falls.

BOERS CHECK HUTTON

His Command Has Narrow Escape From Being Cut Off.

KNEELING NOT AN EXACTION

MID-ROAD CONVENTION

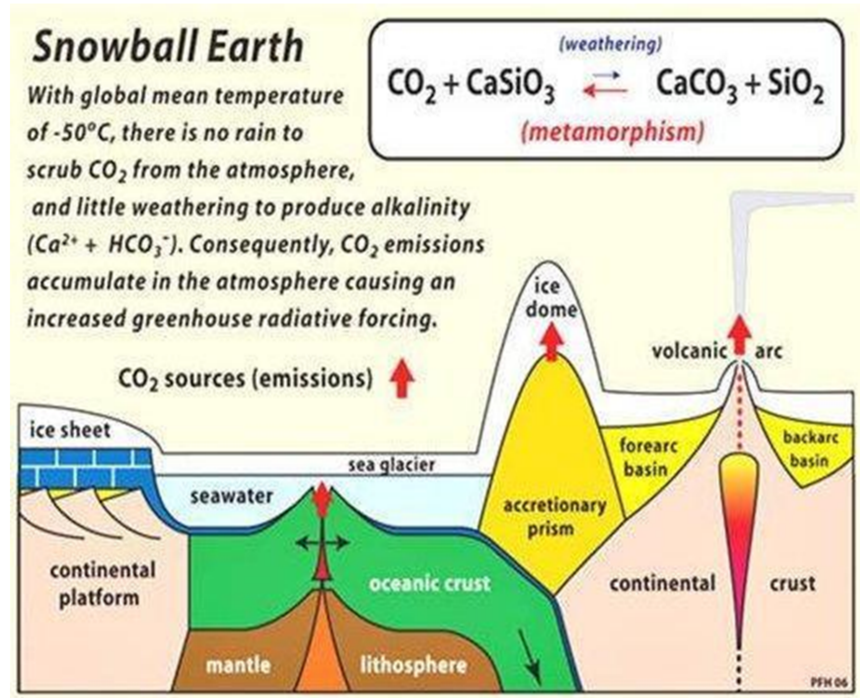
THESE FOUR HATS ARE LATE PARIS PATTERNS. See copies of them ...at... INSKEEP'S.

ST. LOUIS' BIG CAR STRIKE.

- Models Rather than Ontologies
  - Indexing articles from historical newspapers
  - Traditional full-text indexing ineffective
  - Better to develop a community model

Direct Representation of Scientific Research Reports

- Models rather than Ontologies
  - Models are integral to research reports
  - Snowball Earth theory
    - Geological claim that the earth may have frozen over completely – an extreme ice age
    - Main question – how the earth escaped that extreme ice age



- In this talk, we will consider some issues for how to build these models
  - Specifically, the relationship of knowledge representation systems to object-oriented programming languages
  - These models have complex objects and systems (parts, states, mechanisms), microworlds, and context

From Upper Ontologies to Object-Oriented Models

- Upper Ontology (Basic Formal Ontology - BFO)
  - Establishes categories of entities allowed in application ontologies
  - Realist, Aristotelian, Universals/Particulars
  - Main distinctions:
    - Continuants/Occurrents
    - Independent Continuants/Dependent Continuants
- Programming Languages
  - Basic Features:
    - Data Types, State Machines, Guard Conditions, Threads, Concurrency, Conditionals
- Object-oriented Analysis, Models, and Programs
  - Smalltalk is a better example of object-oriented programming than Java.
  - Language Features: Inheritance, Classes and Methods
  - Typical Applications: Microworlds

Representation of Semantics of Complex Objects (#1)

- Transitionals (implement state changes)
  - BFO focuses on Processes, but state changes seem equally important
  - Conditions on whether a transition will occur
  - Sequences of Transitionals are common
    - Mechanisms, Workflows, Other sequences
  - Natural language verbs have semantic roles, which should be applied in semantic modeling.
- Relationships
  - BFO Core relationships ("inheres in").
    - Increasingly, BFO applications include ad hoc relationships.
  - Many ad hoc relationships are actually events
    - If there is a person, there is necessarily a birth event
  - Rules/Axioms
    - Rules are like ad hoc relationships about the world we are trying to model.
    - Example: "Predators eat Prey"
- Definitions
  - Describe what implied about the relationship of the given object to other objects
    - A waterfall must have water and a stream with a drop.
    - A bakery must have a baker, an oven, and baked goods, and be a commercial establishment.
  - For modeling, we need a structure to describe these connections.

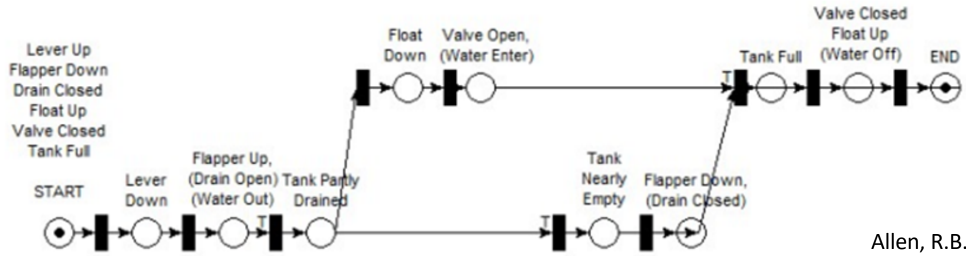
Representation of Semantics of Complex Objects (#2)

Parts: Different senses of Part_of (Winston, et al., 1987)

- *Component/Integral object (handle/cup, punchline/joke)*
  - Parts associated with activities
  - Distinct functional units or structural parts.
- *Feature/Activity (paying/shopping)*
  - Subprocess/Process.
  - Segments of an activity may be modeled with states and threads.
- *Portion/Mass (slice/pie, grain/salt)*
  - If a portion is distinct, it may be a fiat-object part
- *Place/Area (Everglades/Florida, oasis/desert)*
  - Nested spatial regions or nested sites
- *Member/Collection: (tree/forest, card/deck)*
  - Object aggregates, such as "a heap of stones" and "a symphony orchestra"
- *Stuff/Object: (gin/martini, steel/bike)*
  - A material and an object made from it.

Representation of Semantics of Complex Objects (#3)

- States and Stages
  - Simple states attach dependent continuants
  - Complex states are more difficult. Is ice a different entity that liquid water?
    - Representation issues
    - Perhaps it is the state of an aggregate of water molecules, but the details are not clear.



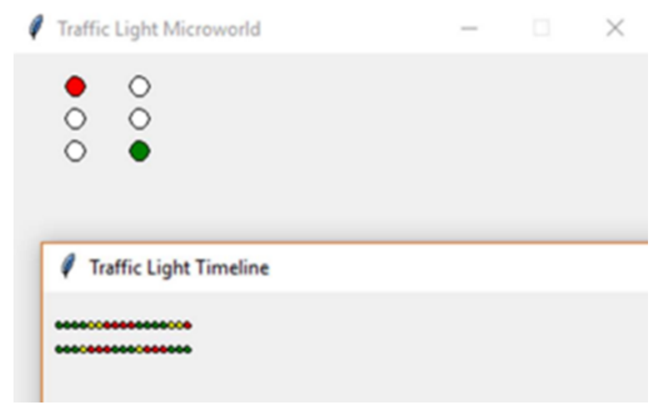
Allen, R.B. Issues for Using Semantic Modeling to Represent Mechanisms, arXiv: 1812.11431

- Configurations of Components and Scenarios
  - A person and the shirt they are wearing
  - Meta-operators, Yoked material entities

Representation of Semantics of Complex Objects (#4)

- Functions
  - In BFO, Functions are Realizable Dispositions
    - For example: “the function of amylase is to break down starch into sugar”
    - Depends on context
- Systems
  - A foundation of programming languages
  - Composed of interacting mechanisms
  - Many complex objects can be considered as systems
- Microworld
  - Environment for interacting objects
    - Can include gravity, temperature, pressure, etc
  - Focus on specific issues by nesting microworlds
  - Could be conceptualized as a type of system

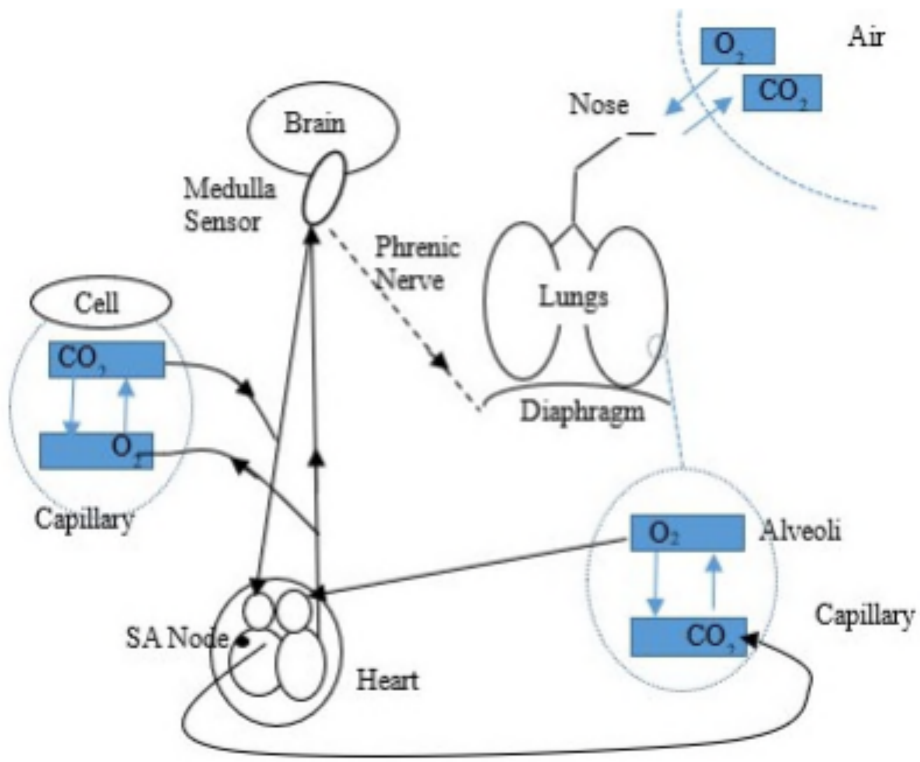
Microworld programmed with semantic modeling framework.



Allen, R.B. and Jones, T.K., XFO: Toward Programming Rich Semantic Models (April2018), arXiv:1805.11050

Example: Semantic Model of Cardio-Pulmonary System

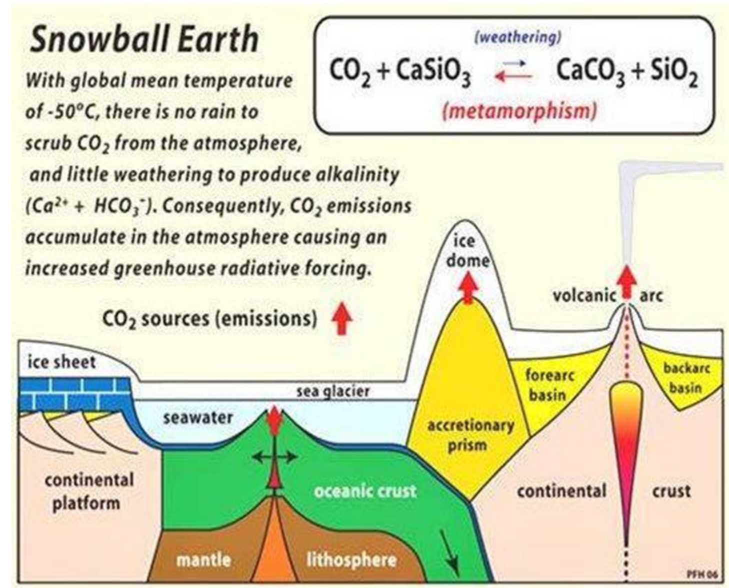
Constructed purely from local interaction (message passing) between material entities.



Allen, R.B., Definitions and Semantic Simulations Based on Object-Oriented Analysis and Modeling, 2019, ARXIV 1912.13186

Evidence and Discourse

- Evidence
  - Snowball Earth model is based on a lot of details geological evidence.
  - Evidence has its own model that needs to be related to the broader model.
  - Collecting evidence
    - Workflows for the collection of evidence
    - Measurement procedures
- Style of presentation in a research report
  - One approach: Tracking the emergence and synergies of the model and the evidence
  - A second approach: Direct Model descriptions
    - Follow the mechanisms of the model.
  - Ideally, one framework could support both approaches.



Conclusion

- We describe a modeling framework that is centered on complex objects.
- We have discussed solutions to several modeling puzzles.
- Future work can include more advanced Object-oriented modeling techniques such as:
    - Actors model (can include timing of interactions)
    - Object-oriented system dynamics
- Overall, modeling is a useful perspective.