What is Knowledge Representation?

Davis, Shrobe and Szolovitz
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Five roles that KR plays

1. A surrogate for some part of the real world
2. A set of ontological commitments
3. A fragmentary theory of intelligent reasoning
4. A medium for pragmatically efficient computation
5. A medium of human expression
1 KR as a surrogate

• Agents “reason” about models of the world to
  – Deduce properties without having to directly gather information from the world
  – Predict consequences of potential actions rather than performing the actions directly

• Given a KR, there are two questions to ask:
  – Semantics -- For what is it a surrogate?
  – Fidelity -- How accurate is it?

• When modeling the natural world, KRs are always imperfect
  – Consequently, even with a sound reasoning system, incorrect conclusions are inevitable!
2 Ontological commitments

• A KR is a set of ontological commitments
• An ontology is a theory of what exists in the world
  – Classes, objects, relations, attributes, properties, constraints, special individuals, etc.
  – We could also view this as providing a vocabulary.
• A KR makes a commitment to a particular ontology – i.e., to describing the world with particular terms.
• “The commitments are in effect a strong pair of glasses that determine what we can see, bringing some part of the world into sharp focus, at the expense of blurring other parts.”
Example of ontological commitments

Problem: representing electronic circuits

• In a “lumped element model”
  – a circuit consists of
    • Components with terminals that have certain I/O behaviors
    • Connections between terminals
  – signals flow instantaneously along the connections.

• Another model may represent the electrodynamics of the situation
  – Signals propagate with finite speed
Note

• Every representation ignores *something* about the world

• A KR is not just a data structure.
  “Part of what makes a language representational is that it carries meaning, i.e., there is a correspondence between its constructs and things in the external world”.
3 KR as a theory of reasoning

• Many knowledge representations offer fragmentary theories of intelligent reasoning.
• Most agree that humans (and animals) employ multiple strategies for representing and reasoning about the world:
  – E.g., deductive, abductive, inductive, Bayesian, case-based, etc.
• Three components of a theory:
  (1) The fundamental conception of intelligent inference
  (2) Sanctioned inferences
  (3) Recommended inferences
(1) What counts as inference?
**(2) & (3) A theory of reasoning**

- Sanctioned vs. recommended reasoning.
- Most, but not all, logical systems assume a sound reasoner.
  - An example of non-sound reasoning is *abductive reasoning*.
  - Humans do pretty well with non-sound reasoning.
- More interesting is having a theory of what inference steps to make.
- There’s been lots of work done on different reasoning strategies.
4 Efficient computation

• Some KR languages and frameworks have focused on “heuristic adequacy” – providing a representation which supports adequately efficient problem solving. E.g.
  – Early heuristic systems
  – Any-time computations
• Other work has focused on the knowledge content and what could, in principle, be derived from it without concern for efficiency except in fairly abstract measures (e.g., complexity), for example
  – Naïve physics
• Both perspectives are important, so avoiding either pole (or including both) is a good idea.
5 Human expression

• Knowledge representations can be intended for humans as well as machines.

• Some KR languages attempt to be easily generated and understood by people and others do not.
  – E.g., neural networks vs. rule based systems
  – E.g., OO representations vs. logical formalisms

• Individual talents, experience and training makes a difference, of course.
Summary

• We’re talking about KR broadly, including KR frameworks, KR languages, and representations of some particular knowledge.

• These have different roles or aspects.

• Any particular approach or piece of work will focus on some of the roles and not others.

• Keeping this in mind will help you in understanding the work and its importance.