



Can Conceptual Modeling Research Inform Other Disciplines?

Panel: New Directions for Conceptual Modeling

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OUTLINE

- * Position Statement
- * Classification – The Questions
- * Classification – The Approach
- * Principles
- The Results
- An Information Processing Model
 - An Information Processing View Based on Classification
 - General Diagram
 - Applying the Diagram to Information Systems
- * Classification and Science
 - Some Examples
 - Classification Principles and the Scientific Method
- Summary (the classification research)
- * The End

Position Statement

- Conceptual modeling emerged as a way to understand the application requirements for databases, software, and information systems.
- Originally, conceptual modeling techniques were mostly graphical, and were not based on well-defined semantics.
- The study of conceptual modeling has expanded in four main directions.
 1. Deep issues of theoretical and practical importance.
 - The interaction of syntax, semantics, and pragmatics
 - The need to combine **epistemological** and **ontological** foundations
 - Cognitive aspects of modelers and model readers
 - Ontological foundations; and support for reasoning.
 2. Recognition of the importance of the modeling process and guiding rules.
 3. A common emerging paradigm and methods for the empirical studies of:
 - Usability and usefulness of models, grammars, and processes.
 4. The study of conceptual modeling has extended beyond the original purpose.
 - Conceptual models can be used for other than their original purposes.
 - Theoretical and empirical findings are applicable to other domains.
 - Research on the IT-related artifacts can be applied also in the natural sciences.
- **The area of conceptual modeling is alive and well and now serves to enrich other domains of study and application.**

Classification – The Questions

- Classification is a major aspect of developing IT artifacts
 - Domain modeling (identifying the important concepts)
 - Knowledge and information sharing (ontologies)
 - Organizing information
 - Design (databases, software)
- The question: How to choose the “right” classes
 - When we organize information
 - Classes, types (even relations in an RDM)
 - Practical: folders, menus...
 - *Have you ever misfiled information?*
 - When we organize knowledge
 - Concepts in the domain knowledge
 - Domain knowledge concepts often become “types” in our organized information

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Classification – The Approach

- Principles for “good” classes using cognitive foundations
 - Well-researched in cognitive sciences (the theory of concepts)
 - Three main approaches: “classic” “prototype” “exemplar”
 - Hierarchy of concepts, degrees of similarities, family resemblance
- The above are epistemological principles
- Working with these ideas requires also ontological considerations
 - What is classified (that which we believe exists)
 - All approaches are based on properties. What is a property?
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- Recently we suggested: usefulness of a class
 - The ability to infer properties of instances
 - Related to survival value of classification
 - Is this ontological or epistemological? It appears that:
 - The nature of the inference – ontological
 - The value of the inference - epistemological

Principles

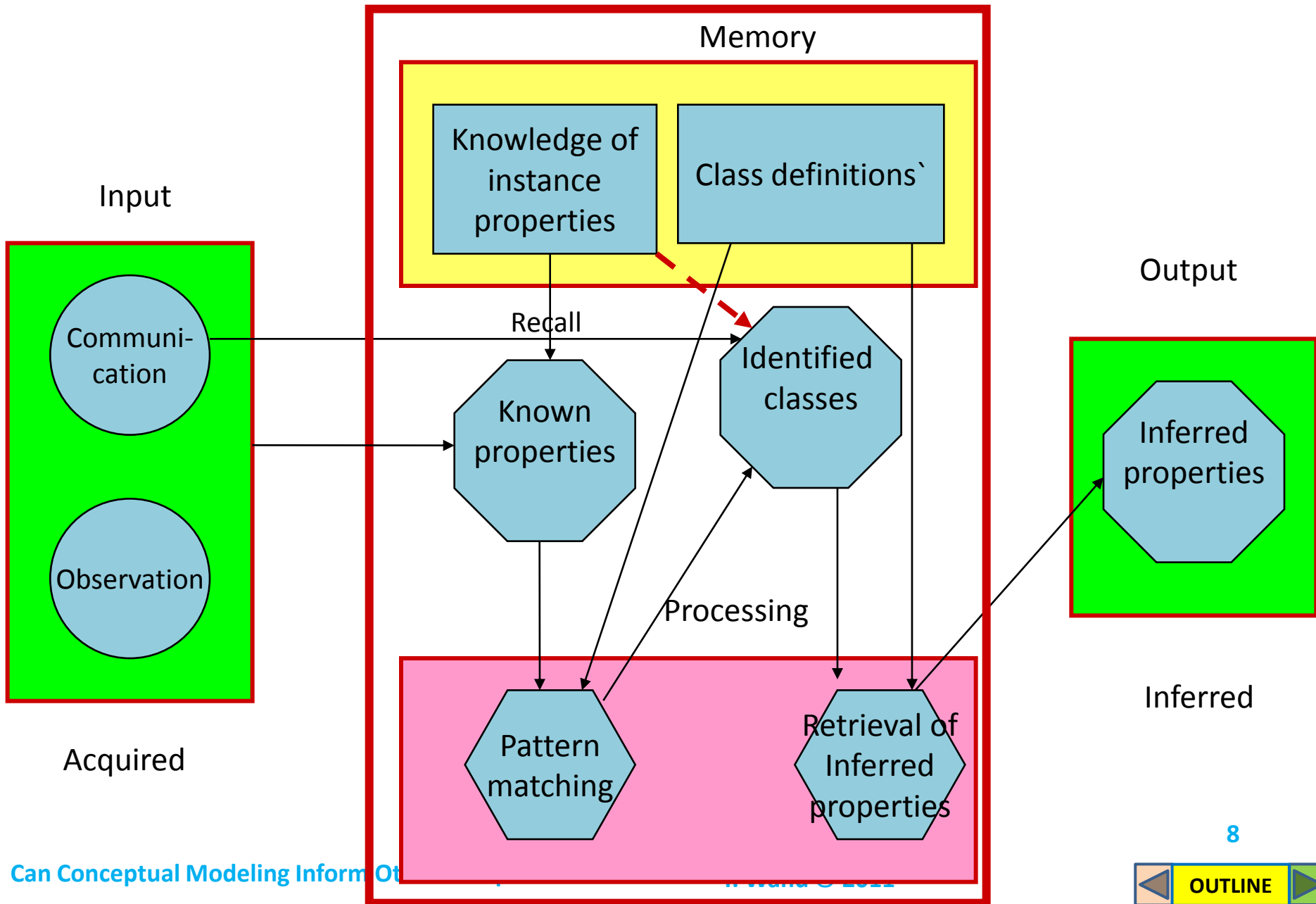
- How to organize the information & knowledge about a Assume a domain of phenomena
- Two types of cognitive principles
 - Classes are useful because they enable inferences
 - Classes are formed to attain economy of resources is
- Three main steps
 - What is a class?
 - As opposed to a category
 - For a set of phenomena – what is a “good” collection of classes
 - Where all are not “just” categories
 - How to use a collection of classes in information processing
 - Applying inferences based on class membership
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The Results

- What is a **class**
 - A category – reflects similarity of properties
 - A class –identifying an instance as a member based on a subset of properties
 - The rest of the properties are inferred based on membership
 - This is what makes the class useful
- For a set of phenomena – what is a “good” collection of classes
 - Maximal abstraction
 - Minimal duplication
 - Add a class only if adds information not already included
 - Can be translated to guiding principles for forming classes in conceptual modeling and in systems design
- For a collection of classes– how are they used in information processing
 - The model is general – independent of technology
 - Applicable to any information processing activity where appearance of instances triggers activities (events)
 - IT artifacts, cognitive activities

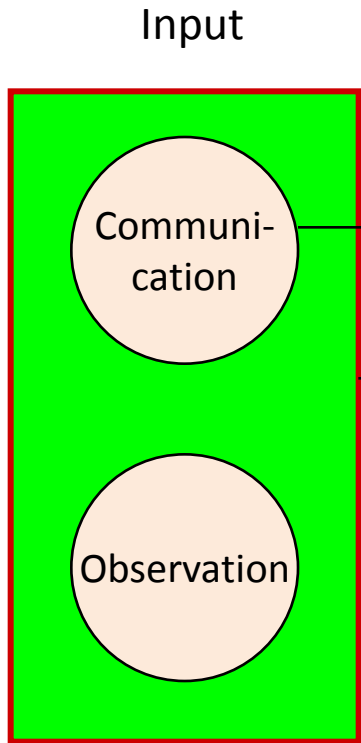


Processing System

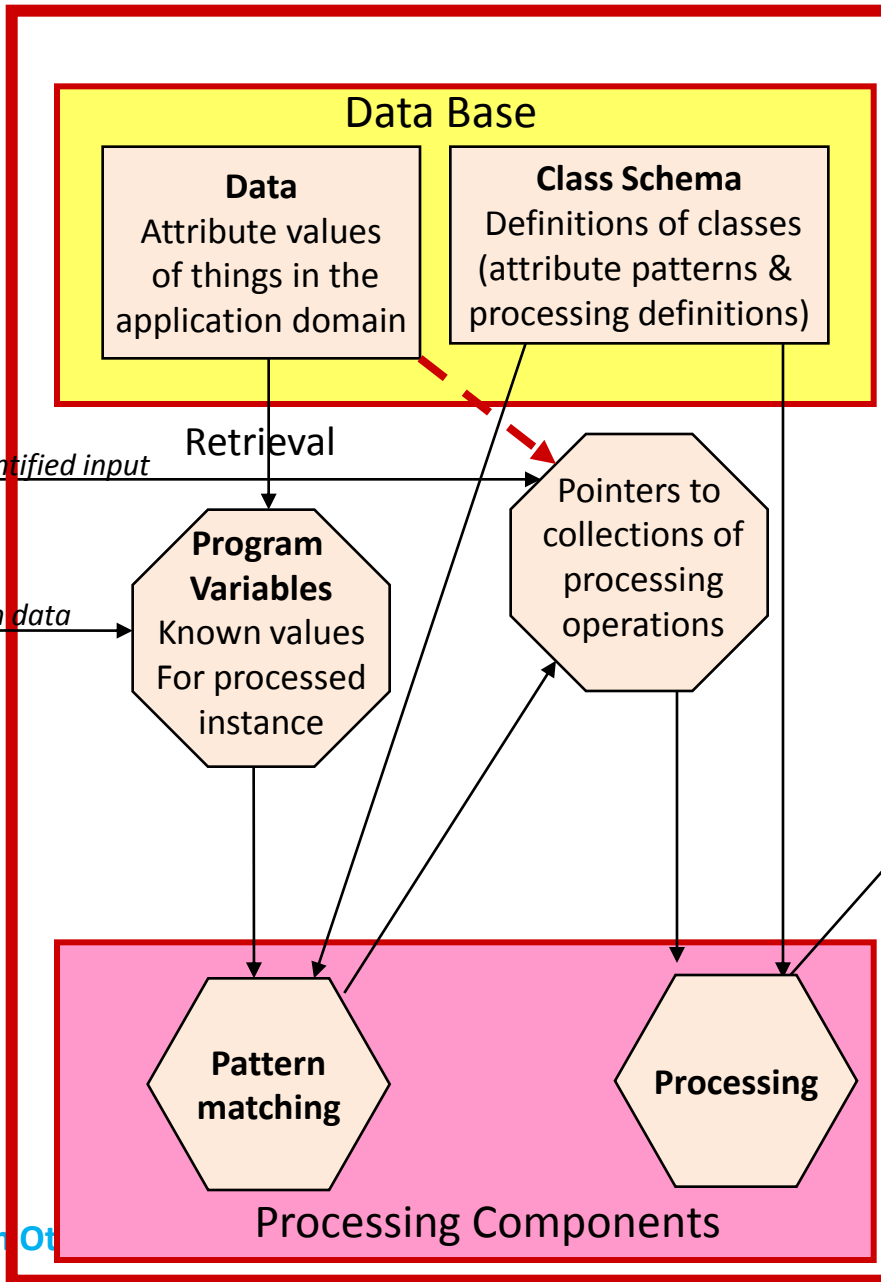


An Classification-Based View of an Information system

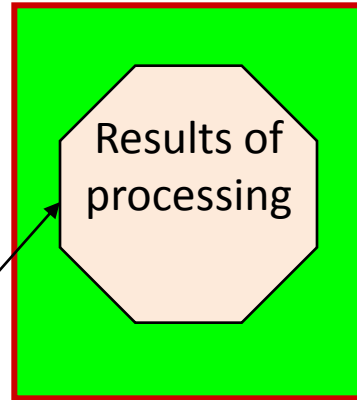
- Insert an instance
- Attach a class to an instance
- Insert a category (def)
- Define a class (cat, inf)
- Modify a class
- Retrieve an instance
- Retrieve instances of a category
- Identify a category from a set of instances



Acquired



Output



Inferred



Classification & Science

Some Examples

Classification Principles and the Scientific Method

Some Examples

- Good class definitions:
 - Is Pluto a planet (it has been “demoted”) in 2006
- Collections of classes
 - What could be a good biological classification
 - Not a specific one – but the guiding principles
 - How the solar system can be described using several classes
 - Planets
 - Giant gaseous planets
 - ...
- How wrong scientific assumptions can be shown as wrong classifications (leading to wrong inferences)
 - What causes ulcers?

Classification Principles and the Scientific Method

- Scientific theories often emerge from classification of phenomena
 - The periodic table of elements
 - Elementary particles
- A paradigm shift often occurs when a phenomenon does not conform to the assumed classification
 - The causes of ulcers (Nobel Prize in Physiology & Medicine 2003)
 - Classifying symmetries in crystals (Nobel Prize in Chemistry 2011)
- The nature of such changes has been explored using frames
 - Andersen, Barker, Chen, “The Cognitive Structure of Scientific Revolutions”, Cambridge University Press, 2006.
 - They state (referring to Kuhn): “According to this theory, the basic conceptual structure of science is a classification system that divides objects into groups according to similarity relations.”
- We are exploring how to use our view of classification in this context
 - Very initial: some hypotheses related to birds (why certain types of feathers might be missing)
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Summary

- We sought to find guiding principles for forming “good” class structures
 - A definition for a useful class (in contrast to a “simple” category)
 - Guidelines for forming collections of classes
 - A model for using classes when processing information
- We found that:
 - We need both epistemological and ontological considerations
 - Epistemology:
 - What is a good class
 - What is a good collection of classes
 - Ontology
 - What is classified
 - The notion of property is fundamental to classification
 - Formalism to make the principles workable
- We applied the view to scientific domains
 - Debates related to classification
 - How good classification principles on can point out to possible new theories
- We are now comparing the classification principles with other approaches.
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The End

Comments, Objections, Suggestions
and
Questions



An Information Processing View Based on Classification

- Known properties of known instances are stored separated from classes (“an instance base”)
- Class definitions are “stored” unrelated to instances
 - Set of properties sufficient to identify all instances as members
 - Inferences that define additional common properties
- When an instance is encountered:
 - All classes to which it belongs are identified
 - Inferences related to all these classes are performed
 - Possible: identify some additional needed to determine the classes to which the instance belongs
 - Inferences might lead to indentifying that same or other instances belong to additional classes – more processing