

Ontology-Based Computing



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The Onslaught

- ✿ Increasingly large amounts of information is becoming accessible electronically.
- ✿ The information sources are increasingly complicated.
- ✿ The diversity of types of information source is also increasing.

Technologies are emerging to cope with this onslaught:
ontology-based computing.

Ontologies

- Shared understanding within a community of people
- Declarative specification of entities and their relationships with each other
- Constraints and rules that permit reasoning within the ontology
- Behavior associated with stated or inferred facts

Relational Database Schemas

- Well established technique for specifying the structure of shared data, not for communication between people or agents
- Declarative specification but of tables, not of entities and relationships
- Some constraints are expressible but no significant rules (such as inheritance)
- No explicit behavior

Object-Oriented Schemas

- ❖ Emerging technology for communication between software components
- ❖ Declarative specifications
- ❖ Constraints and some rules
- ❖ Several ways to specify behavior
- ❖ The Unified Modeling Language (UML) is the standard OO modeling language.

Logic

- ❧ Very expressive but very difficult to use. Not designed for communication.
- ❧ Most logical languages are not based on entities and relationships.
- ❧ Very powerful inferencing capabilities.
- ❧ Do not usually have any associated behavior.
- ❧ Many examples: Prolog, KIF, ...

XML DTDs and XML Schema

- ❧ Defines a hierarchical document type. XML Schema defines data types. Designed for communication over the Web.
- ❧ Good support for entities and hierarchical relationships; awkward for others.
- ❧ Constraints can be imposed on the hierarchical structure and on data types.
- ❧ Behavior can be specified procedurally.

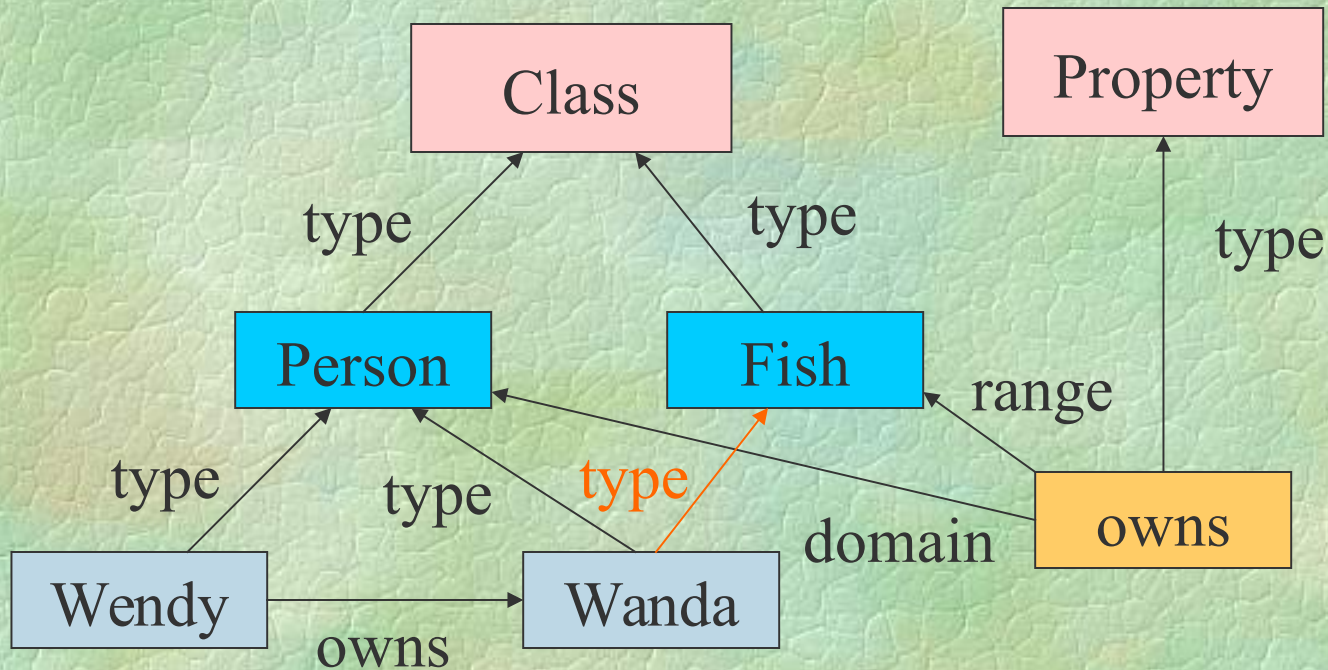
Knowledge Representations

- ❧ Very well developed branch of AI. Many tools, but mostly academic. Not yet used for communication over the Web.
- ❧ Powerful language for specifying entities and their relationships.
- ❧ Most are linked with inference engines.
- ❧ Behavior is typically handled in an ad hoc manner.

RDF and DAML

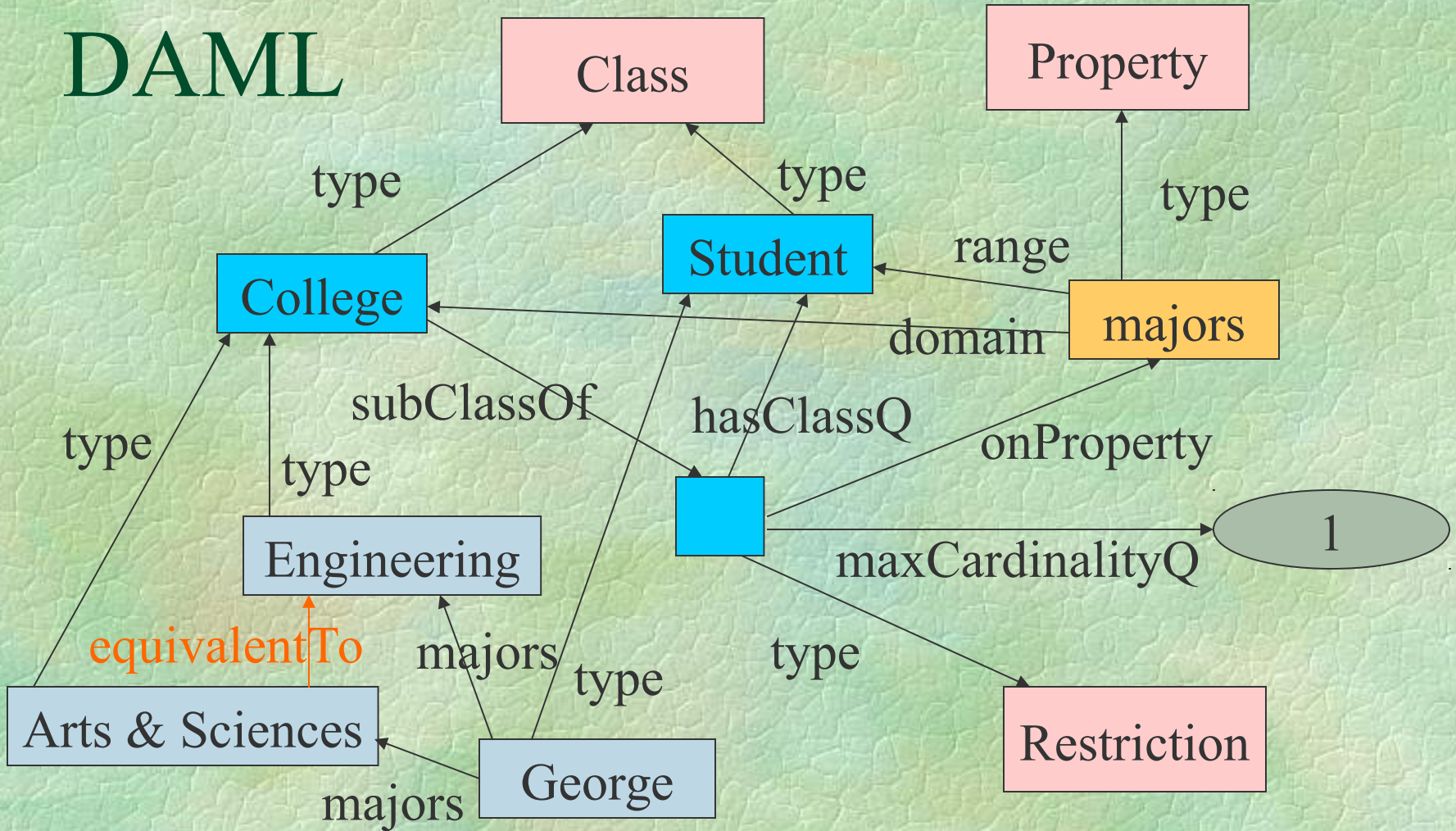
- ❖ Resource Description Framework (RDF) is a knowledge representation language. It is a WWW Consortium Recommendation.
- ❖ The DARPA Agent Markup Language (DAML) is an extension of RDF to serve as the basis for ontology-based computing over the Web: the **Semantic Web**.

Ontological Reasoning in RDF



1. Type constraint violation: The range of owns is Fish
2. There is no inconsistency: Wanda is a Fish (Mermaid?)

DAML



1. Cardinality constraint violation: George can't have two majors
2. There is no inconsistency: Engineering = Arts & Sciences

Representing information

- Relational database: records
- OO database: instances
- Logic: facts
- XML: documents
- KR: annotations
- All of these are graph structures: entities related to other entities by relationships.

Where is the meaning?

- Databases: select-project-join queries
- Logic: rules determined by unification
- XML: XSLT patterns
- KR: templates
- All of these are forms of graph matching.
The units of meaning are small connected subgraphs.

Coping with the onslaught

🐼 Volume of data

- Use distributed systems and indexes

🐼 Complexity of ontologies

- Graphical user interfaces
- Consistency checking

🐼 Diversity of ontologies

- Ontology mediation