OWL, Protégé and Security-Privacy Ontology

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Agenda

- Description Logic (DL)
- OWL
- Protégé
- Protégé-OWL Editor
- RBAC ontology demo
Motivations for DL

- Rigorously model a domain of interest
- Benefit from formal semantics
- Foster a disciplined approach to knowledge engineering
- Leverage software implementations
Benefits of DL Software

- Enables precise descriptions of classes and individuals
- Makes implicit information explicit
- Detects redundancy and circularity
- Ensures logical consistency
- Automatic classification
  - Assists organization of complex taxonomies
  - Guarantees that classes and individuals are found in predictable locations based on their definitions
  - Facilitates navigation
Description Logic (DL)

- Formal logic
- Knowledge representation *and* reasoning
- Languages
  - Focus on descriptions
    - Objects
      - Classes
      - Individuals
    - Properties
  - Emphasis on sound, complete and tractable reasoning
- Inferences
  - Subsumption
  - Classification
- Algorithms
- Reasoners
Class

- Represents a distinct idea
- Denotes a set of possible individuals
- Examples
  - Person, Employee, Patient, …
  - Nurse, Registered Nurse, …
  - Lab Report
  - Create (operation)
  - Top – the universal description (aka Thing)
  - Bottom – the empty description (aka Nothing)
Individual

- Elements in the domain of discourse
- Instances of classes
- Unique (not necessarily uniquely named)
Properties

- Object properties
  - Expressed as relationships to classes and/or individuals
  - Describe relationships between individuals
  - Universal quantification, existential quantification, cardinality

- Examples
  - hasFriend only Human
  - hasFriend some Female
  - hasFriend min 1
  - hasFriend max 86
  - hasFriend exactly 24
  - hasFriend exactly 12 Female

- Data properties

Properties are classified in a hierarchy too
Necessary and Sufficient Conditions

- Primitive classes
  - Examples: Mammal, Female
  - Necessary conditions
    - Example: Human $\subseteq$ Mammal
    - (Protégé: superclasses)

- (Fully) Defined classes
  - Necessary and Sufficient Conditions
    - Example Woman $\equiv$ Human $\cap$ Female
    - (Protégé: equivalent classes)
Subsumption

- Class C1 subsumes class C2 when C1 is more general than C2
  - The set of individuals described by C1 is a superset of those described by C2 (extensional semantics)
  - C1’s description is logically implied by C2’s description (intensional semantics)
Classification

- Integrate a new object (class or individual) into a taxonomy
- Organizes a set of objects into a taxonomy
- Based on subsumption
- As a result of classification, each object in the inferred taxonomy subsumes (is more general than) all its descendants, and is subsumed by (is more specific than) all its ancestors, without exception
- Reclassification
  - When objects change, their positions in the (inferred) taxonomy may change correspondingly
Classifiers

- Make descriptions (fully) explicit
  - Inheritance
  - Propagation
- Classify all objects
- Detect inconsistency
  - Note: inconsistency propagates too!
Gotchas for newbies

- Not a database, not a UML model (though similar names and ideas), ...
- Open world assumption
- No disjointness assumption
- Trivial satisfiability
- No unique name assumption
OWL

- Web Ontology Language
- W3C recommendation
- Now OWL 2.0
- A family of description logics (with variants and profiles)
- (Semantic) Web veneer
  - IRIs
  - XML syntaxes
Protégé

“Ontology editor and knowledge based framework”

SMI, mid 1980’s to present

Customizable, extensible, programmable …

Large and complex

FOSS

Originally focused on frames

Popular OWL environment
Protégé-OWL Editor

- Protégé extension to support OWL
- Plug-in classifiers; now ships with HermiT
- Library of plug-ins, e.g., OWLViz
Demo

Apelon
Discussion