
Applications of Description Logics

Application Areas I

- ☞ Terminological KR and Ontologies
 - DLs initially designed for terminological KR (and reasoning)
 - Natural to use DLs to build and maintain ontologies
- ☞ Semantic Web
 - **Semantic** markup will be added to web resources
 - ➔ Aim is “machine understandability”
 - Markup will use **Ontologies** to provide common terms of reference with clear semantics
 - Requirement for web based ontology language
 - ➔ Well defined semantics
 - ➔ Builds on existing Web standards (XML, RDF, RDFS)
 - Resulting language (DAML+OIL) is **based on a DL** (*SHIQ*)
 - DL **reasoning** can be used to, e.g.,
 - ➔ Support ontology design and maintenance
 - ➔ Classify resources w.r.t. ontologies

Application Areas II

Configuration

- **Classic** system used to configure telecoms equipment
- Characteristics of components described in DL KB
- Reasoner checks validity (and price) of configurations

Software information systems

- LaSSIE system used DL KB for flexible software documentation and query answering

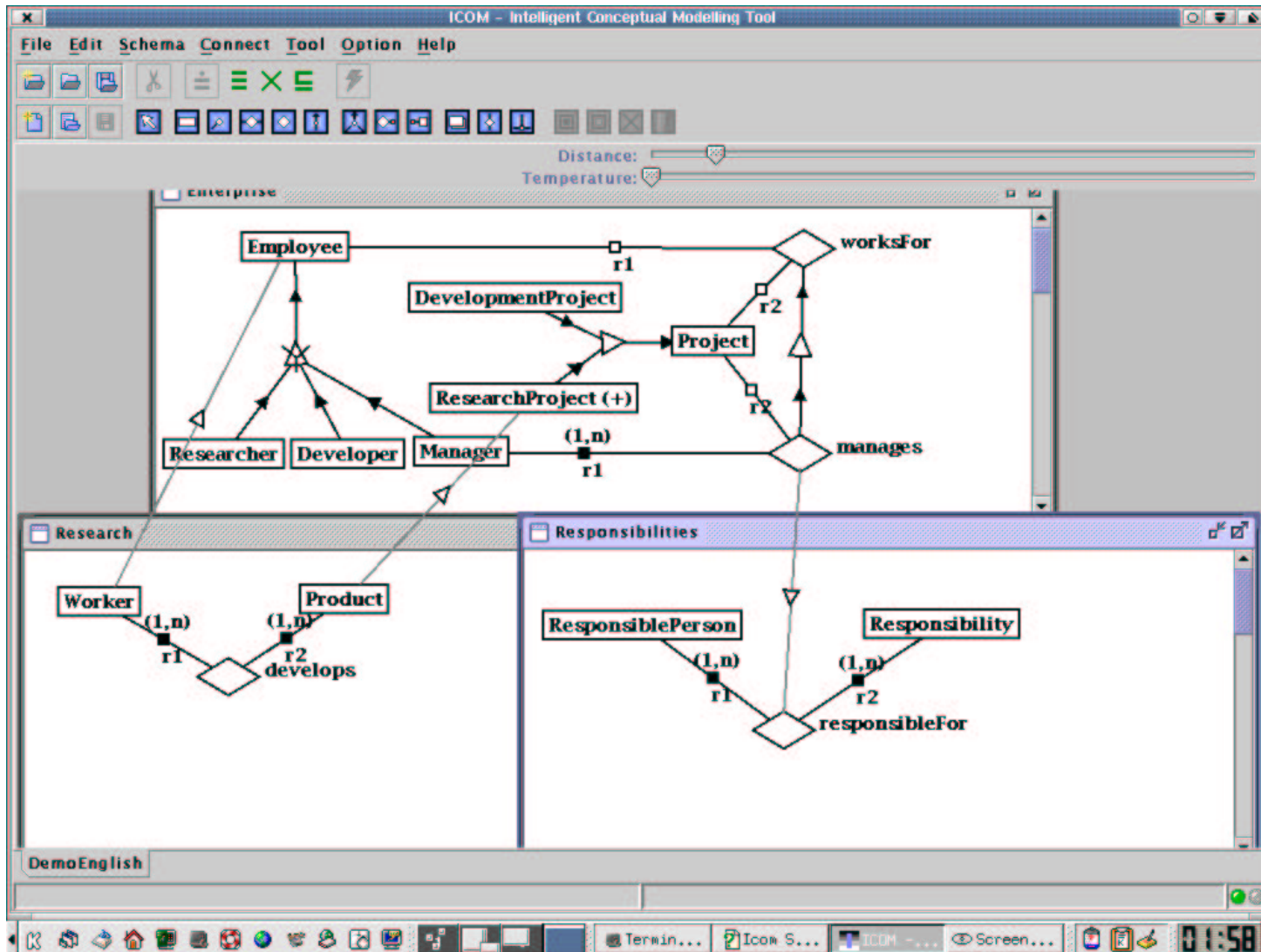
Database applications

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Database Schema and Query Reasoning

- ➡ *DLR* (n-ary DL) can capture semantics of many conceptual modelling methodologies (e.g., EER)
- ➡ Satisfiability preserving mapping to *SHIQ* allows use of DL reasoners (e.g., FaCT, RACER)
- ➡ DL Abox can also capture semantics of conjunctive queries
 - Can reason about query containment w.r.t. schema
- ➡ DL reasoning can be used to support
 - Schema design, evolution and query optimisation
 - Source integration in heterogeneous databases/data warehouses
 - Conceptual modelling of multidimensional aggregation
- ➡ E.g., **I.COM** Intelligent Conceptual Modelling tool (Enrico Franconi)
 - Uses FaCT system to provide reasoning support for EER

I.COM Demo



Terminological KR and Ontologies

- ➡ General requirement for medical terminologies
- ➡ Static lists/taxonomies difficult to build and maintain
 - Need to be very **large** and highly interconnected
 - Inevitably contain many **errors** and **omissions**
- ➡ Galen project aims to replace static hierarchy with DL
 - **Describe** concepts (e.g., spiral fracture of left femur)
 - Use DL classifier to **build taxonomy**
- ➡ Needed expressive DL **and** efficient reasoning
 - Descriptions use transitive/inverse roles, GCIs etc.
 - Very large KBs (tens of thousands of concepts)
 - ➔ Even prototype KB is very large ($\approx 3,000$ concepts)
 - ➔ Existing (incomplete) classifier took ≈ 24 hours to classify KB
 - ➔ FaCT system (sound and complete) takes ≈ 60 seconds

Reasoning Support for Ontology Design

- ☞ DL reasoner can be used to support design and maintenance
- ☞ Example is OilEd ontology editor (for DAML+OIL)
 - Frame based interface (like Protegé, OntoEdit, etc.)
 - Extended to clarify semantics and capture whole DAML+OIL language
 - ➔ Slots explicitly existential or value restrictions
 - ➔ Boolean connectives and nesting
 - ➔ Properties for slot relations (transitive, functional etc.)
 - ➔ General axioms
- ☞ Reasoning support for OilEd provided by FaCT system
 - Frame representation translated into *SHIQ*
 - Communicates with FaCT via CORBA interface
 - Indicates inconsistencies and implicit subsumptions
 - Can make implicit subsumptions explicit in KB

DAML+OIL Medical Terminology Examples

E.g., DAML+OIL medical terminology ontology

- ☞ Transitive roles capture transitive partonomy, causality, etc.
Smoking $\sqsubseteq \exists \text{causes.Cancer}$ plus Cancer $\sqsubseteq \exists \text{causes.Death}$
 \Rightarrow Cancer $\sqsubseteq \text{FatalThing}$
- ☞ GCIs represent additional non-definitional knowledge
Stomach-Ulcer $\doteq \text{Ulcer} \sqcap \exists \text{hasLocation.Stomach}$ plus
Stomach-Ulcer $\sqsubseteq \exists \text{hasLocation.Lining-Of-Stomach}$
 $\Rightarrow \text{Ulcer} \sqcap \exists \text{hasLocation.Stomach} \sqsubseteq \text{OrganLiningLesion}$
- ☞ Inverse roles capture e.g. causes/causedBy relationship
Death $\sqcap \exists \text{causedBy.Smoking} \sqsubseteq \text{PrematureDeath}$
 $\Rightarrow \text{Smoking} \sqsubseteq \text{CauseOfPrematureDeath}$
- ☞ Cardinality restrictions add consistency constraints
BloodPressure $\sqsubseteq \exists \text{hasValue.}(\text{High} \sqcup \text{Low}) \sqcap \leq 1 \text{hasValue}$ plus
High $\sqsubseteq \neg \text{Low} \Rightarrow \text{HighLowBloodPressure} \sqsubseteq \perp$

OilEd Demo

