

Lecture 6: More DLs and Their Applications

2-AIN-108 Computational Logic

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$\sqcap, \sqcup, \neg, \exists, \forall$	\mathcal{ALC}
$\mathcal{ALC} + \text{Tra}()$	\mathcal{S}
$R \sqsubseteq S$	\mathcal{H}
$\mathcal{H} + \exists R.\text{Self}, R_1 \cdots R_n \sqsubseteq R, \text{Sym}(), \text{Asy}(), \text{Ref}(), \text{Irr}(), \text{Dis}()$	\mathcal{R}
R^-	\mathcal{I}
$\{a\}$	\mathcal{O}
$\leq_n R.C, \geq_n R.C$	\mathcal{Q}

Example

Aunt $\equiv \exists \text{hasSibling}.\exists \text{hasChild}.\top$

$\exists \text{hasAncestor}.\text{(King} \sqcup \text{Queen)} \sqsubseteq \text{Royalty}$

$\exists \text{hasSpouse}.\text{Royalty} \sqsubseteq \text{Royalty}$

elisabeth, charles : motherOf

charles, anne : brotherOf

william, charles : sonOf

kate, william : wifeOf

wifeOf \sqsubseteq spouseOf

husbandOf \sqsubseteq spouseOf

daughterOf \sqsubseteq childOf

sonOf \sqsubseteq childOf

sisterOf \sqsubseteq siblingOf

brotherOf \sqsubseteq siblingOf

hasSibling \equiv siblingOf⁻

husbandOf \equiv wifeOf⁻

spouseOf \equiv spouseOf⁻

hasSpouse \equiv spouseOf⁻

childOf \equiv hasChild⁻

ChildOf \sqsubseteq hasAncestor

Tra(hasAncestor)

- Database schema modelling
- Electronic health records
- Big data

Database Schema Modelling

Table **Person**

ID	Name	Office	Phone
p34	Martin	I-7	null
...			

Table **Course**

ID	Name	Credits
c7	Computational Logic	5
...		

Table **Teaches**

ID_Person	ID_Course
p34	c7
...	

Foreign key: ID_Person ref Person.ID, ID_Course ref Course.ID

Person $\sqsubseteq \exists \text{hasName.Name}$

Person $\sqsubseteq \forall \text{hasOffice.Office}$

Person $\sqsubseteq \forall \text{hasPhone.Phone}$

Course $\sqsubseteq \exists \text{hasName.Name}$

Course $\sqsubseteq \forall \text{hasCredits.Credits}$

$\exists \text{teaches.T} \sqsubseteq \text{Person}$

$\text{T} \sqsubseteq \forall \text{teaches.Course}$

Person $\sqcap \exists \text{teaches.Course} \sqsubseteq \text{Professor}$

Professor $\sqsubseteq \exists \text{hasOffice.Office}$

Professor $\sqsubseteq \exists \text{hasPhone.Phone}$

- Representing DB schema as ontology:
 - Consistence checking
 - Redundance checking
 - Extending schema expressivity (e.g. w sufficient conditions)
 - Defining complex classes
- More uses
 - Database integration
 - Ontology-driven data access

SNOMED CT

- Developed since 1965 by College of American Pathologists, later by NHS (UK), and IHTSDO
- Largest medical ontology: 366,000 concepts, 993,000 terms, 1.46M relationships
- Uses $\mathcal{EL}++$ DL fragment
- Commercially available
- Used as basis of EHR in USA, UK and worldwide

Some of domains covered by SNOMED CT:

- Symptoms
- Diagnoses
- Procedures,
- Body structures
- Pharmaceuticals

SNOMED CT Example

Parent(s):

(Select a parent to make it the "Current Concept".)

[Upper respiratory infection \(disorder\)](#)

[Viral respiratory infection \(disorder\)](#)

Current Concept:

[Viral upper respiratory tract infection \(disorder\)](#)

Child(ren):

(N=9) (Select a child to make it the "Current Concept".)

[Common cold \(disorder\)](#)

[Feline viral rhinotracheitis \(disorder\)](#)

[Human papilloma virus infection of vocal cord \(disorder\)](#)

[Inclusion body rhinitis of swine \(disorder\)](#)

[Infectious bovine rhinotracheitis \(disorder\)](#)

[Inflammation of larynx due to virus \(disorder\)](#)

[Influenzal acute upper respiratory infection \(disorder\)](#)

[Viral pharyngitis \(disorder\)](#)

[Viral sinusitis \(disorder\)](#)

Current Concept:

Fully Specified Name: [Viral upper respiratory tract infection \(disorder\)](#)

ConceptId: 281794004

Defining Relationships:

Is a [Upper respiratory infection \(disorder\)](#)

Is a [Viral respiratory infection \(disorder\)](#)

Causative agent [Virus \(organism\)](#)

Finding site [Upper respiratory tract structure \(body structure\)](#)

Pathological process [Infectious process \(qualifier value\)](#)

This concept is fully defined.

Qualifiers:

View Qualifying Characteristics and Facts

Descriptions (Synonyms):

Fully Specified Name: [Viral upper respiratory tract infection \(disorder\)](#)

Synonym: URTI - Viral upper respiratory tract infection

Preferred: [Viral upper respiratory tract infection](#)

Related Concepts:

- All "Is a" antecedents -

- All descendants and related subtypes -

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SNOMED CT Example

Parent(s):

(Select a parent to make it the "Current Concept".)

[Viral upper respiratory tract infection \(disorder\)](#)

Current Concept:

[Common cold \(disorder\)](#)

Child(ren):

(N=0) (Select a child to make it the "Current Concept".)

Current Concept:

Fully Specified Name: Common cold (disorder)

ConceptId: 82272006

Defining Relationships:

Is a [Viral upper respiratory tract infection \(disorder\)](#)

Causative agent [Virus \(organism\)](#)

Finding site [Upper respiratory tract structure \(body structure\)](#)

Pathological process [Infectious process \(qualifier value\)](#)

This concept is primitive.

Qualifiers:

[View Qualifying Characteristics and Facts](#)

Descriptions (Synonyms):

Fully Specified Name: Common cold (disorder)

Preferred: Common cold

Synonym: Acute coryza

Synonym: Acute nasal catarrh

Synonym: Acute rhinitis

Synonym: Infective rhinitis

Synonym: Acute nasopharyngitis

Synonym: Infective nasopharyngitis

Synonym: Head cold

Synonym: Acute infective rhinitis

Synonym: Cold

Synonym: Acute nasopharyngitis, NOS

Synonym: Infective nasopharyngitis, NOS

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- Consistent terminology
- Effective clinical recording of data
- Interoperability and data exchange
 - Across specialities
 - Across sites of care
- Reduction of data variability
- Improves data sharing, reduces repeated examinations, etc.
- Allows to build more powerful medical analytic tools

- Description Logics for Databases. A. Borgida, M. Lenzerini, and R. Rosati, In: The DL Handbook, Cambridge University Press, 2003.
- SNOMED Clinical Terms - Introduction. A. Casey, Royal College of Nursing.
- Summary of SNOMED CT Benefits, International Health Terminology Standards Development Organisation.