Ontology Languages

Web Ontology Language (OWL)

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Objectives

Objective

Explain how ontology is represented in OWL

Objective

Explain the relationship between OWL and DL

Introduction to OWL

A family of KR language for authoring ontologies; W3C Recommendation

Three variants of OWL with different levels of expressiveness

- OWL Lite: not widely used
- OWL DL: correspond with description logic
- OWL Full: designed to extend RDF and RDFS; undecidable

Syntax of OWL:

1. Functional style syntax
2. RDF/XML syntax
3. Manchester syntax

OWL in Functional Style Syntax

```
SubClassOf (
    :C
     ObjectIntersectionOf (
          :D
          ObjectSomeValuesFrom(  :r  :E))))
```

$$C \sqsubseteq D \sqcap (\exists r.E)$$

OWL in RDF/XML

```
<owl:Class rdf:about=":C">
  <rdfs:subClassOf>
    <owl:Class>
      <owl:intersectionOf  rdf:parseType="Collection">
        <rdf:Description rdf:about=":D"/>
        <owl:Restriction>
          <owl: onProperty rdf:resource=" :r"/>
          <owl: someValuesFrom rdf:resource=" :E"/>
        </owl:Restriction>
      </owl:intersectionOf>
    </owl:Class>
  </rdfs:subClassOf>
</owl:Class>
```

OWL in Manchester Syntax

```
Class: :C
   SubClassOf: :D and (:r some :E)
```

Semantics

Two different methods of defining the semantics of OWL ontologies

- Direct semantics: defined for the functional style syntax. Referred to as OWL 2 DL ontologies
- RDF-based semantics: applicable to any graph, including malformed syntax

We will focus on OWL 2 DL, which is close to description logic SROIQ

Description Logic SROIQ

- S: ALC extended with transitive roles
- R: extended set of Role axioms (RBox)
- O: Nominal
- I: Inverse roles
- Q: Qualified number restrictions

SROIQ: Constructors (Omitting ALC)

Roles	Syntax	Semantics
Inverse role	R^{--}	$\{(x,y) \mid (y,x) \in R^I\}$
Universal role	U	$\Delta^I \times \Delta^I$

parentOf ≡ childOf –

Concepts	Syntax	Semantics
At-least restriction	$\geq n\ R.C$	$\{x \mid \text{at least n } \mathrm{R^I} \text{ successors of x are in } \mathrm{C^I}\}$
At-most restriction	$\leq n\ R.C$	$\{x \mid \text{at most n } \mathrm{R^I} \text{ successors of x are in } \mathrm{C^I}\}$
Local reflexivity	$\exists R.Self$	$\{x \mid (x,x) \in R^I\}$
Nominal	$\{a\}$	$\{a^I\}$

SROIQ: Axioms (Omitting ALC)

Roles	Syntax	Semantics
Individual equality	$a \approx b$	$a^I = b^I$
Individual inequality	$a \not\approx b$	$a^I \neq b^I$

RBox	Syntax	Semantics
Role inclusion	$R \sqsubseteq S$	$R^I \subseteq S^I$
Role equivalence	$R \equiv S$	$R^I = S^I$
Complex role inclusion	$R_1 \circ R_2 \sqsubseteq S$	$R_1^I \circ R_2^I \subseteq S^I$, i.e., $\{(d,f) \mid \exists e \text{ s.t. } (d,e) \in R_1^I \text{ and } (e,f) \in R_2^I\} \subseteq S^I$
Role disjointness	$Disjoint(R,S)$	$R^I \cap S^I = \emptyset$

brotherOf ∘ parentOf ⊑ uncleOf

Disjoint(parentOf, childOf)

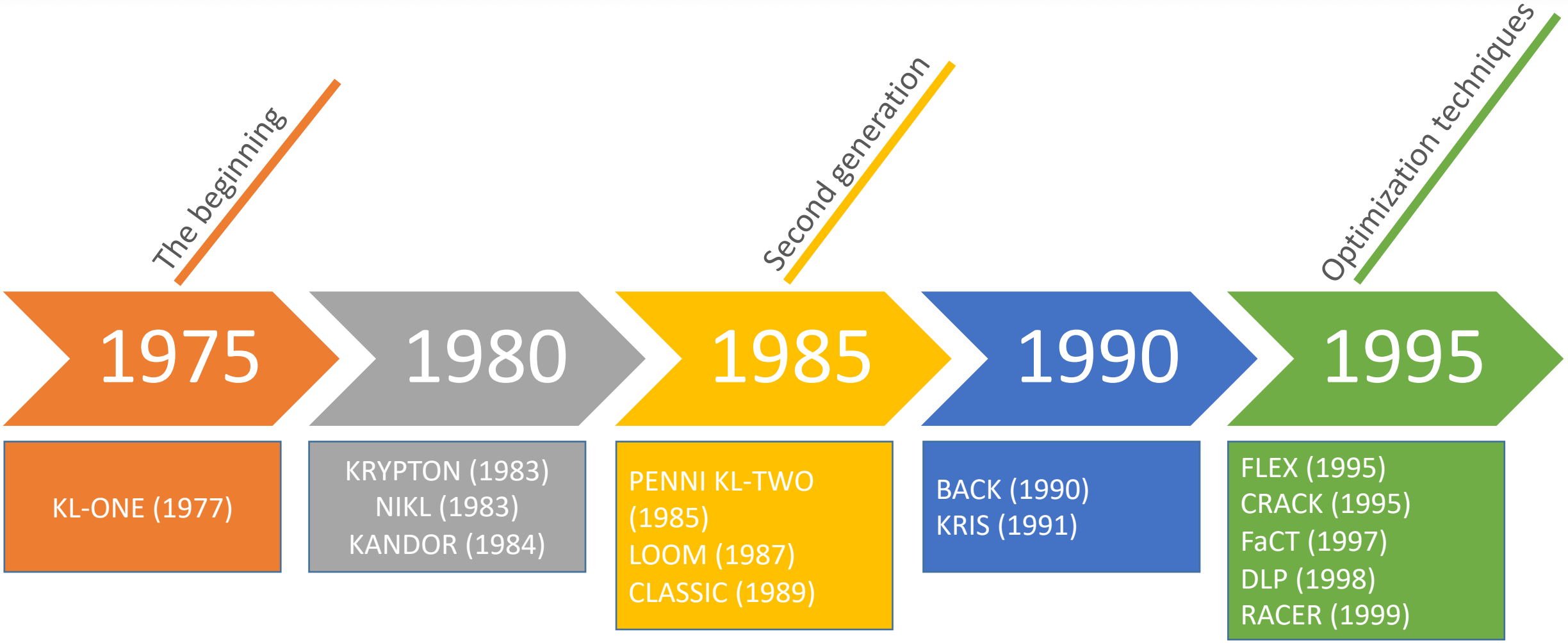
DL and OWL Terminologies

description logics	OWL
concept	class
role	object property
constant/individual	individual
theory	ontology

DL and OWL Syntax

description logics syntax	Manchester syntax (OWL in Protégé)
$C_1 \sqsubseteq C_2$	C_1 SubClassOf C_2
$C_1 \equiv C_2$	C_1 EquivalentTo C_2
$C_1 \sqsubseteq \neg C_2$	C_1 DisjointWith C_2
$R_1 \sqsubseteq R_2$	R_1 SubPropertyOf R_2
$\neg C$	not C
$C_1 \sqcup C_2$	C_1 or C_2
$C_1 \sqcap C_2$	C_1 and C_2
$\exists R.C$	R some C
$\forall R.C$	R only C
$\exists R.\{i\}$	R value$\{i\}$
$(\geq 2\ RC)$	R min 2 C
$(\leq 2\ RC)$	R max 2 C
R^-	inverse R

Implemented DL Systems



Implemented DL Systems, cont'd

DL reasoners for the ontologies and Semantic Web era:

- FaCT++
- RACERPro
- KAON2
- Pellet
- HermiT

NOTE: *See http://www.cs.man.ac.uk/~sattler/reasoners.html for links to webpages of DL reasoners.*

Wrap-Up