Mathematical Logics
Description Logic: Introduction

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Lecture index

1. Intuition: the logic of Knowledge Graphs
2. Examples of Knowledge Graphs
3. Two level knowledge graphs
4. Description logics
5. The architecture of a DL reasoning system

Ingredients of a Description Logic

A **Description Logic (DL)** is characterized by four elements :

(I) A **description language L** : how to form **concepts (KG nodes)** and **roles (KG links) + constraints**

$$\text{Human} \sqcap \text{Male} \sqcap \exists \text{hasChild}.\top \sqcap \forall \text{hasChild}.(\text{Doctor} \sqcup \text{Lawyer})$$

L = formalization of (etypes, entities, properties, property values)

(II) A mechanism to **specify knowledge** about etypes (**concepts**) and properties (**roles**) (i.e., a TBox)

$$T = \left\{ \begin{array}{l} \text{Father} \equiv \text{Human} \sqcap \text{Male} \sqcap \exists \text{hasChild}.\top \\ \text{HappyFather} \sqsubseteq \text{Father} \sqcap \forall \text{hasChild}.(\text{Doctor} \sqcup \text{Lawyer}) \\ \text{hasFather} \sqsubseteq \text{hasParent} \end{array} \right\}$$

Tbox = formalization of (KG schema: etypes, properties) + constraints

(III) A mechanism to specify **properties** of entities (**objects**) (i.e., an ABox)

$$A = \{\text{HappyFather (john)}, \text{hasChild (john, mary)}\}$$

Abox = formalization of (KG entities and prperty values)

(IV) A set of **reasoning services** that allow to infer new properties on concepts, roles and objects, which are logical consequences of those explicitly asserted in the T-box and in the A-box

$$(T, A) \models \left\{ \begin{array}{l} \text{HappyFather} \sqsubseteq \exists \text{hasChild}.(\text{Doctor} \sqcup \text{Lawyer}) \\ \text{Doctor} \sqcup \text{Lawyer (mary)} \end{array} \right\}$$

reasoning services = logical reasoning = extension of formalization of (KG reasoning)

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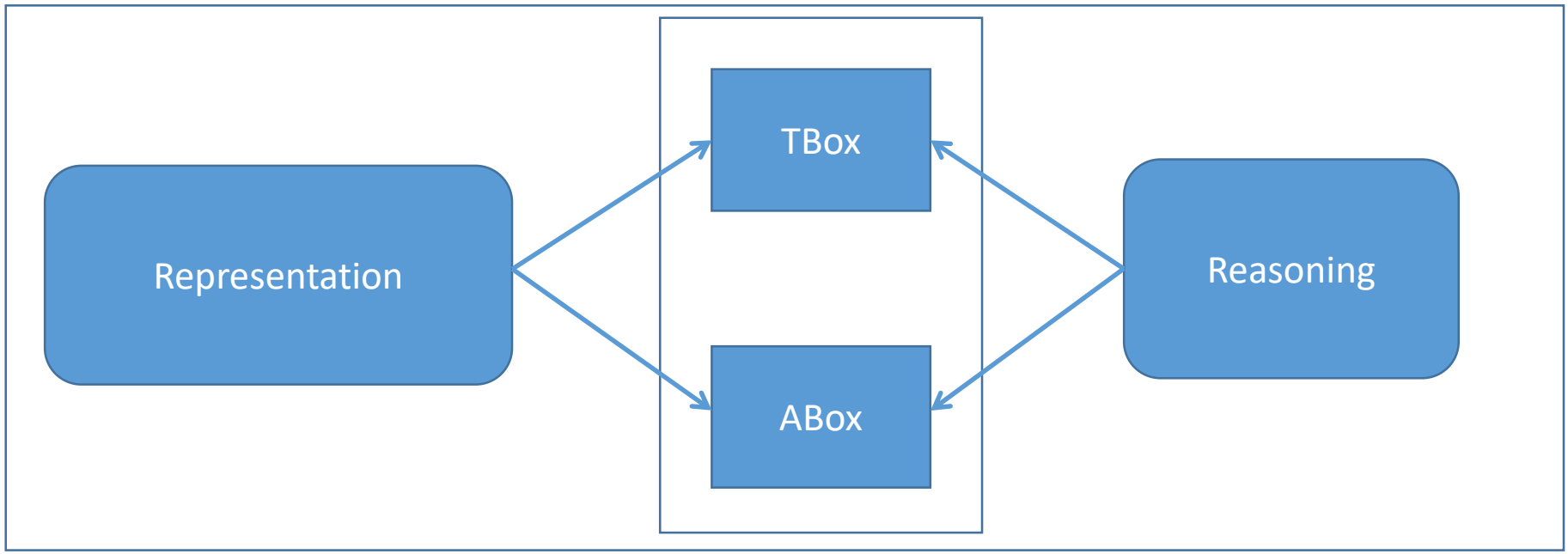
Overview

Description Logics (DLs) is a family of KR formalisms



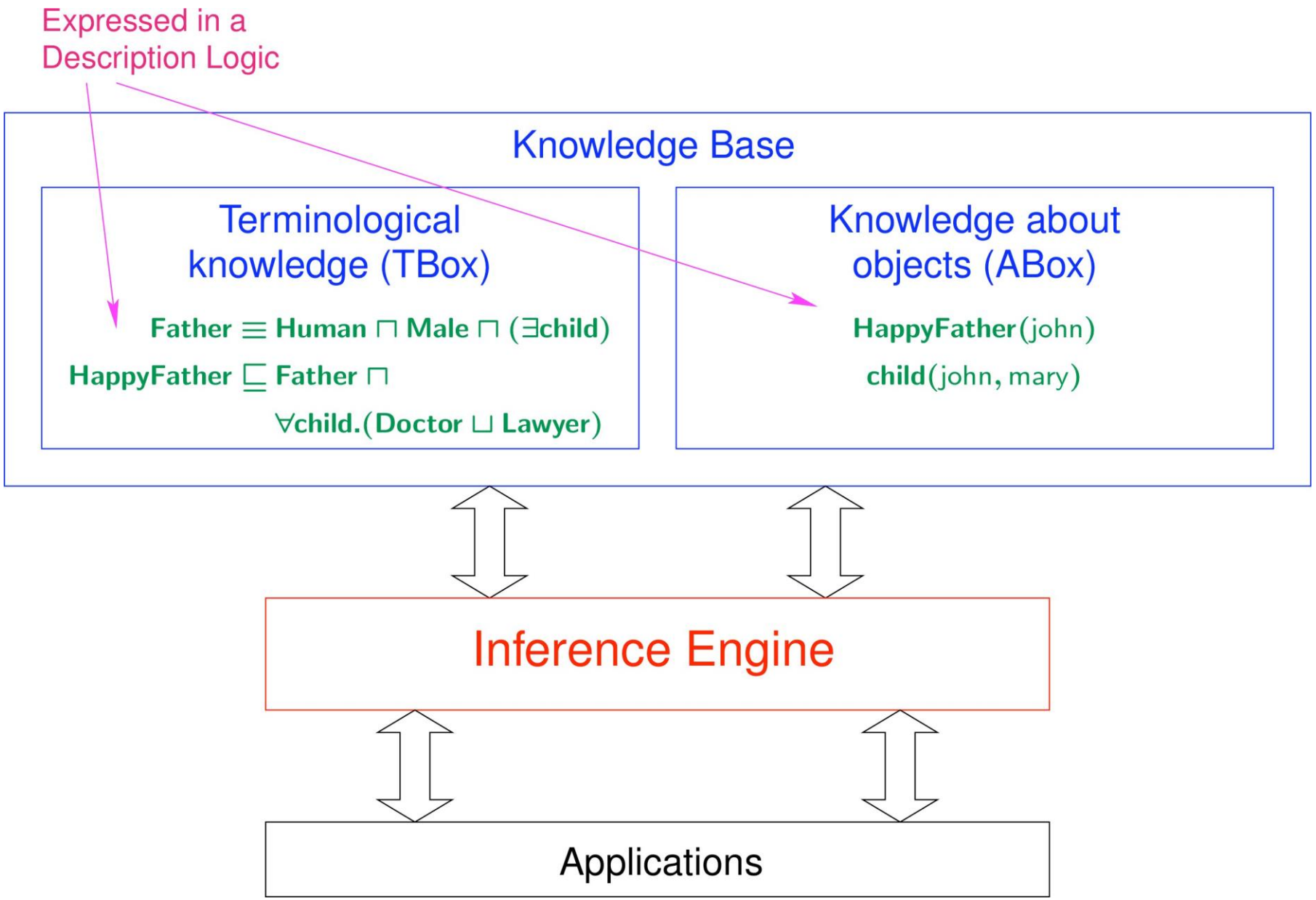
Alphabet of symbols with two new symbols w.r.t. ClassL:

∀R (value restriction)

∃R (existential quantification)

R are atomic role names

Architecture of a Description Logic system



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