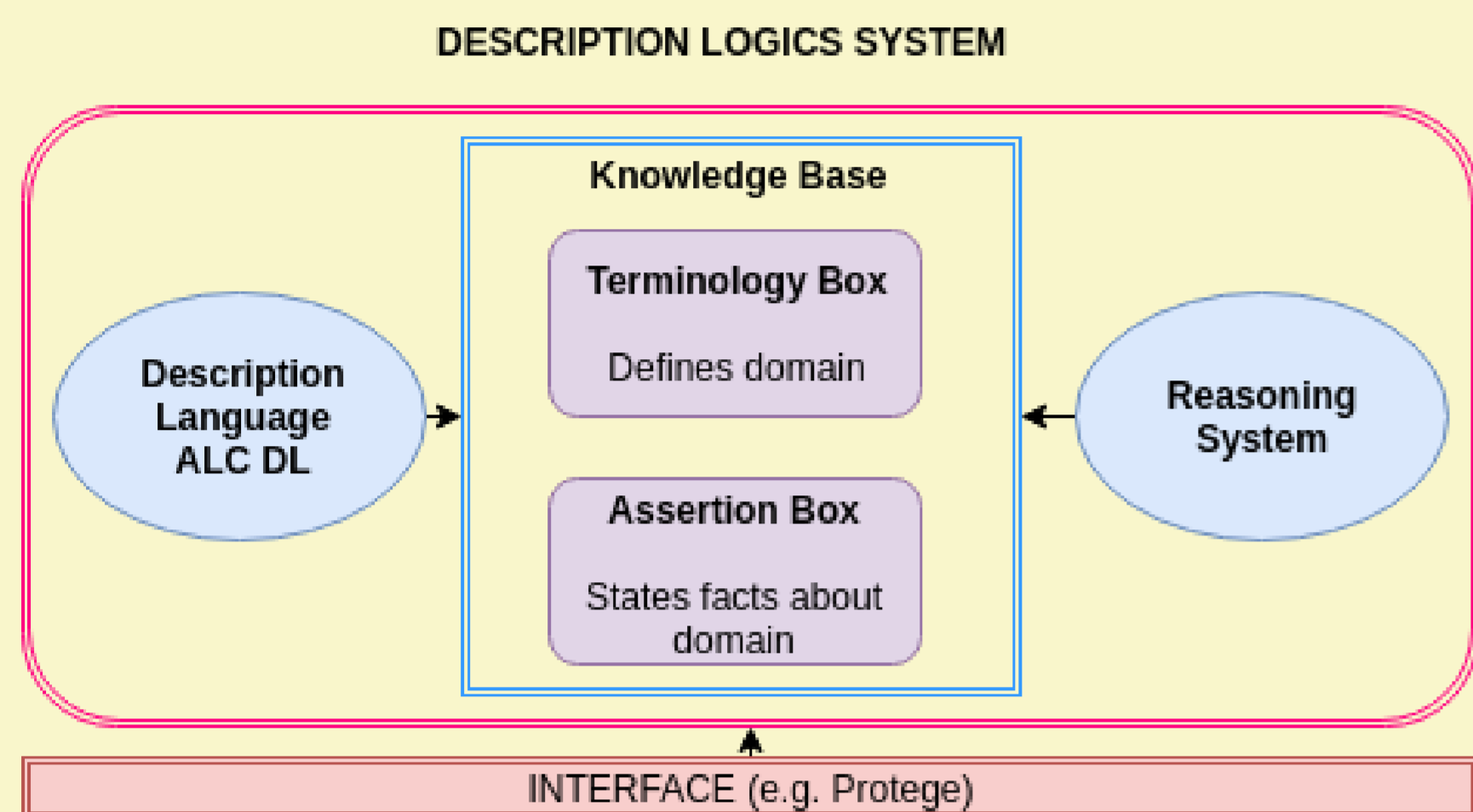


Explanations in Logic-Based Reasoning Systems (EXPLOG)

1. Description Logics

An **ontology** is a machine-readable representation of things (*instances*), groups of things (*classes*), and relationships between things (*relations*).

This representation is formalized with Description Logics (DL), a decidable subset of First Order Logic.



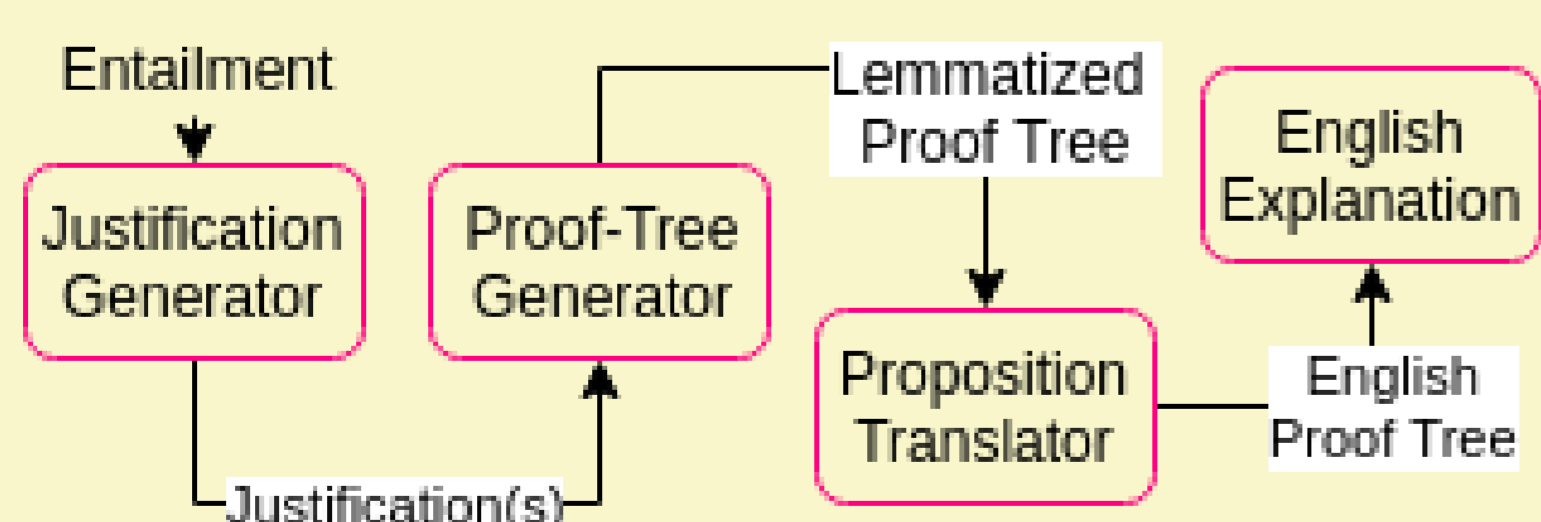
2. Motivation for Explanations

- DLs are the backbone of most expert systems used in many business and scientific fields today.
- Explanations are a key component of knowledge-based systems used by domain experts.
- They help domain experts understand why an entailment was drawn by the logic-based system.
- Explanations help novice users to solve problems faster and more accurately.
- Improved belief leads to solving problems using the system more accurately and in a shorter time.

3. Generating Explanations

A **justification** is a minimal set of propositions that are required to be true for an **entailment** to hold.

Given an entailment, a system generates a justification which is then used to generate an explanation in a natural language



Architecture for English Explanation Facilities

4. Example of an Explanation

Entailment: $Person \sqsubseteq Movie$ (Every person is a movie)

Justification:

1. $GoodMovie \equiv \forall hasRating.FourStarRating$
(A good movie is anything that has only four stars as ratings)
2. $Domain(hasRating, Movie)$
(Anything that has a rating is a movie)
3. $GoodMovie \sqsubseteq StarRatedMovie$
(Every good movie is a star-rated movie)
4. $StarRatedMovie \sqsubseteq Movie$
(Every star-rated movie is a movie)

Explanation:

The statement "Every person is a movie" follows because the ontology implies that "Everything is a movie" (a).

Statement (a) follows because:

- anything that has as rating something is a movie (from axiom 2), and
- everything that has no rating at all is a movie (b).

Statement (b) follows because:

- everything that has no rating at all is a good movie (c), and
- every good movie is a movie (d).

Statement (c) follows because axiom 1 in the justification actually means that "a good movie is anything that has no rating at all, or has only four stars as ratings".

Statement (d) follows because:

- every good movie is a star rated movie (from axiom 3), and
- every star rated movie is a movie (from axiom 4).

Example taken from Matthew Horridge's "Justification-based explanation in ontologies." (2011).

5. Better Protégé Explanations

Protégé is a tool developed at Stanford for creating Web Ontology Language (OWL) Ontologies. The default explanations consist solely of axioms that are difficult to understand for novices. We aimed to improve these explanations by allowing the ontology creator to define an explanation for an axiom using the annotation framework of OWL. We also expanded the keywords used in the Manchester Syntax to utilise more natural language. This is a distinct improvement with scope for further advances. The improved tool can be downloaded from <https://github.com/Pietersielie/Explanation-Workbench-More-Readable-Extension>.

6. Conclusion

Description logics and logic-based reasoning systems are becoming ever more prevalent. Explanations are a key part of these systems, but are theoretically complex to generate. English is itself a complex language that is sometimes ambiguous, and when expressing propositions using explanation generation frameworks we cannot guarantee unambiguous explanations.

Protégé is a popular system for creating ontologies and its improved explanations is of great benefit to the system. There is much scope for further research in this area.

