Introduction to KRR

Propositional Logic and KR

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Objectives

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Explain how to use propositional logic for knowledge representation

Foundations of Propositional Logic and KR

Getting Started

- We might consider using Propositional Logic for representing knowledge
- It is one of the simplest logics
- It can be used to write simple representations of a domain
- There exist reasoning algorithms that exhibit excellent performance in practice

Using PL for KR

Propositional Logic provides a simple KR language.

To write down a representation of our domain do the following:

1. Identify the relevant propositions:
   - Benign The tumor is benign
   - Metastasis The tumor has metastasis
   - Stage 4 The tumor is in Stage 4
   - …

Using PL for KR, cont'd

Express our knowledge using a set of formulas (knowledge base):

- **If the tumor is benign, then it does not have metastasis**
  - $Benign \rightarrow \neg Metastasis$
- **A tumor is in Stage 4 if and only if it is not benign**
  - $Stage\ 4 \leftrightarrow \neg Benign$
- **If a tumor has a treatment, it is either surgery, chemotherapy, or radiotherapy**
  - $Treatment \rightarrow Surgery \vee Chemo \vee Radio$

Reasoning with a Knowledge Base

Knowledge Base K1	Knowledge Base K2
$Benign \wedge Stage4$ $Benign \leftrightarrow \neg Metastasis$ $Stage4 \rightarrow Metastasis$	$Benign$ $Benign \leftrightarrow \neg Metastasis$ $Stage4 \rightarrow Metastasis$

Do our KBs make sense?

- K1 seems contradictory, i.e.,
- K1 is unsatisfiable

What is the implicit knowledge we can derive from our KBs?

- K2 seems to imply the formula $\neg Stage4$, *i.e.,*
- $K2$ entails $\neg Stage4$

Expressivity vs. Complexity

Propositional satisfiability is (famously) NP-complete

Should we just give up? Reasoning is intractable!

No!

- Algorithms such as DPLL are effective in practice.
- Highly optimized SAT solvers can deal with problems obtaining millions of propositional atoms.

Wrap-Up