



Introduction to KRR

Propositional Logic and KR

Objectives



Objective

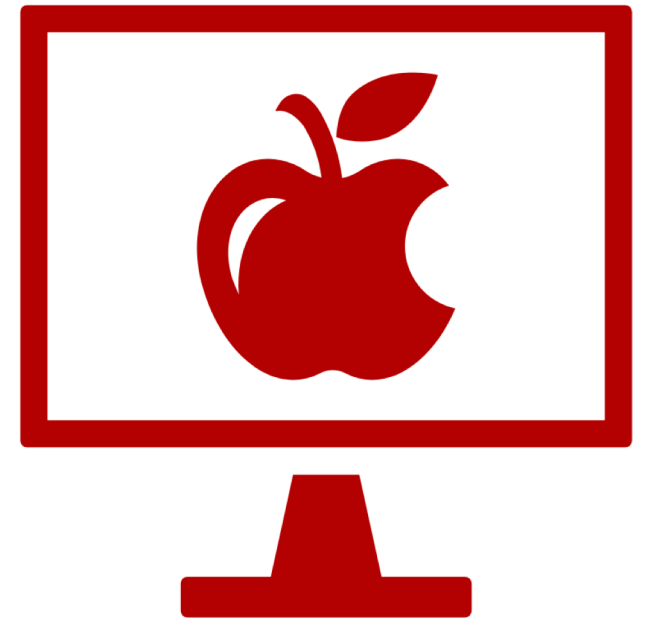
Explain how to use
propositional logic for
knowledge
representation



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

$$- \textit{Benign} \rightarrow \neg \textit{Metastasis}$$

| A tumor is in Stage 4 if and only if it is not benign

$$- \textit{Stage 4} \leftrightarrow \neg \textit{Benign}$$

| If a tumor has a treatment, it is either surgery, chemotherapy, or radiotherapy

$$- \textit{Treatment} \rightarrow \textit{Surgery} \vee \textit{Chemo} \vee \textit{Radio}$$



Reasoning with a Knowledge Base

Knowledge Base K1	Knowledge Base K2
$Benign \wedge Stage4$ $Benign \leftrightarrow \neg Metastasis$ $Stage4 \rightarrow Metastasis$	$Benign^t$ $Benign \leftrightarrow \neg \cancel{Metastasis}^f$ $Stage4 \rightarrow \underline{Metastasis}^f$ \uparrow \uparrow

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

