Knowledge Representation and Reasoning

Logics for Artificial Intelligence

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1 Introduction

1.1 Knowledge Representation

Artificial Intelligence (AI)
A field of computer science and engineering concerned with the computational understanding of what is commonly called intelligent behavior, and with the creation of artifacts that exhibit such behavior.

Knowledge Representation

A subarea of Artificial Intelligence concerned with understanding, designing, and implementing ways of representing information in computers so that programs can use this information

- to derive information that is implied by it,
- to converse with people in natural languages,
- to plan future activities,
- to solve problems in areas that normally require human expertise.

Reasoning

Deriving information that is implied by the information already present is a form of reasoning.

Knowledge representation schemes are useless without the ability to reason with them.

So, Knowledge Representation and Reasoning (KRR)

Knowledge vs. Belief

Knowledge: justified true belief.

John believes that the world is flat: Not true.

Sally believes that the first player in chess can always win,
Betty believes that the second player can always win,
and Mary believes that, with optimal play on both sides,
chess will always end in a tie.
One of them is correct,
but none are justified.

So *Belief* Representation & Reasoning: more accurate
But we'll continue to say KRR.

Manifesto of KRR

a program has common sense if it automatically deduces for itself a sufficiently wide class of immediate consequences of anything it is told and what it already knows. . . In order for a program to be capable of learning something it must first be capable of being told it. John McCarthy, “Programs with Common Sense”, 1959.

Easy NL Inferences

Every student studies hard.
Therefore every smart student studies.

Tuesday evening, Jack either went to the movies, played bridge, or studied.
Tuesday evening, Jack played bridge.
Therefore, Jack neither went to the movies nor studied Tuesday evening.

Background Knowledge: Some Sentences and How We Understand Them.

John likes ice cream.
John likes to eat ice cream.

Mary likes Asimov.
Mary likes to read books written by Isaac Asimov.

Background Knowledge: Some Sentences and How We Understand Them.

Bill flicked the switch.
The room was flooded with light.

Bill moved the switch to the "on" position, which caused a light to come on, which lit up the room Bill was in.

Betty opened the blinds.
The courtyard was flooded with light.

Betty adjusted the blinds so that she could see through the window they were in front of, after which she could see that the courtyard on the other side of the window was bright.

1.2 Logic

- **Logic** is the study of correct reasoning.
- It is not a particular KRR language.
- There are many systems of logic (logics).
- AI KRR research can be seen as a hunt for the "right" logic.

Commonalities among Logics

- System for reasoning.

- Prevent reasoning from “truths” to “falsities”.
  (But can reason from truths and falsities to truths and falsities.)

- Language for expressing reasoning steps.

Parts of the Study/Specification of a Logic

Syntax: The atomic symbols of the logical language, and the rules for constructing well-formed, nonatomic expressions (symbol structures) of the logic.

Semantics: The meanings of the atomic symbols of the logic, and the rules for determining the meanings of nonatomic expressions of the logic.

Proof Theory: The rules for determining a subset of logical expressions, called **theorems** of the logic.