CS 344
Artificial Intelligence
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Logic and inferencing

Obtaining implication of given facts and rules -- Hallmark of intelligence
Inferencing through

- Deduction (General to specific)
- Induction (Specific to General)
- Abduction (Conclusion to hypothesis in absence of any other evidence to contrary)

**Deduction**

Given: All men are mortal (rule)
Shakespeare is a man (fact)

To prove: Shakespeare is mortal (inference)

**Induction**

Given: Shakespeare is mortal
Newton is mortal
Dijkstra is mortal

To prove: All men are mortal (Generalization)
If there is rain, then there will be no picnic

Fact1: There was rain
Conclude: There was no picnic

Fact2: There was no picnic
Conclude: There was no rain (?)

Induction and abduction are fallible forms of reasoning. Their conclusions are susceptible to retraction

Two systems of logic

1) Propositional calculus
2) Predicate calculus
Propositions

- Stand for facts/assertions
- Declarative statements
  - As opposed to interrogative statements (questions) or imperative statements (request, order)

Operators

\[ AND (\wedge), OR (\vee), NOT (\neg), IMPLICATION (\Rightarrow) \]

\[ \Rightarrow \text{ and } \neg \text{ form a minimal set (can express other operations)} \]
  - Prove it.

Tautologies are formulae whose truth value is always T, whatever the assignment is
Model

In propositional calculus any formula with n propositions has $2^n$ models (assignments)
  - Tautologies evaluate to T in all models.

Examples:
1) $p \land \neg p$
2) $\neg(p \land q) \iff \neg p \lor \neg q$  - De Morgan with AND
Semantic Tree/Tableau method of proving tautology

To prove: \( \neg(p \land q) \Rightarrow \neg p \lor \neg q \)

Start with the negation of the formula to be proved a tautology

\[
\left[ \neg(p \land q) \Rightarrow \neg p \lor \neg q \right]
\]

\( \neg(p \land q) \) - \( \beta \) - formula

\( \neg(\neg p \lor \neg q) \) - \( \alpha \) - formula

\( p \)
\( q \)

\( \neg p \)
\( \neg q \)
Example 2: $A \land (B \lor C) \Rightarrow (A \land B) \lor (A \land C)$

Contradictions in all paths
Exercise:

Prove the backward implication in the previous example