EECS 391: Introduction to AI

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Announcements

- HW3 online later today

Inference Strategies

- Syntactic Derivations
  – Useful for propositional logic, and only way to do inference in first-order logic
- Some variant of Inference by Enumeration ("semantic inference")
  – Highly effective for propositional logic, but useless for first order logic

Definitions

- Two formulae α and β are logically equivalent iff $\alpha \models \beta$ and $\beta \models \alpha$

$$\neg(\alpha \wedge \beta) \equiv \neg\alpha \vee \neg\beta$$

- A formula α is valid if it is true in every model (tautology)

- A formula α is satisfiable if it is true in *some* model

Conjunctive Normal Form (CNF)

- A formula is said to be in CNF if it is a conjunction of disjunctions

$$(l_{11} \vee l_{12} \ldots \vee l_{1k}) \wedge (l_{21} \vee l_{22} \ldots \vee l_{2k}) \wedge \ldots$$

k-CNF

Literal: P or ¬ P

Clause

- Every wff in propositional logic can be transformed into a 3CNF formula

Two Results

- Deduction theorem: $\alpha \models \beta$ iff $(\alpha \Rightarrow \beta)$ is valid
- Proof by refutation: $\alpha \models \beta$ iff $(\alpha \wedge \neg\beta)$ is unsatisfiable

Syntactic Inference: Inference Rules

- Given a KB, syntactic inference algorithms apply rules to derive other formulae
- Sequence of rule applications is called a derivation or "proof"
- Rules are written as:

$$\frac{\alpha_1, \alpha_2, \ldots, \alpha_n}{\beta_1, \beta_2, \ldots, \beta_m}$$

If the sentences $\alpha_1,\ldots,\alpha_n$ are in the KB, agent can infer $\beta_1,\ldots,\beta_m$ and add them to the KB.

Inference Rules

- Modus Ponens ("Rule of affirming the antecedent")

$$\frac{\alpha \Rightarrow \beta, \quad \alpha}{\beta}$$

- Modus Tollens ("Rule of denying the consequent")

$$\frac{\alpha \Rightarrow \beta, \quad \neg\beta}{\neg\alpha}$$

- And-Elimination

$$\frac{\alpha \wedge \beta}{\beta}$$

- *Every logical equivalence* can be turned into an inference rule

Resolution (Robinson 1965)

- Unit Resolution: $$\frac{l_1 \vee l_2 \vee m \ldots \vee l_k,\ \neg m}{l_1 \vee l_2 \ldots \vee l_k}$$
- General Resolution:

$$\frac{l_1 \vee l_2 \vee m \ldots \vee l_k, \quad r_1 \vee r_2 \vee \neg m \ldots \vee r_k}{l_1 \vee l_2 \ldots \vee l_k \vee r_1 \vee r_2 \ldots \vee r_k}$$

Factoring: the resulting formula could have duplicate literals. Remove the duplicates.