

CS 2710 Foundations of AI
Lecture 14

Planning

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Administration

- **PS-6:**
 - **Due on Wednesday, October 19, 2005**
- **Midterm:**
 - **Monday, October 24, 2005**
 - **In class**
 - **Closed-book**
 - **Covers: Search, Knowledge representation and Planning**

Planning

Planning problem:

- find a sequence of actions that achieves some goal
- An instance of a search problem

Methods for modeling and solving a planning problem:

- State space search
- Situation calculus based on FOL
 - Inference rules
 - Resolution refutation

Planning problems

Properties of many (real-world) planning problems:

- The description of the state of the world is very complex
- Many possible actions to apply in any step
- Actions are typically local
 - - they affect only a small portion of a state description
- Goals are defined as conditions referring only to a small portion of state
- Plans consists of a large number of actions

- The state space search and situation calculus frameworks may be too cumbersome and inefficient to represent and solve the planning problems

Situation calculus: problems

Frame problem refers to:

- The need to represent a large number of frame axioms

Solution: combine positive and negative effects in one rule

$$\text{On}(u, v, \text{DO}(\text{MOVE}(x, y, z), s)) \Leftrightarrow (\neg((u = x) \wedge (v = y)) \wedge \text{On}(u, v, s)) \vee \\ \vee (((u = x) \wedge (v = z)) \wedge \text{On}(x, y, s) \wedge \text{Clear}(x, s) \wedge \text{Clear}(z, s))$$

Inferential frame problem:

- We still need to derive properties that remain unchanged

Other problems:

- **Qualification problem** – enumeration of all possibilities under which an action holds
- **Ramification problem** – enumeration of all inferences that follow from some facts

Solutions

- **Complex state description and local action effects:**
 - avoid the enumeration and inference of every state component, focus on changes only
- **Many possible actions:**
 - Apply actions that make progress towards the goal
 - Understand what the effect of actions is and reason with the consequences
- **Sequences of actions in the plan can be too long:**
 - Many goals consists of independent or nearly independent sub-goals
 - Allow goal decomposition & divide and conquer strategies