CS 2710 Foundations of AI
Lecture 13

Planning

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Administration

- **PS-6:**
  - **Due on Thursday, October 28, 2004**
- **Midterm:**
  - **Back on Tuesday, next week**

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

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

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