CS 730/830: Intro AI

Regression

Aristotle's Means-ends Analysis

We deliberate not about ends, but about means. For a doctor does not deliberate whether he shall heal, nor an orator whether he shall persuade, nor a statesman whether he shall produce law and order, nor does any one else deliberate about his end. They assume the end and consider how and by what means it is attained, and if it seems easily and best produced hereby; while if it is achieved by one means only they consider how it will be achieved by this and by what means *this* will be achieved, till they come to the first cause, which in the order of discovery is last. . . and what is last in the order of analysis seems to be first in the order of becoming. And if we come on an impossibility, we give up the search, for example, if we need money and this cannot be got; but if a thing appears possible we try to do it.

— Aristotle, *Nicomachean Ethics*, 350BC

Regression

Note that STRIPS has full initial state, partial goal state (= set).
Search over sets of states!

Initial node: set of states in which goal is true
Applicable: at least one effect present, deletes not present, non-deleted preconditions present
Child node: remove adds, add preconditions
Goal node: subset of initial state

Doesn't assume domain has inverse actions
Lower branching factor?
Larger space (3^n vs 2^n)

Grocery World

Initial: At(Home), Sells(HWS, Drill), Sells(SM, Milk), Sells(SM, Bananas)

Go (here,there)

Pre: At(here)

Post: At(there), ¬ At(here)

Buy(store,x)

Pre: At(store), Sells(store, x)

Post: Have(s)

Goal: At(Home), Have(Drill), Have(Milk), Have(Bananas)

Comparison

Forward: states

- − irrelevant states
- + reachable states
- + state known: strong heuristic, expressivity
- − branching factor

Backward: sets of states

- + relevant states
- − unreachable states
- − partial states: larger space, weaker heuristic, expressivity

Break

- asst 8
- projects: final proposals, presentations, papers
- note asst 9 due on a Tuesday

Partial-order Planning

Partial-order Planning

Initial node: empty plan
Branch on all achievers of selected precondition
Branch on all threat resolutions
Goal node: plan without open preconditions

Grocery World

Initial: At(Home), Sells(HWS, Drill), Sells(SM, Milk), Sells(SM, Bananas)

Go (here,there)
Pre: At(here)
Post: At(there), ¬ At(here)

Buy(store,x)
Pre: At(store), Sells(store, x)
Post: Have(s)

Goal: At(Home), Have(Drill), Have(Milk), Have(Bananas)

Searching Plan-space

Principle of least commitment

plan: bindings, temporal links, causal links
complete: every precondition achieved, all vars instantiated
consistent: no temporal or binding contradictions
threat: potential clobber

refinement = adding actions and links

Partial-order Planning

initialize plan to empty
loop
  pick unachieved precondition
  find or **add** action to establish it
    if no such, backtrack
  add causal and temporal link
  for every threat
    put threat before achiever **or** after dependent
    if inconsistent, backtrack
  for possible threats
    add inequality constraint

Finding Threats

For each new effect and each causal link
  check if effect unifies with ¬ (condition of link)
For each new causal link and each step
  check if effect of step unifies with ¬ (condition of link)

- refinement = adding actions and links
- achieve, establish, produce
- promote, demote, protect
- inequality, separatation, non-codesignation

Principles

- Causal links
  - Limits search to relevant actions
  - Easy plan modification and explanation
- Least commitment
  - Flexibility in choosing what to branch on
  - Limits backtracking
  - Smaller search space
  - Allows more pruning of implicit plans
  - Hard to find a good heuristic

Comparison

Forward: states

- + state known: strong heuristic, expressivity
- − branching factor
- − irrelevant states

Backward: sets of states

- + relevant states
- − partial states: larger space, weaker heuristic, expressivity

Partial-order: plans

- + small space
- +/− least commitment
- − poor heuristics

EOLQs

- What question didn't you get to ask today?
- What's still confusing?
- What would you like to hear more about?

Please write down your most pressing question about AI and put it in the box on your way out.
Thanks!