Conditional Nonlinear Planning

Mark A. Peot
Stanford University

David E. Smith
Rockwell International
Warplan-C [Warren 76]

a.

b.

c.

d.
Conditional Planning

- Create Branching Plans
  - Take *observations* into account when selecting actions

- Observations Used to Handle Uncertainty
  - Uncertainty arises from non-deterministic actions
  - Uncertainty arises from lack of knowledge

- Planners Differ With Respect To:
  - Representation of uncertainty (logic, probabilities)
  - Representation of plans (trees, graphs)
  - Representation of observations
  - Search control
CNLP (Peot & Smith, 1992)

- Extensions to SNLP to Create Conditional Plans with Observations

- Extensions to SNLP Representation
  - Three-valued logic (True, False, Unknown)
  - Observations actions
    Observe_Road (?loc1 ?loc2)
    Pre: Unknown (Clear(?loc1, ?loc2))
    +\alpha_1: Clear(?loc1, ?loc2)
    +\alpha_2: \sim Clear(?loc1, ?loc2)
  - Contexts
    - Compatible observation labels


CNLP Extensions to SNLP

• “Conditioning”
  – Can remove threat by *separating contexts* (i.e., making them incompatible)

• Propagation of *context labels* and *reasons*
  – *Contexts*: What actions are incompatible
  – *Reasons*: what goals an action supports

• Tree-structured plan
  – Goal replication
Adding Conditional Operators

Start
- Q, Unknown(P)
- Q & Unknown(P)

Obs1
- P
  - P
    - A1
      - G
        - Finish
        c: \{α₁\}
      c: \{α₁\}
  - ~P
    - A2
      - G
        - Finish₂
        c: \{α₂\}
      c: \{α₂\}

r: Finish, Finish₂
r: Finish, Finish₂

r: Finish
r: Finish₂

c: {}  
c: {}
Conditionally planning a Ski Trip
CNLP Label Propagation

Figure 3: Label propagation in the plan network.
CNLP Summary

- Can Create Conditional Plans with Observation Actions
  - However, no explicit distinction between observations and causal effects

- Can Handle *Disjunctive Uncertainty*
  - No notion of which conditions more likely
  - Increases search space tremendously

- Can Plan with *Failure* as an Option