1. Introduction

- Most current agent theories do not account for:
  - goals with different priorities
  - dynamic goals
  - temporally extended goals
  - dependencies between goals and subgoals

- Important for work on BDI Agent Programming Languages (APLS), e-commerce, etc.

Our Base Framework

- Situation Calculus [Reiter 01]
- Knowledge [Scheurle,Levesque 03]
- New sort of infinite paths – can handle arbitrary temporally extended goals

2. Prioritized Goals

- Prioritized goals (p-goals) are analogous to desires
- Need not be consistent with each other
- Totally ordered – one p-goal per level
- \( G(p,n) \): path p is G-accessible at priority level n in situation s
- Definition of p-goal:
  \[ G(p,n) = \neg \forall p'(n) \rightarrow G(p',n+1) \]
- Number of p-goals need not be finite

Realistic PGoals

- P-goals that are compatible with what the agent knows
- Path p is \( G_{0} \)-accessible if
  - p is G-accessible and
  - p starts with a knowledge-accessible situation

3. Chosen Goals

- Chosen goals (c-goals) are analogous to intentions
- c-goals are computed in every situation using the realistic p-goals – maximal consistent set of higher priority realistic p-goals
- \( G_{0} \)-accessible paths: the prioritized intersection of \( G_{n} \)-accessible paths
- Definition of c-goal:
  \[ C(p,n) = \exists G(p,n) \rightarrow \neg G(p,n+1) \]
- p-goals can be active (chosen) or inactive
- Inactive goals can later become active

4. Dynamics of PGoals

- Specified by providing a Successor State Axiom (SSA) for p-goals/G-accessibility relation – c-goals automatically updated when p-goals change
- regular action: progress all G-accessible paths at all levels to reflect the fact that this action has just happened
- adoption of a p-goal p at level i is left at level n to the agent’s goal hierarchy, and push each goal that has lower priority one level down in the hierarchy
- dropping a p-goal p replaces the propositions that imply the dropped goal in the agent’s goal hierarchy by “true”

5. Example

6. Comparison with Bratman’s Intentions

- C-goals not as persistent as Bratman’s (1987) intentions
- Recall from Bratman (1987)
  - intentions limit the agent’s practical reasoning
  - but could be given up for another intention if utility of doing so is high
- Our c-goals behave like intentions with an automatic filter override mechanism
  - idealized agent – always maximizes her utility
  - will drop an intended goal if an opportunity to commit to a higher priority but inconsistent goal arises

7. Basic Properties

- Consistency
  \[ \forall x \in \text{C}(n). x \rightarrow \neg \text{C}(n+1) \]
- Realism
  \[ \forall x \in \text{K}(n). x \rightarrow \exists 
\text{C}(n+1) \]
- Truth
  \[ \forall x \in \text{C}(n). x \rightarrow \neg \text{K}(n) \rightarrow \text{K}(n) \]

8. Properties (Dynamics)

- Adoption
  - an agent has the
  - \( \exists \) p-goal p at level n in a, after she adopts it at n in a
  - \( \exists \) c-goal that p at n in a, after she adopts it at n in a, provided that all higher priority c-goals in a are consistent with Next(p)
- Drop
  - after dropping the p-goal that p at n in a, an agent does not have the p-goal that the progression of p at n, provided that it is not inevitable in do(shop,p)

9. Persistence Properties

- Persistence of Achievement Realistic PGoals
  - if agent has realistic p-goal that \( \bigcirc x \in a \), then she will retain this p-goal after non-goal-drop action has been performed in a, provided that:
    - she knows that \( \bigcirc x \) has not yet been achieved

- Persistence of Achievement Chosen Goals
  - if agent has primary c-goal that \( \bigcirc x \in n \) in situation a, then she will retain this after some non-goal-drop action has been performed in a, provided that:
    - she knows that \( \bigcirc x \) has not yet been achieved, and
    - \( \bigcirc x \) is consistent with higher priority c-goals after it has been performed in a

10. Handling Subgoals

- First, agent adopts \( \text{C} \rightarrow \text{BeRich} \) in \( s_{1} \), giving \( s_{2} \)
- Next, agent adopts \( \text{BeRich} \rightarrow \text{C} \rightarrow \text{AtWork} \) in \( s_{1} \), giving \( s_{2} \)
- Finally, agent drops \( \text{C} \rightarrow \text{AtWork} \) in \( s_{1} \), giving \( s_{2} \)

- Dropping a goal automatically drops all of its subgoals, but its supergoals are retained

11. Related Work

- (Shapiro & Brewka 07)
  - similar to our framework
  - has some unconsultible properties (due to partial ordering over goals)
  - deals with restricted types of temporally extended goals
- BDI APLs with declarative goals (e.g., Hindriks et al. 09)
  - most only handle achievement goals
  - syntactic formalization of goal dynamics
  - none maintains the consistency of (chosen) goals

12. Conclusion

- Presented a model of prioritized goals and their dynamics
- Extension: relationship between goals and subgoals
- Application: rational APL with prioritized goals (DALT-10)