Continuous Planning (and Multiagent Planning)

Sections 12.6 (and 12.7)
Fixing plan flaws continually

- **Missing goal**: adding new goals
- **Open precondition**: close using causal links (POP)
- **Causal conflict**: resolve threats (POP)
- **Unsupported link**: remove causal links supporting conditions that are no longer true
- **Redundant action**: remove actions that supply no causal links
- **Unexecuted action**: return an action that can be executed
- **Unnecessary historical goal**: if the current goal set has been achieved, remove them and allow for new goals
function CONTINUOUS-POP-AGENT(percept) returns an action

\[ action \leftarrow \text{NoOp} \text{ (the default)} \]
\[ \text{EFFECTS}[\text{Start}] = \text{UPDATE(\text{EFFECTS} [\text{Start}], percept)} \]
\[ \text{REMOVE-FLAW(plan)} \quad \text{// possibly updating action} \]
return \text{action}
Example - start

Start

Someone moved D

dropped C

tried again

Start

Move(C,D)

Move(D,B)

Finish

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Example - after D is moved onto B

Start

Someone moved D
dropped C

tried again

Start

Move(C,D)

Move(D,B)

Finish

Ontable(A)
On(B,E)
On(C,F)
On(D,B)
Clear(A)
Clear(C)
Clear(D)
Clear(G)

On(C,F)
Clear(C)
Clear(D)

On(D,y)

On(D,B)

On(C,D)

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Example - Move(D,B) was redundant

Start

Someone moved D

dropped C

tried again

Start

Move(C,D)

Finish

A B C D

D B C G

C D B

A E F G

Ontable(A)
On(B,E)
On(C,F)
On(D,B)
Clear(A)
Clear(C)
Clear(D)
Clear(G)

On(C,F)
Clear(C)
Clear(D)

On(C,D)
On(D,B)
Example - Move(C,D) was executed

Start

Someone moved D dropped C tried again

Start

Ontable(A) On(B,E) On(C,A) On(D,B) Clear(F) Clear(C) Clear(D) Clear(G)

Finish

On(C,D) On(D,B)
Example - put \text{Move}(C,D) \text{ back in}

Start Someone moved D dropped C tried again

\begin{itemize}
\item \text{On}(A)
\item \text{On}(B,E)
\item \text{On}(C,A)
\item \text{On}(D,B)
\item \text{Clear}(F)
\item \text{Clear}(C)
\item \text{Clear}(D)
\item \text{Clear}(G)
\end{itemize}

\text{Move}(C,D)

\begin{itemize}
\item \text{On}(C,A)
\item \text{Clear}(C)
\item \text{Clear}(D)
\item \text{On}(C,D)
\item \text{On}(D,B)
\end{itemize}

Start

Finish
Example - plan complete

Start Someone moved D dropped C tried again

Ontable(A)
On(B,E)
On(C,D)
On(D,B)
Clear(F)
Clear(C)
Clear(D)
Clear(G)

Start Finish

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Multiagent planning

- **Cooperation:** Joint goals and plans
- **Multibody planning:** Synchronization, joint actions, concurrent actions
- **Coordination mechanisms:** convention, social laws, emergent behavior, communication, plan recognition, joint intention
- **Competition:** agents with conflicting utility functions