Learning Objectives

At the end of the class you should be able to:

- the model of deterministic planning
- represent a problem using both STRIPs and the feature-based representation of actions.

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Planning

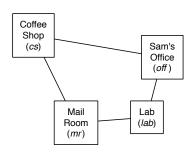
- Planning is deciding what to do based on an agent's ability, its goals. and the state of the world.
- Planning is finding a sequence of actions to solve a goal.
- Initial assumptions:
 - The world is deterministic.
 - ► There are no exogenous events outside of the control of the robot that change the state of the world.
 - The agent knows what state it is in.
 - ► Time progresses discretely from one state to the next.
 - Goals are predicates of states that need to be achieved or maintained.



Actions

- A deterministic action is a partial function from states to states.
- The preconditions of an action specify when the action can be carried out.
- The effect of an action specifies the resulting state.

Delivery Robot Example



Features:

RLoc - Rob's location

RHC – Rob has coffee

SWC – Sam wants coffee

MW – Mail is waiting

RHM - Rob has mail

Actions:

mc - move clockwise

mcc – move counterclockwise

puc – pickup coffee

dc – deliver coffee

pum – pickup mail

dm – deliver mail



Explicit State-space Representation

State	Action	Resulting State
$\langle lab, \neg rhc, swc, \neg mw, rhm \rangle$	тс	$\langle mr, \neg rhc, swc, \neg mw, rhm \rangle$
$\langle lab, \neg rhc, swc, \neg mw, rhm \rangle$	тсс	$\langle off, \neg rhc, swc, \neg mw, rhm \rangle$
$\langle off, \neg rhc, swc, \neg mw, rhm \rangle$	dm	$\ \ \langle \textit{off}, \neg \textit{rhc}, \textit{swc}, \neg \textit{mw}, \neg \textit{rhm} \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$
$\langle off, \neg rhc, swc, \neg mw, rhm \rangle$	тсс	$\langle cs, \neg rhc, swc, \neg mw, rhm \rangle$
$\langle off, \neg rhc, swc, \neg mw, rhm \rangle$	тс	$\langle lab, \neg rhc, swc, \neg mw, rhm \rangle$

Feature-based representation of actions

For each action:

• precondition is a proposition that specifies when the action can be carried out.

For each feature:

- causal rules that specify when the feature gets a new value and
- frame rules that specify when the feature keeps its value.

Example feature-based representation

Precondition of pick-up coffee (puc):

$$RLoc=cs \land \neg rhc$$

Rules for location is cs:

$$RLoc'=cs \leftarrow RLoc=off \land Act=mcc$$

 $RLoc'=cs \leftarrow RLoc=mr \land Act=mc$
 $RLoc'=cs \leftarrow RLoc=cs \land Act \neq mcc \land Act \neq mc$

Rules for "robot has coffee"

$$rhc' \leftarrow rhc \land Act \neq dc$$

 $rhc' \leftarrow Act = puc$



STRIPS Representation

Divide the features into:

- primitive features
- derived features. There are rules specifying how derived can be derived from primitive features.

For each action:

- precondition that specifies when the action can be carried out.
- **effect** a set of assignments of values to primitive features that are made true by this action.

STRIPS assumption: every primitive feature not mentioned in the effects is unaffected by the action.



Example STRIPS representation

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Pick-up coffee (puc):
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- precondition: $[cs, \neg rhc]$
- effect: [rhc]

Deliver coffee (dc):

- precondition: [off, rhc]
- effect: $[\neg rhc, \neg swc]$