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.

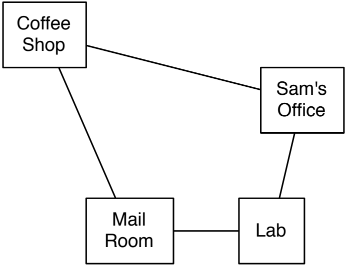
Planning

- 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
$\langle lab, \overline{rhc}, swc, \overline{mw}, rhm\rangle$	mc	$\langle mr, \overline{rhc}, swc, \overline{mw}, rhm\rangle$
$\langle lab, \overline{rhc}, swc, \overline{mw}, rhm\rangle$	mcc	$\langle off, \overline{rhc}, swc, \overline{mw}, rhm\rangle$
$\langle off, \overline{rhc}, swc, \overline{mw}, rhm\rangle$	dm	$\langle off, \overline{rhc}, \overline{swc}, \overline{mw}, \overline{rhm}\rangle$
$\langle off, \overline{rhc}, swc, \overline{mw}, rhm\rangle$	mcc	$\langle cs, \overline{rhc}, swc, \overline{mw}, rhm\rangle$
$\langle off, \overline{rhc}, swc, \overline{mw}, rhm\rangle$	mc	$\langle lab, \overline{rhc}, swc, \overline{mw}, rhm\rangle$
...	...	...

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*):

$$RLoc{=}cs \wedge \overline{rhc}$$

Rules for location is *cs*:

$$RLoc'{=}cs \leftarrow RLoc{=}off \wedge Act{=}mcc$$

$$RLoc'{=}cs \leftarrow RLoc{=}mr \wedge Act{=}mc$$

$$RLoc'{=}cs \leftarrow RLoc{=}cs \wedge Act \neq mcc \wedge Act \neq mc$$

Rules for "robot has coffee"

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

$$rhc' \leftarrow Act{=}puc$$

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

Pick-up coffee (puc):

- precondition: $[cs, \overline{rhc}]$
- effect: $[rhc]$

Deliver coffee (dc):

- precondition: $[off, rhc]$
- effect: $[\overline{rhc}, \overline{swc}]$