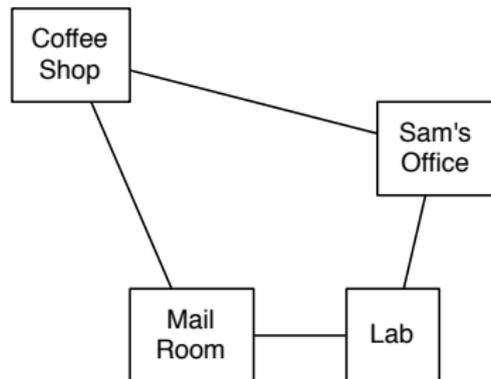


- Planning is deciding what to do based on an agent's ability, its goals. and the state of the world.
- Planning is finding a sequence of actions to solve a goal.
- Initial assumptions:
 - ▶ The world is deterministic.
 - ▶ There are no exogenous events outside of the control of the robot that change 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
$\langle lab, \overline{rhc}, swc, \overline{mw}, rhm \rangle$	<i>mc</i>	$\langle mr, \overline{rhc}, swc, \overline{mw}, rhm \rangle$
$\langle lab, \overline{rhc}, swc, \overline{mw}, rhm \rangle$	<i>mcc</i>	$\langle off, \overline{rhc}, swc, \overline{mw}, rhm \rangle$
$\langle off, \overline{rhc}, swc, \overline{mw}, rhm \rangle$	<i>dm</i>	$\langle off, \overline{rhc}, \overline{swc}, \overline{mw}, rhm \rangle$
$\langle off, \overline{rhc}, swc, \overline{mw}, rhm \rangle$	<i>mcc</i>	$\langle cs, \overline{rhc}, swc, \overline{mw}, rhm \rangle$
$\langle off, \overline{rhc}, swc, \overline{mw}, rhm \rangle$	<i>mc</i>	$\langle lab, \overline{rhc}, swc, \overline{mw}, rhm \rangle$
...

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

For each action:

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