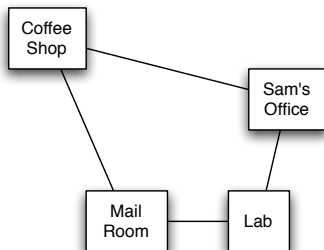


- Planning is deciding what to do based in an agents ability, its goals and the state of the world.
- Planning is finding a sequence of actions to solve a goal.
- Initial assumptions:
 - ▶ The world is deterministic.
 - ▶ There are no exogenous events outside of the control of the robot that change the 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

mac — move anti-clockwise

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>mac</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>mac</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*):

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

Rules for location is *cs*:

$$Loc' = cs \leftarrow Loc = off \wedge Act = mac$$

$$Loc' = cs \leftarrow Loc = mr \wedge Act = mc$$

$$Loc' = cs \leftarrow Loc = cs \wedge Act \neq mac \wedge Act \neq mc$$

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: $[\overline{rhc}, \overline{swc}]$