Learning Objectives

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

- explain the model of deterministic planning
- represent a problem using the STRIPs representation of actions.

State-space Search

- deterministic or stochastic dynamics
- fully observable or partially observable
- explicit states or features or individuals and relations
- static or finite stage or indefinite stage or infinite stage
- goals or complex preferences
- perfect rationality or bounded rationality
- flat or modular or hierarchical
- single agent or multiple agents
- knowledge is given or knowledge is learned
- reason offline or reason while interacting with environment

Classical Planning

- deterministic or stochastic dynamics
- fully observable or partially observable
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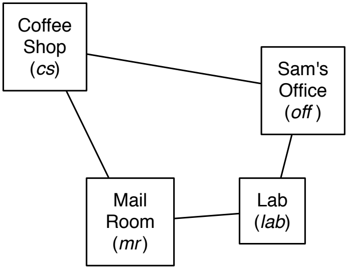
Planning

- Planning is deciding what to do based on an agent's ability, its goals, and the state of the world.
- 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. (Fully observable)
  - Time progresses discretely from one state to the next.
  - Goals are predicates of states that need to be achieved.
- Planning is finding a sequence of actions to solve a goal.

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
$\langle lab, \neg rhc, swc, \neg mw, rhm \rangle$	mc	$\langle mr, \neg rhc, swc, \neg mw, rhm \rangle$
$\langle lab, \neg rhc, swc, \neg mw, rhm \rangle$	mcc	$\langle off, \neg rhc, swc, \neg mw, rhm \rangle$
$\langle off, \neg rhc, swc, \neg mw, rhm \rangle$	dm	$\langle off, \neg rhc, swc, \neg mw, \neg rhm \rangle$
$\langle off, \neg rhc, swc, \neg mw, rhm \rangle$	mcc	$\langle cs, \neg rhc, swc, \neg mw, rhm \rangle$
$\langle off, \neg rhc, swc, \neg mw, rhm \rangle$	mc	$\langle lab, \neg rhc, swc, \neg mw, rhm \rangle$
...	...	...

What happens when we also want to model its battery charge?
Want "elaboration tolerance".

STRIPS Representation

The state is a function from features into values. So it can be represented as a set of feature-value pairs.
For each action:

- precondition a set of feature-value pairs that must be true for the action to be carried out.
- effect a set of a feature-value pairs that are made true by this action.

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

Example STRIPS representation

Pick-up coffee (*puc*):

- precondition: $\{RLoc = cs, RHC = False\}$. "The robot needs to be at the coffee shop and not holding coffee in order to pick up coffee."
- effect: $\{RHC = True\}$. "After the robot picks up coffee, it is holding coffee. Nothing else has changed."

Deliver coffee (*dc*):

- precondition: $\{Rloc = off, RHC = True\}$ "The robot needs to be at the office and holding coffee in order to deliver coffee."
- effect: $\{RHC = False, SWC = False\}$ "After the robot delivers coffee, it is not holding coffee, and Sam no longer wants coffee. Nothing else has changed."

Deterministic Planning

Given:

- A description of the effects and preconditions of the actions
- A description of the initial state
- A goal to achieve

find a sequence of actions that is possible and will result in a state satisfying the goal.