Module 9

Planning

Lesson 23

Planning systems

Version 2 CSE IIT, Kharagpur

9.3 Planning Systems

Classical Planners use the STRIPS (Stanford Research Institute Problem Solver) language to describe states and operators. It is an efficient way to represent planning algorithms.

9.3.1 Representation of States and Goals

States are represented by conjunctions of function-free ground literals, that is, predicates applied to constant symbols, possibly negated.

An example of an initial state is:

At(Home) /\ *-Have(Milk)* /\ *-Have(Bananas)* /\ *-Have(Drill)* /\ ...

A state description does not have to be complete. We just want to obtain a successful plan to a set of possible complete states. But if it does not mention a given positive literal, then the literal can be assumed to be false.

Goals are a conjunction of literals. Therefore the goal is

At(Home) /\ *Have(Milk)* /\ *Have(Bananas)* /\ *Have(Drill)*

Goals can also contain variables. Being at a store that sells milk is equivalent to

At(x) /\ *Sells(x,Milk)*

We have to differentiate between a goal given to a planner which is producing a sequence of actions that makes the goal true if executed, and a query given to a theorem prover that produces true or false if there is truth in the sentences, given a knowledge base.

We also have to keep track of the changes rather than of the states themselves because most actions change only a small part of the state representation.

9.3.2 Representation of Actions

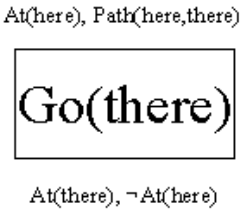
Strips operators consist of three components

- action description: what an agent actually returns to the environment in order to do something.
- precondition: conjunction of atoms (positive literals), that says what must be true before an operator can be applied.
- effect of an operator: conjunction of literals (positive or negative) that describe how the situation changes when the operator is applied.

An example action of going from one place to another:

Op(ACTION:*Go(there)*, PRECOND:*At(here) /\ Path(here, there)*
EFFECT:*At(there) /\ -At(here)*)

The following figure shows a diagram of the operator Go(there). The preconditions appear above the action, and the effects below.



Operator Schema: an operator with variables.

- it is a family of actions, one for each of the different values of the variables.
- every variable must have a value

Preconditions and Effects are restrictive. Operator o is applicable in a state s if every one of the preconditions in o are true in s. An example is if the initial situation includes the literals

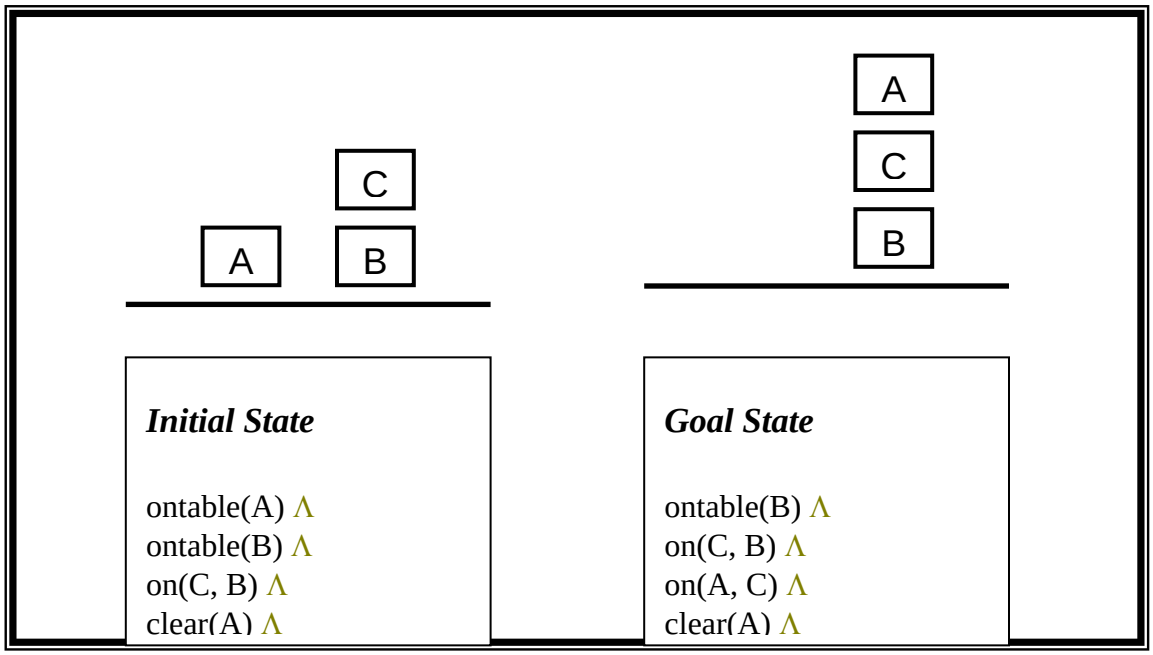
At(Home, Path(Home, Supermarket)...

then the action Go(Supermarket) is applicable, and the resulting situation contains the literals

-At(Home),At(Supermarket), Path(Home, Supermarket)...

The result is all positive literals in Effect(o) hold, all literals in s hold and negative literals in Effect(o) are ignored.

The set of operators for the "Box World" example problem is shown below:



Definitions of Descriptors:

ontable(x): block *x* is on top of the table

on(x,y): block *x* is on top of block *y*

clear(x): there is nothing on top of block *x*; therefore it can be picked up

handempty: you are not holding any block

Definitions of Operators:

Op{ACTION: **pickup(x)**
PRECOND: ontable(x), clear(x), handempty
EFFECT: holding(x), ~ontable(x), ~clear(x), ~handempty }

Op{ACTION: **putdown(x)**
PRECOND: holding(x)
EFFECT: ontable(x), clear(x), handempty, ~holding(x) }

Op{ACTION: **stack(x,y)**
PRECOND: holding(x), clear(y)
EFFECT: on(x,y), clear(x), handempty, ~holding(x), ~clear(y) }

Op{ACTION: **unstack(x,y)**
PRECOND: clear(x), on(x,y), handempty
EFFECT: holding(x), clear(y), ~clear(x), ~on(x,y), ~handempty) }