SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107
Accredited by NAAC-UGC with 'A' Grade
Approved by AICTE, Recognized by UGC & Affiliated to Anna University, Chennai

Department of Artificial Intelligence and Data Science

Course Name – Introduction to Artificial Intelligence

II Year / III Semester

Unit 4 Introduction to Planning

Planning

- Planning is fundamental to “intelligent” behavior. E.g.

  - assembling tasks
  - route finding
  - planning chemical processes
  - planning a report

- **Representation**

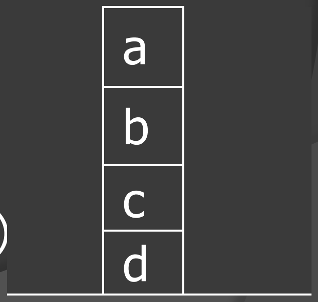
  The planner has to represent states of the world it is operating within, and to predict consequences of carrying actions in its world. E.g.

<u>initial state</u>:

on(a,b)
on(b,table)
on(d,c)
on(c,table)
clear(a)
clear(d)

<u>final state</u>:

on(a,b)
on(b,c)
on(c,d)
on(d,table)
clear(a)



Planning

- Representing an action

  One standard method is by specifying sets of preconditions and effects, e.g.

pickup(X) :

    preconditions: clear(X), handempty.

    deletlist: on(X,_), clear(X), handempty.

    addlist: holding(X).

Planning

- **The Frame Problem in Planning**
- This is the problem of how to keep track in a representation of the world of all the effects that an action may have.
- The action representation given is the one introduced by STRIPS (Nilsson) and is an attempt to a solution to the frame problem
  - but it is only adequate for simple actions in simple worlds.

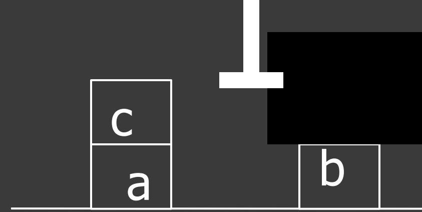
- **The Frame Axiom**
- The frame axiom states that a fact is true if it is not in the last delete list and was true in the previous state.
- The frame axiom states that a fact is false if it is not in the last add list and was false in the previous state.

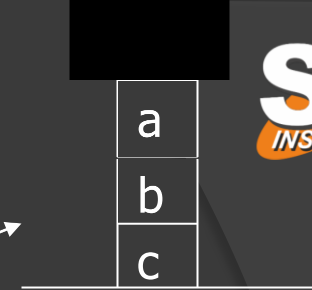
Planning

- Control Strategies
  - Forward Chaining
  - Backward Chaining

The choice on which of these strategies to use depends on the problem, normally backward chaining is more effective.

Planning





Example:

Initial State

clear(b), clear(c), on(c,a), ontable(a), ontable(b), handempty

Goal

on(b,c) & on(a,b)

Rules

R1: pickup(x) P & D: ontable(x), clear(x), handempty A: holding(x)	R2: putdown(x) P & D: holding(x) A: ontable(x), clear(x), handempty
R3: stack(x,y) P & D: holding(x), clear(y) A: handempty, on(x,y), clear(x)	R4: unstack(x,y) P & D: on(x,y), clear(x), handempty A: holding(x), clear(y)

Planning

{unstack(c,a), putdown(c), pickup(b), stack(b,c), pickup(a), stac

Initial situation

next situation

TRIANGLE TABLE

{unstack(c,a), putdown(c), pickup(b), stack(b,c), pickup(a), stack(a,b)}

0	1	2	3	4	5	6
on(c,a) clear(c) handempty	unstack(c,a)					
	holding(c)	putdown(c)				
ontable(b) clear(b)		handempty	pickup(b)			
		clear(c)	holding(b)	stack(b,c)		
ontable(a)	clear(a)			handempty	pickup(a)	
				clear(b)	holding(a)	stack(a,b)
				on(b,c)		on(a,b)

Conditions for action

← goal

Planning

Homework and exam exercises

1. Describe how the two SCRIPS rules **pickup**(x) and **stack**(x,y) could be combined into a macro-rule **put**(x,y).

What are the preconditions, delete list and add list of the new rule.

Can you specify a general procedure for creating macro-rules components?

1. Consider the problem of devising a plan for a kitchen-cleaning robot.

   (i) Write a set of STRIPS-style operators that might be used.

- When you describe the operators, take into account the following considerations:

   (a) Cleaning the stove or the refrigerator will get the floor dirty.

   (b) The stove must be clean before covering the drip pans with tin foil.

   (c) Cleaning the refrigerator generates garbage and messes up the counters.

   (d) Washing the counters or the floor gets the sink dirty.

   (ii)Write a description of an initial state of a kitchen that has a dirty stove, refrigerator, counters, and floor.

(The sink is clean, and the garbage has been taken out).

Also write a description of the goal state where everything is clean, there is no trash, and the stove drip pans have been covered with tin foil.