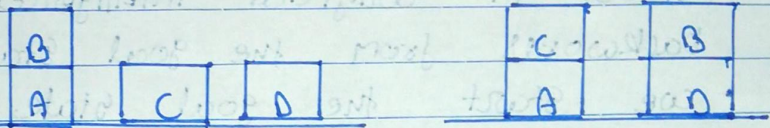


Assignment 02

• **TITLE :** Goal stack Planning

• **Problem :** Implement goal stack planning for the following configurations from the blocks world



• **Objective :**

- To learn and understand concept of goal stack planning.
- To study need and use of goal stack planning.

• To implement goal stack planning algorithm using suitable programming language.

• **Outcomes** we will be able to

- learn concept of goal stack planning
- Implement goal stack planning

• **Software :** OS : Ubuntu / Fedora 20 (64-bit)

and Hardware RAM : 4GB

Requirements HDD : 500 GB

JAVA JOK / Python libraries

Editors : VS / Python framework

• Theory :

Goal Stack Planning :

- One of the earliest techniques in planning using goal stack.
- Goal stack planning is one of the earliest methods in artificial intelligence in which we work backwards from the goal state to the initial state.
- We start the goal state and we try fulfilling the preconditions required to achieve the initial state.
- These precondition in turn have their own set of preconditions which are required to be satisfy first.
- We keep solving these goals and sub goals until we finally arrive at the initial state. We make use of a stack at the initial state to hold these goals that need to be fulfilled as well the actions that we need to be fulfilled for the same.
- Apart from the "initial state" and the "goal state" we maintain a "world state" configuration as well.
- Goal stack uses this world state to work its way from goal stack to initial state.
- world state on the other hand start off as the initial state and ends up being transformed into the goal state.
- At the end of algorithm with an empty stack and a set of actions which help us navigate from the initial state to the world state.

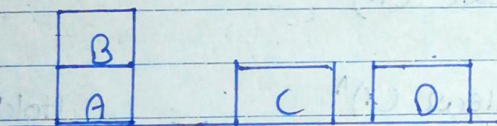
Given below are the list of Predicates as well as their intended meaning.

1. ON (A,B) : Block A is on B
2. ONTABLE (A) : A is on table
3. CLEAR (A) : Nothing is on top of A
4. HOLDING (A) : Arm is holding A
5. ARMEMPTY : Arm is holding nothing.

using this we represent the initial state and goal state in our example like this:

Initial state: $ON(B,A) \wedge ONTABLE(A) \wedge ontable(C) \wedge ontable(D) \wedge clear(B) \wedge clear(C) \wedge clear(D) \wedge armempty$

Goal state: $ON(C,A) \wedge ON(B,D) \wedge ONTABLE(A) \wedge ontable(D) \wedge clear(B) \wedge clear(C) \wedge armempty$.



Initial state

Goal state

operations performed by robotic arm:

The robot arm can perform 4 operations:

1. STACK (x,y): Stacking block x on block y.

2. UNSTACK (x,y): Picking up block x which is on top of block y

3. PICKUP (x): Picking up block x which is on top of the table.

4. PUTDOWN (x): Put Block x on the table.

All four operations have preconditions which need to be satisfied to perform the same. These preconditions are represented in the form of predicates.

Operators	Precondition	Action
Stack (x,y)	$\text{clear}(y) \wedge$ $\text{holding}(x)$	$\text{Arm empty} \wedge$ $\text{on}(x,y)$
Unstack (x,y)	$\text{Arm empty} \wedge$ $\text{on}(x,y) \wedge$ $\text{clear}(x)$	$\text{Holding}(x) \wedge$ $\text{clear}(y)$
Pick up (x)	$\text{clear}(x) \wedge$ $\text{ontable}(x) \wedge$ arm empty	$\text{Holding}(x)$
Putdown (x)	$\text{Holding}(x)$	$\text{Ontable}(x) \wedge$ $\text{clear}(x) \wedge$ arm empty

Test case:

B

A

C

D

c

a

B

O

Initial state

Goal state.

Discription	Exlected output	Result
1. $ON(B,A) \wedge ONTABLE(A) \wedge$ $ONTABLE(C) \wedge ONTABLE(D) \wedge$ $clear(B) \wedge clear(C) \wedge clear(D) \wedge$ $armempty$ Initial state	Goal state: $ON(C,A) \wedge ON(B,D) \wedge$ $ONTABLE(A) \wedge ONTABLE(D) \wedge$ $clear(B) \wedge clear(C) \wedge$ $armempty.$	Pass.
Goal state: $ON(C,A) \wedge$ $ON(B,D) \wedge ONTABLE(A) \wedge$ $ONTABLE(D) \wedge clear(B) \wedge$ $clear(C) \wedge armempty$	Plan generated: unstack BA Pickup C stack CA stack BD	.

Conclusion: Thus we successfully implemented goal stack planning from the blocks worlds problem.