AI ASSIGNMENT – 1

Design State Space Search for Water Jug Problem and Implement same problem in prolog.

Problem: There are two jugs of volume A litre and B litre. Neither has any measuring mark on it. There is a pump that can be used to fill the jugs with water. How can you get exactly of water into the Assuming that we have unlimited supply of water.

For e.g., one having the capacity to hold 3 gallons of water and the other has the capacity to hold 4 gallons of water. There is no other measuring equipment available and the jugs also do not have any kind of marking on them. So, the agent's task here is to fill the 4-gallon jug with 2 gallons of water by using only these two jugs and no other material. Initially, both our jugs are empty.

The initial state is provided by input:

Final state: 4L->2 3L->0.

Production Rules for solving the water jug problem:-

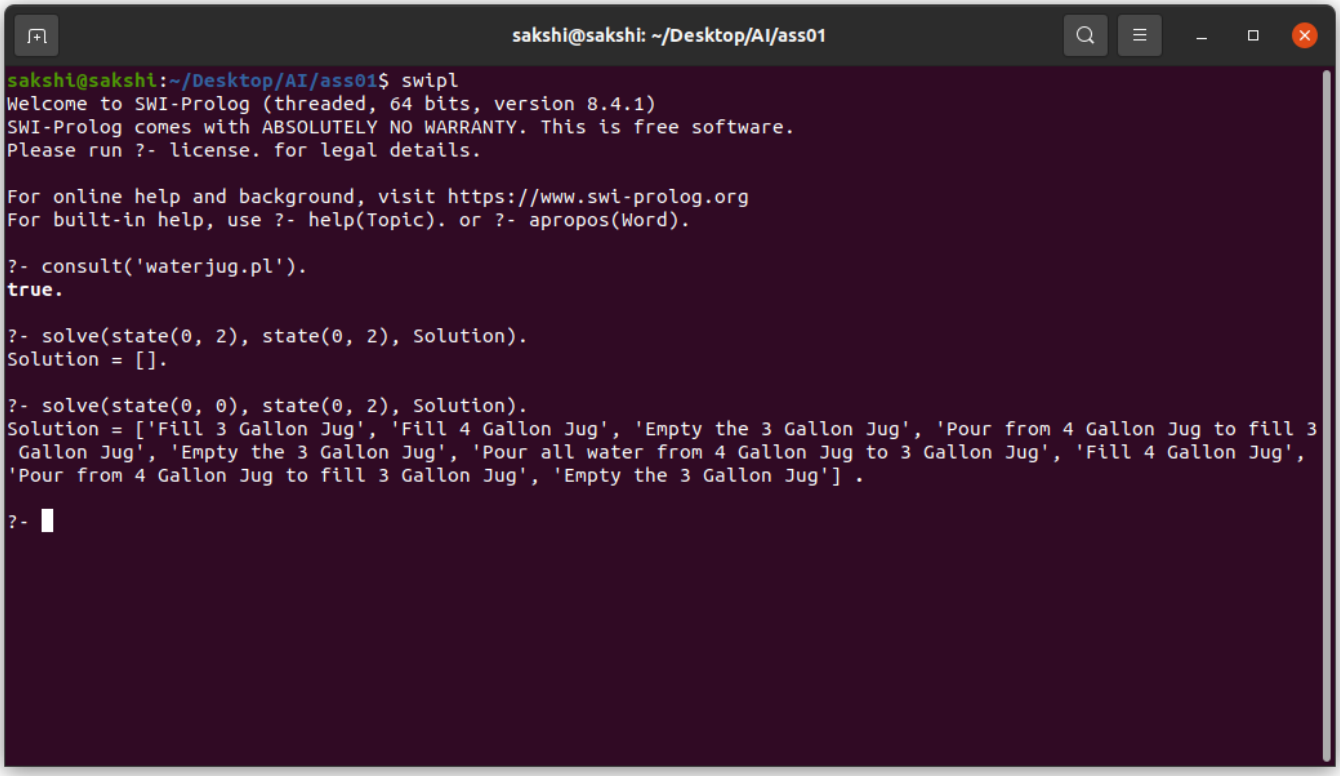
S.No	Initial State	Condition	Final State	Description of action taken
1.	(x, y)	If $x < 4$	$(4, y)$	Fill the 4 gallon jug completely
2.	(x, y)	If $y < 3$	$(x, 3)$	Fill the 3 gallon jug completely
3.	(x, y)	If $x > 0$	$(x-d, y)$	Pour some part from 4 gallon jug
4.	(x, y)	If $y > 0$	$(x, y-d)$	Pour some part from 3 gallon jug
5.	(x, y)	If $x > 0$	$(0, y)$	Empty 4 gallon jug
6.	(x, y)	If $y > 0$	$(x, 0)$	Empty 3 gallon jug
7.	(x, y)	If $(x+y) < 7$	$(4, y-[4-x])$	Pour some water from 3 gallon jug to fill 4 gallon jug
8.	(x, y)	If $(x+y) < 7$	$(x-[3-y], y)$	Pour some water from 4 gallon jug to fill 3 gallon jug
9.	(x, y)	If $(x+y) < 4$	$(x+y, 0)$	Pour all water from 3 gallon jug to 4 gallon jug
10.	(x, y)	If $(x+y) < 3$	$(0, x+y)$	Pour all water from 4 gallon jug to the 3 gallon jug

A solution of water jug problem according to the production rules:-

S.No	4 gallon jug content	3 gallon jug content	Rule allowed
1.	0 gallon	0 gallon	Initial state
2.	0 gallon	3 gallon	Rule 2
3.	3 gallon	0 gallon	Rule 9
4.	3 gallon	3 gallon	Rule 2
5.	4 gallon	2 gallon	Rule 7
6.	0 gallon	2 gallon	Rule 5
7	2 gallon	0 gallon	Rule 9

* On reaching the 7th attempt, we reach our goal state. Therefore, at this state our problem is solved.

```
solve(InitialState, FinalState, Actions) :- plan(InitialState, FinalState, Actions,
[InitialState]).

plan(State, State, [], _) :- !.
plan(State1, State, [Action|R], States) :-  go(State1, State2, Action),
                                            not(member(State2, States)),
                                            plan(State2, State, R, [State2|States]).

go( state(_, L2) , state(3, L2) , 'Fill 3 Gallon Jug' ).
go( state(L1, _) , state(L1, 4) , 'Fill 4 Gallon Jug' ).
go( state(L1, L2), state(0, L2) , 'Empty the 3 Gallon Jug') :- L1 > 0.
go( state(L1, L2), state(L1, 0) , 'Empty the 4 Gallon Jug') :- L2 > 0.

go( state(L1, L2), state(L3, 4), 'Pour from 3 Gallon Jug to fill 4 Gallon Jug') :-
    L1 > 0 , L2 < 4 , L2+L1 >= 4 , L3 is L1-(4-L2).
go( state(L1, L2), state(0, L4), 'Pour all water from 3 Gallon Jug to 4 Gallon Jug') :-
    L1 > 0 , L2 < 4 , L2+L1 < 4  , L4 is L2+L1.

go( state(L1, L2), state(3, L4), 'Pour from 4 Gallon Jug to fill 3 Gallon Jug') :-
    L2 > 0 , L1 < 3 , L1+L2 >= 3 , L4 is L2-(3-L1).
go( state(L1, L2), state(L3, 0), 'Pour all water from 4 Gallon Jug to 3 Gallon Jug') :-

    L2 > 0 , L1 < 3 , L1+L2 < 3  , L3 is L1+L2.
```


sakshi@sakshi: ~/Desktop/AI/ass01
sakshi@sakshi:~/Desktop/AI/ass01$ swipl
Welcome to SWI-Prolog (threaded, 64 bits, version 8.4.1)
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software.
Please run ?- license. for legal details.
For online help and background, visit https://www.swi-prolog.org
For built-in help, use ?- help(Topic). or ?- apropos(Word).
?- consult('waterjug.pl').
true.
?- solve(state(0, 2), state(0, 2), Solution).
Solution = [].
?- solve(state(0, 0), state(0, 2), Solution).
Solution = ['Fill 3 Gallon Jug', 'Fill 4 Gallon Jug', 'Empty the 3 Gallon Jug', 'Pour from 4 Gallon Jug to fill 3 Gallon Jug', 'Empty the 3 Gallon Jug', 'Pour all water from 4 Gallon Jug to 3 Gallon Jug', 'Fill 4 Gallon Jug', 'Pour from 4 Gallon Jug to fill 3 Gallon Jug', 'Empty the 3 Gallon Jug'] .
?-