



Shri Vile Parle Kelavani Mandal's

DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING

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A.Y. 2022-2023

ARTIFICIAL INTELLIGENCE

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EXPERIMENT – 7

Aim: Implement Wumpus World program in Prolog.

Theory:

1. The Wumpus World in Artificial intelligence

The Wumpus world is a basic world example that demonstrates the value of a knowledge-based agent and how knowledge representation is represented. It was inspired by Gregory Yob's 1973 video game Hunt the Wumpus.

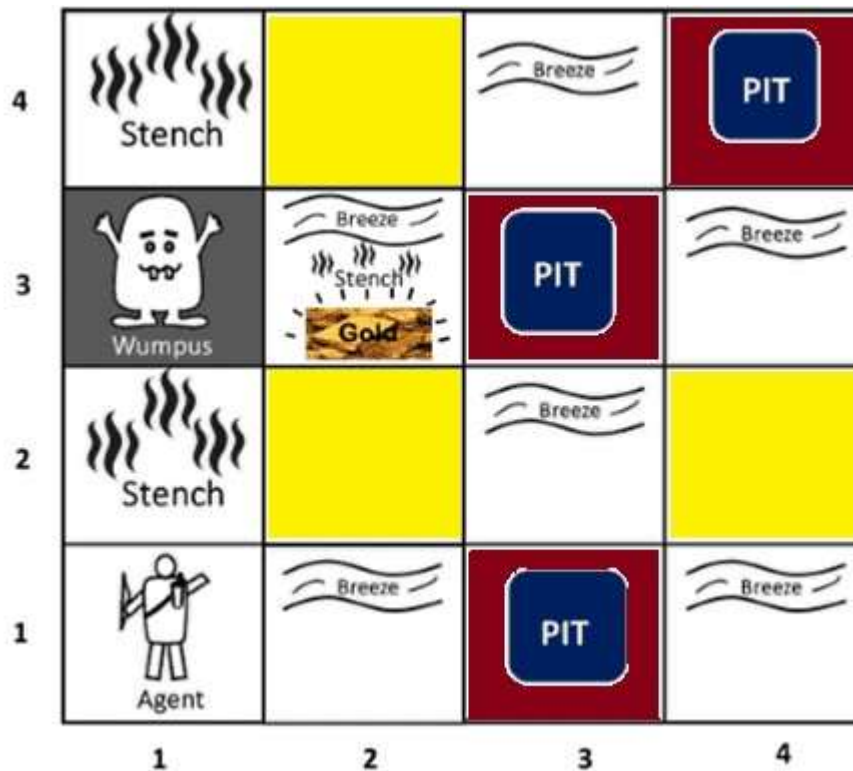
The Wumpus world is a cave with 4/4 rooms and pathways connecting them. As a result, there are a total of 16 rooms that are interconnected. We now have a knowledge-based AI capable of progressing in this world. There is an area in the cave with a beast named Wumpus who eats everybody who enters. The agent can shoot the Wumpus, but he only has a single arrow. There are some Pits chambers in the Wumpus world that are bottomless, and if an agent falls into one, he will be stuck there indefinitely. The intriguing thing about this cave is that there is a chance of finding a gold heap in one of the rooms. So the agent's mission is to find the gold and get out of the cave without getting eaten by Wumpus or falling into Pits. the agent returns with gold, he will be rewarded, but if he is devoured by Wumpus or falls into the pit, he will be penalized.

Note: Wumpus is immobile in this scene.

A sample diagram for portraying the Wumpus world is shown below. It depicts some rooms with Pits, one room with Wumpus, and one agent in the world's (1, 1) square position.



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There are also some components which can help the agent to navigate the cave. These components are given as follows:

- The rooms adjacent to the Wumpus room are stinky, thus there is a stench there.
- The room next to PITs has a breeze, so if the agent gets close enough to PIT, he will feel it.
- If and only if the room contains gold, there will be glitter.
- If the agent is facing the Wumpus, the agent can kill it, and Wumpus will cry horribly, which can be heard anywhere.



2. PEAS description of Wumpus world:

We have given PEAS description as below to explain the Wumpus world:

Following are some basic facts about propositional logic:

Performance measure:

- If the agent emerges from the cave with the gold, he will receive 1000 bonus points.
- If you are devoured by the Wumpus or fall into the pit, you will lose 1000 points.
- For each action, you get a -1, and for using an arrow, you get a -10.
- If either agent dies or emerges from the cave, the game is over.

Environment:

- A 4*4 grid of rooms.
- Initially, the agent is in room square [1, 1], facing right.
- Except for the first square [1,1], the locations of Wumpus and gold are picked at random.
- Except for the initial square, every square of the cave has a 0.2 chance of being a pit.

Actuators:

- Left turn
- Right turn
- Move forward
- Grab
- Release
- Shoot

Sensors:

- If the agent is in the same room as the Wumpus, he will smell the stench. (Not on a diagonal.)
- If the agent is in the room directly adjacent to the Pit, he will feel a breeze.
- The agent will notice the gleam in the room where the gold is located.
- If the agent walks into a wall, he will feel the bump.
- RWhen the Wumpus is shot, it lets out a horrifying scream that can be heard from anywhere in the cave.
- These perceptions can be expressed as a five-element list in which each sensor will have its own set of indicators.
- For instance, if an agent detects smell and breeze but not glitter, bump, or shout, it might be represented as [Stench, Breeze, None, None, None].

**3. The Wumpus world Properties:**

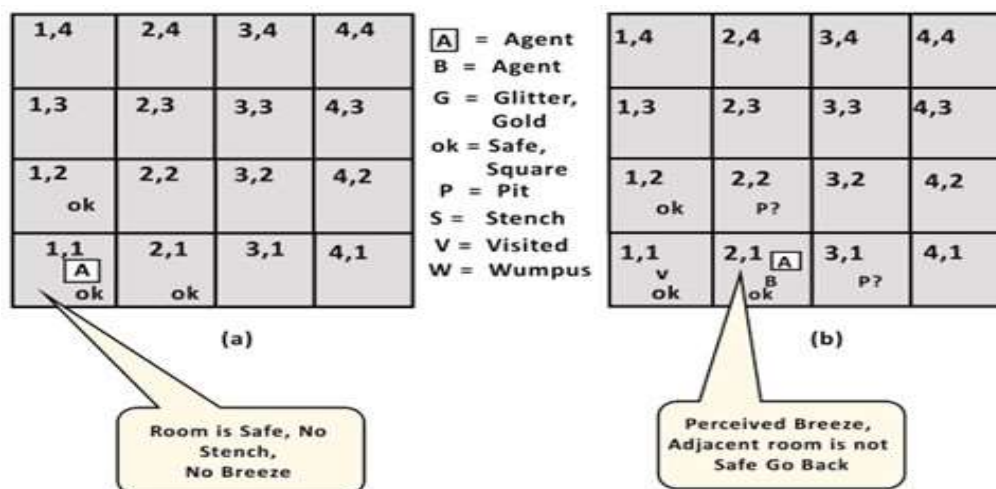
- Partially observable: The Wumpus universe is only partially viewable because the agent can only observe the immediate environment, such as a nearby room.
- Deterministic: It's deterministic because the world's result and outcome are already known.
- Sequential: It is sequential because the order is critical.
- Static: Wumpus and Pits are not moving, thus it is static.
- Discrete: There are no discrete elements in the environment.
- One agent: We only have one agent, and Wumpus is not regarded an agent, hence the environment is single agent.

4. Exploring the Wumpus world:

Now we will explore Wumpus world a bit and will explain how the agent will find its goal applying logical reasoning.

Agent's First step: At first, the agent is in the first room, or square [1,1], and we all know that this room is safe for the agent, thus we will add the sign OK to the below diagram (a) to represent that room is safe. The agent is represented by the letter A, the breeze by the letter B, the glitter or gold by the letter G, the visited room by the letter V, the pits by the letter P, and the Wumpus by the letter W.

Agent does not detect any wind or Stench in Room [1,1], indicating that the nearby squares are similarly in good condition.



Agent's first step



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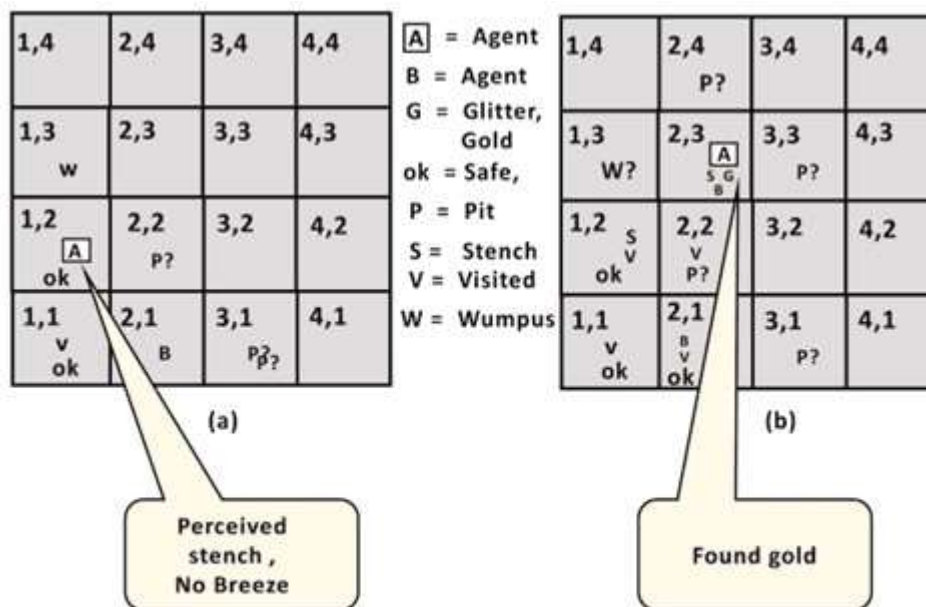
Agent's second Step:

Now that the agent must go forward, it will either go to [1, 2] or [2, 1]. Let's say agent enters room [2, 1], where he detects a breeze, indicating Pit is present. Because the pit might be in [3, 1] or [2, 2], we'll add the sign P? to indicate that this is a Pit chamber.

Now the agent will pause and consider his options before doing any potentially destructive actions. The agent will return to room [1, 1]. The agent visits the rooms [1,1] and [2,1], thus we'll use the symbol V to symbolize the squares he's been to.

Agent's third step:

The agent will now proceed to the room [1,2], which is fine. Agent detects a stink in the room [1,2], indicating the presence of a Wumpus nearby. However, according to the rules of the game, Wumpus cannot be in the room [1,1], and he also cannot be in [2,2]. (Agent had not detected any stench when he was at [2,1]). As a result, the agent infers that Wumpus is in the room [1,3], and there is no breeze at the moment, implying that there is no Pit and no Wumpus in [2,2]. So that's safe, and we'll designate it as OK, and the agent will advance [2,2] .

**Agent's third step**



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Agent's fourth step:

Because there is no odor and no breeze in room [2,2], let's assume the agent decides to move to room [2,3]. Agent detects glitter in room [2,3], thus it should collect the gold and ascend out of the cave.

Code:

% Declaring dynamic methods

```
:- dynamic ([
agent_location/1,
gold_location/1,
pit_location/1,
time_taken/1,      score/1,
visited/1,
visited_cells/1,
world_size/1,
wumpus_location/1,
    isPit/2,
isWumpus/2,
    isGold/2
]).
```

%----- % To

start the game

start

:-

```
    format('Initializing started...~n', []),    init,
    format('Let the game begin!~n', []),    take_steps([[1,1]]).
```

%----- %

Scheduling simulation:

```
step_pre(VisitedList) :-    agent_location(AL),
gold_location(GL),
    wumpus_location(WL),    score(S),
    time_taken(T),
```

```
    ( AL=GL -> writeln('WON!'), format('Score: ~p,~n Time: ~p', [S,T])
```




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```
; AL=WL -> format('Lost: Wumpus eats you!~n', []),
format('Score: ~p,~n Time: ~p', [S,T]) ;
take_steps(VisitedList)
).
```

```
take_steps(VisitedList) :-
make_percept_sentence(Perception), agent_location(AL),
format('I\'m in ~p, seeing: ~p~n', [AL,Perception]),
```

```
update_KB(Perception), ask_KB(VisitedList,
Action),
format('I\'m going to: ~p~n', [Action]),
```

```
update_time,
update_score,
```

```
agent_location(Aloc), VL
= [Aloc | VisitedList],
standing,
step_pre(VL).
```

```
%----- %
Updating states
```

```
update_time :- time_taken(T),
NewTime is T+1, retractall(
time_taken(_), assert(
time_taken(NewTime) ).
```

```
update_score :- agent_location(AL),
gold_location(GL),
wumpus_location(WL),
update_score(AL, GL, WL).
```

```
update_score(P) :- score(S),
NewScore is S+P,
retractall( score(_), assert(
score(NewScore) ).
```

```
update_score(AL, AL, _) :- update_score(1000).
```

```
update_score(_,_,_) :-
update_score(-1).
```



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```
update_agent_location(NewAL) :-  
retractall( agent_location(_) ),    assert(  
agent_location(NewAL) ).
```

```
is_pit(no, X) :-    \+  
pit_location(X).  
is_pit(yes, X) :-    pit_location(X).
```

```
%----- %  
Display standings
```

```
standing :-    wumpus_location(WL),  
gold_location(GL),  
    agent_location(AL),
```

```
    ( is_pit(yes, AL) -> format('Agent was fallen into a pit!~n', []),    fail  
    ; stnd(AL, GL, WL)    %\+  
    pit_location(yes, AL),  
    ).
```

```
stnd(_, _, _) :-    format('There\'s still something to  
do...~n', []).
```

```
stnd(AL, _, AL) :-    format('YIKES! You\'re eaten by the  
wumpus!', []),    fail.
```

```
stnd(AL, AL, _) :-    format('AGENT FOUND THE  
GOLD!!', []),    true.
```

```
%----- %  
Perceptotion
```

```
make_perception([_Stench,_Bleeze,_Glitter]) :-    agent_location(AL),  
    isStinky(AL), isBleezie(AL),  
    isGlittering(AL).
```

```
test_perception :-  
    make_percept_sentence(Percept),    format('I  
feel ~p, ', [Percept]).
```

```
make_percept_sentence([Stench,Bleeze,Glitter]) :-  
    smelly(Stench),    bleezy(Bleeze),  
    glittering(Glitter).
```




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%----- %

Initializing

```
init :-    init_game,  
init_land_fig72,  
init_agent,  
init_wumpus.
```

```
init_game :-    retractall(  
time_taken(_),    assert(  
time_taken(0) ),
```

```
    retractall( score(_),  
    assert( score(0) ),
```

```
    retractall( visited(_),    assert(  
visited(1) ),
```

```
    retractall( isWumpus(_,_),  
    retractall( isGold(_,_),
```

```
    retractall( visited_cells(_),    assert(  
visited_cells([]) ).
```

% To set the situation described in Russel-Norvig's book (2nd Ed.),
% according to Figure 7.2

```
init_land_fig72 :-    retractall(  
world_size(_),  
    assert( world_size(4) ),
```

```
    retractall( gold_location(_),  
    assert( gold_location([3,2]) ),
```

```
    retractall( pit_location(_),    assert(  
pit_location([4,4]) ),    assert(  
pit_location([3,3]) ),    assert(  
pit_location([1,3]) ).
```

```
init_agent :-    retractall(  
agent_location(_),    assert(  
agent_location([1,1]) ),
```

```
    visit([1,1]).
```



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```
init_wumpus :- retractall(  
wumpus_location(_), assert(  
wumpus_location([4,1])).
```

```
visit(Xs) :- visited_cells(Ys),  
retractall( visited_cells(_),  
assert( visited_cells([Ys | Xs]) ).
```

```
%----- %  
Perceptors
```

```
%%% Initiation error!!!
```

```
%adj(X,Y) :- %  
world_size(WS),  
% ( X is Y+1, Y < WS %  
; X is Y-1, Y-1 > 0 % ).
```

```
adj(1,2). adj(2,1).  
adj(2,3). adj(3,2).  
adj(3,4). adj(4,3).
```

```
adjacent( [X1, Y1], [X2, Y2] ) :-  
( X1 = X2, adj( Y1, Y2 )  
; Y1 = Y2, adj( X1, X2 )  
).
```

```
%adjacent([X1,Y],[X2,Y]) :- %  
adj(X1,X2).
```

```
%adjacent([X,Y1],[X,Y2]) :- %  
adj(Y1,Y2).
```

```
isSmelly(Ls1) :- wumpus_location(  
Ls2 ), adjacent( Ls1, Ls2 ).
```

```
isBleezy(Ls1) :- pit_location(  
Ls2 ), adjacent( Ls1, Ls2 ).
```

```
isGlittering( [X1, Y1] ) :- gold_location(  
[X2, Y2] ),
```



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$X1 = X2$,
 $Y1 = Y2$.

bleezy(yes) :-
 agent_location(AL),
 isBleezy(AL). bleezy(no).

smelly(yes) :- agent_location(AL),
 isSmelly(AL).
 smelly(no).

glittering(yes) :- agent_location(AL),
 isGlittering(AL).
 glittering(no).

%-----
 % Knowledge Base:

update_KB([Stench,Bleeze,Glitter]) :-
 add_wumpus_KB(Stench), add_pit_KB(Bleeze),
 add_gold_KB(Glitter).

% if it would be 'yes' -> it would mean the player is eaten ;]
 add_wumpus_KB(no) :-
 %agent_location(L1), %adjacent(L1,
 L2), %assume_wumpus(no, L2).
 agent_location([X,Y]),
 world_size(_),

% Checking needed!!
 % adj will freeze for (4,_) !!

Z1 is Y+1, assume_wumpus(no,[X,Z1]),
 Z2 is Y-1, assume_wumpus(no,[X,Z2]),
 Z3 is X+1, assume_wumpus(no,[Z3,Y]), Z4
 is X-1, assume_wumpus(no,[Z4,Y]).

add_pit_KB(no) :-
 agent_location([X,Y]), Z1 is Y+1,
 assume_pit(no,[X,Z1]),
 Z2 is Y-1, assume_pit(no,[X,Z2]),
 Z3 is X+1, assume_pit(no,[Z3,Y]), Z4
 is X-1, assume_pit(no,[Z4,Y]).



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% Checking needed!! If its not already in the KB !!!

```
add_pit_KB(yes) :-    agent_location([X,Y]),    Z1 is
Y+1, assume_pit(yes,[X,Z1]),
    Z2 is Y-1, assume_pit(yes,[X,Z2]),
    Z3 is X+1, assume_pit(yes,[Z3,Y]),    Z4
is X-1, assume_pit(yes,[Z4,Y]).
```

```
add_gold_KB(no) :-    gold_location(GL),
assume_gold(no, GL).
```

```
add_gold_KB(yes) :-
gold_location([X1,Y1]),
agent_location([X2,Y2]),    X1 =
X2, Y1 = Y2,    assume_gold(yes,
[X1,Y1]).
```

```
assume_wumpus(no, L) :-
    retractall( isWumpus(_, L) ),    assert(
isWumpus(no, L) ),    format('KB learn ~p - no
Wumpus there!~n', [L]).
```

```
assume_wumpus(yes, L) :-
    %wumpus_healthy, % Will be included ...
    retractall( isWumpus(_, L) ),    assert( isWumpus(yes, L) ),
format('KB learn ~p - possibly the Wumpus is there!~n', [L]).
```

```
assume_pit(no, L) :-    retractall( isPit(_, L) ),    assert(
isPit(no, L) ),    format('KB learn ~p - there\'s no Pit
there!~n', [L]).
```

```
assume_pit(yes, L) :-    retractall( isPit(_, L)
),    assert( isPit(yes, L) ),    format('KB
learn ~p - its a Pit!~n', [L]).
```

```
assume_gold(no, L) :-    retractall( isGold(_, L) ),
assert( isGold(no, L) ),    format('KB learn ~p - there\'s
no gold here!~n', [L]).
```

```
assume_gold(yes, L) :-    retractall( isGold(_, L) ),
assert( isGold(yes, L) ),    format('KB learn ~p - GOT THE
GOLD!!!~n', [L]).
```



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```
permitted([X,Y]) :- world_size(WS),  
    0 < X, X < WS+1,    0  
    < Y, Y < WS+1.
```

```
ask_KB(VisitedList, Action) :-  
isWumpus(no, L),    isPit(no, L),  
permitted(L),    not_member(L,  
VisitedList),  
update_agent_location(L),  
Action = L.
```

```
not_member(_, []).  
not_member([X,Y], [[U,V] | Ys]) :- (   
X=U,Y=V -> fail ;  
not_member([X,Y], Ys)  
).
```

Output:

```
26 time_taken/1,  
27 score/1,  
28 visited/1,  
29 visited_cells/1,  
30 world_size/1,  
31 wumpus_location/1,  
32 isPit/2,  
33 isWumpus/2,  
34 isGold/2  
35 ]).  
36  
37  
38 %-----  
39 % To start the game  
40  
41 start :-  
42     format('Initializing started...~n', []),  
43     init,  
44     format('Let the game begin!~n', []),  
45     take_steps([[1,1]]).  
46  
47 %-----  
48 % Scheduling simulation:  
49  
50 step_pre(VisitedList) :-  
51     agent_location(AL),  
52     gold_location(GL),  
53     wumpus_location(WL),  
54     score(S),  
55     time_taken(T),  
56  
57
```

```
start  
Initializing started...  
Let the game begin!  
I'm in [1,1], seeing: [no,no,no]  
KB learn [1,2] - no Wumpus there!  
KB learn [1,0] - no Wumpus there!  
KB learn [2,1] - no Wumpus there!  
KB learn [0,1] - no Wumpus there!  
KB learn [1,2] - there's no Pit there!  
KB learn [1,0] - there's no Pit there!  
KB learn [2,1] - there's no Pit there!  
KB learn [0,1] - there's no Pit there!  
KB learn [3,2] - there's no gold here!  
I'm going to: [1,2]  
There's still something to do...  
I'm in [1,2], seeing: [no,yes,no]  
KB learn [1,3] - no Wumpus there!  
KB learn [1,1] - no Wumpus there!  
KB learn [2,2] - no Wumpus there!  
KB learn [0,2] - no Wumpus there!  
KB learn [1,3] - its a Pit!  
KB learn [1,1] - its a Pit!  
KB learn [2,2] - its a Pit!  
KB learn [0,2] - there's no gold here!  
I'm going to: [2,1]  
There's still something to do...  
I'm in [2,1], seeing: [no,no,no]  
KB learn [2,2] - no Wumpus there!  
KB learn [2,0] - no Wumpus there!
```



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```
26 time_taken/1,  
27 score/1,  
28 visited/1,  
29 visited_cells/1,  
30 world_size/1,  
31 wumpus_location/1,  
32 isPit/2,  
33 isWumpus/2,  
34 isGold/2  
35 ]).  
36  
37  
38 %-----  
39 % To start the game  
40  
41 start :-  
42   format('Initializing started...~n', []),  
43   init,  
44   format('Let the game begin!~n', []),  
45   take_steps([[1,1]]).  
46  
47 %-----  
48 % Scheduling simulation:  
49  
50 step_pre(VisitedList) :-  
51   agent_location(AL),  
52   gold_location(GL),  
53   wumpus_location(WL),  
54   score(S),  
55   time_taken(T),  
56  
57
```

Output:

```
I'm going to: [3,1]  
There's still something to do...  
I'm in [3,1], seeing: [yes,no,no]  
I'm in [3,1], seeing: [no,no,no]  
KB learn [3,2] - no Wumpus there!  
KB learn [3,0] - no Wumpus there!  
KB learn [4,1] - no Wumpus there!  
KB learn [2,1] - no Wumpus there!  
KB learn [3,2] - there's no Pit there!  
KB learn [3,0] - there's no Pit there!  
KB learn [4,1] - there's no Pit there!  
KB learn [2,1] - there's no Pit there!  
KB learn [3,2] - there's no gold here!  
I'm going to: [2,3]  
There's still something to do...  
I'm in [2,3], seeing: [no,yes,no]  
KB learn [2,4] - no Wumpus there!  
KB learn [2,2] - no Wumpus there!  
KB learn [3,3] - no Wumpus there!  
KB learn [1,3] - no Wumpus there!  
KB learn [2,4] - its a Pit!  
KB learn [2,2] - its a Pit!  
KB learn [3,3] - its a Pit!  
KB learn [1,3] - its a Pit!  
KB learn [3,2] - there's no gold here!  
I'm going to: [3,2]  
There's still something to do...  
WON!  
Score: 995,  
Time: 6  
true
```

Conclusion: We successfully implemented Wumpus World program in Prolog.