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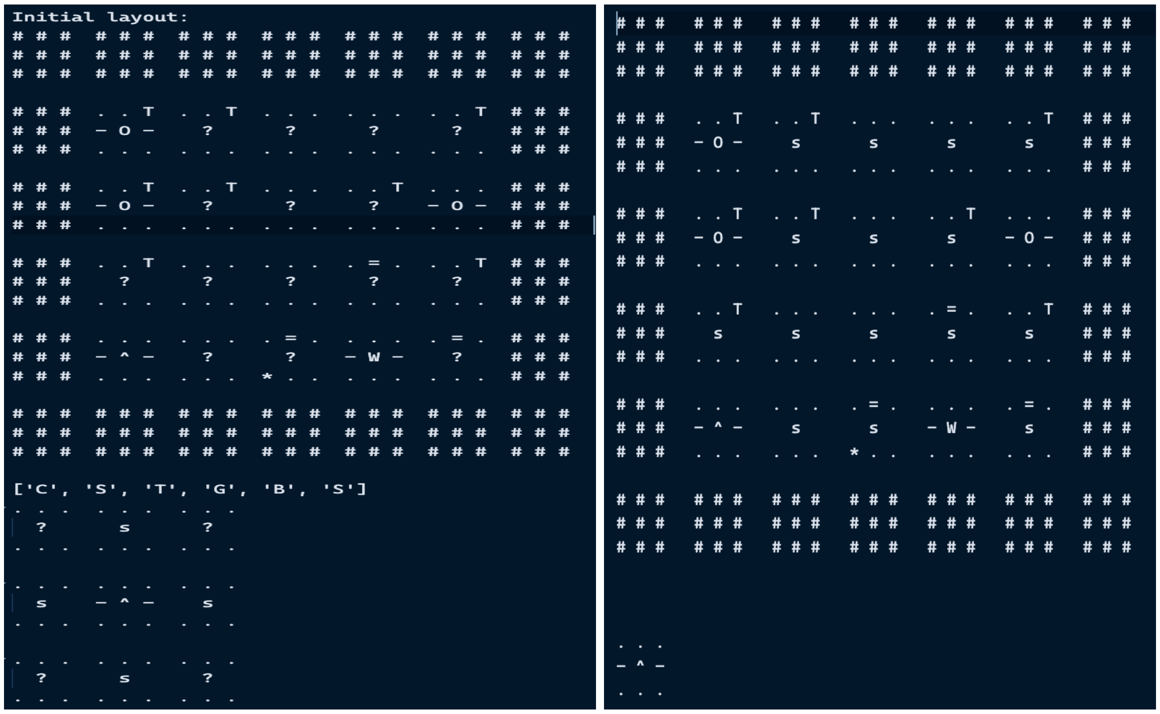
CZ3005 Lab Assignment 2
Team: GohChatsirichai

Wumpus World Driver and Agent

The Friend Driver was provided by **Team EmotionalDamage**. Originally, both drivers generate random maps on each run. For the sake of traceability in this report, a pre-set map consisting of one *wumpus*, three *confundus portals* and one *coin* will be used.

Initial layout of the map



```
Initial layout:
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #

# # #   . . T   . . T   . . .   . . .   . . T   # # #
# # #   − O −     ?       ?       ?       ?     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . T   . . .   . . T   . . .   # # #
# # #   − O −     ?       ?       ?     − O −   # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . .   . . .   . = .   . . T   # # #
# # #     ?       ?       ?       ?       ?     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . .   . . .   . = .   . . .   . = .   # # #
# # #   − ^ −     ?       ?     − W −     ?     # # #
# # #   . . .   . . .   * . .   . . .   . . .   # # #

# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #

['C', 'S', 'T', 'G', 'B', 'S']
. . .   . . .   . . .
  ?       s       ?
. . .   . . .   . . .

. . .   . . .   . . .
  s     − ^ −     s
. . .   . . .   . . .

. . .   . . .   . . .
  ?       s       ?
. . .   . . .   . . .
```

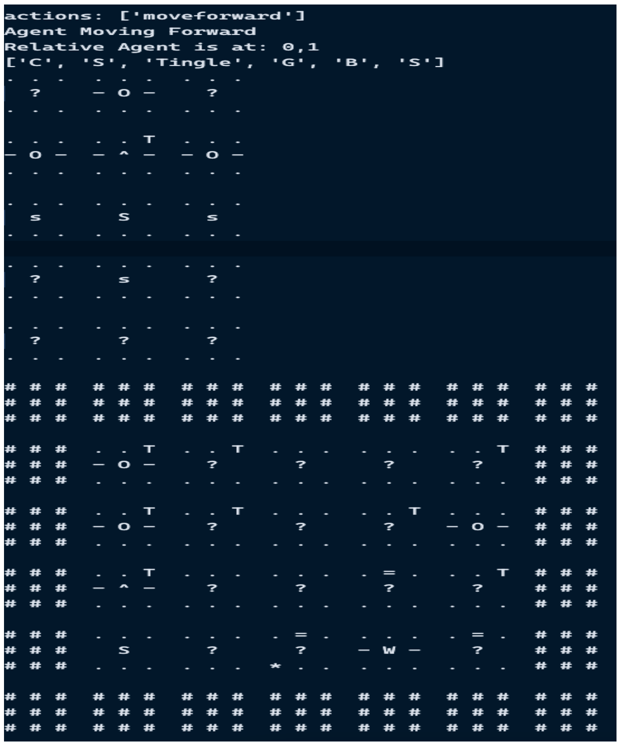
```
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #

# # #   . . T   . . T   . . .   . . .   . . T   # # #
# # #   − O −     s       s       s       s     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . T   . . .   . . T   . . .   # # #
# # #   − O −     s       s       s     − O −   # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . .   . . .   . = .   . . T   # # #
# # #     s       s       s       s       s     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . .   . . .   . = .   . . .   . = .   # # #
# # #   − ^ −     s       s     − W −     s     # # #
# # #   . . .   . . .   * . .   . . .   . . .   # # #

# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #



. . .
− ^ −
. . .
```

Map 1. Initial maps for Self-Self and Self-Friend respectively

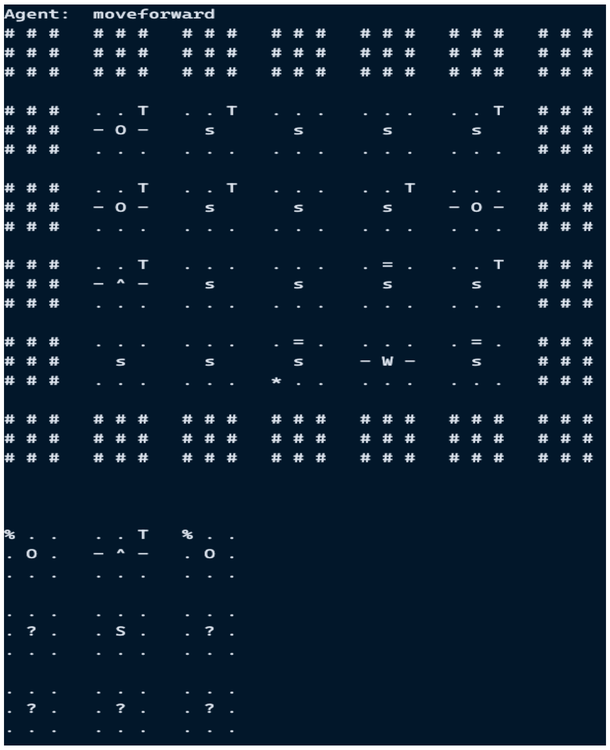
Agent Capabilities

Localisation and Mapping.

The agent maintains its own coordinate and directions through current/3. Direction is affected by turnLeft/3 and turnRight/3 while coordinates are changed through advance/0. Crucially, the consequence of these 3 actions are also subject to the precepts of the agent, passed in move(action, percepts).

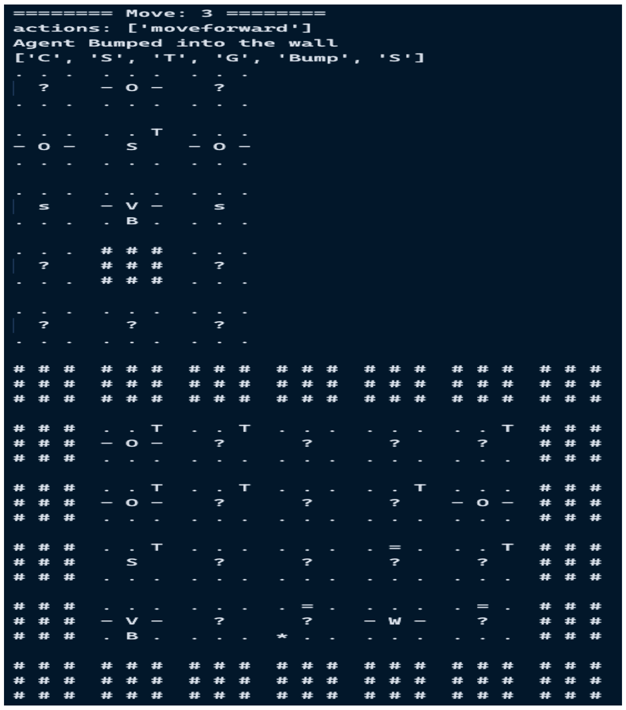


```
actions: ['moveforward']
Agent Moving Forward
Relative Agent is at: 0,1
['C', 'S', 'Tingle', 'G', 'B', 'S']
. . .   . . .   . . .
  ?     - O -     ?
. . .   . . .   . . .

. . .   . . T   . . .
- O -   - ^ -   - O -
. . .   . . .   . . .

. . .   . . .   . . .
  s       S       s
. . .   . . .   . . .

. . .   . . .   . . .
  ?       s       ?
. . .   . . .   . . .

. . .   . . .   . . .
  ?       ?       ?
. . .   . . .   . . .

# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #

# # #   . . T   . . T   . . .   . . .   . . T   # # #
# # #   - O -     ?       ?       ?       ?     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . T   . . .   . . T   . . .   # # #
# # #   - O -     ?       ?       ?     - O -   # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . .   . . .   . = .   . . T   # # #
# # #   - ^ -     ?       ?       ?       ?     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . .   . . .   . = .   . . .   . = .   # # #
# # #     S       ?       ?     - W -     ?     # # #
# # #   . . .   . . .   * . .   . . .   . . .   # # #

# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
```

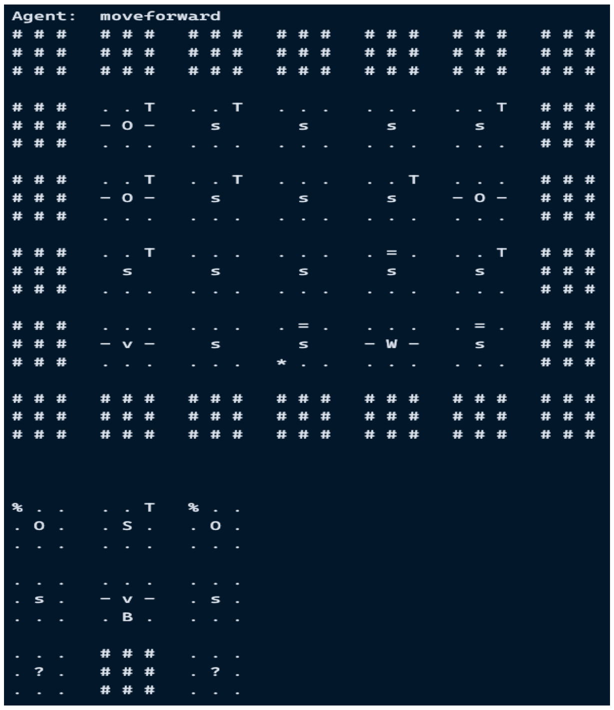


```
Agent:  moveforward
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #

# # #   . . T   . . T   . . .   . . .   . . T   # # #
# # #   - O -     s       s       s       s     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . T   . . .   . . T   . . .   # # #
# # #   - O -     s       s       s     - O -   # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . .   . . .   . = .   . . T   # # #
# # #   - ^ -     s       s       s       s     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . .   . . .   . = .   . . .   . = .   # # #
# # #     s       s       s     - W -     s     # # #
# # #   . . .   . . .   * . .   . . .   . . .   # # #

# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #



% . .   . . T   % . .
. O .   - ^ -   . O .
. . .   . . .   . . .

. . .   . . .   . . .
. ? .   . S .   . ? .
. . .   . . .   . . .

. . .   . . .   . . .
. ? .   . ? .   . ? .
. . .   . . .   . . .
```

Map 2. Tingle: Self-Self (Left) Self-Friend (Right)



```
======== Move: 3 ========
actions: ['moveforward']
Agent Bumped into the wall
['C', 'S', 'T', 'G', 'Bump', 'S']
. . .   . . .   . . .
  ?     - O -     ?
. . .   . . .   . . .

. . .   . . T   . . .
- O -     S     - O -
. . .   . . .   . . .

. . .   . . .   . . .
  s     - V -     s
. . .   . B .   . . .

. . .   # # #   . . .
  ?     # # #     ?
. . .   # # #   . . .

. . .   . . .   . . .
  ?       ?       ?
. . .   . . .   . . .

# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #

# # #   . . T   . . T   . . .   . . .   . . T   # # #
# # #   - O -     ?       ?       ?       ?     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . T   . . .   . . T   . . .   # # #
# # #   - O -     ?       ?       ?     - O -   # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . .   . . .   . = .   . . T   # # #
# # #     S       ?       ?       ?       ?     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . .   . . .   . = .   . . .   . = .   # # #
# # #   - V -     ?       ?     - W -     ?     # # #
# # #   . B .   . . .   * . .   . . .   . . .   # # #

# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
```

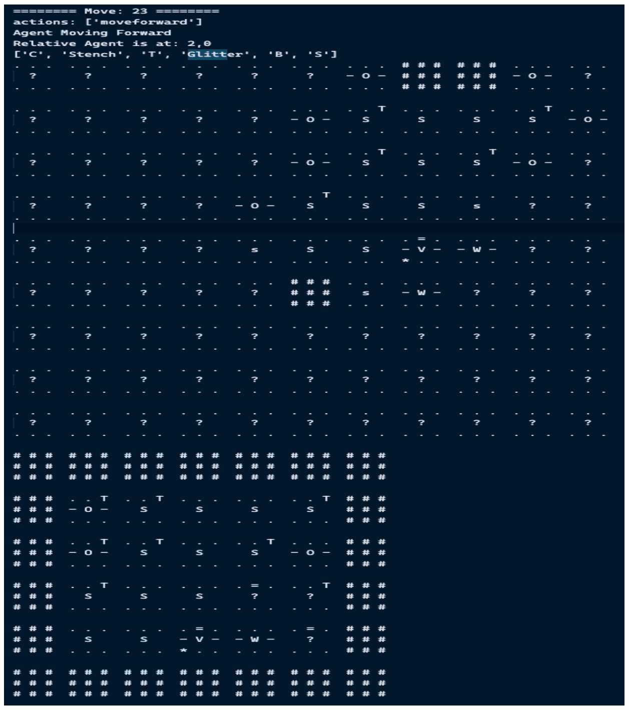


```
Agent:  moveforward
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #

# # #   . . T   . . T   . . .   . . .   . . T   # # #
# # #   - O -     s       s       s       s     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . T   . . .   . . T   . . .   # # #
# # #   - O -     s       s       s     - O -   # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . T   . . .   . . .   . = .   . . T   # # #
# # #     s       s       s       s       s     # # #
# # #   . . .   . . .   . . .   . . .   . . .   # # #

# # #   . . .   . . .   . = .   . . .   . = .   # # #
# # #   - v -     s       s     - W -     s     # # #
# # #   . . .   . . .   * . .   . . .   . . .   # # #

# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #
# # #   # # #   # # #   # # #   # # #   # # #   # # #



% . .   . . T   % . .
. O .   . S .   . O .
. . .   . . .   . . .

. . .   . . .   . . .
. s .   - v -   . s .
. . .   . B .   . . .

. . .   # # #   . . .
. ? .   # # #   . ? .
. . .   # # #   . . .
```

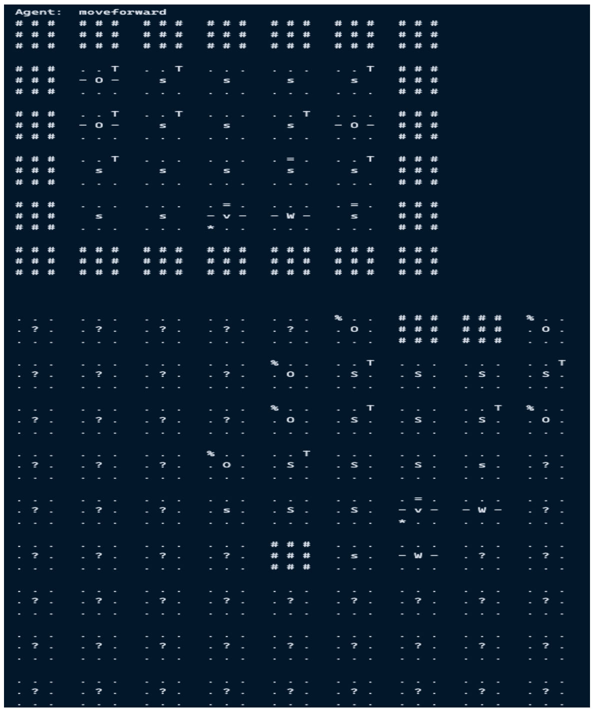
Map 3. Bump: Self-Self (Left) Self-Friend (Right)

From Map 2, we show the agent updating its relative maps correctly after taking a step forward, and Map 3 demonstrates that the agent will remain at the same coordinate after bumping into the wall.

Sensory Interface

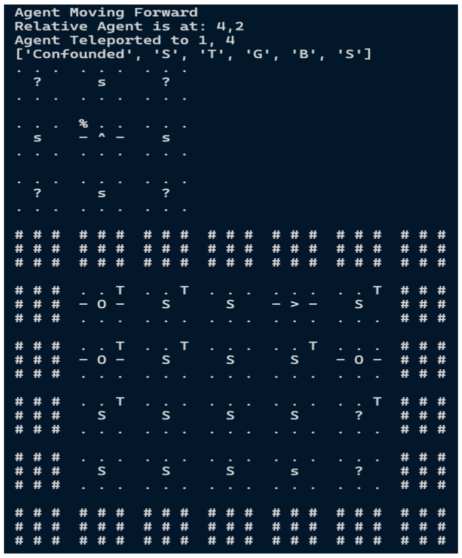


```
======== Move: 23 ========
actions: ['moveforward']
Agent Moving Forward
Relative Agent is at: 2,0
['C', 'Stench', 'T', 'Glitter', 'B', 'S']
. . .  . . .  . . .  . . .  . . .  . . .  . . .  # # #  # # #  . . .  . . .
  ?      ?      ?      ?      ?      ?    - O -  # # #  # # #  - O -    ?
. . .  . . .  . . .  . . .  . . .  . . .  . . .  # # #  # # #  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . . T  . . .  . . .  . . T  . . .
  ?      ?      ?      ?      ?    - O -    S      S      S      S    - O -
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . . T  . . .  . . T  . . .  . . .
  ?      ?      ?      ?      ?    - O -    S      S      S    - O -    ?
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . T  . . .  . . .  . . .  . . .  . . .
  ?      ?      ?      ?    - O -    S      S      S      s      ?      ?
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . . .  . = .  . . .  . . .  . . .
  ?      ?      ?      ?      s      S      S    - V -  - W -    ?      ?
. . .  . . .  . . .  . . .  . . .  . . .  . . .  * . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  # # #  . . .  . . .  . . .  . . .  . . .
  ?      ?      ?      ?      ?    # # #    s    - W -    ?      ?      ?
. . .  . . .  . . .  . . .  . . .  # # #  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .
  ?      ?      ?      ?      ?      ?      ?      ?      ?      ?      ?
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .
  ?      ?      ?      ?      ?      ?      ?      ?      ?      ?      ?
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .
  ?      ?      ?      ?      ?      ?      ?      ?      ?      ?      ?
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #

# # #  . . T  . . T  . . .  . . .  . . T  # # #
# # #  - O -    S      S      S      S    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . T  . . T  . . .  . . T  . . .  # # #
# # #  - O -    S      S      S    - O -  # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . T  . . .  . . .  . = .  . . T  # # #
# # #    S      S      S      ?      ?    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . .  . . .  . = .  . . .  . = .  # # #
# # #    S      S    - V -  - W -    ?    # # #
# # #  . . .  . . .  * . .  . . .  . . .  # # #

# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
```

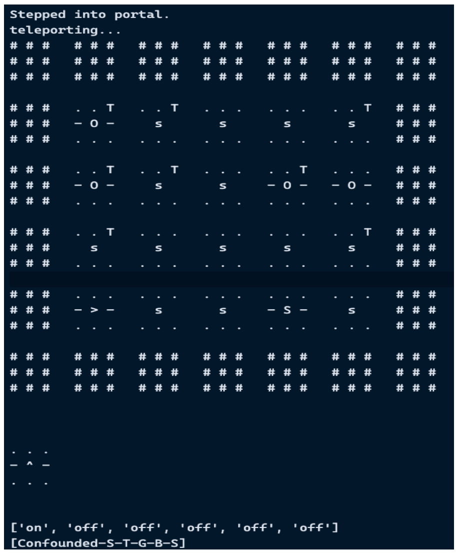


```
Agent:  moveforward
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #

# # #  . . T  . . T  . . .  . . .  . . T  # # #
# # #  - O -    s      s      s      s    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . T  . . T  . . .  . . T  . . .  # # #
# # #  - O -    s      s      s    - O -  # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . T  . . .  . . .  . = .  . . T  # # #
# # #    s      s      s      s      s    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . .  . . .  . = .  . . .  . = .  # # #
# # #    s      s    - v -  - W -    s    # # #
# # #  . . .  . . .  * . .  . . .  . . .  # # #

# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #


. . .  . . .  . . .  . . .  . . .  % . .  # # #  # # #  % . .
. ? .  . ? .  . ? .  . ? .  . ? .  . O .  # # #  # # #  . O .
. . .  . . .  . . .  . . .  . . .  . . .  # # #  # # #  . . .

. . .  . . .  . . .  . . .  % . .  . . T  . . .  . . .  . . T
. ? .  . ? .  . ? .  . ? .  . O .  . S .  . S .  . S .  . S .
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  % . .  . . T  . . .  . . T  % . .
. ? .  . ? .  . ? .  . ? .  . O .  . S .  . S .  . S .  . O .
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  % . .  . . T  . . .  . . .  . . .  . . .
. ? .  . ? .  . ? .  . O .  . S .  . S .  . S .  . s .  . ? .
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . = .  . . .  . . .
. ? .  . ? .  . ? .  . s .  . S .  . S .  - v -  - W -  . ? .
. . .  . . .  . . .  . . .  . . .  . . .  * . .  . . .  . . .

. . .  . . .  . . .  . . .  # # #  . . .  . . .  . . .  . . .
. ? .  . ? .  . ? .  . ? .  # # #  . s .  - W -  . ? .  . ? .
. . .  . . .  . . .  . . .  # # #  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .
. ? .  . ? .  . ? .  . ? .  . ? .  . ? .  . ? .  . ? .  . ? .
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .
. ? .  . ? .  . ? .  . ? .  . ? .  . ? .  . ? .  . ? .  . ? .
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .

. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .
. ? .  . ? .  . ? .  . ? .  . ? .  . ? .  . ? .  . ? .  . ? .
. . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .  . . .
```

Map 4. Glitter and Stench: Self-Self (Left) Self-Friend (Right)

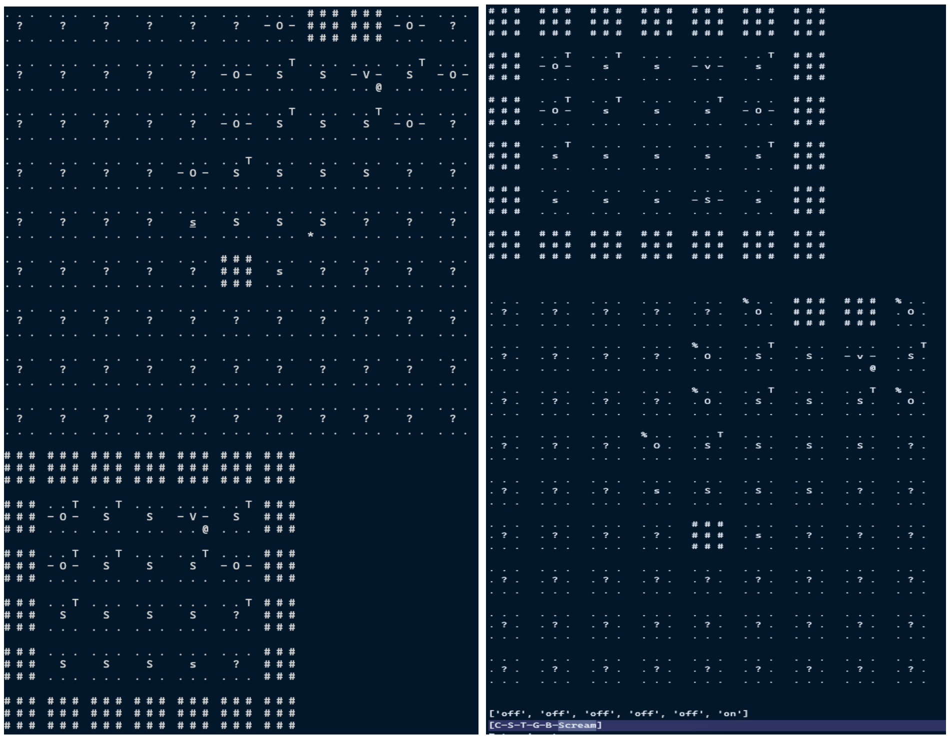


```
Agent Moving Forward
Relative Agent is at: 4,2
Agent Teleported to 1, 4
['Confounded', 'S', 'T', 'G', 'B', 'S']
. . .  . . .  . . .
  ?      s      ?
. . .  . . .  . . .

. . .  % . .  . . .
  s    - ^ -    s
. . .  . . .  . . .

. . .  . . .  . . .
  ?      s      ?
. . .  . . .  . . .

# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #

# # #  . . T  . . T  . . .  . . .  . . T  # # #
# # #  - O -    S      S    - > -    S    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . T  . . T  . . .  . . T  . . .  # # #
# # #  - O -    S      S      S    - O -  # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . T  . . .  . . .  . . .  . . T  # # #
# # #    S      S      S      S      ?    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . .  . . .  . . .  . . .  . . .  # # #
# # #    S      S      S      s      ?    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
```



```
Stepped into portal.
teleporting...
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #

# # #  . . T  . . T  . . .  . . .  . . T  # # #
# # #  - O -    s      s      s      s    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . T  . . T  . . .  . . T  . . .  # # #
# # #  - O -    s      s    - O -  - O -  # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . T  . . .  . . .  . . .  . . T  # # #
# # #    s      s      s      s      s    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  . . .  . . .  . . .  . . .  . . .  # # #
# # #  - > -    s      s    - S -    s    # # #
# # #  . . .  . . .  . . .  . . .  . . .  # # #

# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #
# # #  # # #  # # #  # # #  # # #  # # #  # # #


. . .
- ^ -
. . .


['on', 'off', 'off', 'off', 'off', 'off']
[Confounded-S-T-G-B-S]
```

Map 5. Confounded: Glitter: Self-Self (Left) Self-Friend (Right)



```
['off', 'off', 'off', 'off', 'off', 'on']
[C-S-T-G-B-Scream]
```

Map 6: Scream: Self-Self (Left) Self-Friend (Right)

The above examples [Confounded (Map5), Stench (Map4), Tingle (Map2), Glitter (Map5), Bump (Map3) and Scream (Map6) demonstrate the agent's sensory accuracy on both drivers.

Memory Management through a Portal

Map 5 also shows the agent's response to getting teleported by the confundus portal. As the agent is teleported to a random location, it ends up in different locations for both drivers. Both relative maps are reset. In our implementation of the driver, the agent immediately perceives its surroundings to determine the adjacent cells around it to recreate the 3x3. On the other hand, our Friend driver chooses to maintain a 1x1 grid and receive the agent's percepts in a subsequent action.

Exploration Capabilities

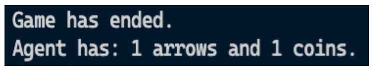
The general algorithm of our exploration is as follows: The agent will freely explore unvisited cells until a bump, whereby it will change directions. When met with a risky situation (Stench/Tingle), the agent immediately withdraws to the immediate Safe cell (i.e backtracks) and recalculates the next safe cell recursively. This approach allows us to determine definite dangerous cells by process of elimination.

Referencing GohChatsirichati-testPrintout-self-self.txt, the capability of averting danger is demonstrated in *move numbers*: 2, 7, 15, 17 (Note that the agent took the same steps in self-friend, but the printout does not enumerate the move number).

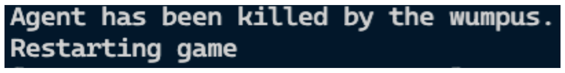
At Move 30, the agent fully explored all reasonably safe cells and completed its search.

End of Game Correctness

Our implementation allows the game to end in two ways: The player manually halts the game, or the agent is eaten by a wumpus and the program exits.



```
Game has ended.
Agent has: 1 arrows and 1 coins.
```



```
Agent has been killed by the wumpus.
Restarting game
```

Safe exit and Death exit respectively.

Driver Capabilities

As shown in the above examples, the driver will print both the relative and absolute maps after each series of moves from explore(L), or a manual input from the user.

Conclusion

This lab assignment was undoubtedly very challenging for us. We grappled against the new language and concept of first-order logic but it ultimately gave us an appreciation for logical-based agents.

Some special notes about our submission:

1. The agent strongly prefers not to enter confundus portals, and will only potentially enter a portal if it perceives *Tingle* upon spawn and has no choice.
2. Our sole precious arrow functions similarly to Sova's ultimate ability in Valorant, and will hit the wumpus as long as it is on the same line of attack, despite any walls. :-)
3. All parts were contributed by both members

References:

https://www.cpp.edu/~jrfisher/www/prolog_tutorial/2_15.html
https://www.cpp.edu/~jrfisher/www/prolog_tutorial/5_1.html