Innopolis University
Introduction to Practical Artificial Intelligence
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Assignment 1

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1 Task description

Harry has decided to use his invisibility cloak to hide from unexpected guests and go to the library during the night. However, he has lost his invisibility cloak somewhere in the library while looking for a book. At that time, Argus Filch and his cat Mrs Norris began inspecting the library. Harry has to find the book and leave the library without being caught.

2 Project structure

The code has been written on Java (JDK 1.8), trying to follow the principles of SOLID and OOP.

To comply with the rules all classes has been placed in one file. For your comfort, the main code repository (with separate classes) could be accessed by link https://github.com/bart02/Introduction_To_AI.

3 PEAS description

3.1 Actors

Harry Potter, Argus Filch, Mrs Norris

3.2 Performance measure

Harry Potter is looking for a book and grab it. After taking the book he is looking for an exit and win the game.

3.3 Environment

The environment is a 9×9 square map. Harry Potter is looking for the book and the exit, sometimes looking for the invisibility cloak.

3.4 Actuator

Harry Potter chooses one of eights possible directions and move. Also he grabs the book and the Invisibility cloak.

3.5 Sensor

Harry Potter has an ability to perceive inspectors and their zones and the Invisibility cloak if Harry Potter is in the same sell. We choose the case Harry can see the cells (Scenario 1 or Scenario 2)

3.6 Environment classification

- Partially Observable
- Dynamic

- Discrete
- Deterministic
- Multi-agent
- Sequential
- Known

4 Algorithms

4.1 Backtracking search

I have used standard backtracking, that deletes dead ends from the path.

Harry move using `actor.goPriority`, that contains diagonals first, then horizontals and verticals. *In second scenario diagonal moves are dangerous, so they have less priority.*

I do not find **the best** way in Backtracking search case, because it takes so much time. So the first found way will be returned.

You should use this algo if you have less time, but big HP.

4.2 A*

First of all this algorithm scans field, using A* without heuristic (aka Dijkstra algorithm). Then it check all possible ways of Harry (start - book - exit, start - cloak - book - exit, start - exit - cloak - book), and returns path that minimal number of steps.

This algo guarantees, that found path is shortest. But it is much (5x) time consuming in compare with Backtracking.

5 Statistical Analysis

Now we compare the algorithms based on test maps generated. So, our comparison for each tests are:

5.1 Backtracking (scenario 1)

Average winrate: 86% including impossible cases

Execution time: $1.1 \cdot 10^{-5}$ s.

Average length: 51 steps

5.2 Backtracking (scenario 2)

Average winrate: 78% including impossible cases

Execution time: $1.6 \cdot 10^{-5}$ s.

Average length: 30 steps

5.3 A* (scenario 1)

Average winrate: 86% including impossible cases

Execution time: $5.7 \cdot 10^{-5}$ s.

Average length: 10 steps

5.4 A* (scenario 2)

Average winrate: 66% including impossible cases

Execution time: $7.4 \cdot 10^{-5}$ s.

Average length: 10 steps

6 Impossible cases

Since we don't have restriction about always winning the game, we have some variants that are impossible to do. Now we have 3 lose-variants that we can't solve.

First of all, let's have a look at our map:

- "0" - Empty cells, so Harry moves to them without losing the game
- "1" - Harry Potter's position
- "2" - Invisibility cloak's position

- "3" - Book's position
- "4" - Exit's position
- "-1" - Enemy's zone
- "-2" - Enemy's position

6.1 First variant

In first variant (Fig.1) we have impossible variant, because Harry Potter can't go through the inspectors zones without Invisibility cloak. And Harry Potter can't reach the Invisibility cloak because Harry Potter can't go through the inspectors zones. Therefore, it's impossible variant.

```
2   0   0   0   0   0   0   0   0
-1  -1  -1  0   0   4   0   0   0
-1  -2  -1  0   0   0   0   0   0
-1  -1  -1  0   0   0   0   0   0
0   0   -1  -1  -1  -1  -1  3   0
0   0   -1  -1  -1  -1  -1  0   0
0   0   -1  -1  -2  -1  -1  0   0
0   0   -1  -1  -1  -1  -1  0   0
1   0   -1  -1  -1  -1  -1  0   0
```

Figure 1: Harry can't go through the inspectors zones and can't reach the Invisibility cloak

6.2 Second variant

In second variant (Fig.2) we have impossible variant, because Harry Potter can't go through the inspectors zones without Invisibility cloak. Harry Potter can grab the book, but he can't reach the exit because Harry Potter can't go through the inspectors zones without Invisibility cloak. And Harry Potter can't reach the Invisibility cloak because Harry Potter can't go through the inspectors zones. Therefore, it's impossible variant.

```
0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   -1  -1  -1
0   0   0   0   0   0   -1  -2  -1
0   0   0   0   0   0   -1  -1  -1
0   3   -1  -1  -1  -1  -1  4   0
0   0   -1  -1  -1  -1  -1  0   0
0   0   -1  -1  -2  -1  -1  0   0
0   0   -1  -1  -1  -1  -1  0   0
1   0   -1  -1  -1  -1  -1  0   2
```

Figure 2: Harry can't reach the exit

6.3 Third variant

In third variant (Fig.3) we have impossible variant, because Harry Potter appears in inspector's zone, so he dies immediately. Therefore, it's impossible variant.

```
0   0   0   0   0   0   0   0   0
0   0   0   0   0   0   -1  -1  -1
0   3   0   0   0   0   -1  -2  -1
0   0   0   0   0   0   -1  -1  -1
-1  -1  -1  -1  0   0   0   4   0
-1  -1  -1  -1  0   0   0   0   0
-1  -2  -1  -1  0   0   0   0   0
-1  -1  -1  -1  0   0   0   0   0
1   -1  -1  -1  0   0   0   0   2
```

Figure 3: Harry dies immediately