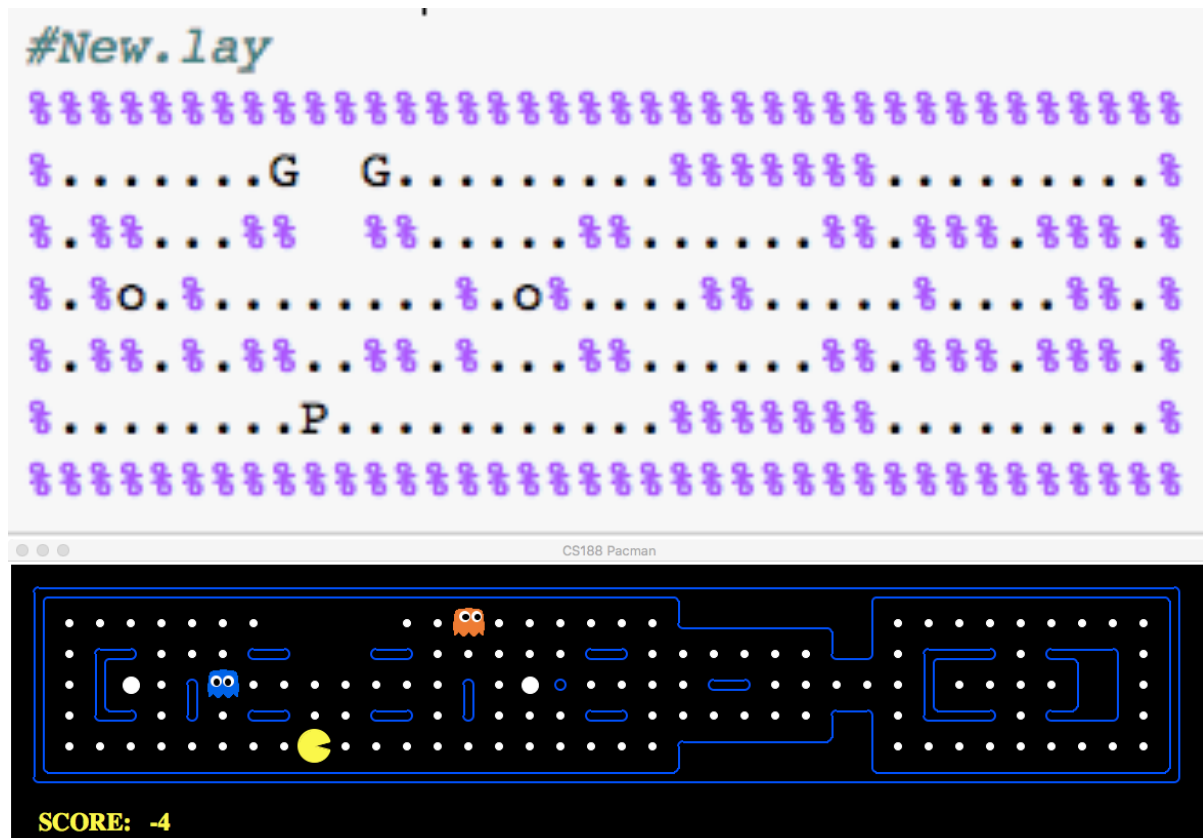


1. Take the multiagent folder from assignment 2 and copy into a new directory for this practical. We will implement a version of minimax for Ghost Agents to make very smart ghosts.

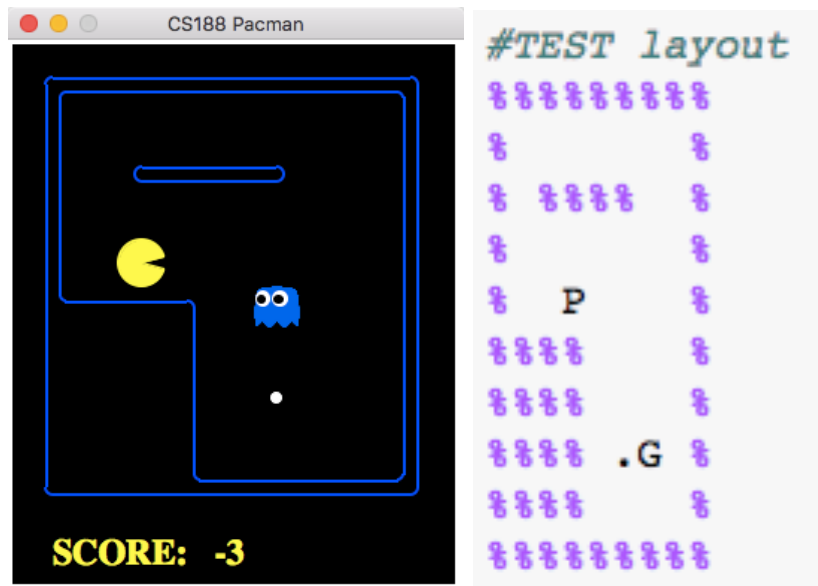
1.1 MiniGhost 程序请见附件

1.2 设计新的地图



2. In this question we will test the new ghostAgent with different pacman agents. In your assignment you were asked to complete a Minimax pacman a version of Expectimax for pacman was provided. If you have not completed the assignment just use the provided expectimax version.

*For this question, I find that only the below layout can give the similar average score as the question itself.



1) random ghost vs. minimax pacman

```
python pacman.py -n 5 -l test -p MinimaxAgent
```

Pacman emerges victorious! Score: 488

Pacman emerges victorious! Score: 287

Pacman emerges victorious! Score: 497

Pacman emerges victorious! Score: 500

Pacman emerges victorious! Score: 474

Average Score: 449.2

Scores: 488.0, 287.0, 497.0, 500.0, 474.0

Win Rate: 5/5 (1.00)

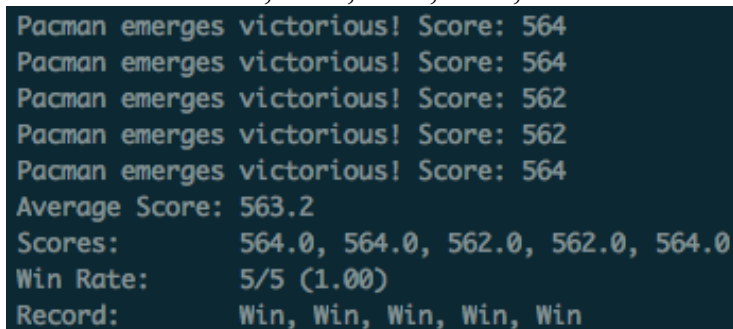
Record: Win, Win, Win, Win, Win

```
Pacman emerges victorious! Score: 488
Pacman emerges victorious! Score: 287
Pacman emerges victorious! Score: 497
Pacman emerges victorious! Score: 500
Pacman emerges victorious! Score: 474
Average Score: 449.2
Scores: 488.0, 287.0, 497.0, 500.0, 474.0
Win Rate: 5/5 (1.00)
Record: Win, Win, Win, Win, Win
```

2) random ghost vs. expectimax pacman

```
python pacman.py -n 5 -l test -p ExpectimaxAgent
```

Pacman emerges victorious! Score: 564
Pacman emerges victorious! Score: 564
Pacman emerges victorious! Score: 562
Pacman emerges victorious! Score: 562
Pacman emerges victorious! Score: 564
Average Score: 563.2
Scores: 564.0, 564.0, 562.0, 562.0, 564.0
Win Rate: 5/5 (1.00)
Record: Win, Win, Win, Win, Win

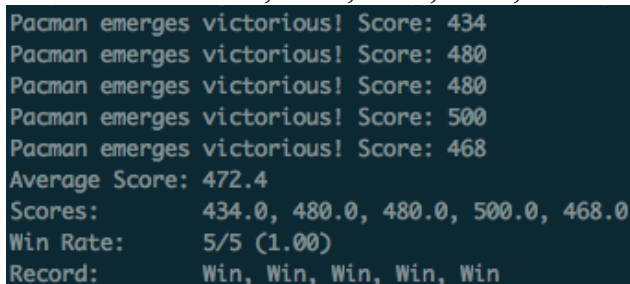


```
Pacman emerges victorious! Score: 564  
Pacman emerges victorious! Score: 564  
Pacman emerges victorious! Score: 562  
Pacman emerges victorious! Score: 562  
Pacman emerges victorious! Score: 564  
Average Score: 563.2  
Scores: 564.0, 564.0, 562.0, 562.0, 564.0  
Win Rate: 5/5 (1.00)  
Record: Win, Win, Win, Win, Win
```

3) minimax ghost vs. minimax pacman

```
python pacman.py -n 5 -l test -p MinimaxAgent -g MinimaxGhost
```

Pacman emerges victorious! Score: 434
Pacman emerges victorious! Score: 480
Pacman emerges victorious! Score: 480
Pacman emerges victorious! Score: 500
Pacman emerges victorious! Score: 468
Average Score: 472.4
Scores: 434.0, 480.0, 480.0, 500.0, 468.0
Win Rate: 5/5 (1.00)
Record: Win, Win, Win, Win, Win

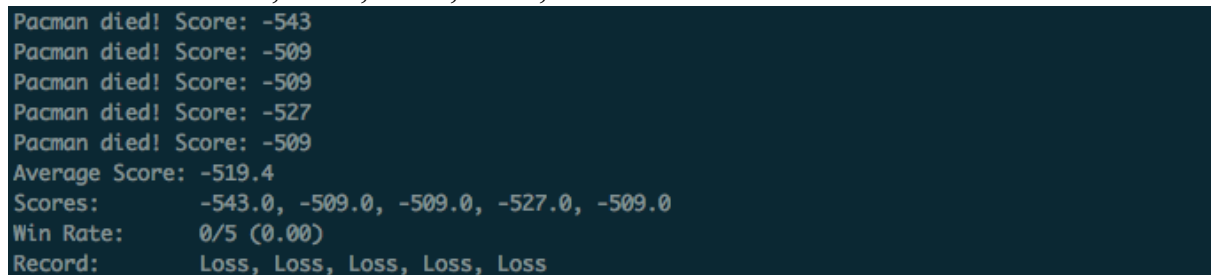


```
Pacman emerges victorious! Score: 434  
Pacman emerges victorious! Score: 480  
Pacman emerges victorious! Score: 480  
Pacman emerges victorious! Score: 500  
Pacman emerges victorious! Score: 468  
Average Score: 472.4  
Scores: 434.0, 480.0, 480.0, 500.0, 468.0  
Win Rate: 5/5 (1.00)  
Record: Win, Win, Win, Win, Win
```

4) minimax ghost vs. expectimax pacman

```
python pacman.py -n 5 -l test -p ExpectimaxAgent -g MinimaxGhost
```

```
Pacman died! Score: -543
Pacman died! Score: -509
Pacman died! Score: -509
Pacman died! Score: -527
Pacman died! Score: -509
Average Score: -519.4
Scores:      -543.0, -509.0, -509.0, -527.0, -509.0
Win Rate:    0/5 (0.00)
Record:      Loss, Loss, Loss, Loss, Loss
```



```
Pacman died! Score: -543
Pacman died! Score: -509
Pacman died! Score: -509
Pacman died! Score: -527
Pacman died! Score: -509
Average Score: -519.4
Scores:      -543.0, -509.0, -509.0, -527.0, -509.0
Win Rate:    0/5 (0.00)
Record:      Loss, Loss, Loss, Loss, Loss
```

3. Describe the performance (in terms of the distribution) of Pacman in each case. In which cases is the Pacman agent implementing the correct assumption of the ghosts' behavior?

1) random ghost vs. minimax pacman

In this case, the movement of random ghost is randomly distributed and the direction of next step is in uniform distribution. However, the minimax pacman's movement are in cumulative distribution. Obviously, the pacman can't correctly assume the ghosts' behavior.

2) random ghost vs. expectimax pacman

The movement of ghost is in uniform distribution but the movement of expectimax pacman is in probability distribution. So, the pacman can't implement the correction assumption of the ghosts' behavior.

3) minimax ghost vs. minimax pacman

The movements of minimax ghost are in cumulative distribution and the same distribution for the movements of minimax pacman. Therefore, the minimax pacman can correctly predict the movements of minimax ghost.

4) minimax ghost vs. expectimax pacman

The movements of minimax ghost are in cumulative distribution and the pacman is in probability distribution, so in some cases, the pacman can correctly assume the movement of ghost, while in some other cases the assumption will be wrong.

4. Describe why the ghosts seem as if they are cooperating when using minimax even though they are not sharing information with each other.

Though minimax ghosts don't share information with others, but for the minimax tree, we only consider one ghost and one pacman. For each ghost, it will rush to the pacman in order to reduce the credits of pacman according to the certain minimax tree. However, the movement of one ghost, will change the gameState and affect evaluation of the minimax tree of another ghost. Therefore, these ghosts will seem as they are cooperating to catch the pacman.