CS440 Assignment 1

Authors (For 3 credit hours):

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Ranran Li

Hui Xu

1.1 Basic pathfinding

1) Medium Maze:

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DFS
Node expanded 222
path cost 102
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BFS
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Greedy
Node expanded 82
path cost 42

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A_star
Node expanded 124
path cost 42

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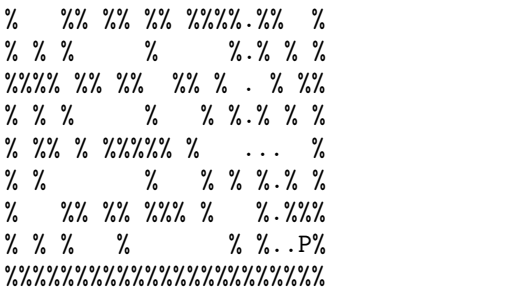
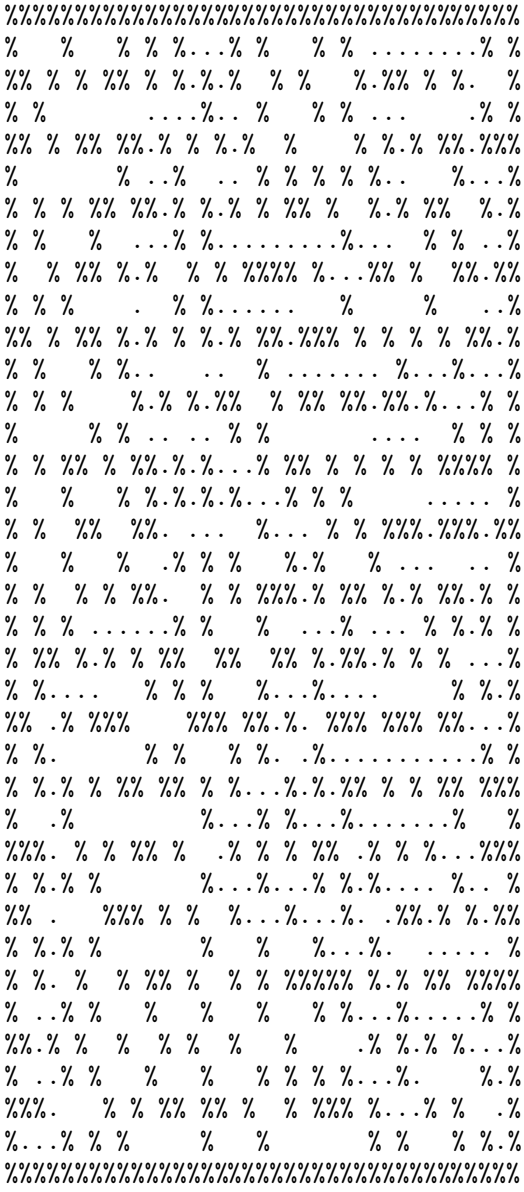


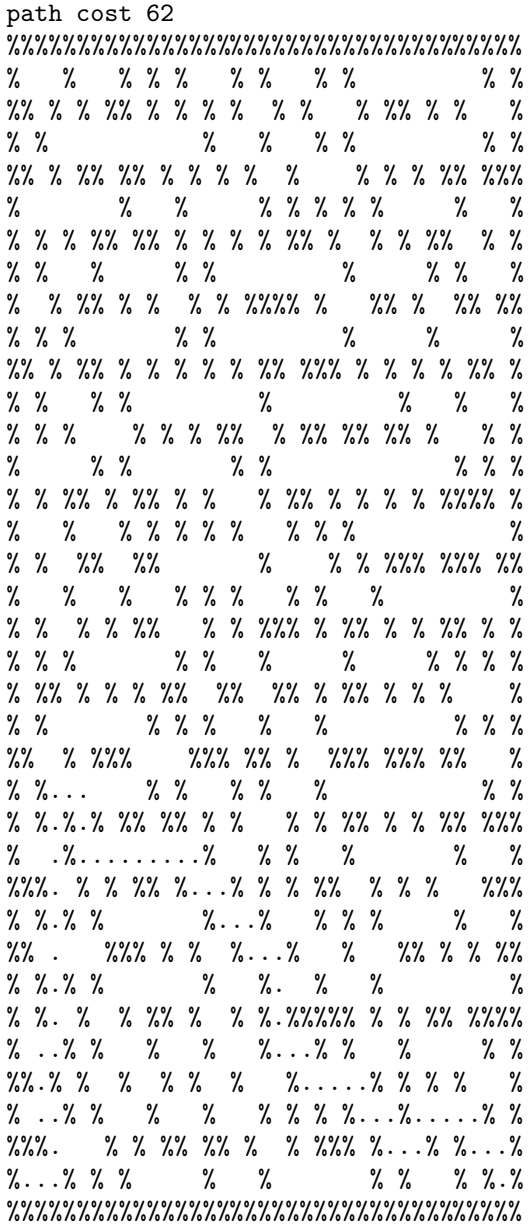
2) Big Maze:

DFS
Node expanded 731
path cost 290

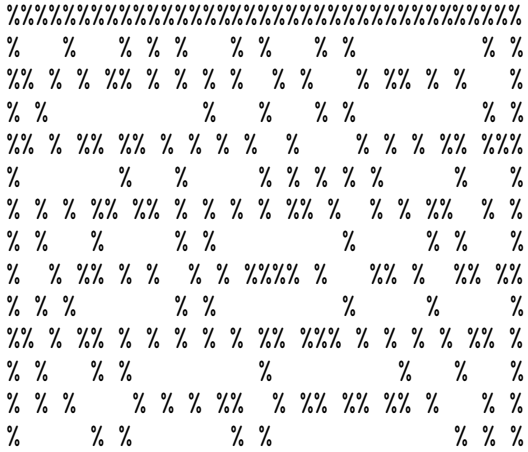


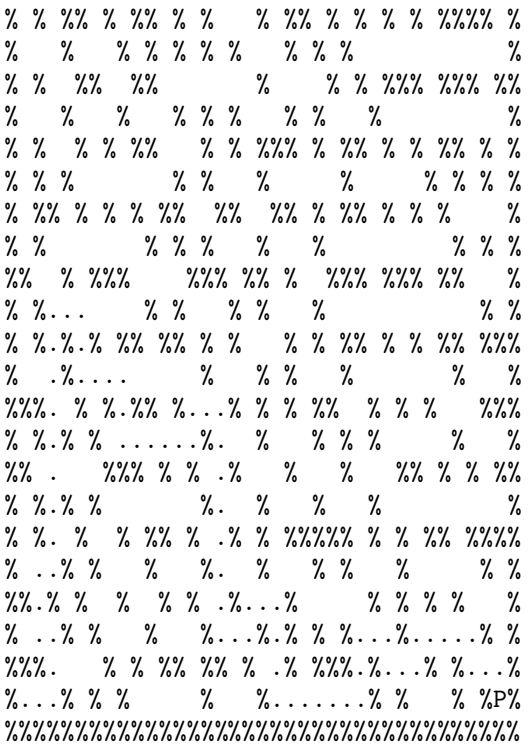
BFS
Node expanded 722

path cost 62

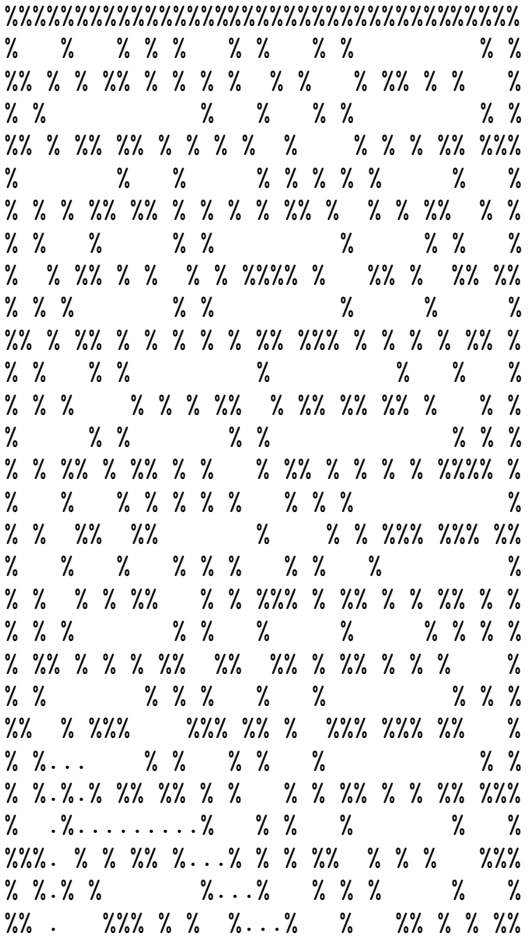


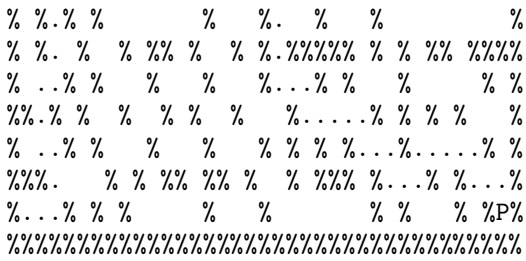
Greedy
Node expanded 146
path cost 70



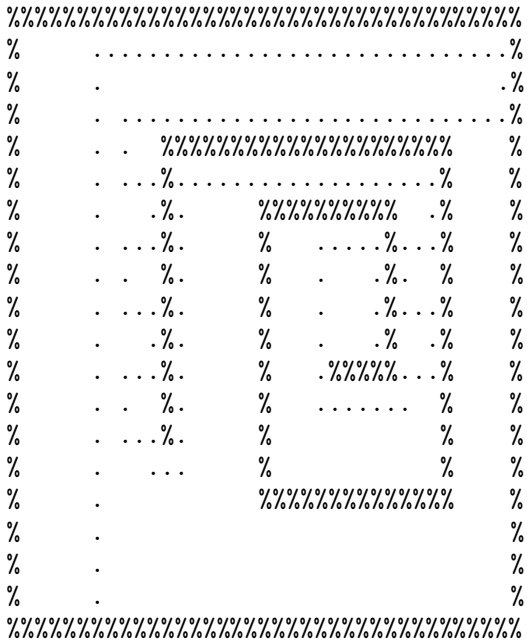


A_star
Node expanded 308
path cost 62

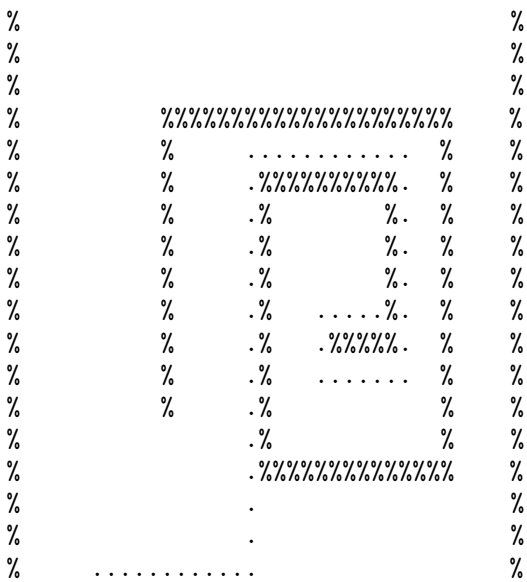


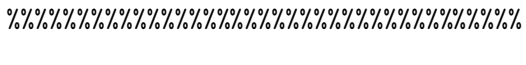


DFS
Node expanded 378
path cost 156

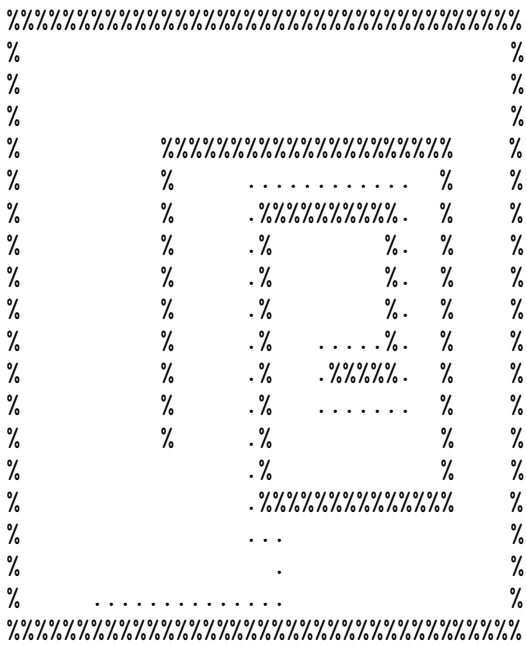


BFS
Node expanded 537
path cost 54

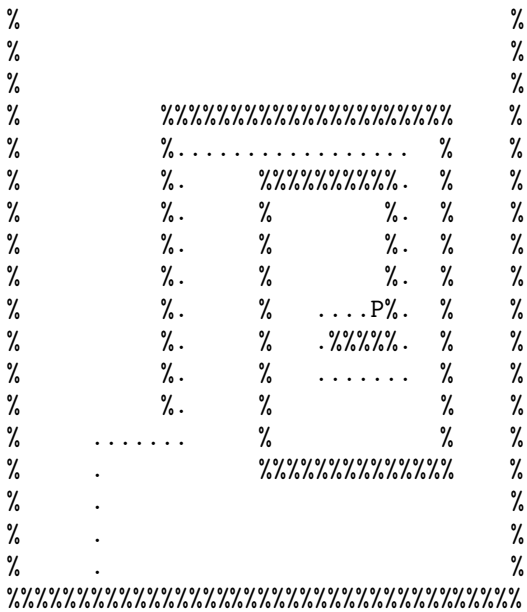




Greedy
Node expanded 282
path cost 72



A_star
Node expanded 228
path cost 54



1.2 Penalizing turns

1) Small Maze:

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Turn: 1, Forward: 2
Node expanded 140
path cost 52
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Turn: 2, Forward: 1
Node expanded 151
path cost 66
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2) Big Maze:

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Turn: 1, Forward: 2
Node expanded 321
path cost 58
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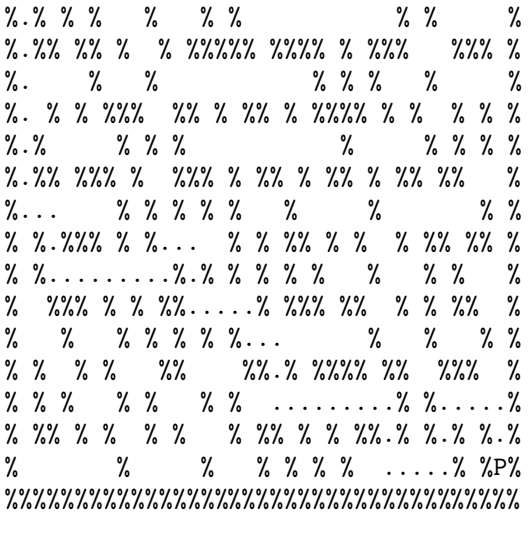

```
Turn: 2, Forward: 1
Node expanded 461
path cost 58
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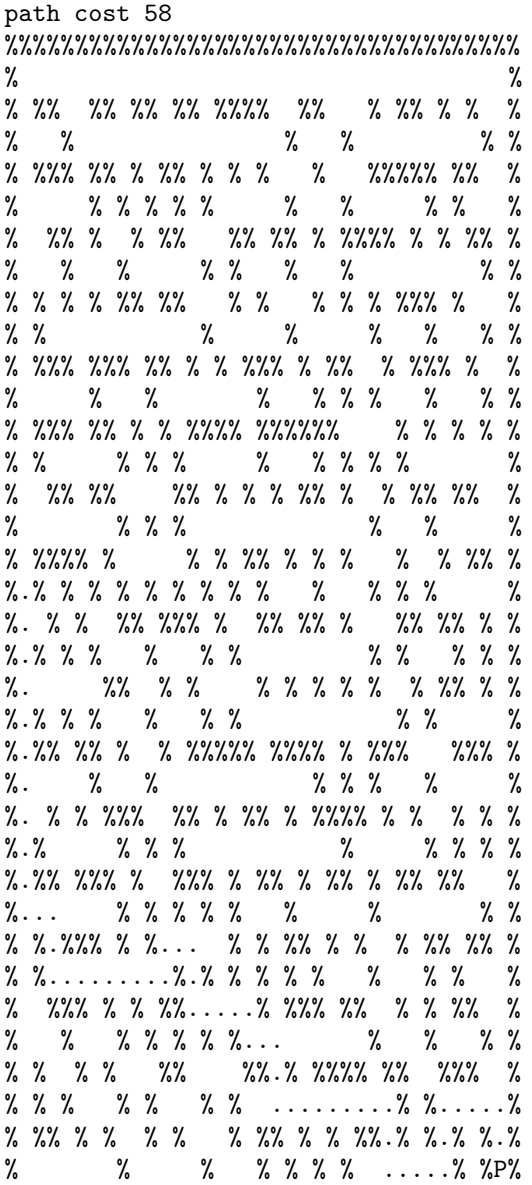

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3) New Heuristic Function:

Since, if the current position of pacman is not on the same line as the goal
or there is a wall between current position and the goal, pacman has to take at
least 2 turns and move 3 steps.

Therefore, a addmissible new heuristic function would be:
H(pos, goal) = min(H(pos+dir, goal) + f(pos, pos+dir), where
if there is no wall between p1 and p2, f(p1, p2) = forward * 1,
else if there is a wall between p1 and p2, f(p1, p2) = forward * 3 + turn * 2.

This new heuristic function reduces the number of nodes expanded during the
search. Here is data comparison

New 1) Small Maze:

For Turn: 2, Forward: 1
Old Heuristic Function: Node expanded: 151, path cost: 66
New Heuristic Function: Nodes expanded: 135, path cost: 66

For Turn: 1, Forward: 2
Old Heuristic Function: Node expanded: 140, path cost: 52
New Heuristic Function: Nodes expanded: 130, path cost: 52

New 2) Big Maze:

For Turn: 2, Forward: 1
Old Heuristic Function: Node expanded: 461, path cost: 66
New Heuristic Function: Nodes expanded: 368, path cost: 66

For Turn: 1, Forward: 2
Old Heuristic Function: Node expanded: 321, path cost: 62
New Heuristic Function: Nodes expanded: 258, path cost: 62

1.3 Pacman with a ghost

We keep tracking the position of the ghost just like we track the pacman.

When the ghost is detected to be at the same position as the pacman will be
or if pacman and ghost will swap position, we consider that a potential ghost
encounter.

If we have a potential ghost encounter, we set the G Value to be infinite going
through the ghost direction.

Small Maze with Ghost:
Nodes expanded: 21
path cost: 19

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Medium Maze with Ghost:
Nodes expanded: 88
path cost: 26

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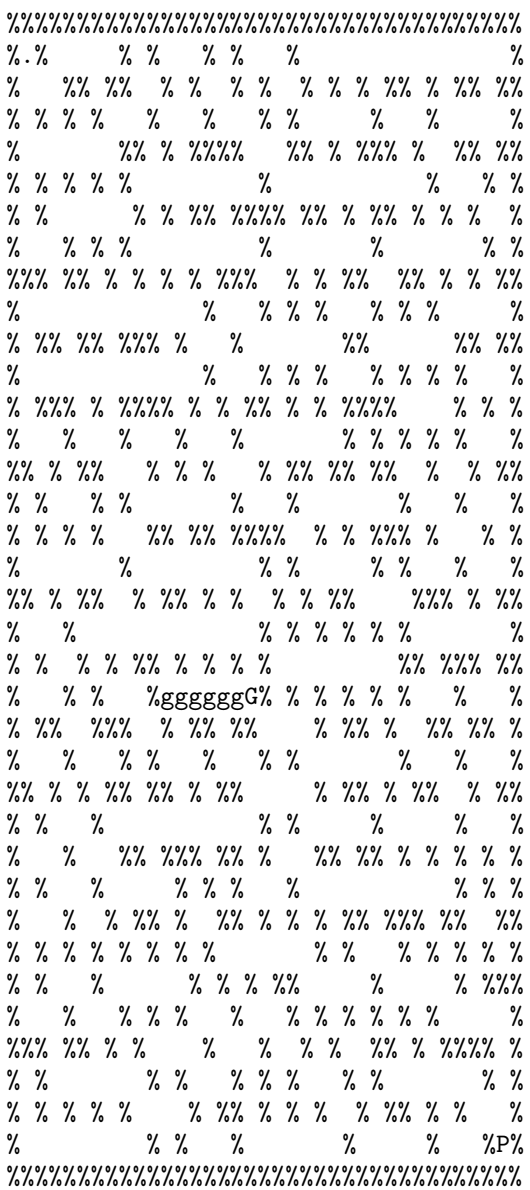
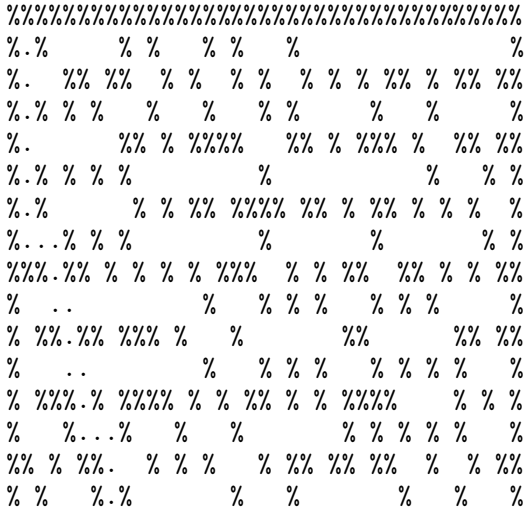
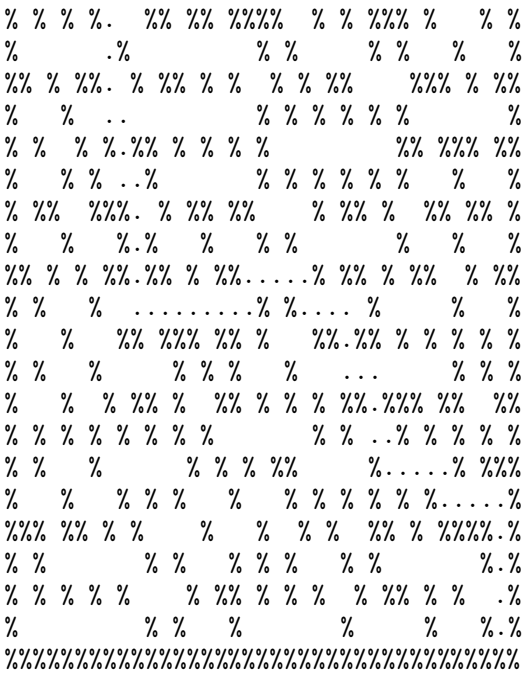
Big Maze with Ghost:
Nodes expanded: 248

path cost: 70







1.4 For full credit

We modified the Heuristic function that is more informed than the current one, Manhattan Distance.

By observation, the mazes we are dealing with can result in different paths of same length. Our algorithm, when finding the optimal path, will explore all these paths with the same length, in another word, paths with the same f value.

To break this tie and encourage the algorithm to favor paths closer to the goal, we scale H value function towards the goal slightly: heuristic *= (1.0 + p)

We chose p so that p < *(minimum cost of taking one step forward) / (expected maximum path cost)*. We expect the path cost to be not more than about 70 by observation, so we chose p = 1/70 ≈0.014*:*

Now that the heuristic function is more informed in the sense that it has an idea of breaking ties by favoring the path closer to the goal.

Comparison:

Big Maze:

For Turn: 2, Forward: 1
Old Heuristic Function: Node expanded: 461, path cost: 66
New Heuristic Function: Nodes expanded: 258, path cost: 66

For Turn: 1, Forward: 2
Old Heuristic Function: Node expanded: 321, path cost: 62
New Heuristic Function: Nodes expanded: 212, path cost: 62