Problem A Report

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4b. *Discuss your new heuristics, are they both admissible and consistent? Why? Then compare the three heuristics (manhattan, euclidean, and random) in terms of performance and explain the differences in performance.*

The implemented Euclidean heuristic is similar to the Manhattan heur. as they both are a function of the current distance to the goal. The Euclidean distance is a more *precise* measurement as it is the coordinate distance exactly to the goal state; however, the Manhattan distance is more *accurate* in terms of the Pacman problem because it measures the distance of legal moves to the goal state (blocks, in this case), making it a consistent and admissible heuristic. In fact, Manhattan expands eight less nodes than the Euclidean (549 to 557, respectively) on the big Pacman maze. The Euclidean distance is consistent because it never measures a distance to the goal that is greater than a neighbouring vertex (similar to Manhattan), but it is not admissible because it will overestimate the amount of moves that it takes to reach the goal state; hence why it expands eight more nodes than Manhattan.

The random heuristic expands a shocking 625 nodes on its search for the goal state, a whole 68 nodes more than the Euclidean heuristic. Because this heuristic is random by nature, it is certainly not consistent. On its search for the goal, it will choose random paths that differ between each neighbouring vertex; decreasing its time and node efficiency. The random heuristic is also not admissible due to its tendency to overestimate the problem when it makes an inefficient random move.

In the case of the Pacman problem, the best heuristic to use for A* search is the Manhattan distance because it appropriately estimates the distance to the goal based on the problem's layout and legal moves. The Euclidean distance is not a *bad* heuristic to use for this problem, as it performs only slightly less efficient than the Manhattan and fits well into the Pacman world scope. The random heuristic is obviously the worst, as it always overestimates the necessary nodes and has no relation to the problem being solved.

5. *What happens on openMaze for the various search strategies? Describe the behaviour seen and explain why it occurs.*

All three search heuristics have the same performance on the openMaze, with Manhattan performing the best and random as the worst. Regardless, it is much easier to observe the behavior of Pacman on the openMaze. With the Manhattan heuristic, Pacman forms a very square, minimal path to the goal and clings to the edges of the maze. The search pattern also looks very uniform and square. With the Euclidean heuristic, Pacman moves in a slightly diagonal and jagged motion, moving to the left and down like a snake slithering towards the goal. This behavior certainly represents its heuristic well simulating the look of a diagonal euclidean line. Since Pacman is not allowed to move diagonally, it must move between several neighbor nodes reducing its efficiency. The random heuristic moves Pacman in a wild, erratic path that changes on each run of the game. It is the only heuristic to cover the map in searched nodes, but its behavior is expected given that the heuristic itself is random.