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### **Rolling Block Maze**

The initial state of the rolling block maze is the block standing upright in the designated start position, a goal position, and various obstacles across the board. The goal test checks to see if the block is standing in the goal position (it checks if the position coordinates of both dice are the same as the goal position coordinates). There are multiple actions that the block can take. If the block is standing, it can flip on its side to the two spaces above it, the two spaces below it, or the two spaces on either side of it as long as it is within the maze and does not hit an obstacle. If the block is lying down, it also can move to all four sides. The path cost is one per action.

For one of the heuristics, we created a modified version of the Manhattan distance. The goal of our heuristic is to estimate the path costs of each position to the goal position in order to choose the optimal path. The Manhattan distance alone as a heuristic was not sufficient for this program because it is not admissible. This is because the block can move 3 spaces in just 2 moves which could result in an overestimate of the actual path cost. To make the heuristic both admissible and consistent, we took the Manhattan distance from the current position to the goal and multiplied it by two-thirds. This ensures that the heuristic will at most be equal to the actual path cost, but will never be an overestimate.

For the second heuristic, we set all estimated path costs to 0 if the block is standing, and 1 if the block is lying down. This heuristic is admissible because it always underestimates the path cost. It is also consistent because the total estimated path cost will be the distance from the start node to the goal node, and this will never overestimate the cost to the goal.

	Maze 1	Maze 2	Maze 3	Maze 4	Maze 5
Nodes in Path	8	18	9	7	39
Nodes Generated	73	119	144	26	270
Nodes Visited	25	59	57	10	132

Modified Manhattan Distance

	Maze 1	Maze 2	Maze 3	Maze 4	Maze 5
Nodes in Path	8	18	9	7	39
Nodes Generated	218	137	432	53	274
Nodes Visited	100	68	211	21	137

Trivial Heuristic (0/1)

We found optimal paths to traverse each of the mazes using both heuristics. The modified Manhattan heuristic helped guide the search less optimally than expected in comparison to the trivial heuristic, which performed reasonably well in most of the mazes, the exceptions being Mazes 1 and 3. It generated only 18 more nodes in Maze 2 and 4 more nodes in Maze 5. It also visited only 9 and 5 more nodes in Mazes 2 and 5 respectively. When implementing the trivial heuristic, we expected it to return significantly more nodes generated and visited, but most likely due to the small board space of each maze, it didn't.