

ECE479 HW3
Ajay Katoch & Jessmer Palanca
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The heuristics we used within this assignment were the number of misplaced tiles and the Manhattan distance. These were both implemented using the A* algorithm in Java. The code follows the same layout as the example given in the homework specification. The user gives an initial and goal state. Then they select a heuristic and the the solution is given along with the number of required moves and nodes explored through the A* algorithm. We can then now use this program to compare the heuristics in terms of search efficiency. Both of these heuristics strive to find the actual number of moves from the initial to the goal state. Both of these heuristics provide an underestimate of the actual amount of moves as they are both admissible. As we see through running the program multiple times with various different initial and goal states, the Manhattan distance is actually a better heuristic than the number of misplaced tiles. This is due to the fact that the Manhattan distance gives a value closer to the actual number of required moves from the initial to the goal state. They are both underestimates however the Manhattan distance always seems to have a value closer to the actual number of moves required then the number of misplaced tiles does. The key reason why Manhattan distance is a better heuristic is because this heuristic takes into account the actual distances whereas misplaced tiles does not. This means that since another important variable is taken into account the outcomes will be closer to the ideal value. There is no formal proof for this, but rather this is shown through experimentation with our code. Running multiple different scenarios through this program shows that Manhattan distance is always a more accurate value closer to the ideal value instead of a number of misplaced tiles. Therefore we now know that since manhattan takes into account the actual distances into account it produces a better approximation which is closer to the ideal value instead of the number of misplaced tiles. As you will see below the experiments we ran show that Manhattan distance has a much greater search efficiency than the number of misplaced tiles. These images below will help illustrate this.

```

Enter the initial state:
1 2 3
4 _ 5
7 6 8

Enter the goal state:
_ 1 2
3 4 5
7 6 8

Select the heuristic
a) Number of misplaced tiles
b) Manhattan distance

b
|
Solution:
Move blank up
Move blank right
Move blank down
Move blank left
Move blank left
Move blank up
Move blank right
Move blank right
Move blank down
Move blank left
Move blank left
Move blank up
Move blank right
Move blank down
Move blank right
Move blank up
Move blank left
Move blank left
Move blank down
Move blank right
Move blank up
Move blank right
Move blank down
Move blank left
Move blank left
Move blank up

Given the selected heuristic, the solution required 26 moves.
The A* explored 131 number of nodes to find this solution.

```

```

Enter the initial state:
1 2 3
4 _ 5
7 6 8

Enter the goal state:
_ 1 2
3 4 5
7 6 8

Select the heuristic
a) Number of misplaced tiles
b) Manhattan distance

a

Solution:
Move blank left
Move blank up
Move blank right
Move blank right
Move blank down
Move blank left
Move blank up
Move blank left
Move blank down
Move blank right
Move blank right
Move blank up
Move blank left
Move blank left

Given the selected heuristic, the solution required 14 moves.
The A* explored 475 number of nodes to find this solution.

```

As we can see on the right side we have the number of misplaced tiles heuristic and on the left side we have the Manhattan distance heuristic. You can see that the number of nodes visited for the number of misplaced tiles heuristic is much greater at 475 instead of the Manhattan distance heuristic which is at 131. This shows that in terms of search engine efficiency the Manhattan distance heuristic is much more efficient. The reason as explained above why this heuristic is better is very important as it allows almost more than 4 times the search engine efficiency. So overall Manhattan distance is a much better heuristic as it achieves a more accurate result and therefore has a greater search efficiency than the number of misplaced tiles heuristic.