# COMP 472 – ASSIGNMENT 2

## The X-Puzzle

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# The heuristics:

**H1:**  We used the Hamming distance:
The number of tiles out of place

**H2:**  We used the Sum of permutations inversion

**H3:**  We defined h3 such that we increment the cost by 2
for each number not in his correct row

We upgraded the functions to consider both goal_1 and
goal_2 and return the minimum heuristic value between them.

# THE ANALYSIS:

Uniform_cost

```
#############################_uniform_#############################

Total length solution path uniform:  162
Average length solution path uniform:  9.0
Total length search path uniform:  82234
Average length search path uniform:  4568.555555555556
Total Number of No solution uniform:  32
Average Number of No solution uniform:  0.64
Total cost uniform:  183
Average cost uniform:  10.166666666666666
Total excution time uniform:  236.81678799999997
Average excution time uniform:  13.15648822222222
```

```
###################################_greedy_h1_###################################

Total length solution path Greedy_h1:  49
Average length solution path Greedy_h1:  9.8
Total length search path Greedy_h1:  111
Average length search path Greedy_h1:  22.2
Total Number of No solution Greedy_h1:  45
Average Number of No solution Greedy_h1:  0.9
Total cost Greedy_h1:  63
Average cost Greedy_h1:  12.6
Total excution time Greedy_h1:  0.0028917999999133582
Average excution time Greedy_h1:  0.0005783599998267164

###########################_greedy_h2_###############################

Total length solution path Greedy_h2:  205
Average length solution path Greedy_h2:  15.76923076923077
Total length search path Greedy_h2:  14063
Average length search path Greedy_h2:  1081.7692307692307
Total Number of No solution Greedy_h2:  37
Average Number of No solution Greedy_h2:  0.74
Total cost Greedy_h2:  302
Average cost Greedy_h2:  23.23076923076923
Total excution time Greedy_h2:  39.255043900000146
Average excution time Greedy_h2:  3.0196187615384726
```

# THE ANALYSIS:

## Greedy_BestFirst _Search

# The analysis:

Optimality of the solution path.

|  | Uniform cost | Greedy_h1 | Greedy_h2 | aStar_h1 | aStar_h2 |
|---|---|---|---|---|---|
| Avg Length solution path | 9 | 9.8 | 15.77 | 11.04 | 11.24 |
| Avg cost | 10.16666 | 12.6 | 23.23 | 12.86 | 13.3 |
| Avg execution time | 13.16 | 0.00058 | 3.02 | 1.47 | 2.91 |
| Avg No solution | 64% | 90% | 74% | 0% | 0% |

```
#############################_aStar_h1_#####################

Total length solution path aStar_h1:  37
Average length solution path aStar_h1:  12.33333333333334
Total length search path aStar_h1:  2689
Average length search path aStar_h1:  896.3333333333334
Total cost aStar_h1:  39
Average cost aStar_h1:  13.0
Total excution time aStar_h1:  6.929896399999992
Average excution time aStar_h1:  2.309965466666664


#############################_aStar_h2_#####################

Total length solution path aStar_h2:  39
Average length solution path aStar_h2:  13.0
Total length search path aStar_h2:  14740
Average length search path aStar_h2:  4913.333333333333
Total cost aStar_h2:  49
Average cost aStar_h2:  16.33333333333332
Total excution time aStar_h2:  168.9249809
Average excution time aStar_h2:  56.30832696666667
```

# THE SCALED-UP EXPERIMENT: 3*4

```
###############################_aStar_h1_###############

Total length solution path aStar_h1:  42
Average length solution path aStar_h1:  14.0
Total length search path aStar_h1:  5970
Average length search path aStar_h1:  1990.0
Total cost aStar_h1:  47
Average cost aStar_h1:  15.6666666666666666
Total excution time aStar_h1:  22.7192588
Average excution time aStar_h1:  7.5730862666666665


###########################_aStar_h2_#######################

Total length solution path aStar_h2:  44
Average length solution path aStar_h2:  14.6666666666666666
Total length search path aStar_h2:  20672
Average length search path aStar_h2:  6890.666666666667
Total cost aStar_h2:  52
Average cost aStar_h2:  17.333333333333332
Total excution time aStar_h2:  404.9909749999995
Average excution time aStar_h2:  134.99699016666665
```

# THE SCALED-UP EXPERIMENT: 2*5

```
########################_aStar_h1_########################

Total length solution path aStar_h1:  35
Average length solution path aStar_h1:  11.666666666666666
Total length search path aStar_h1:  2753
Average length search path aStar_h1:  917.6666666666666
Total Number of No solution aStar_h1:  0
Average Number of No solution aStar_h1:  0.0
Total cost aStar_h1:  41
Average cost aStar_h1:  13.666666666666666
Total excution time aStar_h1:  5.6774705
Average excution time aStar_h1:  1.8924901666666667

########################_aStar_h2_########################

Total length solution path aStar_h2:  35
Average length solution path aStar_h2:  11.666666666666666
Total length search path aStar_h2:  2959
Average length search path aStar_h2:  986.3333333333334
Total Number of No solution aStar_h2:  0
Average Number of No solution aStar_h2:  0.0
Total cost aStar_h2:  41
Average cost aStar_h2:  13.666666666666666
Total excution time aStar_h2:  5.7143884
Average excution time aStar_h2:  1.9047961333333332
```

# THE SCALED-UP EXPERIMENT: 2*4

# THE SCALED-UP EXPERIMENT:

| | 2*4 | | 5*2 | | 3*4 | |
|---|---|---|---|---|---|---|
| | h1 | h2 | h1 | h2 | h1 | h2 |
| Avg Length solution path | 11.66 | 11.66 | 14 | 14.66 | 12.33 | 13 |
| Avg cost | 13.66 | 13.66 | 15.66 | 17.33 | 13 | 16.33 |
| Avg ex_ time | 1.89 | 1.90 | 7.57 | 134.99 | 2.31 | 56.31 |

Tasks distribution:

Toufik: Greedy alg, main, combined_code_with_analysis, heuristic.

Sandy: Uniform_cost alg, output files, Node class, heuristic, analysis.

Shadi: aStar alg, generate_successors fun, heuristic, analysis, scaledUp.