# ANA* Implementation Report

The algorithm was benchmarked with the original A* algorithm and the results obtained have been reported below.

For the Mazes given by the TA:

**A* Performance**

| Parameters | Medium | Hard | Very Hard |
|---|---|---|---|
| Cost G (units) | 3228 | 8228 | 18062 |
| Time Taken (sec) | 0.1178 | 0.3694 | 2.7229 |

A* Output – Hard Maze

**ANA* Performance**

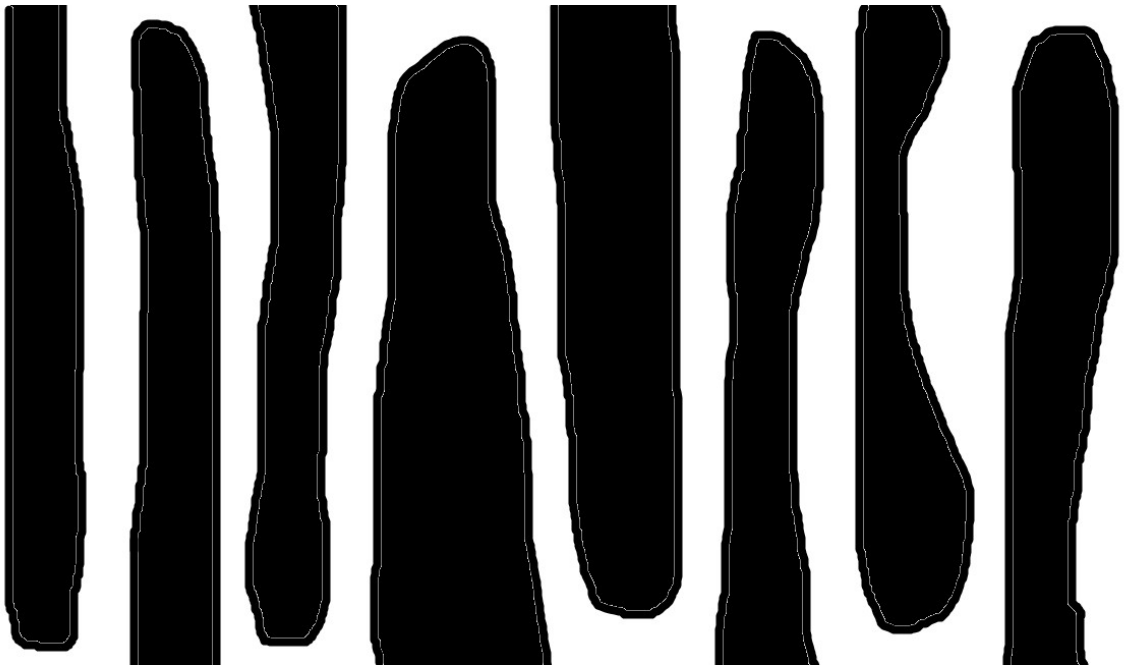
| Improvements | Parameters | Medium | Hard | Very Hard |
|---|---|---|---|---|
| 1 | Cost G (units) | 3228 | 8286 | 18062 |
| | Sub-Optimality E | $3.25 \times 10^{12}$ | $1.620 \times 10^{12}$ | $6.798 \times 10^{12}$ |
| | Time Taken (sec) | 0.1374 | 0.3431 | 3.6829 |
| | | | | |
| 2 | Cost G (units) | 3226 | 8228 | 18062 |
| | Sub-Optimality E | 2.8912 | 1.0042 | 9.0282 |
| | Time Taken (sec) | 0.1474 | 0.5066 | 3.9093 |

**ANA* Output – Hard Maze**

For the following searchable grid maps:

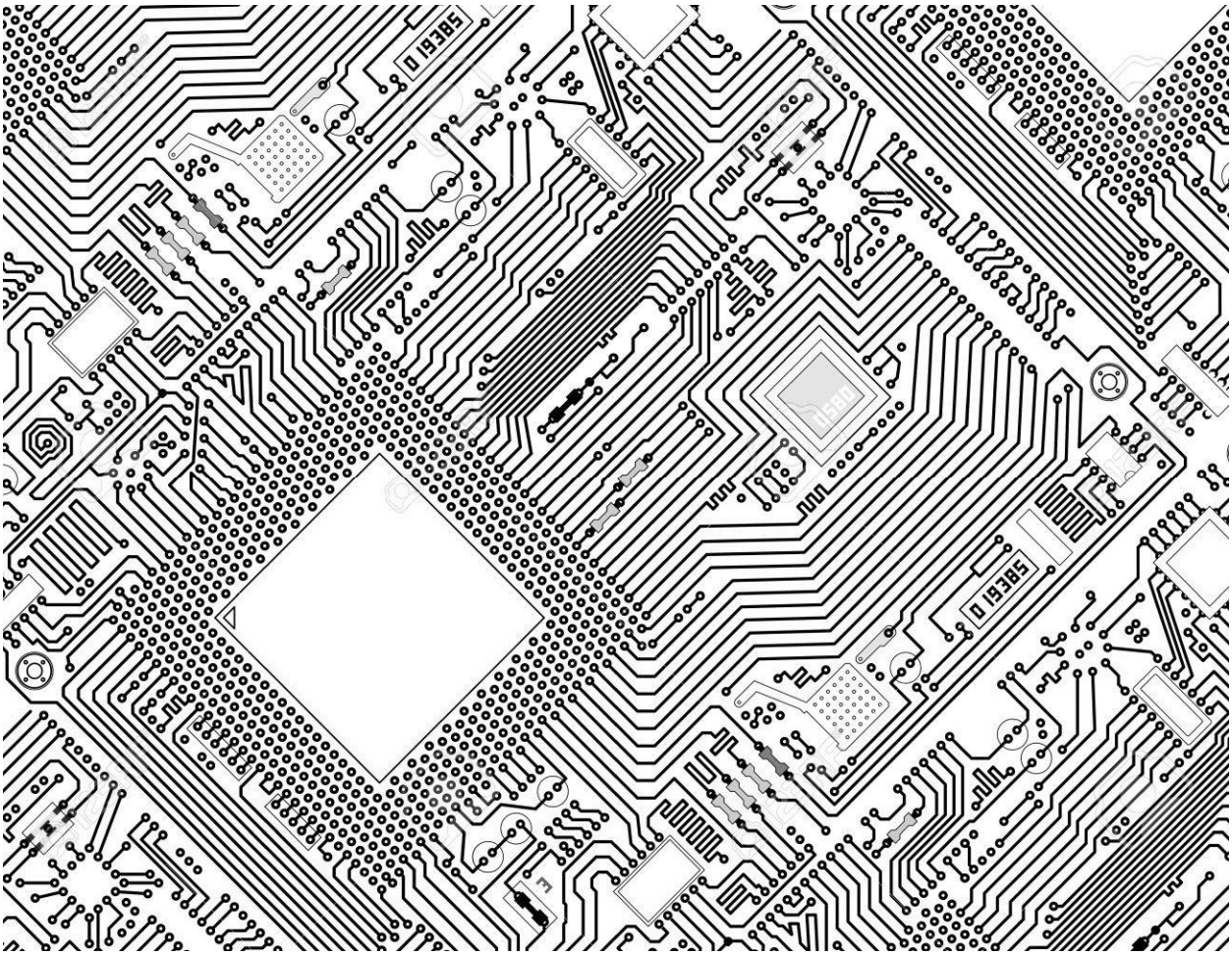
**MAP 1**

**MAP 2**



**MAP 3**

**CRAZY MAP**



**A* Performance**

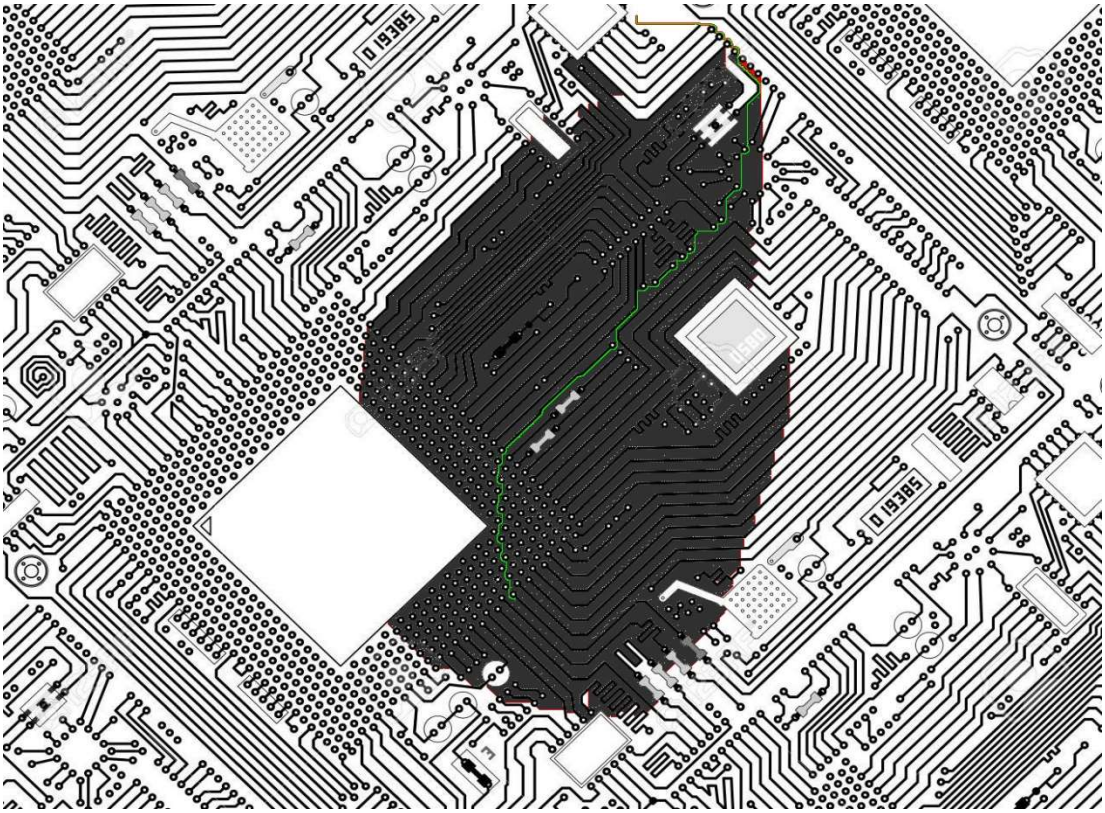
| Parameters | Map 1 | Map 2 | Map 3 | Crazy Map |
|---|---|---|---|---|
| Start node | (5, 5) | (5, 5) | (5, 5) | (604, 741) |
| End node | (1140, 640) | (1140, 640) | (1140, 640) | (749, 13) |
| Cost G (units) | 1952 | 6588 | 1920 | 1248 |
| Time Taken (sec) | 2.408 | 2.2370 | 0.9444 | 1.5408 |

**A* output – Map 1**

**A* output – Map 2**

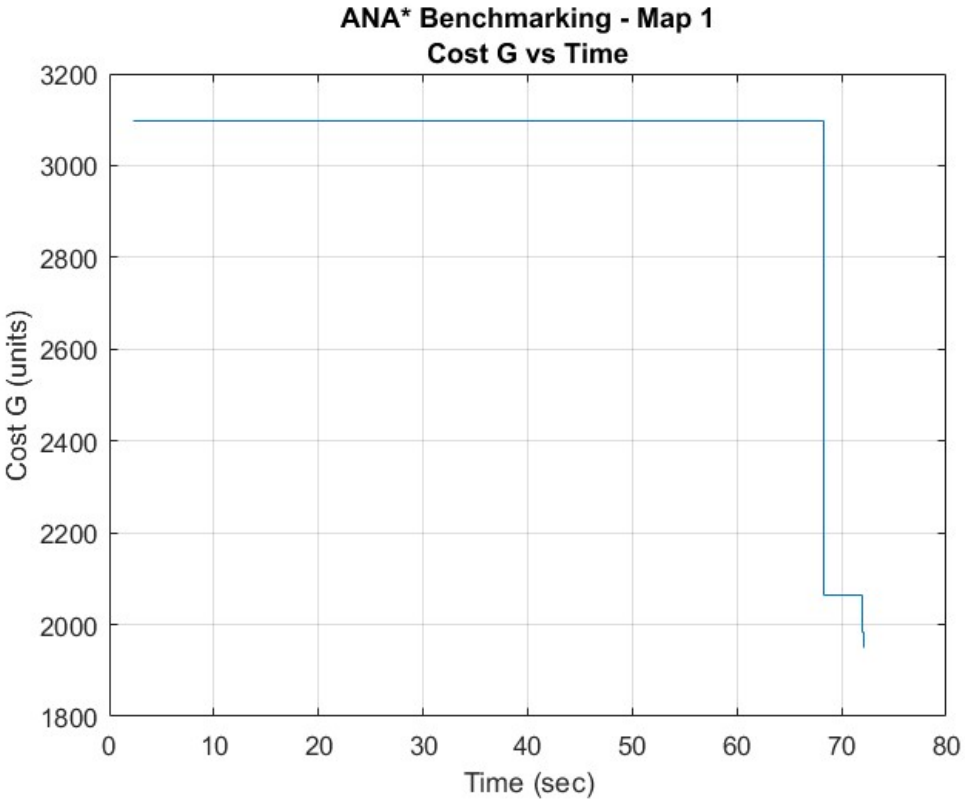
**A* output – Map 3**

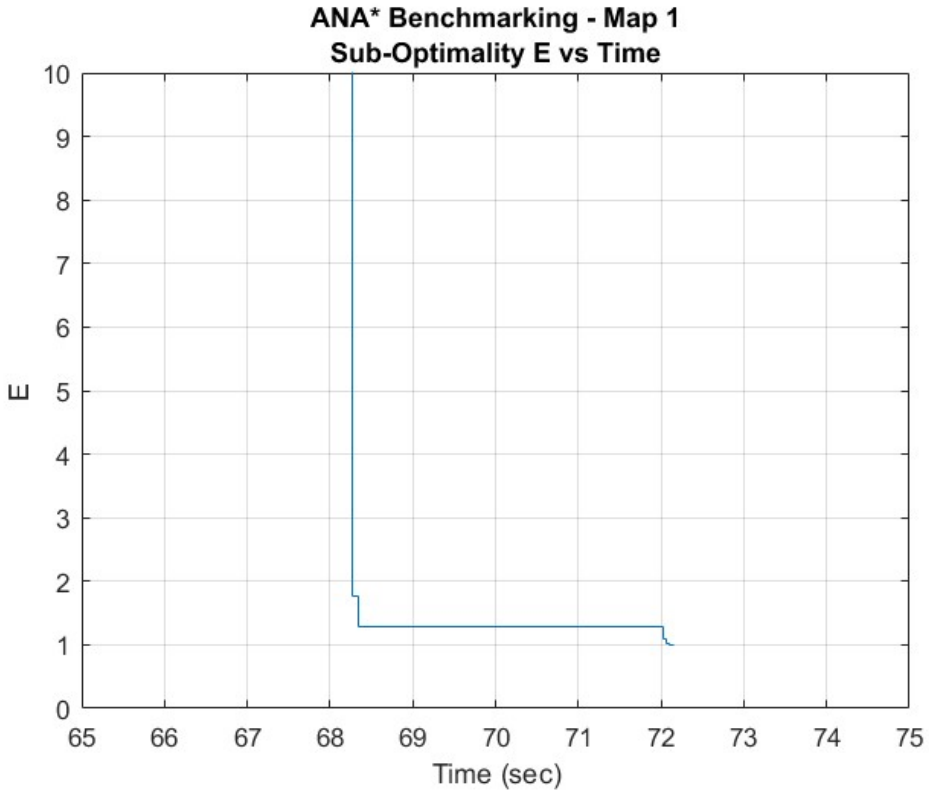
**A* output – Crazy Map**

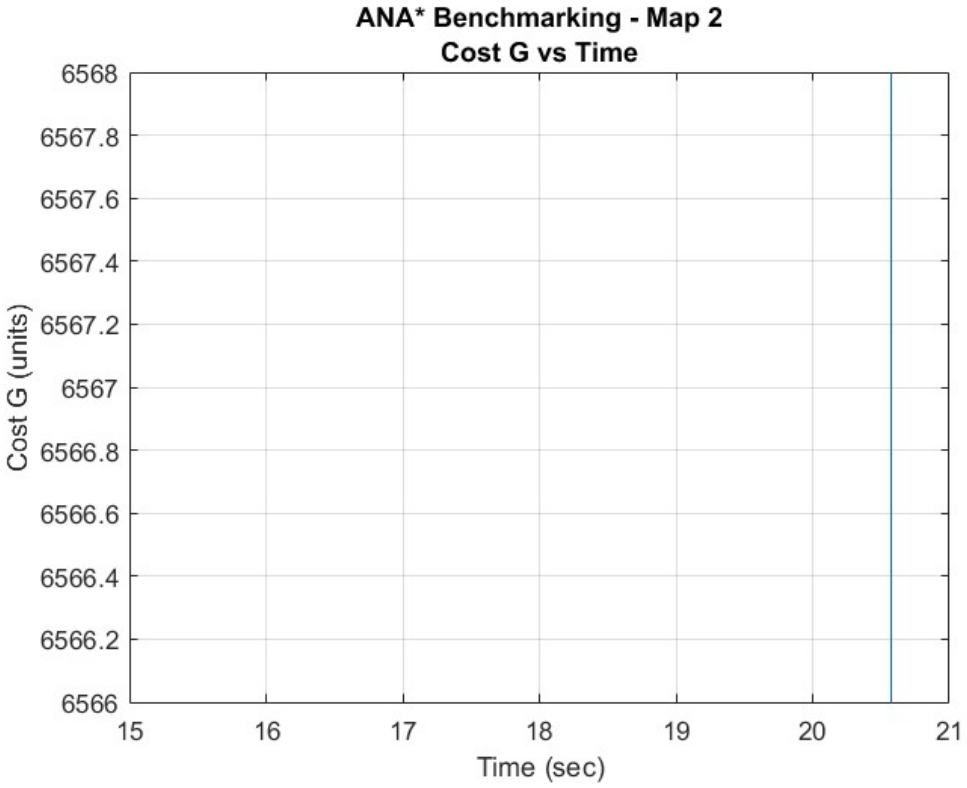


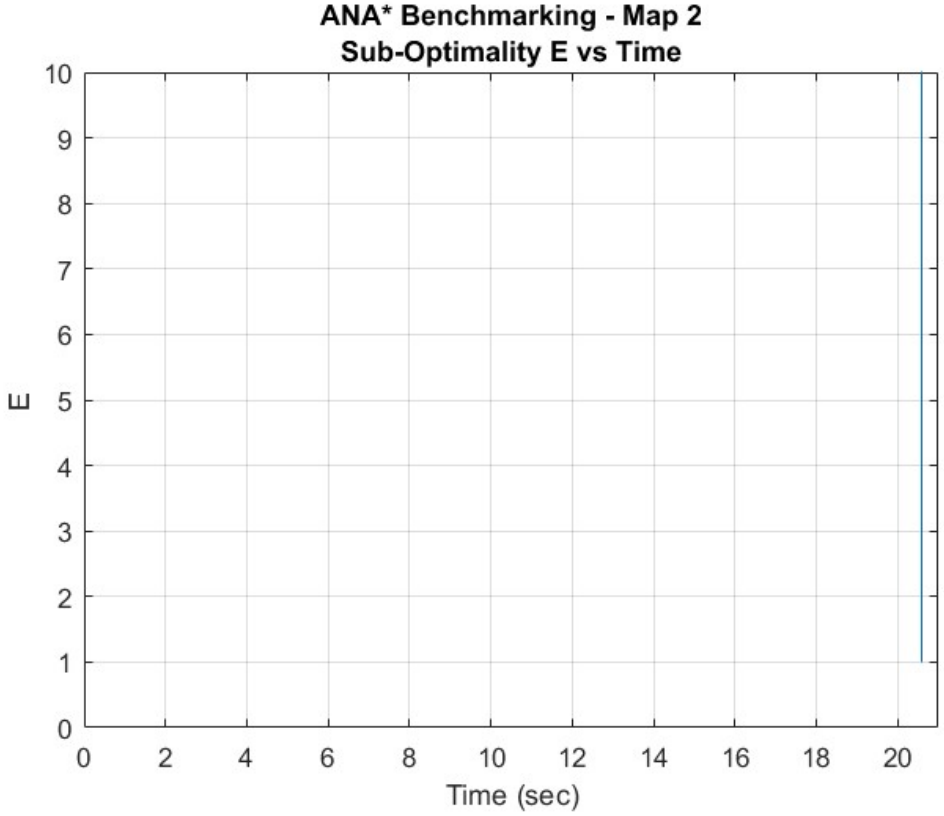
**ANA* Performance** (for the same start and end nodes)

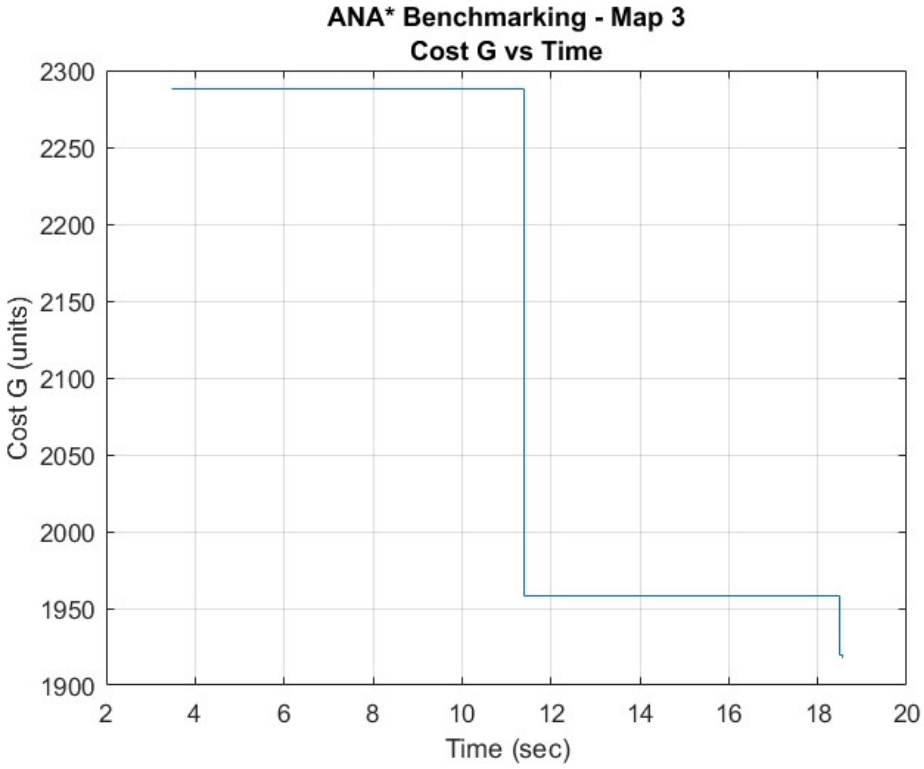
| Improvements | Parameters | Map 1 | Map 2 | Map 3 | Crazy Map |
|---|---|---|---|---|---|
| 1 | Cost G (units) | 3096 | 6566 | 2288 | 1614 |
| | Sub-Optimality E | $5.61 \times 10^{11}$ | $5.61 \times 10^{11}$ | $5.61 \times 10^{11}$ | $1.14 \times 10^{12}$ |
| | Time Taken (sec) | 2.302 | 15.723 | 3.488 | 0.4167 |
| | | | | | |
| **2** | Cost G (units) | 2132 | 6566 | 1958 | 1294 |
| | Sub-Optimality E | 1.768 | 1.0025 | 1.588 | 1.983 |
| | Time Taken (sec) | 68.277 | 20.579 | 11.3929 | 1.4243 |
| | | | | | |
| **3** | Cost G (units) | 2064 | | 1920 | 1248 |
| | Sub-Optimality E | 1.2857 | | 1.0905 | 1.197 |
| | Time Taken (sec) | 68.349 | | 18.500 | 5.9703 |
| | | | | | |
| **4** | Cost G (units) | 1982 | | 1918 | 1248 |
| | Sub-Optimality E | 1.093 | | 1.0014 | 1.0012 |
| | Time Taken (sec) | 72.034 | | 18.560 | 6.5681 |
| | | | | | |
| **5** | Cost G (units) | 1962 | | | |
| | Sub-Optimality E | 1.092 | | | |
| | Time Taken (sec) | 72.0615 | | | |
| | | | | | |
| **6** | Cost G (units) | 1956 | | | |
| | Sub-Optimality E | 1.0245 | | | |
| | Time Taken (sec) | 72.071 | | | |
| | | | | | |
| **7** | Cost G (units) | 1954 | | | |
| | Sub-Optimality E | 1.006 | | | |
| | Time Taken (sec) | 72.093 | | | |
| | | | | | |
| **8** | Cost G (units) | 1950 | | | |
| | Sub-Optimality E | 1.003 | | | |
| | Time Taken (sec) | 72.1508 | | | |

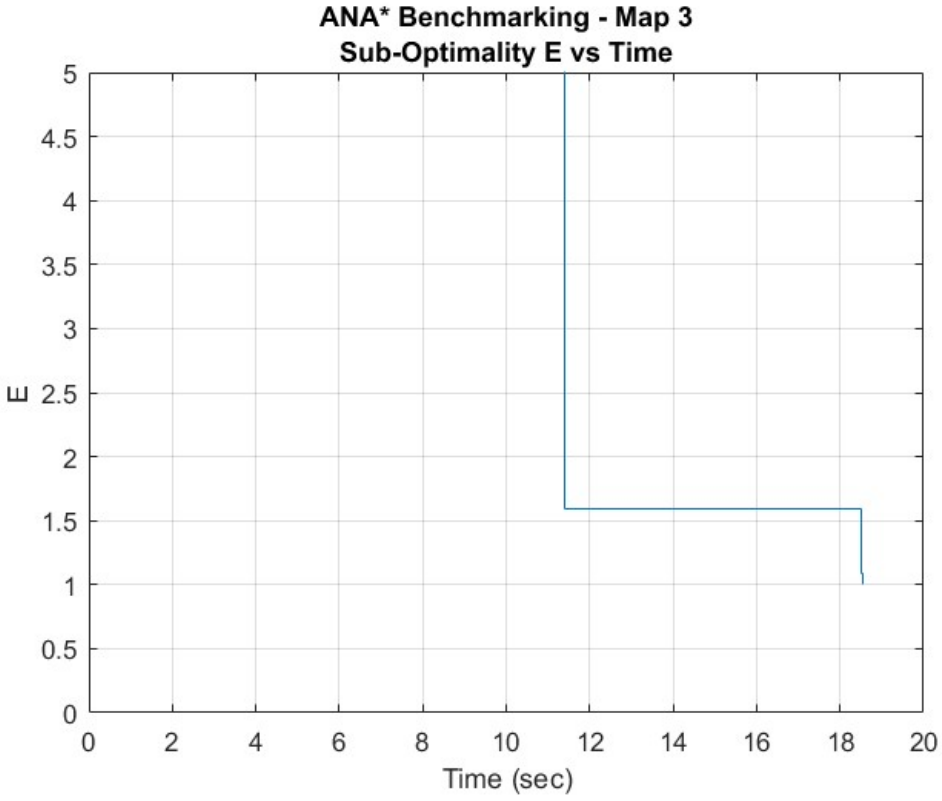

ANA* Benchmarking - Map 1
Cost G vs Time
Cost G (units)
Time (sec)
3200
3000
2800
2600
2400
2200
2000
1800
0
10
20
30
40
50
60
70
80

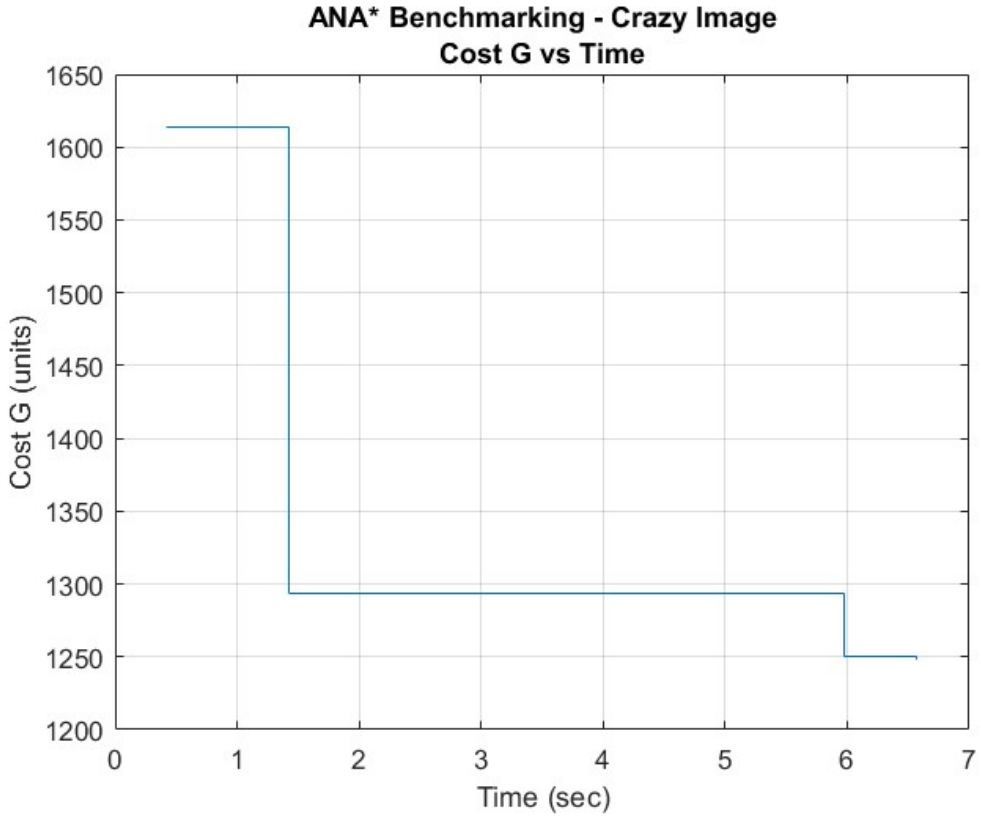

ANA* Benchmarking - Map 1
Sub-Optimality E vs Time
E
Time (sec)
10
9
8
7
6
5
4
3
2
1
0
65
66
67
68
69
70
71
72
73
74
75

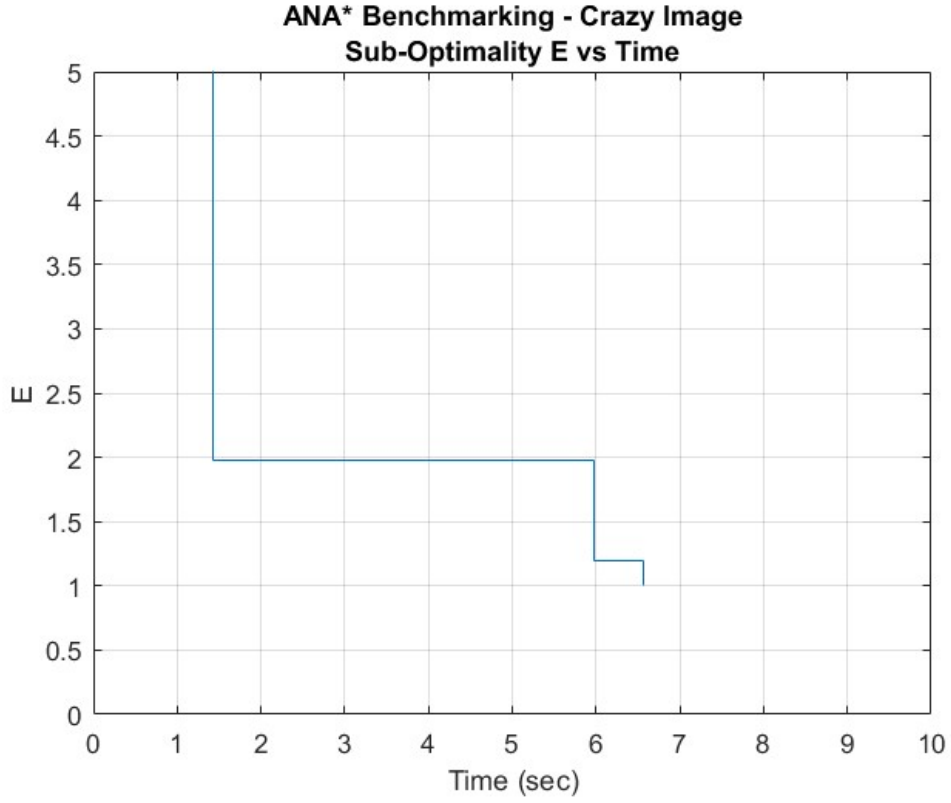

ANA* Benchmarking - Map 2
Cost G vs Time
Cost G (units)
6568
6567.8
6567.6
6567.4
6567.2
6567
6566.8
6566.6
6566.4
6566.2
6566
15
16
17
18
19
20
21
Time (sec)


ANA* Benchmarking - Map 2
Sub-Optimality E vs Time
E
10
9
8
7
6
5
4
3
2
1
0
0
2
4
6
8
10
12
14
16
18
20
Time (sec)


ANA* Benchmarking - Map 3
Cost G vs Time
Cost G (units)
Time (sec)
2300
2250
2200
2150
2100
2050
2000
1950
1900
2
4
6
8
10
12
14
16
18
20


ANA* Benchmarking - Map 3
Sub-Optimality E vs Time
E
Time (sec)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
12
14
16
18
20


ANA* Benchmarking - Crazy Image
Cost G vs Time
Cost G (units)
Time (sec)
1650
1600
1550
1500
1450
1400
1350
1300
1250
1200
0
1
2
3
4
5
6
7

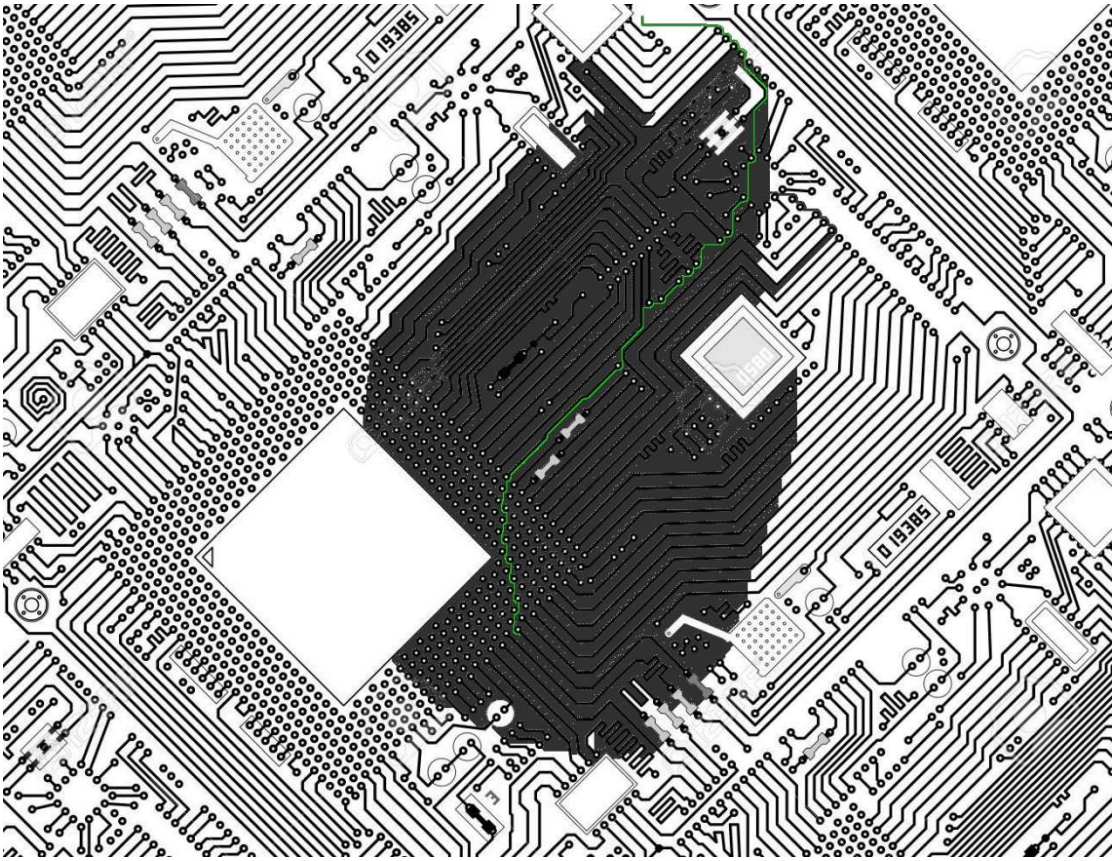

ANA* Benchmarking - Crazy Image
Sub-Optimality E vs Time
E
Time (sec)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5
6
7
8
9
10

**ANA* Output – Map 1**

**ANA* Output - Map 2**

**ANA* Output - Map 3**

**ANA* Output – Crazy**



**RESULTS:**

- A* outperforms ANA* in almost all the Mazes with respect to how fast the algorithm produces an initial optimal solution.
- However, in all our searchable Grid Maps ANA* was quicker to produce an initial sub-optimal solution and it gradually improved over time. The optimality of the solution increases as E decreases from infinity to 1.
- So, to conclude, using ANA* over A* is favorable (and encouraged) when the environment is not too complex.