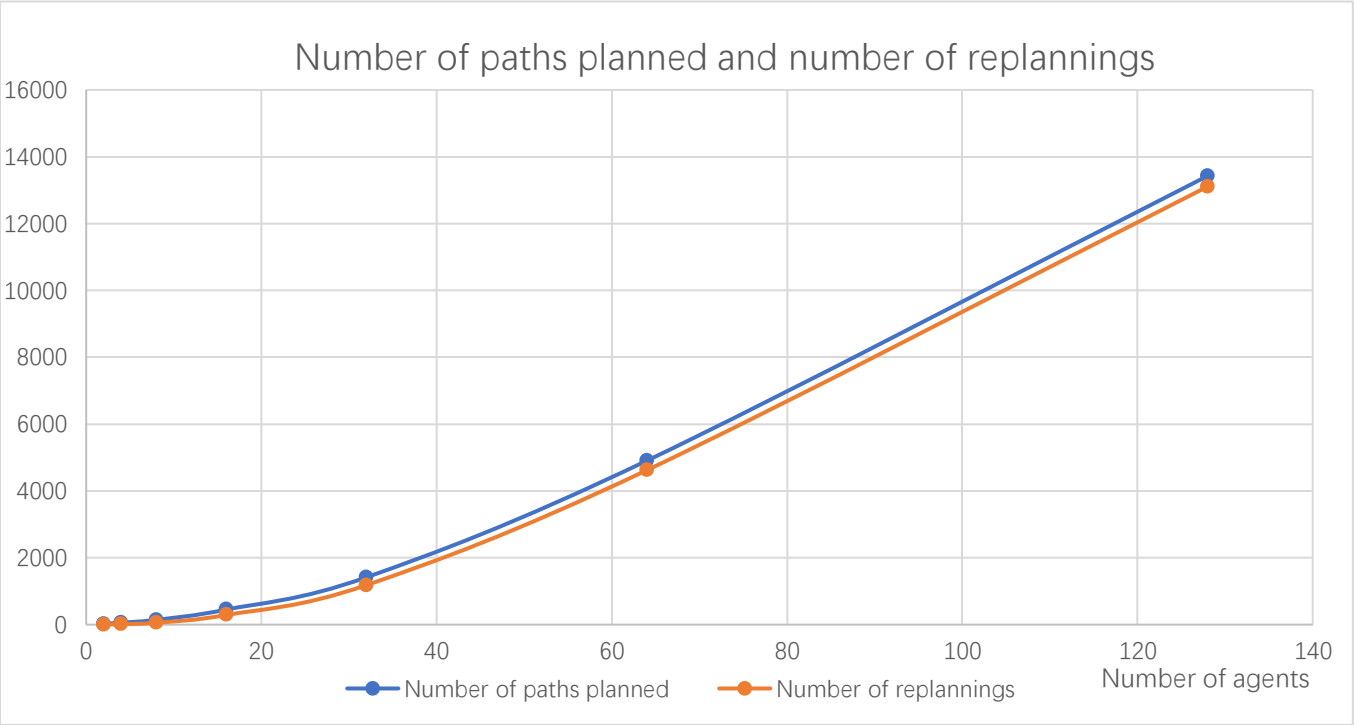
Title: COMP521 A3 by ZiQi Li

- My replanning strategy:

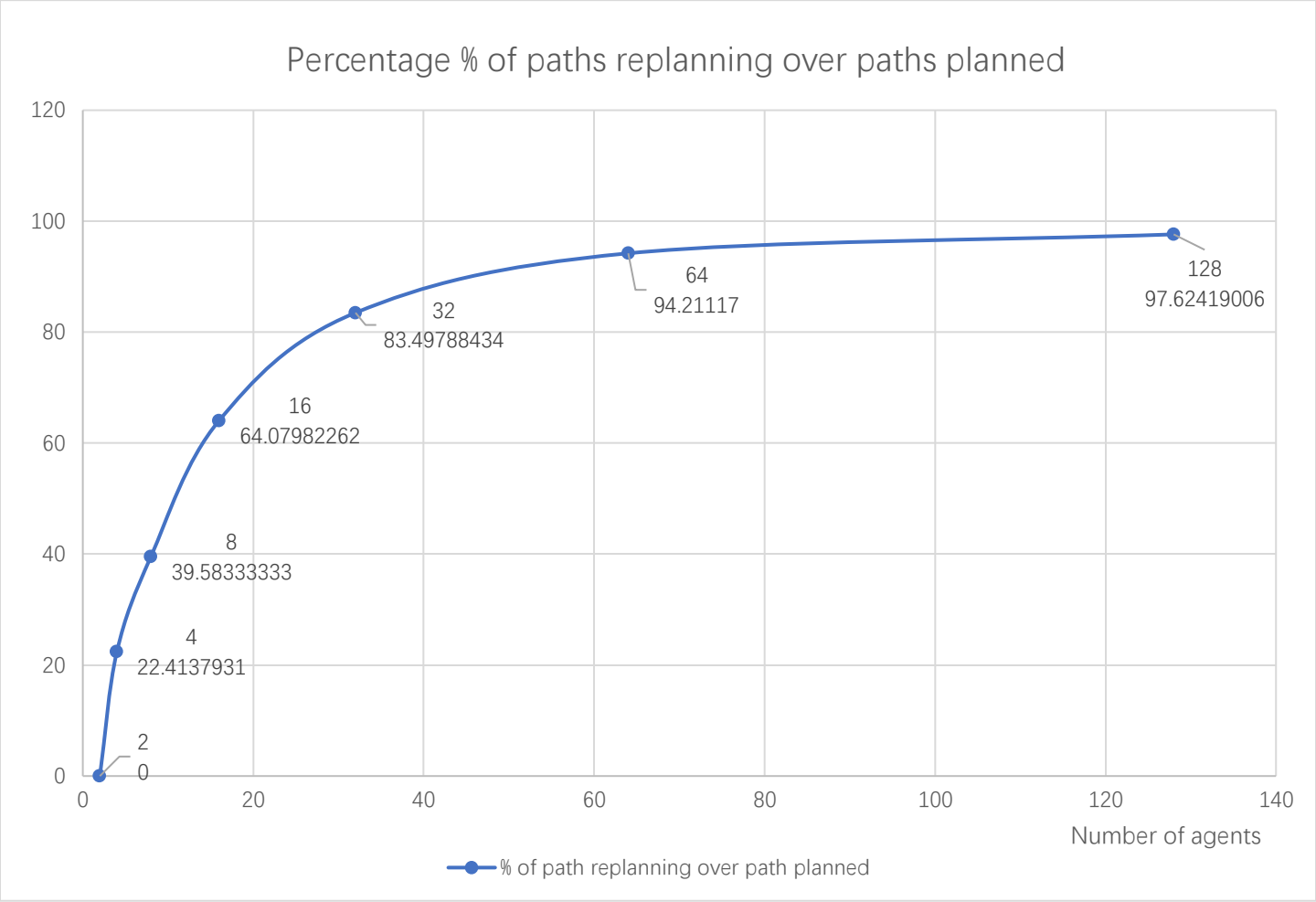
  When an agent (agent A) is going to collide with another agent after a very short amount of time (agent B) which is on the moving direction of agent A, agent A will replan its path to the destination after 100-500ms of stopping. (so if B is moving to the right, and A is moving up and going to collide with B, only A will replan since B is on A's moving path)

- Graphs:

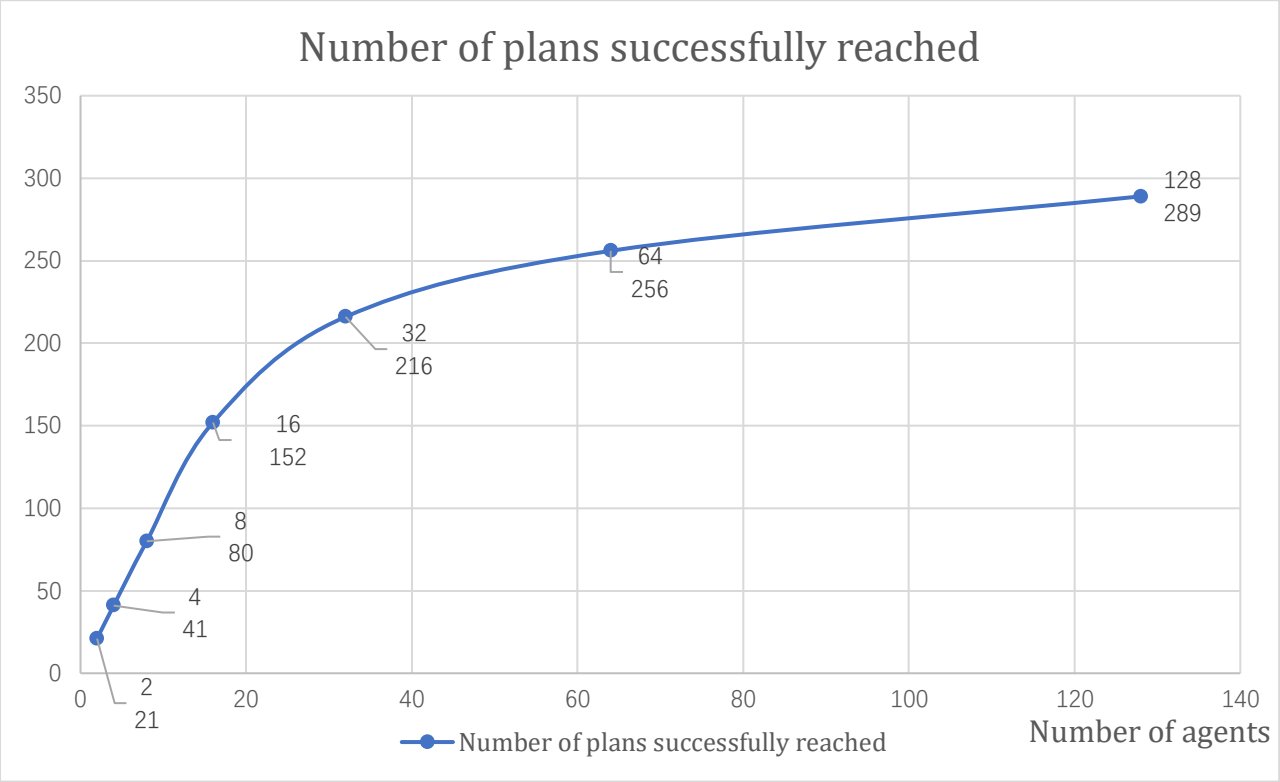
  Note: all the data are collected from the simulation, the values for each case are coming from the average of 3 times of experiments with a running time of 45 seconds. (screenshots are attached at the end of this PDF file)



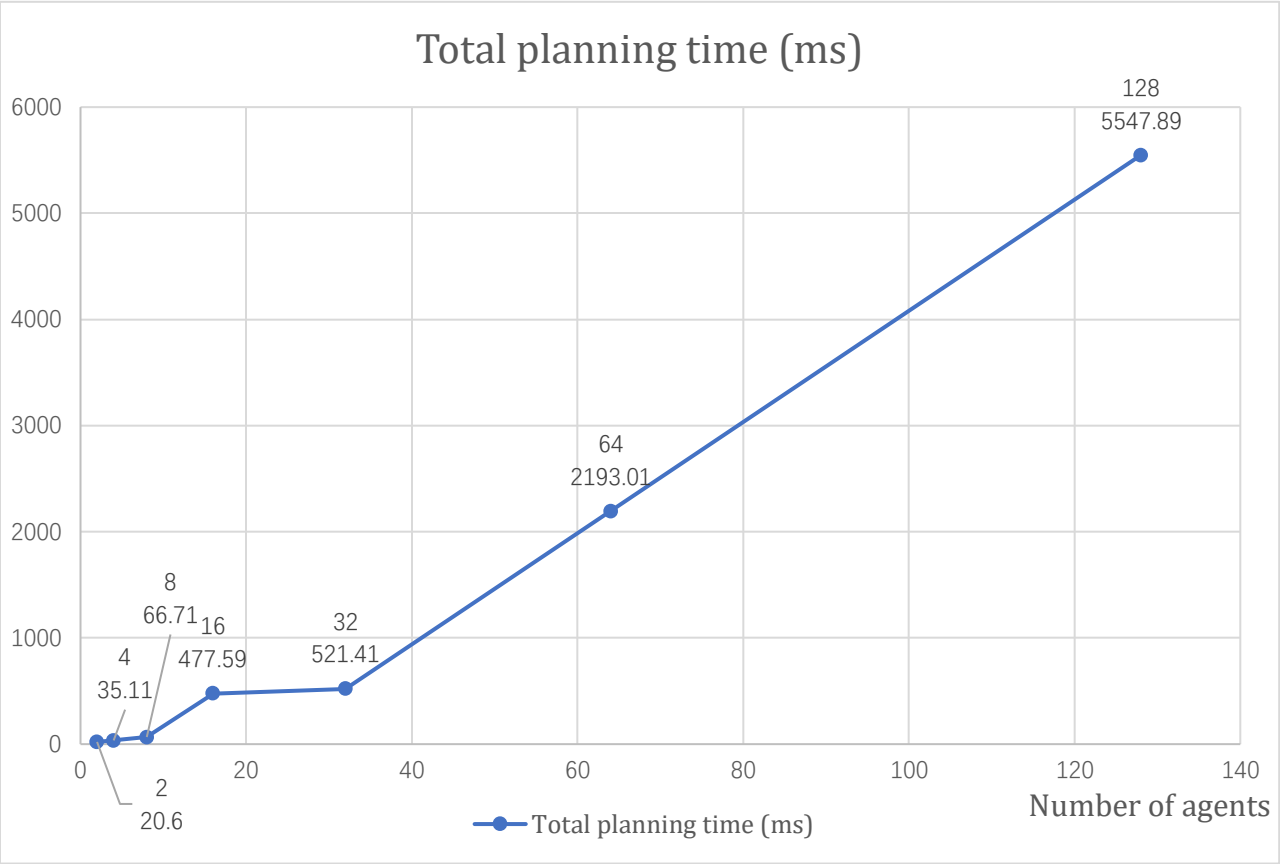
From the above graph, we can calculate the percentage of path replanning over path planned to have a better idea about the data. The new graph is shown below:



From this graph, we can see that as the number of agents is doubled, the percentage of paths replanning over total paths planned increases rapidly. When the number of agents becomes 32, about 83.5% of paths planned by agents are replanning paths, which means that the interference happened seriously between agents in this case.



From this graph, we can see that the rate of change for this graph is decreasing rapidly as the number of agents increases. And after the case with 32 agents, the rate of change is in a very low level. It means that the efficiency of the path finding becomes unacceptable after this case.

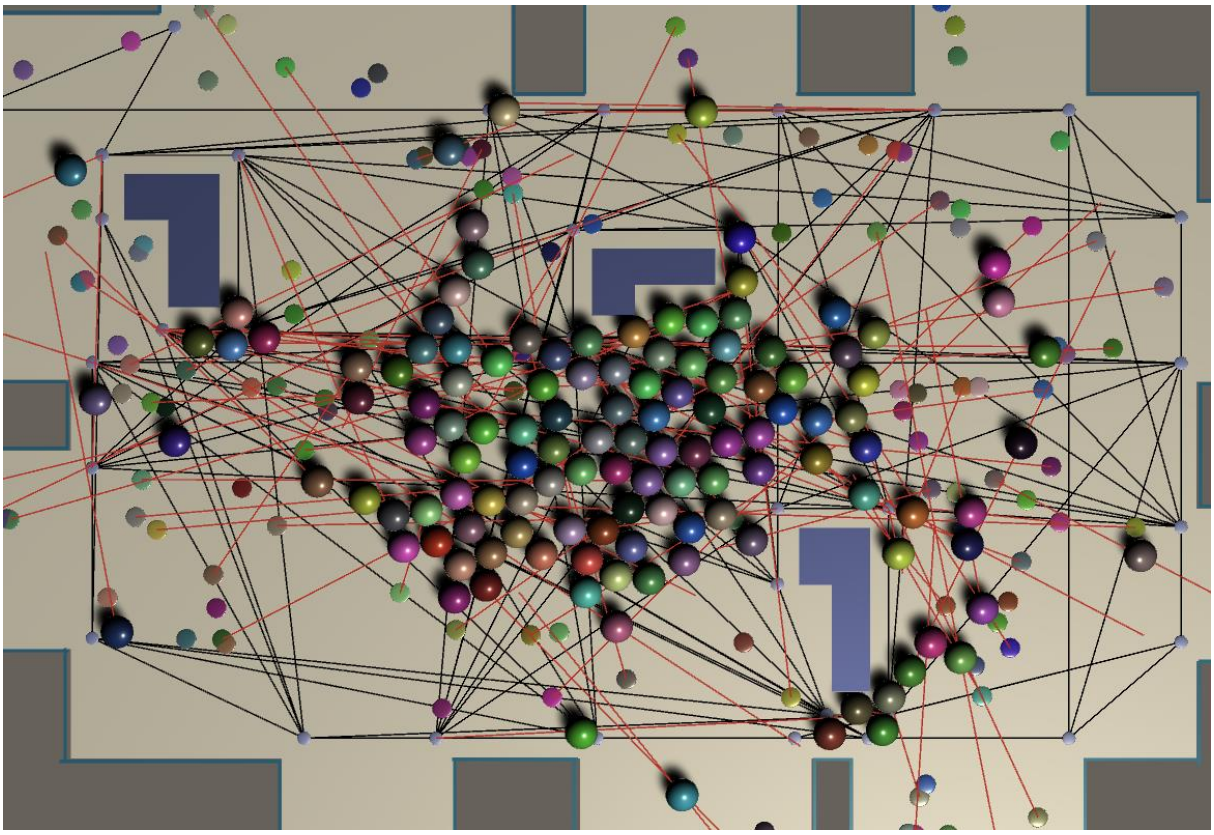


From this graph, we can see that the rate of change for the total planning time increases suddenly when the number of agents becomes 16 and 64. But the total planning time is not changed much when the number of agents increases from 16 to 32, which means that 32 agents on the map is still acceptable in term of total planning time. (Note: total planning time tends to be increased due to the increasing number of agents. But, if the rate of change increases too much, it means that the interference between agents has a big impact on the total planning time due to their replanning process)

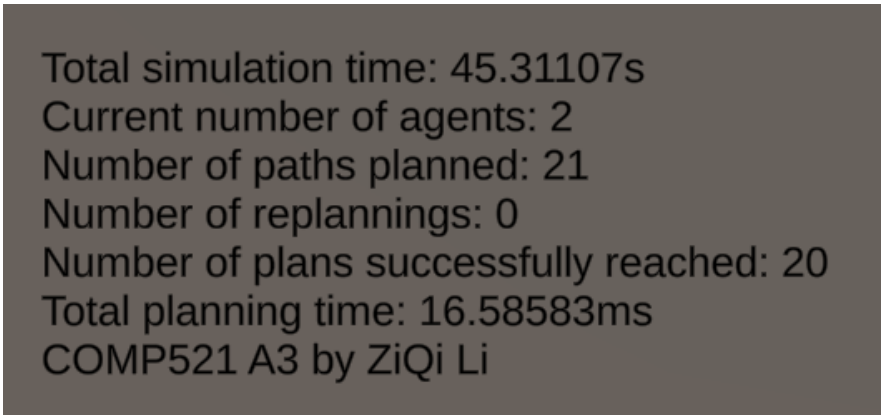
In conclusion, by analyzing all the above graphs, we can estimate that my design can effectively support about 16~25

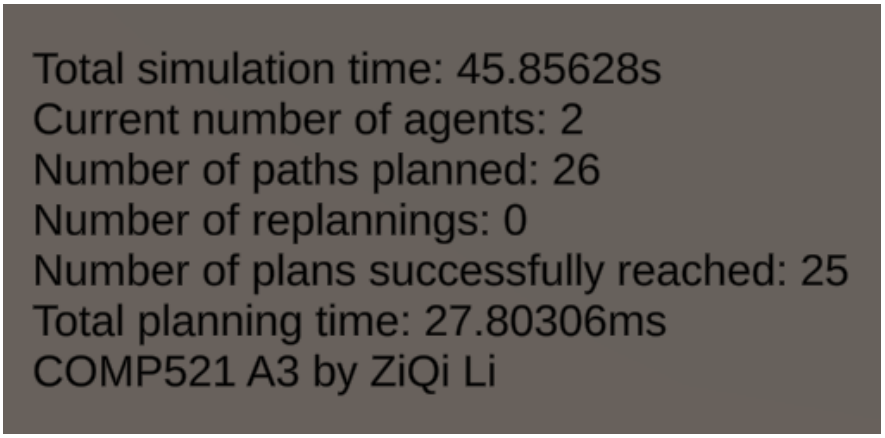
agents. Of course, since the data using for this analysis are not a very huge dataset, some deviations might occur in this analysis due to the randomness of obstacles generation and the randomness of agents' destination choosing process. Also, since the map size and the agent size are some specific values, the simulation data may become very different if we change the sizes.

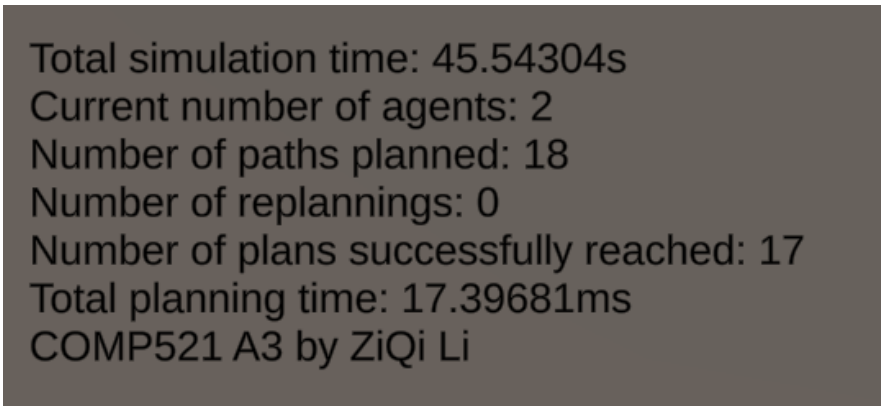
Note: In the case of 128 agents, the most of agents are stuck at the center of map. The behavior is considered to be unacceptable. Thus, the experiment data collection stops at the case of 128 agents. (Image is shown below)



- Data screenshots:
    - 2 Agents case (3 times, each time 45s)







In average:

Number of paths planned = 22

Number of replannings = 0

Number of plans successfully reached = 21

Total planning time = 20.6ms

- 4 Agents case (3 times, each time 45s)

```
Total simulation time: 45.46373s
Current number of agents: 4
Number of paths planned: 56
Number of replannings: 8
Number of plans successfully reached: 44
Total planning time: 40.25328ms
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```
Total simulation time: 45.60738s
Current number of agents: 4
Number of paths planned: 51
Number of replannings: 10
Number of plans successfully reached: 37
Total planning time: 30.48086ms
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```

```
Total simulation time: 45.42186s
Current number of agents: 4
Number of paths planned: 67
Number of replannings: 22
Number of plans successfully reached: 42
Total planning time: 34.61385ms
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```

In average:

Number of paths planned = 58

Number of replannings = 13

Number of plans successfully reached = 41

Total planning time = 35.11ms

- 8 Agents case (3 times, each time 45s)

```
Total simulation time: 45.5677s
Current number of agents: 8
Number of paths planned: 154
Number of replannings: 67
Number of plans successfully reached: 82
Total planning time: 44.8668ms
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```
Total simulation time: 45.74949s
Current number of agents: 8
Number of paths planned: 154
Number of replannings: 69
Number of plans successfully reached: 77
Total planning time: 85.42252ms
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```
Total simulation time: 45.45496s
Current number of agents: 8
Number of paths planned: 123
Number of replannings: 35
Number of plans successfully reached: 81
Total planning time: 69.8719ms
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```

In average:

Number of paths planned = 144

Number of replannings = 57

Number of plans successfully reached = 80

Total planning time = 66.71ms

- 16 Agents case (3 times, each time 45s)

```
Total simulation time: 45.38141s
Current number of agents: 16
Number of paths planned: 498
Number of replannings: 352
Number of plans successfully reached: 136
Total planning time: 222.7588ms
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```
Total simulation time: 45.9626s
Current number of agents: 16
Number of paths planned: 431
Number of replannings: 253
Number of plans successfully reached: 169
Total planning time: 105.7525ms
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```

```
Total simulation time: 45.39874s
Current number of agents: 16
Number of paths planned: 424
Number of replannings: 263
Number of plans successfully reached: 150
Total planning time: 149.0986ms
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```

In average:

Number of paths planned = 451

Number of replannings = 289

Number of plans successfully reached = 152

Total planning time = 477.59ms

- 32 Agents case (3 times, each time 45s)

```
Total simulation time: 45.29933s
Current number of agents: 32
Number of paths planned: 1413
Number of replannings: 1160
Number of plans successfully reached: 233
Total planning time: 474.4259ms
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```

```
Total simulation time: 45.34977s
Current number of agents: 32
Number of paths planned: 1364
Number of replannings: 1132
Number of plans successfully reached: 213
Total planning time: 478.8344ms
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```

```
Total simulation time: 45.32244s
Current number of agents: 32
Number of paths planned: 1476
Number of replannings: 1260
Number of plans successfully reached: 203
Total planning time: 610.9734ms
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```

In average:

Number of paths planned = 1418

Number of replannings = 1184

Number of plans successfully reached = 216

Total planning time = 521.41ms

- 64 Agents case (3 times, each time 45s)

```
Total simulation time: 45.29899s
Current number of agents: 64
Number of paths planned: 5053
Number of replannings: 4758
Number of plans successfully reached: 265
Total planning time: 2314.028ms
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```

```
Total simulation time: 45.28505s
Current number of agents: 64
Number of paths planned: 4822
Number of replannings: 4555
Number of plans successfully reached: 242
Total planning time: 2644.689ms
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```

```
Total simulation time: 45.45265s
Current number of agents: 64
Number of paths planned: 4843
Number of replannings: 4552
Number of plans successfully reached: 260
Total planning time: 1620.304ms
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```

In average:

Number of paths planned = 4906

Number of replannings = 4622

Number of plans successfully reached = 256

Total planning time = 2193.01ms

- 128 Agents case (3 times, each time 45s)

```
Total simulation time: 45.31644s
Current number of agents: 128
Number of paths planned: 13627
Number of replannings: 13292
Number of plans successfully reached: 294
Total planning time: 4091.553ms
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```

```
Total simulation time: 45.34727s
Current number of agents: 128
Number of paths planned: 13474
Number of replannings: 13168
Number of plans successfully reached: 280
Total planning time: 5901.556ms
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```

```
Total simulation time: 45.30474s
Current number of agents: 128
Number of paths planned: 13181
Number of replannings: 12864
Number of plans successfully reached: 294
Total planning time: 6650.571ms
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```

In average:

Number of paths planned = 13427

Number of replannings = 13108

Number of plans successfully reached = 289

Total planning time = 5547.89ms