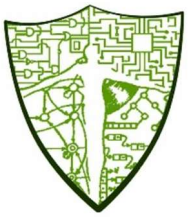
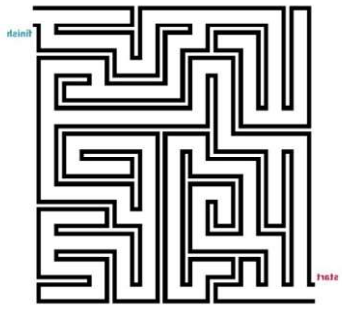
Machine Problem No. 1

"MAZE SEARCH HOORAY"





Introduction to Artificial Intelligence

CMSC 170

October 23, 2017

(Monday)

Submitted to:
Miss Avrie German

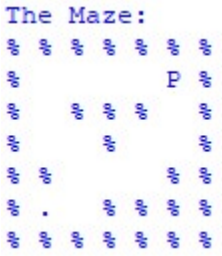
Submitted by:
Bonganay, Arvin
Pama, Jose Arniel

https://github.com/pama-arniel/Maze-Search-Hooray

PYTHON IMPLEMENTATION

PART ONE: BASIC PATHFINDING

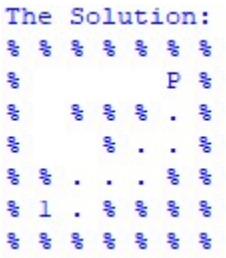
TINY MAZE



Manhattan Distance

Paths:

1.5 2.5 3.5 3.4 4.4 4.3 4.2 5.2 5.1

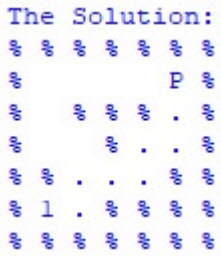


Heuristics: manhattan
Path cost: 8
Nodes expanded: 15
Frontier size: 16

Straight-line Distance

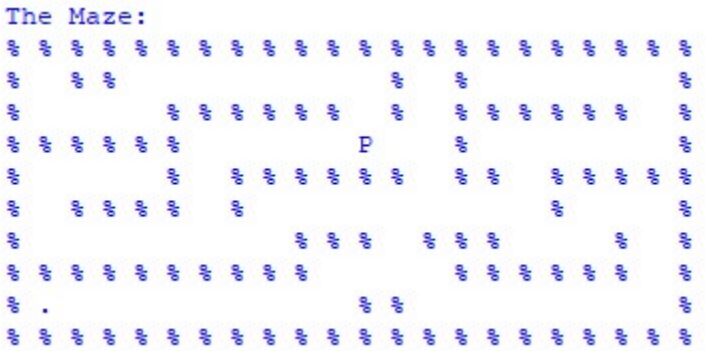
Paths:

1.5 2.5 3.5 3.4 4.4 4.3 4.2 5.2 5.1

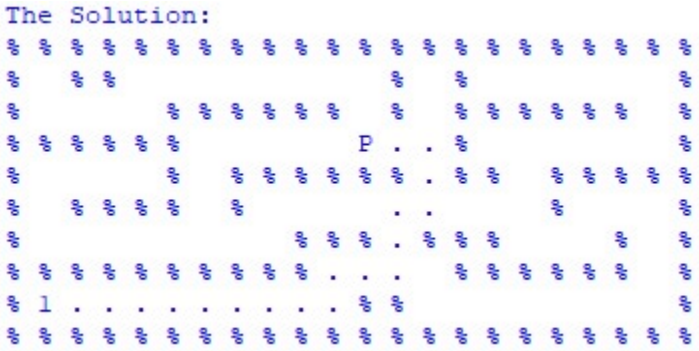


Heuristics: straightline
Path cost: 8
Nodes expanded: 14
Frontier size: 16

SMALL MAZE



Manhattan Distance

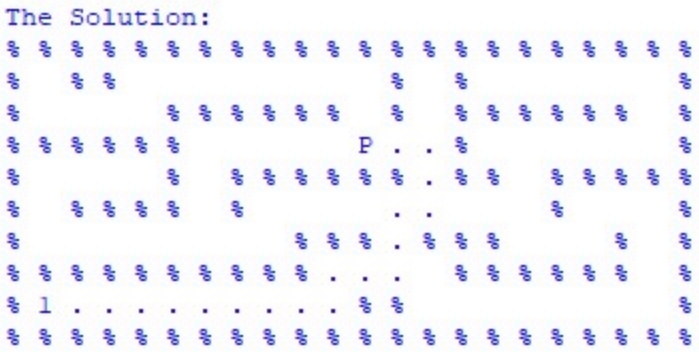


Paths:

3.11 3.12 3.13 4.13 5.13 5.12 6.12 7.12 7.11 7.10 8.10 8.9 8.8 8.7 8.6 8.5 8.4 8.3 8.2 8.1

Heuristics: manhattan
Path cost: 19
Nodes expanded: 54
Frontier size: 59

Straight-line Distance

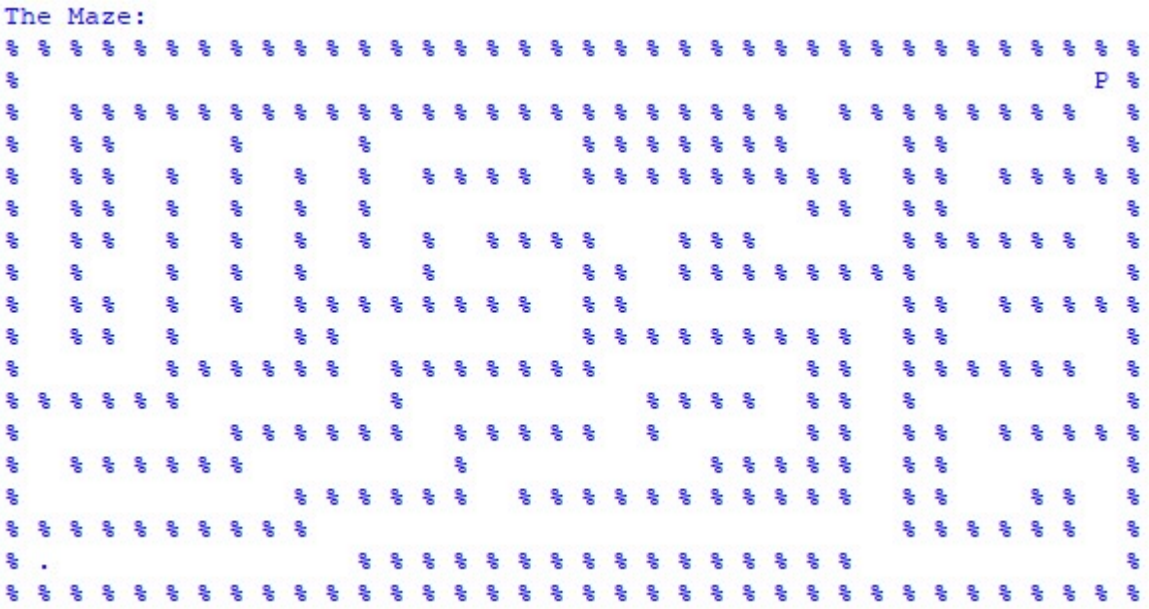


Paths:

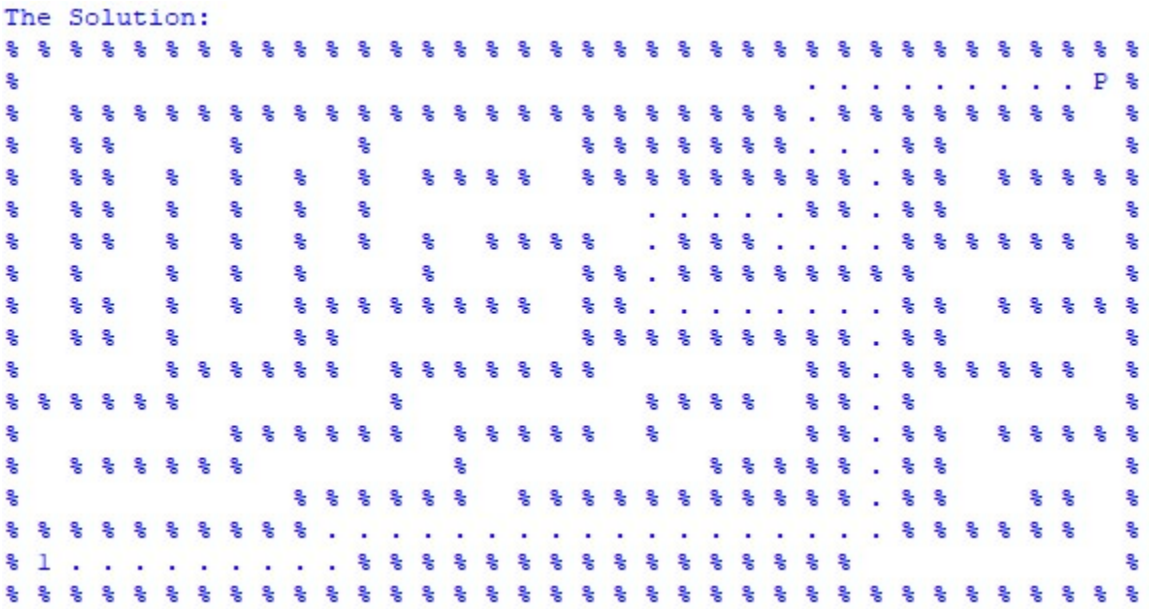
3.11 3.12 3.13 4.13 5.13 5.12 6.12 7.12 7.11 7.10 8.10 8.9 8.8 8.7 8.6 8.5 8.4 8.3 8.2 8.1

Heuristics: straightline
Path cost: 19
Nodes expanded: 57
Frontier size: 61

MEDIUM MAZE



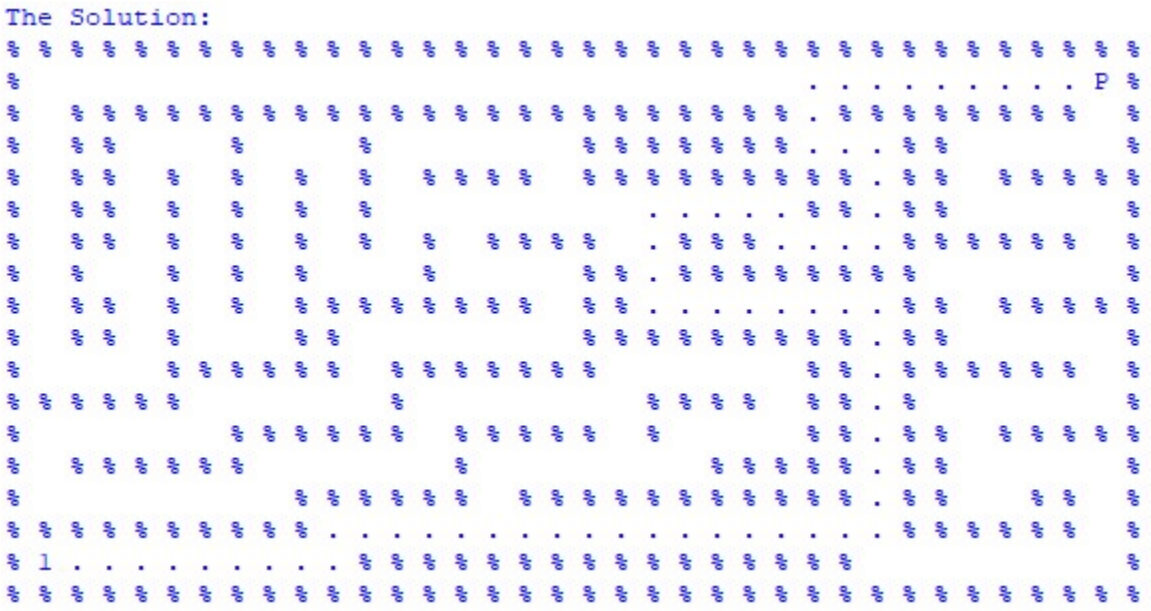
Manhattan Distance



Paths:

1.34 1.33 1.32 1.31 1.30 1.29 1.28 1.27 1.26 1.25 2.25 3.25 3.26 3.27 4.27 5.27 6.27 6.26 6.25 6.24 5.24 5.23 5.22 5.21 5.20 6.20 7.20 8.20 8.21 8.22 8.23 8.24 8.25 8.26 8.27 9.27 10.27 11.27 12.27 13.27 14.27 15.27 15.26 15.25 15.24 15.23 15.22 15.21 15.20 15.19 15.18 15.17 15.16 15.15 15.14 15.13 15.12 15.11 15.10 16.10 16.9 16.8 16.7 16.6 16.5 16.4 16.3 16.2 16.1

Straight-line Distance



Paths:

1.34 1.33 1.32 1.31 1.30 1.29 1.28 1.27 1.26 1.25 2.25 3.25 3.26 3.27 4.27 5.27 6.27 6.26 6.25 6.24 5.24 5.23 5.22 5.21 5.20 6.20 7.20 8.20 8.21 8.22 8.23 8.24 8.25 8.26 8.27 9.27 10.27 11.27 12.27 13.27 14.27 15.27 15.26 15.25 15.24 15.23 15.22 15.21 15.20 15.19 15.18 15.17 15.16 15.15 15.14 15.13 15.12 15.11 15.10 16.10 16.9 16.8 16.7 16.6 16.5 16.4 16.3 16.2 16.1

PERFORMANCE

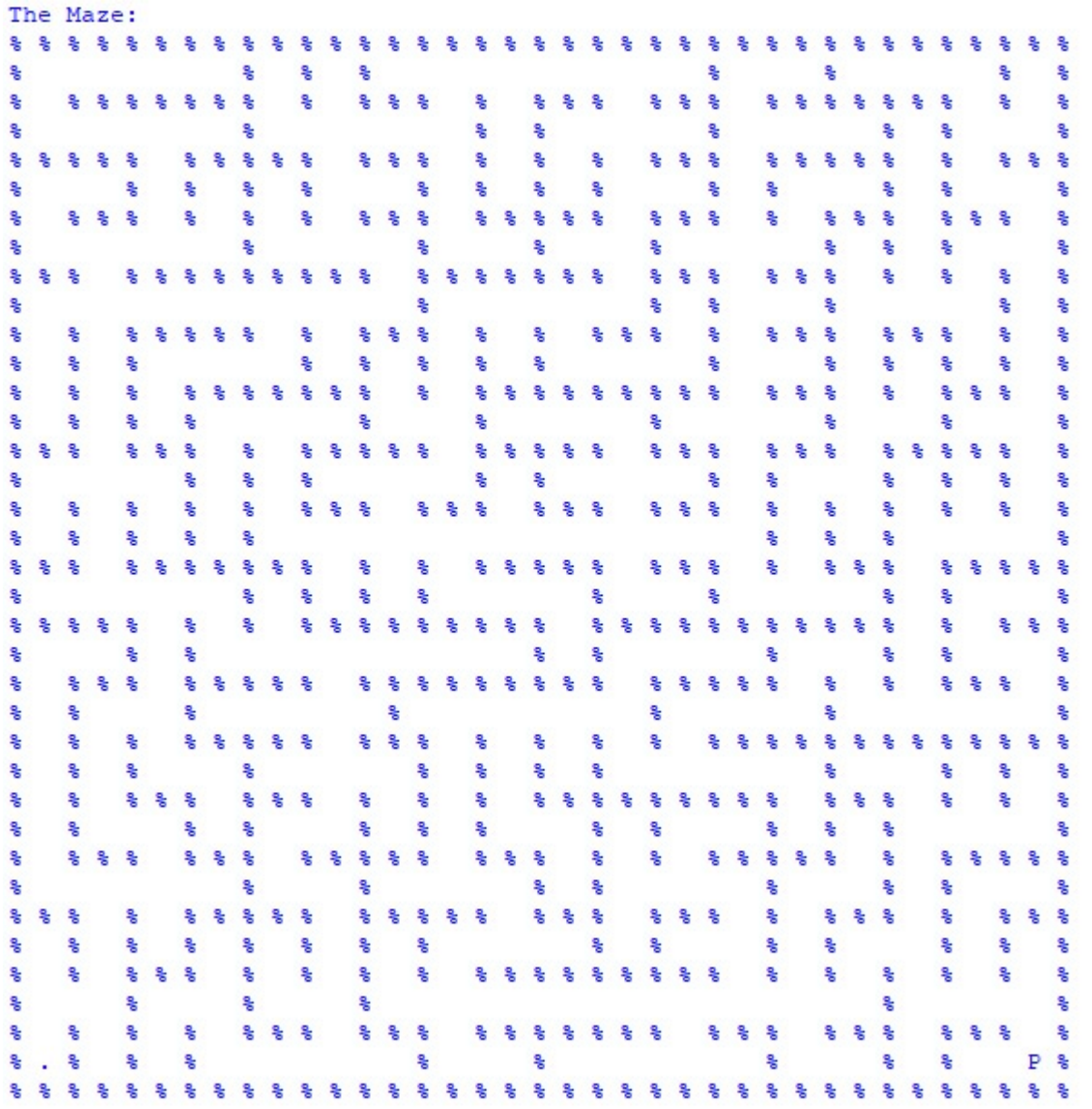
Manhattan:

Heuristics: manhattan
Pathcost: 68
Nodes expanded: 222
Frontier size: 228

Straight-line:

Heuristics: straightline
Pathcost: 68
Nodes expanded: 229
Frontier size: 233

BIG MAZE



PERFORMANCE

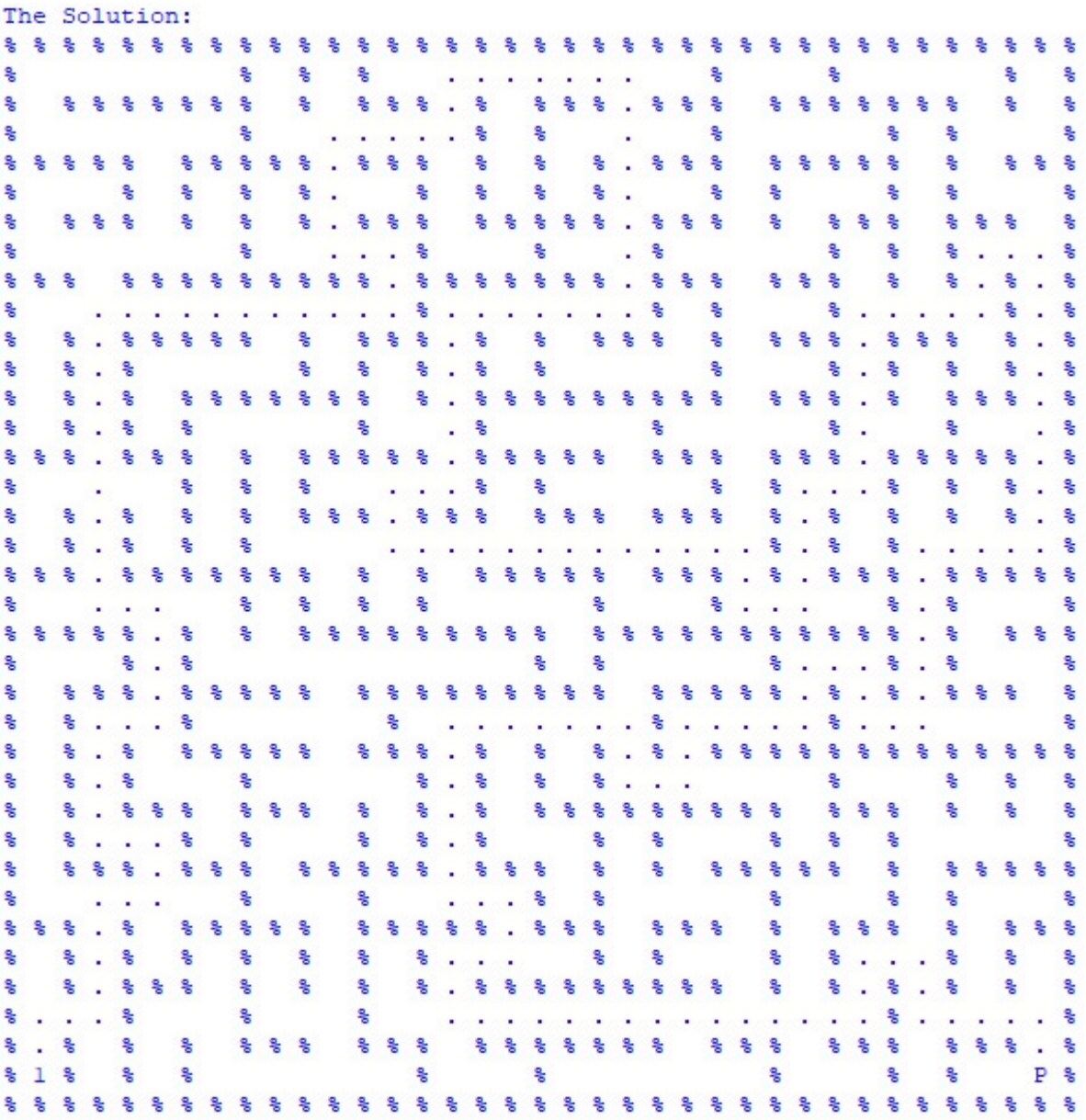
Manhattan:

Heuristics: manhattan
Path cost: 210
Nodes expanded: 550
Frontier size: 557

Straight-line:

Heuristics: straightline
Path cost: 210
Nodes expanded: 579
Frontier size: 588

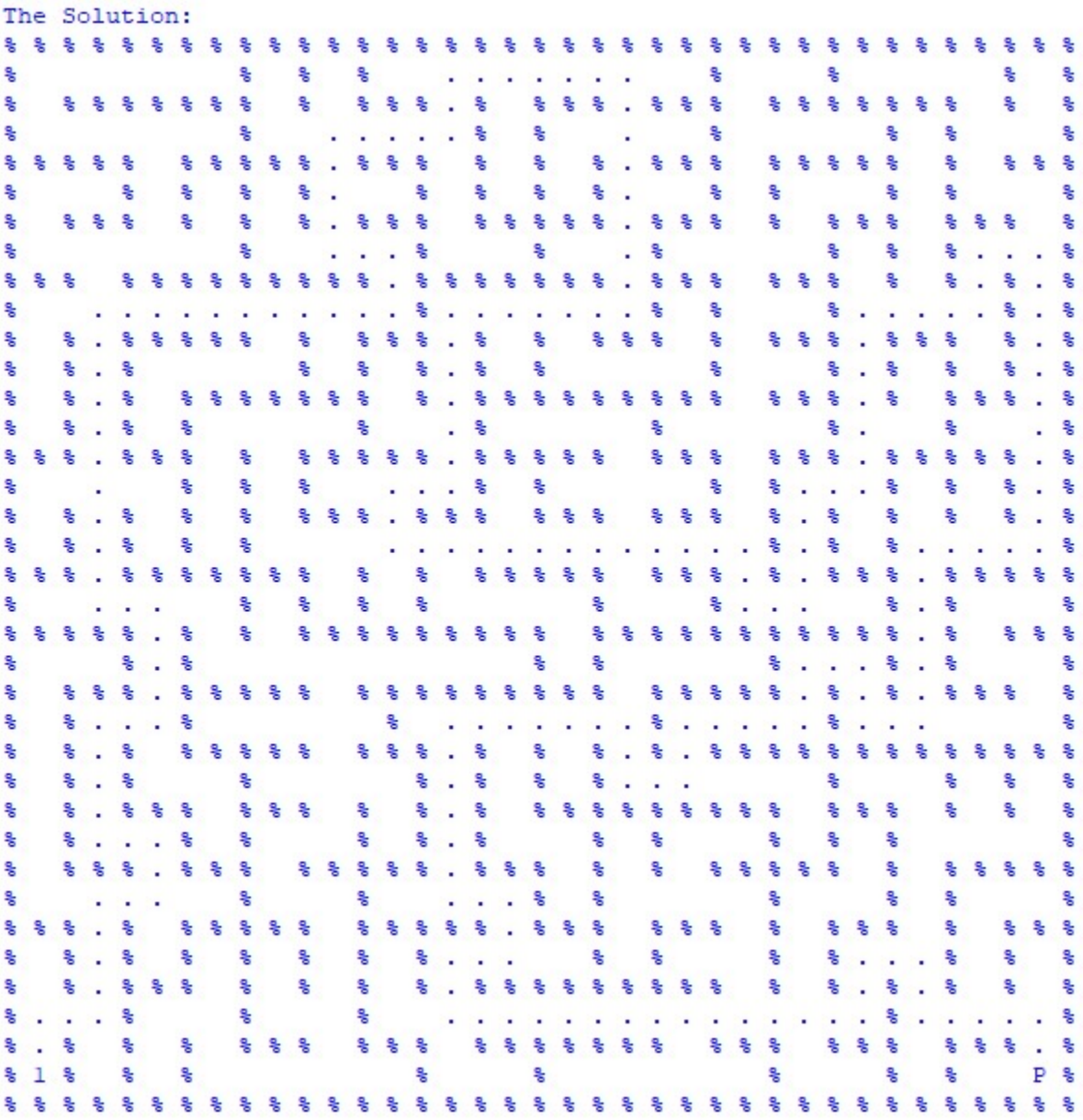
Manhattan Distance



Paths:

35.35 34.35 33.35 33.34 33.33 33.32 33.31 32.31 31.31 31.30 31.29 32.29 33.29 33.28 33.27 33.26 33.25 33.24 33.23 33.22 33.21 33.20 33.19 33.18 33.17 33.16 33.15 32.15 31.15 31.16 31.17 30.17 29.17 29.16 29.15 28.15 27.15 26.15 25.15 24.15 23.15 23.16 23.17 23.18 23.19 23.20 23.21 24.21 25.21 25.22 25.23 24.23 23.23 23.24 23.25 23.26 23.27 22.27 21.27 21.28 21.29 22.29 23.29 23.30 23.31 22.31 21.31 20.31 19.31 18.31 17.31 17.32 17.33 17.34 17.35 16.35 15.35 14.35 13.35 12.35 11.35 10.35 9.35 8.35 7.35 7.34 7.33 8.33 9.33 9.32 9.31 9.30 9.29 10.29 11.29 12.29 13.29 14.29 15.29 15.28 15.27 16.27 17.27 18.27 19.27 19.26 19.25 18.25 17.25 17.24 17.23 17.22 17.21 17.20 17.19 17.18 17.17 17.16 17.15 17.14 17.13 16.13 15.13 15.14 15.15 14.15 13.15 12.15 11.15 10.15 9.15 9.16 9.17 9.18 9.19 9.20 9.21 8.21 7.21 6.21 5.21 4.21 3.21 2.21 1.21 1.20 1.19 1.18 1.17 1.16 1.15 2.15 3.15 3.14 3.13 3.12 3.11 4.11 5.11 6.11 7.11 7.12 7.13 8.13 9.13 9.12 9.11 9.10 9.9 9.8 9.7 9.6 9.5 9.4 9.3 10.3 11.3 12.3 13.3 14.3 15.3 16.3 17.3 18.3 19.3 19.4 19.5 20.5 21.5 22.5 23.5 23.4 23.3 24.3 25.3 26.3 27.3 27.4 27.5 28.5 29.5 29.4 29.3 30.3 31.3 32.3 33.3 33.2 33.1 34.1

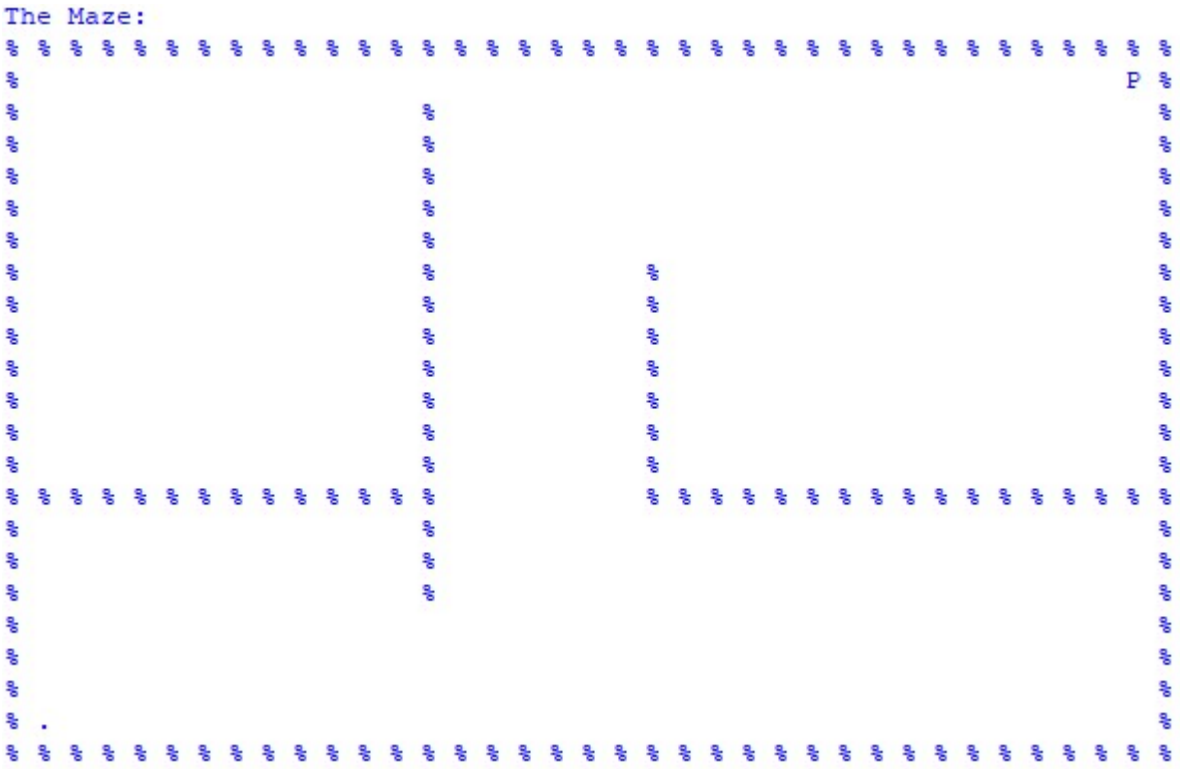
Straight-line Distance



Paths:

35.35 34.35 33.35 33.34 33.33 33.32 33.31 32.31 31.31 31.30 31.29 32.29 33.29 33.28 33.27 33.26 33.25 33.24 33.23
33.22 33.21 33.20 33.19 33.18 33.17 33.16 33.15 32.15 31.15 31.16 31.17 30.17 29.17 29.16 29.15 28.15 27.15 26.15
25.15 24.15 23.15 23.16 23.17 23.18 23.19 23.20 23.21 24.21 25.21 25.22 25.23 24.23 23.23 23.24 23.25 23.26 23.27
22.27 21.27 21.28 21.29 22.29 23.29 23.30 23.31 22.31 21.31 20.31 19.31 18.31 17.31 17.32 17.33 17.34 17.35 16.35
15.35 14.35 13.35 12.35 11.35 10.35 9.35 8.35 7.35 7.34 7.33 8.33 9.33 9.32 9.31 9.30 9.29 10.29 11.29 12.29 13.29
14.29 15.29 15.28 15.27 16.27 17.27 18.27 19.27 19.26 19.25 18.25 17.25 17.24 17.23 17.22 17.21 17.20 17.19 17.18
17.17 17.16 17.15 17.14 17.13 16.13 15.13 15.14 15.15 14.15 13.15 12.15 11.15 10.15 9.15 9.16 9.17 9.18 9.19 9.20
9.21 8.21 7.21 6.21 5.21 4.21 3.21 2.21 1.21 1.20 1.19 1.18 1.17 1.16 1.15 2.15 3.15 3.14 3.13 3.12 3.11 4.11 5.11 6.11
7.11 7.12 7.13 8.13 9.13 9.12 9.11 9.10 9.9 9.8 9.7 9.6 9.5 9.4 9.3 10.3 11.3 12.3 13.3 14.3 15.3 16.3 17.3 18.3 19.3 19.4
19.5 20.5 21.5 22.5 23.5 23.4 23.3 24.3 25.3 26.3 27.3 27.4 27.5 28.5 29.5 29.4 29.3 30.3 31.3 32.3 33.3 33.2 33.1 34.1

OPEN MAZE



PERFORMANCE

Manhattan:

Heuristics: manhattan
Path cost: 39
Nodes expanded: 126
Frontier size: 182

Paths:

1.35 1.34 2.34 2.33 3.33 3.32 4.32 4.31 5.31 5.30 6.30 6.29 7.29 7.28 8.28 8.27 8.26 8.25 8.24 8.23 7.23 7.22 6.22 6.21 6.20 6.19 6.18 7.18 7.17 8.17 8.16 9.16 9.15 10.15 10.14 11.14 12.14 13.14 14.14 15.14 16.14 17.14 18.14 18.13 19.13 19.12 20.12 20.11 21.11 21.10 21.9 21.8 21.7 21.6 21.5 21.4 21.3 21.2 21.1

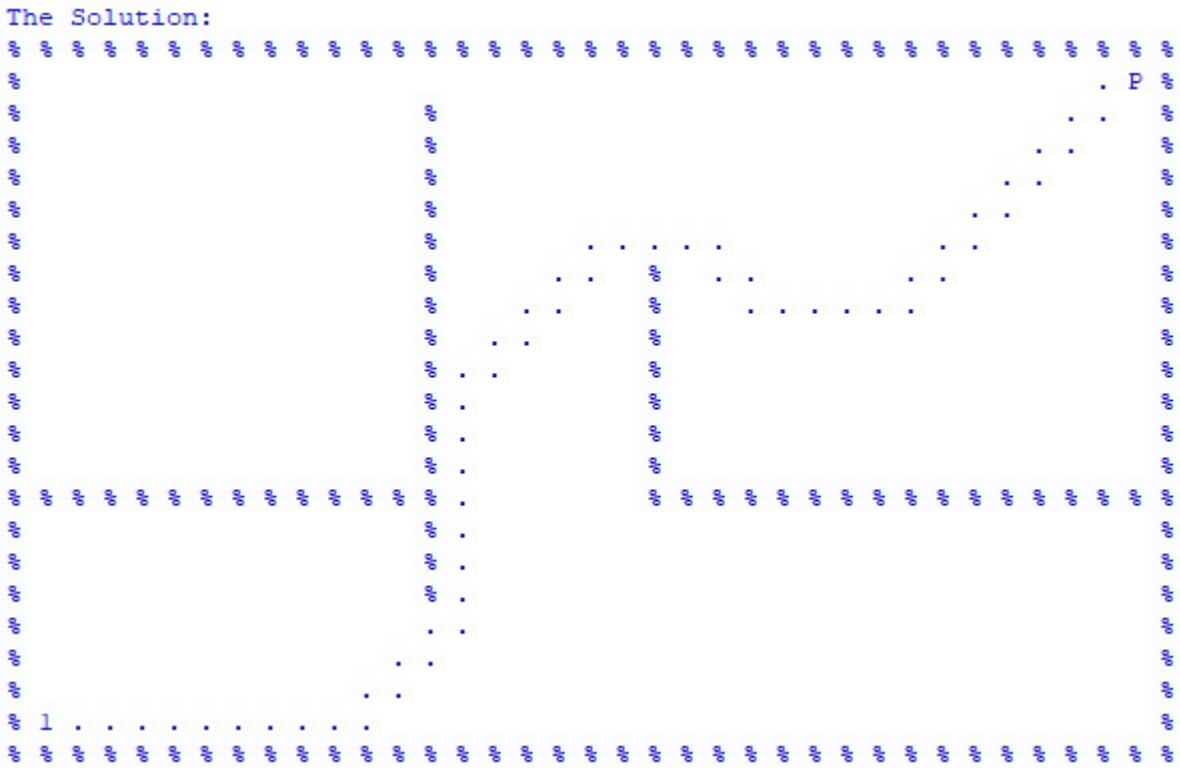
Straight-line:

Heuristics: straightline
Path cost: 32
Nodes expanded: 255
Frontier size: 300

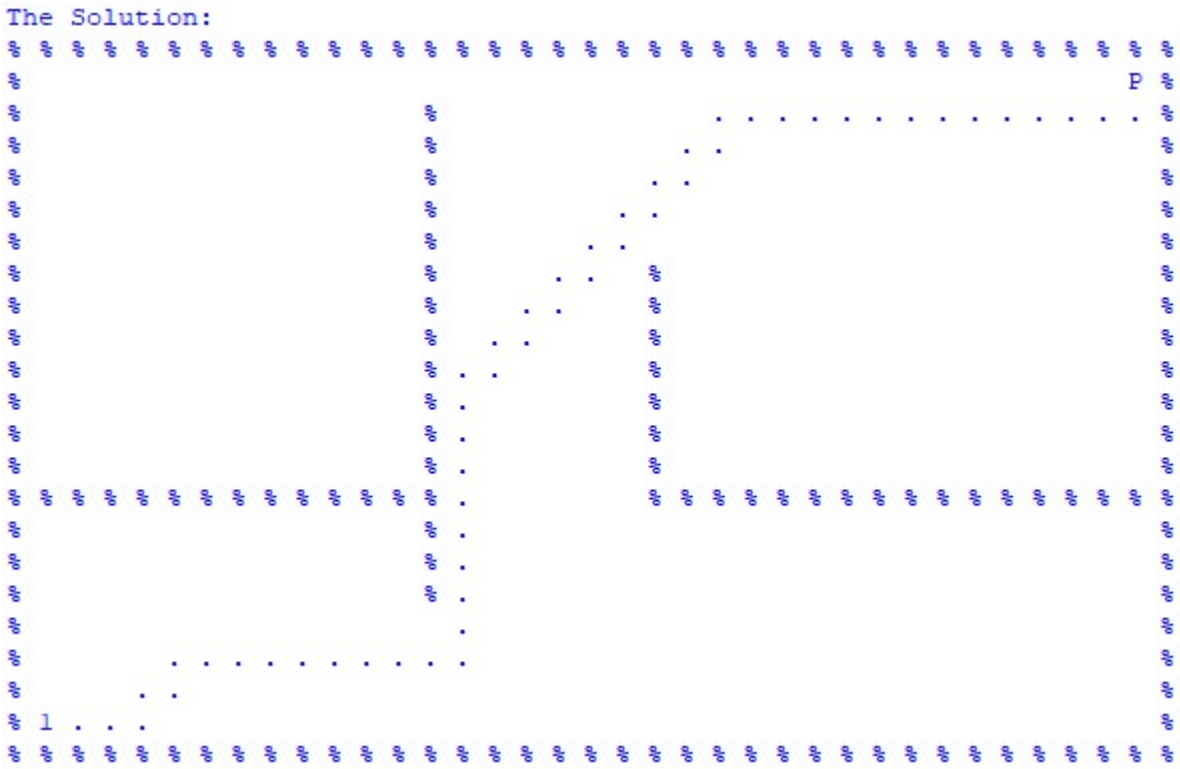
Paths:

1.35 2.35 2.34 2.33 2.32 2.31 2.30 2.29 2.28 2.27 2.26 2.25 2.24 2.23 2.22 3.22 3.21 4.21 4.20 5.20 5.19 6.19 6.18 7.18 7.17 8.17 8.16 9.16 9.15 10.15 10.14 11.14 12.14 13.14 14.14 15.14 16.14 17.14 18.14 19.14 19.13 19.12 19.11 19.10 19.9 19.8 19.7 19.6 19.5 20.5 20.4 21.4 21.3 21.2 21.1

Manhattan Distance

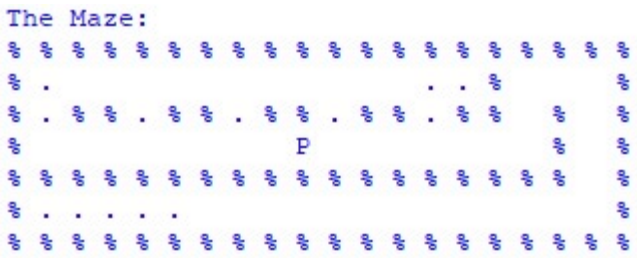


Straight-line Distance

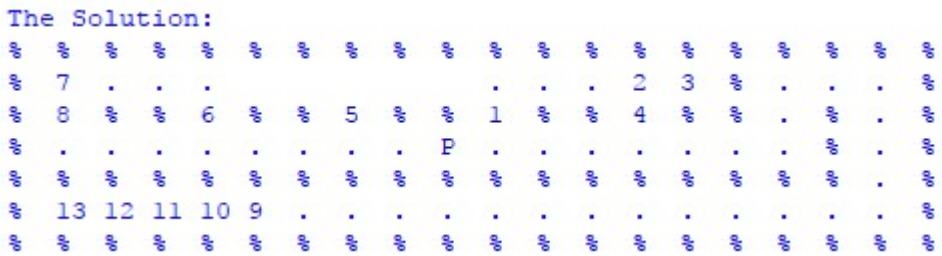


PART TWO: SEARCH WITH MULTIPLE GOALS

TRICKY SEARCH



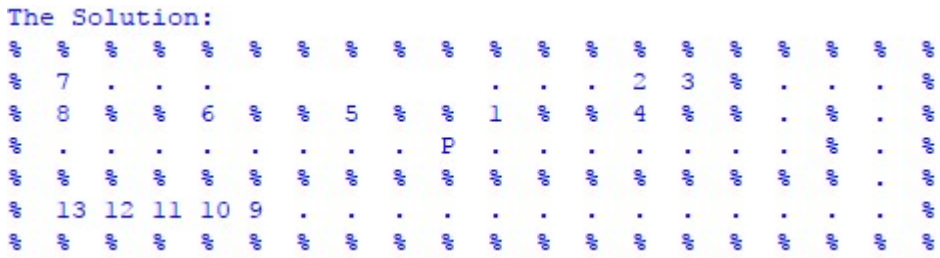
Manhattan Distance



Paths:

3.9 3.10 2.10
2.10 1.10 1.11 1.12 1.13
1.13 1.14
1.14 1.13 2.13
2.13 3.13 3.12 3.11 3.10 3.9 3.8 3.7 2.7
2.7 3.7 3.6 3.5 3.4 2.4
2.4 1.4 1.3 1.2 1.1
1.1 2.1
2.1 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 3.10 3.11 3.12 3.13 3.14 3.15 3.16 2.16 1.16 1.17 1.18 2.18 3.18
4.18 5.18 5.17 5.16 5.15 5.14 5.13 5.12 5.11 5.10 5.9 5.8 5.7 5.6 5.5
5.5 5.4
5.4 5.3
5.3 5.2
5.2 5.1

Straight-line Distance



Paths:

3.9 3.10 2.10
2.10 1.10 1.11 1.12 1.13
1.13 1.14
1.14 1.13 2.13
2.13 3.13 3.12 3.11 3.10 3.9 3.8 3.7 2.7
2.7 3.7 3.6 3.5 3.4 2.4
2.4 1.4 1.3 1.2 1.1
1.1 2.1
2.1 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 3.10 3.11 3.12 3.13 3.14 3.15 3.16 2.16 1.16 1.17 1.18 2.18 3.18
4.18 5.18 5.17 5.16 5.15 5.14 5.13 5.12 5.11 5.10 5.9 5.8 5.7 5.6 5.5
5.5 5.4
5.4 5.3
5.3 5.2
5.2 5.1

PERFORMANCE

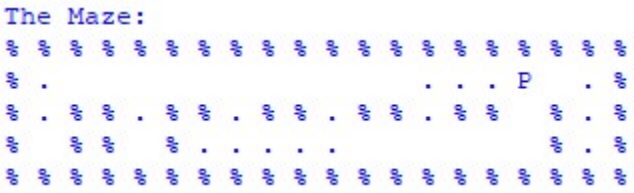
Manhattan:

Heuristics: manhattan
Path cost: 68
Nodes expanded: 111
Frontier size: 133

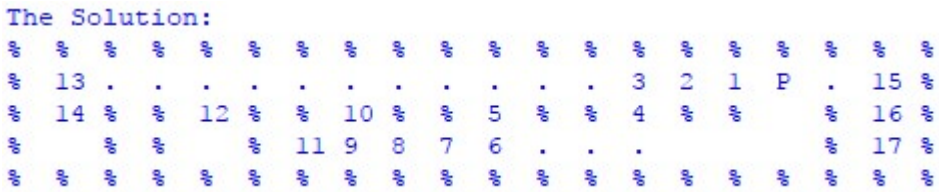
Straight-line:

Heuristics: straightline
Path cost: 68
Nodes expanded: 115
Frontier size: 139

SMALL SEARCH



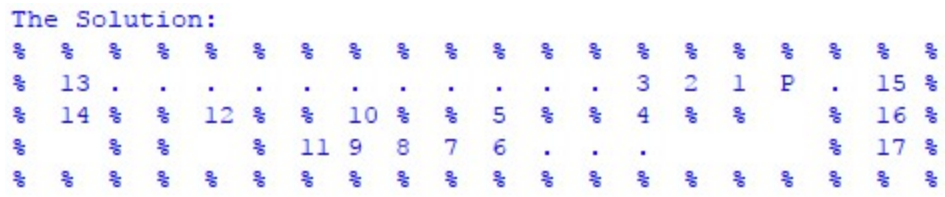
Manhattan Distance



Paths:

1.16 1.15
1.15 1.14
1.14 1.13
1.13 2.13
2.13 3.13 3.12 3.11 3.10 2.10
2.10 3.10
3.10 3.9
3.9 3.8
3.8 3.7
3.7 2.7
2.7 3.7 3.6
3.6 3.7 2.7 1.7 1.6 1.5 1.4 2.4
2.4 1.4 1.3 1.2 1.1
1.1 2.1
2.1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 1.10 1.11 1.12 1.13 1.14 1.15 1.16 1.17 1.18
1.18 2.18
2.18 3.18

Straight-line Distance



Paths:

1.16 1.15
1.15 1.14
1.14 1.13
1.13 2.13
2.13 3.13 3.12 3.11 3.10 2.10
2.10 3.10
3.10 3.9
3.9 3.8
3.8 3.7
3.7 2.7
2.7 3.7 3.6
3.6 3.7 2.7 1.7 1.6 1.5 1.4 2.4
2.4 1.4 1.3 1.2 1.1
1.1 2.1
2.1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 1.10 1.11 1.12 1.13 1.14 1.15 1.16 1.17 1.18
1.18 2.18
2.18 3.18

PERFORMANCE

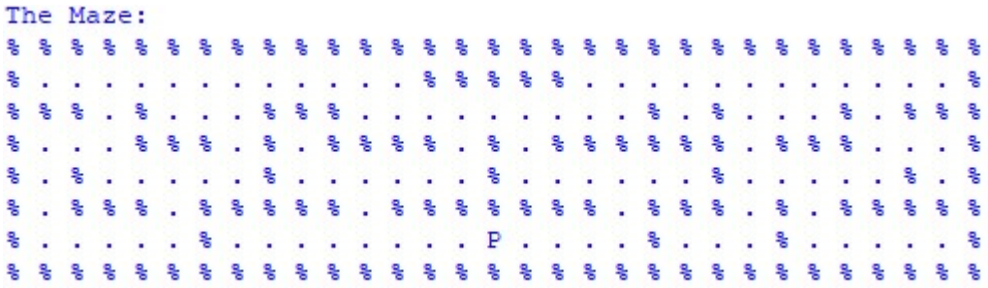
Manhattan:

Heuristics: manhattan
Path cost: 48
Nodes expanded: 70
Frontier size: 103

Straight-line:

Heuristics: straightline
Path cost: 48
Nodes expanded: 72
Frontier size: 103

MEDIUM SEARCH



Manhattan Distance

```
The Solution:
%   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %
%   27  26  25  24  23  22  21  20  19  18  17  49  %   %   %   %   %   55  56  57  58  59  60  61  62  63  64  65  66  %
%   %   %   28  %   48  47  46  %   %   %   50  16  15  14  51  52  53  54  82  %   81  %   78  79  80  %   67  %   %   %
%   31  30  29  %   %   %   45  %   9   %   %   %   %   13  %   83  %   %   %   %   %   %   77  %   %   %   68  69  70  %
%   32  %   42  41  40  43  44  %   8   7   6   10  11  12  %   84  85  86  87  88  89  %   76  75  74  73  72  %   71  %
%   33  %   %   %   39  %   %   %   %   %   5   %   %   %   %   %   %   %   90  %   %   %   99  %   103 %   %   %   %   %
%   34  35  36  37  38  %   98  97  96  95  4   3   2   1   P   94  93  92  91  %   102 101 100 %   104 105 106 107 108 %
%   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %
```

Straight-line Distance

```
The Solution:
%   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %
%   27  26  25  24  23  22  21  20  19  18  17  49  %   %   %   %   %   55  56  57  58  59  60  61  62  63  64  65  66  %
%   %   %   28  %   48  47  46  %   %   %   50  16  15  14  51  52  53  54  82  %   81  %   78  79  80  %   67  %   %   %
%   31  30  29  %   %   %   45  %   9   %   %   %   %   13  %   83  %   %   %   %   %   %   77  %   %   %   68  69  70  %
%   32  %   42  41  40  43  44  %   8   7   6   10  11  12  %   84  85  86  87  88  89  %   76  75  74  73  72  %   71  %
%   33  %   %   %   39  %   %   %   %   %   5   %   %   %   %   %   %   %   90  %   %   %   99  %   103 %   %   %   %   %
%   34  35  36  37  38  %   98  97  96  95  4   3   2   1   P   94  93  92  91  %   102 101 100 %   104 105 106 107 108 %
%   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %   %
```

PERFORMANCE

Manhattan:

Heuristics: manhattan
Path cost: 175
Nodes expanded: 315
Frontier size: 465

Straight-line:

Heuristics: straightline
Path cost: 175
Nodes expanded: 321
Frontier size: 471

Manhattan

Paths:

6.15 6.14
6.14 6.13
6.13 6.12
6.12 6.11
6.11 5.11
5.11 4.11
4.11 4.10
4.10 4.9
4.9 3.9
3.9 4.9 4.10 4.11 4.12
4.12 4.13
4.13 4.14
4.14 3.14
3.14 2.14
2.14 2.13
2.13 2.12
2.12 2.11 1.11
1.11 1.10
1.10 1.9
1.9 1.8
1.8 1.7
1.7 1.6
1.6 1.5
1.5 1.4
1.4 1.3
1.3 1.2
1.2 1.1
1.1 1.2 1.3 2.3
2.3 3.3
3.3 3.2
3.2 3.1
3.1 4.1
4.1 5.1
5.1 6.1
6.1 6.2
6.2 6.3
6.3 6.4
6.4 6.5
6.5 5.5
5.5 4.5
4.5 4.4
4.4 4.3
4.3 4.4 4.5 4.6
4.6 4.7
4.7 3.7
3.7 2.7
2.7 2.6
2.6 2.5
2.5 2.6 1.6 1.7 1.8 1.9 1.10 1.11 1.12
1.12 1.11 2.11
2.11 2.12 2.13 2.14 2.15
2.15 2.16
2.16 2.17
2.17 2.18
2.18 1.18
1.18 1.19
1.19 1.20
1.20 1.21
1.21 1.22
1.22 1.23
1.23 1.24
1.24 1.25
1.25 1.26
1.26 1.27
1.27 1.28
1.28 1.29
1.29 1.28 1.27 2.27
2.27 3.27
3.27 3.28
3.28 3.29
3.29 4.29
4.29 3.29 3.28 3.27 4.27
4.27 4.26
4.26 4.25
4.25 4.24
4.24 4.23
4.23 3.23
3.23 2.23
2.23 2.24
2.24 2.25

2.25 1.25 1.24 1.23 1.22 1.21 2.21
2.21 1.21 1.20 1.19 2.19
2.19 2.18 2.17 2.16 3.16
3.16 4.16
4.16 4.17
4.17 4.18
4.18 4.19
4.19 4.20
4.20 4.21
4.21 4.20 4.19 5.19
5.19 6.19
6.19 6.18
6.18 6.17
6.17 6.16
6.16 6.15 6.14 6.13 6.12 6.11 6.10
6.10 6.9
6.9 6.8
6.8 6.7
6.7 6.8 6.9 6.10 6.11 5.11 4.11 4.12 4.13 4.14
3.14 2.14 2.15 2.16 2.17 2.18 1.18 1.19 1.20
1.21 1.22 1.23 2.23 3.23 4.23 5.23
5.23 6.23
6.23 6.22
6.22 6.21
6.21 6.22 6.23 5.23 4.23 4.24 4.25 5.25
5.25 6.25
6.25 6.26
6.26 6.27
6.27 6.28
6.28 6.29

Straight-line

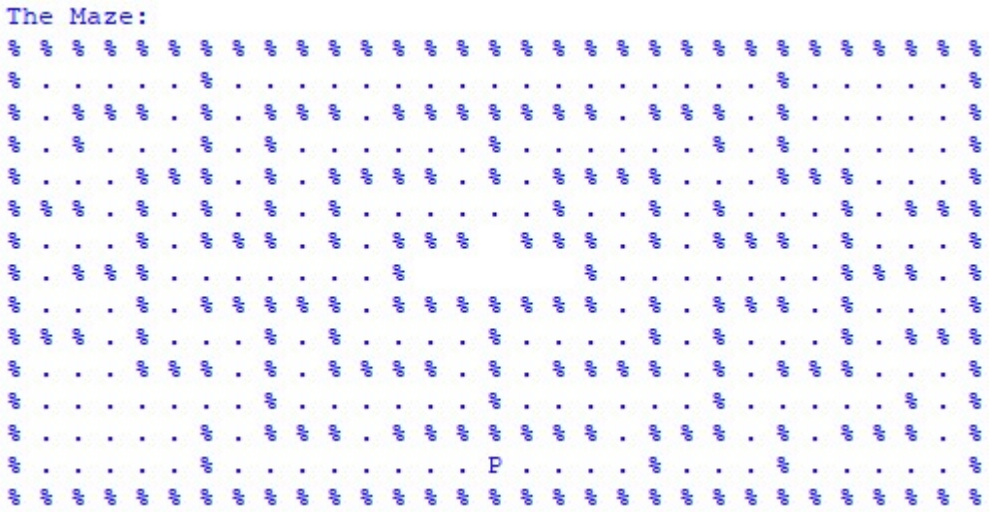
Paths:

6.15 6.14
6.14 6.13
6.13 6.12
6.12 6.11
6.11 5.11
5.11 4.11
4.11 4.10
4.10 4.9
4.9 3.9
3.9 4.9 4.10 4.11 4.12
4.12 4.13
4.13 4.14
4.14 3.14
3.14 2.14
2.14 2.13
2.13 2.12
2.12 2.11 1.11
1.11 1.10
1.10 1.9
1.9 1.8
1.8 1.7
1.7 1.6
1.6 1.5
1.5 1.4
1.4 1.3
1.3 1.2
1.2 1.1
1.1 1.2 1.3 2.3
2.3 3.3
3.3 3.2
3.2 3.1
3.1 4.1
4.1 5.1
5.1 6.1
6.1 6.2
6.2 6.3
6.3 6.4
6.4 6.5
6.5 5.5
5.5 4.5
4.5 4.4
4.4 4.3
4.3 4.4 4.5 4.6
4.6 4.7

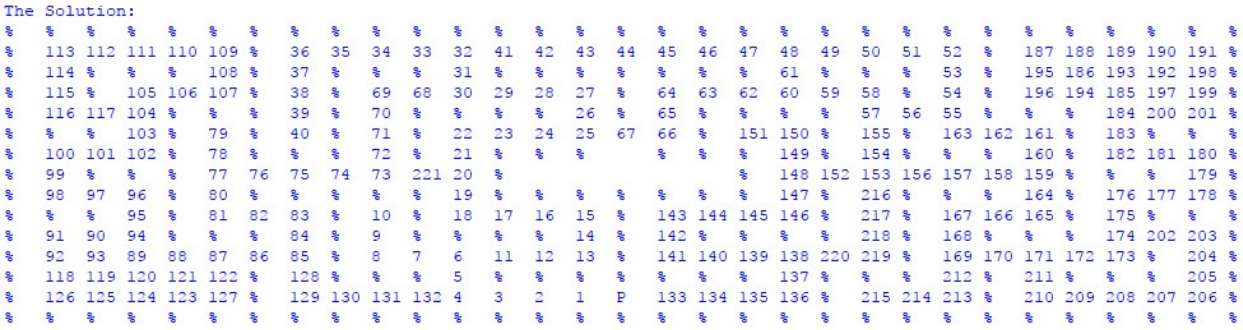
4.7 3.7
3.7 2.7
2.7 2.6
2.6 2.5
2.5 1.5 1.6 1.7 1.8 1.9 1.10 1.11 1.12
1.12 1.11 2.11
2.11 2.12 2.13 2.14 2.15
2.15 2.16
2.16 2.17
2.17 2.18
2.18 1.18
1.18 1.19
1.19 1.20
1.20 1.21
1.21 1.22
1.22 1.23
1.23 1.24
1.24 1.25
1.25 1.26
1.26 1.27
1.27 1.28
1.28 1.29
1.29 1.28 1.27 2.27
2.27 3.27
3.27 3.28
3.28 3.29
3.29 4.29
4.29 3.29 3.28 3.27 4.27
4.27 4.26
4.26 4.25
4.25 4.24
4.24 4.23
4.23 3.23
3.23 2.23
2.23 2.24
2.24 2.25

2.25 1.25 1.24 1.23 1.22 1.21 2.21
2.21 1.21 1.20 1.19 2.19
2.19 2.18 2.17 2.16 3.16
3.16 4.16
4.16 4.17
4.17 4.18
4.18 4.19
4.19 4.20
4.20 4.21
4.21 4.20 4.19 5.19
5.19 6.19
6.19 6.18
6.18 6.17
6.17 6.16
6.16 6.15 6.14 6.13 6.12 6.11 6.10
6.10 6.9
6.9 6.8
6.8 6.7
6.7 6.8 6.9 6.10 6.11 5.11 4.11 4.12 4.13 4.14
3.14 2.14 2.15 2.16 2.17 2.18 1.18 1.19 1.20
1.21 1.22 1.23 2.23 3.23 4.23 5.23
5.23 6.23
6.23 6.22
6.22 6.21
6.21 6.22 6.23 5.23 4.23 4.24 4.25 5.25
5.25 6.25
6.25 6.26
6.26 6.27
6.27 6.28
6.28 6.29

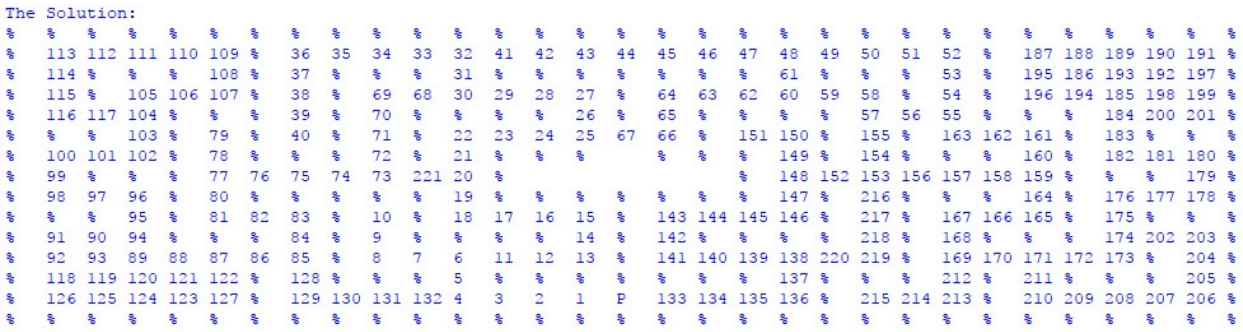
BIG SEARCH



Manhattan Distance



Straight-line Distance



Manhattan:

Heuristics: manhattan
Path cost: 329
Nodes expanded: 649
Frontier size: 986

Straight-line:

Heuristics: straightline
Path cost: 329
Nodes expanded: 683
Frontier size: 1023

Manhattan

Paths:

13.15 13.14
13.14 13.13
13.13 13.12
13.12 13.11
13.11 12.11
12.11 11.11
11.11 11.10
11.10 11.9
11.9 10.9
10.9 9.9
9.9 10.9 11.9 11.10 11.11 11.12
11.12 11.13
11.13 11.14
11.14 10.14
10.14 9.14
9.14 9.13
9.13 9.12
9.12 9.11
9.11 8.11
8.11 7.11
7.11 6.11
6.11 5.11
5.11 5.12
5.12 5.13
5.13 5.14
5.14 4.14
4.14 3.14
3.14 3.13
3.13 3.12
3.12 3.11
3.11 2.11
2.11 1.11
1.11 1.10
1.10 1.9
1.9 1.8
1.8 1.7
1.7 2.7
2.7 3.7
3.7 4.7
4.7 5.7
5.7 4.7 3.7 2.7 1.7 1.8 1.9 1.10 1.11 1.12
1.12 1.13
1.13 1.14
1.14 1.15
1.15 1.16
1.16 1.17
1.17 1.18
1.18 1.19
1.19 1.20
1.20 1.21
1.21 1.22
1.22 1.23
1.23 2.23
2.23 3.23
3.23 4.23
4.23 4.22
4.22 4.21
4.21 3.21
3.21 3.20
3.20 3.19
3.19 2.19
2.19 3.19 3.18
3.18 3.17
3.17 3.16
3.16 4.16
4.16 5.16
5.16 5.15
5.15 5.14 4.14 3.14 3.13 3.12 3.11 3.10
3.10 3.9
3.9 4.9
4.9 5.9
5.9 6.9
6.9 7.9
7.9 7.8
7.8 7.7
7.7 7.6
7.6 7.5
7.5 6.5
6.5 5.5
5.5 6.5 7.5 8.5
8.5 9.5
9.5 9.6
9.6 9.7

9.7 10.7
10.7 11.7
11.7 11.6
11.6 11.5
11.5 11.4
11.4 11.3
11.3 11.2 10.2
10.2 10.1
10.1 11.1
11.1 11.2
11.2 11.3 10.3
10.3 9.3
9.3 8.3
8.3 8.2
8.2 8.1
8.1 7.1
7.1 6.1
6.1 6.2
6.2 6.3
6.3 5.3
5.3 4.3
4.3 3.3
3.3 3.4
3.4 3.5
3.5 2.5
2.5 1.5
1.5 1.4
1.4 1.3
1.3 1.2
1.2 1.1
1.1 2.1
2.1 3.1
3.1 4.1
4.1 4.2
4.2 4.3 5.3 6.3 6.2 6.1 7.1 8.1 8.2 8.3 9.3 10.3
10.2 11.2 11.1 12.1
12.1 12.2
12.2 12.3
12.3 12.4
12.4 12.5
12.5 12.4 13.4
13.4 13.3
13.3 13.2
13.2 13.1
13.1 13.2 13.3 13.4 13.5
13.5 12.5 11.5 11.6 11.7 12.7
12.7 13.7
13.7 13.8
13.8 13.9
13.9 13.10
13.10 13.11 13.12 13.13 13.14 13.15 13.16
13.16 13.17
13.17 13.18
13.18 13.19
13.19 12.19
12.19 11.19
11.19 11.18
11.18 11.17
11.17 11.16
11.16 10.16
10.16 9.16
9.16 9.17
9.17 9.18
9.18 9.19
9.19 8.19
8.19 7.19
7.19 6.19
6.19 5.19
5.19 5.18
5.18 5.19 6.19 7.19 7.20
7.20 7.21
7.21 6.21
6.21 5.21
5.21 6.21 7.21 7.22
7.22 7.23
7.23 7.24
7.24 7.25
7.25 6.25
6.25 5.25
5.25 5.24
5.24 5.23
5.23 5.24 5.25 6.25 7.25 8.25
8.25 9.25
9.25 9.24
9.24 9.23
9.23 10.23
10.23 11.23
11.23 11.24

11.24 11.25
11.25 11.26
11.26 11.27
11.27 10.27
10.27 9.27
9.27 8.27
8.27 8.28
8.28 8.29
8.29 7.29
7.29 6.29
6.29 6.28
6.28 6.27
6.27 5.27
5.27 4.27
4.27 3.27
3.27 3.26 2.26
2.26 2.25 1.25
1.25 1.26
1.26 1.27
1.27 1.28
1.28 1.29
1.29 1.28 2.28
2.28 2.27
2.27 2.26 3.26
3.26 3.25 2.25
2.25 3.25
3.25 3.26 3.27 3.28
3.28 3.29 2.29

2.29 3.29
3.29 3.28 4.28
4.28 4.29
4.29 4.28 4.27 5.27 6.27 6.28 6.29 7.29 8.29
8.28 8.27 9.27 10.27 10.28
10.28 10.29
10.29 11.29
11.29 12.29
12.29 13.29
13.29 13.28
13.28 13.27
13.27 13.26
13.26 13.25
13.25 12.25
12.25 11.25 11.24 11.23 12.23
12.23 13.23
13.23 13.22
13.22 13.21
13.21 13.22 13.23 12.23 11.23 10.23 9.23 9.24
9.25 8.25 7.25 7.24 7.23 7.22 7.21 8.21
8.21 9.21
9.21 10.21
10.21 11.21
11.21 11.20
11.20 11.19 12.19 13.19 13.18 13.17 13.16
13.15 13.14 13.13 13.12 13.11 12.11 11.11
11.12 11.13 11.14 10.14 9.14 9.13 9.12 9.11
8.11 7.11 7.10

Straight-line

Paths:

13.15 13.14
13.14 13.13
13.13 13.12
13.12 13.11
13.11 12.11
12.11 11.11
11.11 11.10
11.10 11.9
11.9 10.9
10.9 9.9

9.9 10.9 11.9 11.10 11.11 11.12
11.12 11.13
11.13 11.14
11.14 10.14
10.14 9.14
9.14 9.13
9.13 9.12
9.12 9.11
9.11 8.11
8.11 7.11

7.11 6.11
6.11 5.11
5.11 5.12
5.12 5.13
5.13 5.14
5.14 4.14
4.14 3.14
3.14 3.13
3.13 3.12
3.12 3.11
3.11 2.11
2.11 1.11
1.11 1.10
1.10 1.9
1.9 1.8
1.8 1.7
1.7 2.7
2.7 3.7
3.7 4.7
4.7 5.7
5.7 4.7 3.7 2.7 1.7 1.8 1.9 1.10 1.11 1.12
1.12 1.13
1.13 1.14
1.14 1.15
1.15 1.16
1.16 1.17
1.17 1.18
1.18 1.19
1.19 1.20
1.20 1.21
1.21 1.22
1.22 1.23
1.23 2.23
2.23 3.23
3.23 4.23
4.23 4.22
4.22 4.21
4.21 3.21
3.21 3.20
3.20 3.19
3.19 2.19
2.19 3.19 3.18
3.18 3.17
3.17 3.16
3.16 4.16
4.16 5.16
5.16 5.15
5.15 5.14 4.14 3.14 3.13 3.12 3.11 3.10
3.10 3.9
3.9 4.9
4.9 5.9
5.9 6.9
6.9 7.9
7.9 7.8
7.8 7.7
7.7 7.6
7.6 7.5
7.5 6.5
6.5 5.5
5.5 6.5 7.5 8.5
8.5 9.5
9.5 9.6
9.6 9.7
9.7 10.7
10.7 11.7
11.7 11.6
11.6 11.5
11.5 11.4
11.4 11.3
11.3 11.2 10.2
10.2 10.1
10.1 11.1
11.1 11.2
11.2 11.3 10.3
10.3 9.3
9.3 8.3
8.3 8.2
8.2 8.1
8.1 7.1
7.1 6.1
6.1 6.2
6.2 6.3
6.3 5.3
5.3 4.3
4.3 3.3
3.3 3.4
3.4 3.5
3.5 2.5

2.5 1.5
1.5 1.4
1.4 1.3
1.3 1.2
1.2 1.1
1.1 2.1
2.1 3.1
3.1 4.1
4.1 4.2
4.2 4.3 5.3 6.3 6.2 6.1 7.1 8.1 8.2 8.3 9.3 10.3
10.2 11.2 11.1 12.1
12.1 12.2
12.2 12.3
12.3 12.4
12.4 12.5
12.5 12.4 13.4
13.4 13.3
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13.1 13.2 13.3 13.4 13.5
13.5 12.5 11.5 11.6 11.7 12.7
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10.16 9.16
9.16 9.17
9.17 9.18
9.18 9.19
9.19 8.19
8.19 7.19
7.19 6.19
6.19 5.19
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7.20 7.21
7.21 6.21
6.21 5.21
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7.22 7.23
7.23 7.24
7.24 7.25
7.25 6.25
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5.24 5.23
5.23 5.24 5.25 6.25 7.25 8.25
8.25 9.25
9.25 9.24
9.24 9.23
9.23 10.23
10.23 11.23
11.23 11.24
11.24 11.25
11.25 11.26
11.26 11.27
11.27 10.27
10.27 9.27
9.27 8.27
8.27 8.28
8.28 8.29
8.29 7.29
7.29 6.29
6.29 6.28
6.28 6.27
6.27 5.27
5.27 4.27
4.27 3.27
3.27 3.26 2.26
2.26 2.25 1.25
1.25 1.26
1.26 1.27
1.27 1.28
1.28 1.29
1.29 1.28 2.28
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2.27 2.26 3.26
3.26 3.25 2.25

2.25 3.25
3.25 2.25 2.26 2.27 2.28 2.29
2.29 2.28 3.28
3.28 3.29
3.29 3.28 4.28
4.28 4.29
4.29 4.28 4.27 5.27 6.27 6.28 6.29 7.29 8.29
8.28 8.27 9.27 10.27 10.28
10.28 10.29
10.29 11.29
11.29 12.29
12.29 13.29
13.29 13.28
13.28 13.27
13.27 13.26
13.26 13.25
13.25 12.25

12.25 11.25 11.24 11.23 12.23
12.23 13.23
13.23 13.22
13.22 13.21
13.21 13.22 13.23 12.23 11.23 10.23 9.23 9.24
9.25 8.25 7.25 7.24 7.23 7.22 7.21 8.21
8.21 9.21
9.21 10.21
10.21 11.21
11.21 11.20
11.20 11.21 10.21 9.21 8.21 7.21 6.21 5.21 4.21
3.21 3.20 3.19 3.18 3.17 3.16 4.16 5.16 5.15
5.14 5.13 5.12 5.11 6.11 7.11 7.10

CONTRIBUTIONS

Bonganay – implemented the solution in Java; compared the solution with Pama's; came up with an algorithm for PART TWO; **documentation for Java implementation is yet to be made.**

Pama – implemented the solution in Python; compared the solution with Bonganay's; came up with a different algorithm for PART TWO (different with Bonganay's); documented the Python implementation.

FINDINGS

Bonganay's code and Pama's code were more or less the same for PART ONE. There were only some point difference between the expanded nodes, maximum frontiers, and path cost.

For PART TWO, although Bonganay's algorithm was correct, it was inconsistent and did not always guarantee the optimal solution. It utilized the heuristics in finding the next goal to go to. Pama's implementation, on the other hand, proved better in terms of finding the more optimal solution, since it calculated all the path costs to each goal and chose the goal with the least path cost to go to next in each round. However, it suffered from having a greater time complexity than Bonganay's.