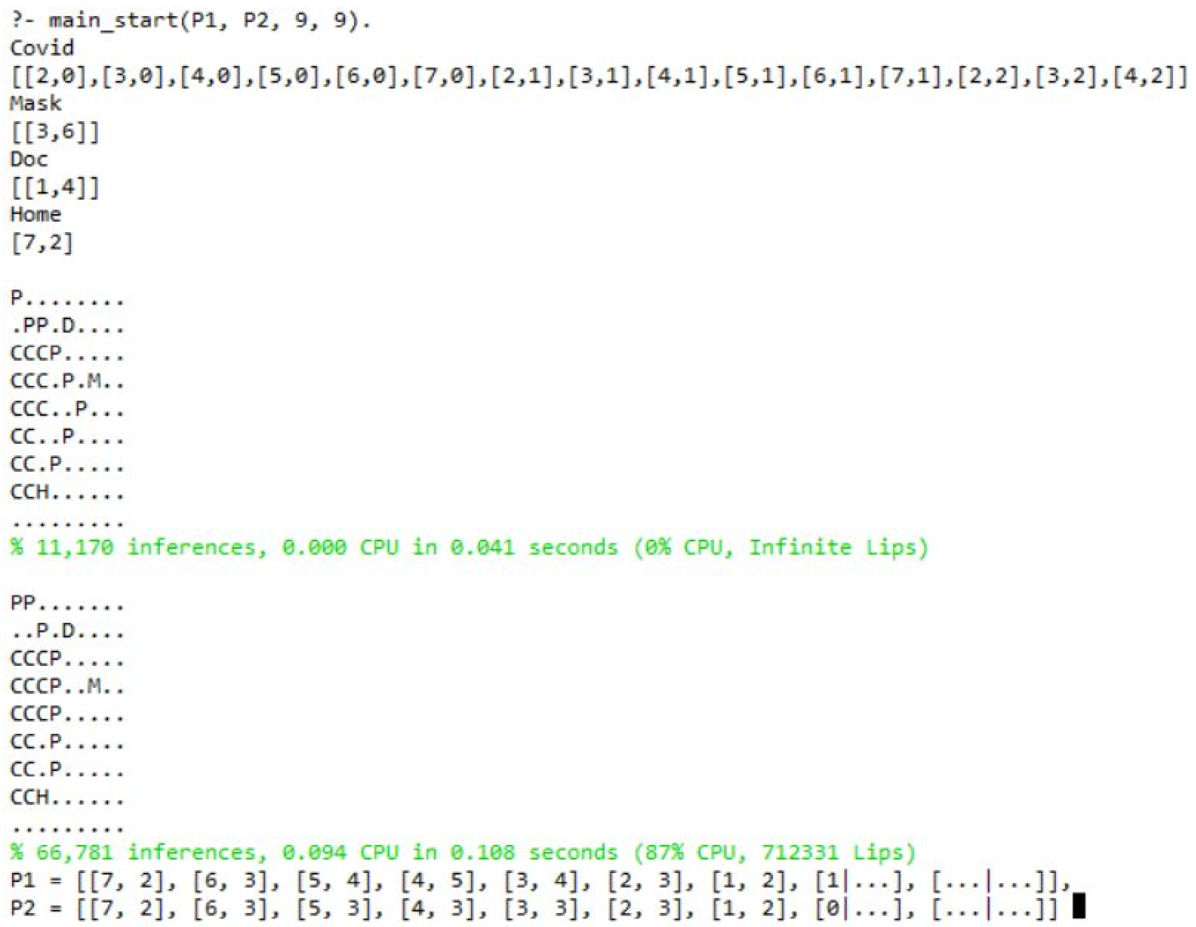
AI Assignment 1

Dinislam Gabitov - BS19-05

*****NOTE*** Backtracking part will not work on the online compiler, because it cannot work with assign() predicate. Please use SWI-Prolog on Win/Linux/Mac.**

HOW TO RUN:



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?- main_start(P1, P2, 9, 9).
Covid
[[2,0],[3,0],[4,0],[5,0],[6,0],[7,0],[2,1],[3,1],[4,1],[5,1],[6,1],[7,1],[2,2],[3,2],[4,2]]
Mask
[[3,6]]
Doc
[[1,4]]
Home
[7,2]

P........
.PP.D....
CCCP.....
CCC.P.M..
CCC..P...
CC..P....
CC.P.....
CCH......
.........
% 11,170 inferences, 0.000 CPU in 0.041 seconds (0% CPU, Infinite Lips)

PP.......
..P.D....
CCCP.....
CCCP..M..
CCCP.....
CC.P.....
CC.P.....
CCH......
.........
% 66,781 inferences, 0.094 CPU in 0.108 seconds (87% CPU, 712331 Lips)
P1 = [[7, 2], [6, 3], [5, 4], [4, 5], [3, 4], [2, 3], [1, 2], [1|...], [...|...]],
P2 = [[7, 2], [6, 3], [5, 3], [4, 3], [3, 3], [2, 3], [1, 2], [0|...], [...|...]]
```

main_start(P1, P2, 9, 9).

prints all objects on the map, then, if fail prints 'fail' and prints map, if successful, prints the map - Covid - 'C', Doc - 'D', Mask - 'M', Home - 'H', and Path to home - 'P'.

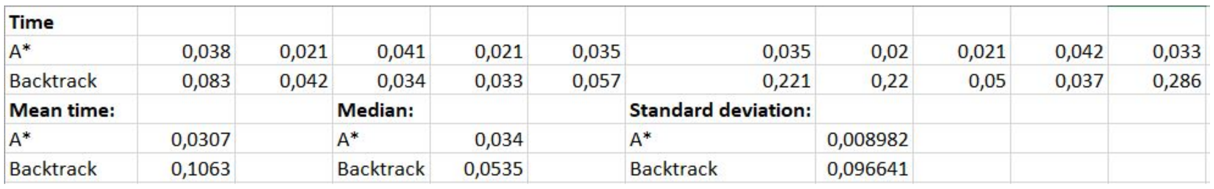
Backtracking: Backtracking implemented with several improvements.

1st improvement is to cut all paths that minimum possible length less than the minimum found path. Example: found a path with length 12. On the backtrack we have current_path = 8, the minimal possible length is 4 => Cut this part, since 8 + 4 > 12 is false.

The 2nd improvement is heuristic. The function is the length between point and home. When deciding where to go, firstly go to point with a minimal heuristic.

A*: Basic A* algorithm. Set [0, 0] to open, While not home, or open is empty, pop value from open with smallest heuristic value(heuristic is length to home). Add to open all adjacent tiles.

Statistic

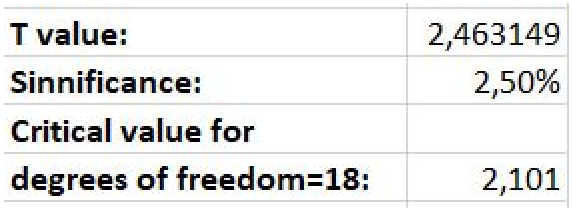


Time										
A*	0,038	0,021	0,041	0,021	0,035	0,035	0,02	0,021	0,042	0,033
Backtrack	0,083	0,042	0,034	0,033	0,057	0,221	0,22	0,05	0,037	0,286
Mean time:			**Median:**			**Standard deviation:**				
A*	0,0307		A*	0,034		A*	0,008982			
Backtrack	0,1063		Backtrack	0,0535		Backtrack	0,096641			

Covid sense for 1 and 2 tiles are the same because backtracking anyway will go through all possible tiles. On A* algorithm, there is no reason to distinct covid adjacent tiles and others, because the shortest path can also go through covid adjacent tiles. Also, there is no sense to go away from covid tiles

All statistics valid for 9*9 map. As we can see by statistic, on average by mean time A* is about 3,46 times faster, by the median time A* is 1.57 times faster. A* is always faster. A* works almost the same for any inputs, while backtracking may work long for some input, especially when the home is far away from the initial point. The more standard deviation in Backtracking also tells us that backtracking works for a long time in specific situations.

Let's also try to use the Student t test and try to reject the null hypothesis. Null hypothesis: Backtracking and A* have the same time efficiency.



T value:	2,463149
Sinnificance:	2,50%
Critical value for	
degrees of freedom=18:	2,101

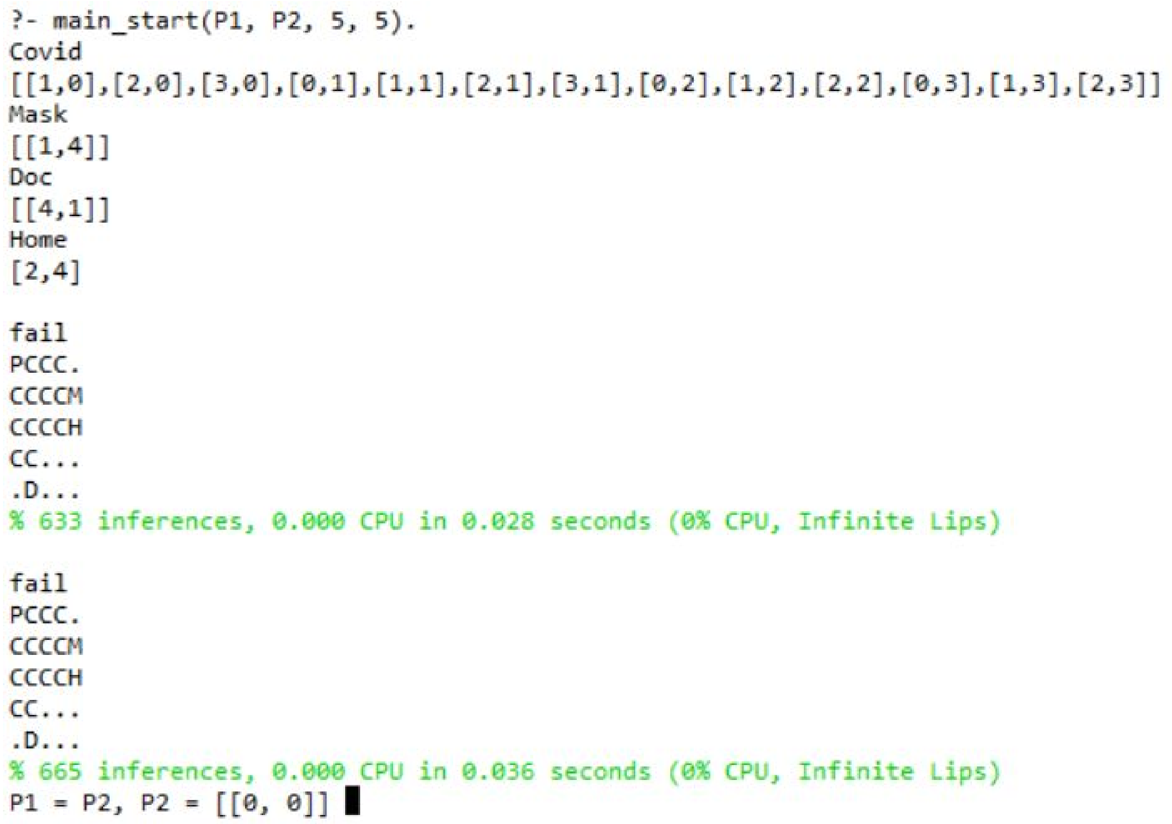
As we can see T value > critical value, then the null hypothesis is rejected, meaning that only in 2,5% null hypothesis is correct.

PEAS: Agent - human, that wants to go home, Performance measurement - time to reach the home, Environment - lattice H*W, Actuators - move to an adjacent cell, take Mask or Vaccine from Doc, Sensors - Covid sense in adjacent cells, Home, Mask, and Doc sense in the cell.

Environment description:

1) Partially observable - an agent can see covid only on adjacent tiles
2) Single-agent - only 1 agent
3) Deterministic - for the same turns we will always get the same results

4) Sequential - agent next turn based on previous
5) Static - no environment change at all
6) Discrete - the path is just discrete turns
7) Partially known - We know that there is covid, mask, doc, and home, but they randomly generated



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?- main_start(P1, P2, 5, 5).
Covid
[[1,0],[2,0],[3,0],[0,1],[1,1],[2,1],[3,1],[0,2],[1,2],[2,2],[0,3],[1,3],[2,3]]
Mask
[[1,4]]
Doc
[[4,1]]
Home
[2,4]

fail
PCCC.
CCCCM
CCCCH
CC...
.D...
% 633 inferences, 0.000 CPU in 0.028 seconds (0% CPU, Infinite Lips)

fail
PCCC.
CCCCM
CCCCH
CC...
.D...
% 665 inferences, 0.000 CPU in 0.036 seconds (0% CPU, Infinite Lips)
P1 = P2, P2 = [[0, 0]]
```

Impossible map to solve. Returns fail when the map is impossible to solve

Some maps:

```
Covid
[[6,0],[7,0],[8,0],[6,1],[7,1],[8,1],[3,6],[4,6],[5,6],[3,7],[4,7],[5,7],[3,8],[4,8],[5,8]]
Mask
[[4,3]]
Doc
[[6,8]]
Home
[3,5]

Length
6
P........
.P.......
..P......
...P.HCCC
...MP.CCC
......CCC
CC......D
CC.......
CC.......
% 12,225 inferences, 0.000 CPU in 0.017 seconds (0% CPU, Infinite Lips)

Legth
6
PPP......
...P.....
....P....
.....HCCC
...M..CCC
......CCC
CC......D
CC.......
CC.......
% 19,506 inferences, 0.000 CPU in 0.016 seconds (0% CPU, Infinite Lips)
P1 = [[3, 5], [4, 4], [3, 3], [2, 2], [1, 1], [0, 0]],
P2 = [[3, 5], [2, 4], [1, 3], [0, 2], [0, 1], [0, 0]]
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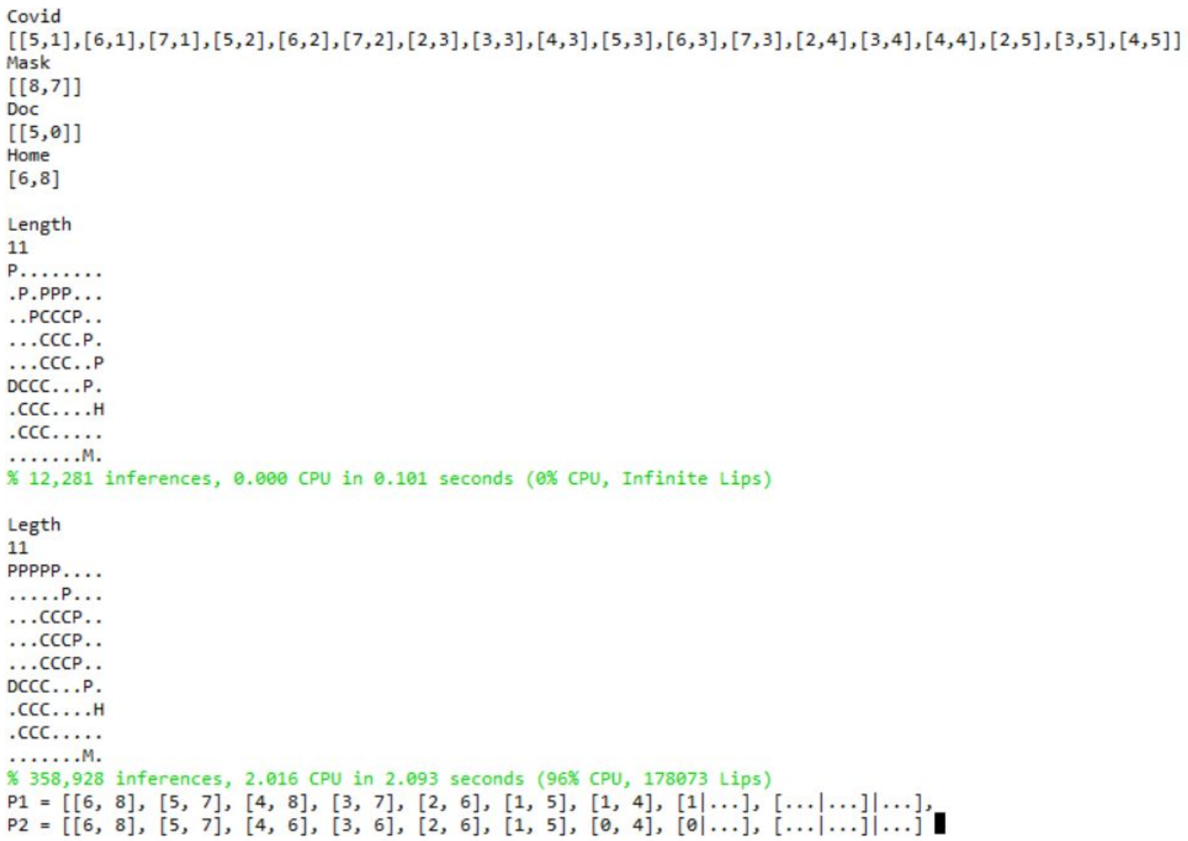

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Covid
[[5,1],[6,1],[7,1],[5,2],[6,2],[7,2],[2,3],[3,3],[4,3],[5,3],[6,3],[7,3],[2,4],[3,4],[4,4],[2,5],[3,5],[4,5]]
Mask
[[8,7]]
Doc
[[5,0]]
Home
[6,8]

Length
11
P........
.P.PPP...
..PCCCP..
...CCC.P.
...CCC..P
DCCC...P.
.CCC....H
.CCC.....
.......M.
% 12,281 inferences, 0.000 CPU in 0.101 seconds (0% CPU, Infinite Lips)

Legth
11
PPPPP....
.....P...
...CCCP..
...CCCP..
...CCCP..
DCCC...P.
.CCC....H
.CCC.....
.......M.
% 358,928 inferences, 2.016 CPU in 2.093 seconds (96% CPU, 178073 Lips)
P1 = [[6, 8], [5, 7], [4, 8], [3, 7], [2, 6], [1, 5], [1, 4], [1|...], [...|...]|...],
P2 = [[6, 8], [5, 7], [4, 6], [3, 6], [2, 6], [1, 5], [0, 4], [0|...], [...|...]|...] 
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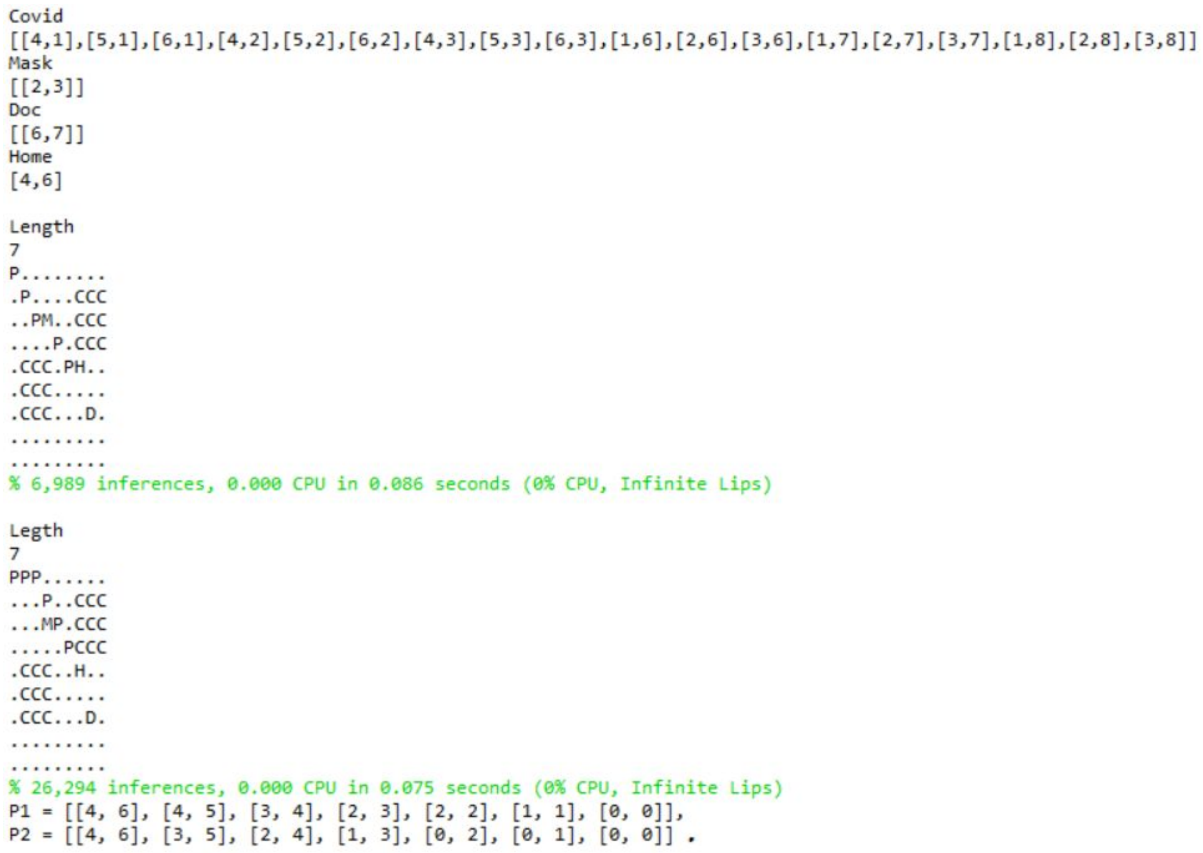

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Covid
[[4,1],[5,1],[6,1],[4,2],[5,2],[6,2],[4,3],[5,3],[6,3],[1,6],[2,6],[3,6],[1,7],[2,7],[3,7],[1,8],[2,8],[3,8]]
Mask
[[2,3]]
Doc
[[6,7]]
Home
[4,6]

Length
7
P........
.P....CCC
..PM..CCC
....P.CCC
.CCC.PH..
.CCC.....
.CCC...D.
.........
.........
% 6,989 inferences, 0.000 CPU in 0.086 seconds (0% CPU, Infinite Lips)

Legth
7
PPP......
...P..CCC
...MP.CCC
.....PCCC
.CCC..H..
.CCC.....
.CCC...D.
.........
.........
% 26,294 inferences, 0.000 CPU in 0.075 seconds (0% CPU, Infinite Lips)
P1 = [[4, 6], [4, 5], [3, 4], [2, 3], [2, 2], [1, 1], [0, 0]],
P2 = [[4, 6], [3, 5], [2, 4], [1, 3], [0, 2], [0, 1], [0, 0]] .
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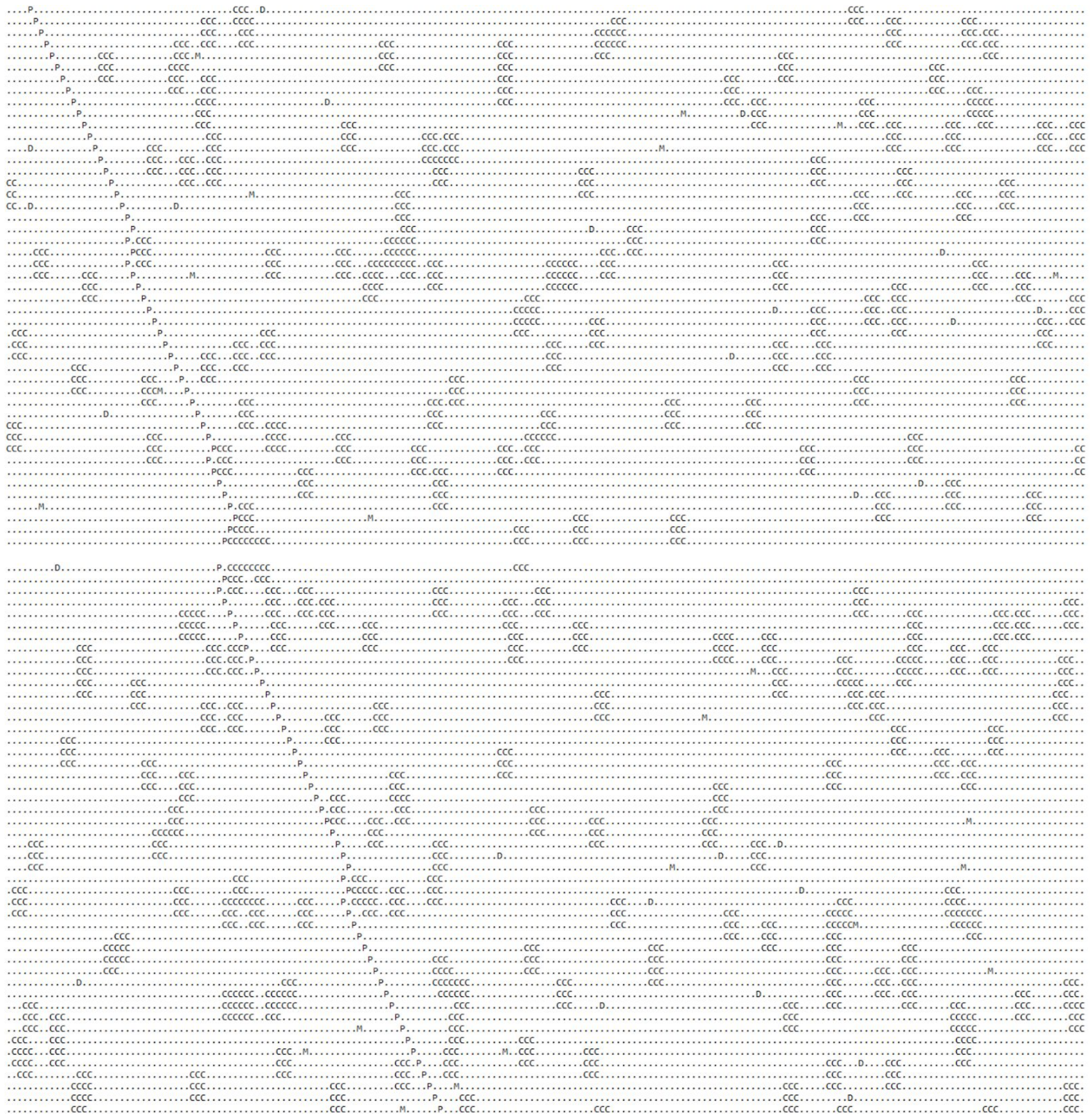
Also, for 200*200 map with 500 covid, 50 masks, and 50 docs A* works surprisingly well, about 14-30sec to run (Backtrack dies on 15*15)



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[illegible]
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