## Day 2 Task 3: Maze

In southern Ontario, many corn farmers create cornstalk mazes like the one shown. The mazes are created in the fall, after the grain has been harvested. There is still time for you to help design the best maze ever for 2010.


A field is covered with corn stalks except for a few obstacles (trees, buildings and the like) where corn cannot grow. The stalks, which are extremely tall, form the walls of the maze. Pathways are created on a square grid by crushing 1 m square areas of stalks. One grid square on the edge is the entrance, and one grid square is the core of the maze.

Jack visits a corn maze every year, and has become adept at finding his way quickly from the entrance to the core. You are designing a new maze, and your job is to determine which stalks to crush, so as to maximize the number of squares Jack must visit.

The grader will determine which square is the entrance (the only one on the perimeter) and which square is the core (the one that Jack must walk farthest to reach).

A map of the rectangular field is represented as text; for example, a 6 m by 10 m field with eight trees might be represented as:

## \#\#X\#\#\#\#\#\#

\#\#\#X\#\#\#\#\#\#
\#\#\#\#X\#\#X\#\#
\#\#\#\#\#\#\#\#\#
\#\#XXXX\#\#\#\#
\#\#\#\#\#\#\#\#\#\#
The symbol \# represents a square with standing cornstalks, and X represents a square with an obstacle (such as a tree) that cannot be crushed to form a pathway.

The field is transformed into a maze by crushing squares occupied by corn. One crushed square (the entrance) must be on the edge of the field. The other crushed squares must be in the interior. The objective is to maximize the shortest path from the entrance to the core, measured by the number of crushed squares that Jack must pass through, including the entrance and the core. It is possible to pass from one square to another only if both are crushed and they share an edge.

In your submission, the crushed squares should be identified by periods (.). Exactly one of the crushed squares should be on the perimeter. For example:

```
#. X#######
#.#X#...##
#...X#.X.#
#.#......#
#. XXXX##.#
##########
```

Below, for illustration purposes only, we mark the entrance e , the core c and remainder of the path using + . The path length is 12 .
\#EX\#\#\#\#\#\#\#
\#+\#X\#C+.\#\#
\#+++X\#+X.\#
\#.\#++++..\#
\#. XXXX\#\#.\#
\#\#\#\#\#\#\#\#\#\#
The folder /home/ioi2010-contestant/maze contains several text files named field1.txt field2.txt etc. containing maps of cornfields. You are to copy them to files named maze1.txt maze2.txt etc., and transform them into valid mazes by replacing some of the \# symbols by periods.

Note: the Grading Server Public Test will award 1 point per subtask for any valid solution (regardless of the path length). The Grading Server Release Test will award the remaining points. The total score for the task will be rounded to the nearest integer between 0 and 110.

## Subtask 1 [up to 11 points]

The field described above (of size $6 \times 10$ ) may be found in the file field1.txt. Create a maze for this field named maze1.txt that has a shortest path from the entrance to the core with length P. Your score for this subtask will be the minimum of 11 and $10^{\mathrm{P} / 20}$. Note that the sample solution scores 3.98 points.

## Subtask 2 [up to 11 points]

The file field2.txt represents a field of size $100 \times 100$. Create a maze for this field named maze2.txt that has a shortest path from the entrance to the core of length $P$. Your score for this subtask will be the minimum of 11 and $10^{\text {P/4000 }}$.

## Subtask 3 [up to 11 points]

The file field3.txt represents a field of size $100 \times 100$. Create a maze for this field named maze3.txt that has a shortest path from the entrance to the core of length $P$. Your score for this subtask will be the minimum of 11 and $10^{\text {P/4000 }}$.

## Subtask 4 [up to 11 points]

The file field4.txt represents a field of size $100 \times 100$. Create a maze for this field named maze 4 .txt that has a shortest path from the entrance to the core of length $P$. Your score for this subtask will be the minimum of 11 and $10^{\text {P/4000 }}$.

## Subtask 5 [up to 11 points]

The file field5.txt represents a field of size $100 \times 100$. Create a maze for this field named maze5.txt that has a shortest path from the entrance to the core of length $P$. Your score for this subtask will be the minimum of 11 and $10^{\text {P/5000 }}$.

## Subtask 6 [up to 11 points]

The file field6.txt represents a field of size $11 \times 11$. Create a maze for this field named maze6.txt that has a shortest path from the entrance to the core of length $P$. Your score for this subtask will be the minimum of 11 and $10^{\mathrm{P} / 54}$.

## Subtask 7 [up to 11 points]

The file field7.txt represents a field of size $20 \times 20$. Create a maze for this field named maze 7 .txt that has a shortest path from the entrance to the core of length $P$. Your score for this subtask will be the minimum of 11 and $10^{\mathrm{P} / 33}$.

## Subtask 8 [up to 11 points]

The file field8.txt represents a field of size $20 \times 20$. Create a maze for this field named maze8.txt that has a shortest path from the entrance to the core of length P . Your score for this subtask will be the minimum of 11 and $10^{\mathrm{P} / 95}$.

## Subtask 9 [up to 11 points]

The file field9.txt represents a field of size 11x21. Create a maze for this field named maze9.txt that has a shortest path from the entrance to the core of length P . Your score for this subtask will be the minimum of 11 and $10^{\mathrm{P} / 104}$.

## Subtask 10 [up to 11 points]

The file fieldA.txt represents a field of size 200x200. Create a maze for this field named mazeA. txt that has a shortest path from the entrance to the core of length $P$. Your score for this subtask will be the minimum of 11 and $10^{\text {P/8800 }}$.

## Implementation Details

- This is an output-only task.
- Implementation folder: /home/ioi2010-contestant/maze/
- To be submitted by
contestant: maze1.txt maze2.txt maze3.txt maze4.txt maze5.txt maze6.txt maze 7.txt maze8.txt maze9.txt mazeA.txt.
- Contestant interface: none
- Grader interface: none
- Sample grader: grader.c or grader.cpp or grader.pas
- Sample grader input: grader.in. 1 grader.in. 2 etc.

Note: the implementation folder contains very simple solutions mazel.txt, maze2.txt etc.. Copy these to grader. in. 1 grader. in. 2 etc. for testing.

- Expected output for sample grader input: if the input is a valid maze for subtask $N$, the sample grader will output ok $N P$ where $P$ is the path length.
- Compile and run (command line): runc grader. c or runc grader.cpp or runc grader.pas
- Compile and run (gedit plugin): Control-R, while editing the grader.
- Submit (command line): submit maze1.txt or submit maze2.txt etc. All.txt files in the implementation folder will be submitted, regardless of which is specified in the submit command.
- Submit (gedit plugin): Control-J, while editing any .txt file.

