

The following tasks are inspired by tasks from <https://adventofcode.com/>

Feel free to use any code from the sample solutions of exercises 7 and 8.

1 Pathfinder (9 points)

Your input is a heightmap that shows a local area from above broken into a grid; the elevation of each square of the grid is given by a single lowercase letter, where a is the lowest elevation, b is the next-lowest, and so on up to the highest elevation, z.

Also included on the heightmap are marks for the start position (S) and the target position (E). The start position (S) has elevation a, and the target position (E) has elevation z.

Find a way from S to E in as few steps as possible. During each step, you can move exactly one square up, down, left, or right. The elevation of the destination square can be at most one higher than the elevation of your current square or it can be lower. That is, if your current elevation is m, you could step to elevation m or n, but not to elevation o. Or you could go downhill and step to elevations lower than m (a, b, ..., l).

For example:

```
S a b q p o n m
a b c r y x x l
a c c s z E x k
d c c t u v w j
a b d e f g h i
```

Here, you start in the top-left corner; your goal is near the middle. You could start by moving down or right, but eventually you'll need to head toward the e at the bottom. From there, you can spiral around to the goal. For the example above, the shortest path (as drawn with arrows) looks like this:

```
∨ . . ∨ < < < <
> ∨ . ∨ ∨ < < ^
. > ∨ ∨ > E ^ ^
. . ∨ > > > ^ ^
. . > > > > ^
```

This path reaches the target position in 31 steps, the fewest possible.

Find the shortest path from S to E for this heightmap:

<https://www.dfki.de/~steffen/advanced-java/pathfinder.txt>

Write a unit test that verifies that the target position can be reached in 490 steps.

2 Pathfinder Reloaded (6 points)

Assume that you can freely choose a start position. The only requirement is that it has an elevation a . The target position is still the square marked E . How many steps has the shortest possible path under these conditions?

Again, consider the example from above:

```
S a b q p o n m
a b c r y x x l
a c c s z E x k
d c c t u v w j
a b d e f g h i
```

There are five choices for starting position (four marked a , plus the square marked S that counts as being at elevation a). If you start at the bottom-left square, you can reach the goal most quickly:

```
. . . v < < < <
. . . v v < < ^
. . . v > E ^ ^
. > v > > > ^ ^
> ^ > > > > ^ ^
```

This path reaches the goal in only 29 steps, the fewest possible.

Write a unit test that verifies that the shortest possible path from a square with elevation a to the target position has 488 steps.

Try to calculate your solution as efficient as possible! Ideally, your unit test should take no longer than 100 milliseconds on an average PC.