FINDING MOON ON IMAGE

COURSE WORK #06

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PROBLEM STATEMENT

You have a digital monochrome photo of the night sky. The photo consists of black and white pixels. The largest white circle in the photo is the Moon and all other white circles are the stars. You need to find the Moon in the photo and print its radius.

Input. The first string contains two numbers: W and H (1<=W, H<=200) divided by spaces. The next H strings contain W symbols each: “.” — black pixel or “*” — white pixel.

Output. A single number — the Moon radius.

PROBLEM STATEMENT

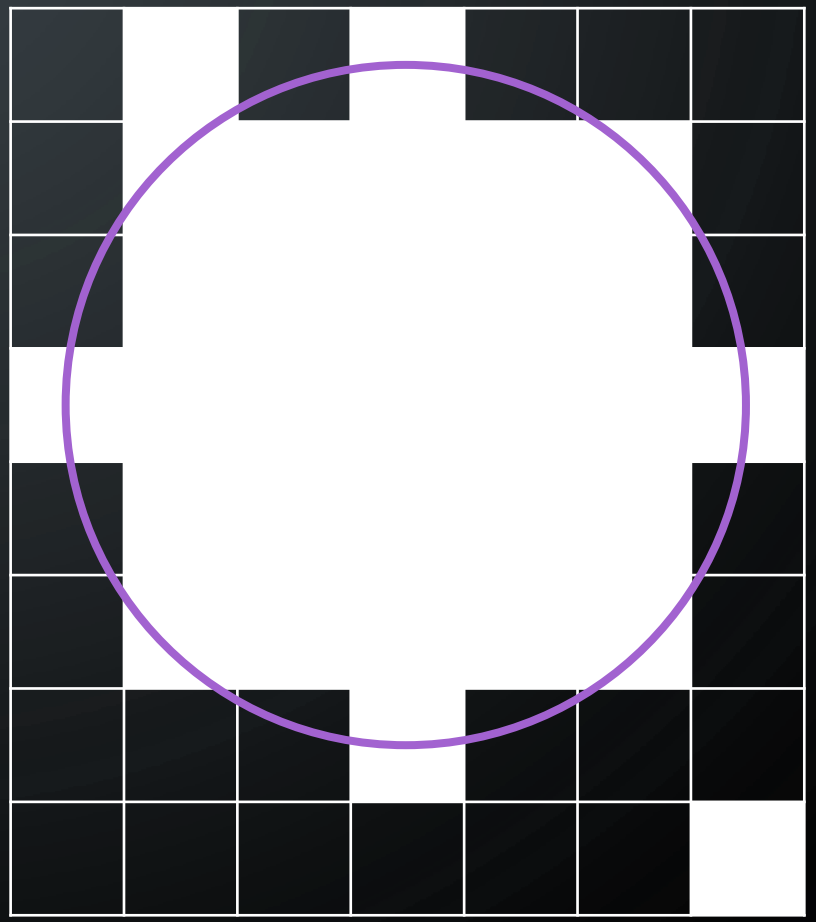
Example. W = 7 and H = 8

Input:

7 8

.*.*...
.*****.
.*****.
****
.*****.
.*****.
...*...
.....*

Output: 3



THE PROBLEM SOLVING

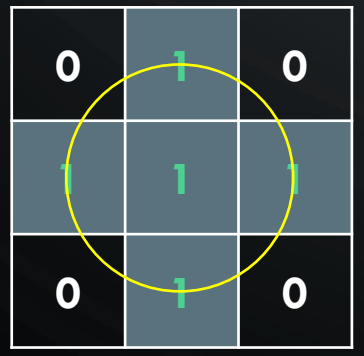
Let's change symbols by digits and assign 1 to white color and 0 to black. Now we can calculate the maximum possible Moon radius. It will be min(W, H)/2 rounded to smaller integers. So, we will test each radius from 1 to the maximum to find the Moon.

To solve this problem we use a dynamic programming approach. For that, we need to determine the overlapping subproblems and optimal substructure properties. The overlapping subproblem here is to find the circle of radius 1, 2, 3, and so on. The optimal substructure property is using the solution for finding circles with a lesser radius. To find a circle with radius **N**, firstly we need to find circles with radius **N-1**.

THE PROBLEM SOLVING

Step 0. Fill the black pixels with zeros and the white with ones.

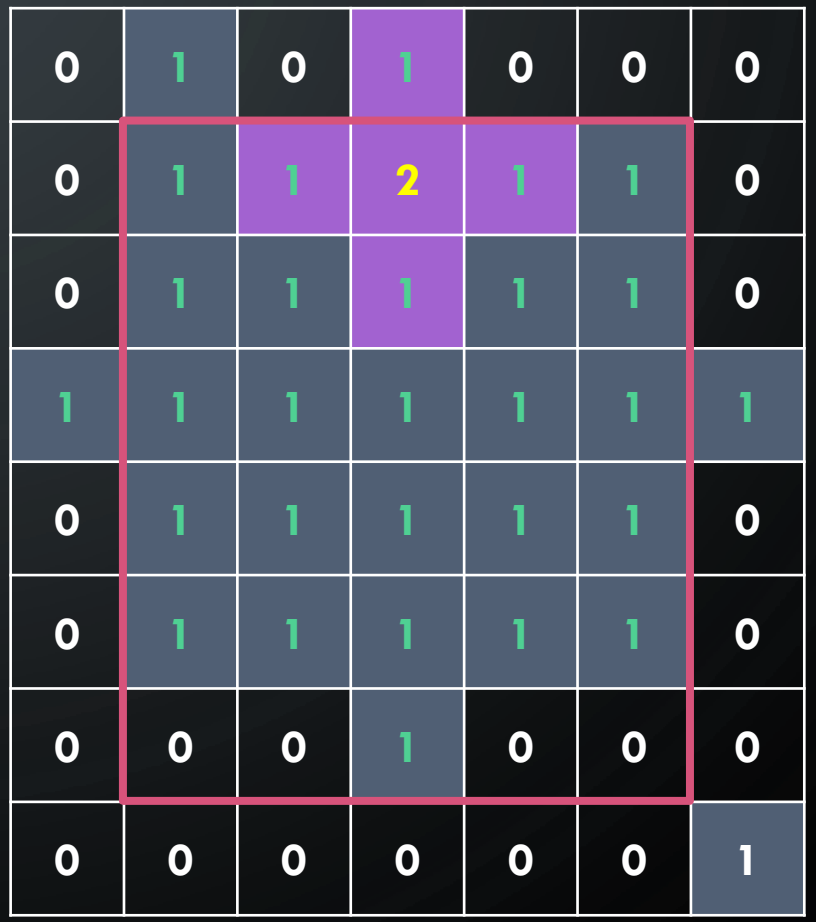
Now let's understand how to define a circle with radius 1. This must be five pixels with ones as depicted in the figure below.



0	1	0	1	0	0	0
0	1	1	1	1	1	0
0	1	1	1	1	1	0
1	1	1	1	1	1	1
0	1	1	1	1	1	0
0	1	1	1	1	1	0
0	0	0	1	0	0	0
0	0	0	0	0	0	1

THE PROBLEM SOLVING

Step 1. Now we traverse the array of pixels with a one-pixel margin and when a circle with radius one is detecting we update its center with the number 2.



THE PROBLEM SOLVING

Step 2. Now we traverse the updated array of pixels with a two-pixel margin and when a circle with radius one is detecting we mark its center by the number 3. Now we construct a circle using pixels with number 2.

0	1	0	1	0	0	0
0	1	1	2	1	1	0
0	1	2	3	2	1	0
1	2	2	2	2	2	1
0	1	2	2	2	1	0
0	1	1	2	1	1	0
0	0	0	1	0	0	0
0	0	0	0	0	0	1

THE PROBLEM SOLVING

Step 3. Now we traverse the updated array of pixels with a three-pixel margin and when a circle with radius one is detecting we mark its center by the number 4. Now we construct a circle using pixels with number 3.

We know it will be our last traverse because the current margin is equal to the maximum possible radius. If we can construct a circle, then the Moon's radius is 3, otherwise is 3-1=2.

0	1	0	1	0	0	0
0	1	1	2	1	1	0
0	1	2	3	2	1	0
1	2	3	4	3	2	1
0	1	2	3	2	1	0
0	1	1	2	1	1	0
0	0	0	1	0	0	0
0	0	0	0	0	0	1

THE PROBLEM SOLVING

The algorithm to solve this problem.

1. Create a 2D array of **W** x **H** size.
2. Fill the black pixels with 0 and white with 1. Set the radius **R**=1.
3. Traverse the array with the margin **R**.
4. If a circle with radius 1 is found then increase the central pixel value by 1.
5. Increase current radius **R**=**R**+1 and repeat steps 3 and 4 until no one circle is found.

THANK YOU!