Programming Challenge

YEC 2020 - 2021

Background

In the year 2021, research on making powerful bio-bombs that carry certain Archaea and Bacteria across large distances has become a popular approach to spark life on uninhabitable planets. The theoretical solution is to detonate these bombs on the surface of the planet and over decades the micro-organisms will develop, some will produce oxygen and the planet would be a step closer to sustaining Human life.

You work for a Bio-Engineering Organization that is conducting research on these bio-bombs. After an experiment at testing site “4S-N100" (a patch of land in the Canaediyan Desert), a mutated life form in the shape of a massive growing amoeba emerges from the epicenter of the detonation and grows rapidly.

The Organization immediately evacuates all personnel and material off the testing grounds. After observing the life form for 20 hours, the researchers classify it as an A7 hazard, the highest possible level of toxicity. It is not at all ideal for starting life on another planet. The life form, given a code name "Specimen-F", consists of several individual amoeba-like units, each about 10 meters wide, that function together to act as a large singular body. Although the lifespan of each unit is only 4 hours, what is troubling is the ferocity at which Specimen-F reproduces new units.

24 hours after the initial detonation, and a significant mass of Specimen-F has formed, a secondary blast (possibly from fragments that did not burst during the original detonation) takes place at the very same location as the initial detonation. The mass of specimen-F is blown sky high and scatters across the testing grounds.

Challenge

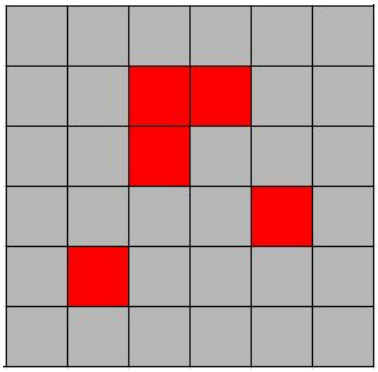
The organization takes immediate action and executive orders arrive to eliminate the life form. News is heard of similar life forms that have appeared at testing ground 4S-N400 and the situation there is out of control as well. Researchers decide to take an aerial shot to view the scattered Specimen-F across the landscape and gather the following information in this confidential .txt file. Each value represents a 10 meter by 10 meter square block of land.

Example

The following data file corresponds to the following land, where O signifies heat signatures and thus the land that contains life. The .'s are areas of uninhabited land.

.txt file

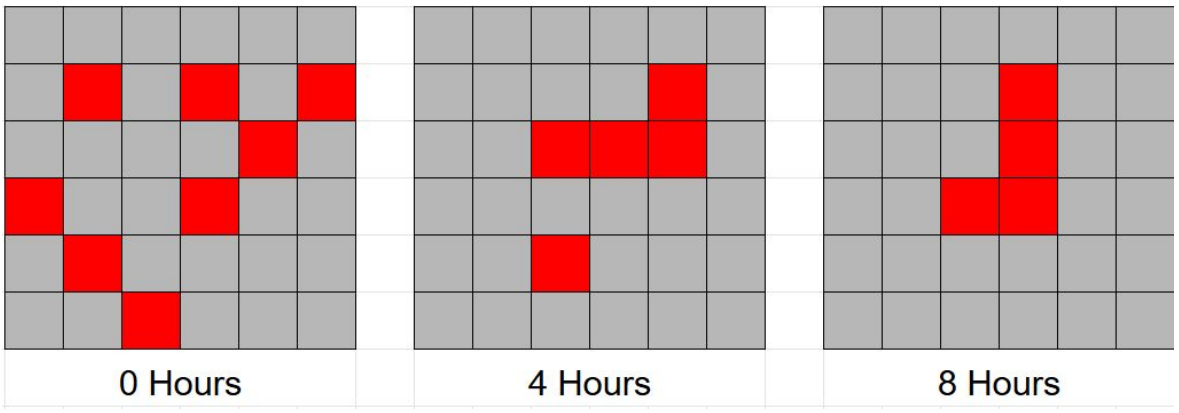
.,.,.,.,.,.
.,.,O,O,.,.
.,.,O,.,.,.
.,.,.,.,O,.
.,O,.,.,.,.
.,.,.,.,.,.



Additional information has been gathered about the behavior of Specimen-F

1) Specimen-F is vulnerable alone, it will die after 4 hours if it does not have at least 3 or more units of itself surrounding it. (surrounding means directly adjacent and diagonal)
2) Specimen-F takes advantage of any free land area to reproduce once every 4 hours. Any land that contains 3 or more units of Specimen-F surrounding it will be populated after 4 hours.

These two behaviours are illustrated together below:



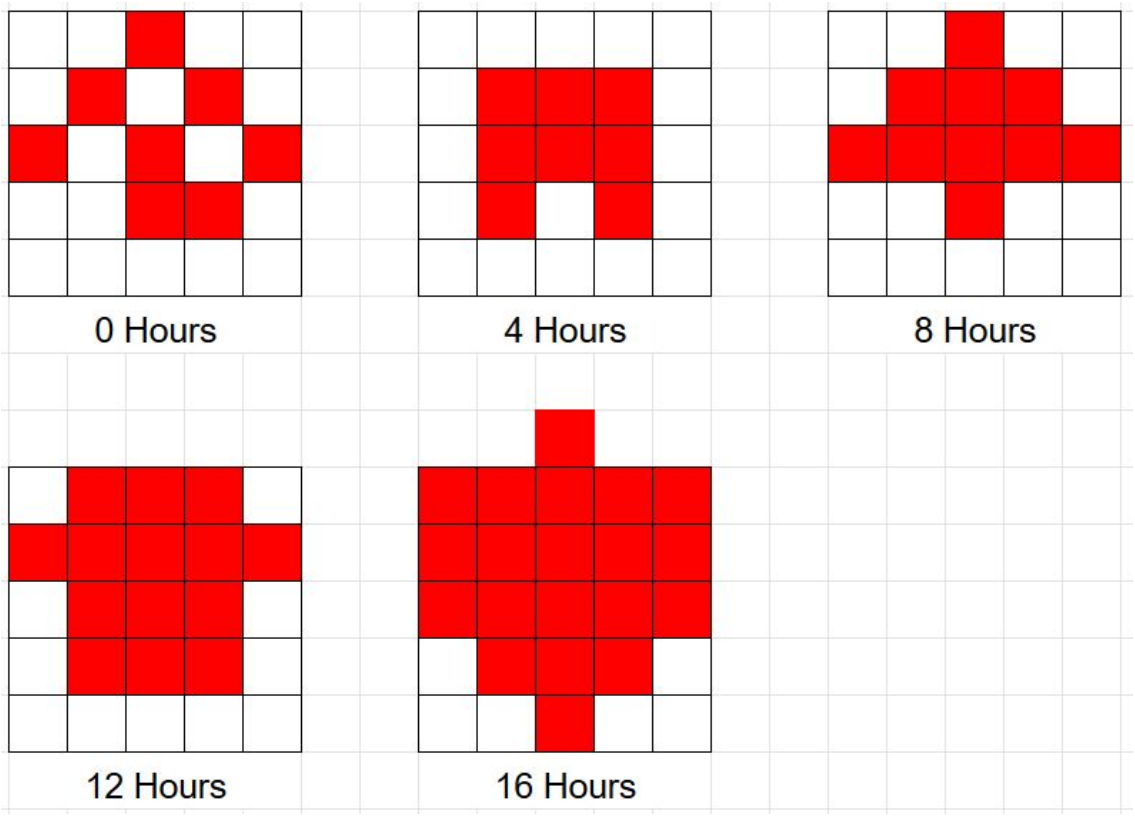
Part 1 - (software test) Testing Ground 4S-N25

The testing ground 4S-N25 does not exist, you will use this fictional area for the purpose of testing if your code works before attempting to simulate testing grounds 4S-N100

How long does the organization have to produce a countermeasure against specimen-F before it breaches the testing grounds?

If Specimen-F dies, or never breaches the testing grounds, simply output “GG” to the .txt file.

The answer is:
Specimen-F has breached the testing grounds after 16 hours



Create a program in a programming language of your choice to simulate the life of Specimen-F.
You will be asked to run the program during the presentation.

You have been given the input data file 4S-N25.txt
Your program must read the file as input and produce an output data file.
Your output data file must look like the file 4S-N25(Solution).txt

In the data file
The symbol “.” represents unpopulated land

The letter “O” represents specimen-F units

Part 2 - Testing Ground 4S-N100

Part 1 was a test given by the organization to confirm that your program works
Now you will move on to the real testing grounds

Use the data file “4S-N100.txt” as input to develop an output file named “4S-N100(Solution)”
The output file should contain the state of the testing grounds at the hour of the breach
In the output file:
The symbol “.” should represent unpopulated land.
The letter “O” should represent specimen-F units.

How long does the organization have to produce a countermeasure against specimen-F before it breaches the testing grounds?
If Specimen-F dies, or never breaches the testing grounds, simply output “GG” to the .txt file.

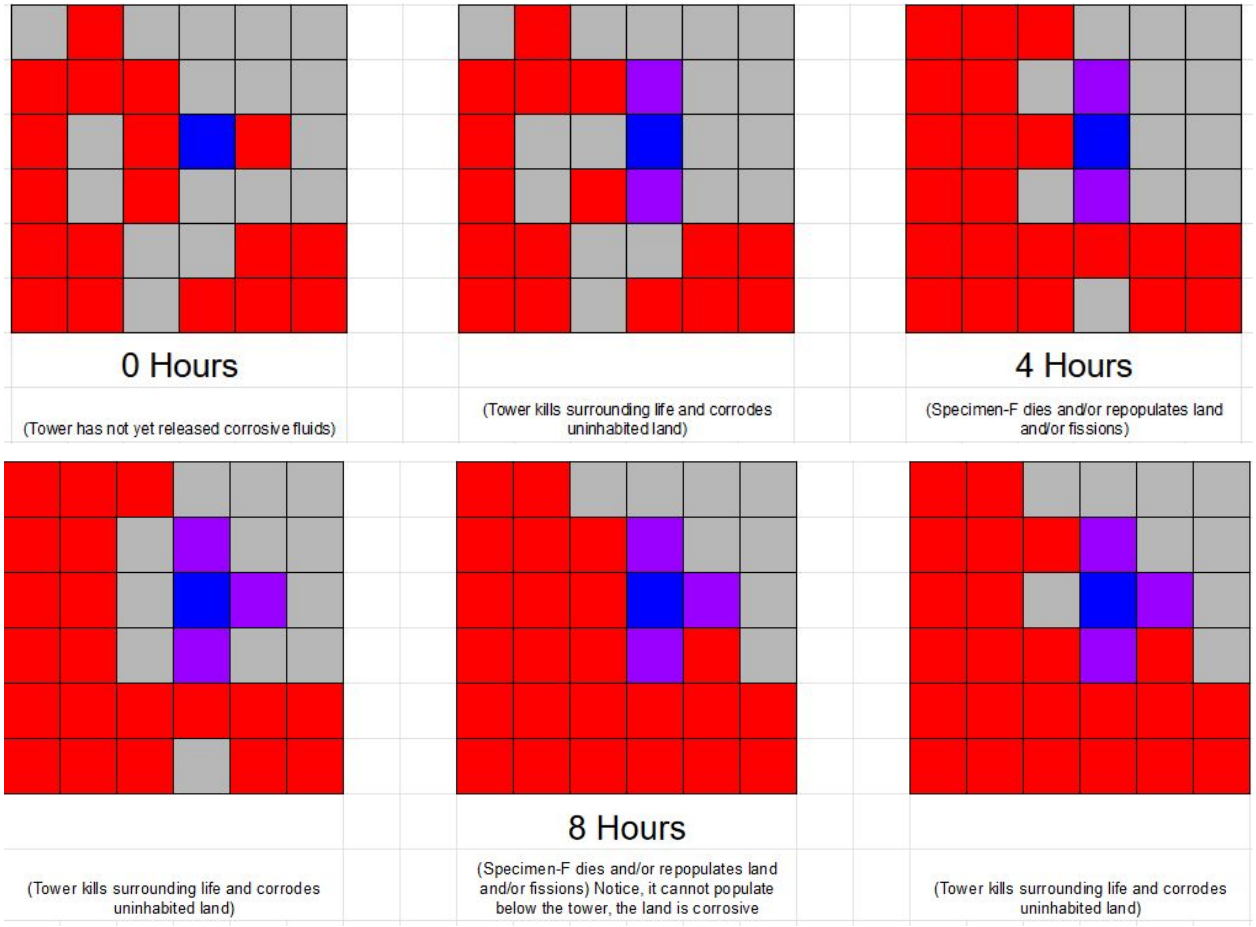
Create a program in a programming language of your choice to simulate the life of Specimen-F.
You will be asked to run the program during the presentation.

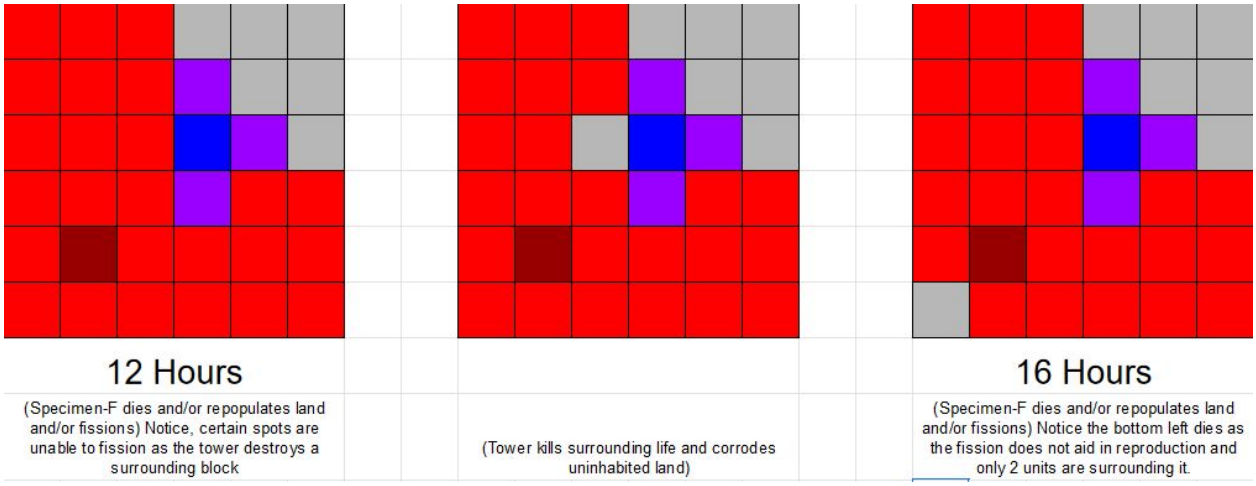
Part 3 - Testing Ground 4S-N400

At testing grounds 4S-N400, the situation is slightly different. The testing grounds here have control towers that house corrosive liquids. Due to the explosions, they have been damaged and are intermittently leaking out their contents. The contents of the control towers are fatal to Specimen-F upon exposure. If Specimen-F is inhabiting the land area adjacent to the towers, it will perish. If the land does not contain anything, then the corrosive liquid will seep into the desert sands and that land will no longer be survivable for Specimen-F. Naturally, Specimen-F cannot populate any land the corrosive towers lie on.

Another characteristic about Specimen-F has been detected here, (the specimen has adapted to the harsher environment and is capable of Fissioning). If a unit of the specimen is surrounded by itself on all 8 sides for 4 hours, it will fission into a solid mass that cannot be destroyed by the corrosive liquid. But, the solid mass is incapable of reproduction and does not assist in populating the land

These two additional factors are illustrated in a simulation below:





Given the following data file of NS-400, The organization needs 200 hours to procure and deploy a system to wipe out specimen-F. Will the organization wipe out the life form before it breaches the testing grounds?

How many hours will it take the life-form to breach the testing grounds?
Where on the testing grounds will the breach take place?
If Specimen-F dies, or never breaches the testing grounds, simply output “GG” to the .txt file.

Use the data file “4S-N400.txt” as input develop an output file named “4S-N400(Solution)”
The output file should contain the state of the testing grounds at the hour of the breach

The symbol “.” represents unpopulated land
The letter “O” represents specimen-F units
The letter “Y” represents corrosive towers
In the output file:
You must also represent the Fissions and Corrosive land respectively using the symbols “M” and “+”.

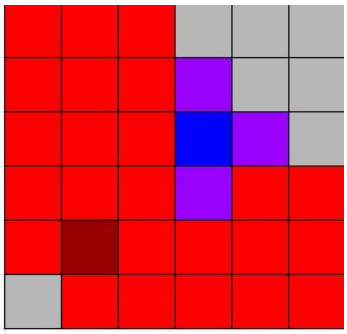
Create a program in a programming language of your choice to simulate the life of Specimen-F. You will be asked to run the program during the presentation.

Part 4 - Deploying Extermination System 4S-NS400

Once the Virus breaches testing grounds, the company deploys a system to exterminate the units of Specimen-F, a decontamination vehicle that cleans a single spot on the grid.

Passing over a unit of Specimen-F will kill the unit while fissioned units will require two passes to kill. If the vehicle is released at position (0,0), the top left position of the testing grounds, output a series of comma separated coordinates of the form (x,y) specifying a path to clean the grounds of all units of Specimen-F while avoiding all corrosive towers and corroded land.

Use your output for Part 3 as a sample input for this problem.



An appropriate output for this file may be:
(0,0),(0,1),(0,2),(1,2),(1,1),(1,0),(2,0),(2,1),(2,2),(3,2),(3,1),(3,0),(4,0),(4,1),(4,2),(4,1),
(4,2),(4,3),(4,4),(3,4),(3,5),(4,5),(5,5),(5,4),(5,3),(5,2),(5,1)

Note: There are many correct solutions and outputs for this problem.

How can you find the minimum number of moves required to clean the area entirely? Discuss this in your presentation.

Part 5 - Additional Insight

If you have completed Part 4, you can move on to these optional additions:
Use the simulation to glean information about specimen-F that may be useful to the organization
Some examples:

- What is the doubling period of Specimen-F?
- Create a graph of the population of Specimen-F by time (hours)
- How many units of specimen-F have the corrosive towers killed within a certain timespan?
- Graph the testing grounds using a method of your choice so that it displays the grounds like the examples above at a 4 hour interval.

Add the information you gathered in the presentation and be prepared to explain how you managed to gather the information.

Submission

Begin your submission at least 30 minutes before the deadline so that you make sure you have sufficient time.
You must submit 4 files in a SINGLE email before the deadline to **avpe@lasengsoc.com**
The email subject line must be in the following format:
Suppose your team name is “Cola”
Then your subject line will be: “ [Cola]-YEC Programming Submission “

File 1
The output .txt file “4S-N100(Solution)”

File 2
The output .txt file “4S-N400(Solution)”

File 3
The output .txt file named “Deploying Extermination System 4S-N400(Solution)”

File 4
The file (for example a .java file or .py file) that contains your program

File 5
The file that contains your presentation

During the presentation, you will be asked to demonstrate your solution.
Address the following prompts during your presentation:

Part 2
How long does the organization have to produce a countermeasure against specimen-F before it breaches the testing grounds?

Part 3
Will the organization wipe out the life form before it breaches the testing grounds?
How many hours will it take the life-form to breach the testing grounds?
Where on the testing grounds will the breach take place?

Part 4
Can you find the minimum number of moves required to clean any given testing ground for 4S-N400? Discuss with respect to the number of contaminated areas, fissions, and units of Specimen-F.

You will be judged not only on your correctness, but also on your ability to approach the problem.