**Assignment 2 – Biological Weapon Fallout**

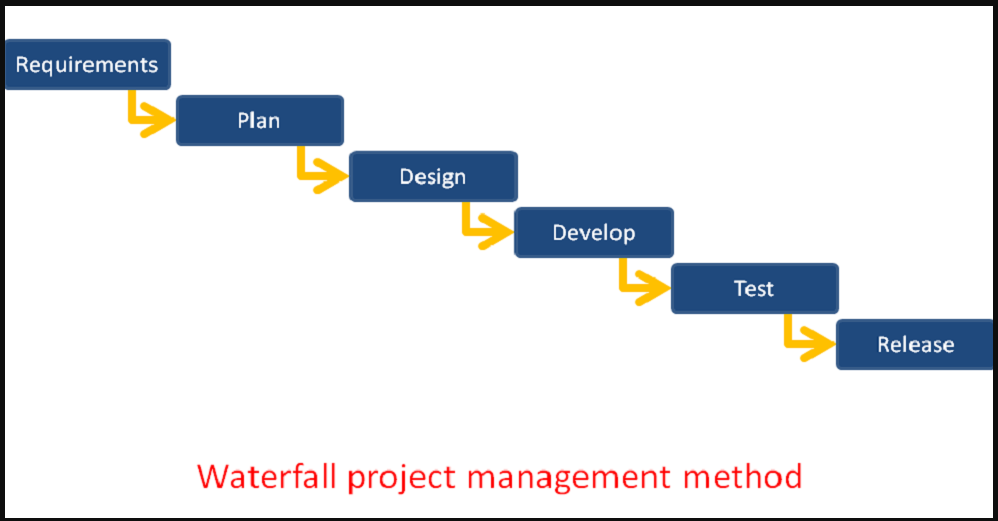
**Background**

Bacteria\_bomb is an agent base model that depicts the scenario of a terrorist attack, particularly a bomb that has released and spread harmful bacteria within an area, known to be deadly if within human contact. The logical code written takes 5000 agents (each agent depicting a bacterium), and moves them randomly, dependent on the probability of what cardinal direction the wind will blow it towards, and whether it touches the ground or not as the bomb is stationed on top of a 7m meter high building. A class method has been created to help move the agents from the starting location (bomb point), to where it is most likely going to end up.

A move function was coded to calculate each agent should move 5% West, 10% North/South or 75% East. Subsequently, a height function was coded to simultaneously run with the move function to determine whether the bacterial agents will land on the ground or not. Thus, each agent's location was then plotted to a graph to distinguish the overall density and location of the contamination. The density map will then support the process of the government’s anti-terrorist department to ascertain where the bacteria has spread to.

**Development processes and software design methods**

In order to start coding the model, a software development process was needed as a guide to manage the structure and produce an interconnecting flow of methods. Thus, the waterfall methodology was chosen and utilised to help initiate each step to complete the agent base model. Such methodology is a linear project management framework which focuses on the requirements needed to complete a project, before following sequential steps to accomplish the established requirements (Waterfall Methodology in Project Management 2019). Figure 1 depicts the framework of the waterfall methodology. The project included the process of analysing the requirements steps and data listed in the project brief, then logically writing and testing different statements until each step was successfully coded.



# **Figure 1: waterfall methodology (Waterfall project management- A tutorial, 2019).**

**Errors encountered and debugging methods**

*Error 1*

A for loop was created to append the location of the bomb into a separate list from the environment file (wind.raster.txt). However, the coded for loop produced a list of the environment followed by several empty brackets. To solve this error, an enumerate function was used to read through the environment’s lists index and values to append the location to the bomb list. Such method was also a tidier approach in comparison to the “range(len” method, as less lines of code are used (Enumerate() in python n.d).

*Error 2*

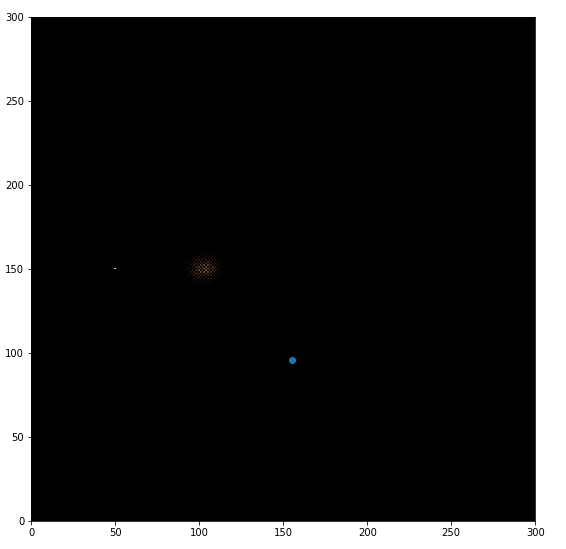
Whilst testing to ascertain if the spread.py model produced an x and y variable from the Agent class, the following error appeared “a = spread.Agent() TypeError: \_\_init\_\_() missing 3 required positional arguments: 'environment', 'bacteria', and 'bomb'”. To solve this, the environment, bacteria and bomb variable names was added to the print syntax to call function from the main model.

*Error 3*

The spread and height function that calculates the direction the agents will move and whether they will drop or not (retrospectively) produced the results “None” when ran to test if the calculations worked. To correct this issue, the code “environment[bacteria[i].y][bacteria[i].x] += 1” needed to be indented in line with the while loop to pick up the calculations produced by the move and height agent methods.

*Error 4*

Lastly, the graph that depicts where the bacterial agents will end up appears to produce minimal results as expected, furthermore, the results seems to be unlikely placed at the wrong location. Figure 2, evident a small cluster North West of the bomb’s location, however, the likeliness of the bacterial agent being blown West is less frequent in comparison to the wind directing it East (75% likely) and North and South (10% likely). The results also evidence the lack of bacteria to the South and North of the bomb. The issue identified was that my result was inverted; my code instructed python to read my x value before my y as which was wrong as it was later discovered that the location of the bomb was 150, 50 (y coordinates first). The issue was fixed by swapping the coordinates within the for loop that reads in my environment to read x, y. Now, the results are places to the East of the bomb, which were the most probable outcome.



**Figure 2: Bacterial agents density map.**

**Bibliography**

GeeksforGeeks. *Enumerate() in python.* [Online]. [Accessed 29th August 2019]. Available from: [https://ww https://www.geeksforgeeks.org/enumerate-in-python/w.islington.gov.uk/~/media/sharepoint-lists/public-records/environmentalprotection/qualityandperformance/reporting/20112012/20120303chapter6sustainabletransport](https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/environmentalprotection/qualityandperformance/reporting/20112012/20120303chapter6sustainabletransport)

ProjectManager. Waterfall Methodology in Project Management. [Online].[Accessed 24 September 2019]. Available from: <https://www.projectmanager.com/software/use-cases/waterfall-methodology>

Binfire. Waterfall project management- A tutorial.[Online]. [Accessed 23rd September 2019]. Available from: <https://www.binfire.com/blog/2017/04/waterfall-project-management-tutorial/>