Report: Brine Shrimp Simulation

Purpose

The purpose of this Brine Shrimp report is to conduct an experiment to see how the results of the simulation is impacted from varying the input parameters and to seeing the outcome of the changing parameters. This report will draw and discuss conclusions relating to the lifecycle of the Brine Shrimps simulation and the results of the experiment. The parameters that can be changed include the tank size, initial Brine Shrimp population, age steps, time step, death probability and reproduction probability. To see more of the lifecycle simulation it is recommended to set the initial Brine Shrimps population to at least 10. From changing these parameters we would expect to see different changes to the simulation and the states of the Brine Shrimps over time.

Background

The purpose of this Brine Shrimp simulation is to see how and why changing the parameters, mentioned above, will affect the simulation of Brine Shrimps and their lifecycle. Brine shrimps are small invertebrates under the sub-Phylum Crustacean class and are found in brine pools and salt lakes. When the egg cysts are dry they remain inactive until they are wet. The lifecycle consists of different stages such as eggs, hatchlings, larvae, sub-adults, and then adults. This is shown in the diagram below taken from '*Sexual selection in brine shrimps'* article by Stephen P. Tomkins and Leighton Dann (https://bioenv.gu.se/digitalAssets/1575/1575641_artemiaeng.pdf):

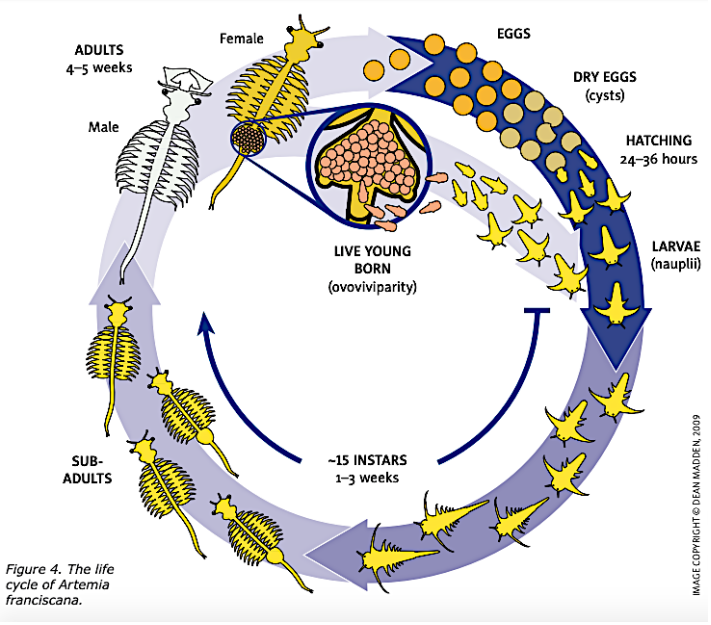


Figure 4. The life cycle of Artemia franciscana.

There are varying ways of changing the parameters for this experiment and therefore different impacts on the simulation. Changing the tank size will either leave more room for collisions or less room for collisions and changing the population will have an impact on the final time step, for an example if there were less than 10 Brine Shrimps for the initial time step then there is a less of a chance of having any shrimps alive at the last time step. Also changing the age step and time step will impact what stages the shrimps are demonstrating,

changing the death rate will either decrease or increase the chances of having less shrimps as a higher rate will likely result to having less shrimps on the last time step and changing the reproduction rate will either decrease or increase the chance of creating more eggs and therefore more shrimps. The parameters investigated for test 1 include tank size of 1000 and 500, population of 30, age step of 6 days, timestep of 5 days, death rate of 10% and reproduction rate of 50% .Test 2 parameters include tank size of 1000 and 500, population of 30, age step of 6 days, time step of 5 days, death rate of 50% and reproduction rate of 10%. By changing the death rate and the reproduction rate, the results will show that there is a huge difference in how the shrimps simulate and progress.

Methodology

Egg (Age = 0 – 1 ,)
Hatchling (Age = 2 – 7,)
Juvenile (Age = 8 – 21,)
Adult (Age = 22 – 28,)
Dead (Age >= 29,)

Test 1:
Command line = `python3 shrimpSimBase.py 1000 500 30 6 5 10 50`

```
Tank size: ( 1000 , 500 )

Shrimp Population:  30

Age Step:  6 Day(s)

Time Step:  5 Day(s)

Death Rate is:  10 %

Reproduction Rate:  50 %
```

A population of 30 is chosen to ensure that there are enough shrimps to reproduce and to show more stages of their lifecycle. Age step of 6 days is chosen to show the age increase and the change of states of the shrimps. Time step of 5 days is chosen as juvenile shrimps age to an adult at the age of 22 days and to reproduce, shrimps must be adults. A low death rate of 10% and high reproduction rate of 50% is chosen to show how the shrimps progress with a high chance of reproducing and a low chance of dying.

Test 2:
Command line = `python3 shrimpSimBase.py 1000 500 30 6 5 50 10`

```
Tank size: ( 1000 , 500 )

Shrimp Population:  30

Age Step:  6 Day(s)
```

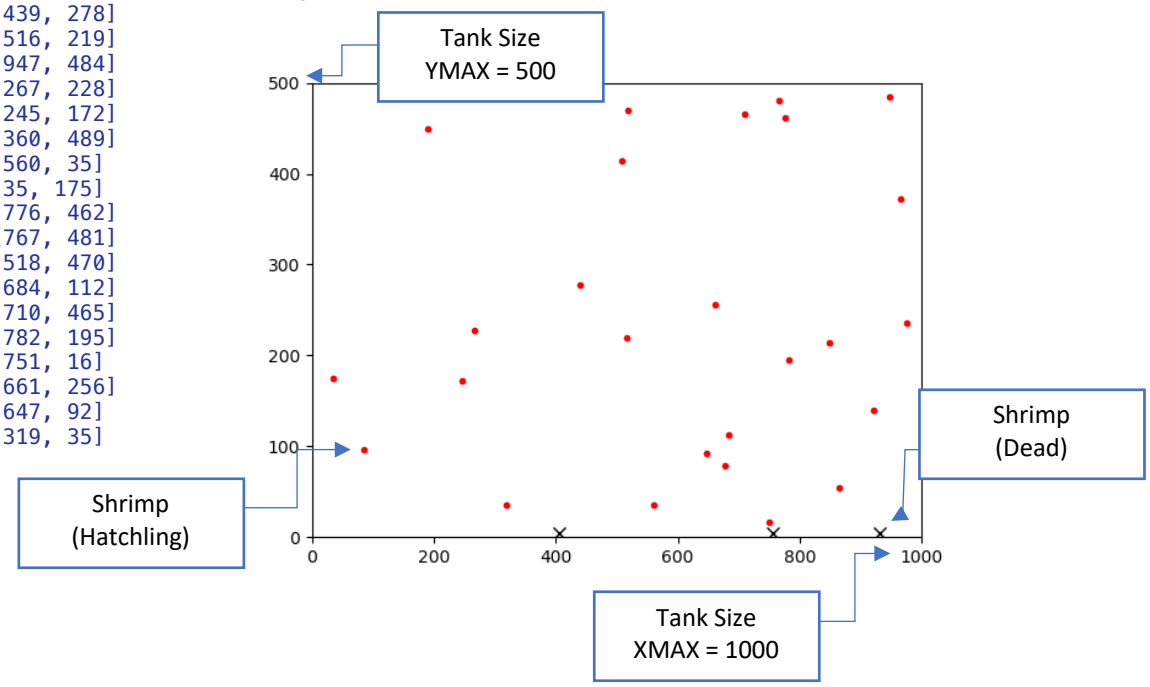
```
Time Step:  5 Day(s)

Death Rate is:  50 %

Reproduction Rate:  10 %
```

The parameters for tank size, population, age step and time step are kept the same as test 1 in order to see the clear impacts of changing the death and reproduction rates only. In test 2 a high death rate of 50% and low reproduction rate of 10% is chosen to see how the shrimps progress with a low chance of reproducing and a high chance of dying in comparison to test 1.

Results

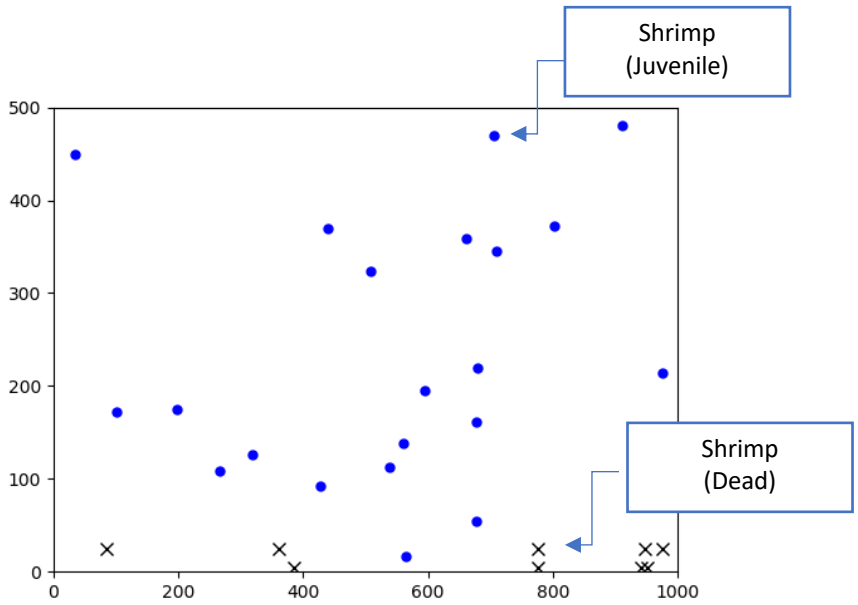
Test 1:

```
### TIMESTEP  0 ###
hatchling @ [85, 96]
hatchling @ [865, 54]
hatchling @ [976, 235]
dead @ [932, 5]
hatchling @ [849, 214]
dead @ [405, 5]
hatchling @ [439, 278]
hatchling @ [516, 219]
hatchling @ [947, 484]
hatchling @ [267, 228]
hatchling @ [245, 172]
hatchling @ [360, 489]
hatchling @ [560, 35]
hatchling @ [35, 175]
hatchling @ [776, 462]
hatchling @ [767, 481]
hatchling @ [518, 470]
hatchling @ [684, 112]
hatchling @ [710, 465]
hatchling @ [782, 195]
hatchling @ [751, 16]
hatchling @ [661, 256]
hatchling @ [647, 92]
hatchling @ [319, 35]
hatchling @ [922, 140]
hatchling @ [508, 414]
dead @ [756, 5]
hatchling @ [189, 450]
hatchling @ [677, 79]
hatchling @ [965, 372]
```



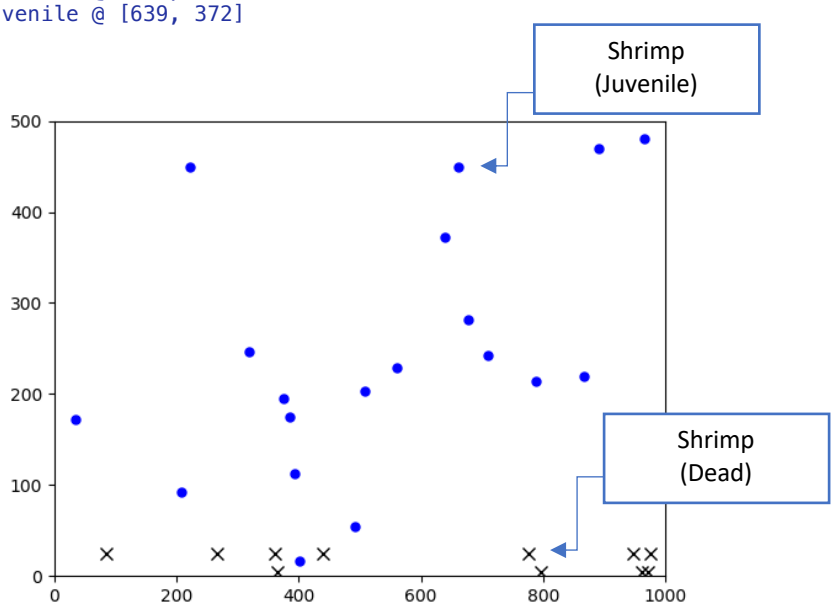
```
### TIMESTEP  1 ###
dead @ [85, 25]
juvenile @ [678, 54]
dead @ [976, 25]
dead @ [952, 5]
juvenile @ [975, 214]
dead @ [385, 5]
juvenile @ [439, 369]
juvenile @ [679, 219]
dead @ [947, 25]
juvenile @ [267, 108]
juvenile @ [100, 172]
dead @ [360, 25]
juvenile @ [560, 138]
juvenile @ [198, 175]
dead @ [776, 25]
juvenile @ [912, 481]
juvenile @ [705, 470]
juvenile @ [539, 112]
juvenile @ [710, 345]
juvenile @ [595, 195]
juvenile @ [564, 16]
juvenile @ [661, 359]
juvenile @ [427, 92]
juvenile @ [319, 126]
```

```
dead @ [942, 5]
juvenile @ [508, 323]
dead @ [776, 5]
juvenile @ [35, 450]
juvenile @ [677, 161]
juvenile @ [802, 372]
```

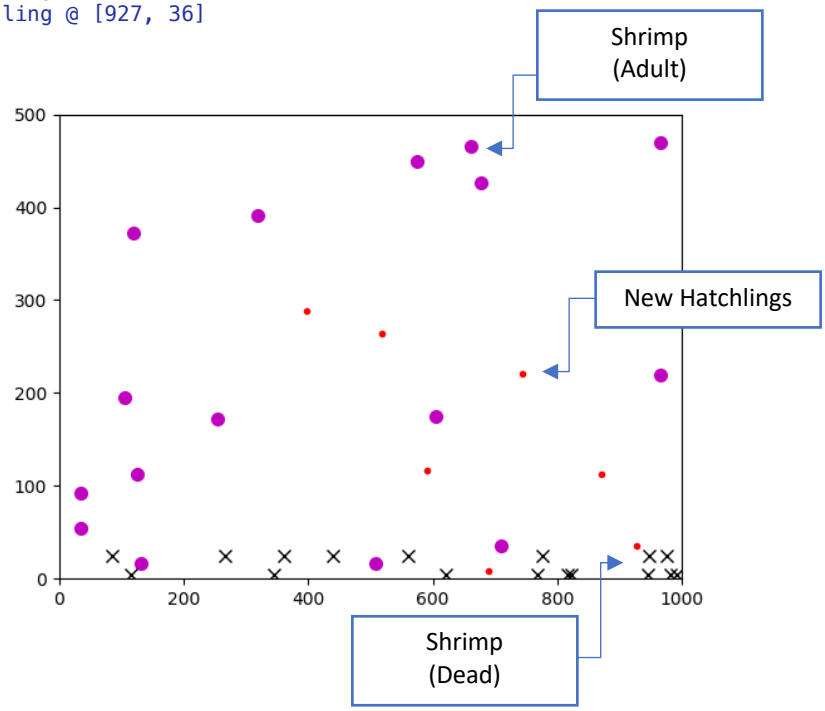



```
### TIMESTEP  2 ###
dead @ [85, 25]
juvenile @ [491, 54]
dead @ [976, 25]
dead @ [972, 5]
juvenile @ [788, 214]
dead @ [365, 5]
dead @ [439, 25]
juvenile @ [866, 219]
dead @ [947, 25]
dead @ [267, 25]
juvenile @ [35, 172]
dead @ [360, 25]
juvenile @ [560, 229]
juvenile @ [385, 175]
dead @ [776, 25]
juvenile @ [965, 481]
juvenile @ [892, 470]
juvenile @ [394, 112]
juvenile @ [710, 242]
juvenile @ [375, 195]
```

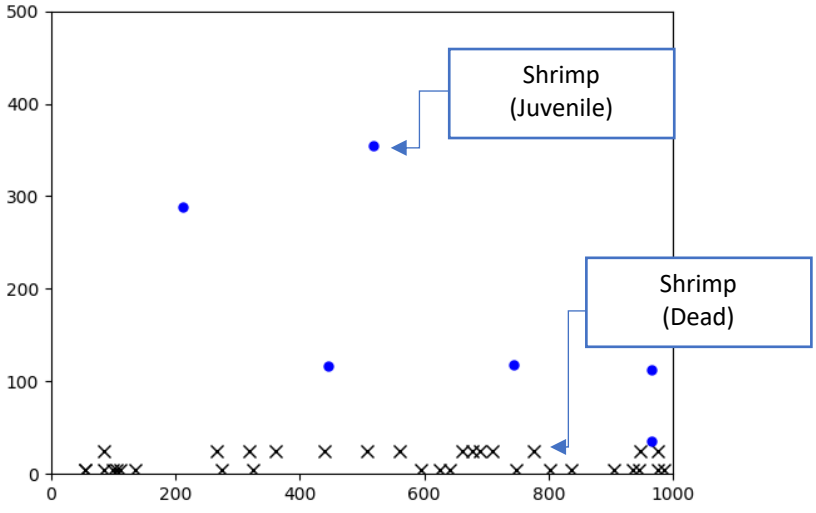
```
juvenile @ [401, 16]
juvenile @ [661, 450]
juvenile @ [207, 92]
juvenile @ [319, 246]
dead @ [962, 5]
juvenile @ [508, 203]
dead @ [796, 5]
juvenile @ [222, 450]
juvenile @ [677, 281]
juvenile @ [639, 372]
```



```
### TIMESTEP  3 ###
dead @ [85, 25]
adult @ [35, 54]
dead @ [976, 25]
dead @ [992, 5]
dead @ [768, 5]
dead @ [345, 5]
dead @ [439, 25]
adult @ [965, 219]
dead @ [947, 25]
dead @ [267, 25]
adult @ [255, 172]
dead @ [360, 25]
dead @ [560, 25]
adult @ [605, 175]
dead @ [776, 25]
dead @ [945, 5]
adult @ [965, 470]
adult @ [124, 112]
adult @ [710, 35]
adult @ [105, 195]
adult @ [131, 16]
adult @ [661, 465]
adult @ [35, 92]
adult @ [319, 391]
dead @ [982, 5]
adult @ [508, 16]
dead @ [816, 5]
adult @ [575, 450]
adult @ [677, 426]
adult @ [119, 372]
hatchling @ [870, 113]
dead @ [822, 5]
hatchling @ [519, 264]
hatchling @ [591, 117]
hatchling @ [689, 8]
dead @ [621, 5]
hatchling @ [744, 221]
dead @ [115, 5]
hatchling @ [398, 289]
hatchling @ [927, 36]
```



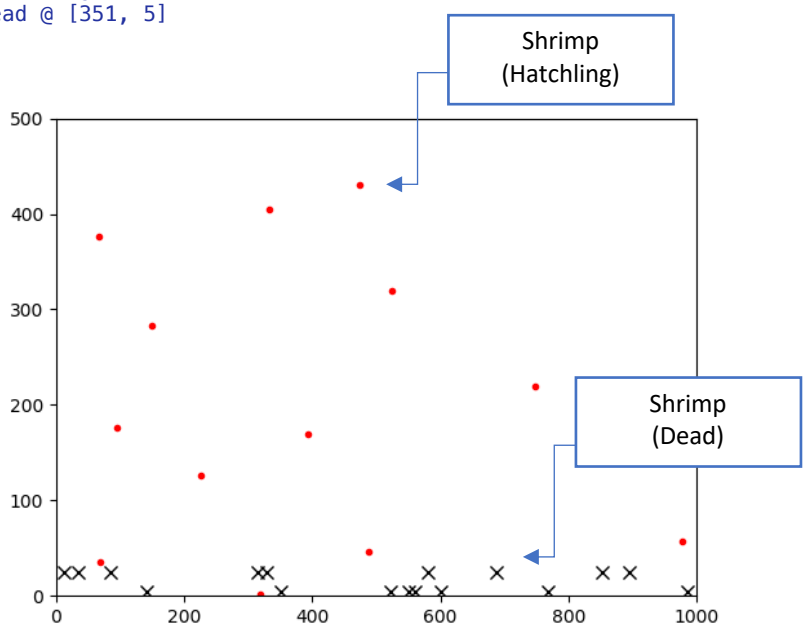

```
### TIMESTEP  4 ###
dead @ [85, 25]
dead @ [55, 5]
dead @ [976, 25]
dead @ [975, 5]
dead @ [748, 5]
dead @ [325, 5]
dead @ [439, 25]
dead @ [935, 5]
dead @ [947, 25]
dead @ [267, 25]
dead @ [275, 5]
dead @ [360, 25]
dead @ [560, 25]
dead @ [625, 5]
dead @ [776, 25]
dead @ [905, 5]
dead @ [945, 5]
dead @ [104, 5]
dead @ [710, 25]
dead @ [85, 5]
dead @ [111, 5]
dead @ [661, 25]
dead @ [55, 5]
dead @ [319, 25]
dead @ [985, 5]
dead @ [508, 25]
dead @ [836, 5]
dead @ [595, 5]
dead @ [677, 25]
dead @ [99, 5]
juvenile @ [965, 113]
dead @ [802, 5]
juvenile @ [519, 355]
juvenile @ [446, 117]
dead @ [689, 25]
dead @ [641, 5]
juvenile @ [744, 118]
dead @ [135, 5]
juvenile @ [211, 289]
juvenile @ [965, 36]
```



Test 2:

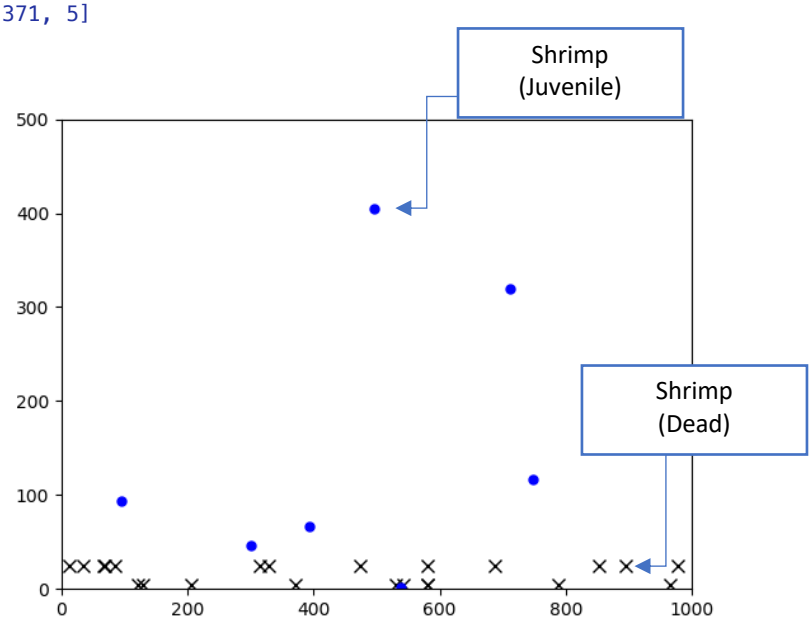
```
### TIMESTEP  0 ###
dead @ [600, 5]
hatchling @ [68, 35]
dead @ [523, 5]
hatchling @ [67, 377]
dead @ [895, 25]
dead @ [141, 5]
dead @ [581, 25]
hatchling @ [978, 57]
hatchling @ [332, 405]
hatchling @ [94, 176]
hatchling @ [488, 46]
hatchling @ [474, 431]
dead @ [688, 25]
dead @ [328, 25]
dead @ [13, 25]
dead @ [85, 25]
hatchling @ [226, 126]
dead @ [561, 5]
hatchling @ [747, 220]
dead @ [550, 5]
hatchling @ [318, 1]
hatchling @ [525, 320]
dead @ [853, 25]
dead @ [769, 5]
```

```
dead @ [985, 5]
hatchling @ [393, 169]
dead @ [34, 25]
dead @ [315, 25]
hatchling @ [150, 283]
dead @ [351, 5]
```

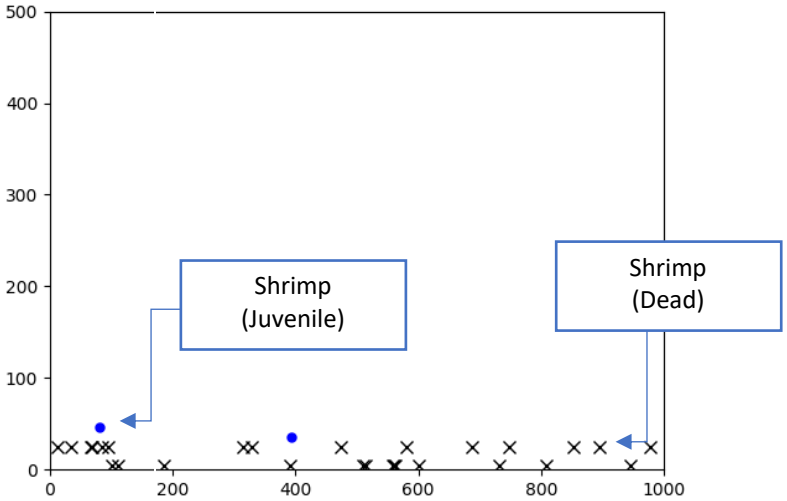



```
### TIMESTEP  1 ###
dead @ [580, 5]
dead @ [68, 25]
dead @ [543, 5]
dead @ [67, 25]
dead @ [895, 25]
dead @ [121, 5]
dead @ [581, 25]
dead @ [978, 25]
juvenile @ [495, 405]
juvenile @ [94, 94]
juvenile @ [301, 46]
dead @ [474, 25]
dead @ [688, 25]
dead @ [328, 25]
dead @ [13, 25]
dead @ [85, 25]
dead @ [206, 5]
dead @ [581, 5]
juvenile @ [747, 117]
dead @ [530, 5]
juvenile @ [538, 1]
juvenile @ [712, 320]
dead @ [853, 25]
dead @ [789, 5]
```

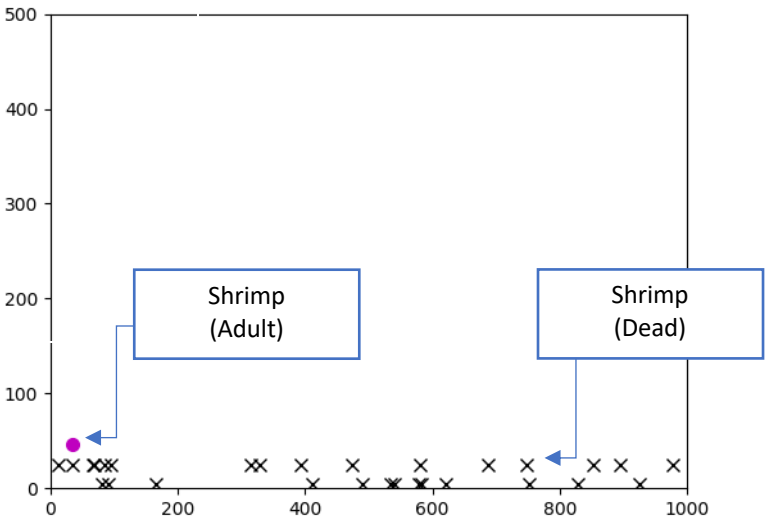
```
dead @ [965, 5]
juvenile @ [393, 66]
dead @ [34, 25]
dead @ [315, 25]
dead @ [130, 5]
dead @ [371, 5]
```



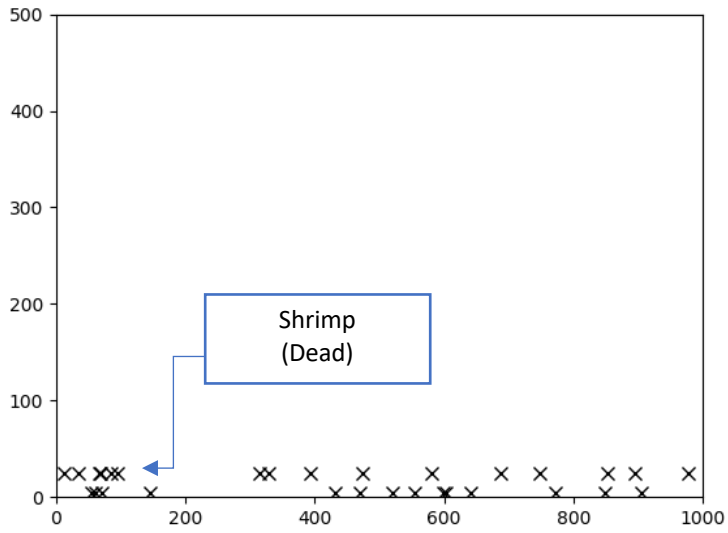
```
### TIMESTEP  2 ###
dead @ [560, 5]
dead @ [68, 25]
dead @ [563, 5]
dead @ [67, 25]
dead @ [895, 25]
dead @ [101, 5]
dead @ [581, 25]
dead @ [978, 25]
dead @ [515, 5]
dead @ [94, 25]
juvenile @ [81, 46]
dead @ [474, 25]
dead @ [688, 25]
dead @ [328, 25]
dead @ [13, 25]
dead @ [85, 25]
dead @ [186, 5]
dead @ [601, 5]
dead @ [747, 25]
dead @ [510, 5]
dead @ [558, 5]
dead @ [732, 5]
dead @ [853, 25]
dead @ [809, 5]
dead @ [945, 5]
juvenile @ [393, 35]
dead @ [34, 25]
dead @ [315, 25]
dead @ [110, 5]
dead @ [391, 5]
```




```
### TIMESTEP  3 ###
dead @ [540, 5]
dead @ [68, 25]
dead @ [583, 5]
dead @ [67, 25]
dead @ [895, 25]
dead @ [81, 5]
dead @ [581, 25]
dead @ [978, 25]
dead @ [535, 5]
dead @ [94, 25]
adult @ [35, 46]
dead @ [474, 25]
dead @ [688, 25]
dead @ [328, 25]
dead @ [13, 25]
dead @ [85, 25]
dead @ [166, 5]
dead @ [621, 5]
dead @ [747, 25]
dead @ [490, 5]
dead @ [578, 5]
dead @ [752, 5]
dead @ [853, 25]
dead @ [829, 5]
dead @ [925, 5]
dead @ [393, 25]
dead @ [34, 25]
dead @ [315, 25]
dead @ [90, 5]
dead @ [411, 5]
```



```
### TIMESTEP  4 ###
dead @ [520, 5]
dead @ [68, 25]
dead @ [603, 5]
dead @ [67, 25]
dead @ [895, 25]
dead @ [61, 5]
dead @ [581, 25]
dead @ [978, 25]
dead @ [555, 5]
dead @ [94, 25]
dead @ [55, 5]
dead @ [474, 25]
dead @ [688, 25]
dead @ [328, 25]
dead @ [13, 25]
dead @ [85, 25]
dead @ [146, 5]
dead @ [641, 5]
dead @ [747, 25]
dead @ [470, 5]
dead @ [598, 5]
dead @ [772, 5]
dead @ [853, 25]
dead @ [849, 5]
dead @ [905, 5]
dead @ [393, 25]
dead @ [34, 25]
dead @ [315, 25]
dead @ [70, 5]
dead @ [431, 5]
```



Conclusion

In conclusion, it is shown that by changing the death rate and reproduction rates it in fact will result in an impact on the simulation and progress of the shrimps. This program is useful, however, it is unrealistic as it doesn't take other important factors into account, such as, prey, genders and female reproduction. The results from the two tests show that with a higher reproduction rate and a lower death rate the shrimps simulation last longer than it did with a lower reproduction rate and a higher death rate. Test 1, with a higher population rate of 50% and lower death rate of 10%, demonstrates that it simulates (reproduces) more shrimps than the initial population and at time step 4 the results show there is 6 alive shrimps out of the 40 in the tank. Test 2, with a lower reproduction rate of 10% and a higher death rate of 50%, demonstrates that it simulates (reproduces) less shrimps than the first test and at time step 4 the results show there is no alive shrimps out of the 29 shrimps in the tank. Therefore from these results it is demonstrated that changing the parameters of the simulation does have an impact on the simulation and progress of the shrimps. To improve on the on this experiment a function can be implemented to reproduce shrimps depending on female reproduction and by adding animations it would make the simulation more realistic.