Preface

This simulation concerns the effects of average distances between cows and the growth rate of said cow population. This is done through Agent Based Modelling (ABM) which is the main framework of all of the main classes within this simulation. The distances between cows will affect the average number of interactions taking place per iteration due to the limits of reach for cows to be able to interact with each other.

Initial Parameters

```
gridRows, gridCols = (50,50)
boxSize = 15
offset = 3 * boxSize
numEntities = 500
simTime, simEnd = 0, 160
lifespan = 80
seasonDuration = 20
```

Figure 1 Shows the initial parameters of the simulation

The initial parameters are configured such that it follows a fuzzy percentage-based value system which is scaled based on the time scale of the simulation. 16 iterations within the simulation coincides with a year in real time. The size of each box of grass within the field grid is roughly 5 m^2 in real metrics.

boxSize is the graphical scale of the grass box and does not translate to real life metrics whatsoever. The same goes to offset which is calculated scaling with the boxSize.

numEntities is the initial number of entities started with in the simulation. 500 is a rather small population for the area of 250m^2, therefore the consequential simulation will result in a dwindling population of cows due to the large gaps between cows on average within the field.

simTime and simEnd coincide with the duration of the simulation. SimEnd being 160 iterations due to the simulation taking place for 10 years of real time. Lifespan is the overall lifespan of the cows. 80 iterations coincide with 5 years for a cow which is the average lifespan of one (De Vries & Marcondes, 2020).

Finally, season duration coincides with the regrowing period for grass on the field. This is so that the grass fields don't completely deplete over the course of the entire simulation.

Population + Gender Disparity

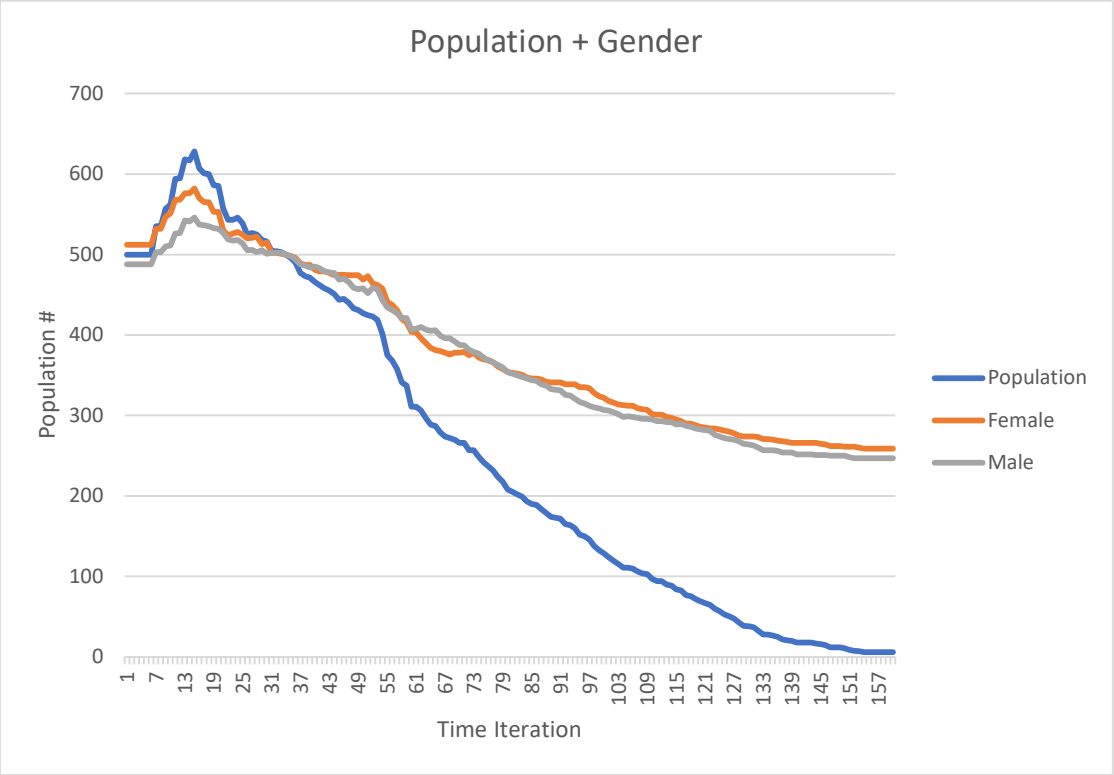

Figure 2: Cow Population + Gender graph

This graph shows the population trend for the entire duration of the simulation. As shown by the graph, the population of cows decline over the course of 10 years. The gender graphs are to show a possible link between the ratio of male to female cow members and the thriving of the overall population. Generally, the trending of female and male cow populations do not seem to show much of a significant trend which greatly affects the overall cow population. This is expected as having a 50/50 ratio for male and females for a species tends to leave a stable population within an environment. Below is a more detailed graph of the first year of the simulation.

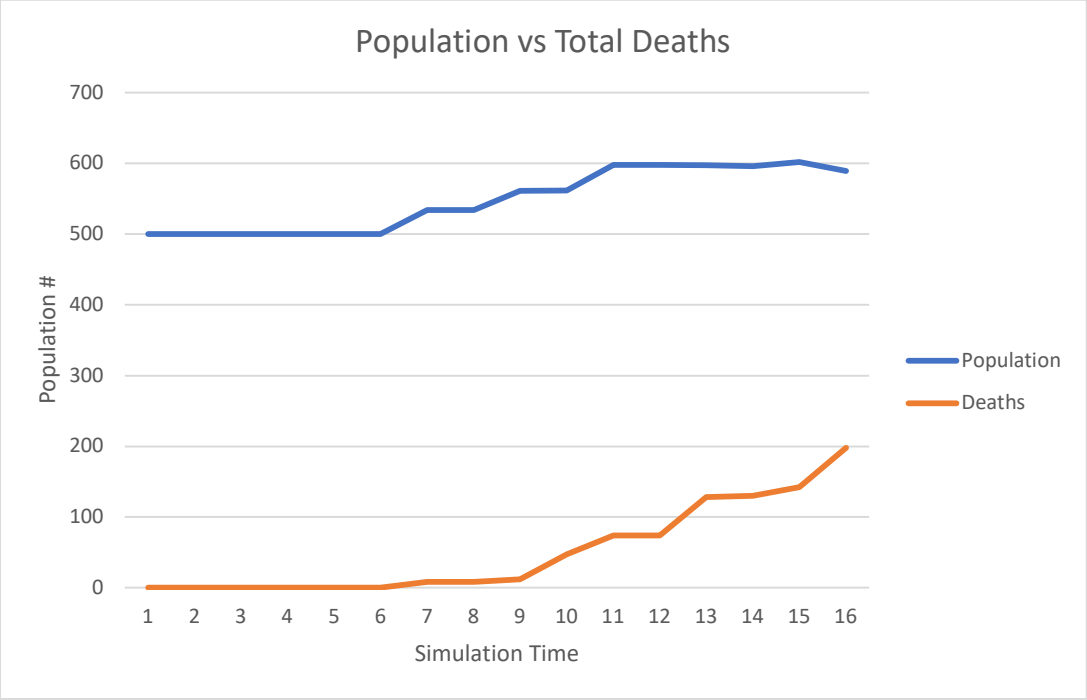

Figure 3: Cow Population vs Total Deaths

This is the 1-year graph for the population vs total deaths within the simulation. As shown beginning from halfway in the year, the cow population begins to increase, but not by much. At the same time, the life expectancy for the cows begin to catch up and the cows begin to die in bigger numbers. At the end of the year, cow deaths have reached 200 cows and the population growth rate begins to take a slight dip in growth.

Additional Features

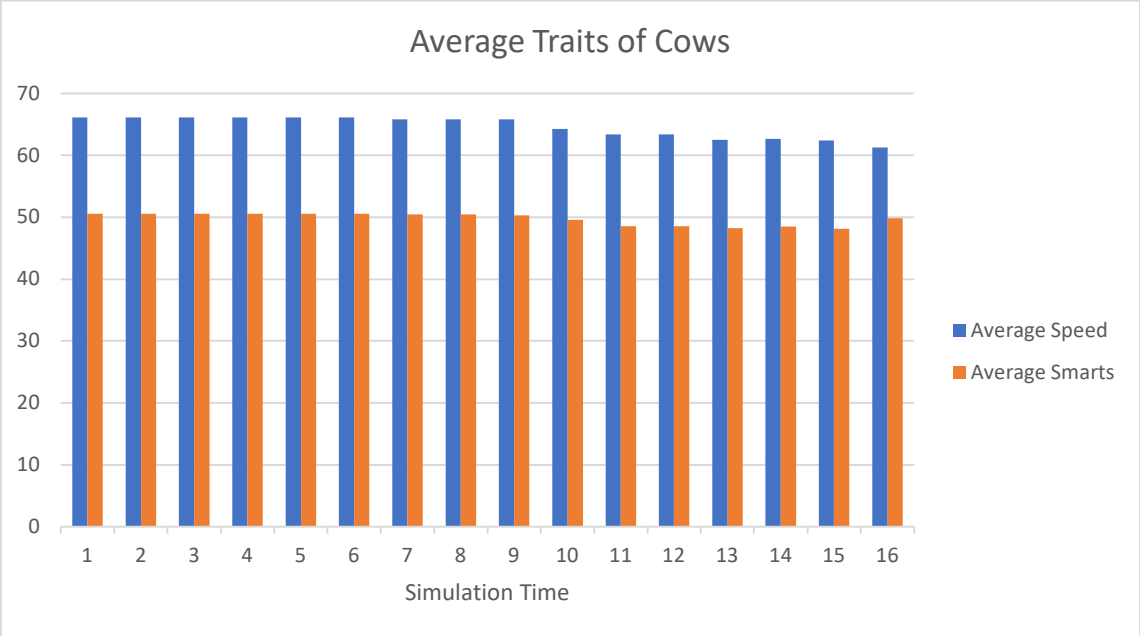

Figure 4: The changes in the average traits of cows throughout the duration of the simulation

I have also included additional traits for each cow class which includes their speed and smartness. A cow's speed is the distance a cow is able to travel within an iteration. The cow's smartness is the cow's decision-making ability which will determine the time delay for each turn and the decision options available for the cow.

Overall, the traits average trait of each cow within the living population is relatively stable and no significant change seems to be able to be discerned at the end of one year of changes.

References

1. De Vries, A., & Marcondes, M. I. (2020). Review: Overview of factors affecting productive lifespan of dairy cows. *Animal*, *14*. https://doi.org/10.1017/s1751731119003264
2. Sekimura, T., Suzuki, N., & Takeuchi, Y. (2017). A model for population dynamics of the mimetic Butterfly Papilio polytes in Sakishima Islands, Japan (II). *Diversity and Evolution of Butterfly Wing Patterns*, 221–237. https://doi.org/10.1007/978-981-10-4956-9_12