Coursework 2 of ABM

Aim

This report is to explore two Netlogo models, ‘Sugarscape 1 Immediate Growback’ and ‘Sugarscape 2 Constant Growback’ (J.Li and U.Wilensky;, 2009a, 2009b). Originally the model was developed using computer simulations to study the accumulation of wealth in an artificial society (Epstein and Axtell, 1996).

Noticing that the main difference between the 2 models are how fast the resources grow back. In Sugarscape 1, the sugar for all patches would recover to its maximum level immediately after turtles eating. While in Sugarscape 2, they would grow back starting from 1 unit and gradually achieve its maximum value after consuming. So, the main purpose of this report is to focus on the survival of turtles and their features on different recovery speed of resources. It would be achieved by adding reporters to the original models and producing analysis of behaviour space with visualisations when the two models are stabilised. Then this report will provide appropriate discussion and reflection.

Methods

New measurement and reporters

All the processes are achieved through Netlogo (Wilensky, 1999). This step is to define several measurements to describe the survival situations and apply them to both models. The first one is the survival rate and is formulated as below.

$$Survival\ Rate\ = \frac{Number - of - survived - turtles}{Number - of - original - population} \times 100\%$$

Then for the active turtles, their necessary features are their average sugar, vision and metabolism. These could imply which kind of turtles are more likely to live. To analyze them with more details, use bar charts to explore the distribution of these 3 properties at steady state. As the variables that required to calculate these measurements are already presented in the original models, it is only necessary to add ‘reporters’ at the end of codes. These codes would be attached at Appendix part.

BehaviourSpace

This part is to use the tool called ‘BehaviourSpace’ in Netlogo. The original initial population set in the models are 400. In order to consider comprehensively, the experiment should be performed using relatively smaller and larger figures compared to 400. So, set it to be 50, 400 and 1000.

To minimize bias, it is essential to carry out 10 repetitions of the experiments for different value of initial population. Besides, it is not reasonable to analyze a model that is not stable. From the info of model 1, the authors said the agents would no longer move after 20 ticks. But agents in model 2 would not stop moving until ticks bigger than 800. Therefore, in order to align the test, the time to stop the simulation is set to 1000 ticks. Use the final value of each test to calculate the mean of each reporter and present them as results. Compare them based on different initial population.

Results

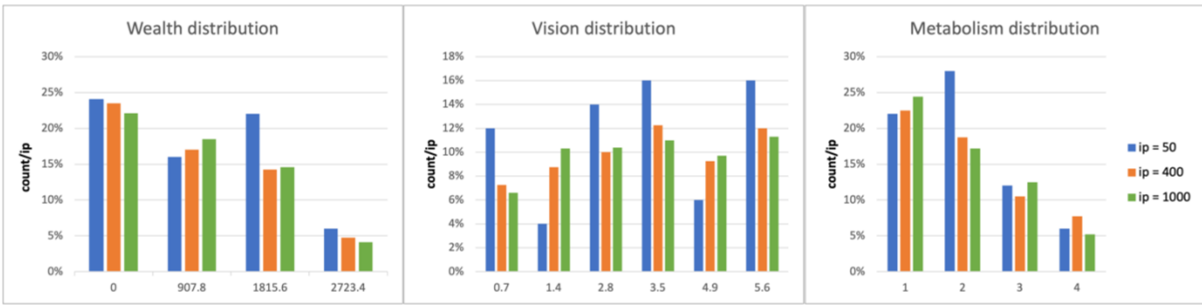
After 1000 ticks and repeat 10 times, the output is presented as shown in the figure.

Figure 1 Experiment Output of two Sugarscape models

SugarScape1				SugarScape2			
initial population = 1000				initial population = 1000			
average survival rate	average wealth	average vision	average metabolism	average survival rate	average wealth	average vision	average metabolism
0.6012	992.672016	3.76668172	1.95754105	0.4401	846.761574	3.60032262	1.46728939
initial population = 400				initial population = 400			
average survival rate	average wealth	average vision	average metabolism	average survival rate	average wealth	average vision	average metabolism
0.6255	1052.59233	3.75108938	1.9980645	0.5645	1144.29303	3.85569956	1.82104213
initial population = 50				initial population = 50			
average survival rate	average wealth	average vision	average metabolism	average survival rate	average wealth	average vision	average metabolism
0.66	1087.80771	3.88945391	2.10451507	0.716	1665.67415	3.86791697	2.10563222

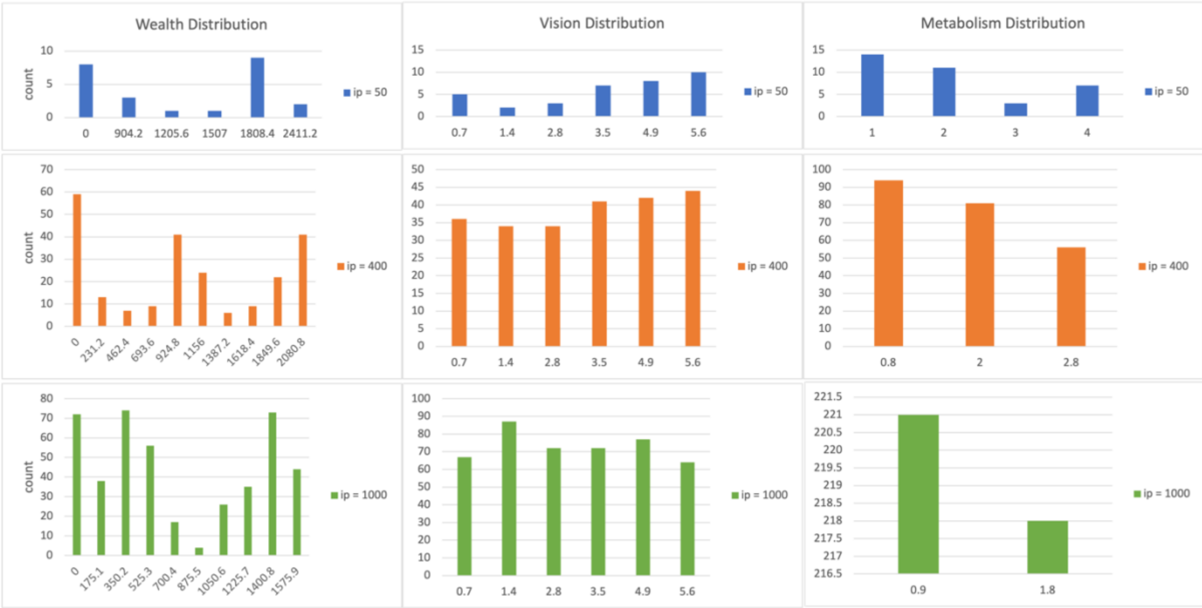
The following histograms are the distribution of wealth, vision and metabolism after 100 ticks for different population in 2 tests. 'ip' is short for initial population. The output of model 1 are aligned well, so the different population can be plotted together. For better visualization, the y-axis is the ratio of the count of turtles over initial population rather than the count itself. Notice the value of wealth have very slight differences.

Figure 2 Sugarscape 1 wealth, vision and metabolism final distribution (initial population = 50, 400, 500)



The produced figures of model 2 are distributed randomly. So, they should be plotted individually. For the convenience of reading, colours used in above and below are the same. (blue for ip = 50, orange for ip = 400, green for ip = 1000) Different from above, the y-axis below is not ratio but the count.

Figure 3 Sugarscape 2 wealth, vision and metabolism final distribution (initial population = 50, 400, 500)



Discussion

From the output table, it is found that not all turtles would survive in both models, regardless of the initial number of populations. In model 1, the survival rate fluctuates around 0.62 for different populations. Similar for the 3 features, final value of average wealth is around 1000, vision is around 3.8 and metabolism is around 2. Generally speaking, for immediately recovered resources, the initial population has almost no effect on the survival of turtles and their features. While for model 2, when the initial population is increasing, the number of active turtles is decreasing, as well as the average wealth, metabolism. Due to the very slight change in vision, it seems to be not affected. So, to describe it generally, with larger population, the competition of survival would become more intense. The average wealth would decrease due to the slower recovery speed of resources but more consuming. And the turtles with lower metabolism would be more likely to live. That is to say, if the recovery speed of sugar is taken in account, it would then bring the carrying capacity of the environment into consideration. For wealth, as long as the turtles are active, their wealth would increase without doubt. But for vision and metabolism of the survived turtles, it deserves to explore more about their distributions. Average value is not enough to draw the conclusions.

By looking at the coloured location graphs, the general trends expressed by them seem similar. For more details, it is necessary to look at the detailed distribution of vision and metabolism for further analysis.

From the distribution plots, it is found that there is huge difference of wealth among turtles at the end regardless of its original population, though the sugar of each turtle is set randomly at the beginning. Then for vision, the trend seems that the survived turtles have higher value of it. And for metabolism, it is obvious that turtles with lower metabolism are more possible to live. That is to say the conclusion drawn before is true but forget to mention that there is clear wealth gap within turtles and turtles with higher vision and lower metabolism are more likely to survive.

Conclusion

This report explores the survived turtles in the two Sugarscape tests with setting different initial population. In general, both results are similar: Not all turtles can survive and those survived tend to have higher vision and lower metabolism with huge gap in wealth. The population has less effect if resources can recover immediately, otherwise, it will intensify the competition of survival due to the carrying capacity of the environment.

Reference

Epstein, J. M. and Axtell, R. (1996) *Growing artificial societies: social science from the bottom up*. 1st edn. Cambridge, Massachusetts: The MIT Press (MIT Press Books).

J.Li and U.Wilensky; (2009a) ‘NetLogo Models Library: Sugarscape 1 Immediate Growback’. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL. Available at: http://ccl.northwestern.edu/netlogo/models/Sugarscape1ImmediateGrowback (Accessed: 22 February 2021).

J.Li and U.Wilensky; (2009b) ‘NetLogo Models Library: Sugarscape 2 Constant Growback’. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL. Available at: http://ccl.northwestern.edu/netlogo/models/Sugarscape2ConstantGrowback (Accessed: 22 February 2021).

Wilensky, U. (1999) ‘NetLogo’. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL. Available at: http://ccl.northwestern.edu/netlogo/ (Accessed: 22 February 2021).

Appendix

The codes of adding reporters are as follow:

```
to-report survival-rate
  report (count turtles)/ initial-population
end

to-report average-wealth
  report mean [sugar] of turtles
end

to-report average-vision
  report mean [vision] of turtles
end

to-report average-metabolism
  report mean [metabolism] of turtles
end
```

Full details are stored in my Github: https://github.com/amberyli/ABM-cw2.