Agent-Based Modelling – Coursework 2

Systematic Experimentation – SugarScape 1 & 2

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Aim

By running two models, SugarScape 1 and 2, it can be found that when the initial population is fixed, other parameters such as final population, average vision, average, and average wealth will be different. SugarScape 2 differs from SugarScape 1 Immediate Growback in that the growback of sugar is gradual rather than instantaneous. Because each experiment has certain randomness, that is, sugar will move randomly on the map, the output of each parameter will be slightly different in repetitions. This research will use BehaviorSpace to ensure the accuracy of data analysis and evaluate and analyse the parameters final population, average vision, average metabolism, and average wealth in two different growback models.

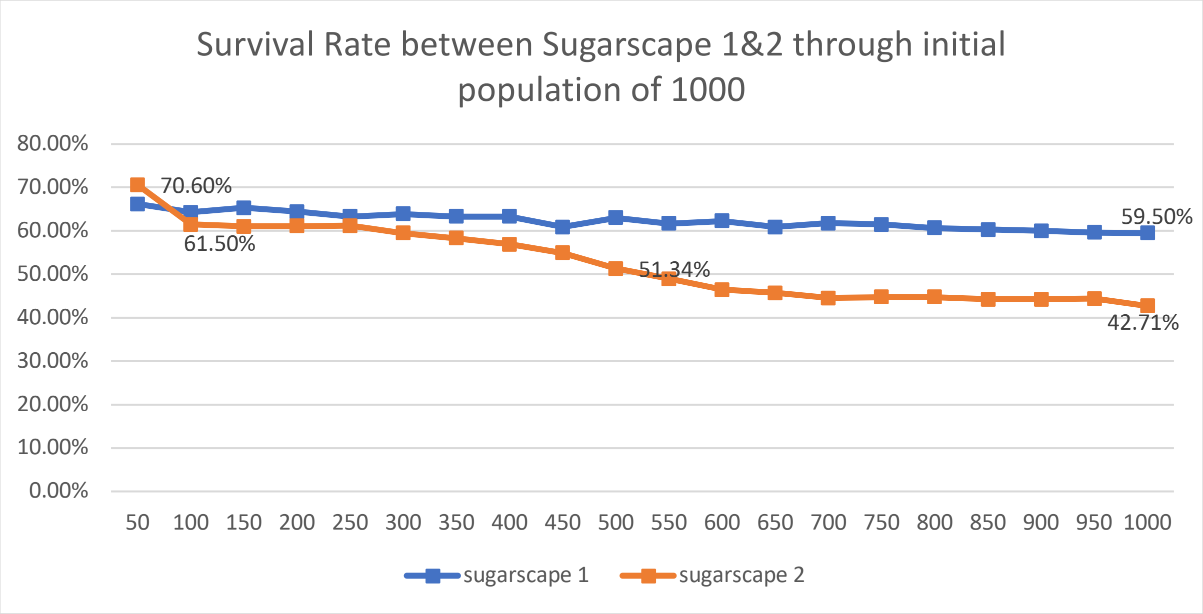
Methods

- Simple Trendline Graph for varies initial population
  - Use BehaviourSpace to process data after control variables and perform repetitions to achieve data accuracy. First, in order to observe the final survival changes of the two models under different initial populations. Simply set vary variables to ["initial-population" [50 50 1000]] and repetitions to 10.
- Colour Scale Metrix for max-metabolism and max-vision
  - To investigate the survival rate and the distribution of mean metabolism and vision that survived when changes in max metabolism and max vision. Requires choose max metabolism and max vision as new parameters to use in BehaviourSpace.
  - Set ["max-metabolism" [1 1 10]] and ["max-vision" [1 1 10]] in vary variable. And add mean [vision] of turtles and mean [metabolism] of turtles in reporters to get the average metabolism and vision that survived. repetitions is equal to 10, time limit is equal to 800.

- Colour Scale Metrix in different population
    - For a more in-depth analysis of which individual properties: metabolism and vision affect individual survival. It is necessary to control the value of one of the two properties and change the initial population and the maximum of one of the properties, thus achieving the logic of the data.

Results

- Simple Trendline Graph



From the simple trend line it can be seen that the overall survival rate for SugarScape 1(the model with faster growback) remains between 60% and 70%. When the initial population was between 300-700, the survival rate did not change much: it remained between ±61%. For SugarScape 2(which has a relatively stable growback rate), the overall survival rate decreases as the initial population increases. The survival rate plummeted from 70% in 50 people to 42.7% in 1,000 people.

- Colour Scale Metrix

		max-vision									
		1	2	3	4	5	6	7	8	9	10
	1	86.7%	87.8%	89.7%	91.0%	92.4%	93.4%	94.1%	95.3%	95.6%	96.3%
	2	76.2%	78.8%	81.2%	82.7%	85.3%	87.3%	89.1%	89.6%	91.3%	92.8%
	3	62.5%	66.1%	66.8%	70.5%	73.5%	74.8%	77.4%	79.4%	81.7%	84.1%
	4	50.2%	53.2%	55.1%	56.7%	60.7%	61.7%	65.1%	68.1%	69.6%	71.5%
max-metabolism	5	40.0%	42.1%	44.4%	46.7%	48.1%	50.4%	51.7%	54.2%	57.5%	57.5%
	6	34.9%	34.9%	37.1%	38.5%	39.5%	42.7%	45.1%	45.3%	48.0%	48.2%
	7	28.2%	29.8%	31.5%	33.6%	34.4%	36.2%	38.9%	40.2%	41.2%	42.2%
	8	24.2%	25.7%	28.3%	28.0%	31.1%	32.3%	33.7%	35.5%	36.2%	37.5%
	9	23.0%	22.5%	24.1%	25.5%	25.5%	28.7%	29.5%	31.3%	32.6%	34.1%
	10	19.8%	22.0%	22.5%	22.7%	24.4%	26.4%	26.6%	26.7%	28.6%	31.2%

		max-vision									
		1	2	3	4	5	6	7	8	9	10
	1	85.5%	88.3%	90.0%	90.9%	92.8%	93.9%	94.1%	95.5%	95.9%	96.1%
	2	77.7%	80.5%	82.3%	84.0%	86.7%	88.4%	89.8%	91.3%	91.5%	92.5%
	3	53.0%	55.5%	56.8%	57.7%	58.1%	59.2%	60.5%	60.3%	60.0%	61.4%
	4	41.3%	45.6%	47.3%	48.4%	48.8%	49.5%	49.7%	49.5%	50.5%	49.7%
max-metabolism	5	34.9%	37.1%	39.3%	41.0%	43.1%	44.0%	45.0%	45.4%	45.7%	46.2%
	6	31.5%	32.5%	34.4%	36.1%	38.0%	39.3%	39.7%	38.6%	40.3%	41.8%
	7	27.3%	28.1%	29.0%	31.2%	32.6%	33.3%	33.8%	35.6%	36.3%	36.3%
	8	24.2%	25.1%	26.0%	27.4%	29.3%	29.7%	31.2%	31.2%	31.4%	31.8%
	9	22.1%	22.5%	22.9%	24.2%	25.9%	25.9%	27.3%	28.9%	27.8%	28.1%
	10	20.1%	20.7%	21.3%	21.6%	24.2%	25.2%	24.3%	24.7%	25.0%	26.3%

The figure above shows the changes in max-metabolism and max-vison at constant initial population 550. Each cell represents its survival rate. The upper image represents SugarScape 1, and the lower image represents SugarScape 2.

The survival rate trending of the two graphs is the same, that is, when the vision is larger and the metabolism is smaller, the survival rate will be greatly improved. Although the growback rates of the two models are different, it can be seen from the graph that the highest and lowest survival rates are nearly equal: both are between ±95% and ±20%.

- Colour Scale Metrix for in different population

		max-metabolism									
		1	2	3	4	5	6	7	8	9	10
	100	1.00	1.49	1.91	1.99	2.14	2.00	2.20	2.11	2.10	2.04
	200	1.00	1.48	1.81	2.03	2.06	2.03	2.00	2.07	2.04	2.05
	300	1.00	1.47	1.85	2.02	2.05	2.07	2.02	2.08	2.03	2.06
	400	1.00	1.45	1.83	2.02	2.02	2.05	1.99	1.98	2.00	2.07
initial-population	500	1.00	1.46	1.80	2.01	1.98	2.00	2.05	2.02	2.02	2.04
	600	1.00	1.47	1.79	1.98	1.99	2.04	2.03	2.03	2.01	2.07
	700	1.00	1.46	1.80	1.97	2.00	1.97	2.01	2.02	2.01	2.01
	800	1.00	1.45	1.80	1.95	2.01	2.00	2.03	2.03	2.02	2.03
	900	1.00	1.46	1.78	1.98	2.00	1.99	2.00	2.03	2.04	2.00
	####	1.00	1.46	1.79	1.95	1.99	1.98	2.02	2.04	2.00	2.02

		max-metabolism									
		1	2	3	4	5	6	7	8	9	10
	100	1.00	1.46	1.92	1.93	2.00	2.08	2.08	2.18	2.22	2.14
	200	1.00	1.48	1.85	1.87	1.93	1.90	1.93	1.99	2.01	2.00
	300	1.00	1.46	1.81	1.86	1.88	1.90	1.88	1.91	1.93	1.88
	400	1.00	1.48	1.66	1.80	1.84	1.85	1.88	1.88	1.97	1.91
initial-population	500	1.00	1.47	1.51	1.69	1.81	1.84	1.88	1.89	1.84	1.89
	600	1.00	1.47	1.45	1.55	1.76	1.81	1.82	1.84	1.87	1.90
	700	1.00	1.46	1.45	1.47	1.61	1.75	1.77	1.84	1.81	1.85
	800	1.00	1.43	1.47	1.45	1.55	1.67	1.74	1.80	1.80	1.85
	900	1.00	1.41	1.45	1.46	1.49	1.57	1.67	1.75	1.80	1.84
	1000	1.00	1.36	1.46	1.47	1.45	1.49	1.60	1.73	1.72	1.80

The upper image shows the average metabolism after 800 ticks in model SugarScape 1, and the lower image represents as value in SugarScape 2. As can seen from the colour blocks, in Model 1 and Model 2, the orange and dark red colour blocks occupy most of the cells. This means that individuals surviving after 800 ticks have similar metabolisms, although in the original ticks the range of metabolism is different: i.e. the mean metabolism is about ±1.8. But it can be found that in model 1, the average metabolism is slightly higher than in model 2.

Discussion

The reason why SugarScape 1 has a more stable survival rate at 100-1000 population is that for SugarScape 2, it can quickly restore resources. For SugarScape 2, when the population increases, the demand for resources is greater, but the model cannot quickly restore resources; therefore, the survival rate will decrease significantly with the increase of the initial population.

In order to the subsequent data analysis of the two parameters metabolism and vision. The initial population was set at 550 using the control variable method; also because at population 550, both SugarScape 1 and SugarScape 2 had a relatively considerable survival rate. It can be found from the above matrix diagram: the data on each row is not very different; on the contrary, the difference in survival rate on each column has a significant difference. This also shows that on a constant initial population, the metabolism gap of each individual affects the survival rate of the individual more than the individual's vision ability. This is even more pronounced on the SugarScape 2 model, where individuals with a high need for metabolism have a lower survival rate because of their relatively low growback rate.

Because it can be found from the above results that the range of metabolism has a very significant impact on the survival rate, therefore, in-depth data analysis of average metabolism and different initial populations is required. What they have in common from the two graphs in results: that is, when the population increases, the average metabolism gradually decreases. This is especially evident in the model SugarScape 2. This shows that in the context of a slower growback rate, if the initial population increases (competition increases), only lower metabolism can survive. It can be observed that in SugarScape 1, the colour blocks in the first four columns are distinguishable, while in the 5th to 10th columns, the colour blocks cannot be distinguished. This shows that in the ideal condition, the population has not much influence on the metabolism.

Conclusion

This experiment found that in a loss-free model (SugarScape 1), the survival rate of the population and the average metabolism of the surviving population would remain high. But in this mode, the consumption of resources is huge. In the context of SugarScape 2, the growback rate is relatively high. Patches with fewer resources and relatively large consumption will preferentially replenish resources, which will lead to resource skew and greatly reduce the survival rate. But this model is more in line with the sociology of reality. Individuals who successfully survive and gain a lot of wealth need to have a high vision and low metabolism.

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