CW's SUGARSCAPE

WHAT IS IT?

This program attempts to replicate the classic model, Sugarscape, as described in Epstein & Axtell (1996). Most of the functions are provided, and qualitatively similar (if not numerically indistinguishable) results can be obtained from experiments in most cases. Many people have tried to replicate some or all of Sugarscape. This is my attempt.

HOW IT WORKS

The functionality and thinking behind the model's design can be found in Epstein & Axtell (1996), and will not be reproduced here. For further thoughts on the design, see Watts (2015).

There is one breed of turtles, called "agents". The sugarscape itself is made up of patches. Agents move around the landscape, seeking patches with spare resource, which the agents need to replenish their stocks. In the base model, there is one resource, called "sugar". Later scenarios can include a second resource, called "spice". Agents whose stocks run out will die.

New agents can enter the model through some form of reproduction: either initiated whenever another agent dies (so that the population remains constant), or the result of sexual reproduction between adjacent male and female agents of fertile age. Children from sexual reproduction inherit attributes from their parents, and may optionally also inherit a share of their wealth when the parents die.

HOW TO USE IT

Choose parameter values and menu options. Then click "Setup" and "Go".

You can also click "Setup Scenario" to jump to preset scenarios, roughly corresponding to those described in the book. These are:

1. Movement (Chapter 2, p.30-1)
2. Replacement (Ch. 2, p.33)
3. Migration (Ch. 2, p.42)
4. Seasonal Migration (Ch. 2, p.44)
5. Pollution (Ch. 2, p.47-8)
6. Sexual Reproduction (Ch. 3, p.58-67)
7. Inheritance (Ch. 3, p.67)
8. Cultural Transmission & Groups (Ch. 3, p.73)
9. Combat (Ch. 3, p.82-3)
10. Sugar & Spice (Ch. 4)
11. Trade (Ch. 4, p. 105-9)
12. Foresight (Ch. 4, p. 129)
13. Lending (Ch. 4, p. 131-3)
14. Disease & Immunity (Ch. 5, p. 144-5)
15. All processes together

THINGS TO NOTICE

Agents will migrate over the sugarscape, and their numbers may rise and fall. The distribution of wealth (i.e. sugar) is plotted, along with the calculation of a

Lorenz curve and Gini coefficient to show any inequality in this distribution. Depending on the parameter settings, log-normal distributions or scale-free (Pareto) distributions may be seen.

THINGS TO TRY

A key challenge is to obtain a self-sustaining population. After this, see how large a population the sugarscape can carry.

Which factors have the most influence over the sustainability of the society and the carrying capacity of the sugarscape?

Try the alternative scape: a square grid of patches uniform in their sugar and spice resources ("Max-Resources"). What is the relation between grid size, max-resources, mean metabolic rates and carrying capacity?

EXTENDING THE MODEL

Epstein & Axtell's attempt at modelling an artificial socio-economic system using only the simplest assumptions included several important assumptions that others might question.

Individualism: Agents act as individuals responsible for their own survival. Evidence from archaeology and anthropology suggests that such individualism is not the most realistic assumption for modelling ancient communities. Rather individuals produced items for their small community, and consumed food and other items from this communal store. Trade was initially between communities, not between individual members. How might we represent this alternative theory in Sugarscape? Might comparing models tell us something about the relative success of individualist and communalist societies?

Homes: The agents have no attachment to any particular patch or area of patches. Why do real human agents have homes? What advantages stem from this? What causes humans to migrate?

Family: Family relations are not acted on. Males and females gather sugar and engage in combat at the same rate as each other. They do not collect resources for partners, parents or children.

Age determines fertility and death from old age but nothing else. So 1-year-old children engage in migration, consumption and combat at the same rate as mature adults and the elderly.

Groups: Cultural groups do not influence the distribution of resources, other than through combat. Work on tags models by Axelrod and colleagues demonstrates how homophily can form the basis of cooperative norms.

RELATED MODELS

There have been many attempts to replicate some or all of the Sugarscape model. Iain Weaver's (2009) Netlogo version seems particularly polished and extensive, and it achieves a similar range of features to the current program. See:
http://ccl.northwestern.edu/netlogo/models/community/Sugarscape
http://www2.le.ac.uk/departments/interdisciplinary-science/research/the-sugarscape.

Sugarscape can be seen as the fore-runner to various models of land-use and sustainable resource use, artificial economies and market trading. Along with

Axelrod (1997), and some of the work at the Santa Fe Institute, Epstein & Axtell (1996) were among the first major contributions to agent-based simulation modelling of social phenomena.

Axtell et al. (1996) attempted to adapt the Sugarscape model to replicate Axelrod's model of cultural influence.

CREDITS AND REFERENCES

Epstein, J. M., & Axtell, R. (1996). Growing artificial societies : social science from the bottom up. Washington, D.C. ; London: Brookings Institution Press ; MIT Press.

Axelrod, R. M. (1997). The complexity of cooperation : agent-based models of competition and collaboration. Princeton, N.J. ; Chichester: Princeton University Press.

Axtell, R., Axelrod, R., Epstein, J., & Cohen, M. (1996). Aligning simulation models: A case study and results. Computational & Mathematical Organization Theory, 1(2), 123-141. doi: 10.1007/BF01299065

Watts, C. (2015) Sugarscape re-evaluated: an appreciation of an early classic in social simulation, with proposals for the future development of Artificial Economics. Paper presented at the ESSA Social Simulation Conference 2015, Gronningen, NL.

Weaver, Iain, (2009) Sugarscape. NetLogo User Community Models: Northwestern University, Evanston, IL.