

Modelling Landuse Development Using Multi-Agent Systems

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Biography

Ian Turton is director of the Centre for Computational Geography and the GeoComputation Research Fellow in the School of Geography at the University of Leeds. Research Interests include the use of high performance computing to explore and model geographic socio-economic data.

Introduction

The paper will address the use of intelligent multi agent models to investigate complex spatial systems. As Wilson (2000) notes many “interesting” spatial systems are too large and complex to allow a traditional theoretical or mathematical analysis, but that by building simulations of these systems it is possible to carry out theory development and testing. In the example presented the open source agent modelling toolkit REPAST is used to investigate Von Thunen’s theory of agricultural landuse. While Von Thunen (1826) developed his theory using an isolated city surrounded by a flat (infinite) plain, clearly these situations occur rarely (if ever) in the real world. By building a simulation environment that can start as a single market in a homogeneous area and then modifying the simulation to add alternative markets and or more realistic geographies it is possible to see if farmer-agents acting as Von Thunen suggested produce the sort of landuse patterns that are seen in reality.

Von Thunen’s Theory of Agricultural Landuse

Von Thunen was an economist and farmer, it is unsurprising therefore that his main interest as a theorist was agricultural landuse. His work is based on the concept of land rents which are closely related to the potential profit a farmer can make from growing a crop. As this profit is related not just to the value of a crop at market but also to the cost to transport it to that market, rent for any particular crop falls off with distance from the market. When farmers have a choice of crops to grow they will, obviously, chose the most profitable one so a series of concentric rings will grow up around the market, with crops with the highest profits growing nearest to the city.

REPAST

The University of Chicago's Social Science Research Computing’s REPAST (<http://repast.sourceforge.net/>) is a software framework for creating agent based simulations using the Java language. It provides a library of classes for creating, running, displaying and collecting data from an agent based simulation. In addition, REPAST can take snapshots of running simulations, and create quicktime movies of simulations. REPAST borrows much from the Swarm simulation toolkit and can

properly be termed "Swarm-like." In addition, REPAST includes such features as run-time model manipulation via graphical user interface (GUI) widgets first found in the Ascape simulation toolkit (<http://www.brook.edu/dybdo-croot/es/dynamics/models/ascape/>).

The model

The model is constructed by creating a large number of agents (the farmers) which each contain a rule set that allows them to select a profitable crop for their location. Initially agents own a small parcel of land randomly allocated to them, as time progresses they can acquire surrounding land either from the "state" (i.e. unallocated land) or their neighbours at the market rate. At the start of each time step (year) agents make their crop choices. These are based on their rule set and applying knowledge of last year's results. It is possible to view the model as it runs or to look at video of the complete run. Once the model has achieved equilibrium (where possible) the resulting land use patterns can be compared to observed landuse patterns.

Initial runs are of simple rule sets on flat plains while later runs show development in areas of more complex geography such as valleys and with multiple markets. By adjusting the geography of the model to match an observed transport network it is also possible to see how inhomogeneous transport costs affect the landuse of a region. It is also possible to produce agents with different rule sets so some farmers are for example organic or have other targets as well as profit maximisation.

References

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