ENVIROMENTAL MODELLING LAB #1

SCHELLING'S SEGREGATION MODEL

DESCRIPTION

The Schelling Segregation Model (SSM), also referred to as the "Schelling Tipping Model," was first developed by Thomas C. Schelling (Micromotives and Macrobehavior, W. W. Norton and Co., 1978, pp. 147-155). It represents one of the first constructive models of a dynamical system capable of self-organization. Schelling set out to demonstrate the hypothesis that "*the interplay of individual choices, where unorganized segregation is concerned, is a complex system with collective results that bear no close relation to individual intent.*" He was concerned with phenomena of large-scale spatial segregation of socioeconomic—particularly ethnic—groups in urban America.

"The demographic map of almost any American metropolitan area suggests that it is easy to find residential areas that are all white or nearly so and areas that are all black or nearly so but hard to find localities in which neither whites nor nonwhites are more than, say, three-quarters of the total."

Schelling was interested in finding out why ethnic groups did not live in spatially integrated areas of the city. Schelling proposed a simple model to test various hypotheses about the mechanisms driving metropolitan segregation. Conceptually, this model closely resembles a two-dimensional CA. Cells could adopt three color types (states): black ('black people'), white ('white people'), or grey (vacant sites without population). Each cell carried an additional state that denoted the '*contentedness*' of its population. Residents of a given cell were content with their location so long as the majority of their neighbors (in a Moore neighborhood) were the same color. If the residents were not content they moved to a new location in the next time step (i.e., the color of the cell transitioned to a new state).

Micromotives at the local level give rise to macrobehavior at the aggregate (global) level, but this emerging macrobehavior does not simply correspond to the underlying micromotives, i.e., segregation occurs although no individual agent strictly prefers this. Another reason for the fame of Schelling's model is educational. It is unusually simple. Combined with its intellectual appeal, this makes it a convenient means to illustrate the idea of unintended consequences resulting from the interaction between individuals.

ASSIGNMENT

Implement Schelling´s segregation model in an N x N square lattice with periodic boundary conditions. Consider two distinct populations, that, in Schelling's words refer to "*membership in one of two homogeneous groups: men or women, blacks and whites, French-speaking and English speaking, officers and enlisted men, students and faculty, surfers and swimmers, the well dressed and the poorly dressed*." Denote by B (black squares) and R (red squares) these two populations. Together these agents fill up some of the N^2 sites, with V remaining vacant sites (white squares). Each agent has eight nearest neighbors (Moore neighborhood). Fix a disparate neighbor '*contentedness*' threshold $T \in \{0, 1,\ldots 8\}$, and declare that a B or R is happy if T or more of its nearest eight neighbors are B's or R's, respectively. Else it is unhappy. Demographically, the parameter N controls the size of the city, $v = V/N^2$ controls the vacancy ratio, and T is an *"agent contentedness index"* that quantifies an agent's tolerance to living amongst disparate nearest neighbors.

Begin the evolution by choosing a random initial configuration and randomly selecting an unhappy B and a vacant site surrounded by at least T nearest B neighbors. Provided this is possible, interchange the unhappy B with the vacant site, so that this B becomes happy. Then randomly select an unhappy R and a vacant site having at least T nearest neighbors of type R. Provided this is possible, interchange the unhappy R with the vacant site, so that R becomes happy. Repeat this iterative procedure, alternating between selecting an unhappy B and an unhappy R, until a final state is reached, where no interchange is possible that increases happiness. For some final states, some (and in some cases, many) agents may be unhappy, but there are no allowable switches.

Consider various configurations:

(a) A cell space of size N= 100 (random allocation of B´s and R´s).

(b) Agent contentedness index T = 3, 4, 5.

(c) Vacancy ratios v = (5%, 10%, 15%, 20%, 25%, 30%, 35%).

For each configuration pair of *(T,v)*, run your model at least 10 times and find the average level of segregation of each configuration pair, as defined by Schelling. He defines as segregation (S_0) the percentage of agents whose eight nearest neighbors all have the same label, and thus are completely surrounded by like agents. Plot the value of (S_0) in a graph with axis (S_0, v) for values of T=3,4, and 5. Try to interpret the results. For your reference, Schelling used N=8, T=3, v=33%, but did everything with pencil and paper.