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Cellular automata modeling applied in eco-epidemiology - Simulation of the spatial spread of epidemics with individual contact

The spread of epidemics should be complex phenomena. As the exchange of economics and culture among different countries and areas become much closer in recent years, it has been an ecological issue that influences public health for invading of epidemics to new areas. Generally, there are two types of mathematical models to describe the spread of epidemics, determinate models and network dynamics models. Most of the existing mathematical models of simulating epidemics are built on the basis of ordinary and partial differential equations traditionally. These determinate models have an obviously weakness that the local characteristics of transmission were neglected. In particularly ,they could not simulate the problems properly as following: the process of individual contactthe effects of the individual behaviorthe spatial problems of epidemical transmissionthe effects of mixed pattern of individual.

As a typical representative of network dynamics models, cellular automata model has provided a useful and powerful tool for the research of complex systems. According to the definite of cellular automata model, it can be represented as an array of four elements, A=(Ld,S,N,f),where A is the cellular automata system; Ld is the cellular space; S is set of states; N is the set of neighbors of cell, N=(S1,S2,S3,„Sn),n is the number of neighbors of cell; f is the map of state transfer from Sn to S. Based on cellular automata, a simple theoretical model was presented in this work to simulate the spatial spread of epidemics with individual contact. Population is divided into three classes: infected, immunized and susceptible. Each state of the cell stands for one class of the populations. The epidemic model with the characteristic of vertical transmission and contact was considered particularly. The model, moreover, is extended to include the effect of population vaccination. This kind of effect can reduce the epidemic propagation. The proposed model can serve as a basis for the development of algorithms to simulate the spatial spread of epidemics using real data.

Keywords: Cellular Automata; Epidemics; Spatial Spread; Computer Simulation

References

[1] G.C.Sirakoulis, I.Karafyllidis, and A.Thanailakis, A cellular automaton model for the effects of population movement and vaccination on epidemic propagation. Ecological Modelling, 2000, 133(3):209-223

[2] A.Johansen, A simple model of recurrent epidemics, Journal of Theoretical Biology, 1996, 178(1):45-51

[3] C.Beauchemin, J.Samuel, and J.Tuszynski, A simple cellular automaton models for influenza A viral infections. Theoretical Biology, 2005, 232:223-234

[4] R.Willox, B.Grammaticos, A.S.Carstea, and A.Ramani, Epidemic dynamics: discrete-time and cellular automaton models, Physica A, 2003, 328:13-22