Deriving Cellular Automata Rules for Areas at Risk of West Nile Virus Infection

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Abstract

This paper describes the derivation of a cellular automaton (CA) model that simulates the evolution of geographic areas at risk of West Nile virus infection. The model uses the daily risk statistics derived by Theophilides et al. (2006) for each ½ by ½ mile cell in a given study area, in this case Sacramento/Yolo Counties, California, in 2005, as inputs to a system that extracts CA rules based on the cell state changes over time. The CA rule space is defined by subsets of each cell's spatial and temporal neighborhood (i.e. a master template), which can be represented by a pattern of bits amenable to refinement using a genetic algorithm (Richards et al., 1991). Candidate patterns within the master template are assigned a fitness based on the corresponding information content in the data, and a probability that the pattern will result in an on or off cell. The risk process changes over the course of a season, so an optimal rule is selected for each of several timeframes, the duration of which is derived by examining the changes in information content in test patterns from day to day. The result is a CA model with an optimal rule for each timeframe, consisting of an input pattern and an associated probability, which can be used to predict the future risk for a given area at any time in the season. The goal is to examine the relationship between the optimal rules at a given time period and the human incidence of West Nile Virus at various lags as per defined in Theophilides et al. (2006).

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References

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