Advanced Science and Technology Letters
Vol.53 (ACE 2014), pp.212-217
http://dx.doi.org/10.14257/astl.2014.53.45

Research and Application of the Combination Model in Simulating Kiln Landscape

Tao Liu [1], Xuan Xiao[1], Donglan Ying[2]

[1]Information Engineering School, Jingdezhen Ceramic Institute, Jingdezhen 333403, China
[2]Department of Foreign Language, Jingdezhen Ceramic Institute, Jingdezhen 333403, China
E-mail: ltjdz@126.com

Abstract. Current research has emphasized that the transformation process of kiln has been described by literal presentation. However, Dynamical and visual model can provide insights into kiln change processes and is valuable for land use transformation. For this reason, we create virtual maps of ancient Fu Liang area and propose such constructs to unambiguously denote a combination model. In this model, ancient virtual maps are created by ARCGIS10.0 software and PCI9.0 software, land use changes are performed through cellular automata, decision processes are controlled beyond the multi-agent, spatial optimization is represented by particle swarm optimization. The model can better reflect the interaction of the political situation, institutions and the natural environment.

Keywords: Multi-agent; Particle Swarm Optimization; Cellular Automata; Kiln

1 Introduction

Recently decade, many land use change have been researched and reported in the literature with various approaches and varying performance during the past (Jenerette & Wu 2001, Conant et al 2001, Lin et al 2008). However, the study of kiln change is little. For the reason, we developed a combination model consists of CA and MAS to simulate the kiln dynamics of the ancient Fu Liang area. In this model, land use changes are performed through cellular automata, decision processes are controlled beyond the multi-agent. Additionally, agents are divided into two categories, they are the political agents and the artificial agents, respectively represents the political information and the position of kilns in the real-world. We use the particle in particle swarm optimization (PSO) to denote the candidate position of kilns. Land use allocation belongs to a typical discrete combinatorial optimization problem, which cannot be solved by the original PSO directly. Hence, this paper uses modified PSO to solve above problem under a dynamic environment with cooperative agents.

ISSN: 2287-1233 ASTL

2 Study area and virtual map

Since Fu Liang GIS information has not been established in ancient, which results in the detailed terrain of the study area at that time having no direct access. I ever use Flash software to build the similar region map(Tao, L., et al. 2013), but the method is not suitable in this paper due to the amplification of the study area. By consulting relevant literature, we know the nature environment of Fu Liang almost no change over the years. So in the actual drawing process, we assume the land use of Fu Liang in the Ming Dynasty is extremely similar to 1980. Following, in PCI Geomatica V9.0 software environment, by means of the TM data of the study area in 1980 from the U.S. Geological Survey, the rivers, the surrounding mountains, the farmlands, the shrubs, the residents in the region can be recognized by Visual interpretation. The diverse lands in the region are represented various colors, detail as Fig.1. Fig.2 shows the land use types of study area in 1980. In the case of CA model, the data were converted into grid cells (30m*30m) in Arcgis10.0.

Fig.1. land type

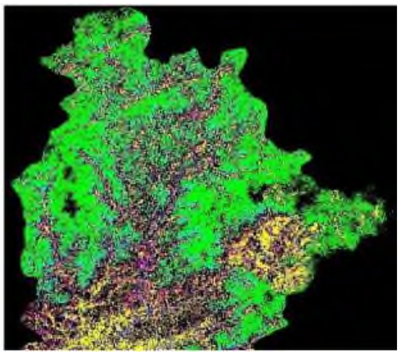

Fig.2. virtual map

3 The integration model

The integration model in this paper is developed to forecast land use change. It will mainly consider the following two aspects: (1) the decision-making behavior of government; (2) the spatial suitability of land use change, such as slope and neighborhoods attribute. The overcall model framework is composed of two main components: a multi-agent model, a CA model. The multi-agent model represents the individual's decision-making behavior, including political agent and artificial agent. A transitional rule with agent predict that the probability of change of land use state of each cell in the CA model.

3.1 A multi-agent model

4 2 2

, , ,

In general, many factors may influence land use change in some way, but it is impossible and unnecessary to explicitly consider every factor given the purpose of our model. In addition, constrained by relevant research data, the agents in our model are classified into two groups: political agents and artificial agents.

3.1.1 Political agents

Decision-making is implemented at two layers: the individual and joint decision among all agents. The hierarchical structure of social organization indicates that the lower-level processes are constrained by higher-level dynamics (Wu 1999; Wu and David 2002; Verburg 2006). In our study, imperial court usually has more power than local official in decision making in ancient peacetime, furthermore, political situation has the highest prerogative in decision making. Based above the view, the political agents in this paper mainly consider political situation and political institution. The research is divided into four stages in term of the feature of political situation and political institution: 1) A.D.1271-A.D.1349,2) A.D.1350-A.D.1362,3) A.D.1363-A.D.1401,4) A.D.1402-A.D.1554.

$f\ x\ y\ ,\ w\ x\ x\ y\ y$

3.1.2 Artificial agents

Artificial agents are used to solve the allocation problem of kilns. Essentially, the problem is a spatial optimization problem. Evolution Algorithms is one common way solving the problem. Among them, PSO is highly robust and can offer different routes through the problem hyperspace than other evolution algorithms. In this article, basic PSO is modified by redefining fitness function to be suitable for solving spatial combinatorial optimization problems. Based on considering the important extent of the traffic and craftsman, we shall enhance the weight of the distance from the dock and village. As a result, the fitness function of particle swarm optimization algorithm is defined as Equation 1.

(1)

Among them, is the nearest dock away from the current grid, is nearest mountain from the current grid, is nearest clay mine from the current grid, is nearest clay mine from the current grid, is current grid coordinates. , , and are the corresponding weight coefficient. Moreover, i□

1

3.2 A CA Model

In this study, the division of the CA of the square grid space as an experimental basis, using the Moore neighborhood, fixed value boundary. After the data are processed by a set of tools (e.g. Matlab,ArcGis), cellular space

, dimension ,and state set

, number 1-7 respectively stands for mountain, shrub, resident, river, background, farmland, kiln. The transition rules described as follows:

(1)Through artificial agents constantly moves in 2392×2264 cellular space to seek the location of candidate kilns. These locations will be developed into candidate land of the kiln.

(2)We derive the value of the suitability to development from each of candidate lands according to its land type and slope. The formula (Equation 2) will return the real value between 0 and 1, such as if the land type is river, else is 0.

(2)Among them, represents the state of (i,j) land at t-th iteration.

(3)We count the number of developed cells in Moore neighborhoods through the neighborhood function (Equation 3).

(3)

(4) Whether a candidate land can be developed into a kiln can be obtained by the formula 4, compare with set the conversion probability threshold, if the result is greater than the probability threshold, it can evolve into the kiln; otherwise, it can't. The

conversion probability threshold is influenced by political agent and assigned different values in different research stage through two variables.

(4)

4 Model simulation and evaluation

Hereafter, simulation results are presented in order to demonstrate the essential principle of the model. The study area is located in the Northeast part of the Jiang Xi

Province, China. The initial cellular domain (of 2392*2264 cells) represents the original land use type of study area. This domain is representative of all possible cells and agents combinations. At each time step, some parameters of the model and the states of the affected cells are changed under the control of the interaction of agents. As a result, the simulation result is also changed with time go. The detailed data of the main land type change in the different stages show Table 1.

Table 1. the statistics of cells in ArcGis10.0

Research stage	mountain	Shrub	Resident	Farmland	kiln
Stage 1	783145	261295	379910	104350	1850
Stage 2	814809	292843	317983	104960	0
Stage 3	800517	278213	330652	112697	8471
Stage 4	799802	277059	330661	121079	1949

In this paper, Moran's I index is used for model checking, and the compared results of the table 1 are programmed in Matlab7.0, as shown in Table 2.

Table 2. Moran's I index contrast

years	Moran’ s I Index	
	actual value	simulate value
A.D.1271-	0.6626	0.6614
A.D.1350-	0.6196	0.6471
A.D.1363-	0.5931	0.6445
A.D.1402-	0.6078	0.6452

From table 1 and table 2, we can find:

(1) The kilns growth in the third stage are fastest than that in other stages, because the political situation is stable and the skilled craftsmen can utilize good raw materials to produce ceramic. Furthermore, the development of the folk kilns had slow down in the fourth stage and become the verge of extinction in the second stage because of the official kiln’s emergence and war. It indicated the development of the folk is constrained by the official kiln and war.

(2) The simulation of integration model is of richer changing hierarchy, which reflects the evolving situation of kiln in different times. The evolution regularity of kilns is that the location of kilns distribute along river and around village. With time go, the location of kiln spread out from northeast to southwest. The interaction and information communication between these two kinds of agents help the model to modify the suitability of land and probability threshold dynamically, which better reflects the interaction between complex political factors and natural environment.

(3) Because of continuous evolvement, from the entire research phase, we can find that the number of the farmland continuous increase from stage 2 to stage 4, which shows the policies of Ming dynasty and wartime pay high attention to agriculture product in spite of farmland was so few in ancient Fu Liang area. Moreover, our

model not only reflects the evolution of kilns but also reflects other land type change with time. In the third stage, the numbers of mountain and shrub were decreased due to the expansion of the ceramic product. As a result, the number of the craftsman increase lead resident land increase.

5 Conclusion

Our model is a novel land use model developed by combining CA and multi-agent models. Multi-agent system models are increasingly recognized as a powerful tool to simulate social systems because they can capture important human decision and behavior that are difficult to formulate by using other tools (Lempert, 2002). In our model, the agents are equipped with land use related preferences and information extracted from political policies. Artificial agents may change their behavior in response to their environmental change based on their political development. The heterogeneity of agents is represented by adjusting diverse sets of weights according to GIS data. Eventually, we simulate the human-environment system and the evolution process of kilns in Fu Liang from 1271 to 1554 by using the integration model. The simulation results indicate that this novel model is of richer changing hierarchy and can better reflect the whole evolution process of kilns and land use change due to the interaction between political environment and the natural environment can dynamically modify transition probability threshold and look for the preferable location.

References

1. Conant RT, Paustian K, Elliott ET. 2001. Grassland management and conversion into grassland: effects on soil carbon. Ecological Applications 11: 343-55
2. Jenerette GD, Wu J. 2001. Analysis and simulation of land-use change in the central Arizona–Phoenix region, USA. Landscape Ecology 16: 611-26
3. Lin L, Qing F, Heping W, Li J, Xiaoyong P. 2008. STUDY OF THE FIGURE’S EVOLUTIONARY DEVELOPMENT OF JINGDEZHEN KILNS. China Ceramics 2: 022
4. Lempert, R., 2002. Agent-based modeling as organizational and public policy simulators. Proceedings of the National Academy of Sciences of the United States of America , pp. 7195–7196.
5. Tao, L., et al. 2013.Ancient Jing De Zhen Dong He River Basin Kiln and Farmland Land-use Change Based on Cellular Automata and Cultural Algorithm Model. Advance Journal of Food Science & Technology 5(9):1168-1173
6. Verburg, P.H., 2006. Simulating feedbacks in land use and land cover change models. Landscape Ecology 21, 1171–1183.
7. Wu, F., 2002. Calibration of stochastic cellular automata: the application to ruralurban land conversions. International Journal of Geographical Information Science 16, 795–818.
8. Wu, J., 1999. Hierarchy and scaling: extrapolating information along a scaling ladder. Canadian Journal of Remote Sensing 25, 367–380.

