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**In GIS**

**Development of the Local and Global Transition Rules in Statistical and Intelligent Models for Improvement of Urban Growth Prediction in Cellular Automata**

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**Abstract**

Many researches have been conducted in the subject of predicting urban growth by Cellular Automata (CA), which in most of them global models have been used in order to define transition rules. However, the use of global models to analyze spatial relationships and the prediction of environmental variables face serious challenges due to specific characteristics of a place as well as spatial heterogeneities. In addition, in practice, the efficiency of CA models and the prediction of urban growth are significantly influenced by particular factors involved in the growth of urban areas in different locations. Therefore, changing transition rules form stationary into non- stationary or from global to local can play a major role in the increase of simulation accuracy.

In present research, Geographically Weighted Logistic Regression (GWLR) and Local Support Vector Machines (LSVM) models were used with the aim of local probabilities prediction of urban growth. Moreover, transition rules of CA were developed based on weighted linear combination of probabilities resulting from the calibration of the local and global models. Also in this study a method has been proposed to determine the optimum bandwidth of GWLR, based on the assumption that the sensitivity of fitted values to training samples should be greater than the variance reducing factor. Furthermore, the calibration of LVSM algorithm was developed using cross-validation method which is based on central training sample; and in the calibration process the condition of eliminating score transformation step functions was also considered.

The developed models, in this research, were implemented in two distinct periods, from 1371 -1381 and 1375 -1391 in parts of Islamshar-Robatkarim urban area located in the southwest of Tehran. The periods of 1371-1375 and 1375-1381 were used for the calibration of models in the first and the second simulations respectively; and periods 1375-1381 and 1383-1391 were used for prediction. Likewise, to precise analysis of the behavior of models, the study area was divided into 9 different zones on the basis of existing towns and cities and the prediction accuracies were calculated in terms of the local model weights.

Because of the smaller bandwidth of the local model and the non-linear nature of the global model, CA models based on support vector machines produced more accurate results than the statistical models in the calibration phase. The maximum accuracy prediction of CA models based on SVM, in the calibration phase of the first and the second simulation according to Figure of Merit (FOM), were 0.602 and 0.713, while these figures for statistical CA models were 0.458 and 0.574 respectively. In the prediction phase, however, the accuracy of the statistical CA models increased duo to the smaller bandwidth, and the over-fitting of SVM to training samples. The results of urban growth simulation, in this phase, the combination of local and global models produced maximum accuracy for both the statistical and SVM CA models. . The maximum accuracy in the period of 1375 to 1381 based on FOM was 0.354 and for 1383 to 1391 was 0.218. However these figures for the local and global SVM in similar periods were 0.331 and 0.195 respectively

According to the results of this research, some advantages of statistical models as compared to support vector machines are the increase in the simulation accuracy in the prediction phase, because of the ability of the definition of greater bandwidth based on estimated variance, and the exploration of relationships between the predicting variables and urban growth. Efficiency of local models in the prediction of urban areas relies on the spatial correlation between the density of urban development over the period of simulation.

**Keywords:** Cellular Automata, Local Transition Rules, Geographically WeightedRegression, Support Vector Machines, Urban Growth