Predict Coordinated Development Degree of County Eco-Environment System Using GA-SVM: A Case Study of Guanzhong Urban Agglomeration

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ABSTRACT

This article describes how economic development has had a significant impact on the environment. County eco-environment coordinated development has contributed to regional coordinated development in China. A support vector machine (SVM) model was constructed to classify and predict coordinated development degrees of the county eco-environment system. In order to improve the discrimination precision of SVM in classification, a Genetic Algorithm (GA) was used to optimize SVM parameters in the solution space. The method was compared with artificial neural network, decision tree, logistic regression and naive Bayesian classifier regarding coordinated development degree of county eco-environment system prediction for Guanzhong urban agglomeration. It found that the method has the best accuracy rate, hit rate, covering rate and lift coefficient. The simulation indicates that the county slowing-down of economic development would not have positive effect on the environment sustainability. GA-SVM provides an effective measurement for region eco-environment system classification and prediction.

KEYWORDS

Coordinated Development Degree, County Eco-Environment System, Genetic Algorithm, Prediction, Support Vector Machine

1. INTRODUCTION

County eco-environment system coordinated development is an essential factor for regional coordinated development as well as for promoting the healthy development of urbanization (Siciliano, 2012). It is becoming clear that counties are now the key source of economic vitality for nation-states. Based on the development trends over the past decade or so, we can well expect that county economy will play a more significant role in the national economy in the future (Li & Fang, 2016). But we seem to be getting further and further away from sustainability. Economic development has had a significant and terrible impact on the environment in recent years. The resources depression and environment

DOI: 10.4018/JGIM.2018070101

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deterioration in county frequently fit the economic development in county in China. So, a small improvement in coordinated development degree of county eco-environment system would yield a considerable increase in regional coordinated development for country and healthy development of urbanization. Therefore, different promoting measures could be carried out for different county eco-environment system through classifying counties based on the predicted coordinated development degree (Zhao, Liu & Zhao, 2014). These classification and prediction on county eco-environment system can help policy makers, researchers, and the public to set goals and monitor progress.

Data mining technology could detect important information behind large amounts of data by building regional eco-environment system models (Jagatheesan & Anand, 2014). Regional eco-environment system, characterized by integration, dynamics and nonlinearity, is composed of economic and environment subsystems. These modelers have developed many methods, such as expert systems, genetic algorithms(GA) (Dey et al., 2015; Karaa et al., 2016), artificial neural networks (ANNs), and support vector machine(SVM) (Yaşar & Özyön, 2012, Khashei, Bijari & Ardali, 2009, Liu, Chen, Han & Zhong, 201). But the accuracy rates of these models are not high enough.

According to county eco-environment system dataset characteristic, this paper presented an improved SVM model by using GA to optimizing SVM parameters in the solution space and utilized county dataset provided by Guanzhong urban agglomeration of Shaanxi province China to make a county level of eco-environment system coordinated development degree prediction during the period 1994-2024. The method has been shown the highest accuracy compared with the recently proposed classifiers including decision tree, naive Bayesian classifier, and artificial neural network, etc.

2. METHODOLOGY

The support vector machine (SVM) first proposed by Cortes & Vapnik is gaining popularity because of its excellent properties of high generalization performance and global optimal solution (Cortes & Vapnik, 1995). Not only its structure is simple, but also its various technical capabilities is obviously boosted, especially the generalization ability. The detailed explanation and proof of SVM may be contained in the book (Ukil, 2007).

For given training set:

\[
T = \{(x_1, y_1), \cdots, (x_n, y_n)\} \in (X \times Y)^n
\]

\[
x_i \in X = R^d, \quad y_i \in Y = R, \quad i = 1, 2, \cdots, n
\]

First, through nonlinear transform of \( x \rightarrow \varphi(x) \), the paper mapped the input space into Hilbert space (Qin, S. J., & Badgwell, T. A., 2003), to construct the optimal linear function:

\[
f(x) = w \cdot \varphi(x) + b \tag{1}
\]

Thus, it could get the linear approximation in feature space, Vapnik advanced that could take \( \varepsilon \)-insensitive loss function as measurement of approximation:

\[
L(x, y, f(x)) = |y - f(x)| = \max \{0, |y - f(x)| - \varepsilon\} \tag{2}
\]

\( \varepsilon \) is a pre-selected permitted error and is positive. In interval \([ -\varepsilon, \varepsilon] \), there is not error between the classification function \( f(x) \) and actual value \( y \), the function loss “sensitivity”, so called as
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