An Efficient Hybrid Artificial Bee Colony Algorithm for Customer Segmentation in Mobile E-Commerce

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ABSTRACT

Customer segmentation can enable company administrators to establish good customer relations and refine their marketing strategies to match customer expectations. To achieve optimal segmentation, a hybrid Artificial Bee Colony algorithm (ABC) is proposed to classify customers in mobile e-commerce environment, which is named KP-ABC. KP-ABC is based on three famous algorithms: the K-means, Particle Swarm Optimization (PSO), and ABC. The author first applied five clustering algorithms to a mobile customer segmentation problem using data collected from a well established chain restaurant which has operations throughout Japan. The results from the clustering were compared to the existing company customer segmentation data for verifications. Based on the initial analysis, special characteristics from those three algorithms were extracted and modified in our KP-ABC method which performed extremely well with mobile e-commerce applications. The result shows that KP-ABC is at least 2% higher than that of other three algorithms.

Keywords: Artificial Bee Colony, Customer Segmentation, K-Means, Mobile E-Commerce, Particle Swarm Optimization

1. INTRODUCTION

The updating of current Internet and mobile technologies and the creation of new ones allow for the continued growth of mobile e-commerce. Mobile e-commerce is a kind of business activities which use mobile devices, such as cell phone and WiFi in business transactions. Compared with more established e-commerce business model, the mobile e-commerce usually deal with a large customer population; and the time and location of business activities are more unpredictable (Schejter et al., 2010). To design an efficient mobile e-commerce business model for marketing products or services, it is essential to have an accurate customer segmentation database (Ngai & Gunasekaran, 2007). With properly classified customers, a service or product provider can target a more receptive audience.

Recent researches have shown that using data mining algorithms to properly classify

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customers into various marketing segments generates some very promising results (Miguéis et al., 2007). Among those clustering algorithms the K-means method (MacQueen, 1967) is a robust and efficient algorithm which has been used to address the customer segmentation problems (Kim & Ahn, 2008) and among many other applications. A recent developed algorithm, the Particle Swarm Optimization (PSO) (Kennedy & Eberhart, 2005) shows extreme efficiency and effectiveness in solving continuous nonlinear optimization problems (Chiu et al., 2009). Recently, a new swarm intelligence algorithm, artificial bee colony algorithm (ABC) (Karaboga, 2005) has been applied to classification benchmark problems. ABC has a global search ability that prevents the search from premature convergence problem (Karaboga & Akay, 2009), and it can produce better results on multimodal and multivariable problems than other algorithms, such as GA and PSO (Gao et al., 2012).

When used properly, those algorithms mentioned above did generate some very fine results. However, as those algorithms used alone, some inherited problems such as local optima, stochastic dependencies, divergence, and other problems will destroy the integrities of those algorithms. In specific, some of the potential problems of those three algorithms include:

1. The K-means is more sensitive to initial cluster centers, which may lead to unpredictable results. The K-means has the shortcomings of premature convergence to local optima, which may result low accuracy segmentations and low practical application value (Kim & Ahn, 2008; Bagirov et al., 2011).

2. The PSO has faster convergence rate and lower time complexity compared to K-mean, SOM and GA. However, it sometimes suffers from the problem of being trapped in local optima, and the final outputs have some stochastic dependency issues (Tsai & Kao, 2011).

3. The ABC is a very simple, robust and population based stochastic optimization algorithm. However, the convergence speed of ABC algorithm will decrease as the dimension of the problem increases (Gao et al., 2012; Akay & Karaboga, 2012).

In this study, we propose a novel clustering algorithm, which is a hybrid algorithm based on special features from K-means, PSO and ABC. The proposed KP-ABC method, which takes the first letter from each of those three algorithms it originated, is easy to set up, fast in convergence, and adaptive to the changing environment. It also has build-in mechanism to break away from local optima. It is especially suitable to be used in a mobile e-commerce environment, which involves large amount of dynamically changing customer information.

2. BACKGROUND REVIEW

2.1. K-Means

The K-means algorithm is one of the oldest clustering techniques, which has been applied in many different fields. The algorithm itself is constructed based on the iterative hill climbing process. When the K-means algorithm is applied to a set of data an individual data points is classified into a cluster or segment based on a distance measurement from the data point to the center of a cluster. In our Mobile e-commerce application a data point is a customer and a cluster or a segment represent a group of similar customers.

Assumed that a set of \(m\)-dimensional points \((x_1, x_2, \ldots, x_m)\) is represented by the set \(D=\{x_i|i=1,2,\ldots,m\}\) where \(x_i=(x_{i1}, x_{i2}, \ldots, x_{in})\); the \(K\) clusters is represented by center set \(C=\{c_j|j=1,2,\ldots,K\}\), where \(c_j=(c_{j1}, c_{j2}, \ldots, c_{jn})\); and the Euclidean distance between a data point \(x\) and a cluster center \(c_j\), \(d(x, c_j)\) is defined as:

\[
d(x, c_j) = \sqrt{||x - c_j^1||^2 + \ldots + ||x - c_j^n||^2}
\]

\( (1) \)
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