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THE DEPOSITION OF MULTIPLE PHEROMONES IN ANT-BASED CLUSTERING

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Abstract. *This paper focuses on an Ant-Based Clustering algorithm from an Ant Foraging model's point of view, and proposes the method of using two kinds of deposited pheromones at each grid, Trailing Pheromone and Foraging Pheromone, namely Multiple Pheromones in Ant-Based Clustering. Cluster quality is evaluated by using an Average Distance function. Using the two pheromone methods, the experimental results show improvements in clustering time efficiency when compared with a basic algorithm without any pheromone or where only Trailing Pheromone or Foraging Pheromone is present. In addition, the use of the proposed method produces better clustering with shorter Average Distance values compared to other methods.*
Keywords: Ant-based clustering, Ant foraging, Pheromone influence, Multiple pheromones, Data clustering

1. **Introduction.** The inspiration of nature and social insects such as ants and bees inspires development research of self-organization, stigmergic, and distributed systems. Stigmergy is observed in the communication methods of social insects, for example; ants drop chemical substances on the ground while walking. This chemical substance is a kind of indirect communication called pheromone. Termites for instance, use pheromone to aid in the building of their nests. There are many researches focus on solving discrete optimization problems related to Social Intelligence, for example, Ant Colony Optimization (ACO) which is inspired by the ant foraging theory of ant colonies [1, 2]. Particle Swarm Optimization (PSO) is an optimization technique which is inspired by the behaviors in social life in bird flocking and fish schooling [3, 4, 5, 6, 21], and etc.

Ant-Based Clustering algorithm (ABC) [7] is one of those research themes which has been inspired by behaviors and activities of real ant colonies in clustering corpses which has a defined method for clustering a collection of similar and dissimilar objects.

The ant behavior in gathering food can be similarly applied to the problem of data clustering. There are several previous works which have used real ant behavior to solve these kinds of problems. One of the first works conducted by Deneubourg in 1991 was related to the ant-like agents that are allowed to move objects randomly on a two dimensional (2D) grid as clustering [7]. In 1994, Lumer and Faieta [8] applied the clustering algorithm to data analysis and in 1995, they applied their algorithm to exploratory database analysis as an alternative to the characteristic of the clusters. There are three features in Lumer and Faieta model; ants or agents with different moving speeds, ants or agents with short term memory, and ants or agents with behavioral switches. In 2002, Ramos et al. [9] improved Lumer and Faieta model by introducing spatial transition probabilities based