1. Introduction

Optimization is strongly related to various types of problems in the real world. It can also be used to solve varying problems, such as searching either minimum or maximum point in a particular function or solving both ordering and arranging problems and identifying an object.

The optimization problem could be categorized into two categories, continuous optimization and discrete optimization. Problems related to continuous variables include problems with problems that have limits and multi-modal problems. In order to optimize a continuous problem, an accurate and fast algorithm is needed. An accurate algorithm is vital to make sure the generated solution is correct. Besides, the algorithm should be computationally efficient. This is especially true when trying to find the best solutions from a large dataset with various variables, as an inefficient algorithm will require a relatively long time to find solutions.

A swarm intelligence (SI), which is also known as a collective intelligence (CI), is one of the areas in the artificial intelligence field. SI has generally been utilized for both continuous as well as discrete optimizations. It concerns on both natural and artificial systems, which contain multiple individuals coordinating each other by decentralized control and self-organization [1]. In their paper about analyzing the intelligence capability of the cellular robotic system [2], Gerardo Beni and Jin Wang are the first researchers using the SI expression in the context of cellular robotics in 1989. It specifically deals with collective behaviour emerging from a group of homogeneous individual interactions, such as fish or bird flocks, termite colonies, and land animals.

The choice of collective intelligence as a method for finding solutions to optimization problems is because collective intelligence has various algorithms [3] for finding various types of continuous optimization problems. Collective intelligence has proven to be highly successful in solving various optimization problems, evidenced by its ability to solve optimization problems such as travelling salesman problem as discussed in various paper about solving travelling salesman problem with various collective intelligence methods such as particle swarm optimization (PSO) [4], a discrete variation of cuckoo search [5], or variant of discrete firefly algorithm with edge-based movement scheme [6], solving vehicle routing problem with hybrid evolutionary firefly algorithm [7], optimizing neural network training with PSO as well as artificial bee colony algorithm (ABC) for data classification [8], optimizing parameter used in deep learning with bat algorithm [9], optimizing scheduling problems with various swarm intelligence methods such as PSO, ant colony optimization (ACO), and ABC algorithm as discussed by Madureira in 2011 [10], a variation of genetic algorithm employing greedy algorithm for initialization and directed mutation using certain rules [11], a modified bee colony optimization utilizing global evolution instead of local evolution for its population [12], an improved meta-heuristic reward-based variation of the aforementioned modified bee colony optimization with global evolution to solve the nurse rostering problem [13], a variation of firefly algorithm with discretization scheme to solve discrete problem of examination scheduling table [14], solving or supporting machine learning problems about using collective intelligence as a source for the self-supervising agent used in a method in a machine learning algorithm [15], or using genetic algorithm to optimize the training process method as utilized by Emilia in 2012 for word recognition [16], proposed as solution for problems related to energy and its possible applications as discussed by Kayakutlu in 2018 [17], solving speech processing optimization problem such as using genetic algorithm to optimize various parameters used in post-processing methods for automatic speech segmentation [18], or in other methods such as normalization, assimilation, or splitting [19], and many other problems that require various form of optimizations. This is due to the characteristic of collective intelligence algorithms, which are flexible and sturdy. Thus, they can be considered more superiors than the conventional algorithm techniques to solve optimization problems, as can be inferred from various papers and publications discussing swarm intelligence in general [20], [21], [22]. However, not all of these algorithms work with the same performance. An algorithm can work better for a problem than other algorithms. It is this diversity of algorithm performance that must be identified, analyzed, and compared so that the algorithms can be used more effectively.