

BEES ALGORITHM HYBRID WITH HOOKE METHOD

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BEES ALGORITHM HYBRID WITH HOOKE METHOD

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Management (Hons.))

by

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This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) (Hons.). The member of the supervisory is as follow:

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ABSTRAK

Algoritma Lebah adalah satu algoritma pengoptimuman yang meniru sifat dan kelakuan lebah madu mencari makan makanan . Algoritma Lebah telah digunakan secara meluas dalam pelbagai masalah pengoptimuman yang wujud khususnya dalam bidang sains komputer, kawalan kejuruteraan dan reka bentuk mekanikal. Algoritma Lebah juga telah menjadi tarikan dan digunakan dalam bidang kejuruteraan untuk sejak bertahun lagi. Walau bagaimanapun, terdapat beberapa kelemahan ketara dalam Algoritma Lebah. Algoritma Lebah mempunyai kelajuan yang perlahan malah tidak konsisten dan bergantung kepada masalah pengoptimuman atau fungsi sesuatu ujian. Oleh itu, kaedah baru yang dikenali sebagai Algoritma Lebah hibrid dengan kaedah Hooke telah dicadangkan bagi meningkatkan kecekapan dari segi kelajuan penumpuan. Hasil dari kaedah baru ini akan dibandingkan dengan Algoritma Lebah yang asal bagi membuktikan perubahan dalam kedua-dua algoritma. Kedua-dua algoritma kemudian tertakluk kepada pelbagai fungsi ujian penanda aras dan telah diuji dengan menggunakan tetapan parameter yang berbeza. Dengan menggunakan perbezaan set tetapan parameter, ia mungkin membantu untuk mendapat hasil dan bacaan yang lebih optima. Di samping itu, semua keputusan yang telah disahkan dengan Statistik Ujian Penting (T-Test). Merujuk kepada keputusan itu, parameter 1 dan parameter 2 mempunyai bilangan tertinggi keputusan signifikansi berdasarkan ujian-t. Keputusan yang diperolehi telah membuktikan bahawa prestasi kaedah yang dicadangkan iaitu Algoritma Lebah hibrid dengan kaedah Hooke adalah lebih baik mengatasi Algoritma Lebah yang asal dari segi kecekapan dan kelajuan penumpuan.

ABSTRACT

Bees Algorithm is an optimization algorithm that mimic real nature honey bees food foraging behavior. Bees Algorithm has been widely used in various optimization problems that exist widely such as in computer science, engineering control, and mechanical design. Bees Algorithm also had been attracted and applied in many engineering fields for recent years. However, there is some significant weakness in Bees Algorithm. Bees Algorithm have slow convergence speed that is not consistent and depending on the optimization problems or test function. Therefore, new method so called Bees Algorithm hybrid with Hooke Method has been proposed in order to enhance the efficiency in term of convergence speed. The result from this new method will be compared with the original Bees Algorithm to prove the changes in both algorithm. Both algorithm are then subjected to various benchmark test functions and were tested by using different parameter settings. By using difference set of parameter settings, it might help to identify the best performance of the newly improved Bees Algorithm. In addition, all the result had been validated with Statistical Significant Test (T-Test). Refer to the result, parameter 1 and parameter 2 have the highest number of significant results based on T-test. The result obtained has proved that the performance of the new proposed method is significantly outperform the basic Bees Algorithm in terms of efficiency and convergence speed.

DEDICATION

This study is dedicated to my beloved Mother and Father who have supported me all the way since the beginning of my life till now;

Azman bin Mohd Ali

Nazihah binti Muhammad

And also to my project supervisor with all the knowledge

Encik Nik Mohd Farid bin Che Zainal Abidin

Also, this study is dedicated to my siblings who have been a great source of motivation and inspiration

Aqilah Najwa binti Azman

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Thank you for the encouragement, support and motivation given in completion of this
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LIST OF ABBREVIATIONS

AI	-	Artificial Intelligence
PSO	-	Particle Swarm Optimization
ACO	-	Ant Colony Optimization
ABC	-	Artificial Bee Colony
BA	-	Bees Algorithm
EAs	-	Evolutionary Algorithm
SI	-	Swarm Intelligence
GA	-	Genetic Algorithm
DE	-	Differential Evolution
UC	-	Unit Commitment
MACO	-	Modified version of ant colony optimization
MSDP	-	Minimum Connected Dominating Set Problem
MANETs	-	Mobile ad hoc networks
SPSO	-	Standard Particle Swarm Optimization
SePAT	-	Simple Evolutionary Parameter Tuning
MPAW	-	Multi process alloy welding
GAHJ	-	Genetic Algorithm hybrid Hooke and Jeeves
NFL	-	No Free Lunch
UNIX	-	Uniplexed Information and Computing Service
MATLAB	-	Matrix Laboratory
FORTTRAN	-	Formula Translation
ASCII	-	American Standard Code for Information Interchange
R2014b	-	Release in 2014
maxEval	-	Maximum Evaluation
BAH	-	Bees Algorithm hybrid with Hooke Method

CHAPTER 1

INTRODUCTION

This chapter will discuss about the background of the study, basic knowledge and information about the concept of the optimization. Then, it will follow by the problem statement of the study and objective of the project that need to be achieve based on problem statement. The scope of the study also has been highlight. Next are the significant of the study and organization of the report.

1.1 Project Background

Optimization algorithms is a search methods of identifying the optimal solution that give high potential performance. There are many types of optimization algorithm and its implementation depending on the main goals and variable that wanted to be achieved. Optimization algorithm can be classified into two part that is stochastic and deterministic algorithm. Real world engineering contains many issues that needs the random system variable number to obtain a better quality parameter (Pham and Castellani, 2009). The efficiency of a process and result produced is an example of quality parameter that needs to be highlight. Application of Artificial Intelligence (AI) in this problem are helpful for engineers to solve engineering problems. AI is a developed method that empowers non-living thing such as computer or machines to perform a task like human.

Swarm based optimization is a nature inspired metaheuristic. It is a method of computational problem solving specifically in AI area. Swarm based optimization was inspired by insects behavior such as bee and ant. It is an implementation that relates to an observation on how insect solve their problems. Swarm intelligence has two fundamental concepts that is self-organizing and division labor (Dorigo and Di Caro, 1999). There are many kind of swarm based optimization methods. For an example, Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Artificial Bee Colony (ABC) and the Bees Algorithm (BA) (Kiran & Babalik, 2014).

In 2005, Professor Pham have introduced Bees Algorithm (BA) and at the same time Dervis Karaboga and his team has created Artificial Bee Colony (ABC) algorithm. Both of them is an efficient optimization problem solvers. BA and ABC is a swarm- based optimization metaheuristic that imitate the food foraging behavior of honey bees (Pham and Castellani, 2009). Both method has been successfully applied to engineering sector in order to enhance performance in solving difficult problems.

1.2 Problem Statement

Even though Bees Algorithm is well known for efficiency and effectiveness in solving optimization problems, there are several disadvantages that restrict its performance. Bees Algorithm applies uniform random distribution that helps the system to create new solutions especially in a complex problem. This case will happen in initialization phase and the effect of this situation will cause Bees Algorithm to have slow convergence rate in order to achieve optimum solution. Based on studies, Bees Algorithm has slow converge speed in order to get an optimum solution and low efficiency in search performance. Convergence speed of Bees Algorithm is different when using variety number of parameters. Combination of Hooke method with Bees Algorithm will create a new solution to overcome this problem.

1.3 Objective

- a) To demonstrate the use of Hooke method in Bees Algorithm in order to improve its convergence speed.
- b) To evaluate the functionality of the develop Bees Algorithm by using benchmark function test.
- c) To compare the proposed algorithm with the standard Bees Algorithm in terms of convergence speed, mean, standard deviation and elapsed time.
- d) To apply the newly improved bees algorithm in specified application.

1.4 Scope of Project

The focal point of this research will be highlighted on implementation of Hooke method in Bees Algorithm to raise the efficiency of search performance. Hooke method is a new development to the Bees Algorithm in this swarm intelligence. This research also studies about the Hooke Method and Hooke and Jeeves Method development in other algorithm by referring to previous projects. There are four parameters that will be selected. Both new developed BA and standard BA will be applied by using MATLAB software and will be tested in benchmark test function. Finally, the outcome of the proposed algorithm will be analyzed in T-Test.

1.5 Report Structure

The flow of the report is organized as follows:

- a) Chapter 1 : Introduction
This chapter is focusing on background, problem statement, objective, and scope and chapter review of the report.
- b) Chapter 2 : Literature Review
This chapter presents the basic theory and information based on the previous research that related to this project.
- c) Chapter 3 : Methodology
This chapter is discussing about all the methodology that has been carried out in order to produce a result, data and outcome of this project.
- d) Chapter 4 : Result & Discussion
This chapter is discussing and will explain more about all the result obtained from the research.
- e) Chapter 5 : Conclusion & Future Work
This chapter is focusing on the conclusion of the result and future work that can be done for next research.

CHAPTER 2

LITERATURE REVIEW

This chapter is focusing to a review and research of findings and methodology from previous studies that can be relate and helpful for this research.

2.1 Optimization

Optimization has been used in various work industry from engineering, music and art, manufacturing, business planning to route of internet. Yang has an opinion that optimization can use everywhere. In this globalization era, computer simulation has been develop to be a problem solver. MATLAB and Octave is an example of mathematic tools to solve a problems. In optimization, they will find and optimal solution or highest achievable performance to fix a problems. To make the quality parameter in optimize form, randomization of a number of system variable are needed especially in real world engineering problem (Pham and Castellani, 2009). There are many type of quality parameter such as, accuracy of a process, reliability of a process, the sum of a product produce and the performance of a product. Hence, we need optimization process in certain application. Optimization process must be relate with real life problem in order to analyze details and complexities. The details and complexities need to be sort because they might be relevant and some of them not.

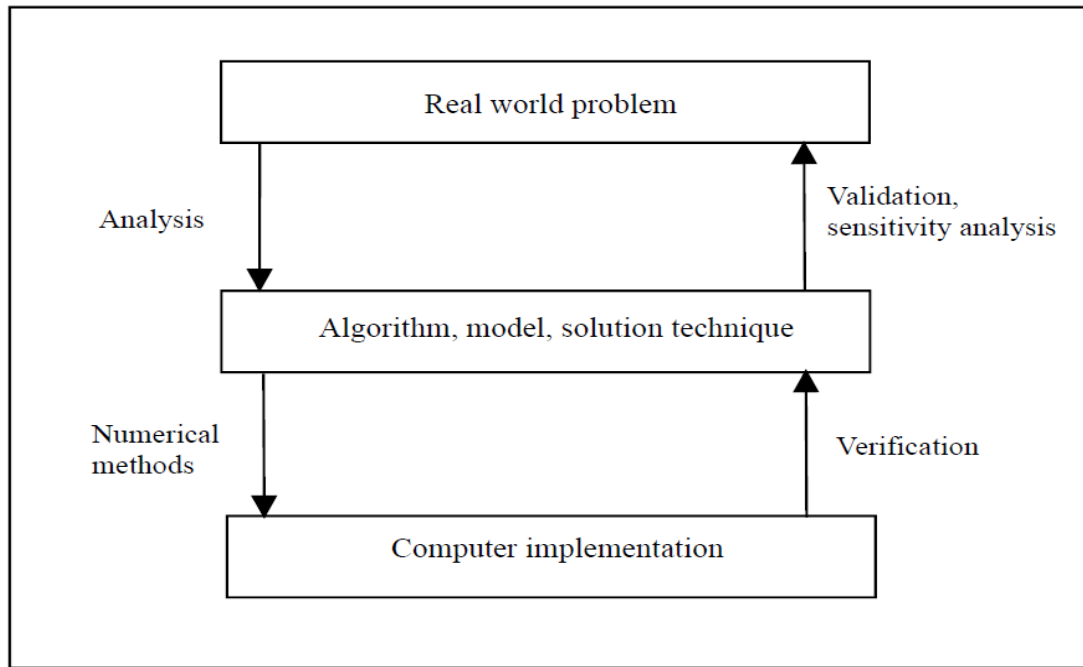


Figure 2.1: The optimization process (Krink and Paterlini, 2011)

Figure 2.1 shows a schematic diagram of an optimization process stages. There are three stage in optimization process that is real world problems, algorithm model solution technique stage, and computer implementation stage. The arrows represents normal process of optimization cycles. Firstly, identifying process will take part based on real world problem and the data will be transfer to algorithm, model, and solution technique. Next, computer implementation will take part. Then, verification process will take place to double check the simulation model whether its already translated into computer program. Validation process is important to test and improve a model to enhance its validity and also to confirm that the model is a true representation as what its represent in real system. Other than validation, sensitivity analysis also is an important part in optimization process. Sensitivity analysis is used to determine the level of sensitivity for the model parameters can be verified.

Local optimization algorithms usually are in gradient based. This gradient based has been widely used nowadays. It is useful for solving optimization problems in engineering field. Gradient based is very efficient. Even gradient based is an efficient, it also have disadvantages. Gradient based can only locate a local optimum and it's hard to solve discrete optimization problems using this method (Akbari and Ziarati, 2011). This bring a conclusion that global optimization algorithm usually non gradient based will have a better possibility of finding compared to the local algorithm.

Refer to Binitha and Sathya (2012) article, previous technique cannot adapt if the problem size increase due to high computational effort. This may lead to tendency to fail result. Its need a lot of improvement to boost their performance. For a precaution action, researcher has taken an alternative way by implement metaheuristic stochastic optimization algorithm to the deterministic method. Metaheuristic are based on iterative improvement. It has been divided in to two part that is single point solution and population-based solution. Both part are used to solve an optimization problem. They must be employ randomization and local search. Example of single point solution is Tabu Search and Simulated Annealing. Basically, single point solution is where single point is develop at each time step. Metaheuristic computing has been applied in multidimensional combinatorial problems, most design problems in engineering bio- medical ,control jobs hop scheduling, job selection problems, production engineering and power system (Li and Yang, 2016) (Binitha, 2014).

Evolutionary Algorithm (EAs) and Swarm Intelligence (SI) is the main categories in population based. Both are inspired by natural evolution and animal behavior in nature for an example bee foraging behavior in ABC and ant foraging behavior in ACO .Genetic Algorithms (GA) and Differential Evolution (DE) is the most successful members of EAs. Genetic Algorithm is more famous compared to Differential Evolution for being an optimal solution for optimization problem. This can be proved by thousands of research and articles that focus to this algorithm (Li and Yang, 2016).

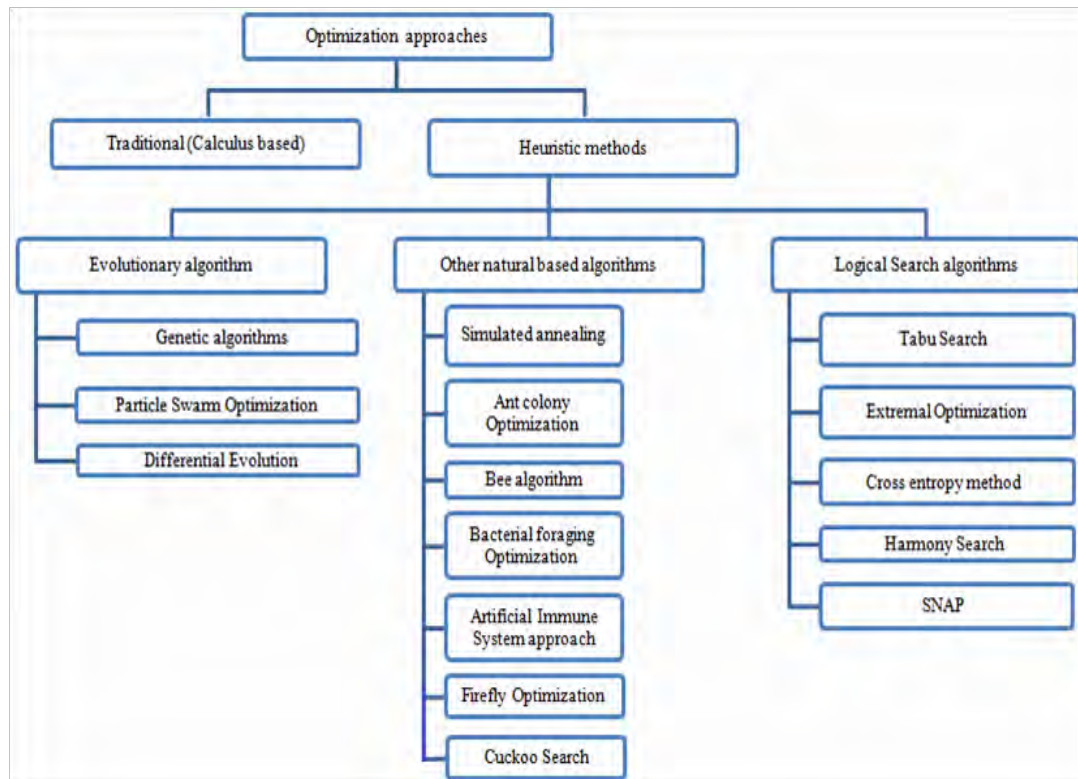


Figure 2.2: Type of optimization approaches (Binitha, 2014)

Field of optimization has grown faster in past few decades. As we can see in Figure 2.2, many type of algorithm and computational contributions of optimization has been introduced. Lin *et al.* (2012) share the same opinion regarding to optimization technique. They have conclude that optimization technique can be separated into two part that is deterministic and stochastic. Deterministic methods is a traditional methods that also known as direct search algorithms. This method will develop a sequence points that concentrate to a global solution. Linear programming, non-linear programming and mixed-integer non-linear programming is an example of deterministic methods. This method can provide general tools to solve optimization issue. The essential goal of this method is to obtain a global optimum (Lin and Zhang, 2013). Figure 2.3 shows a structure of stochastic method classification.