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Cargo fleet routing model with limited timeframe using honey bee algorithm (Case study: Pak Gostar Dairy Products)

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Abstract

Cargo fleet routing problem is part of the problems that arise and are used in the transportation industry. In this research, one of the specific types of this issue as the time fleet tracking with a limited time period which is the most common problem in operations research at the present time will be discussed. The aim of solving this problem is to provide service to many customers at different locations and different demands by a sufficient fleet. Considering these limitations each customer should set a period of time in service and delays in service are to a certain extent. In this study, reach sooner at the fleet to each of the destinations has given the delay in the service to a certain amount of the fines in accordance with the early and late is acceptable. In terms, they call it (period of application). According to surveys, in order to achieve the above objectives, the use of Bees Algorithm is used in this thesis. Using the Bee algorithm in this research is due to the evolutionary nature of this algorithm.

Keywords: Cargo fleet routing, honey bee algorithms, limited timeframe
2020 MSC: 65D15

1 Introduction

Vehicle Routing Problem (VRP) is one of the most combinational optimization problems that scientists and researchers have noticed. This includes routing to a fleet vehicle in which any of its devices meets a plethora of clients, providing that each customer only and only meets one vehicle. the objective is to minimize the distances traveled by all vehicles. Vehicle Routing Problem simultaneously with the receipt and delivery of the product (VRP_SPD) an extension of the VRP In which vehicles delivered to customers are not only commodities but also deliver the commodities at the same time. The basic idea of the vehicle routing problem (VRP) for the first time was discussed by [11] as a central issue in the field of transportation, distribution and logistics that showed applying management methods and discussions on the topic of transportation optimization has a significant impact on reducing transport costs 11 to 13% of the total cost of goods constituted and according to studies of Tat and Virgo [11], uses the correct methods and modern transportation creates 5 to 20% savings in total cost of production.

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The authors present a mixed integer nonlinear model to determine the optimal number and locations of collection points as well as centralized return centres. A solution method based on genetic algorithms is developed. It is mentioned in the paper that one of the alternatives to improve the efficiency of product returns is the enhancement of customer convenience. Therefore, a sufficient number of collection facilities have to be established in the proximity of the product holders' sites in order to reduce their travelling time and effort to return their used products. Once again, the volume of products returned by product holders is a deterministic parameter [1]. Location decisions are used in any field of facility establishment. The term "location" refers to the modelling, formulation, and solution of a class of problems that can best be described as sitting facilities in some given space [2]. Given the speed of urbanization, increasing traffic loads and congestion levels in cities, and rapid growth in e-commerce and customer-centric delivery services, fast, efficient, and reliable urban delivery systems are indispensable. In this paper, we introduce a multi-modal, UAV-based delivery problem, so-called the Simultaneous Traveling Repairman Problem with Drones (STRPD), aiming at minimizing customer waiting times for deliveries [10].

1.1 Problem statement

The cargo fleet routing (whether facing urban routes and suburban routes) is one of the issues addressed by transportation circles around the world. In fact, due to the increasing development of human societies and consequently the development of villages, cities, and countries, as well as the need to communicate between these areas and to meet their needs, millions of daily truck traffic between the ports serve different purposes. Due to the variety of paths, during their diversity, safety and economic considerations and also the existence of traffic problems, meeting the demand of all applicants and yet regard to the above considerations is difficult. Cargo fleet routing is a method to optimize time and cost for applicants' service providers and at the same time take into account all the above considerations. Given the amount of attention to this issue, routing problem trucks is divided into different branches. Some of these branches are: routing with a limited fleet and matched from a source to a destination, routing for heterogeneous fleets (restricted or unrestricted) and several single-source and multi-source and multi-destination basis, routing by taking inventory, routing cargo fleet periodically, routing by taking inventory, routing cargo fleet alternatively, routing cargo fleet with limited timeframe to reach the destination and return to the origin or destination so on [3]. Studies and research conducted so far on routing with a limited timeframe are divided into two categories: Non-flexible routing by time period and flexible routing by time period. Therefore, the difference is that in non-flexible routing by the time period when the fleet reaches the cargo, not during the determined period the consignment is not deliverable anymore and the fleet should go towards the next destination.

But inflexible routing by the time period when the fleet reaches the destination, not at the determined time, considering a number of fines (depending on the duration was late or early) in the model, the fleet is allowed to and after delivery can proceed to the next destination. In this project the aim Mola cargo fleet since the routing is flexible. Major cases studied in this thesis are a model with the use of a multi-objective algorithm (due to the fact that most of the algorithms used in the routing algorithms are single objective and all parameters such as cost or the equivalent in the form of a track and modelling. This method is a kind of innovation and gets help from honey bee to model routing algorithm fleet with the interval time limit and find a way to achieve a reasonable estimate for the consideration of a number of fines and was built according to the type of shipment, interval destination and the violation of the model [3, 4].

1.2 Importance of the issue

With regard to the development of human societies and consequently increase in the need for transport and movement of goods, the use of management methods and optimization of freight transportation seems inevitable. One of the most efficient methods of optimized fleet routing of cargo is handling and transportation time to work with a limited time interval. In other words, the advantages are VRPTW which specifications of each unit of production and transportation compatible with the system have more and more profits advantage of this system. These include:

1. Due to limited resources, the use of VRPTW has a significant effect on optimizing the use of resources.
2. This system will provide maximum efficiency with minimum deployment.
3. Increasing customer satisfaction with the application of this system causes to increase in the significant factors of success in a competitive market-produced goods.
4. Given that the system is inherently based on finding the best and shortest route to the end users, it has a significant effect in reducing the traffic thoroughfares.
5. The system works by reducing transportation costs, and reducing the cost of production and the resulting product is placed by the customer at a lower cost that will have development in sales and earnings data to mobile units.
6. Due to the increasing rate of gasoline, the reduction of fuel consumption using this system is very important.

1.3 Research objectives

Due to major traffic problems LED movement of goods within urban and suburban Iran plays a crucial role in today's society the main goal of this research:

1. Achieve practical way to guide cargo fleet in the appropriate time
2. Cost of transport systems optimized for use on goods. It is clear that the success of such a target will be to win customers' favor distributors of the product as well;
3. Reducing suburban inner-city street traffic ensures safety and mobility.
4. Service to a higher level of demand (more destinations) is with the less optimized use of the fleet.

1.4 Research questions

1. What parameters are effective in solving the problem of routing cargo fleets with limited timeframes?
2. What are the benefits of problem-solving as soft (flexible) compared to Hard Mode (consolidated)?
3. Between the methods of multi-objective optimization of bee colony algorithm, what is the proper method to solve the problem of fleet routing with a limited time period time?

2 Theoretical framework

Multi-objective optimization problem (MOP) called to the problem that the goal is to find decision variables that satisfy all the constraints and improve the objective function optimally. (In fact, this Ardebileh of individual functions is the goal that the purpose of optimizing them). The multi-objective optimization can be only one solution to the problem presented as the best answer. On these issues, there is a set of solutions that meet one of the objectives at an acceptable level that is introduced as the sum of the optimal solutions.

Bee Algorithm includes a group-based algorithm search algorithm the first was developed in 2005; this is a simulation algorithm for food searching behavior of groups of bees. In the first version of this algorithm, it does some kind of local search that combines with random search (Shuffle) and can be used for combinatorial optimization or optimization function.

2.1 Operating bee model

Operating bee Model inspired by saving feed-seeking behaviors of the bee colony. Bee's operating model is composed of four factors: Depending on the terms, identify Indicators, feed-seekers, and procession. In the following, we identify words rather than identifying the factor of feed seeking, barley use instead of feed barley, etc. [5].

2.1.1 The package

The package imitates the work of the food storage containers and working bands mimic bees. They always reside within the node where the data packet is received from the transport layer in the memory. The main job they find, feed barley for their data packets, when the feed barley is delivered, once destroyed.

2.1.2 Identifiers

Identifiers discover new ways of the destination node. Each identifier to all nodes using the original release and set a time to live (TTL) is transferred when each detector can monitor the re-publication. Each identifier forms a unique identification number with a key-based and it's tied up. When any other identifiers reach the destination, going back on the same route start, all reach the destination node identifier to ensure the discovery of multiple paths. When a detector returns to node origin, feed-seekers use a virtual dance to encourage its path. (Identified by bees in nature is done.) Recent identify separate each dance (to encourage bees to feed barley in nature).

2.1.3 Feed-seekers

Feed seekers are home workers of the bee colony algorithm. They found the ward's data packets from the pack and then transferred them to their destination. Each feed has a special type: Delays or lifetime. Feed-seekers delayed collect delay information from the network. We try to choose the path that has less delay, while the next step will be to increase the network lifetime [6]. Each feed barely full path to the sequence of nodes that lead to the identification of suppliers or other foods found in the militants.

Each feed barely peer mode follows the player to the destination and collects information about network mode and their dependence. Each time any feed barely reaches its destination since then remains to be transmitted network traffic destination node to the source node. Also, feed-seekers at the time of arrival at their source, do the virtual dance-like identifiers.

2.1.4 Procession movement

Unreliable transformation Protocol such as UDP does not send any clear acknowledgement for acceptable data packets. Such forward-seekers cannot provide a way back to feed, so some will never return to their origin. Unreliable transformation protocol such as UDP does not send any clear acknowledgement for acceptable data packets. Such forward-seekers cannot provide a way back to feed, so some will never return to their origin.

As a result, it is possible to finish all the feed and not be able to continue the relationship. We have solved this problem with the help of the masses. When the difference between feed and feed asylum-seekers arrived out of the nodes of node i i i makes access to the quorum node by node i to j start moving mass. When a node procession arrives at I the feed-seekers are drawn out from useful load [7].

2.1.5 Architecture in Bees Algorithm

Each hive is composed of three parts: packaging floor, entrance and dance floor. An input interface Media Access Control (MAC). Hall packaging is the transport layer interface. All packets arrive at the hive entrance. The ballroom including the feed is (routing information) for routing data packets in the initial nodes.

3 Methodology

The aim of this study is applied and descriptive data collection, for this purpose the survey method is used to describe and explain the relationships between the variables. Applied research aimed at the development of practical knowledge in a particular field and dealing with problem situations, is the basis of applied research [8]. Since the investigation period with limited cargo fleet routing modelling using the bees algorithm, therefore, can have practical use from results [8].

4 Experimental results

Performance on ABC accuracy solution compared with MABC accuracy performance. The results are shown in Table 3 in terms of best, worst, median, mean and standard deviation obtained in 30 independent execution solutions by any algorithm. Figure 1 is a graphical comparison in terms of the characteristics of the evolutionary process integration solution that provides 8 different issues. An interesting finding is that the ABC 2 algorithm based on minimum f_7 has more confidence. In the f_7 point is rather that area. Therefore, this issue may be resolved relatively easily with a 100% success rate.

Important observations in connection with the integration and reliability of the results can be different algorithms presented in Figure 1 and Tables 3 obtained.

These results argue that in many functions of MABC, the convergence test is better than ABC. In particular, MABC can be optimized solutions $f_{26}, f_{25}, f_{13} - f_{11}$ and finds D=30. MABC has high accuracy for almost all functions except the functions and D= 100, 30 gives D=100. D=100, where the functions and are D= 100, 30, the simulation results show that convergence is MABC worse than ABC. However, as the results of MABC's order of magnitude are the same as the results of ABC, ABC is superior to MABC in terms of best, worst, median and A standard deviation are not very specific solutions. In other words, superior search capabilities and efficiency in terms of the characteristics of the proper balance between exploration and inference MABC.

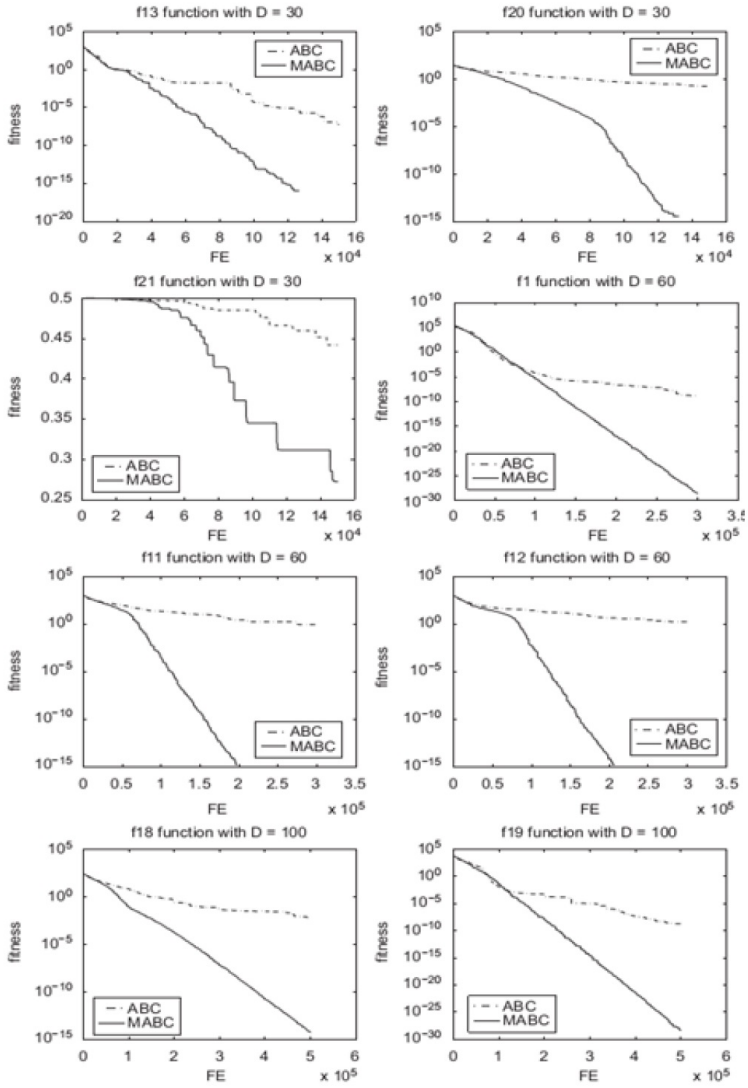

Figure 1: Different ABC convergence performance test functions

Finally, basic explanation, is capable of MABC Bees can be prevented from falling into the local minimum, the process of evolution and efficiency significantly reduced (faster convergence), calculated more efficiently and improves search capabilities Bumblebee for ABC.

4.1 Change function optimization

ABC algorithm fitness function is defined as follows:

$$f_i = \begin{cases} \frac{1}{1+F(x_i)}, & F(x_i) \geq 0 \\ |1 + F(x_i)|, & F(x_i) < 0. \end{cases}$$

A series of numerical benchmark tests on 28 functions to compare the performance with the performance of ABC carried MABC.In all simulations, with increased optimization parameters, the maximum number of function evaluations (Max FE) and 500,000 respectively for each function is 150000. 300000 assess the (size of the population is 150, i.e. (SN =75). All results reported in this study approach are obtained by 30 runs and independent commands. MABC, 30 times in each of these functions is executed and mean and standard deviation results are provided in the table. Since all test functions are minimizing problems, if the end result is smaller, it is better. From Table 1, we can see that P could affect the results. When P is zero, acceleration faster convergence and better results in the functions we find Asfirr and Akli. For the four other test functions better results, were obtained when the P almost, is 0.7. At the same time, P has a smaller impact on Asfyr functions and Akly than the other four test functions.

Therefore, in this study, the possibility of a selective P test is determined at 0.7 for all functions. In this case, more and more studied approaches can achieve a balance between exploitation and exploration [9].

4.2 Fleet capacity

Fleet capacity is based on each vehicle carrying capacity of the shed. In this case, according to the owner and the observation of the drivers of refrigerator factory products under study formed based on the Nissan. Nissan pickup on the basis of information received from the Department of Plant and Nissan Pickup drivers any capacity with the size of each container of milk and given the size of the fridge this means, 1500 was closed.

4.3 Implementation of the model in software

As mentioned in the previous section the interval of time for each customer and demand and spatial coordinates as input shops MATLAB software was determined. Again, note in the process of spot optimizing, N probability parameters of the initial population size 200, Archive size 200 and operator of synthetic compounds 0 have been considered. The results of the model jump to 0.1 and 0.5 probability of mating are described in detail.

Table 1: The minimum number of fleet costs and fines obtained from the graph model output.

The lowest number of fleet	The lowest price	The lowest penalty
3	160,0870	0

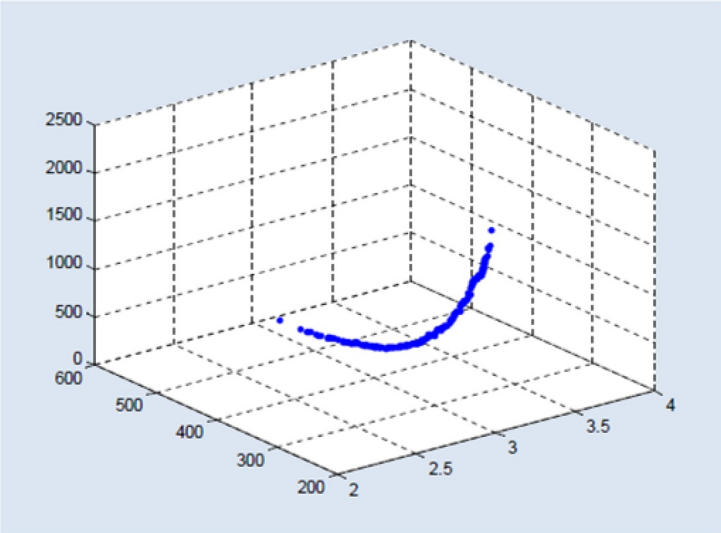

Figure 2: Sensitivity analyses of changes in the composition operator.

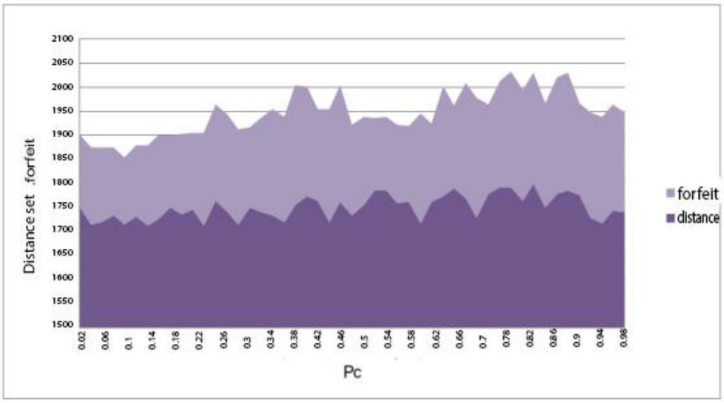

Figure 3: Sensitivity analysis of changes in the composition operator.

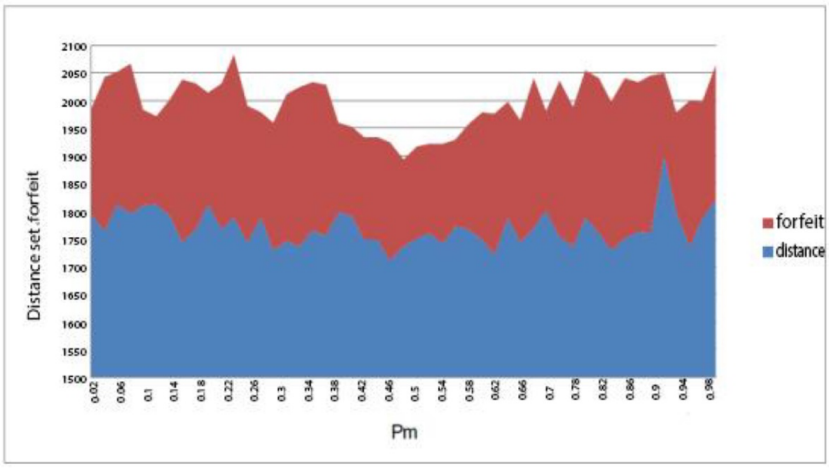

Figure 4: Sensitivity analyses of mutation operator changes.

Table 2: Time intervals of cities

	Ardabil	Prasabad	Hir	Meshkinshahr	Namin	Nir	Khalkhal	Germmy
Ardabil	0	1333	435	2242	333	667	1329	1268
Prasabad	0	0	1160	1020	590	1060	1220	1050
Hir	0	1160	0	1740	1720	210	160	250
Meshkinshahr	0	1020	1740	0	710	1530	1900	1520
Namin	0	590	1720	710	0	1580	1820	1570
Nir	0	1060	210	1530	1580	0	370	30
Khalkhal	0	1220	160	1900	1820	370	0	400
Germmy	0	1050	250	1520	1570	30	400	0

After solving levels and other variables will be as follows:

Table 3: of the variables X_{ij}

	Ardabil	Prasabad	Hir	Meshkinshahr	Namin	Nir	Khalkhal	Germmy
Ardabil	0	1	0	0	1	0	0	1
Prasabad	0	0	1	0	0	0	0	0
Hir	0	0	0	0	0	0	1	0
Meshkinshahr	1	0	0	0	0	0	0	0
Namin	0	0	0	1	0	0	0	0
Nir	1	0	0	0	0	0	0	0
Khalkhal	1	0	0	0	0	0	0	0
Germmy	0	0	0	0	0	1	0	0

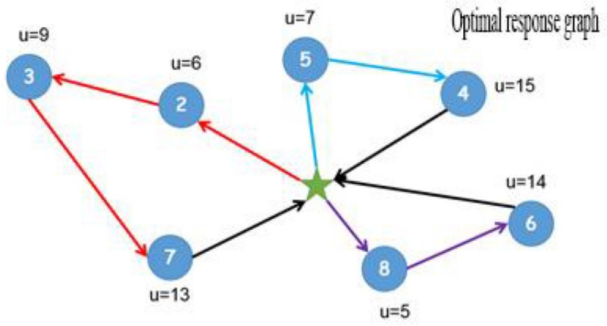

Figure 5: Optimal response graph

Table 4: Optimal response graph

	ET	LT	T	D	Q	U
Ardabil	0	0	0	0	0	0
Prasabad	0	1440	990	0	6	6
Hir	0	1440	2165	740	3	9
Meshkinshahr	0	1440	1425	0	8	15
Namin	120	1440	700	0	7	7
Nir	120	1440	2095	670	9	14
Khalkhal	120	1440	2340	915	4	13
Germmy	120	1440	2050	625	5	5

4.4 Times to reach each city and delay time

Output cost function is as follows. As can be seen heading is in the direction that algorithms reduce the cost.

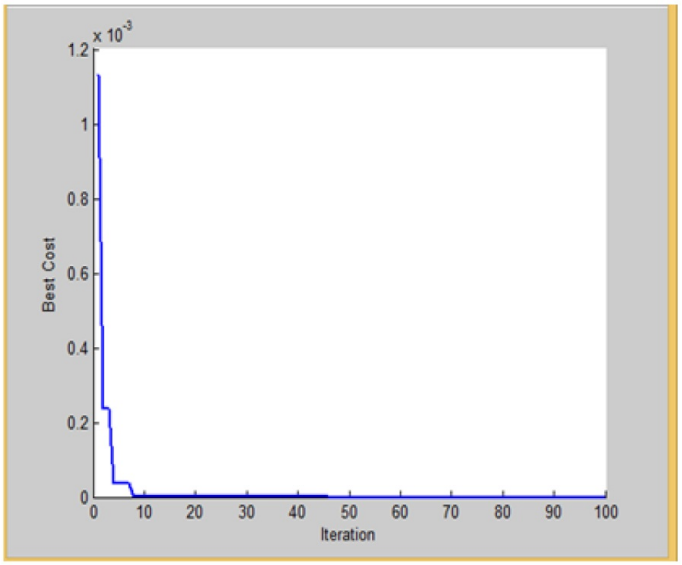

Figure 6: Output with function 4

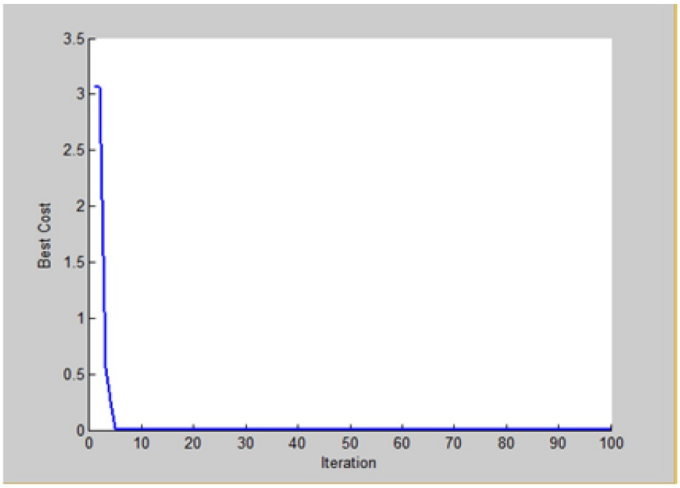

Figure 7: Output with function 3

5 Conclusion

In this thesis, we investigate the new algorithm optimization MABC entitled to seek a solution by determining equation modified on ABC and provide a new form without phase project possible and made a bee phase. In addition, the initial population through a combination of learning methods in contrast to irregular systems has been produced for increasing global convergence. Experimental results of 28 benchmark tests show that MABC works better than ABC and MABC. As a result, MABC could be a promising tool and available for the evaluation of complex numerical optimization problems. Applying further MABC continuous optimization problems to solve real and complex problems, such as clustering, data mining, design and optimization of communication networks is more favourable. Further research includes studies on how to develop MABC to study combinatorial optimization problems such as flow shop scheduling problems (flow shop), Vehicle Routing Problem and Traveling Salesman Problems. According to the obtained results, it was concluded that the Bee routing algorithm proposed in this study, the problem-solving ability of cargo fleet with an average of 0.371% compared to other methods. Correction bee colony algorithm proposed by scouts and scout bee bound obtained from the algorithm was effective in improving young people's expense. Tying scout bees results in reduced intersections And a shorter final answer will be achieved. Scouts Bee with innovative algorithms results in the Bee colony algorithm starting with better solutions and finally achieving better solutions and discoveries compared with other algorithms.

Recommendation for future researches

- Consideration of problem-solving on a larger scale
- Using different combinations of mutation operators in order to achieve better solutions and optimization
- Using bee-integrated two-stage algorithms to improve responses
- Involving traffic volume pathways in the decision-making model to find the optimal path

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