PROJECT REPORT

on

Implementation of BCO for travelling sales man problem

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(September-November, 2019)

DECLARATION

We hereby declare that We have completed our synopsis of Soft Computing from 24/09/19 to 30/09/19 under the guidance of Usha Mittal Ma'am. We have declare that We have worked with full dedication during my project report and our learning outcomes fulfil the requirements of training for the award of degree of Bachelor of Technology, Lovely Professional University, Phagwara.

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ABSTRACT:

In a bee colony, bees perform waggle dance in order to communicate the information of food source to their hive mates. This foraging behaviour has been adapted in a Bee Colony Optimization (BCO) algorithm together with 2-opt local search to solve the Traveling Salesman Problem (TSP). To reduce the high overhead incurred by 2-opt in the BCO algorithm proposed previously, two mechanisms named frequency-based pruning strategy (FBPS) and fixed-radius near neighbour (FRNN) 2-opt are presented. FBPS suggests that only a subset of promising solutions are allowed to perform 2-opt based on the accumulated frequency of its building blocks recorded in a matrix. FRNN 2-opt is an efficient implementation of 2-opt which exploits the geometric structure in a permutation of TSP sequence. Both mechanisms are tested on a set of TSP benchmark problems and the results show that they are able to achieve a 58.42% improvement while maintaining the solution quality at 0.02% from known optimal.

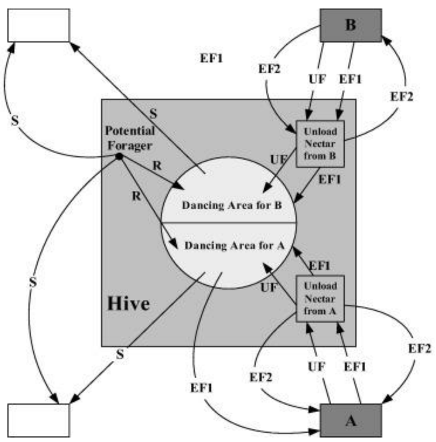
INTRODUCTION:

Bees are highly organized social insects. The survival of the entire colony depends on every individual bee. Bees use a systematic task segregation among them to ensure a continued existence of its colony. They perform various tasks such as foraging, reproduction, taking care of young, patrolling, housekeeping and constructing hive. Of these, foraging is a major activity as bees have to ensure an undisrupted supply of food source to the colony.

The foraging behaviour of bees remains mysterious for many years until von Frisch translated the language embedded in bee waggle dances [2]. Waggle dance operates as a communication tool among bees. Suppose a bee found a rich food source. Upon its return to the hive, it starts to dance in a figure eight pattern. Via this informative dance, the bee has actually informed its hive mates about the direction and distance to the new food discovery. This will eventually attract more bees towards the new food source. Discussions about waggle dance can be found in.

The foraging behaviour of bees has been adapted as a useful computational algorithm to solve complex problems in different domains. Among them are dynamic server allocation for Internet hosting centre, numerical function optimization telecommunication network routing, stochastic vehicle routing problem and Job Shop Scheduling Problem

Another problem that has been attempted is the Traveling Salesman Problem (TSP). TSP is a problem that requires a salesman to visit a set of fully connected cities where each connection between two cities is associated with a cost. The traveling sequence has to comply with a constraint that is the salesman will start at a city, visit each city exactly once, and back to the start city. The resulting route should incur a minimum cost. TSP is common in areas such as logistics, transportation and semiconductor industries. Finding an optimized scan chains route in integrated chips testing, parcels collection and delivery in logistics companies, are some of the potential applications of TSP. Efficient solution to such problems will ensure the tasks are carried out effectively and thus increase productivity. Due to its importance in many industries, TSP is still being studied by researchers from various disciplines and it remains as an important testbed for many newly developed algorithms.



This paper depicts an efficient Bee Colony Optimization (BCO) algorithm that significantly improves the algorithm proposed previously by the authors in terms of computational speed. In a BCO algorithm with 2-opt was tested on a set of TSP benchmark instances. Each solution generated by bees was locally optimized by an exhaustive 2-opt. The 2-opt heuristic is implemented according to the basic idea which eliminates two arcs in order to obtain two different paths. These two paths are then reconnected in the other possible way if the new path results in a shorter tour length. Although the integration of 2-opt gave promising results, the results presented showed that the execution time could be improved further. To achieve this, two mechanisms, namely frequency based pruning strategy (FBPS) and fixed-radius near neighbour (FRNN) 2-opt, are presented in this paper. FBPS is a strategy that allows only a subset of promising solutions to perform 2- opt and FRNN 2-opt is an efficient implementation of 2-opt. This paper starts with a discussion on the BCO algorithm (Section II). It is followed by a discussion on FBPS (Section III) which describes the building block concept and its working mechanism. Section IV describes the FRNN 2-opt adapted from. (Section V) describes the implementation details, experiment platform and source of the benchmark problems utilized in this study. It is then followed by (Section VI) which presents the findings of this paper. Finally, this paper ends with a conclusion.

BCO FOR TSP :

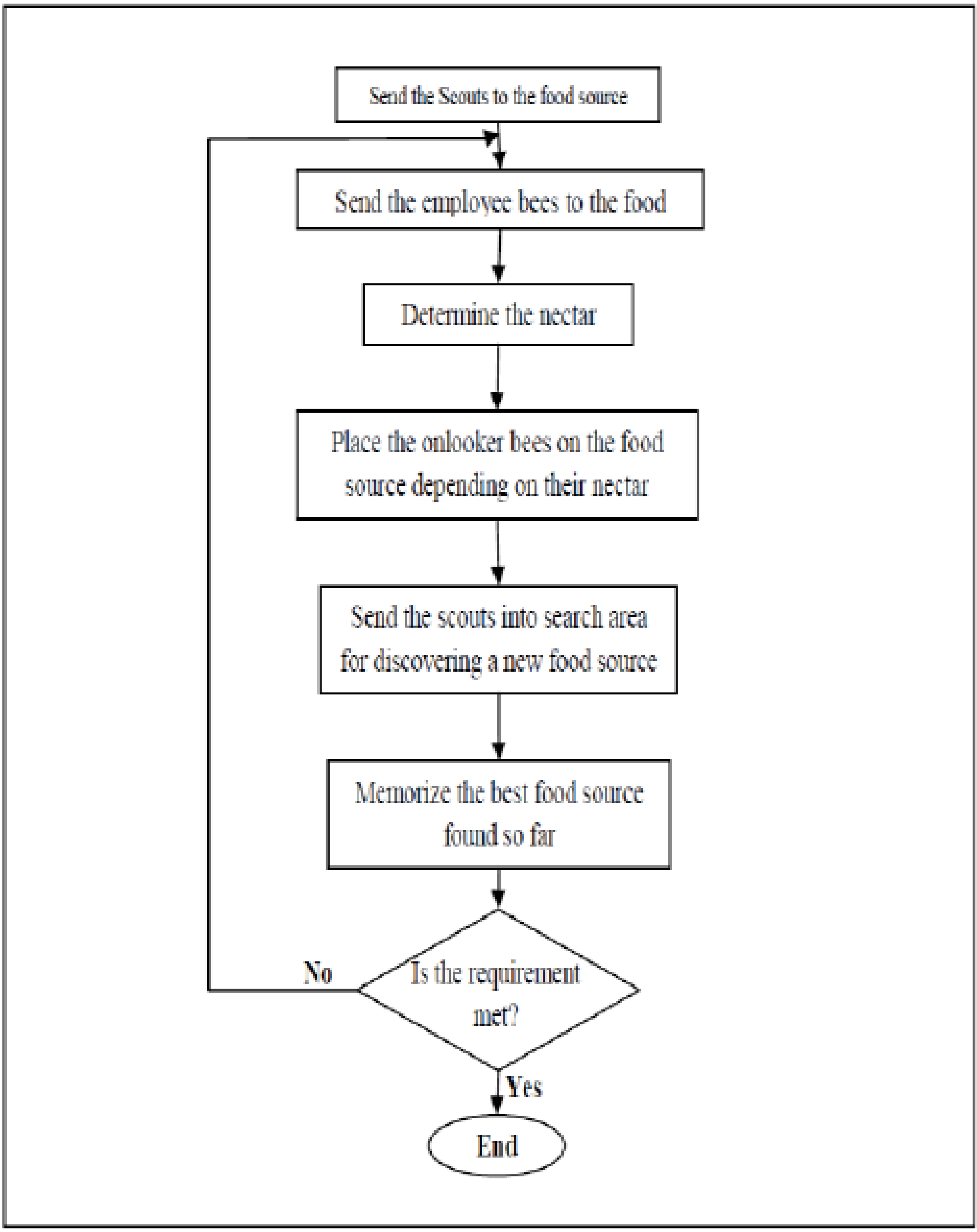
This section explains the BCO algorithm for TSP which is inspired by the foraging behaviour of bees. An overview of the proposed BCO algorithm integrated with FBPS and FRNN 2-opt is presented. Details on path construction and waggle dance by bees will also be presented. A. Overview of BCO with 2-opt The outline of the BCO algorithm is shown in Algorithm 1. In the algorithm, a group of bees is created during the initial stage. The number of bees, NBee, is equal to the total number of cities in the TSP problem instance. During the first iteration, as no dance is observed, bees use state transition heuristic and Nearest Neighbourhood heuristic to generate initial solutions. These two approaches share equal likelihood to be chosen by a bee. State transition heuristic is implemented such that a bee starts from a random city, and chooses the next city to visit by using the state transition rule discussed in Section II-B. Under the Nearest Neighbourhood heuristic, a bee starts from an arbitrary city and then chooses the nearest city to move ahead. Random selection is applied if there is a tie in distance.

Algorithm 1 BCO with 2-opt local search for TSP:

```
procedure BCO
global best tour length, T LBest ← ∞
Initialize Population()
while stop criteria are not fulfilled do
for each forager bee fi do
tour T ← {}
fi.Observe and Select Dance()
T ← fi.Forage ByTransRule()
if T is not pruned by FBPS then
T ← fi.Perform FRNN 2-Opt()
end if
if T.length < fi.best tour length then
fi.Perform Waggle Dance()
end if
if T.length < TLBest then
T LBest ← T.length
end if
end for
end while
end procedure BCO
```

For subsequent iterations, foraging process is initiated. A bee will decide if it needs to follow a dance before leaving the hive. After it completes a tour, the frequency-based pruning strategy (FBPS, refer Section III) will check if it needs a transformation by the fixed-radius near neighbour 2-opt (FRNN 2-opt, refer Section IV). The bee will start performing waggle dance if the resulting tour is shorter than its own personal best tour length. These steps will be repeated for a certain number of iterations until the stopping criteria are fulfilled. The differences between the proposed algorithm as given in Algorithm 1 and the one in [1] will be explained in Sections III-B and IV.

FLOW CHART:



CONCLUSION:

A BCO Algorithm with a pruning strategy has been proposed in this paper. It is combined with an efficient implementation of 2-opt adapted from. The experimental results show that the addition of both FBPS and FRNN 2-opt in the BCO algorithm is able to significantly improve its execution performance compared to the BCO algorithm proposed in. The proposed algorithm will ensure that only a set of promising solutions are locally optimized by FRNN 2-opt, and hence avoid performing an exhaustive 2-opt on each and every solution generated by bees. The algorithm will be tested on other larger benchmark problems (e.g. thousands or millions cities). To achieve this, a study to develop a parallel version of the algorithm will be conducted.

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