A Review on ANT Colony Optimization Technique to Solve Scheduling Problem

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Abstract

Ant Colony Optimization is a swarm intelligence approach that has turned out to be helpful in explaining a several classes of discrete and continuous optimization issues. One set, called scheduling issues, is critical both to scholastics and to experts. This paper describes how the present literature utilizes the ACO way to deal with take care of scheduling issues. An examination of the literature permits various reason that ACO is an immensely practical way to deal with scheduling problems. On the basis of the literature review, we were not just ready to infer certain rules for the usage of ACO calculations, additionally to decide conceivable bearings for future research.

Keywords— *ACO, Advanced ACO, Scheduling, ANT COLONY, Optimizations, Behaviour.*

I. INTRODUCTION

Ant Colony Optimization (ACO) is a higher level approach proposed by [1]. The conduct normal to all methodologies including ant-based calculations lies in the mimicry of the conduct utilized by ""genuine"" ants to locate the ideal way between their home and a food source. The prior utilization of ACO was to understand the outstanding NP-Hard Traveling Salesman Problem. In this issue, there is a graph in which every hub relates to a city, and the curves correspond to the distance between cities. The problem comprises of visiting minimum nodes as possible. The final aim should be minimization of the visits and length of the nodes.

This paper goes for exploring and arranging distributed reviews that utilization ACO to tackle scheduling issues, and it concentrates on the four established environment (single machine, parallel machine, flow shop and job shop). Various scheduling issues, for example, scheduling are excluded in the revision. What's more, this paper focuses just on uses of the ACO meta-heuristic all alone.

A. Scheduling of Task

Allocating task to user is a tedious task. Scheduling concepts contains almost infinity set of problems which has to solve by system before allocation.

Scheduling problems are divided into 3 main attributes:

1. The manufacturing environment: sets of system in which algorithm runs. For e.g. single machine, parallel machine environment.
2. Constraints: used to bind by certain specification and rule to be used in algorithm.
3. Objective function: They are several performance measures through which algorithm are evaluated.

By using these three function one can use the scheduling classification.

II. ANT COLONY OPTIMIZATION

ACO deals with the behavior of ANT species working together to collect food from one source to another. ANT leave pheromone in the path so that other ANT can follow another. This path considered as right path that will followed by another associated ant of the same colony. ACO algorithm applies to various problem solving and optimization problems. The movement of ant is shown in fig.1.

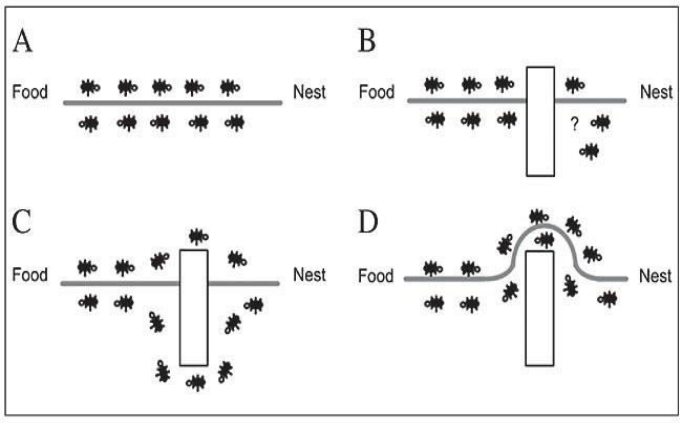

Fig.1. Ant Behavior

A. Application of ACO

ACO may be applied to various fields to solve problems. Some of them are presented in table 1.

TABLE 1: Various Application of ACO Algorithm

S.NO	Application Type	Application Name
1	Assignment	Quadratic Assignment
		Graph Coloring
		Frequency Assignment
2	Routing	Travelling Salesman
		Vehicle Routing
		Sequential Ordering
		Connection Oriented Network Routing
		Optical Network Routing
3	Scheduling	Project Scheduling
		Car Scheduling
4	Machine Learning	Classification Rules
		Bayesian Network
		Neural Network
		Fuzzy System
5	Subset	Set covering
		Multiple Knapsack
		Maximum Clique
6	Bioinformatics	Protein Folding
		DNA Sequencing

B. Advantages of ACO

i. Parallelism in execution of jobs.
ii. No Central control.
iii. Feedback mechanism for rapid discovery of solutions.
iv. Efficient for TSP (Travelling Salesman Problem) and TSP types of Problem.
v. Can be used in dynamic applications.

C. Disadvantages of ACO

i. Theoretically difficult to frame.
ii. Depended on decisions.

III. LITERATURE REVIEW

Various classification are described below to compare various ACO approaches over different attributes. The attributes are:

Attribute 1:
Base algorithm used in literature

Attribute 2:
Whether job uses absolute position to find source.

Attribute 3:
Whether position of job is depended on the previous sequenced job or not.

Attribute 4:
Whether algorithm uses some dominance criteria.

Attribute 5:
Pheromone initialization uses value Constant or Heuristic.

A. Applying Ant Colony Optimization to Solve the Single Machine Total Tardiness Problem

Bauer et al. [2] designed an algorithm for both approaches, using well-known dispatch rules such as Earliest Due Date (EDD) to determine the visibility values. The authors used the Adjacent Pairwise Interchange (API) and a 2-opt heuristic as a local search.

Attribute Number	Used
Attribute 1	ACO
Attribute 2	NO
Attribute 3	YES
Attribute 4	NO
Attribute 5	CONSTANT

B. Ant colony optimization for the total weighted tardiness problem

Den Besten et al. [3] approached the problem wi * ti. Their results showed that the ACO algorithm was able to obtain the best solution for all test instances. The local search algorithms used were an insert–interchange and an interchange–insert.

Attribute Number	Used
Attribute 1	ACO
Attribute 2	NO
Attribute 3	YES
Attribute 4	NO
Attribute 5	CONSTANT

C. Scheduling a single batch-processing machine with arbitrary job sizes and incompatible job families

Kashan and Karimi [4] approached the problem 1=batch, incompatible, Sij= P (wi * Ti) (minimize total weighted tardiness on a single machine environment with formation of processing batches where some tasks cannot be processed in the same batch as others with sequence-dependent setup times). In this paper, the authors proposed two ACO algorithms, each one having different visibility functions.

Attribute Number	Used
Attribute 1	ACO
Attribute 2	NO
Attribute 3	YES
Attribute 4	YES
Attribute 5	CONSTANT

D. An ACO approach for the parallel machines scheduling problem

The problem Pm || Tmax was approached by Gatica et al. [5]. The authors compared usage of four dispatch rules as a visibility rule (Earliest Due Date, EDD; Shortest Processing Time, SPT; Largest Processing Time, LPT; Least Slack, SLACK). These visibility rules were compared with each other and then with a genetic algorithm. To perform the comparison, four performance variables were used: (i) best percentage error of the best found solution; (ii) mean percentage error of the best found solution; (iii) mean objective value; and (iv) percentage of runs where the ACO found the best known value (named ‘‘hit ratio’’).

Attribute Number	Used
Attribute 1	MMAS
Attribute 2	NO
Attribute 3	YES
Attribute 4	NO
Attribute 5	CONSTANT

E. A fast ant-colony algorithm for single-machine scheduling to minimize the sum of weighted tardiness of jobs

Holthaus and Rajendran [6] used the Fast Ant Colony Optimization (FACO), which initializes the pheromone levels using a constructive heuristic. In this case, the problem characteristics were embedded in the pheromone matrix, allowing the visibility rule to have a constant value of Z. In this case, because the visibility rule did not need be calculated, the algorithm is faster to execute

Attribute Number	Used
Attribute 1	ACO
Attribute 2	YES
Attribute 3	NO
Attribute 4	NO
Attribute 5	HEURISTIC

The ants are driven by a probability rule to choose their solution to the problem, known as a tour. The probability rule between two nodes j, called Pseudo Random-Proportional Action Choice Rule, and it depends on two factors: the heuristic and met heuristic.

$$p_{ij} = \frac{\tau_{ij}]^{\alpha}[\eta_{ij}]^{\beta}}{\sum_{h \in s}[\tau_{ij}]^{\alpha}[\eta_{ij}]^{\beta}}$$

Where τ is the pheromone, η is the inverse of the distance between the two nodes.

IV. TOOLS USED

There are many tools available for executing and simulating ANT colony optimization algorithm. Various tools are described below.

a. ACOTSP: provide an implementation of ACO algorithms for the symmetric TSP under one common framework. The implementation is reasonably high performing.
b. Ant-Miner is GUI Ant-Miner is a tool for extracting classification rules from data. It is an updated version of a data mining algorithm called Ant-Miner (Ant Colony-based Data Miner)

V. CONCLUSION

This paper reviews some of the interesting paper which concerns with the use of ACO techniques. The ACO method can be used in various scheduling algorithm. The scope of this survey covers various attributes on which algorithm performs. The analysis verify that ant based algorithm are valid and optimized technique for scheduling jobs. The ACO algorithm effectively finds the scheduling criteria for the jobs based on

ANT colony. There still exists some intensive research which need to carry further for scheduling of high priority, large scale jobs.

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