IMPLEMENTATION OF EFFECTIVE BED ALLOCATION AND JOB SCHEDULING IN HOSPITALS USING ANT COLONY OPTIMIZATION

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Abstract:
In this work, Ant Colony Optimization (ACO) algorithm based applications have been developed and implemented for effective bed allocation system for patients and job scheduling system for employees of hospital. For the task of assigning beds to patients, constraints considered were total number of beds available, number of beds available unoccupied, number of days of patient admission in bed i.e. discharge details, nature of treatment to be provided, nature of lab that will be utilised for diagnostics, doctors invigilating the patient, etc. The task of job scheduling to employees includes inputs like employee background and details, number of employees of similar qualification in the duty period, inpatient details, location of the employee and his department, etc. The output of the algorithm developed for the above discussed systems keeping into consideration few of the mentioned constraints were satisfactory. The outputs were simulated for different distributions and number of nodes and the results obtained were highly optimized. Providing the constraints to the algorithm, the graphical output provides efficient results reducing the cost such as money, manpower, distance travelled, time etc in a probabilistic manner and when iterated for several times the error reduces to minimum and the output generated becomes constant. The simulation time consumed after providing the inputs were completely dependent on the number of nodes and its distribution. The time consumed for a complex distribution with lesser number of nodes was higher than that of the case with greater number of uniformly distributed nodes. The work has been extended to calculate the correlation coefficient between the number of nodes and number of iterations. The implementation can also be extended to other departments present in the hospital to bring them under a common platform with their own constraints and provide effective optimization techniques individually.

Keywords: Ant colony optimization, pheromone, bed allocation, job scheduling.

I INTRODUCTION

Ant colonies being distributed systems present a highly organized and structured social organization in spite of their simplicity. These insects uniting together perform huge load of tasks which would take years for individual ant to complete. From the study of the unity of the ants, came the optimization algorithm called Ant colony optimization (ACO), a probabilistic technique used for solving computational problems to find the minimal cost [1]. *Pheromone* is an important and special volatile chemical deposited by the travelling ants over the path [2]. After few trips from home to food source the ants get capable of analyzing the pheromone concentration and choosing the path with maximum concentration. The ant's memory allows them to retrace the path it has followed while searching for the destination node [3] [4]. It is this mechanism which enables ants to transport food to their nest effectively by travelling minimum distance. Artificial implementation of ACO is brought out by assuming that ants travel at a constant speed of one length per unit time, chooses nodes in probabilistic manner and deposits one unit of pheromone every time it travels on the path [5-7]. The algorithms multi-dimensional analysis capability provides with better solutions to applications in the field of finance, telecom and Web, sales and marketing, logistics, production or manufacturing, etc [8]. The applications that have been solved using ACO are travelling salesmen problem (TSP), budget allocation and resource planning, web-page classification and ranking, etc [9-12]. In the current work, TSP problem has been extended with alterations and manipulated to occupy the constraints of job scheduling and bed allocation tasks in hospitals [13]. The GUI based nodal input system has been developed in which the user will be able to input the nodes by clicking on the screen. For very huge number of nodes the user can also provide the file with details as input.

II METHODOLOGY

The ACO algorithm is programmed for implementation of patient bed allocation and job scheduling in hospitals [13]. Each of the application implementation is discussed in detail below.

A. PATIENT BED ALLOCATION

Patient bed allocation using ACO algorithm block diagram is as shown in figure 1. The program has been developed according to the ACO algorithm. The user provides the input and constraints for the program either manually or through a file. The inputs and constraints to be provided are total number of beds available unoccupied in different wards and the departments surrounding the wards. Following to it discharge details of the patients from different wards are provided which will be automatically updating the unoccupied beds available. Input also includes the nature of treatment to be taken, diagnostics and therapies to be underwent as prescribed by the doctor. Given all the inputs the program will provide the bed details which when allocated to that patient would optimize and comfort the patient during his stay in hospital minimizing the travelling time, manpower, cost etc. The result directly depends on the interlinking of the departments and laboratories present and the kind of treatment to be provided to the patient and hence there arises the influence of complexity of the constraints.

B. JOB SCHEDULING

In this task, a program has been developed for job scheduling in hospitals especially to nurses using ACO algorithm whose block diagram is as shown in figure 1. Once the user inputs are provided and processed iteratively, jobs will be scheduled to the nurses effectively. The number of nurse's available, complete details of their job schedule of each nurse initially and also the discharge details are obtained. The treatment procedure and hospitality to be provided to the patient are also gathered. Having these constraints fed as input to the program, the output provides the optimum results for scheduling the nurse.

III RESULTS AND DISCUSSION

The system implemented for bed allocation and job scheduling performs effective management of resources available to obtain maximum efficiency. The simulated output for input conditions which was practically noted from a hospital i.e. the distance between the resources present,

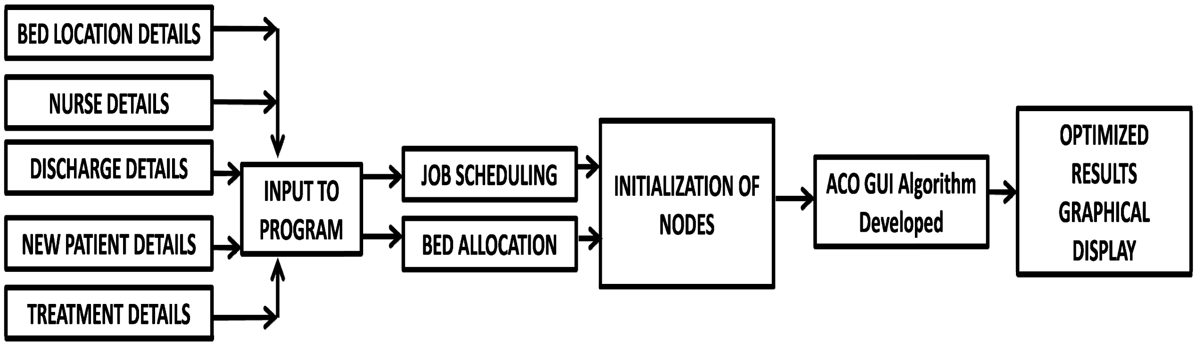
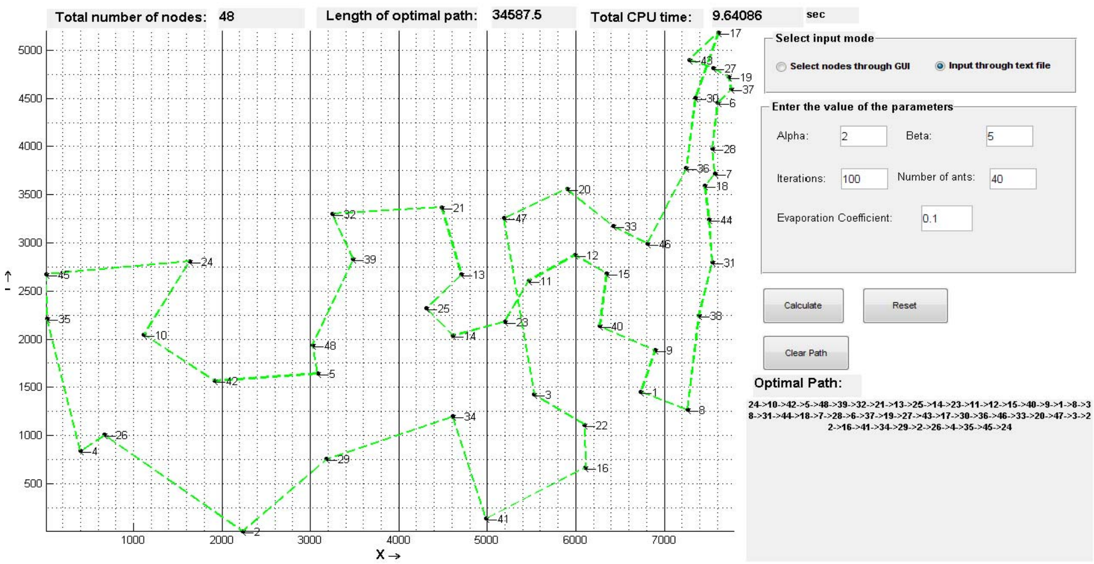


Fig.1. ACO implemented bed allocation and job scheduling block diagram.

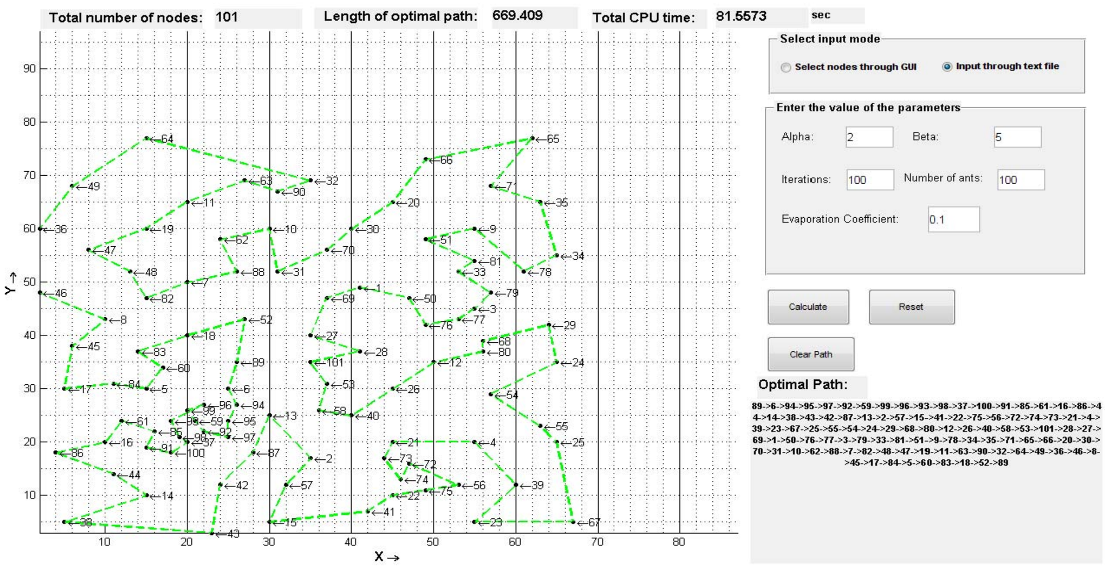
nature of patient and his history, treatment undertaken, etc are as shown in figure.2. The output provides the nodes with number in the order of preference for bed allocation of patient. Figure 2 (a) depicts graphically the result for 48 nodes, alpha parameter equal to 2 and beta parameter equal to 5. The number of iterations considered in this case is 100 and number of ants distributed was 40. Evaporation co-efficient were taken as 0.1. For the given input parameters and constraints, the optimal output and time taken for calculation is as shown in figure 2 (a). Figure 2 (b) is a simulation for alpha equal to 2, beta equal to 5, number of ants and iterations equal to 100 and evaporation coefficient is taken as 0.1. Both the output figures display the preference of nodes in descending order for efficient output in the right hand side. The same can be tried for job scheduling with its own respective conditional inputs. When limiting the alpha parameter value to that stated in the algorithm, the output efficiency was not as expected and hence was chosen on trial and error method to improve its efficiency. An algorithm is being developed for automatic fixation of the alpha parameter by learning the input parameters and constraints. The simulation time consumed after providing the inputs were completely dependent on the number of nodes and its distribution. The time consumed for a complex distribution with lesser number of nodes was higher than that of the case with greater number of uniformly distributed nodes. The correlation coefficient is being calculated between the number of nodes and number of iterations to define a relation between them. The number of constraints can be increased or decreased depending on the real time situation. For the bed allocation application, the inputs provided led to effective output that enhances the management of beds available to occupy maximum number of inpatients with at most comfort. ACO algorithm can also be extended to other hospital departments like that of food, pharmacy and laundry. It can also be implemented for effective doctor distribution for the most needful patients within their visiting time. When several departments and constraints are considered, the weights provided to each of them should be accordingly distributed and varied in the order of preference to obtain the results expected.

IV CONCLUSION

The input of the nodes for the program can be provided either from a text file or also through GUI developed by clicking. This technique helps the user to apply any kind of constraints to the program. The algorithm performs well for varying alpha and beta values and finally fixed by trial



(a)



(b)

Fig.2. (a) GUI Output for 48 nodes (b) GUI Output for 101 nodes.

and error method. As stated an algorithm is being developed for automated fixation of alpha and beta parameters by learning the constraints and inputs for effective optimization. Correlation coefficient is also being between the number of nodes and number of iterations that would produce optimum results thereby would help in defining a relationship between them. Memory property of ACO makes it perform better than other global optimization techniques. As it retains memory of the entire colony and not that of the previous iteration alone, it helps in improving the precision and accuracy of the optimization. Being complex systems, ACO algorithm behaviour is determined by many components like input parameters, macroscopic algorithm components (e.g., the form of the probabilistic rule used by ants to build solutions, or the type of pheromone update rule used, etc) and problem characteristics. Accuracy and precision is ensured by multi level iterations of the program. The time taken for the execution of the program and outputs obtained depends on the characteristics of the constraints provided.

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