SCHEDULING AND RESOURCE ALLOCATION FOR EMPLOYEES IN SOFTWARE PROJECTS

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Abstract – The need for computer-aided tools for Resource allocation and Task Scheduling in Software Industry is increasing. The proposed method uses both Ant Colony Optimization (ACO) and Event-Based Scheduler (EBS) to tackle both the problems in Project Planning. The underlying idea of ACO is that the ants deposit a special chemical called pheromone on the path they travel through while they search for food. The pheromone is the communication medium between the ants and by sensing the concentration of pheromone, others ants follow the path to find the food. The basic idea of the EBS is to make the allocation on event-basis. The proposed method is practical and flexible compared to the existing systems. The method allocates each employee with the best suited task. Hence the proposed method will be expected to bring a better result than already existing techniques.

Keyword: Ant Colony Optimization (ACO), Event Based scheduler (EBS), Software Project Management

I. INTRODUCTION

Planning plays a vital role in achieving the desired goal and the planning cycle merges all aspects of planning into a unified process. The purpose of Project Planning in software industry is to identify the scope of the project, create project schedule and based on schedule to estimate the work involved in the project. Project planning divides the activity into setting the objectives, identifying deliverables, planning the schedule, making supporting plans. Project Scheduling schedules when each activity should be done, what activity has been completed and the order in which things need to be finished. Schedules also provide a basis to monitor and control project activities. They help to determine how to allocate resources to achieve the project goal and how time delays will impact the project. It figures out where excess resources are available and it allocate to other projects and then they provide a basis to track project progress. Project Scheduling assists for efficient project plan, assigns time, provides dependencies among the task and keep track of project. Hence, in a software industry it is necessary to plan and schedule each and every project.

The software industry includes businesses for developing, maintaining and publication of software that are using different business models. In order to succeed in the market, a company should focus on minimising the cost and maximising the profit. Cost minimisation for a project can be attained by proper resource allocations which are mainly humans. Proper scheduling can also have an impact in cost minimisation of a project. Maximising the profit in software industry can be done by boosting the sales price of software products, minimising the production cost, using the available resources judiciously, completing the given task on time and satisfying the client needs. However, these two problems can be manually done by a Project Manager in the case of a small-scale project. But, nowadays most of the projects are medium to large-scale projects which makes it a complicated task for the Project Manager. There are traditional techniques for project management like Program Evaluation and Review Technique (PERT), Critical Path Method (CPM) and Resource Constrained Project Scheduling Problem (RCPSP). The PERT and CPM technique defines the significant activities in a project, develop relationships among activities, assigns time and decide cost for each activity but lack the consideration of resource allocation and scheduling models like RCPSP involves project scheduling subject to precedence and resource constraints.

II. PROBLEM DESCRIPTION

Software projects are people-intensive activity and require employees with different skills. Assigning employees to the best-fitted tasks and human resource allocation has become a crucial part in software project planning. Due to the importance and difficulty of software project planning, there is a growing need for developing effective computer
aided tools for software project planning in recent years. The existing techniques usually regard task scheduling and human resource allocation as two separated activities. The existing models also have the assumption that each employee can only be assigned to a single task at one time due to this project are not completed on time and lacks proper planning and scheduling in the project. This assumption reduces the flexibility of resource allocation in software project planning. The existing scheduling models has 3D matrix representation, which specifies the workload for each employee with time duration in completing the task but this matrix representation occupies a very large space. The problem of task pre-emption exists in the previous models. The existing system also suffers from the problem of allocating the same task for different group of employees in different periods. The Proposed model overcomes the problems in the existing models.

III. PROPOSED WORK

Project planning is part of project management, which is to use the schedules to plan and subsequently report progress within the project environment. The purpose of project planning is to identify the scope of the project, estimate the work involved, and create project schedule. Project planning begins with requirements that define the software to be developed. The project plan describes the tasks that will lead to completion of the project. In the proposed method a practical and effective approach for the task scheduling and human resource allocation problem in software project planning with an ant colony optimization (ACO) algorithm is developed. The underlying idea of ACO is the ants deposit a special chemical called pheromone on the path they travel through while they search for food. The pheromone is the communication medium between the ants and by sensing the concentration of pheromone, others ants follow the path to find the food. An ACO algorithm works by dispatching a group of artificial ants to build solutions to the problem iteratively. ACO algorithm is the repeated execution of three main procedures, Solution construction, Pheromone Management and Daemon actions.

The proposed method is characterized by two major features. First, a representation scheme composed of task list and a planned employee allocation matrix along with a novel event-based scheduler is developed. It enables the modeling of task preemption and resource conflict. Second, an ACO approach is proposed as it shows successful application to various combinatorial optimization problems. ACO builds solutions in a step-by-step manner which makes d ants to schedule the critical tasks as early as possible and to assign the project tasks to suitable employees with required skills. The proposed method effectively manages employees using an employee database and it describes the tasks using a Task Precedence Graph (TPG) which defines that a task can only start when all of its direct predecessor tasks have finished. Hence the planning objective in the proposed method is promising.

The proposed system will reduce overall project cost, resources are efficiently utilized in the project and a new method for solving the software project planning problem it will reduce the two basic problems in software project management that are task scheduling and employee allocation. It provides the clear idea for time scheduling and resource allocation and will reduce the manual effort. The proposed system use the resources efficiently and allowing the employers to complete the particular task in the given period of time. It provides the best solution for task scheduling and employee allocation problems in software project management process. Depending upon the employee skill set, allocating employee to certain task resource will allow the project to be completed on time. By calculating employees work time that is per hour salary for normal time and overtime the cost of the project can be minimized. The proposed system helps Project manager in allocating projects to Team leaders and in turn for Team leaders for allocation of task to team members. It helps allocate employee to work in overtimes to manage their tasks and the proposed algorithm manages to yield better plans with lower costs, more stable workload assignments reduces the size of the search space compared with other existing approaches.

IV. MODEL DESCRIPTION

The Proposed software project planning model addresses both the problems of human resource allocation and task scheduling.

To manage employees, an employee database is needed to record the employees’ information of skills, wages and working constraints. The problem of employee allocation is to assign employees to best fitted tasks so that the tasks can be done efficiently. Suppose m employees are involved in the project, for the ith employee (i ¼ 1; 2; . . . ; m) the following attributes are considered.
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. bs — The basic salary for the employee per time period (e.g., month).
. hs — The salary for the employee’s per-hour normal work.
. ohs — The salary for the employee’s per-hour overtime work.
. nh — Legal normal working hours per month.
. maxh — Maximum possible working hours per month of the employee for the project.
. [join, leave] — The time window when the employee is available for the project.

In a software project, tasks can be any activity involved in software construction, for example, class design, programming and testing. A commonly used technique for task description is the task precedence graph (TPG).

For a task \( tj \), the following attributes are considered.

- \( pmj \) — The estimated work effort of the task in person months. Several famous methods, for example, the COCOMO models, can be adopted for work effort estimation.
- \( SK_j \) — The set of skills required by the task.
- \( Maxhead_j \) — The maximum headcount for the task.

In application, as too many employees working on the same task will incur higher communication overhead and result in low efficiency, it is necessary to limit the number of employees for a task. According to [6], the maximum headcount can also be estimated based on the COCOMO model. Deadline — The deadline of the task. In practice, it is common to define deadlines for milestone tasks.

As the software project planning problem involves task scheduling and employee allocation, a plan for a project must specify when the tasks of the project are processed and how the workloads of employees are assigned to the tasks. The plan must satisfy the following constraints:

1. The processing order of tasks must obey the precedence constraint defined by the TPG.
2. The working hours of the \( i^{th} \) employee per month must not exceed the limit \( maxh_i \).
3. The number of employees assigned to a task \( tj \) is limited by the maximum headcount.

V. ALGORITHMS USED

A. Ant Colony Optimization Algorithm:

An ACO algorithm can be viewed as the interplay and the repeated execution of the following three main procedures:

- Solution construction
- 1. Construction of Task List
- 2. Construction of Employee Allocation Matrix
- Pheromone management
- Daemon actions

Solution construction — 1. Construction of Task List and 2. Employee Allocation Matrix takes place during the solution construction procedure. Group of ants set out to makeup solutions to the problem in each and every iteration of the algorithm. Each ant constructs a solution in a constructive manner by selecting components in a step by step manner to form a complete solution. The selections are based upon pheromone and heuristic information.

Pheromone management — Along with the solution construction procedure, pheromone values are updated according to the performance of the solutions built by ants. Ants lead to deposit more pheromone to the components of better-performed solutions.

Daemon actions — The centralized operations that cannot be done by single ants is termed as daemon actions. Local search procedure is the commonly seen daemon actions. Many existing ACO variants use various kinds of daemon actions to improve performance and it is optional to use daemon actions in ACO.

Construction of Task List: To build a task list, an ant has to determine an order of the tasks. In project planning problem, since one task can be assigned to several employees, one employee can undertake several tasks simultaneously, and skill proficiency is considered, it is more difficult to define related tasks for the relation-learning model. Therefore, we adopt the absolute position model with the summation rule in the proposed approach. The summation rule will be presented in detail in the construction procedure of the task list.

Estimate the shortest possible make span of each task. Based on the shortest possible make span of each task, the earliest start time and the latest start time of each task can be evaluated.
B. Event-Based Scheduling

A schedule is a listing of a project's milestones, activities, and deliverables, usually with intended start and finish dates. The proposed work combines the task list representation and the employee allocation matrix representation so that both the problems of task scheduling and human resource allocation are addressed.

The EBS is characterized by making new assignments at events. We regard the time t as an event if t satisfies any one of the following three conditions:

1) \( t = 1 \) is the beginning of the project
2) any employee joins or leaves the project at t or
3) any task just finished in the previous time period and the corresponding resources become released and available at t.

It is done in order to adjust the planned working hours to the actual working hours. The EBS adjusts a plan into an actual timetable by means of two rules. Initially, if there is resource conflict between two tasks, the task that appears early in the task list has a higher priority to use the resource. That is, assuming that the \( i^{th} \) employee is originally planned to simultaneously dedicate \( pwh_{ij} \) and \( pwh_{ik} \) of his working hours to \( t_j \) and \( t_k \), respectively, if \( pwh_{ij} + pwh_{ik} > maxh_i \), the employee will first dedicate his working hours to the task with a higher priority. Second, new workload assignments are only made when events occur. If no employees join or leave the project or no human resource is released by the tasks just finished, the workload assignments remain the same as the previous time period.

The employees are been expected to work more for the allocated projects so that cost for hiring extra employees are saved. Based on the employee working hours the salary determined.

If the employee completes the work before the allocated time then based on the skill the work assignments are rescheduled.

CONCLUSION

A novice method for solving the software project planning problem has been developed. Experimental results show that the representation scheme with the EBS is effective and the ACO manages to yield better plans with lower costs, complicated planning problems and more stable workload assignments compared with other existing approaches. In future research, it will be interesting to consider employee experience and the training model to make the considered problem more comprehensive.

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REFERENCES