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Survey paper for Software Project Scheduling And Staffing Problem

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Abstract: In software development effective project planning is essential. Failure to plan and/or poor management can cause delays and costs that, given timing and budget constraints, are often unacceptable, leading to business critical failures. Software development organizations often struggle to deliver projects on time, within budget and with the required quality. One possible cause of this problem is poor software project management and, in particular, inadequate project scheduling and ineffective team staffing. Software project scheduling problem (SPSP) is one of the important and challenging problems faced by the software project managers in the highly competitive software industry. As the problem is becoming hard with the increasing numbers of employees and tasks, only a few algorithms exist and the performance is still not satisfying. To develop a flexible and effective model for software project planning, in this paper we have tried to do the survey of several techniques and methodologies and results yielded are elaborated.

KEYWORDS: Software engineering, project management, software project resources, project scheduling, RCPSP, SPSP, ACO.

I. INTRODUCTION

Project management is an application of knowledge, skills, tools and technique to solve project scheduling problem. Research into developing effective computer aided techniques for planning software projects is important and challenging for software engineering. Different from projects in other fields, software project development is a human centric activity.[1] Software development organizations often struggle to deliver projects on time, within budget and with the required quality. One possible cause of this problem is poor software project management and, in particular, inadequate project scheduling and ineffective team staffing. [2] Staffing a software project is tedious activity. Manager is supposed to choose from the team of employees , there could be possibility of many combinations. [1]

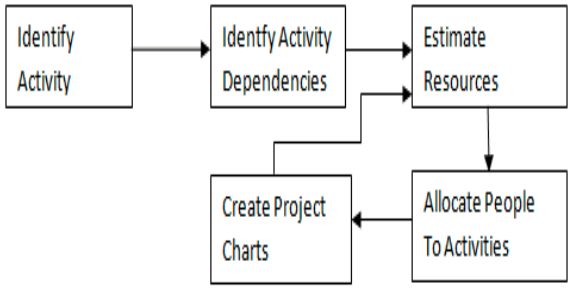

Fig. 1

Thus, employee allocation or staff scheduling is an important factor when software development is considered as a value-driven business.

II. PROJECT MANAGEMENT COMPONENTS

A. Resources

Each activity requires some resources for its processing. Examples of resources are: machines and tools, human and their skills, raw materials and semi-finished products, natural resources (energy, water, land, etc.), information, money etc.

B. Activities

Usually each activity is characterized by: resource requirements, processing model, and precedence constraints with other activities, but other parameters can occur in the problem formulation as well.

C. Objectives

Motivated by real-world situations, a wide variety of objectives for project scheduling have been studied in the literature. Let us just mention that from among all of them, some objectives may be related to time, as they concern temporary usage of renewable and doubly constrained resources, whereas others – to cost, as they deal with consumption of nonrenewable and doubly constrained resources. These two kinds usually represent conflicting objectives, since shortening the processing time results in increasing the resource consumption, and vice versa – decreasing the execution cost (in terms of the resources consumed) lengthens the project duration.

D. Schedules

A schedule is defined by a sequence of activity start (completion) times, but it is insufficient for problems where activities can be executed in multiple modes. Thus, in these cases additional information about processing modes is necessary. A schedule is time-feasible if it satisfies all precedence and time constraints defined for the project, and resource-feasible if all resource constraints are met. A schedule is said to be feasible if it is both time- and resource-feasible. An optimal schedule is a feasible schedule for which a given performance measure is optimized.

E. Stake holders

Every project has stakeholders. Stakeholders are people who have an interest in the successful completion of the project. There are many different types of stakeholders, and the stakeholders vary by project. But the important thing to remember is that the stakeholders should have

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some part in defining the project objectives, since they are the people who will be affected by the outcome. When defining project stakeholders, the project manager and members of her or his team should carefully think through who will be the end users of the product, whether it be services or goods, and whether the product will have a positive effect, and how it is likely to be received. Some of the stake holders are Customers/clients, Sponsors, Company, Team members and the Project Manager.

III. PROBLEMS FACED IN PROJECT MANAGEMENT

A. RCPSP- Resource Constrained Project Scheduling Problem

In its most general form, RCPSP asks the following:
Given a set of activities, a set of resources, and a measurement of performance, what is the best way to assign the resources to the activities such that the performance is maximized? what is the best way to assign the resources to the activities at specific times such that all of the constraints are satisfied and the best objective measures are produced?

RCPSP can be defined as follows:

- a set of activities that must be executed
- a set of resources with which to perform the activities,
- a set of constraints which must be satisfied
- a set of objectives with which must be achieved [1]

In order to accurately model the uncertainty common in real problems, the general formulation includes the following dynamic characteristics:

- resource availabilities may change
- resource requirements may change
- objectives may change [2]

B. SOFTWARE PROJECT SCHEDULING PROBLEM (SPSP)

SPSP is a problem of finding an optimal schedule for a software project so that the precedence and resource constraints are satisfied and the final project cost consisting of personal salaries and project duration is minimized. In addition to considering the salaries and skills of employees, SPSP also takes workload and required skills of each task into account, so SPSP is suitable and capable to describe the real software project scheduling.

Although SPSP is close to RCPSP, there are a few differences between SPSP and RCPSP. First, there is one more objective (i.e., cost associated with the employees) to be optimized in SPSP in addition to the project duration minimization objective in RCPSP. Second, employees with several possible skills are the major resource in SPSP while there are several kinds of resources in RCPSP.[3][1]

SPSP is related to the resource-constrained project scheduling problem (RCPSP) which aims to find an optimal schedule that meets the precedence and resource requirements while minimizing the project duration.

IV. METHODOLOGIES FOR SOLVING SPSP

A. GENETIC ALGORITHMS

A genetic algorithm is one of the stochastic search methods and it has been successfully applied in many search, optimization, and machine learning problems. Optimized scheduling problems can be solved using GAs.[7]
Based on simplifications of natural evolutionary processes, genetic algorithms operate on a population of solutions rather than a single solution and employ heuristics such as selection, crossover, and mutation to evolve better solutions.

GAs maintain a population on a certain size. Each individual, which represents a tentative solution to problem, is competitively manipulated by applying some variation operators to find a global optimum.[3] To achieve the goal of finding a global optimum the problem variables are encoded into what are called the chromosomes. Thus, one individual is associated with not only one encoded solution(chromosome) but also its associated fitness corresponding to the solution. GAs improve the individual fitness, which means the optimization level of solution, by using kinds of competitive operations. And with the increase of generation quality, fitness of chromosomes is becoming better. [7]
In the application of GA to SPSP problems there two essential tasks

- Encoding-The solution to SPSP problem is represented by negative matrix.
- Fitness function- The next expression is used to compute the fitness of solution

B. ANT COLONY OPTIMIZATION

Different from the GA and TS approaches developed in the existing studies, another attention grabbing is an ACO approach. It can be applied to various combinatorial Optimization Problems. ACO algorithms make use of simple agents called *ants* which iteratively construct candidate solutions to a combinatorial optimization problem. The ants' solution construction is guided by (artificial) pheromone trails and problem-dependent heuristic information. In principle, ACO algorithms can be applied to any combinatorial optimization problem by defining *solution components* which the ants use to iteratively construct candidate solutions and on which they may deposit pheromone. An individual ant constructs candidate solutions by starting with an empty solution and then iteratively adding solution components until a complete candidate solution is generated.[8]

V. PREEMPTABILITY

In many models of project scheduling problems it is assumed that activities are non preemptable, but in some projects this assumption is relaxed and it is allowed to preempt activities. In general, each of the project activities may be either preemptable or non preemptable. However, usually it is assumed that (non) Preemptibility concerns all activities at once. Under this assumption, we talk about a set of non preemptable activities if none of them may be

preempted, whereas we talk about a set of preemptable activities if each activity can be preempted at any time and restarted later with no cost. Preemption may be either discrete, if activity preemption is allowed at the end of time periods only, or continuous, if preemption may occur at an arbitrary time instant.[4][8]

VI. CONCLUSION

Software development involves time, talent, and money. In a competitive market, a software development organization's major goal is to maximize value creation for a given investment. Therefore, a proper usage of every available resource in a software project is very important. Although SPSP is close to RCPSP, there are a few differences between SPSP and RCPSP. First, there is few more objectives

1. Cost associated with the employees to be optimized in the project duration minimization objective in RCPSP.
2. Employees with several possible skills are the major resource in SPSP while there are several kinds of resources in RCPSP.

- Among several methodologies ACO sounds better as it builds solutions in a step-by-step and iterative manner enabling the use of problem-based heuristics to guide the search direction of ants, it is possible to design useful heuristics to direct the ants to schedule the critical tasks as early as possible and to assign the project tasks to suitable employees with required skills.
- This review of various techniques will be helpful for better study and inventing new ideas for even better scheduling techniques.

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