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Review of Ant Colony Optimization for Software Project Scheduling and Staffing with an Event Based Scheduler

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Abstract-Software project scheduling is one of the most important scheduling areas faced by software project management team. For a successful project, both software engineering and software management are very necessary. To complete the software project within a specified time limit, allocate a start and end date that determine the milestones and outcomes of the tasks and, determine which tasks depend on another task to complete its operation. It does the task of save time, build consistency, enhance visibility scheduling is very essential. There are several software project management resources and schedule estimation methods have been developed. Here, represents review of some of these software project scheduling techniques which are used recently and are helpful in handling the various type of scheduling used in software projects.

Keywords: Ant colony optimization, discrete optimization, Hybridization, Project Scheduling, Event based scheduler

I. INTRODUCTION

A. *Software*

Organized information in the form of operating systems, utilities, programs and applications that enable computers to work. Software consists of carefully organized instructions and code written by programmers in any of various special computer languages. Software is divided commonly into two main categories:

- System software: controls the basic (and invisible to user) functions of a computer and comes usually pre installed with the machine.
- Application software: handles multitude of common and specialized tasks a user wants to perform, such as accounting, communicating, data processing, word processing.

1. *Software delivery:*

Software delivery is all of the activities that make a software system available for use.

The general deployment process consists of several interrelated activities with possible transitions between them. Therefore, "delivery" should be interpreted as a general process that has to be customized according to specific requirements or characteristics.

2. *Software Delivery activities:*

The release activity follows from the completed development process. It includes all the operations to prepare a system for assembly and transfer to the customer site. Therefore, it must determine the resources required to operate at the customer site and collect information for carrying out subsequent activities of deployment process.

Install and activate

Activation is the activity of starting up the executable component of software. For simple system, it involves establishing some form of command for execution. For complex system, it should make all the supporting systems ready to use.

Deactivate

Deactivation is the inverse of activation, and refers to shutting down any executing components of a system.

Adapt

The adaptation activity is also a process to modify a software system that has been previously installed. It differs from updating in that adaptations are initiated by local events such as changing the environment of customer site, while updating is mostly started from remote software producer.

Update

The update process replaces an earlier version of all or part of a software system with a newer release.

Built-In

Mechanisms for installing updates are built into some software systems. Automation of these update processes ranges from fully automatic to user initiated and controlled. Other software products provide query mechanisms for determining when updates are available.

Version tracking

Version tracking systems help the user find and install updates to software systems installed on PCs and local networks.

3. *Applications of software delivery:*

Corporate system

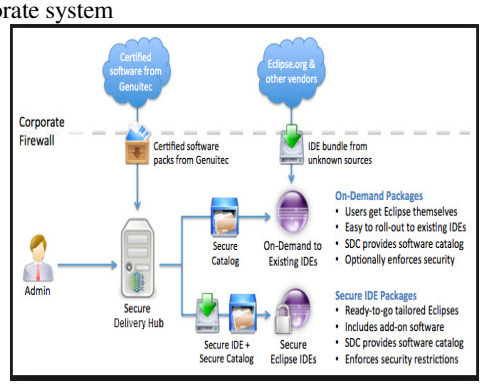

Fig 1: corporate working system

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As IT systems become an important competitive element in many industries, technology projects are getting larger, touching more parts of the organization, and posing a risk to the company if something goes wrong. Unfortunately, things often do go wrong. Software projects run the highest risk of cost and schedule overruns. After comparing budgets, schedules, and predicted performance benefits with the actual costs and results, also found that the longer a project is scheduled to last, the more likely it is that it will run over time and budget, with every additional year spent on the project increasing cost overruns by more percent.

Health care system

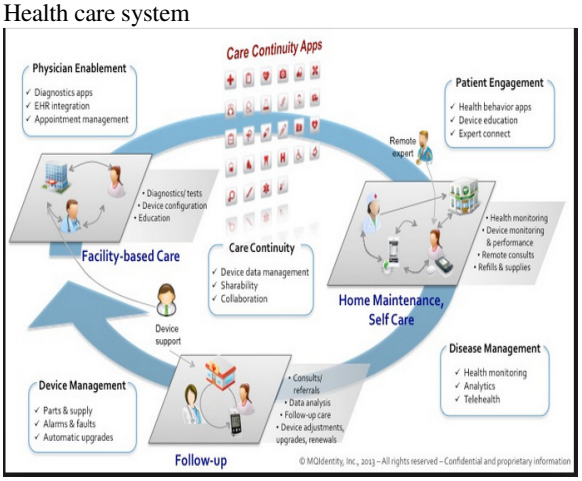

Fig 2: health care working system

In a digital healthcare system, providers can have the information they need right at the point of care. Computer algorithms can catch mistakes and prompt to ensure consideration of latest scientific developments. Public health officials can be alerted nearly immediately of unusual patterns that might indicate a natural or biotech error infectious outbreak, or to catch the next before tens of thousands are put at risk. Researchers would have vast new databases to learn more about what works.

Software Implementation by GE Healthcare IT Services gives you the project management, workflow design, and application training you need to get up and running smoothly. Strengthened by our implementation specialists and equipped with the latest communication tools, our teams have successfully delivered thousands of projects with impressive results:

Low adoption, project mismanagement, poor communication, and lack of strategic vision are only a few of the factors that could account for statistics indicating that 50 percent of all healthcare software implementations are unsuccessful1. Be among those whose software implementation is seamlessly executed as a result of a balanced approach with equal parts technology, process, and people. Gain high adoption right from the start with the help of Implementation specialists.

SAAS- Software as a service system

Fig 3: Stages of SAAS system

Software as a service sometimes referred to as "on-demand software" supplied by ISVs or "Application-Service-Providers" (ASPs), is a software delivery mode in which software and associated data are centrally hosted on the cloud. SaaS is typically accessed by users using a thin client via a web browser. SaaS has become a common delivery model for many business applications, including Office & Messaging software, DBMS software, Management software, CAD software, Development software, Gamification, Virtualization, accounting, collaboration, customer relationship management, management information systems(MIS),enterprise resource planning (ERP), invoicing, human resource management (HRM), content management (CM) and service desk management. SaaS has been incorporated into the strategy of all leading enterprise software companies. One of the biggest selling points for these companies is the potential to reduce IT support costs by outsourcing hardware and software maintenance and support to the SaaS provider.

4. *Reasons for Late Software Delivery:*

- An unrealistic deadline established by someone outside the software engineering group and forced on managers and practitioners within the group
- Technical difficulties that could not have been fore seen in advance.
- Human difficulties that could not have been fore seen in advance.
- Miscommunication among project staff that results in delays
- A failure by project management to recognize that the project is falling behind schedule and a lack of action to correct the problem

The need for project scheduling:

- Project scheduling provides a basis for software delivery to monitor and control project activities.
- They help us to determine how best to allocate resources so you can achieve the project goal.
- They help us to assess how time delays will impact the project.
- We can figure out where excess resources are available to allocate to other projects.

II.PROJECT SCHEDULING

On large projects, hundreds of small tasks must occur to accomplish a larger goal

- Some of these tasks lie outside the mainstream and may be completed without worry of impacting on the project completion date
- Other tasks lie on the critical path; if these tasks fall behind schedule, the completion date of the entire project is put into jeopardy

A .*For scheduling of project we use Event based scheduler.*

```
procedure scheduler //EBS
01  initialize the number of available human resources during the whole scheduling window;
02  set the beginning time and the time when employees join or leave the project as events;
03  t = 1;
04  while the project is not finished
05      if t is an event
06          find the tasks that can be implemented at time t and arrange these tasks into a sequence seq
              according to the order defined by the task list;
07          while seq is not empty
08              set t_j as the first task in seq and remove t_j from seq;
09              for i=1 to m //for every employee
10                  if the planned working hours pwh_ij is not larger than the remaining available working
                      hours of the i-th employee at t
11                      wh_ij' = pwh_ij;
12                  else
13                      wh_ij' is set to the remaining available working hours of the i-th employee at t;
14                  end if-else
15              end for
16          end while
17          (local refinement: let regular employees devote all of their normal working hours to the project.)
18      else
19          the workload assignments are the same as those at t-1;
20      end if-else
21      evaluate the completion situation of the tasks at time t;
22      if there are any tasks finished at time t
23          set the time t+1 as an event;
24          (local refinement: release redundant working hours of employees.)
25      end if
26      t = t+1;
27  end while
end procedure
```

Fig 4: Event Based Scheduler Algorithm

B. *Why ant colony optimization in project scheduling?*

1. In 3d Genetic algorithm method allows tasks preemption and schedules the workloads period by period based on 3d employee allocation matrix... Such a plan is actually unstable and impractical for real world software projects.
2. In Travel salesmen problem method it is designed for the multi skill scheduling problem. The models of these studies do not allow task preemption and usually assume that an employee can only be assigned to a task at one time.
3. So Ant colony optimization along with Event Based scheduling, the plans generated seem to be more flexible and practical. When task is finished and its related resources are released, these resources can be assigning to other tasks immediately. So we better prefer Ant colony optimization in project scheduling

III. ANT COLONY OPTIMIZATION

Ant colony optimization (ACO) is a population-based Meta heuristic that can be used to find approximate solutions to difficult optimization problems.

A. *Basic ant colony optimization algorithm*

The principle of ant colony system algorithm is that a special chemical trail (pheromone) is left on the ground during their trips, which guides the other ants towards the target solution. More pheromone is left when more ants go through the trip, which improved the probability of other's ants choosing this trip. Furthermore, this chemical trail (pheromone) has a decreasing action over time because of evaporation of trail. In addition, the quantity left by ants depends on the number of ants using this trail. Fig.6 presents a decision-making process of ants choosing their trips.

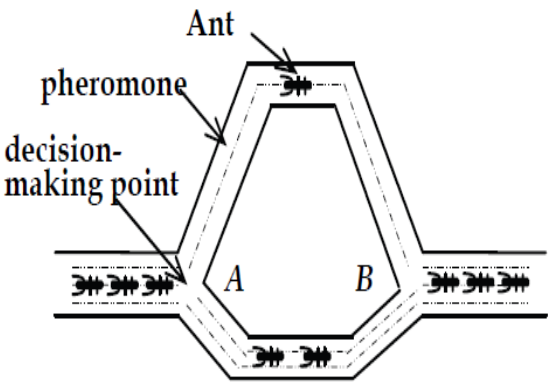

Fig. 6. A decision-making process of ants choosing their trips according to pheromone.

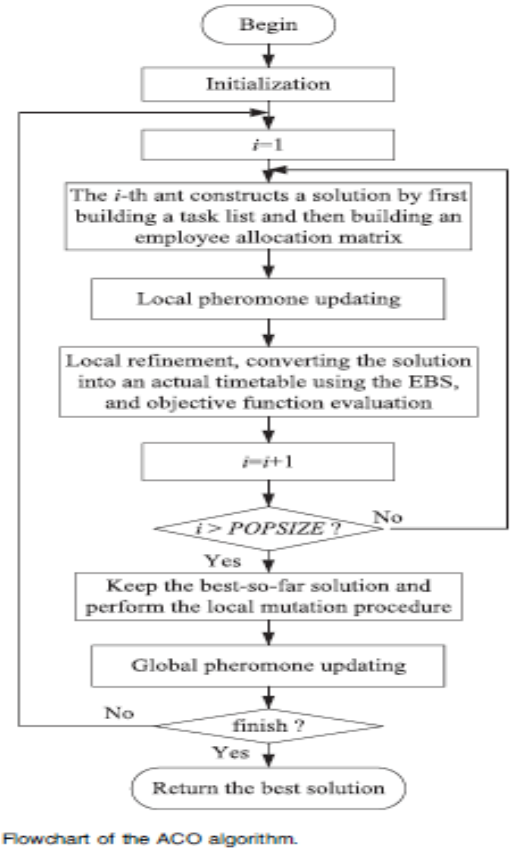

Fig 7: Flowchart

IV. A REVIEW OF ANT COLONY OPTIMIZATION ALGORITHM AND VARIOUS SOFTWARE PROJECT SCHEDULING TECHNIQUES

Table 1: A Review Of Ant Colony Optimization Algorithm And Various Software Project Scheduling Techniques

Sl. No	Paper name	Technique used	Advantages	Disadvantages	Results/Conclusion
1.	A Hybrid approach for software project scheduling.	1.Event based scheduling 2. Ant colony optimization algorithm	1.Eliminates the difficulty in staff scheduling 2. Allocates the no of employees to the task. 3.Snap scheduling for employee allocation where employee can work only in working days, (days matter)	Inefficient resources in software development performance.	[1] This method provides scheduling also allocation of resources. It assigns the project task to suitable employees with required skills.
2.	A Review Of Various Software Project Scheduling Techniques	1.project scheduling 2.multi agent real time scheduling systems 3.operation research and dynamics project scheduling	1. Comparision of various type of scheduling techniques which are used in software projects. 2. Handle uncertainty and also provides analysis to manage and represents many sources of uncertainty in project planning.	schedule constraint	[2] To complete the software project within a specified time limit, allocate a start and end date that determines the milestones and outcomes of the tasks, Review of some of these project scheduling techniques which are used recently and are helpful in handling the various type of scheduling used in software projects.
3.	Meta-Heuristic Algorithm based on Ant Colony Optimization Algorithm and Project Scheduling Problem (PSP) for the Traveling Salesman Problem	Ant colony optimization algorithm for travelling salesman problem	1. ACO algorithm produce redundant states in earlier steps, but if we combine ACO with project scheduling problem (PSP) adding cost effort functions. 2.ACO algorithm is better in minimizing the time and effort costs to enhance the behavior of the individual systems.. 3. This method	Time and efficiency is not effective.	[3] Every project has a set of activities involving a target and set of restrictions. Each activity has a set of restricted resources and an assigned cost. So the PSP(Project scheduling problem) is a generic name given to a whole class of problems in which it is necessary scheduling of optimum way the time, cost and resource of project.

			has a better performance.		
4.	An Ant Colony Optimization algorithm for Flexible Job shop scheduling problem	ACO for flexible job shop scheduling	1.The ACO for solving FJSP for minimum makespan time criterion 2.Capable of finding the optimal or near optimal solutions 3.ACO can be easily adapted to generated scheduler for any scheduling objectives of FJSP	Termination criterion used for ACO requires a more iteration hence leads to consumption of more time than total time.	[4] Job shop scheduling problems provides important insights into the solutions of the scheduling problems encountered in more realistic and complicated systems. Here improving machine utilization is reducing lead time.
5.	Review of Solving Software Project Scheduling Problem with Ant Colony Optimization	1.Ant colony optimization 2. Genetic algorithm	1. Manual calculations of time complexity is difficult so this problem is solved by using meta heuristic approach. This approach is solved by using GA and ACO. 2.ACO is better than GA i.e. the average hit rate and project duration of ACO solution is always better than GA 3.SPSP is effective and promising in the following aspects.	Its time complexity is very high.	[5] Here using 2 algorithms for this model SPSP splits the task and distribute dedication of employees to task nodes.(GA) Genetic algorithms used to solve such problems and ACO for solving SPSP problems. Later results of this are compared with GA to solve SPSP.
6.	The use of Search-Based Optimization Techniques to Schedule and Staff Software Projects: an Approach and an Empirical Study	1.search-based optimization techniques 2.queuing simulation model	1.an iterative procedure that searches for the best solution of a given Problem among a population having a constant or variable size. 2.search-based techniques can be used to address problems of staffing level adjustment, allocation of	1. The presence of interdependent overlapping requires some extra joint work	[6] It shows how search-based optimization techniques can be combined with a queuing simulation model to address NP hard problems**.** The obtained staff and task allocations aim to minimize the completion time and reduce schedule fragmentation

			staff to teams, reduction of project fragmentation and team composition based on different programmer expertise and required knowledge.		
7.	Classification Rule Discovery with Ant Colony Optimization	1.Decision tree induction 2.Ant colony optimization	1.Ant-Mer produces a higher accuracy rate and fewer rules than decision-tree induction 2.pheromone update rule which can cause future ants to make better decisions	1.NO improvement time Efficiency. 2.Detailed experimentation is needed to determine the effects of parameters, and develop an understanding of methods to set the parameters appropriately for particular learning problems.	[7] Applying ACO to data mining classification problems, where they introduced a Classification algorithm called Ant_Miner. In this paper, we Present an improvement to Ant_Miner The proposed version was tested on two standard problems and performed better than the original Ant_Miner algorithm.
8	Antcolony optimization: Introduction and recent trends	1.discrete optimization 2.Hybridizing ACO with beam search 3. ACO and constraint programming	1.reduction of the search space that has to be explored by ACO. 2.useful when large scale problem instances are considered 3.we outlined the general framework of the ACO meta heuristic and presented some of the most successful ACO variants today	Detailed experimentation is needed to determine the effects of parameters	[8] we outline ant colony optimization in more general terms in the context of discrete optimization, and present some of the nowadays best performing ant colony optimization variants. After summarizing some important theoretical results, we demonstrate how ant colony Optimization can be applied to continuous optimization problems. Finally, we provide examples of an interesting recent research Direction: The hybridization with more classical techniques from artificial intelligence and operations research.
9.	ACO Algorithms for the Traveling Salesman Problems	1.local search for the TSP 2.MAX-MIN Ant System	1. able to improve the best known solutions for many benchmark instances.	this is a very Expensive operation if large TSP instances should be solved.	[9]The ACO algorithm, called Ant System (AS), has been applied to the Traveling Salesman Problem (TSP). Starting from Ant System, several improvements of the basic algorithm have been proposed Typically, these improved algorithms have been tested again on the TSP. All these improved versions of AS have in common a stronger

					exploitation of the best solutions found to direct the ants' search process.
10.	Ant Colony Optimization for Project Scheduling and Staffing with an Event-Based Scheduler	1.Event based scheduler 2.Ant colony optimization algorithms	1. Event based scheduler which helps in scheduling tasks in proper manner, EBS is effective. 2. ACO to solve the complicated planning problem	There should be Research into considering employee experience and training model to make the considered problem more comprehensive.	[10] To develop flexible and effective model for software project planning, we use (EBS). This approach represents a plan by a task list and a planned employees allocation matrix.EBS, the beginning time, finished time, when employees join or leave the project are regarded as events and keep the allocation unchanged at non events.

V. CONCLUSION

The better method among these is Ant colony optimization for Project scheduling and staffing with Event Based Scheduler. The difficulty in staff scheduling is taken into consideration and so the Ant Colony Optimization technique can be enhanced to solve the problem. The application satisfies the requirements by applying the algorithm for given POP size and global pheromone update count with given number of employees and tasks. The employee count and task count are given different values and the result is derived. They can be viewed for various analysis purposes. Disadvantage of the best method is ACO algorithm method cannot be applied to multiple projects with same employee count. But it can be overcome by designing new system such that those enhancements can be integrated with current modules easily with less integration work.

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