International Journal of Advanced Research and Development
ISSN: 2455-4030
Impact Factor: RJIF 5.24
www.advancedjournal.com
Volume 3; Issue 1; January 2018; Page No. 214-217

Software project scheduling using ant colony optimization

Mandeep Kaur
Assistant Professor, Department of Computer Science, Khalsa College for Women, Civil Lines, Ludhiana, Punjab, India

Abstract
The size and complexity of software has increased with time. It has become important to efficiently schedule the different tasks of a project so as to deliver good quality software within the end user's budget and specified time limit. Software project planning deals with project task scheduling and human resource allocation. The scheduling parameters can be optimized by various optimizing techniques in order to get efficient schedules. Ant Colony Optimization is based on the natural behavior of ants to find the shortest path from nest to food source. Ant Colony Optimization is meta-heuristics technique used to obtain better schedules. This paper presents a survey on the use of ant colony optimization for software project scheduling. The literature survey suggests that many researchers have used ACO for software project scheduling and have obtained better results as compared to other techniques.

Keywords: software project management, software project scheduling, ant colony optimization (ACO), event based scheduling (EBS), resource constrained project scheduling problem (RCPSP)

1. Introduction
Software development activities consist of requirement gathering, analysis, design, coding, testing and maintenance which need to be carried out for specified amount of time to deliver a good quality, reliable, easy to use software to the end user within the specified budget. To ensure the development of software on time it is essential to plan, monitor and control the software development procedure. In recent years, many nature-inspired, meta-heuristic techniques have been used to optimize the parameters of given problem in order to obtain better results. Ant Colony Optimization is swarm intelligent technique that has been widely used in the field of software project scheduling. This paper presents a review of literature on the use of ACO for software project scheduling.

2. Software project management
Software project management consists of satisfying the user requirements by delivering quality software within the budget. Software project manager act a project leader, manages the human resources, defines and sets the project scope, monitors and controls the development of software [1]. Software project management focuses on four P's [2]: people, project, process and product.

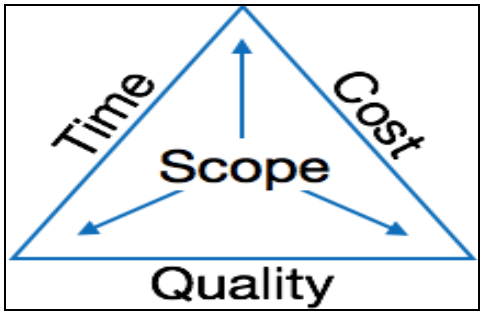

Fig 1: Constraints for Software Project (source: https://www.tutorialspoint.com/software_engineering/software_project_management.htm)

2.1 Software project scheduling
Software project scheduling is the distribution of estimated effort across the different tasks of a software project which need to be completed within specified time limit. The process of software project scheduling consists of the following phases [4, 5]:

1. **Defining Activities:** The software project is divided into smaller modules. A Work Breakdown Structure (WBS) can be used to map out the tasks required to complete the software project.
2. **Dependency Determination:** This phase consists of defining the interdependencies amongst the various tasks.
3. **Estimation:** Time and effort required for each task is estimated.
4. **Resource Allocation:** Once the tasks are defined, other resources required to complete these tasks are allocated.
5. **Project Charts:** It consists of creation of activity charts and bar charts.

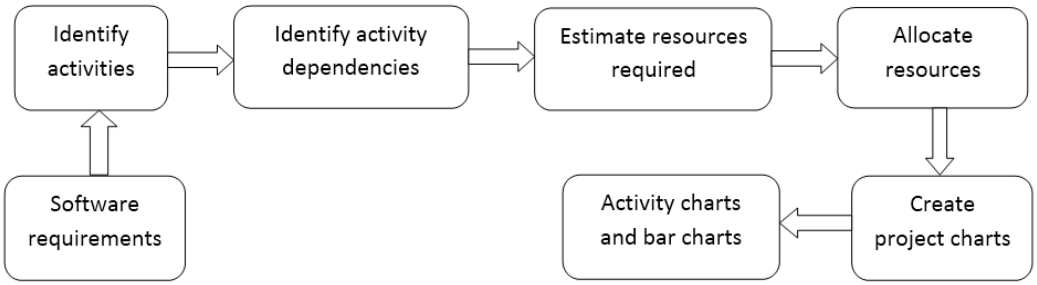

Fig 2: Software Project Scheduling Process

2.2 Project scheduling problems

1. Estimating the difficulty of problems and hence the cost of developing a solution is hard
2. Productivity is not proportional to the number of people working on a task. Sometimes the increase in the number of people working on a task increases the overhead.
3. The unexpected always happens.

There exist many software project scheduling techniques that help in scheduling the activities of software development. The schedules need to be accurate to insure timely delivery of software.

3. Ant Colony Optimization

Ant Colony Optimization was introduced to solve travelling salesman problem by Marco Dorigo *et al*. in 1992 [6, 7]. It is a nature inspired swarm intelligent technique which is based on the behavior of ants which are in search of shortest path from their nest to food source. Every ant leaves a pheromone trail from food source to their nest and vice versa. This pheromone trail has a property of quick evaporation so this pheromone trail does not stay for much time on longer paths. On the contrary it exists for much time on shortest paths. The other ants are attracted to this trail and hence the paths which are shorter are followed by more ants making it as the best path.

3.1 Ant Colony Optimization Algorithm

Start
Initialize
While end criteria is not met do
Initialize each ant to starting node

Repeat for each ant **do**
Select next node by applying transition rule
Apply pheromone update

end for

Until each ant has a local solution
Select best solution, update as global solution
end while

end

3.2 Advantages of Ant Colony Optimization

1. Inherent parallelism,
2. Positive Feedback accounts for rapid discovery of good solutions,
3. Can be used in dynamic applications (adapts to changes such as new distances, etc.),
4. Efficient for travelling salesman and other related problems.

3.3 Disadvantages of ant colony optimization

1. Theoretical analysis is difficult,
2. Sequences of random decisions (not independent),
3. Probability distribution changes by iteration,
4. Research is experimental rather than theoretical,
5. Time to convergence is uncertain.

This natural phenomenon of ants is used to optimize the parameters in software project scheduling. The next section consists of a review of literature where ant colony optimization has been used for software project scheduling.

4. Literature Review

[8] Sharma A. *et al*. used an Event Based Scheduler (EBS) and Ant Colony Optimization (ACO) to develop a model for software project planning. The proposed model used task list and employee allocation matrix as project plan. In the Event based system, event is defined as the initial time when the resources are released from completed tasks and the time when employees join or leave the project. This paper used ant colony optimization to adjust the allocation of employees in event based scheduling. The research showed that the ant colony optimization in addition to event based scheduling is effective in modeling the resource conflicts, task preemption and preserved the flexibility in human resource allocation.

[9] Karthiga V. and Sumangala K. proposed a combination of Ant Colony Optimization and Event Based Scheduling for allocating the resources in software project ACO helped to allocate suitable employees with required skills for specific tasks. It was observed that hybrid approach provided for appropriate project scheduling.

[10] Jagtap V. and Joglekar P. specified that software scheduling is a NP-complete problem, where it is essential to generate an optimal solution which is cost effective, which utilizes the resources efficiently, within the specified timeline. This research used ant colony optimization for task scheduling and resource allocation thereby providing a modified function to reduce the cost based on the rate card of employees of a company.

[11] Wei-Neng C. and Zhang J. suggested that software project planning suffers from the problem of project task scheduling and human resource allocation. But many projects suffer from the problem of improper and inefficient project task

scheduling and human resource allocation. This paper presented a combination of event-based scheduler (EBS) and an ant colony optimization (ACO) algorithm. The proposed method was implemented on 83 instances and it was found to provide better results.

[12] Taj S., Ramana DVS. suggested that it was essential to decompose the project into smaller modules, decide the start and end time, task dependency, outcomes and budget of each module. Various methods have been used for software project management resources and schedule estimation. This paper presented a review of recently used software project scheduling techniques. The review suggested that Ant colony optimization was best for software project scheduling and staffing with Event Based Scheduler.

[13] Vitekar KN. *et al*. suggested that software project scheduling problem is a NP-hard (Non Polynomial) problem. This paper presented the survey of methods that were used for software project scheduling. The review suggested that Ant Colony Optimization was a meta-heuristics approach to solve the software project scheduling problem. It was observed that the proposed method of software scheduling is better as compared to GA.

[14] Merkle D. presented the implementation of ant colony optimization (ACO) for the resource-constrained project scheduling problem. The research studied combination of two pheromone evaluation methods. The ACO algorithm was tested on a set of large benchmark problems from the Project Scheduling Library. The results were compared with genetic algorithms, simulated annealing, tabu search and it was found that ant colony optimization provided best solutions as compared to other techniques.

[15] Xiao J and Ting X. used ant colony optimization for software project scheduling problem, a method called ACS-SPSP algorithm. The research involved splitting the tasks and distribution of employees to task thereby getting a construction graph for ACO. Six domain-based heuristics were designed to consider the factors of task efforts, allocated dedications of employees and task importance ACS-SPSP was tested on 30 random instances and the results obtained were compared with a genetic algorithm. The proposed algorithm provided higher hit with more accuracy as compared to the solution provided by genetic algorithm.

[16] Paweł B proposed a Hybrid Ant Colony Optimization (HAntCO) approach in solving Multi--Skill Resource Constrained Project Scheduling Problem (MS--RCPSP). The approach updated the pheromone values based on the worst and best solutions stored by ants. The approach was implemented on artificially created dataset instances, based on real--world ones. It was observed that the ACO-based hybrid method was effective in providing better project scheduling.

[17] Chiang CW. *et al*. implemented ant colony optimization for solving the multi-mode resource-constrained project scheduling problem (MRCPSP) which is an NP-hard problem within a reasonable amount of computation time. The proposed algorithm, ACO-MRCPSP, was used to find a project schedule with minimum completion time within specified resource constraints. To construct feasible solutions for MRCPSP, ACO-MRCPSP used a self-adaptive parameter control strategy. The results of the proposed algorithm were compared with other meta-heuristic techniques like simulated annealing (SA) and genetic algorithms (GAs). The algorithm was tested on project instances from project scheduling library. It was observed that the ACO-MRCPSP provided better scheduling as compared to other techniques.

5. Conclusion

Software project scheduling is essential to monitor and control the process of development of software within the specified time constraints, budget, satisfying the requirements of user. The effort estimated should be divided properly amongst the different tasks so as to complete the project on time, hence making software project scheduling an important activity of software project management. Ant colony optimization, a meta-heuristic technique helps to optimize the solutions of the problem therefore providing better project scheduling that needs to be followed for time delivery of software to end user. This paper presented a review on the use of ant colony optimization for software project scheduling. It was observed from the literature review that the solutions provided by ACO for project scheduling were better as compared to other techniques.

6. References

1. https://www.tutorialspoint.com/software_engineering/software_project_management.htm
2. Pressman RS. Software Engineering, A Practitioner's Approach, McGraw-Hill, New York.
3. http://slideplayer.com/slide/6417787/
4. Mall R. Fundamentals of Software Engineering, PHI Learning Private Limited, New Delhi, 2008.
5. http://wayne.cif.takming.edu.tw/SE/engbook/ch4.pdf
6. Sharma S, Kaushik A. Enhancement in Software Cost Estimation Using Ant Colony Optimization, International Journal of Advanced Research in Computer Science and Software Engineering, 2016, 6(5).
7. Dorigo M, Cargo GD, Gambardella LM. Ant Colony Optimization for Distributed Discrete Optimization, Artificial Life, MIT Press, 1999.
8. Sharma A, Bhele NR, Dhamale SS, Parkhe B. A Proposed Scheme for Software Project Scheduling and Allocation with Event Based Scheduler using Ant Colony Optimization, International Journal of Application or Innovation in Engineering & Management IJAIEM, 2015, 4(1).
9. Karthiga V, Sumangala K. A Hybrid Approach for Software Project Scheduling, International Journal of Computer Applications, 2012, 59(16).
10. Jagtap V, Joglekar P. Study of Project Scheduling and Resource Allocation Using Ant Colony Optimization International Journal of Current Engineering and Scientific Research, 2015, 2(12).
11. Wei-Neng C, Zhang J. Ant Colony Optimization for Software Project Scheduling and Staffing with an Event-Based Scheduler, IEEE Transactions on Software Engineering, 2013, 39(1).
12. Taj S, Ramana DVS. Review of Ant Colony Optimization for Software Project Scheduling and Staffing with an Event Based Scheduler, International Journal of Computer Sciences and Engineering. 2014; 2(5):32-38.
13. Vitekar KN, Dhanawe SA, Hanchate DB. Review of

Solving Software Project Scheduling Problem with Ant Colony Optimization, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering.
14. Merkle D, Middendorf M, Schmeck H. Ant Colony Optimization for Resource-Constrained Project Scheduling, IEEE Transactions on Evolutionary Computation, 2002, 6(4).
15. Xiao J, Ting X. Solving Software Project Scheduling Problems with Ant Colony Optimization, Computers & Operations Research. 2013; 40 (1):33-46.
16. Paweł B, Myszkowski, Marek E, Skowroński ME, Olech LP, Oślizło K. Hybrid Ant Colony Optimization in Solving Multi-Skill Resource-Constrained Project Scheduling Problem, Soft Computing, 2014, 19(12).
17. Chiang CW, Qing HU, Wang WY. Ant Colony Optimization with Parameter Adaptation for Multi-Mode Resource-Constrained Project Scheduling, Journal of Intelligent & Fuzzy Systems. 2008; 19(4/5):345-358.