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RESEARCH ARTICLE

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# OPTIMIZATION OF SOFTWARE PROJECT SCHEDULING BASED ON HILL CLIMBING TECHNIQUE

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**ABSTRACT**

Developing a software project scheduling is important and demanding in software field. In software companies, the software project is mainly based on human resource. Some of the model has been developed to deal with the problem that occurs in project scheduling. The fortunate model is developed based on human resource allocation and task allocation which is accomplished by the scheduler known as event based scheduler. To make scheduling process optimized we go for hill climbing technique, this in which we can add or remove the elements until no further refinement can be made in the resources.

*Key Words*— Software project scheduling, event based scheduler, Hill Climbing technique (HC), resource allocation, task allocation, scheduling models.



## I. INTRODUCTION

The global software industry is growing with the increase in development of software projects. Some of the software industries are facing some difficulty in developing an efficient software project. In smaller projects the software project scheduling can be made easily but when we go for complex or larger project the software project scheduling is difficult and so some of the projects get failure, due to error that occur during scheduling.

Some of the software projects are carried out successfully within the given time and budget which contains the required features and provides high quality products. Some of the companies fail to plan and properly measure their software development process which causes lack of success which is found by most of the researchers. The main remarkable cause allocated to project failure has been due to improper and unsuitable actions carried out by the management. Sometimes the project delay is estimated before and after the project development whereas; nowadays the project delay is due to assigning the task to less suitable human resources which leads to low quality products.

For developing a software project, the project manager has to estimate the amount of work has to be done by human, required resources, cost and scheduling models. Some of the popular models like constructive cost model are used for

cost estimation. Some of the methods like program evaluation and review techniques, critical path method are used to deal with the resource allocation and task scheduling. All those techniques do not deal with both the resource allocation and task scheduling. Those tools deal with the resource allocation and task scheduling separately. So we go for Event based scheduler which is used to deal with the resource allocation and task allocation in an efficient manner. The main resources in software developments are humans so that the resources in software projects should usually be allocated in a more flexible way than those in development or manufacturing projects. We develop a practical and effective approach for the task allocation and human resource allocation problem in software project scheduling using hill climbing algorithm. Hill climbing or steepest ascent hill climbing is one of the best local and global optimization technique used in this paper.

## II. PROBLEM STATEMENT

Nowadays software project scheduling is not effective because they do not address the problem of allocation of task to suitable employee. In this project the issues of human resource and task allocation in software project scheduling are taken into account.

## III. Objectives of the proposed system

This project focuses on Software Project Scheduling based on hill climbing algorithm which is used to allocate task for suitable employee. It depends upon employee skill set and per hour salary for normal time and overtime. In this approach the resources are efficiently used by the employers for completing the particular task in the given period of time. The framework is extended by adding the employee experience and training model. It provides the best solution for task scheduling and employee allocation problems in software project management process by incrementally changing a single element of the solution. If the change produces a better solution, an incremental change is made to the new solution, repeating until no further improvements can be found.

## IV. PREVIOUS WORK

Our work is to investigate a strategy to assign employee to task, and to increase the quality of project with decrease in cost. The project manager carries out the task based on two categories:

*A. Software project estimation*

The software project is estimated based on two the effort and cost. Many models have been developed to obtain the effort estimation like Function Point analysis (FP) and Source Line of Code (SLOC). The commonly known model Cost Construction Model (COCOMO) which is used to estimate the cost of the software projects. Some other models like Bayesian analysis used to predict the software effort and some models used to estimate the distance between the effort that is estimated with the historical data.

*B. Software project scheduling*

The software project should be scheduled properly. Many scheduling problems like Resource Constrained Software Project Scheduling (RCPSP), Resource allocation, Multi-skilled models and Time line based have been developed to address the problem that occur during project scheduling. In the proposed method we use Event based scheduler to schedule the software projects. To improve Software project scheduling many optimization techniques have been developed. Some of the algorithm like genetic algorithm, tabu search, ant colony has been developed, but they lack the consideration of minimizing large search space, and changing the single element in the solution to obtain the better results. To obtain the best solution we go for hill climbing technique which is used to overcome that difficulty that occurs in previous algorithms.

*C. Overview of the previous model*

The representation of the problem consists of:

1. The project task is represented using the task precedence graph. It is a directed acyclic graph which consists of nodes and edges, the nodes represent the task and edges represent the successor of the task that to be performed.
2. An employee database with the information of skills sets and salary.
3. The heuristic function used to evaluate the effectiveness of the schedule.

The hill climbing representation is a hierarchical like structure which consists of nodes and links. The search based on local and global minima. In this technique we consider the training

models and employee experience with employee skill sets, salary, and employee working hours like full time or part time is considered to improve the scheduling model during the software project scheduling.

Here some of the limitations of the previous models like

1. Restrictions on task
2. Restriction on employee assignment
3. Skill match and experience
4. Different scales of objectives

The restriction of the task in which the task should be started as soon as possible and the task should not be stopped during its execution. The employee should be worked on the assigned task from start to end of the project the re-assigning cannot be taken once it is assigned. Some of the models lack the consideration of assigning the employee to particular task based on skills. The different scales of objective which includes the amount of time taken to complete the task, cost, and the total time.

The new model which consists of the

1. Employee skill sets
2. Employee training models
3. Employee experience models
4. Employee availability model
5. Task model
6. Employee effort estimation
7. Task importance model
8. Maximum headcount
9. Employee-task assignment scheme

The new model which consists of employee skill sets, training models and their experience and provides details about the availability of the employee present. The employee effort estimation which is used to estimate the effort required to complete a task, which may include the person work per month, or day. Employee task assignment which is used to assign the task for the suitable employee in the software projects.

When comparing with any other search algorithm like tabu search, genetic algorithm, the hill climbing gives the better solution. The parameter used may contain the employee attribute like employee skill set based on front end and back end, experience, training models, deadline to complete the project. The hill climbing algorithm used in many areas like artificial intelligence, and are used in examples like n-queens problems, travelling sales man problems, software project scheduling. Hence hill climbing gives a better solution which occupies less memory space, with best solution and is more efficient in software project scheduling when compare with any other search algorithm.

**V. Architectural diagram of system**

System architecture deals with the behavior of the system and also shows how the software scheduling process takes place in the software project. An architectural overview of the overall system is given below in which it contains three layer like presentation layer, application layer and database layer. In which the presentation layer contain the UI components and the application layer contain how the request and response takes place during scheduling and database layer contain information about the project that to be scheduled.

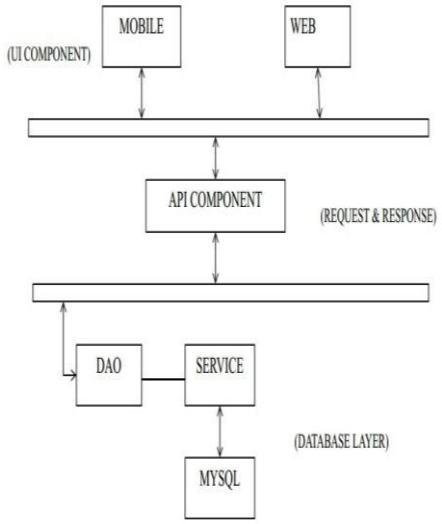


Fig. 1.System Architecture

**VI. Detailed Design**

Mainly the software projects are constructed based on two things, one is cost oriented and another is schedule oriented. The cost oriented may be the direct cost or indirect cost can be calculated based on some models like cost construction model(COCOMO).And the scheduling process based on time and resources used. Here we use event based scheduler for project scheduling.

The detailed design contains the details about resource allocation, employee allocation, task scheduling and global time table. The resource allocation deals with how the resources are selected

and used to the particular task. Resources are selected based on the task performed. After adding the task, the task is allocated to the suitable employee using scheduling models. The global timetable deals with time taken to complete a task are shown below.

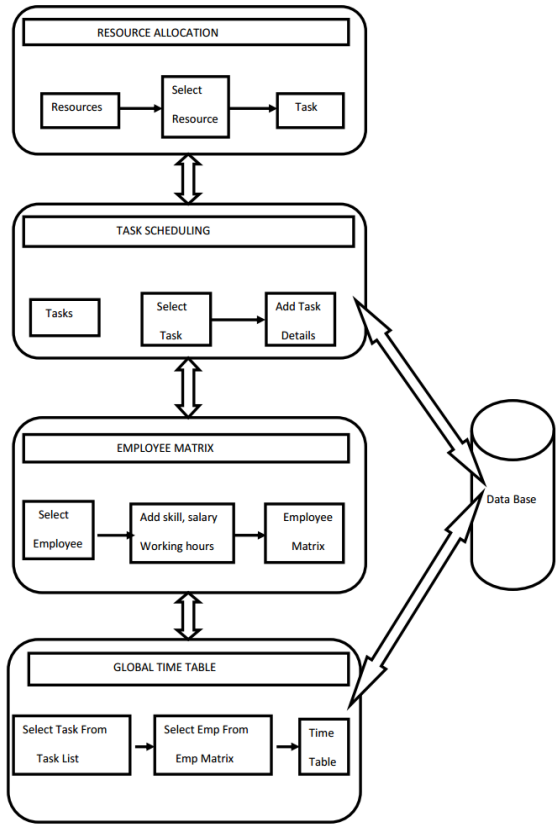


Fig. 2. Detailed design

## VII. Algorithm and techniques used

Hill climbing is a mathematical optimization technique which belongs to the family of local search. It attempts to find a better solution by incrementally changing a single element of the solution. If the change produces a better solution, an incremental change is made to the new solution, repeating until no further improvements can be found.

**Algorithm**

**Hill-climbing** (problem)return state
Node: present, neighbor;
present:= Make-Node(Initial-State(problem));
loop do
Neighbor:= highest-value-successor(present)
if(Value(neighbor)<Value(present))
then return State(present)
else current:= neighbor
end loop
end function

The simplicity of the algorithm makes it a popular first choice amongst optimizing algorithms. It is used widely in artificial intelligence, for reaching a goal state from a starting node. Choice of next node and starting node can be varied to give a list of related algorithms. Although more advanced algorithms such as simulated annealing or tabu search may give better results, in some situations hill climbing works just as well. Hill climbing can often produce a better result than other algorithms when the amount of time available to perform a search is limited, such as with real-time systems. On performing this algorithm we can correctly map the resource allocation and task scheduling for a particular employee.

**FLOW CHART**

Software project scheduling is based on the resource allocation and task allocation. Initially we begin the process by adding the employee details and the task that are performed during the project, and then the attribute of employee like skill set, experience, training models are added. And the task details like task that are performed during the project are added. Allocating the employee to the suitable task. If a new employee with greater experience or skills are added then the algorithm reallocate the employee for the suitable task. This process is done until we obtain the best solution which is shown below, The hill climbing algorithm also known as steepest-ascent hill climbing, and is called gradient descent search. The evaluation function is based on minimizing cost. This algorithm will loop until a solution is found or a complete iteration produces no change to current solution. If the successor is better than the current solution then we set the current solution as successor. By this way the resource and task allocation is performed in project scheduling.

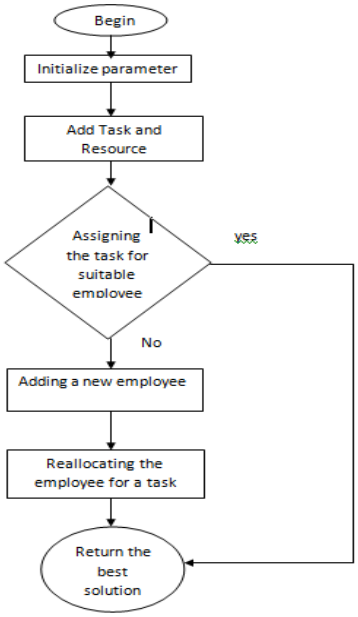


Fig. 3. Flow Chart of Software Project Scheduling using Hill climbing

**LOCAL VERSES GLOBAL SEARCH**

There are many problems that require search of all solutions to obtain one solution that satisfies all the conditions. For searching those problems we obtain two fundamental strategies. One is local search and other is global search strategy. The local search strategy searches to obtain nearby solution which is well performed by hill climbing technique.

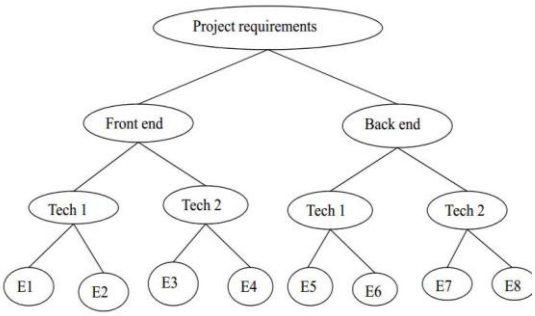


Fig. 4. Search Process in Software Project Scheduling using Hill climbing

Whereas, the global search strategy searches the overall problem to obtain the better solution. The main concept of hill climbing is generation of successor node. The successor node is generated using the production rule.

$(X_1,X_2...,X_i...,X_n) \rightarrow (X_1,X_2,...X_{i+1},...,X_n)$ for i=1,2...n

The production rule is used to generate all possible nodes that are present in the neighborhood of the current node. By this was the successors nodes are generated in hill climbing. In hill climbing search, if any local change that improves the current value then we go for the better solution until no further change takes place.

Hill climbing incorporates the strategy of backtracking ie, when the solution fails to produce better solution from the successor nodes, it leaves the current nodes and backtrack the nodes to obtain the best solution. Backtracking is continued for each and every node during the search process. Therefore the hill climbing search provides a powerful strategy for exploring combinational search in which we obtain better performance than any other search algorithms and main advantage in this algorithm is search space is reduced and there is no conflicts that occur during employee-task allocation.

**VIII. EXPERIMENTAL RESULTS**

Using this model we obtain the performance analysis of employee skill sets and experience. From the performance analysis we can obtain the ratio that the employee. When we are adding the new employee the performance analysis gets varied. The parameters used in these experiments are employee attributes like skills sets, experience, and training. The graph below show the performance analysis of employee in the software project.

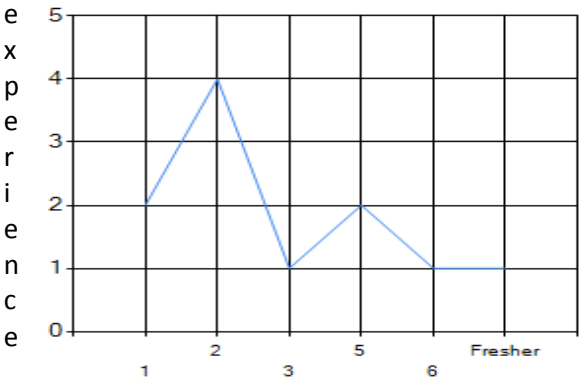


Fig. 5. Performance analysis on Hill climbing technique.

**IX. Conclusion and future work**

The proposed method based on hill climbing technique which is used to overcome the issues that takes place during software project scheduling and makes the software project scheduling more optimized by adding employee experience and training models. Future work can be made by adding the cost estimation that essential during the software scheduling.

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