Improve Makespan in Job Allocation using Modified Hungarian Algorithm in Cloud Computing

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ABSTRACT: *nowadays, Cloud computing services providing multiple technical application over internet to solve simple and complex problems. It gives a platform to solve jobs or problems on different hardware and software resources. Scheduler here is an essentially main concept which executes jobs according to underlying algorithm. The Scheduling algorithm needs to make sure that cloud system can execute the jobs effectively and in minimum time along with improving the utilization of resources. Here, in this paper approach to improve performance of scheduling algorithm in terms of make span. Many Job/task scheduling algorithm are used to allocate resource to jobs based on priority. But Hungarian approach a mathematical technique which can be used for job assignment in cloud to improve efficiency. This approach is mainly based on priority-based scheduling and can be executed in polynomial time. Job/task scheduling in cloud computing will be to use Modified Hungarian Algorithm to further optimize performance and make span. In Hungarian algorithm solution can be obtained by iterating the logic / some steps to reach the final solution. in modified Hungarian algorithm one can get solution intermediately without iterating up to certain condition or reaching final step as in Hungarian algorithm.*

Key Words: *Cloud Computing, Scheduling algorithms, modified Hungarian Method, Hungarian Method, Job Allocation, Task scheduling, Makespan*

I. INTRODUCTION

Cloud computing platform whichsatisfies for discrete types of users in different ways. Mostly all requirements are managed by cloud with deployment model- SAAS, PAAS, IAAS, & etc. Cloud iscoming after of distributed computing which has provides more facility like Virtualization. Consumer can enlarge thecomputing power and storage capacity throw elasticity. Cloudcomputing is built to use applications that only place on different location and also provide different type of virtualized platform that accomplish cloud costumers' jobs in minimumtime and minimum cost.Cloud Computing facilitate rapid changes in the world, to increases the maximum profits from cloud computing environment. In industry each and every day new applications coming up and maximize the complexity of scheduling methods. Due to this purpose, job scheduling plays important responsibility of current researchers to provide efficient resource utilization of resource and yields less response time in cloud platform. Which require efficient task scheduling algorithm for job allocation Many job scheduling algorithms havebeen proposed for handling job in smart way by researcher.

There are some evaluation parameters which decide a job place on smart way like performance, throughput, utilization of resources, response time, make span, load balancing index and etc. The task allocation in cloud computing platform is to ensure the quality of service to cloud customers, the key to improve the resource utilization. The main Purpose is to allocate tasks to the Virtual Machines (VMs) in time, which involves finding out a proper sequence in which jobs can be execute on cloud computing environment. The job allocation in cloud computing environment is a challenge. To solve up this challenge review the number of efficiently job scheduling algorithms. It aims at an optimal job scheduling by assigning end user task/ job. Job Scheduling in cloud computing environment refers to allocate the computing tasks to resource pooling between different virtual resource users based on certain rules of resource use given cloud circumstances.

Scheduling of jobs based on priority is a concern issue because every job wants to execute in limited time of period.Some task scheduling algorithm must consider priority for resolve this problem there are lots of algorithm consider priority of jobs.For solving this issue Combinatorial Optimizationalgorithm can be get used. One example of this algorithm isHungarian Method. Hungarian Method provides solutions ofassignment problem in polynomial time. This method isdeveloped in 1957 by great Hungarian mathematicians: Denes Konig and JenoEgrary can be used in cloud computingto get better result in scheduling process. In this paper shown that, minor modifications to the original codes used for the Hungarian algorithm can cause large reductions in execution time. This paper assesses the effect of another

minor modification. In practical terms, it may be argued that all the algorithms and computer codes used are quick anyway, so that there is no need for further improvement. However, there are occasions where a result is required very quickly, as in an interactive system, or where a long series of successive assignments needs to be made ,when it is important to use as quick a method as possible.

The main objective of this paper is mainly focused on priority-based scheduling using Modified Hungarian algorithm. Proposed algorithm gives improvement in makespan for allocating jobs. The rest of this paper is organized by following section as: section 2 with literature review, section 3 explain Modified Hungarian Method with calculations, section 4 Proposed scheduling algorithm based on Hungarian on cloud environment with calculation, section 4 Experimental setup for analyzing algorithm finally section 6&7results and conclusion of this paper

II. LITERATURE SURVEY

There are various Job scheduling algorithms used to allocation of job in cloud computing in such manner to improve job Allocation. In this section, various scheduling algorism review briefly.

An Optimized Task Scheduling Algorithm [2]: In such a case, the execution time of some tasks are too higher in compare to the other meta task list. If that task has higher priority in compare to the other task then, it will be giving larger increase in resulted makespan. the total makespan is higher just because the larger execution time task. Especially if that task in on Slowest resource then it will result larger makespan. The speed difference between slowest and fastest resource have major difference .in this paper, by using the optimized task allocation algorithm trying to balance the load equally and allocate the job to slow resource and fast resource properly. Thus, that will show result in increased load balancing, improved makespan. in cloud computing

Purposed algorithm Optimized Task Scheduling Algorithm, is intelligent technique of computer. In which system adapts the advantages of the existing algorithms as per as the situation.

Er. Mandeep kaur, et.al. [2] shows the hybrid of GA and ACO. In proposed method takes the jobs in data center of cloud .in next step Explore grows ants and update tail of ACO amounts and after that evaluate the pheromone in which is ant's communication of each other to enhance the search performance .so in this case, pheromone tail-based trick, which utilize local.ACO method is used for solving discrete optimization problems that need to find paths to goal and Genetic Algorithm is used for reducing the scheduling time. Hybrid approach is adopting the qualities of the both ant colony optimization (ACO) and genetic algorithm (GA) to make the optimal solution in small period of time.

Paul Moggridge, et.al. [3] paper represent a novel algorithm which is considers on allocation of VM. Max-Min allocates job to max possible completion time to the higher execution time VM. It is gives poor average task make span because of placing many smaller tasks to the slower VM. Max-Min improved allocation of job with shortest execution time to VM that completion time is less . Another outcome of this paper is that, it provides a better and easy environment for testing algorithms.

Amitha B.*, et.al. [4] represent the policy for allocation of resource in cloud computing.. the proposed method used the Hungarian method and VM allocation modified policy to allocate job to the resource /VM. The given jobs assigned to VM in existing method randomly but here we using proposed method. which gives efficient result. In VM allocation policy perform matrix of difference between free space and requested space on VM. It will assign host to VM which has the lesser different space compare with others. This propose method give improve resource utilization.

Ronakkumar R Patel, et.al. [5] present the paper based on scheduling jobs using Hungarian method in cloud computing environment. Scheduling of the jobs based on priority is big issue so, very jobs wants to execute on time. For solving this issue combinational optimization algorithm used such as Hungarian method it gives the result of the assignment problem in polynomial time. The proposed algorithm is in two stages: job and resource based. In Job stage parameters like length of task, requirement of bandwidth for execute job, requiring speed for processing and at the Resource stage how many instructions handle by the resource and transfer rate of the resource. All parameter used for calculated priority based Hungarian method. this algorithm focused on the jobs who has the greater priority. For the evaluation purpose in this paper used cloudsim simulation for modeling of cloud computing environment.

III. HUNGARIAN METHOD

Assigning jobs is a crucial thing but Hungarian method provides best solution without any direct / indirect comparison of every solution. It works on principle of minimizing the given cost matrix to a opportunity costs matrix. Opportunity costs shows the relevant penalties associated with assigning resource

to an activity as opposed to making the better or minimum cost assignment. If we can able to minimize the cost matrix to the extent of having at least one zero in each column and row, then it may be possible to make better assignments (opportunity costs are all zero). Hungarian method is works on combinational optimization algorithm which solves the assignment problem in polynomial time[5].

Steps of Hungarian Method:

1)Find minimum value from each row and subtract that value from all the entries of its row.

2) Find minimum value from each column and subtract that value from all the entries of its column.

3) Draw lines across rows and columns so all the zero values of cost matrix are covered and also smallest number of lines are used.

4) Testing Optimality: (I) If smallest number of covering lines is n then optimal assignment of zeroes are possible and algorithm finishes. (ii) If minimum
number of covering lines is less than n then optimal assignment of zeroes is not possible. So go to step 5.

5) Find the smallest value not covered by any horizontal or vertical line. sum that value to each uncoveredcolumn, and subtract smallest value from each
covered row. back to step 3

Mathematically Representation of Hungarian algorithm: -

Step 1: define smallest value in each raw.

JOBS	VM1	VM2	VM3	VM4
1	90	75	75	80
2	35	85	65	55
3	125	95	90	105
4	45	110	95	15

TABLE1

Step 2: subtract smallest value from each row.

JOBS	VM1	VM2	VM3	VM4
1	15	0	0	5
2	0	50	20	30
3	35	5	0	15
4	0	65	50	70

TABLE 2

Step 3: subtract smallest value from each column.

Step 4: count minimum no of rows and column that covers all zero.

JOBS	VM1	VM2	VM3	VM4
1	~~15~~	~~0~~	~~0~~	~~0~~
2	0	50	20	25
3	~~35~~	~~5~~	~~0~~	~~10~~
4	0	65	50	65

TABLE 3

Step 5: test the optimality No of lines = 3<4 where n= 4 so, optimality not satisfied so forward to step 6 .

Step 6: values that arenot covered in lines. Find min value from available value and add that to intersection point, subtract from available value

After the all calculation done result matrix is:

JOBS	VM1	VM2	VM3	VM4
1	~~40~~	~~0~~	~~0~~	~~0~~
2	~~0~~	~~30~~	~~0~~	~~25~~
3	~~55~~	~~5~~	~~0~~	~~10~~
4	~~0~~	35	30	45

TABLE4

Hence, no of lines are 4 so we are going to allocate job to VM .job 1 --- VM 2 ,job 2 --- VM 1 , job 3 --- VM 3, job 4 ---VM 4.

IV. PROPOSED ALGORITHM

Job scheduling based on Hungarian method shows healthier and adequate results in comparison with the other traditional algorithm.But there are occasions when an outcome is required so quickly, as in an interactive system, or where a long series of successive assignments needs to be made, and when it is important to use as quick a method as possible. here we used modified Hungarian method. Hungarian algorithm can be solved in 5 simple steps to obtain solution to a given problem. In Hungarian algorithm solution could be get by iterating the logic or some steps to reach the final solution rather than in modified Hungarian algorithm one can get solution intermediately without iterating up to certain condition or reaching last final step like in Hungarian algorithm.

Steps of modified Hungarian method:

1) Search for the smallest value from each row and subtract that value from all the entries of its row a*nd get altered matrix.*

2) Search for minimum amount of column and subtract form *altered matrix.*

3) lines across rows and columns so all the zero / less than zero values of cost matrix are covered and also minimum number of lines.

4) Testing Optimality: (I) If minimum number of covering lines is n (n=no of job) then optimal assignment is possible and algorithm finishes. (ii) If minimum number of covering lines is less than n then optimal assignment of zeroes is not possible. So, proceed to step 2 to 4.

Mathematically Representation of Hungarian algorithm: -

Step 1: find smallest value in each raw Step 2: subtract smallest value from each row.

TABLE5

JOBS	VM1	VM2	VM3	VM4
1	15	0	0	5
2	0	50	20	30
3	35	5	0	15
4	0	65	50	70

Step 3: subtract the min no of the column from the matrix.

Step 4: count min no of rows and column that covers all zero or negative number.

JOBS	VM1	VM2	VM3	VM4
1	10	0	0	0
2	0	45	15	25
3	30	0	0	10
4	0	60	45	65

TABLE 6

Step 5: Hence, no of lines are 4 so we are going to allocate job to VM .job 1 --- VM 2 ,job 2 --- VM 1 , job 3 --- VM 3, job 4 ---VM4

Hence, we can see that by using the modified Hungarian method we can get the same result in less no of step.

V. EXPERIMENTAL RESULTS

The proposed Method, Modified Hungarian method can improve the job Allocation related to proper resource which leadto the measurable performance improvement in terms of reduced makespan time. For evaluation purpose,workflowsim resource simulator which is a toolkit formodeling and simulation of cloud computing platform andevaluation of resource provisioning algorithms. When jobs areentered in to the cloud environment, proposed algorithm startto execute the jobs. For that first calculation are done based on Modified Hungarian method and get the priority of the jobs based onrequirement. Same calculations are done on resource side also. Then highest priority jobs are allocated on best resource. After the allocation is

completed and execution is completed theworkflowsim automatically update the set of jobs and resource aswell. For check the proposed algorithmtake 1000,100,50 montage data set , take different amount of Virtual Machine 5,10,25,50,75 &100 ,then execute Hungarian & modified Hungarian Method on each dataset and each no of VM for five round to get better consistent result. having large data volume and perform proposed algorithm ondifferent set of Resources which gives superior results

Comparison of Hungarian Algorithm and Modified Hungarian Algorithm base on makespan.

Average Result after the 5 rounds execution task of base on makespan

VM	5		10		25	
Jobs	MOD_HUNGARIAN	HUNGARIAN	MOD_HUNGARIAN	HUNGARIAN	MOD_HUNGARIAN	HUNGARIAN
50	154.298	190.404	119.038	103.088	103.892	101.982
100	323.988	379.802	208.512	378.986	148.334	176.324
1000	3333.114	3878.734	2063.694	2442.464	1726.5	1732.984

TABLE 7

VM	50		75		100	
Jobs	MOD_HUNGARIAN	HUNGARIAN	MOD_HUNGARIAN	HUNGARIAN	MOD_HUNGARIAN	HUNGARIAN
50	103.128	117.424	95.24	88.204	101.266	120.416
100	151.436	176.97	154.42	139.354	144.652	159.874
1000	947.244	1153.368	933.204	1022.862	834.784	1168.46

TABLE 8

Figure 1 Result for 50 Dataset

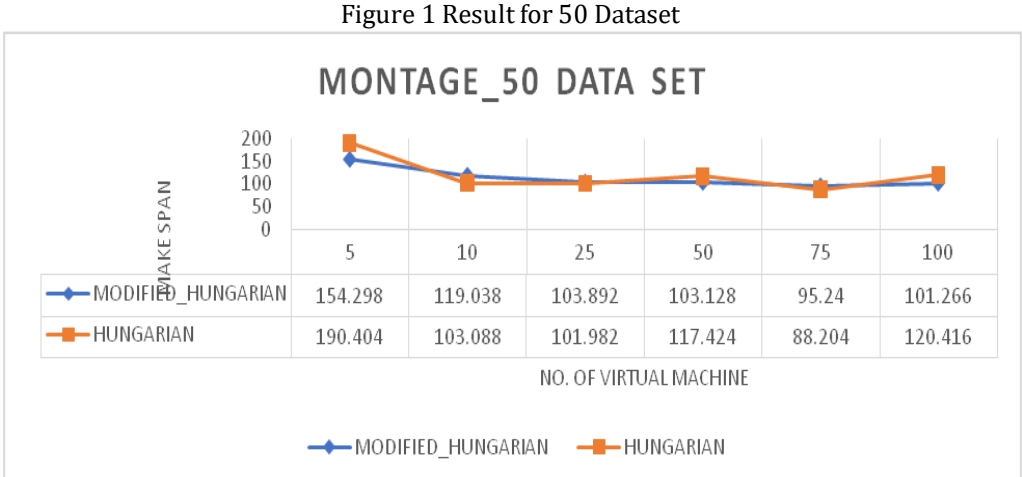


Figure 2 Result for 100 Dataset

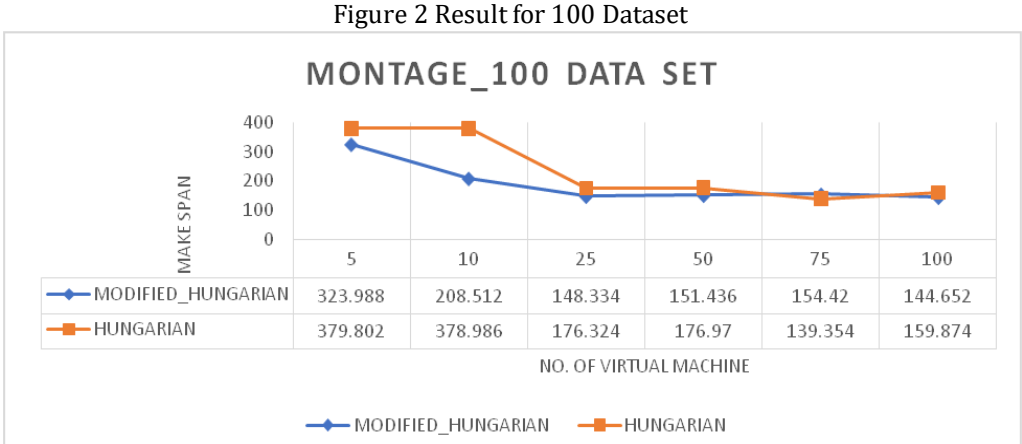
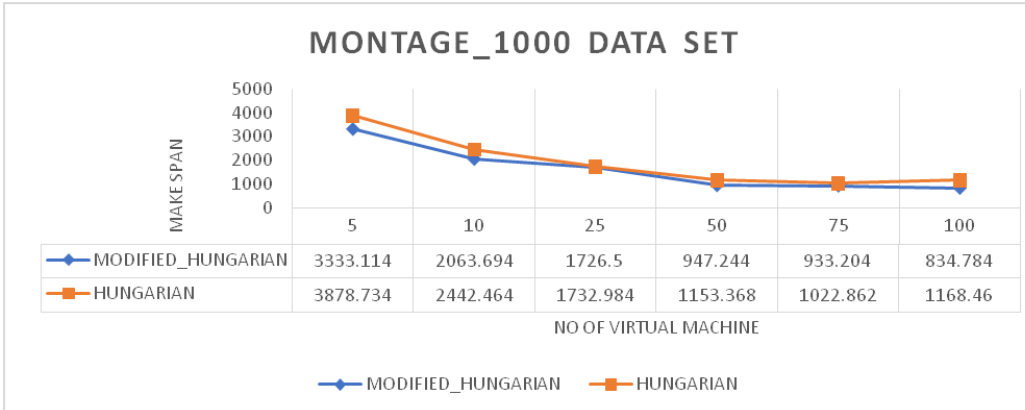


Figure 3 Result for 1000 Dataset



VI. Evaluation Parameters

Consistency

Consistency means each and all matrixes have logically reasonable value. decision maker can make a number of stable matrixes based on Hungarian Calculation. consistency of all matrixes can be calculated [5]. consistency check is not an issue as there is no need to check whether the matrix is consistent or not. Hungarian algorithm is itself consistent.

Make span

The overall time taken by each the tasks/jobs in meta-task to get executed is makespan. Meta-task is a one type of queue in which job which is ready to execute, is stored. Minimize the amount of make span better utilization of resources, better throughput and response time [5].

Throughput

Throughput is a measure of numbers of requested jobs assigned resource in a given amount of time. Using propose method we can improve the throughput of job allocation process.

Completion time

Propose method help to reduce some iterative steps of method which gives the improvement in completion time.

Further it also reduces cost for customer by reducing executing time and utilization of resources.

VII. CONCLUSION

In cloud computing, allocation of jobs based on requirement is a more interesting topic for research. There are many existingalgorithms priority-based scheduling algorithm is available. Hungarian method is quite different from those traditional algorithms in terms of time as well ascomplexity [5]. In fact, it is itself consistent method. Proposed modified Hungarian Algorithm gives better makespan time compare to exixting Hungarian algorithm. Minimize the amount of make span time gives better utilization of resources, better throughput and response time.This algorithm can further improvement by
considering large number of resources and execute in real cloud infrastructure.

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