Minimizing the Makespan using Hybrid Algorithm for Cloud Computing

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Abstract— **Cloud computing technologies offer major benefits to the IT industries in terms of elasticity and rapid provisioning, pay-as-you-go-model, reduced capital cost, access to unlimited resources, flexibility. Job scheduling is a combinatorial optimization problem in the fields of computer science where the ideal jobs are assigned to required resource at a particular instant of time. In this paper we proposed Hybrid algorithm which combine the advantage of ACO and Cuckoo search. The makespan or completion time can be reduced with the help of hybrid algorithm, since the jobs have been executed with in the specified time interval by allocation of required resources using the Hybrid algorithm. The obtain results shows that Hybrid algorithm performs well than compared with the ACO algorithm in terms of performance of the algorithm and makespan.**

Keywords--ACO-Ant Colony Optimization, CS-Cuckoo Search, RS-Relative Superiority.

I. INTRODUCTION

Cloud computing technologies offer major benefits to the IT industries such as elasticity and rapid provisioning includes increasing or decreasing the infrastructure facilities for a particular time based upon the required needs. Pay-as-you-go-model deals with the organization that requires any services and pay for the exact amount of resources they utilized in terms of infrastructure, platform and software as services. Reduced capital cost is that an organization no need to have an inbuilt infrastructure there resulting in the reduction of infrastructure. Accesses to unlimited resources in a cloud computing is that the cloud provider has been able to deploy hundreds of server instance simultaneously there by it is possible to access the unlimited resources. Flexibility means that deploying the cloud instances with varying hardware configuration, different operating systems and software packages. Several benefits of cloud such as 1. High availability and fault tolerance: since the cluster worker nodes are spread around the cloud sites, in case of cloud down time or failure the cluster operations will not be interrupted at any cost of time since worker nodes will take care of it. 2. Infrastructure cost reduction: the pricing models among the cloud providers may vary considerably; the cluster node will change the location from one provider to another one. There by reducing the overall infrastructure cost.

Job scheduling is a combinatorial optimization problem in the fields of computer science where the ideal jobs are assigned to required resource at a particular instant of time. Makespan or completion time is the total time taken to process a set of jobs for its complete execution. Minimization of makespan can be done by assigning the set of J_i jobs to set of virtual machines ' vm', the order of execution of the jobs in virtual machines does not matters. If of jobs that need to process and be the possible schedule for a given job scheduling problem. Then J_i of jobs need to processed by the virtual machine $vm_m = (vm_1, vm_2, vm$where 'm' is the mth virtual machine , the minimal value of the makespan (completion time) among all the possible schedule is given by the processing time of the operations P_j . denotes the completion time.

The contribution of this paper is.

1. Proposal of Hybrid algorithm by combining the advantage of ACO and Cuckoo search.
2. Performance comparison of Hybrid Algorithm with ACO Algorithm.
3. Analysis of energy consumption based on number of tasks.
4. Comparison of Makespanof Hybrid algorithm with ACO algorithm.

II. RELATED WORK

Parallel bi-objective genetic algorithm is based on Energy-conscious scheduling heuristic. It minimizes the energy consumption and the make span. The major drawback is that it consumes more resources [1]. Community-Aware Scheduling Algorithm (CASA) can improve both the average job slowdown and average job waiting time dramatically without asking for detailed information of the participating node or the centralized node [2]. Elastic cluster architecture supports the execution of the heterogeneous application domain, which dynamically partitions the cluster capacity and adapts to variable demands [3]. Thus we've analyzed the performance of the cloud computing services for scientific computing workloads i.e. for loosely coupled applications [4]. Mobile agent techniques is used to avoid failure, it can improved by using co-operative problem solving techniques [4][5].

Mathematical models demonstrate to achieve an optimal growth in a heterogeneous cloud infrastructure, where the slowest node's response time should be not more than three times that of the fastest node [6]. Game quick algorithm and game cost outperforms so as to achieve feasibility and predictability i.e. it predict the execution time of the workflow. Game cost assigns deadline to the activity classes and partitions the workflows into sub-workflows according to the assigned deadlines [7]. The techniques used in global replica management and key word matching can in used for optimization problem [8-10]. Job scheduling algorithm based on Berger model, classifies user tasks by Qos preferences, resource fairness justice function to judge the fairness of the resource allocation [11]. Agent technology can also be used for combinatorial optimization problems [12-16]. Near-optimal scheduling policies exploit the heterogeneity across multiple data centers for a cloud provider by energy efficiency factors such as energy cost, carbon emission rate, workload, CPU power efficiency [17]. The frame work used for testing of multi agent can also be considered for the optimization to improve the efficiency [18][19] Historical and a layered queuing performance model can provide a good level of support for a dynamic-urgent cloud environment. It provides guidelines for parameterizing the models at a lower overhead. Multi cloud cost analysis shows that for the workload that considered some hybrid configuration, exhibits performance-cost ratio than the local setup [20-21]. A hybrid algorithm for job scheduling and for optimization ACO algorithm adopted for it [22-24]. Efficiency of the algorithm can used to calculate the performance and it is also used in many applications [26-29].

III. PROPOSAL

Makespan

Job scheduling is a combinatorial optimization problem in the fields of computer science where the ideal jobs are assigned to required resource at a particular instant of time. And the description is as follows.

Makespan or completion time is the total time taken to process a set of jobs for its complete execution. Minimization of makespan can be done by assigning the set of J_i jobs to set of virtual machines ' vm', the order of execution of the jobs in virtual machines does not matters.

Notations

Let J_i represent the job and Pj denotes the processing time of the jobs,

And thus the processing time of the Job set B, can be defined as

$$P(B) = \sum_{J_j \in B} P_j$$

If be a possible schedule for a given scheduling problem, notation are

1. S_j , starting time of the job J_j in a possible schedule π.
2. E_j , end time of the job J_j.
3. P_j , processing completion time of the job J_j.
4. $P_j = \sum(E_j - S_j)$
5. N_j , number of jobs
6. C_j , completion time of the job J_j.

Let be the set of jobs that need to process and be the possible schedule for a given job scheduling problem. J_i of jobs need to processed by the virtual machine $vm_m = (vm_1, vm_2, vm$ where 'm' is the mth virtual machine, the minimal value of the makespan (completion time) among all the possible schedule is given by the processing time of the operations P_j . denotes the completion time.

Scheduling on m parallel virtual machines

Let us considered that 'm' parallel virtual machines is available, and now at time being let us assume that one is always in busy state it not available to the job execution. To perform the scheduling jobs are arriving J_i : and it is necessary to schedule the jobs to available virtual machines. Constraints are that new jobs that need to be scheduled arrive only after already existing jobs are scheduled. Let us assume that virtual machine is periodically unavailable and the virtual machine which is not available will start at the unavailable period of time. The aim is to minimize the makespan (completion time). For our assumption, let the length of the available virtual machine and unavailable virtual machine is 1 and , respectively. , denotes the processing time of the virtual machines, is the completion, and algorithm respectively. For a given problem pm, |online| and thus, there is no online algorithm with lower bound of ratio less than 2. Let be positive number of small value, and jobs J_i arriving have a common processing time as .

Hybrid Algorithm

Combining the advantage of Ant colony optimization and cuckoo search a Hybrid algorithm has been developed for combinatorial optimization problems. The disadvantage of the Ant colony optimization has been overcome by cuckoo search that is in Ant colony optimization ant moves in the random direction for search of food source around the colony. A chemical substances called pheromone is deposited along the path. While trying to solve the optimization problems it lures the ants and hence to perform the local search time taken is considerably more. To overcome the above draw backs cuckoo search is used, to perform the local search in the Ant colony optimization. The major advantage of using the cuckoo search is that it essentially uses a single parameter apart from the population size.

Description of Ant colony optimization and cuckoo search

Ant Colony Optimization

For solving computational problems Ant colony optimization technique can be used because of the probabilistic nature, Ant colony optimization is used to discover best path through graphs,

Based on the activity of ants looking for a path among their colony and a source of food. This idea has been used to solve varies numerical problems; many problems as been came out based on the various distinct feature of the behavior of ants.

Explanations

Ant moves in the random direction for search of food source around the colony, if the food source has been discovered by the ant it will come directly to the nest, leaving a trail of pheromone in path. Since the pheromone are attractive by its nature the rest of the ants are tended to follow the directly the path. Once coming back to their colony they further leave a trail of pheromone in path, which will strengthen the route. If there exist more than one route to reach identical food source, the shorter path will be traveled by many number of ants than the longer path because pheromone deposit in the longer path will be evaporated for a particular instant of time. This is due to the volatile nature of the pheromones, finally all the ants decided to travel the shortest path.

Generally environment is used a communication medium by ants, for exchange information and among the ants and it has been taken place with the help of pheromone that have been deposited. The scope of the information exchange is local, those colony ant located where the pheromones left has a belief of them.

Local decision policies (trails and attractiveness)

All the colony ants try to construct the solution for the given problem iteratively, once the solution is constructed for the problem. Evaluation of the solution will be carried out by ant and then try to modify the trail value which is used in construction of the solution. The modified pheromone information is used by the future ant to search further.

Trail evaporation and daemon

Reduction of trail value will be carried by trail evaporation to avoid getting stuck further in local optima. For the searching of non-local perspective is carried out by daemon.

Edge selection

In ant colony optimization algorithm ant acts as computational agent. It incrementally try to build the solution for the problem, the solution which are derived instantly are called solution states.

Each and every looping of the algorithm ant moves from state 'm' to state 'n', resulting to more feasible solution. Each ant 'k' works out a set of feasible elaboration to its current state in each looping, the probability of moving from state 'm' to state 'n' based on the arrangement of two values. Attractiveness of the move, and the trail of the move, this show how capable in the past for a particular move.

Thus the Kth ant move from state 'm' to state 'n' with probability

$$P_{mn}^{k} = \frac{(T_{mn}^{\alpha})(\beta_{mn}^{\eta})}{\sum(T_{mn}^{\alpha})(\beta_{mn}^{\eta})}$$

, amount of pheromone interested from state 'm' to 'n', 'α' is to control the influence of ,

, is the state transition desirability from 'm' to 'n', η to control the influence of

Pheromone update

if all ant have completed a solution , the updated trail equation is

$$\beta_{mn} \leftarrow (1-\rho)\beta_{mn} + \sum\Delta\beta_{mn}^{k}$$

Where, β_{mn} is the amount of pheromone dumped for a state transition mn, ρ is the *pheromone evaporation coefficient* and $\Delta\beta_{mn}^{k}$ is the amount of pheromone dumped by 'k'th ant.

Cuckoo search

Cuckoo search is used for optimization problem, it has been seen that the performance of the cuckoo search is more than other Meta heuristic algorithm.

Representation of cuckoo search (CS)

Each and every egg in the nest denotes a solution; a new solution is represented by cuckoo egg. The main motivate of cuckoo egg is to derive a best solution and to replace the solution, which are not so-good in the nests. Each nest contains exactly one egg.

Cuckoo search is based on the following rules,

1. Each cuckoo lays only one egg at a particular time, and then in a randomly chosen nest egg has been dumped.
2. For the next generation, the high quality of eggs in the best nest is carried out.
3. Generally the hosts nests is fixed, the probability of the egg laid by the cuckoo bird is di found by host bird p_a € (0, 1). On finding this we can further do some operation on the worst nests, solution which are derived is dumped for the farther calculations.

Hybrid Algorithm

Step1: Initialization

Heuristic information, pheromone trails, number of nests, random initial solution.

Step2: Iterative loops

Starting jobs are determined by the colony of the ants,

For each and every ant schedule is constructed.

Step3: Repeat

For next processing job to execute apply the transition rule.

Complete schedule is constructed for every ant.

Step4: Statement

Till the complete schedule being constructed do the following,

Cuckoo search is processed for local searching.

Trail of Pheromone is updated.

Process global updation rule.

Step5: Termination

If non-local search, local search and pheromone updation completed.

Termination the process,

Else go to step 4.

Local search function

Step 1: Iterative loop:

Current best nest is identified.

While

Through random walk get cuckoo value, Levy's flight is applied to replace the solution.

Step 2: Evaluation:

Evaluation of quality/fitness.

Randomly nest is chosen .

Step 3: Condition:

If (

Value of is replaced by new solution.

Step 4: Statement:

New nests are constructed, based on the worst nest destruction.

Maintain best solution/nests.

Ranking of solution/nests,

Current best nest is identified.

Current best nest is carried to next generation.

End loop.

Flow chart

The figure 5 shows the flow chart of the hybrid algorithm, thus initialization of pheromone, heuristic information, number of nest and random initial solution have to done. The jobs that have to be done by the colony of ant are determined. For processing of the next job, transition rule have to be applied. Construction of ant scheduling for each and every ant is carried out, that is which ant have to be execute first is scheduled. Finding of resources for the job scheduling in the cloud computing has been performed using the cuckoo search process, since cuckoo search is very easy to implement that is local search in the Ant colony optimization is performed using cuckoo search. Trail of pheromone is updated using the new solution and global updation is also carried out. Once local search and other non-local is performed process is terminated.

Local search

The current best nest which has been carried out from the past generation is fetched. Condition function is evaluated for checking the fitness with the maximum generation, if the condition is satisfied the cuckoo value has been fetched and the levy's flight is applied.

Evaluation of the quality/fitness is carried and a random nest is chosen and if the fitness is greater than the random nest that have been chosen. The value of the new nest has been replaced, construction of nest is taken placed and ranking are given to them. The best solution from the current best nest is carried out to the next generation.

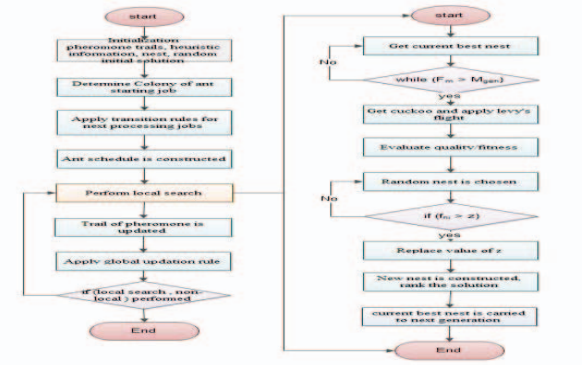

Figure 1. Flow chartof Hybrid Algorithm

IV. EXPERIMENTAL ANALYSIS

A cloud computing lab has been step up using 10 clients. The various layer such as Infrastructure as a service has been created by using the Xen Cloud Platform (XCP). The major advantage of using XCP is open source and provides enterprise-ready server virtualization and XCP also provide cloud computing platform. The various range of guest operating systems such as windows, Linux, network and storage support for data and data center are support with the help of Xen Hypervisor. All the supports are provided with the help of XCP appliance which is used as a management tool and it has been tested by XCP provider as an installable image.

The cloud provider's needs such as hosting the services and data centers are addressed by the XCP using the combination of multi-tenancy capabilities provided with the help of Xen hypervisor and isolation. The virtual infrastructure cloud services provide the storage and network virtualization technologies. XCP platform also addresses the requirements of the private and public clouds such as security, performance, availability and isolation.

The platform as a service has been provided by windows Azure which is open and elastic cloud platform. With the help of datacenters which has been managed by Microsoft, is possible to build our application, deploy and manage the applications. With the help of Microsoft window Azure it is possible to build our own applications using any language which convenient, it is also possible to integrate tools or framework in windows Azure for building our applications. Windows Azure is providing a feature of integrating our existing IT environment with public cloud applications.

Solving computationally demanding and data-demanding problem can be solved with the help of matlab more easily and quickly. Using parallel computing toolbox in matlab. The jobs are created and for parallel execution of jobs is done by using workers, 15 tasks have been created for the corresponding jobs. And thus job creation time, tasks creation time, destruction time, result retrieval time and total execution time have been calculated. Using some of the parallel processing operation such as parallel for-loops and message-passing functions which allow us to implement task and data- parallel algorithms in matlab.

The table I shows the comparison of Hybrid algorithm with ACO algorithm based on number of task as the number of task increases the performance also increased. The figure 4 shows the comparison graph and thus the performance of the hybrid algorithm is considerably increases based on the number of task. The table II show the makespan improvement of Hybrid algorithm with ACO algorithm based on number of task as the number of task increases the makespan also tends to decreases The figure 3 shows the makespan improvement graph and thus the makespan of the hybrid algorithm is considerably decreases based on the number of task than ACO algorithm. The table III show the energy improvement and makespan improvement of Hybrid algorithm based on number of tasks as the number of tasks increases the energy utilize and makespan also tends to decreases and thus hybrid algorithm consumes less energy than the ACO algorithm. The figure 4 shows the makespan and energy improvement graph and thus the energy utilization of the hybrid algorithm is considerably decreases based on the number of tasks than ACO algorithm.

TABLE I. COMPARISON OF HYBRID WITH ACO ALGORITHM BASED ON NUMBER OF TASK

HYBRID and ACO			
Sl.No	**No. of task**	**Hybrid**	**ACO**
1	1	4.20694	4.20691
2	2	4.208	4.206
3	4	4.21428	4.211
4	8	4.22055	4.2132
5	16	4.25946	4.2432
6	32	4.26580	4.2487
7	64	4.27216	4.251
8	128	4.27364	4.2538
9	256	4.2766	4.2551

TABLE II. MAKESPAN AND ENERGY IMPROVEMENT HYBRID ALGORITHM BASED ON TASKS

ENERGY COMPARISON			
Sl.No	**No. of tasks**	**Energy**	**Makspan**
1	5	33.18	26
2	10	31.6	24
3	15	31.07	23.66
4	20	29.26	22.25
5	25	29.072	22.08
6	30	28.7	21.8
7	35	28.23	21.45
8	40	28.104	21.35
9	60	22.92	17.41
10	80	20.34	15.45
11	100	18.78	14.27
12	120	17.74	13.48
13	140	17.74	12.92
14	160	17.02	12.5

TABLE III. MAKESPAN IS COMPARED WITH HYBRID AND ACO ALGORITHM BASED ON TASKS

MAKESPAN			
Sl.No	**No. of Processor**	**Hybrid**	**ACO**
1	5	26	26
2	10	24	24
3	15	23.66	26.6
4	20	22.25	25
5	25	22.08	24
6	30	21.8	23.3
7	35	21.45	22.8
8	40	21.35	22.5
9	60	17.41	21.6
10	80	15.45	20.7
11	100	14.27	19.8
12	120	13.48	18.9
13	140	12.92	18
14	160	12.5	18.01

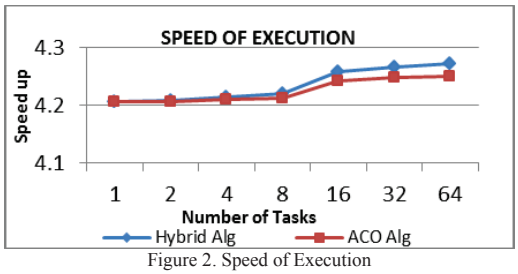

Figure 2. Speed of Execution

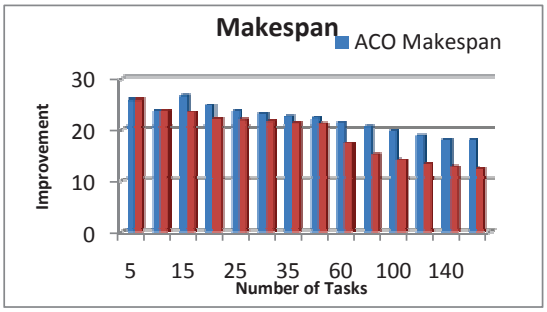

Figure 3.Makespan based on number of tasks.

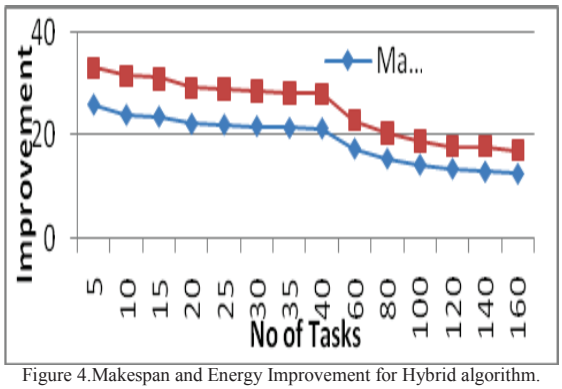

Figure 4.Makespan and Energy Improvement for Hybrid algorithm.

V. CONCLUSION

Cloud computing technologies offer major benefits to the IT industries several benefits of cloud such as High availability, fault tolerance and Infrastructure cost reduction. The main objective of the job scheduling is to decrease the makespan. In this paper we proposed a Hybrid algorithm which combines the advantage of ACO and Cuckoo search. We scheduled the tasks based on the reduction of makespan. Experimental results show that the efficiency of the hybrid algorithm is considerably increases. Makespan gets reduced by using a hybrid algorithm. In future Hybrid algorithm can be utilized for more and more jobs.

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