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Improved Genetic Algorithm with Min-Min Approach for Efficient Task Scheduling in Cloud Computing

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Abstract
Cloud computing has emerged to be a significant and prevalent computing model, which helps to provide services on demand. It renders metered services. Making efficient use of resources through the reduction of execution time and expense and consequently, maximizing the profit is the primary objective of cloud service provider. Hence, making use of efficient scheduling algorithms still remains an important challenge in cloud computing. Job planning as well as weight balancing in the Virtual Machine (VM) and reducing the makes pan involved in completing the tasks are the important research worries. In this work, Improved Genetic Algorithm with Min-Min (IGAMM) approach is proposed for efficient task scheduling over cloud. In the newly introduced technique, the workload imposed on machines gets added and reduced down as per their power. The major aim of this technique is to reduce the make span time, increase the usage of resources, and decrease the amount of energy consumed. A technique is introduced for workload scheduling in accordance with grouping of VMs in cloud environments. The objective of the novel technique is to improve the performance of cloud computing by minimizing the make span and response time, and by maximizing the usage of VM. The comparison of the novel algorithm is carried out with the available techniques in terms of different performance metrics. The results of the evaluation reveal that the performance IGAMM algorithm proposed is much superior compared to the existing techniques.

Keywords: *Cloud computing, Task scheduling, Improved Genetic Algorithm with Min-Min (IGAMM).*

1 Introduction

Cloud computing has developed leaps and bounds and garneredsubstantialfocusas it rendersscalability and efficiency to companies. Cloud computing is termed a distributed system of large scale thatprovides a massive set of computational resources to the clients of thecloud over the World Wide Web. Several cloud providers are available that route on the cloud calculatingsetting including Amazon, Google Engine, IBM, and Microsoft. Meanwhile, theyofferboth facilitiesthenassets to the clients on pay per use foundation wherever and whenever required [1].Cloud calculating provides three important distributionrepresentations that include Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). In the case of Software as a Service (SaaS), users are provided with applications and access management tools. Platform as a Service (PaaS) reduces tools like operating systems, files, as well assystem so that theclients can deploy and create their software and applications as desired. Infrastructure as a Service (IaaS) yields entrée to

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the physical components like hardware part as well assystem so that theclients can deploy as well as evolve their operating systems as well aspresentations according to their will [2].

Meanwhile, the cloud environment also faces several risks. The cloud computing environment includes two kinds of players, which are the cloud providersand another, the cloud user. Both these kinds of player functionbased on individualobjectives [3]. The cloud providers desire to improve the utilization of resources and then again, the cloud user like to reduce the cost when satisfying their needs. However, a deficit of information sharing exists between the cloud provider as well as cloud operator and therefore, it becomesquite hard to perform the resource allocation.

The scheduling concept in cloud computing indicates the approach of chartingof a group of tasks onto a group of virtual machines (VMs) or assigning the VMs to executeusing the resources obtainable to fulfil the requirements of the users [4]. The objective behind theusage scheduling approaches in the cloud environment is to increase thethroughput and load balancing of the system, improve the resource usage, conserve energy, minimize theexpenses incurred, and reduce the overall time taken in processing. Hence, the scheduler has totake the virtualized resources and users' demandedconditionsinto consideration to obtain aneffective match between the tasks and resources. Every scheduling approachneeds to be based on one or multiplemechanisms. The most common and significant strategies or goalsinclude time, cost, energy, QoS, and fault endurance [5].

Job Scheduling in cloud calculating is aboutdesignating the computational tasks onto the resource pooling queue between various resource users as perspecific criteria of resource usage under particular cloud conditions. Currently, no standard exists aimed atworkplanning in the cloud calculating environment. Reserveorganizationas well asworkplanning form the coretechnologies in cloud computing, which has a significant part in carrying out the cloud resource administration efficiently[6].

The aim of the scheduler is to reduce the subjective flow time of a group of PSE tasks, when too reducing Makespan while a Cloud is used. As in the ACO algorithm, the load calculation is done on every host considering the CPU used by all of the VMs, which are running on every host. This evaluation metric is quite helpful aimed at an ant to select the host that is loadedto the least amount to assign its VM [7]. Parameter Sweep Experiments (PSE) is a kind of numeric imitation, which is aboutexecuting several stand-alonetasks and generallyneeds much of computing capacity. These tasksneeds to be processed with efficiency in the various computational resources belonging to a distributed environment likes the ones that the Cloud provides. As a result, in this context, job scheduling certainlyplays a pivotal role.

The Min-min algorithm, even though isbest at reducing the scheduling time taken for choosing the task from the waiting queue, and is simplein making the task workload being sent to the most efficient resource, it may at times increase the makespan. Although Suffer age algorithm is quick in getting rid of these problems and exhibitsa commendable performance in terms of both makespan time and the leveraged system workload, there are still chances that the scheduling is repeated for the same task. Also, all these scheduling techniques do nottake regard of the various levels of QoS requests pertaining to user tasks and the resource characteristics of being dynamic and heterogeneous in the cloud computing environment.

2 Related Work

LipsaTripathy, et al. [8] used a scheduling strategyfor scheduling the different occupations in jobplanning. The works get arranged in cloud

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employing this strategy used to get rid of the drawbacks faced in the existing protocols. It helps in improving the resource utilization, server presentationas well asoutput. A technique is developed, which in turn, reduces the time taken for switching, improves the resource usage and boosts the throughput and server performance. This techniqueor elseprocedureis basedon the arranging activity on the jobs sent into the cloud and useful in resolving the setbacks encountered in the earlier protocols. In this, the priority is allocated to the job thatyieldssuperior performance and it is tried to reduce the waiting and switching times. Attempts have been put in to the best to tackle with the scheduling of jobs for resolving the shortcomings observed in the earlier procedures and also improves the efficacy and output attained in the server.

NimaJafariNavimipour, et al. [9] explained about a novel algorithm designed for jobplanning known as cuckoo search algorithm (CSA) in the Cloud calculating environment. CSA procedure depends on the parasitic nature of an obligate breed of cuckoo combined with the Levy flight characteristic of few fruit flies and birds. Just one solitary egg is laid thrueach cuckoo at a certain point time that itputs into a neighbouring randomly chosen nest, and so the host of the nest can define the presence of a foreign egg with a likelihood of Pa [0, 1]. The value of Pareduces to an extremely less value when the speed and convergence of the algorithm goes to the extreme.

Xiaonian Wu, et al. [10] formulated an algorithm, which depends on the QoS given. The algorithm identifies the priority degree of variouskinds of tasks, which depends on variouskinds of properties of the jobsas well as also uses the categorisation operation on the jobs mapped onto a facility that can help further in finishing the task. In the first step, the newly introduced procedure finds the priority of various tasks considering the specific kind of attributes of tasks, whichdepict the tasks precedence order and then the sorting of tasks takes placein accordance with their priority. In the next step, the algorithm computes the achievementperiod of every task on variouskinds of services and schedulesevery task onto that particular service that can finish the task veryquickly with ease in line with the ordered task queue. The results depend on Cloud Sim and its note worthy presentation and load balancing is shown in terms of QoS, obtained from both importancethenachievement time that the procedure achieves.

Zhao et al [11] suggested a jobplanning algorithm encompassed with source attributes assortment, which can choose the best node requiredfor task execution as per its resource demands and the level of fitnessexisting between the resource node and the task. The outcomesof experiments reveal that a substantial improvementis observed in the execution throughput and resource usagein comparison with the three of theearlier algorithms and four planningstructures. As per the comparison between scheduling algorithms, the throughput achieved is 77% more than the Min-Min algorithm and the resource usage can go up to 91%. As per the association between the different scheduling frameworks, the throughput (along with work-stealing) is nearly 30% morecompared to the existing structures and then the source usagecan go up to 94%.

Eleonora Maria Mocanu, et al. [12] used the genetic algorithm forfinding the optimal resolution for resolving theproblem of jobplanning. The associatedtest was carried out in the Hadoop platform. A Genetic Scheduler is fundamentallyfound from the Job queue scheduler period. The importantgoal of this research work is to design a scheduler that depends on genetic algorithm, useful in resolving different issues and also boosts the efficiency achieved of Hadoop's platform.

3 Proposed Methodology

In this work, a technique for scheduling the tasks with the objective of reducing makespan, reducing the average response time, and improving the resource efficacy is introduced. The newly introduced system is quite dynamic, implying that the tasks are sent ina dynamic fashion, however the resources of the system remainconstant. At first, virtual machines are organizeddepending on the processing potential and are classified into three categories, which are: low MIPS (Million Instruction per Second), Medium MIPS, and high MIPS.

In order to resolve the problem of the recent large-scale applications for cloud computing rapidlyevolving in variousfields such as industrial, governance, scientific and personal, it is vital to explore and designthe resource management strategies, particularly the task scheduling strategies. Through the mapping performed of m user's tasks onto n resources suitably, task scheduling technique could effectivelyincrease the resource usage, reduce the makespan and thus improve the performance achieved out of the cloud computing system on the whole. But, it becomesdifficult to get the most optimized solution among the n! resource subset space in very less time for the NP-complete having a big m and n. As a result, heuristic algorithms that yielddesired suboptimal solutions in an affordable amount of computational time are designed.

3.1 QoS Parameters:

QoS is a broad concept, which differs between applications. The traditional network parameters of QoS comprises of bandwidth, latency and the distance between nodes, whereas the classical computational part of QoS consists of CPU speed, size of memory andlatency in data access. Particularly, the data input time of the task is introduced to be the new Qos parameter in this model due to the dynamic and non-homogeneous cloud computing environment, which accounts for the varying task/host attraction [13].

With the aim ofattaining the performance of both the user tasks' metrics involving Qos requirements and the lessercomplexity in execution, thenewly introduced model classifies the tasks into two categories as high QoSneeds(group1) and low QoSneeds(group2). The tasks present in group1 having higher QoSneeds can only be run on hosts provisioned with higher QoS, whereas the tasks present in group1 with low QoSneeds shall be run in nearly all of the hosts.

The tasks present in the set of high QoS needs has to be scheduled just prior the tasks present in the set of low QoSneeds. Both the methodologies associated withtraditional min-min heuristic algorithm and suffer age heuristic algorithm do not take the impact of QoS into consideration, which in turnneedsitprior to task scheduling. In the present task scheduling, the tasks having various extents of QoS requests contend for resources. When a task having no request for QoS could be run on both the high QoS and low QoS resources, the execution of a task requesting for a higher QoS service can only be performed on a resource that yields asuperior quality of service. Therefore, there are chances for tasks of low QoS to take up high QoS resources whereas tasks with high QoS wait for the low QoS resources to become vacant. In order to get over this disadvantage, the resource allocation for tasks in the set of high QoS needs has to be executed first.

3.2 Improved Genetic Algorithm with Min-Min (IGAMM) approach for task scheduling

Genetic algorithms can perform chromosome encoding in two means, which include: dual coding as well as floating point quantity coding. Even though binary coding is pressed by the flaws of uninterrupted function discretization plotting mistake as well as separate coding cord, it may not be able to satisfy the accuracy demands within a shorter span of time, however the search

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capability of binary coding is quite bettercompared to the floating point number coding. The variationis more prominentwith the increase in the size of the population. [6] Hence, the chromosome encoding in this workfollows binary encoding, employsa two dimensional array for storing purposes, the rows indicate jobs as well as columns denote the computational assets.

The time that every computing resources takes for executing each of the allocations can be computedusing the chromosomes and the ETC (Expected Time to Compute) matrix [7] (ETC [i] [j] indicates that the time for the ith task executing on the jth computing resources required for completion). Also the time taken for completing all the tasks is given by the full amount of time computed as above. Presume that the number of computational assets as n, the number of jobs as m. So the overall time taken for completing the scheduling is expressed by:

$$\text{Schedule time} = \max \left\{\sum_{i=0}^{m} \mathrm{ETC}[i][j] \times \mathrm{chromosome}[i][j]\right\} \quad (1)$$

The initial population is randomly generated. Every time of generated the population is generated, few of the particular patterns has to be removed. The presence of these particular designs (implying that the same task gets scheduled again and again so that it can be run on several computing resources) will have animpact on the search efficacy [14].

The aim of job planning optimization in this research work is not just about reducing the overall task time, but also the balancing ofthe load of all the computational resources. This load balancing is quantified using the standard deviation of the time taken by every computational resources to finish all the tasks assigned to it. The task execution time of every computational resource is given by:

$$\text{VM time} = \sum_{i=0}^{m} \mathrm{ETC}[i][j] \times \mathrm{chromosome}[i][j] \quad (2)$$

The lesser the standard deviation, the neither would be the task execution time on every computational resource to the normal task execution time on every computational source, and the more balance would be imposed on the load. Therefore, the Fitness Function is expressed by

$$Fi = 1/\mathrm{ScheduleTime} + \mathrm{Load} \quad (3)$$

It indicates that the scheduling represented by the individual takes the minimum overall time to finish the task and the load getting balanced on every computational resource, and the greater the fitness value, the simpler for it to be selected.

The Selection Probability

Selection operation forms the elementarymeans of the genetic algorithm used for realizing the transmission of good genes. In the modified algorithm, roulette selection is employed during the selection operation. Also, the probability of every individual being chosen is in proportion to the fitness function's value. Therefore, the selection probability is computed with the fitness function given below

$$Pj = Fj / \sum_{j=0}^{n} F_j \quad (4)$$

When choosing the next set of species, the probability that every individual will bechosen is computed using (5). This selection finds that few individuals exists with the leastoverall task time along withthe balanced load present in the population, when stillpreserving the genetic diversenessin the populace.

The min-min algorithm approach schedules the tasks present in the set of low QoSneeds. The min-min algorithm could be helpful in scheduling the job for the tasks present in the set of low QoSneeds for computing time and reducing the make span since that every task can be executed at every node such that the makespan would not get extended. The min-min algorithm is integrated

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with genetic algorithm to improve the performance of the cloud.

Crossover and Mutation

Crossover is hailed to be the important examine worker used in genetic algorithm, which replicates the procedure of recombinationinvolving sexual replica observed in cosmos, and it takes the real best genes to the next subsequentset of species, and produces new species with agood gene formation. Mutation can helpenlarge the novel exploration space and preserve the population diversenessif there is local convergence of the population. In case, the crossover probability of genetic algorithm is more, then the genetic model having agreater fitness shall be eradicated.

In caseof the crossover probability beingless, the search conducted for the optimal solution will not be quitefast. In a similar way, for the probability of change, if it is very high, fewremarkable genetic models will be more possibly get eliminated. If the probability of change is greater, then the genetic algorithm will degrade intoa random search algorithm. When the probability of change is less, then the search procedure of the algorithm will tend to slow down. Determining the crossover and mutation probability is a hardjob, and the probability of finding is not really the optimum likelihood. Hence, the newly introduced IGAMM algorithm maximizes the probability of crossover and mutation if thepopulation's fitnessexhibits consistency, and it automatically decreases the probability of crossover and mutation if the fitness getsdistributed. Meanwhile, individuals having fitness that is higher compared to the average fitness must be providedwith a lesser probability of crossover mutation to get into the subsequent subsequentspecies. In the case of individuals with the fitness less compared to the average fitness, a bigger likelihood of crossover mutation must be provided to remove them as earlier as conceivable.

4 Experimental Result

In this section, the existing Min-Min Algorithm (MMA) and ACO algorithms are considered to evaluate the performance metric against proposed IGAMM algorithms. The performance metrics considered include accuracy and time complexity.

Accuracy

The system offers better performance when the proposed algorithm yieldsgreater accuracy.

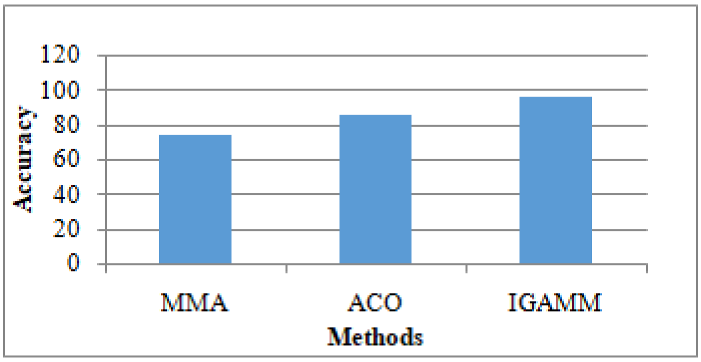

Fig 1 Accuracy

Fig 1 given aboveshows the evaluation of the accuracy metric by comparing the earlier and proposed techniques. The techniques are plotted along the x-axis and the accuracy value is plotted along the y-axis. The earliertechniques including GA and ACO algorithm yieldsmuch accuracy while thenewly introduced IGAMM techniqueyieldsmuch better accuracy for the data provided. Thus the result concludes that the proposed IGAMM improves the resource allocation process over the cloud computing.

Time complexity

The system is superior if the proposed method yieldsmuch lesser time complexity

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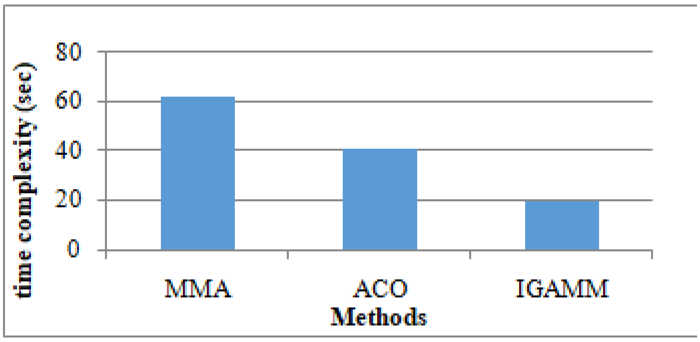

Fig 2 Time complexity

Fig 2 shows the comparison analysis carried out on theearlier and proposed techniques in terms of time complexity. The techniques are plotted along the x-axis and the time complexity value is plotted along the y-axis. The available methods are such as GA and ACO algorithm yields bigger time complexity valueswhile thenewly introduced IGAMM method yieldsmuch lesser time complexity for the data given. Thus the result concludes that the proposed IGAMM improves the resource allocation process over the cloud computing

5 Conclusion

In this work, a noveltechnique IGAMM is introducedas a scheduling algorithm to increase the cloud computing performance. The newly introducedtechniqueinitiallycategorizes the virtual machines on the basis of processing capability. Thereafter, by utilizing the fitness function values, the jobs getassigned to the suitable virtual machine. QoS is a broad concept and is different for different applications. In this work, a new scheduling heuristic is introduced by taking the QoS factor into consideration for scheduling and few changes are proposed with the help of min-min algorithm and genetic algorithm. The results of the experiments reveal that new IGAMM method can be immensely help in minimizing the makespan and average response times. In addition, it maximizes theusage of resources in this work.

References

1. D. C. Marinescu, Cloud computing: theory and practice. Newnes, 2013.
2. N. Almezeini and A. Hafez, “An enhanced workflow scheduling algorithm in cloud computing,” in CLOSER 2016 - Proceedings of the 6th International Conference on Cloud Computing and Services Science, 2016, vol. 2
3. V. Manglani, A. Jain, and V. Prasad, “Task Scheduling in Cloud Computing.,” Int. J. Adv. Res. Comput. Sci., vol. 8, no. 3, 2017
4. L. Liu and Z. Qiu, “A survey on virtual machine scheduling in cloud computing,” in 2016 2nd IEEE International Conference on Computer and Communications (ICCC), 2016, pp. 2717–2721
5. D. P. Chandrashekar, “Robust and fault-tolerant scheduling for scientific workflows in cloud computing environments.” University of Melbourne, Australia, 2015
6. Kamal Kc, KemaforAnyanwu. “Scheduling Hadoop Jobs to meet deadlines”, IEEE Second International Conference, pp- 388-398, 2010.
7. Mateos, C., Pacini, E., &Garino, C. G. (2013). An ACO-inspired algorithm for minimizing weighted flowtime in cloud-based parameter sweep experiments. Advances in Engineering Software, 56, 38-50.
8. LipsaTripathy, RasmiRanjanPatra “Scheduling in cloud computing” International Journal on Cloud Computing: Services and Architecture (IJCCSA) ,Vol. 4, No. 5, October 2014
9. NimaJafariNavimipour and FarnazSharifiMilani,“Task Scheduling in the Cloud Computing Based on the Cuckoo Search Algorithm” International Journal of Modeling and Optimization, Vol. 5, No. 1, February 2015
10. Xiaonian Wu, Mengqing Deng , Runlian Zhang , Bing Zeng, Shengyuan Zhou “A task Scheduling algorithm based on QOS- driven” International conference on Information Technology and quantitative Management(ITQM) pp. 1162- 1169 , ELSEVIER(2013)
11. Zhao, Yong, et al. "Efficient task scheduling for Many Task Computing with resource attribute selection." China Communications 11.12 (2014): 125-140.

12. Eleonora Maria Mocanu, MihaiFlorea, MugurelIonuţAndreica, NicolaeŢăpuş "Cloud Computing – Task Scheduling based on Genetic Algorithms" ©2012 IEEE
13. Han, Haiwen, et al. "A Qos Guided task Scheduling Model in cloud computing environment." 2013 Fourth International Conference on Emerging Intelligent Data and Web Technologies. IEEE, 2013.
14. Liu, Jing, et al. "Job scheduling model for cloud computing based on multi-objective genetic algorithm." International Journal of Computer Science Issues (IJCSI) 10.1 (2013): 134.