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Fault and QoS Based Genetic Algorithm for Task Allocation in Cloud Infrastructure

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Abstract: Cloud computing is now trending and more popular in these days for the computation and adopted by many companies like google, amazon, Microsoft etc. As the cloud size increases with increase in number of data center power consumption over a data center increases. As number of request over the data center increase with increase in load and failure probability over a data center. So the requests need to be balanced in such manner which having more effective strategy for resources utilization, request failure and improved system reliability. A recent survey on cloud computation shows that the failure probability of a server, increasing in a linear way due to increase in number of independent resource (processors) resulting in request failure at datacenters. So to overcome these issues in cloud Infrastructure as a service (IaaS), we have proposing a fault and learning based Genetic algorithm for task allocation to minimize the request failure and improve QoS (Quality of Service) over a data center. Proposed algorithm has proven to have better performance in term of load and request failure rate as compared to previously proposed task allocation algorithm for cloud IaaS.

Keywords: *Cloud computing, QoS, Resource Utilization, Failure probability, Reliability, Cloud Infrastructure as a service.*

1. INTRODUCTION

Cloud computing is more popular and promising epitome for both consumer and provider in different field like engineering mathematics and highly used in business industries in homogeneous and heterogeneous way. Request from different kind of area are served by data centers in cloud environment also increase power consumption. However, to keep computing large scale requests on data centers required huge amount of power, which leads to high power consumption. Request type also affect the services i.e., private or public requests. As per survey in 2006, data center consumed around 4.5 billion kWh, which is equal to 1.5% of total power consumed by USA, and increasing 18% yearly [1]. In general Cloud Computing deals with various issues listed as follows: 1) as cloud computing adopted by industry and number of user also rapidly growing with number of data centers with increasing power consumption. 2) task allocation among data centers without having information of QoS provided by them.3) Current task allocation algorithms focus on load balance when request load increases but not on failure probability of server. 4) High loaded data centers has high failure probability to compute requests

and may be due to high load theses data center slow down which is not good for user as well cloud provider.5) Some data centers having less load compare to highly loaded data center and they are under maximum load but high loaded data center computing them with high failure rate.6) Some request are need to be computed with QoS but due to high load and fault rate they may the QoS promised which is not appropriate to user and will be a critical issue. 7) As per recent study [4-7], utilization of data centers is major problem because 60% data centers are idle and most of 20% data centers are fully utilize and wastes of resource. This show poor utilization of resources but this shows importance of new approach that have sufficient strategy to minimize wastes of resources as much as and increasing reliability by allocating task over resources which in case of Cloud is VM with low failure probability to provide high QoS to users.

This paper focus on fault tolerant task allocation algorithm that emphasis hardware capability and faults in cloud. Proposed algorithm lead computation with fault tolerance in new directions and improved utilization of all resources accordingly. There are many factors of cloud computing which are untouched and can give best results and optimize the computation schema, request failure is one of them. VM or request failure at a datacenter depends on configuration of server hardware, high configuration of hardware and most priory load on a datacenter, that can be network load, storage load, computational load. Data centers are processing the requests which are scheduled by scheduler using a scheduling algorithm and at the end they need to be computed on allocated resources which may be faulty or over loaded. There is always a fixed capacity of data center to serve request beyond that data center need extra resource to do extra computation with the same hardware configuration, here is chance of task failure or some interruption during the process due to limited resource. This paper proposed an approach to avoid such situation with efficient manner as well continue task computing without any interruption.

Data center applies an algorithm to allocate resource to complete request with some configuration which makes it computable as soon as possible to serve request and response them, but some time due to more than its request server capability request comes and queued and data center compute the task with its maximum serve capability and finish the computation and it's increase the load and there are chances of system failure which is not appropriate and cause loss of money. This scenario may be coming into existence and decrease the productivity and down the system performance. There are many algorithms to find least loaded server, which can provide service efficiently and economically.

This paper proposes an dynamic way to minimize the computation and maximize utilization of resource by allocation resource to request by getting energy efficiency, fault tolerant and factors which make it more efficient and reliable computation over cloud environment. Proposed algorithm emphases on learning base algorithm to find an appropriate solution which cannot be achieved using static algorithm like max-min, min-min and ant colony optimization take fault into consideration.

2. RELATED WORK

Cloud Computation is a new domain and need more research to make it more reliable, in order to have a better user experience in term of task computation.

We have proposed a scheduling algorithm which is based on fault and reliability of task to complete task scheduling in high reliable manner and better utilization.

Many researchers have done research and introduce us some beneficial and optical scheduling algorithm. [1] Proposed and algorithm Min-min algorithm, in this choose least the completion time of task and schedule to serve accordingly. In this paper they proposed load balance Min-min algorithm which having basic properties of Min-min algorithm and consider minimizing completion of all request. In this proposed three level service model used.

1. **Request manager :** To take request and forward to Service managers.
2. **Service manager:** Various manger works or task and dispatch them to respective service node.
3. **Service Node :** Service node provide service to request which came to request mode

They have merged two approaches (OLB Opportunistic load balancing and load balance min-min) scheduling algorithms in this model. The main focus of combined approaches is to distribute the request or dispatched task basis of their completion time to suitable service node via an agent. This approach not saying about main system, suppose if request are somehow moving or scheduled in the same server and due to lots of load sever need more power to complete these request and more physical heat will generate and to stop heating system need an external cooling system which also lead to extra power source and one more important thing is due to overheating system performance slow down The same way [2] proposed and another algorithm for task scheduling, this paper proposed VM resource allocation basis on genetic algorithm to avoid dynamic VM migration to completion of request. They have proposed a strategy to share or allow resource equally to VM so it can work fast and minimize response time to subscribe. They also proposed hotspot memory (virtual memory) assignment and dispose that after completion of request via remapping of VM migration. Here VMware distribution tool is used to schedule computation work in a virtual environment. As genetic algorithm characteristics is to find best, fittest VM in terms of Cloud computation.

This paper checks fitness of each VM and schedule task accordingly. When creating a VM a process executes to create that and increase process work that also lead to more process and increase energy consumption.

Hu, Jinhua et al.[3] Proposed another scheduling algorithm, this paper proposed an approach for collective collaborative computing on trust model. The trust value taking as a factor for task scheduling, trust value mutually took from consumers as well service provider, which make it fail free execution environment. Here they have proposed a mathematical equation to calculate the Reputation point which enhances the reputation of VM in terms of fast execution and type of task. If the reputation of VM is high them more task allocation will be happening to that VM. To calculate Reputation many factors have to consider which also reflect QoS of cloud computing. This paper also proposed a way to serve a request reliability, as well trust management with a reputation of VM factor which are lead to trustworthy. Trust has calculated by a mathematical equation and schedule accordingly.

Hu, Jinhua et al. [4] Proposed a live VM migration algorithm, this paper proposed a method for VM live migration with various resource reservation system. VM migration is taking place on the basis of source machine load, if the load is high then it can wear, during execution of the request it migrates the VM to another server or data centers to complete the task without interruption for better performance. Resource reservation done both sides, i.e., Source machine and target machine as well will in such manner CAP (maximum availability of CPU) allocate them and adjust memory resource dynamically. At the end of target machine, they properties time bound program which will keep monitoring for cup resource utilization. Memory Reservation done by allocating crating certain number of VM and when the migration process comes into existence these VM got shut down to evacuate the space to migrate VM. Sometime it may be possible that target machine not having enough space to migrate in such condition that physical machine should remove from candidate machine for migration and which physical machine having the capability or enough space will lead to migrate VM. This paper implemented and simulated using Xen Virtualization.

Barroso et al.[5] This paper proposed an algorithm, dynamic and integrated resource scheduling algorithm for cloud datacenter which balance load between servers in overall run time of request, here they are migrating an application from one datacenter to another without interruption. Here they are introducing some measurement to ensure load balancing. They have given a mathematical reputation to calculate imbalance load to calculate average utilization to its threshold value to balance load. To implement DAIRS they have used physical server with physical cluster and Virtual servers with virtual cluster. Application migration saves time instead of

migrating whole VM data.Barroso et al. [6] - proposed a most known base scheduling algorithm ACO (ant colony optimization) they proposed ant colony optimization algorithm to load balance by distributing request in a cloud computing environment. This paper proposed LBACO with dynamic load balancing strategy to distribute load among the node.

The problem with traditional ACO in cloud is that it's a schedule task to most frequent (high pheromone intensity) node, if what if node is bearing heavy load in such situation may create a problem of overhead. This paper proposed and LBACO algorithm to reduce such problem. In this algorithm decrease the time of computation and monitor load on each VM with tracking previous scheduling.Xiaobo et al. [7] proposed and Real-time VM provisioning model, which is based on energy models which follow a Min-Price RT-VM Provisioning to allocate VM.Suraj, S. Rin et al. [14] proposed a genetic algorithm for task allocation in cloud environment with least execution time and maximum resource utilization.

Above proposed algorithms are either general scheduling algorithms or proposing a strategy to improve resource utilization and has assumed the cloud to be non-faulty. In real world faults occur at datacenter due to hardware failure or software failure, which may decay the reliability of system to process requests.So in next section we have proposed an algorithm, which will deal with such problem in a faulty system, and requests have to be completed within less failure probability and with higher resource efficiency.

3. PROPOSED MODEL

In above section existing proposed algorithms are either discus about task scheduling or resource utilization and some of them talk about task or VM migrating to fulfil requests but the existing algorithm do no consider fault nature of infrastructure or software failure into consideration which can't be ignore. They consider cloud as an ideal non-faulty system.

The problem with these algorithms is that these algorithms are proposing simple task scheduling based on power or resource utilization to complete the task and maintain quality of service at data center. Existing algorithms are not fault tolerant and only take load over the datacenter into consideration, which is in sufficient to maintain quality of service to the user.

So to overcome these issues a fault aware learning based resource allocation algorithm is been proposed using Genetic algorithm. Genetic algorithm helps us to find a solution, which cannot be, achieved my any static or dynamic algorithm. More over fault tolerant genetic algorithm help to find a fittest solution in term of least makespan (Time taken to complete a request) and least request failure probability. Proposed algorithm uses Poisson probability distribution for random request failure at virtual machine i.e. at host and datacenter level. On the other hand, request failure over a datacenter may occur randomly due to storage, network failure or VM crashes. Based on fault over a datacenter and computing capability of a system, we have proposed a task allocation policy to minimize the total makespan over the system and reduce request failure probability. According to algorithm collect the information of data center resources and capability, and the count of failure occurred over a period of time on a datacenter.

Proposed algorithm is divided into four phases which are as follows:

1. Initialization
2. Evaluation and selection
3. Crossover
4. Mutation

1. **Initialization :** In this phase we have a set of tasks (T1, T2, T3, T4, T5, T6…. T n) and a set of resources in term of virtual machine (VM1, VM2, VM3, VM4, VM5…. VM m) are pre allocated on hosts in distributed datacenters. Here we initialize asset of sequences or schedules allocated randomly, each sequences act a chromosomes for genetic algorithm. The complete set of chromosomes is said to be a population, acting as a input for algorithm.

2. **Evaluation and selection :** In this phase we evaluate the fitness value for each set of sequence or chromosome, which depends up on the computing capability, total time taken to complete the schedule and the failure probability of complete schedule.

Where

Fi : Faults occurred on a system over the time T

FRi : Fault rate that is the number of request failed due to system failure over time *t*.

FPi : Failure probability over a Host *i*.

REi : Reliability of a Host *i*.

ʎ **:** Fault rate over a time T

Since faults over a datacenter are random in nature and follows Poisson distribution, which over a period of time *t* and $t + \Delta T$ can be defined as:

$$\text{FPi}\ (t \le T \le t + \Delta T \mid T > t) = \frac{\exp(-\lambda t) - \exp(\lambda(t + \Delta T))}{\exp(-\lambda t)} \quad (1)$$

$$\text{FPi}\ (t) = 1 - \exp(-\lambda \Delta t) \quad (2)$$

$$\text{RPi} = e^{-\lambda t} = e^{t/m} \quad (3)$$

If

VM_MIPS *i* : MIPS of ith virtual machine

T_Leng *i* : Length of ith Task

Then the predicted time to complete a task Ti is defined:

$$\text{T\_Exei} = \left(\frac{\text{T\_Lenght } i}{\text{VM\_MIPS}i}\right) \quad (4)$$

$$\text{Total\_time} = \sum_{i=1-n} \frac{\text{T\_Lenght } i}{\text{VM\_MIPS}i} \quad (5)$$

The fitness value for a chromosome is defined by the fitness function gives as:

$$\text{Fitness\_chromosome}_i = \alpha(\text{Total\_time } i) + \beta(\text{FPi}) \quad (6)$$

Where $a + b = 1$ (7)

Based on the fitness value of chromosome the fittest one is selected having least fitness value. The population is sorted based on the fitness value and best two are selected for next phase.

3. **Crossover :** In this step two fittest solutions based on least make span and failure probability is selected. We have used multi point crossover to generate new fittest sequences/ chromosome. Steps to generate crossover are as follows.

a) The two fittest chromosomes are selected

b) A new fittest chromosome is generated using multi point cross over by interchanging the set of schedules between two chromosomes.

c) The new chromosome replaces the chromosome with highest fitness value.

4. **Mutation :** In this phase new merging the new offspring, which can be better solution with remaining which, regenerates population keeps the total population size constant after each iteration. After specific count of iteration predefined as an input to genetic algorithm, best chromosome is selected *i.e*. the chromosome with least fitness value is selected for schedule.

3.1. Proposed algorithm

Fault Based Genetic Algorithm Task Allocation

Algorithm:-FGATA(VM List VM_l , Task list T_i, population size Po , Iteration Itr)
//Input : Po, VM_l, Itr and T_i
1. $VM_i \leftarrow$ VM_List() ;
2. FI ←getFault();
3. i ←No. of VM
4. $T_i \leftarrow$ Task_List();
5. C ← Genetic _algo(Vmi ,Ti, Po, Itr);
6. Allocate_Resource(C); // processing the client request.
7. End

Figure 1: Proposed Algorithm initialization

Genetic Algorithm

Genetic _algo(VMi ,Ti, Po, Itr)
//Input : Po, VM_l, Itr and T_i
1. Po ← Initiate_Population(Ti,) ;
2. Evaluation();
3.C1 ← getFittest1();
4.C2 ← getFittest2();
5. Crossover(C1,C2)
6. Mutation(Po , C1, C2);
7. Return(getFittest());
6. End

Figure 2: Proposed Genetic Algorithm

```
1. Evaluation(){
2. For each Ci   i=0 - po
3.       For each Ti
4.           temp= α (Ti/Vmi ) + β (FPi)
5.           Fitnessi = Fitnessi +temp
6.       End
7. END
8. }
```

Figure 3: Proposed Evaluation Phase

```
1. Allocate_Resource(C){
2. Ci ← Getchromosomes();
3. For each Ci
4.       Allocate(Ci);
5. END
6. }
```

Figure 4: Proposed Allocation Phase

Proposed algorithm provides a benefit over existing static scheduling algorithm, that it can search for best global solution rather than assuming the local best solution as the best solution. Moreover, the proposed algorithm takes into consideration the faulty behaviour of cloud, which helps in find a solution with similar high utilization and least failure probability.

4. EXPERIMENTAL RESULT

For simulation we CloudSim 3.0 power module is used. CloudSim 3.0 provides cloud simulation and predefined power model simulation. We have simulated proposed fault aware Genetic task allocation algorithm in CloudSim. Proposed algorithm is being tested over various test cases with 10 servers D0-D9 and Poisson distribution model for random request and fault model in distributed environment.

Table 1
Stimulation settings

Server	*RAM (Mb)*	*MIPS*	*Storage (Gb)*	*Core*	*PE*	*HOST*
D0	2000	10000	100000	4	6	2
D1	2000	10000	100000	4	6	2
D2	2000	10000	100000	4	6	2
D3	2000	10000	100000	4	6	2
D4	2000	10000	100000	4	6	2
D5	2000	10000	100000	4	6	2
D6	2000	10000	100000	4	6	2
D7	2000	10000	100000	4	6	2
D8	2000	10000	100000	4	6	2
D9	2000	10000	100000	4	6	2

Testing of proposed algorithm is done with basic Genetic algorithm proposed by Suraj, S. Rin [14]. Testing is done for 1000, 1500, 2000, 2500, 3000, 3500 requests with population size been 100, 200, 300, 400. Iteration for simulation of each simulation is 100.Table 1 shows the simulation setup and server configurations.

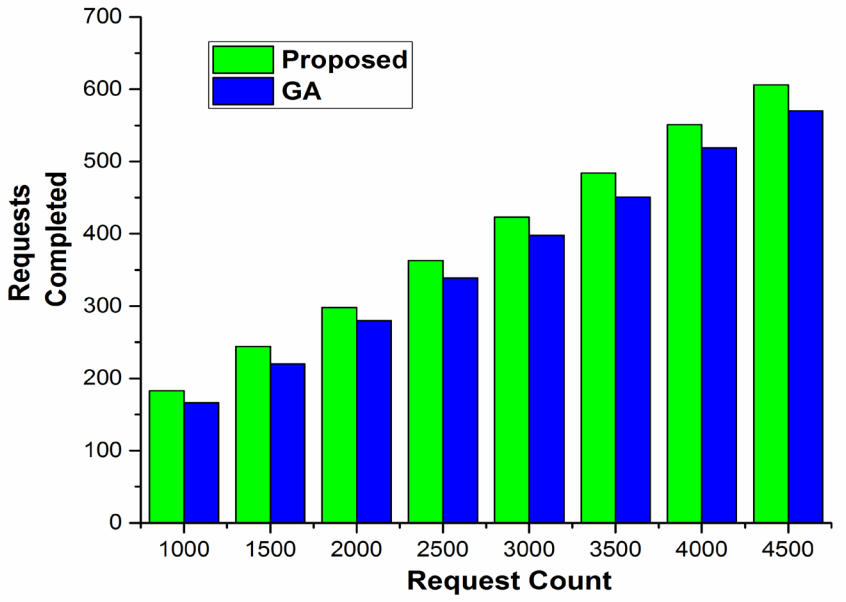

Figure 5: Comparison of improvement in request completed

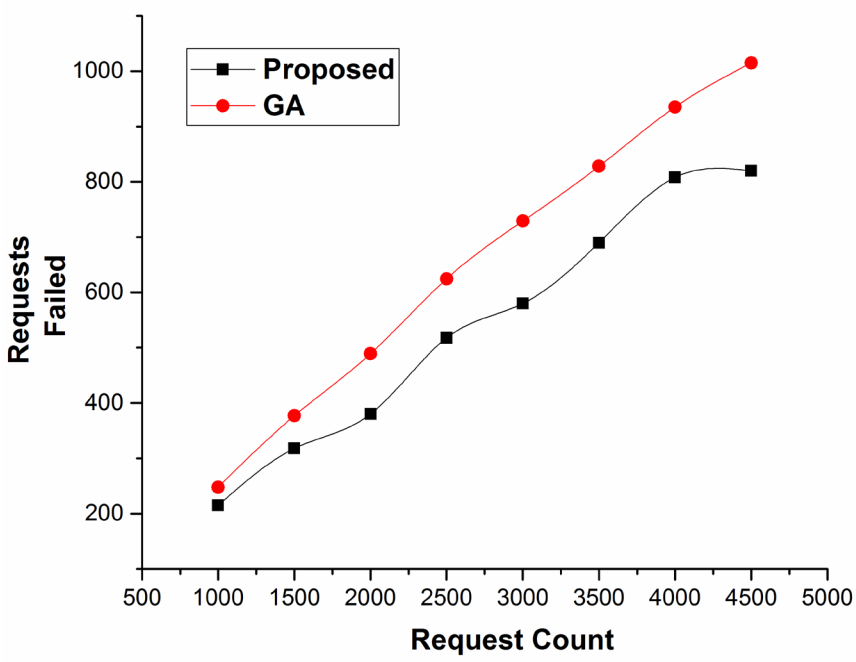

Figure 6: Comparison of improvement in request failed

Figure 5-6 compares the improvement in number of request failed and request competed with increase in number of requests over the system. The failure count reduces over the proposed system in increase in completed requests over the system.

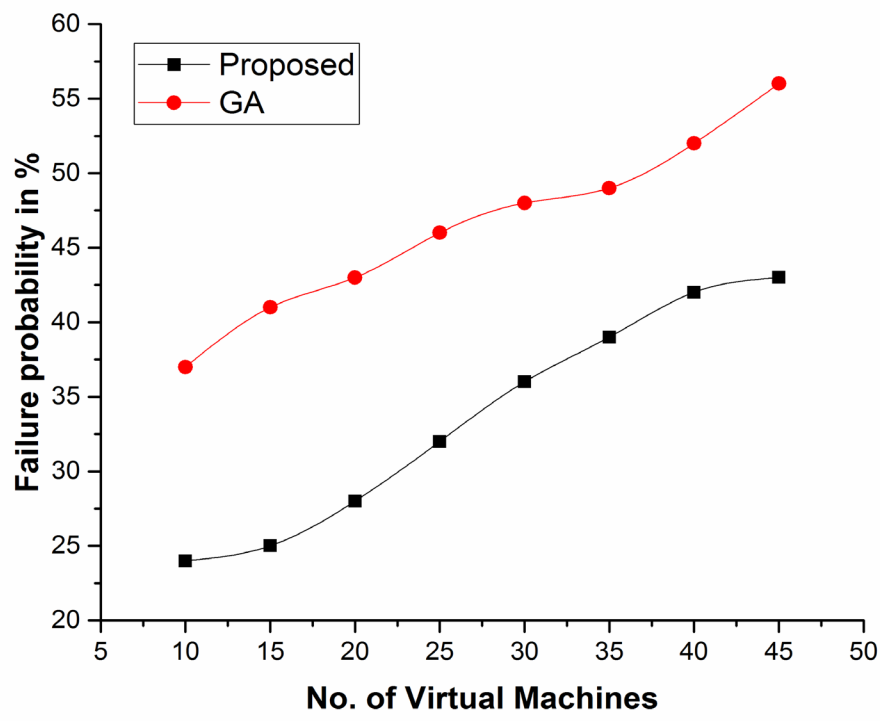

Figure 7: Comparison of failure probability with variable resources

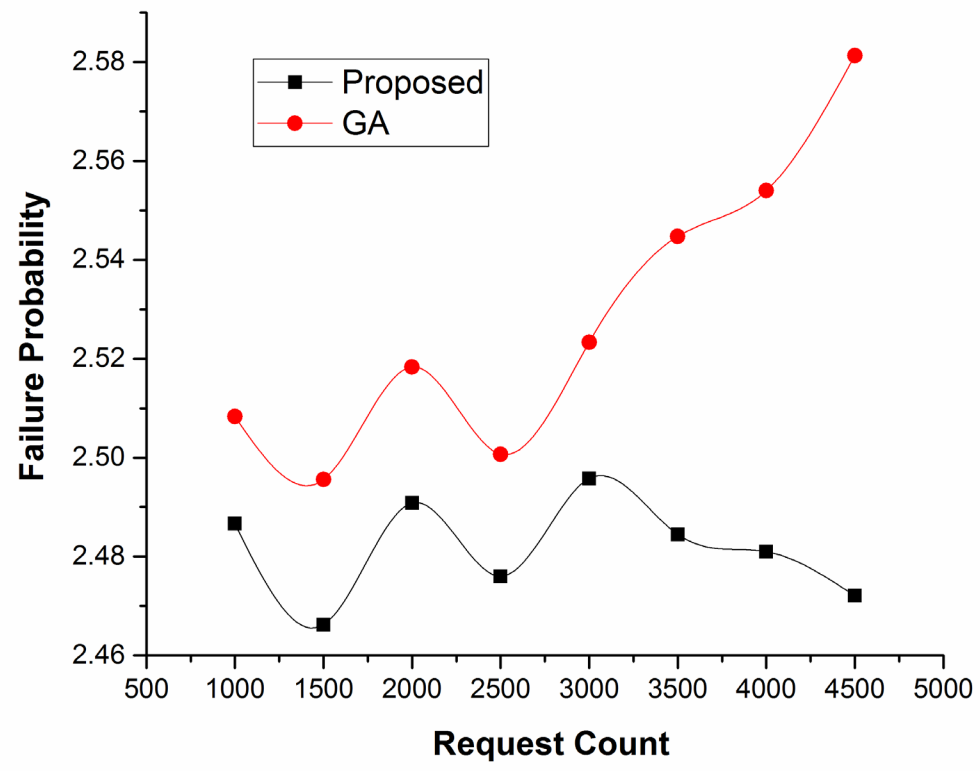

Figure 8: Comparison of failure probability with variable request

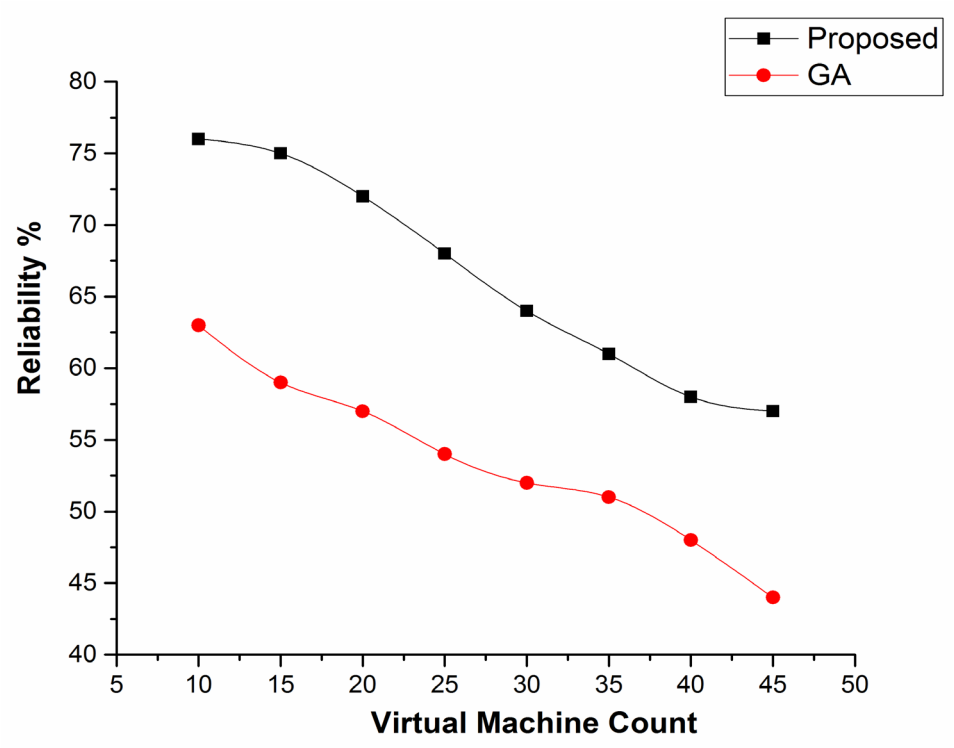

Figure 9: Comparison of reliability with variable resources

Figure 7 discourses the improvement in failure probability with increase in number of resources since with increase in number of VM's the probability of failure increases over the system. Figure 8 shows the improvement in failure probability with increase number of request count. Figure 9-10 shown the increase in reliability with increase number of VM's and request counts.

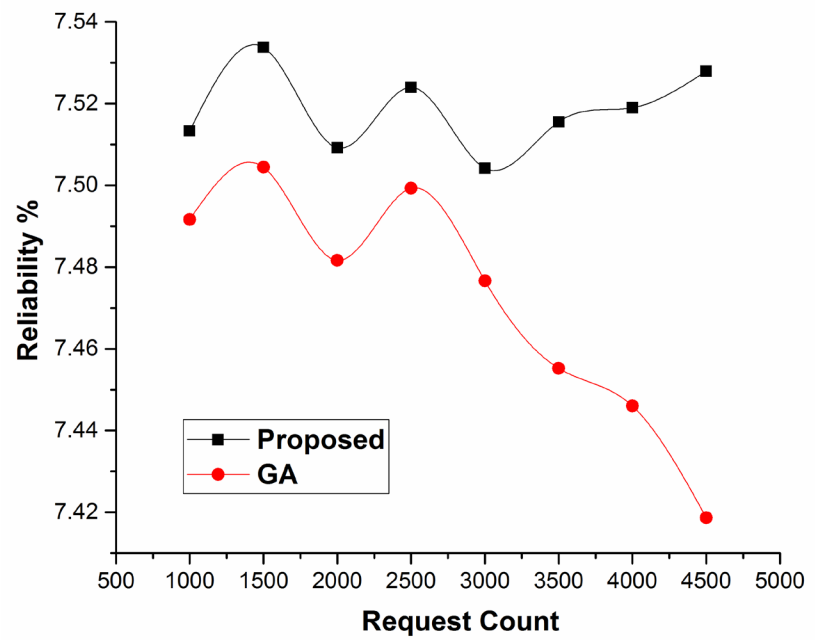

Figure 10: Comparison of reliability with variable requests

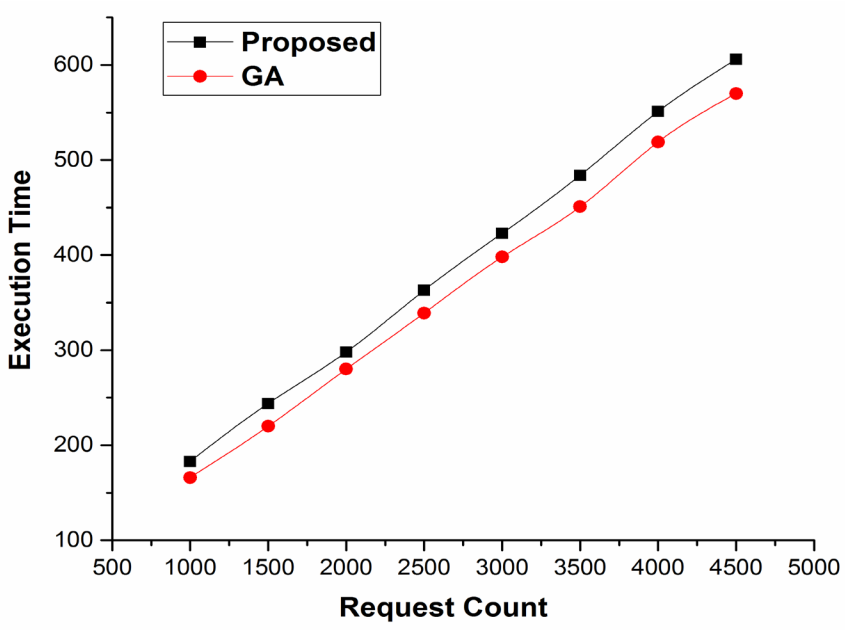

Figure 11: Comparison of execution time with variable resources

Figure 11 shows the drawback of proposed algorithm with small increase in complete execution time.

5. CONCLUSION

From experimental result section, it is clear that proposed fault aware GA (Genetic Algorithm) provides better QoS (Quality of service) as compared to previous proposed GA algorithm. The main idea of this algorithm in cloud computing is to complete maximum number of requests with least failure probability, proposed algorithm shown that it can maximize reliability and minimize the number of request failed. This strategy has proven that it provides better QoS in term of high reliability with increase in number of requests and resources with failure probability.

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