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SERVICE REQUEST SCHEDULING IN CLOUD COMPUTING USING META-HEURISTIC TECHNIQUE: TEACHING LEARNING BASED OPTIMIZATION (TLBO)

Kritika Shrivastava[1], Dr.Ramesh Kumar[2]

[1]PG Scholar, Department of Computer Science & Engineering, Bhilai Institute of Technology (BIT), Durg, Chhattisgarh, India
[2]Professor, Department of Computer Science & Engineering, Bhilai Institute of Technology (BIT), Durg, Chhattisgarh, India

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Abstract - *Cloud computing is the field in the IT world, which comprises of all kind of services provided over the internet. But, for its flawless performance and smooth services delivery to the users it needs to be effectively managed, that can be by the mode of "Scheduling". There are different types of scheduling done in cloud environment. Many optimization algorithms have also been applied in scheduling which gives sub-optimal solution for the problem domain i.e. Heuristic optimization technique. But, in Heuristics optimization time taken is too large for wider set of problems. So, for solving the large problem set we use Meta-Heuristics Optimization technique which gives near optimal solution for the problem and solves it in a particular limited time for the given set of search spaces. Heuristic optimization is the subset of the Meta-Heuristic optimization, which is problem independent which means it can be applied to any set of problems whereas heuristic approach is problem specified which means it is designed for solving a particular problem only. In this paper, we are using nature inspired meta-heuristics method "Teaching Learning Based Optimization" (TLBO) for scheduling in cloud computing among the user and the cloud service provider: Service Request Scheduling using TLBO. We will generate the effective scheduling result in form of comparative analysis with the other meta-heuristic algorithm. comparative analysis with the other meta-heuristic algorithm.*

Keywords: Cloud Computing, Service Request Scheduling, Meta-Heuristics, Heuristic, TLBO, GA, PSO, Fitness.

1. INTRODUCTION

Cloud computing-an environment which deals with 3-tiers architecture: 'Consumer/User', 'Service provider' and 'Resource provider'. We know, very well now that cloud computing environment provides shared pool of resource on-demand request from the user via internet. The cloud computing fulfills different features like storage management, computation management, web based resources for the users as requested by them.
There are different types of clouds based on their deployments they are: Public, Private, Hybrid & community cloud. [3] Flexibility, scalability, reliability, multi-tasking, availability, virtualization & easy computation are the various characteristics of the cloud which makes it so popular among the people. [1]

The Cloud Environment Services is categorized in 3 parts as: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) & Software as a Service (SaaS). IaaS provides the resources, virtualized resources to the user as a stored data etc that too on demand. PaaS makes it easy for user to program in cloud or to develop some application.[2] Software, Application for use is provided by SaaS. Various Examples of cloud are Amazon's EC2, S3 and salesforce.com. [9].But to get the proper blend of each of its characteristics, features to the users there is need to have a staunch functioning among each of the level of the 3 tier architecture of Cloud, for which "Scheduling" is a must, so that effective services is being reached to the user in less time and with ease of use.

There are many scheduling done in cloud computing, but mostly two types of scheduling is being focused in 3 - tier architecture of cloud "Resource Scheduling" . Resource scheduling is Scheduling between the service provider and resource provider [11] whereas service request scheduling is between the user and the service provider.Many researchers have focused on the scheduling issue of allocating resources and tasks in the cloud computing system i.e. on resource scheduling part. But, scheduling between the user and the service provider is more complicated [4] as service provider is

being flooded with many of the user request at the same time and not many researchers have been carried out in this scheduling as compared to the resource scheduling.

2. LITERATURE REVIEW

Scheduling whether in the field of cloud computing or in the other field, it is a must so as to carry out efficient performance in particular area of field. Scheduling is done, so as to schedule different hardware, task, resources and users to one another according to their assigned task/purpose. The main reason behind scheduling is that the number of one of the main module is less or there is scarcity, so to avoid scarcity problem and to use the available no. of hardware (Virtual machine, servers, PCs etc) we do scheduling, so that the task can be effectively done in available sources only.

In cloud computing the problem of scheduling falls under the NP-hard problem, which is related to the time complexity to solve any problem. NP-hard means that the problem cannot be sorted out in a polynomial time complexity optimally by algorithm. [16]Therefore, many algorithms have been used in the cloud computing environment for the scheduling of its various functionalities in different forms. The use of algorithm for scheduling in cloud environment is categorized into 3 categories: “General traditional scheduling Algorithm”, “Heuristic optimization algorithm” & “Meta-Heuristics Optimization”. [13]

Where general algorithm includes various traditional scheduling algorithms like First come first serve (FCFS), Shortest Job First (SJF), Round Robin and much more.[10] Heuristics include min-min, enhanced min-min algorithm etc.[17] And Meta-Heuristics include Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) and Teaching Learning Based Optimization technique (TLBO), which we are using in this paper. We will discuss some of the methods proposed using this algorithm in cloud environment:

a) First Come First Serve (FCFS) is the most common scheduling method used. [4] This is the simplest of all method in which the task which arrives first n the scheduler will be scheduled first rather less any priority preferences it is having. It first initializes the task and then assign queued task to the n numbers and hence process it. For which the next task have to be wait long in a queue which concludes in large time consumption.

b) Shortest Job Scheduling Algorithm (SJF) [2] is another general scheduling algorithm used. SJF works on the basis of execution time which can be taken by the job to be executed. The job which will have lowest time to be taken in execution is being executed first and is queued first for the execution process, because of which the job with highest execution time has to wait long in the queue for its execution.[12]

c) Round-Robin Scheduling which assigns particular time to each job to be processed. It is fairer in nature as it allots the time slices for that particular time only it will process and if it processed after the allotted time then the process is being added to the tail of the queue. Queue in Round robin works in a circular form.[18]

d) Efficient Task Scheduling [19] is the blend of Longest cloudlet fastest Processing (LCFP) and Shortest cloudlet fastest Processing (SCFP) algorithm which helps in calculating the completion time of cloudlets and to minimize the time taken for the completion of the cloudlets.

e) Authors proposed a Service request scheduling algorithm on “Dynamic Priority Scheduling Algorithm (DPSA)” algorithm on service request scheduling in cloud computing, scheduling is done with help of DPSA and is compared to SPSA which concluded that DPSA gives better performance than the existing technologies. [4].

f) In the paper [14],Author proposes a scheduling method in cloud environment using Meta heuristic approach i.e. Particle swarm Optimization (PSO) and compared the enhanced method to other method like Genetic Algorithm (GA),Brute Force(BF) and FIFO but found that the PSO scheduling was much better than the rest.

g) In this paper [5], the TLBO Comparison with different Meta heuristic approach is provided, and concluded that TLBO is better than GA, ACO and improvised TLBO method is proposed.

h) This paper , uses Genetic Algorithm(GA) for the dynamic scheduling of cloud data by using the memory usage and the computation as a factors , the scheduling is performed using GA.[15]

i) The paper [13], gives the detailed comparative analysis of various Meta heuristics algorithm used in the cloud computing scheduling.

j) The paper describes the use of Min – Min Heuristic to generate the initial population. [20]

k) Various problem of size optimization is solved using TLBO and the TLBO algorithm is explained very efficiently in this paper. [21]

l) In the paper "Efficient Resource Utilization Algorithm for Service Request Scheduling in Cloud", EURA algorithm helps to improve the QoS between the user and the service provider by the help of the utilization ratio which increases the resource utilization and hence resulting in efficiency rate enhancement [7].

m) In the paper, "Profit –Driven Service Request Scheduling in Clouds", where sharing through maximum utility and maximum profit based model is being made. [8].

3. TEACHING LEARNING BASED OPTIMIZATION (TLBO): OVERVIEW

In this paper, we are proposing a scheduling method in Cloud Computing between the user and cloud service provider (Service Request Scheduling) using a natural meta-heuristic optimization technique: Teaching Learning Based Optimization (TLBO)".

TLBO is the Meta-heuristics algorithms, which is nature inspired. It works on the teachers-learners based behavior in classroom. In this technique there is basically two phase:-

1) Teacher Phase
2) Learner Phase

It is the optimization technique based on population, design variable and its possible solution. It is a non-traditional optimization technique. It takes out best near to optimal solution for a problem.

1) **First Phase**, **Teacher Phase***:* The rest of the learner gets to learn from the teacher and improve their knowledge. As we know that the teachers taught the students to increase and explore their knowledge, similarly here in algorithm, teacher phase, the teacher will try to enhance the performance of learner.

In Teacher's phase among whole population the 'best solution' is calculated and is termed as 'Teacher' (Best Solution)($X_{teacher}$) among all, this is the procedure how we select the teacher among all the population .The Best solution ($X_{teacher}$) is being compared to all the learner's mean result(X_{mean}),so that the teacher can enhance the mean performance of all learners accordingly like Best Solution ($X_{teacher}$).Parameters 'r' & 'T_f' are applied in the TLBO method so as to maintain the staunch features of TLBO search as it is. Where, 'r' is the random number & 'T_f' is factor, teaching factor (which ranges between 1 - 2 only). [21]

TLBO can be formulated as:

$$X_{new} = X_i + r\,(X_{teacher} - T_f . X_{mean})$$

Where, X_i is the existing learner and X_{new} is the new updated X_i.

2) Second Phase: ***Learners Phase:*** Learners phase, the learner gets to another learner to learn more and more and increase its knowledge. If our learner is not better than other from whom it learns it will move towards that learner or get itself updated, and it can be formulated as:

$$X_{new} = X_i + r.\,(Xi - X_j)$$

Where $f(X_i) < f(X_j)$ i.e. X_i is better than X_j (another learner from whom learner learns). [6]
Similarly, If, $f(X_j) < f(X_i)$ then:

$$X_{new} = X_i + r.\,(Xj - X_i)$$

Finally, if X_{new} gives the best among all then it is finally selected. The pseudo code or the algorithm procedure of TLBO (Fig.1):

TLBO Process

Step 1:- Population *Initialization*

Step 2:- *Fitness Evaluation* among the population

Step 3:- Best Solution or *Teacher Selection*

Step 4:- **If** *Termination Criteria* met, ***then*** Select the Optimal Solution required and Stop, ***else*** Update the population via Learner phase then again repeat the Step 2 again until the criteria is meet.

Step 5:- *Best Solution* as Output

Fig - 1: TLBO Pseudo Code

4. GENETIC ALGORITHM: BREIF OVERVIEW

Genetic Algorithm (GA) is the biological inspired population generation technique for calculating the optimal solution for the particular problem. [22] When we use GA, initial population called as chromosome is generated randomly. '*Fitness Value*' is also present in this GA as TLBO; so as to select the effective chromosome among the population its fitness value is measured and then the chromosome is selected through the selection process. After this, on the selected chromosome genetic factors like *crossover* and *mutation* is performed so as to create *offspring* for the new chromosomes and the process will terminate depending on the size of the chromosome having the best fit value among rest of the population.
The Pseudo Code of GA is:

Genetic Algorithm

Step 1:- *Chromosome generation* or Initial Population generation

Step 2:- Fitness value is calculated

Step 3:- Selection process is performed

Step 4:- Selected Chromosome go through the ***Crossover.***

Step 5:- Operation of ***Mutation*** is done.

Step 6:- If the best fitness value chromosome is generated terminate ***else*** repeat from step 3 again

Fig - 2 : Genetic Algorithm Pseudo Code

5. RESULT OF TLBO SCHEDULING IN CLOUD ENVIRONMENT

In our proposed method we are taking two features for service request scheduling (user and the cloud service provider) in cloud environment i.e. firstly, No. of Users (U_n) & secondly, the No. of virtual machines (V_n).The scheduling takes place between these two aspects. As, in TLBO we are having 3 main characters i.e. population, Design variable and its Possible solution in relation to our proposed method the 'population' will be the 'No. of Users', 'Design variable' will be the 'Virtual Machines'.

As per the TLBO formula, we do the 'Fitness evaluation', so as to calculate the fitness value among all the population and the design variable (here, formulated in a matrices form as a random no.). After the fitness evaluation we do the 'Trainer Selection' according to which the no. of users can be updated. The 'Termination Criteria' will be the maximum no. of iterations to search for best solution.

If the Criteria are not meet, then again it will update the no. of users (U_n) the learner phase followed by the fitness evaluation again and then the trainer selection and when the termination criteria is meet then select the best optimal combination of U_n & V_n and then the process will be terminated as the best cost or best solution is being calculated.

Implementation: We used MATLAB for this TLBO scheduling. Flowchart of our TLBO Service Request Scheduling is as follows:

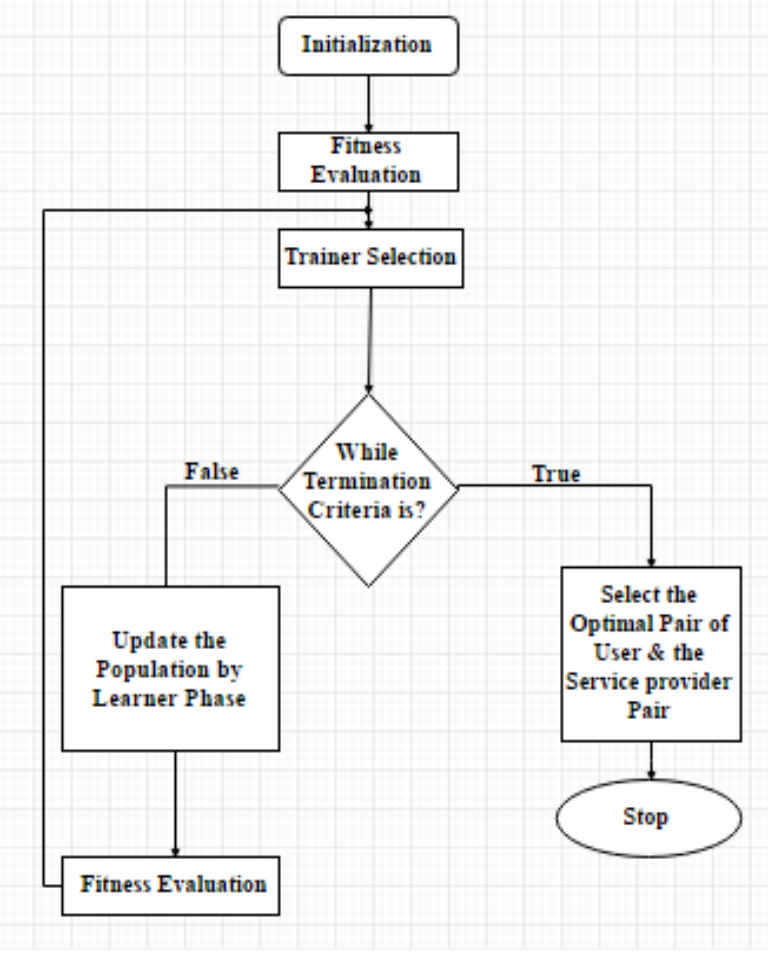

Fig- 3: Flowchart of TLBO Scheduling

When we execute the TLBO scheduling the results occurs as such given in Fig. 4 & Fig.5:

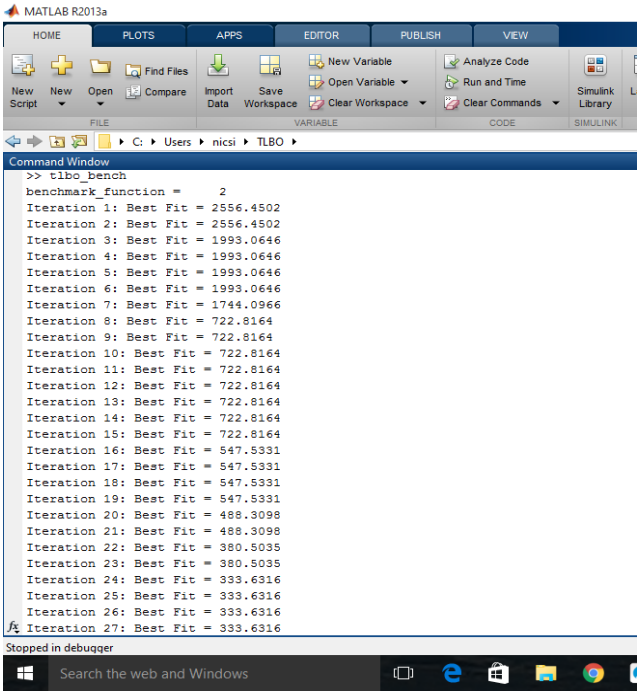

Fig- 4: Initial Iterations

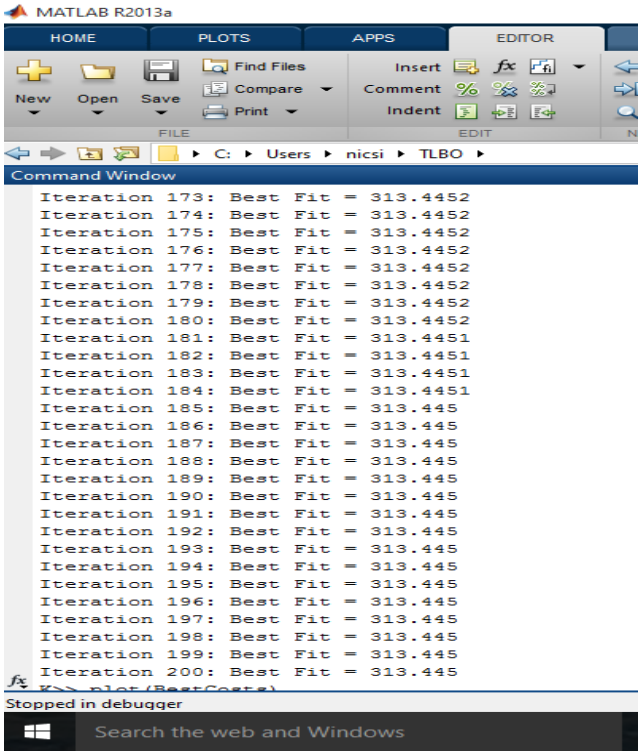

Fig- 5: Final Iteration with Best Fit

After the execution of the TLBO scheduling, the graph of *Fitness* Vs *Iteration* is given in Fig-6:

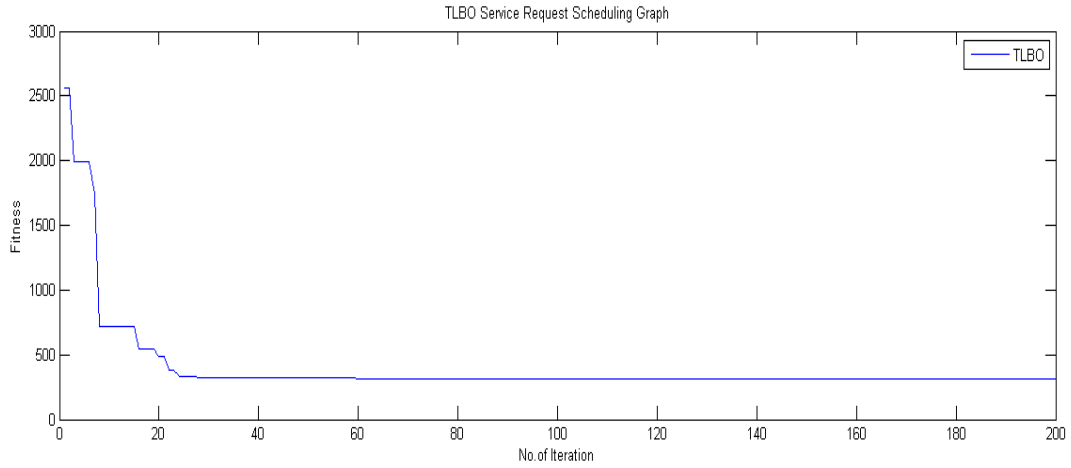

Fig-6: TLBO Scheduling: Fitness Vs Iteration

Now to see our TLBO scheduling is effective or not we compare our TLBO method with that of Genetic Algorithm (GA).The graph is being plotted with two factors like *fitness* value against

the *iterations*. Where *X-plane* represents the *iteration* and *Y-plane* represents the *fitness*. Blue line represents the Genetic Algorithm and Red line represents the TLBO. [Fig – 7 & 8]

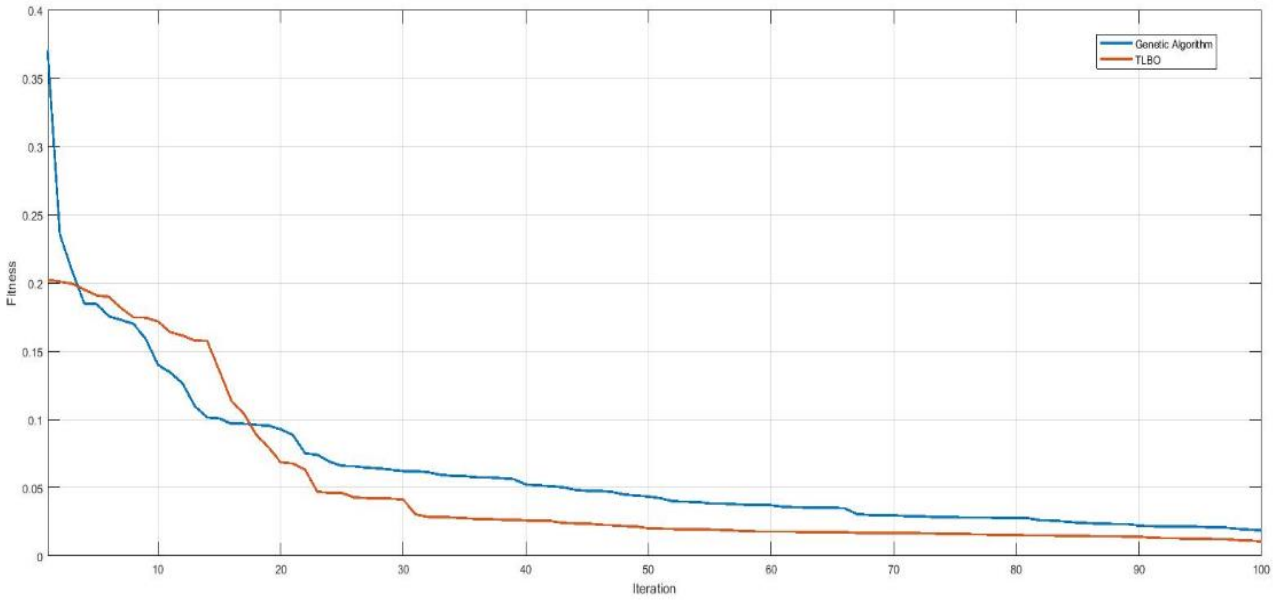

Fig - 7 : TLBO Vs GA Graph Comparison

In the above Fig.7 graph showed the comparison between the TLBO & GA where for TLBO when initial population is 100, then in less no. of iterations only we got our best solution where as not in the GA case.

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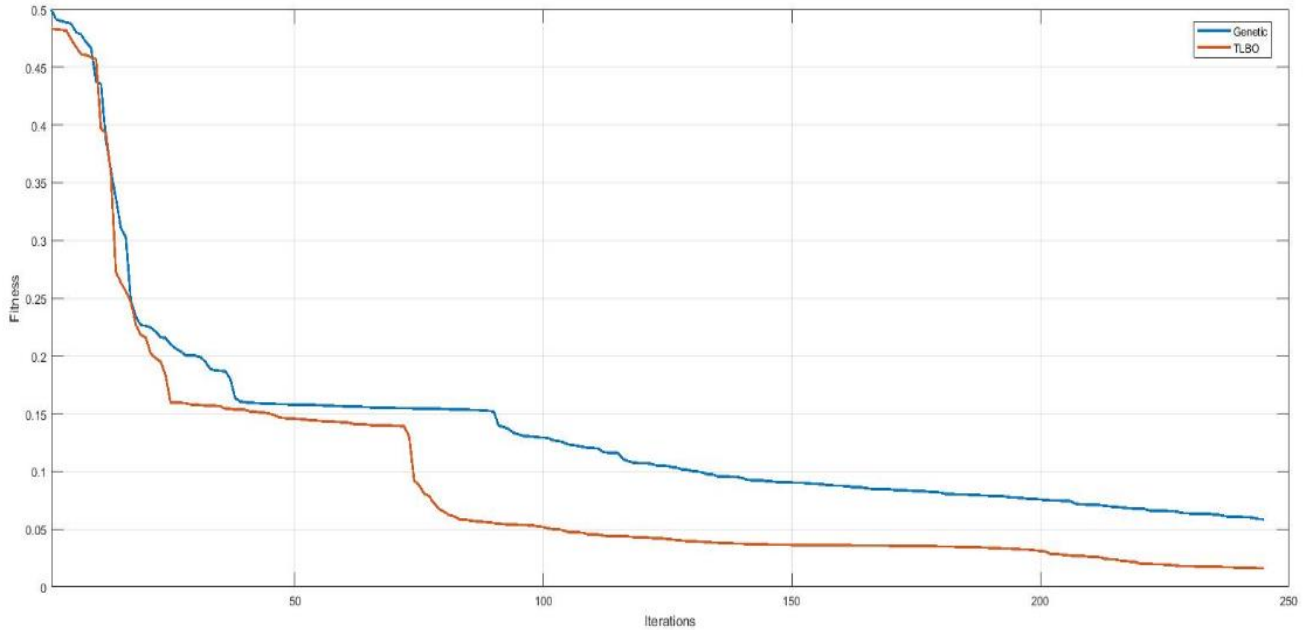

Fig-8: TLBO Vs GA Graph Comparison 2

Similarly in the graph Fig - 8 when the initial population is 50, then also we get our best solution much more early then GA as we can see that TLBO gets saturated before GA that means in less time and is less complex then GA and the best fit in case of TLBO is much feasible.

6. CONCLUSION AND FUTURE SCOPE

In this paper, we had used TLBO meta-heuristic method so as to improve the service request scheduling part of the cloud computing, where we had done the scheduling among the no. of users and the virtual machines. By the help of the TLBO method we calculated the best solution for the selection of the optimal combination of the user and the virtual machine pair which resulted in reducing the delay, increasing the performance and hence therefore helping to use the optimization technique rather than the exhaustive algorithm who were complex and as well as had large time complexity to do scheduling in cloud environment. When compared to GA the TLBO resulted in faster processing as for calculating the best fit or best solution the GA has to go through several operations whereas in TLBO it's only about the best solution through two phases itself in less time as compared to GA.

The future work which could be carried out can be that we can consider much more factors another than no. of users and no. of virtual machine for service request scheduling using enhanced TLBO method thereby improving the QoS of the cloud Computing.

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