PERFORMANCE ANALYSIS OF GENETIC ALGORITHM IN DIFFERENT CLOUD COMPUTING ENVIRONMENTS

Navpreet Kaur Walia[1], Dr. Navdeep Kaur[2]
Department of Computer Science and Engineering
Sri Guru Granth Sahib World University
Fatehgarh Sahib, Punjab, India
navpreet.walia12@gmail.com[1] , drnavdeep.sggswu@gmail.com[2]

ABSTRACT: Cloud Computing is the inevitable emerging technology which thrives on managing the services to users in an effective manner. Providing those services requires an optimal solution for scheduling tasks to the resources within time bound. Genetic Algorithm (GA) is one of the scheduling algorithm which is based on evolutionary concept has been extensively studied in literature. In this paper, the performance of the Efficient Genetic Algorithm (EGA) is evaluated in different cloud computing environments. A comparison analysis revealed that EGA is more effective in heterogeneous environment as compared to homogeneous environment.

KEYWORD- Genetic Algorithm; scheduling; cloud environment.

I. INTRODUCTION

Cloud computing is the new buzzword which aims at freeing up the users from the management of software, hardware, data resources and networks. Cloud computing based on dynamic provisioning has the ability to provide the users what they require and only pay for what they actually use via Internet. With the exponential growth in the demands of users, cloud computing provides a flexible computational architecture, collection of autonomous systems in high performance computing environment [6].

Cloud computing uses the technology of virtualization as the fundamental concept. Virtualization technology not only brings a large number of virtual resources in cloud but also provide a lot of convenience to cloud computing [7]. With the use of this technology, cloud computing in tandem allows users to utilize computation, data, storage and services to fulfil the computational demands of users.

With the help of virtualization technology, the services provided by the cloud are Software as a service available in application layer, Infrastructure as a service available in physical layer, Platform as a service available in virtualization layer. A Virtual Machine (VM) instantiated with the requested resource in the server for every user request and hence, virtualization is the backbone of the cloud.

Scheduling is one of the prerequisites, which focus on the implantation of tasks with resources in such a way that the user gets the best performance. Task Scheduling is one of the most popular combinatorial optimization problems which maps different tasks to the numerous resources such that users can access them ubiquitously efficiently and effectively. There are numerous scheduling algorithms which are designed to meet the optimal performance by achieving different application requirements such as fairness, minimizing makespan, minimizing energy consumption, reducing cost and aware deadline constraint [15].

For these algorithms, the environments in which they are implemented are very important aspect to consider. The environment can be either homogeneous or heterogeneous. Homogeneous environment is the environment in which hardware and software generates similar results and storage representation on each hardware processor as well as software and contains similar output on floating point's compilations. It contains homogeneous machines which work under homogeneous network as a group of homogeneous systems. Heterogeneous environment is the environment in which multiple compilers are encapsulated as one and different machines

represent different results in accordance with time [1].

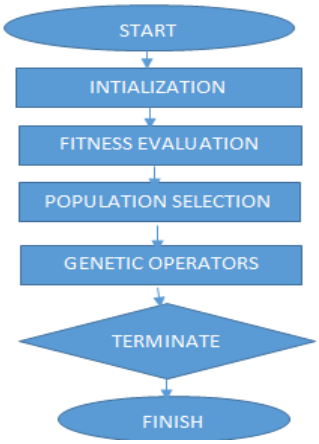
In the paper, we have considered the genetic algorithm and focused on the performance of this algorithm in different cloud computing environments i.e. homogeneous and heterogeneous. Section-II presents the working of the genetic algorithm. Section-III discusses the related work done on genetic algorithm. Section-IV consists of the analysis done on the performance of the algorithm and Section-V concludes the work.

II. GENETIC ALGORITHM

Genetic Algorithm (GA) has brought a remarkable impact to many growing fields [7], such as Knowledge discovery, Image Processing, Product Process Design, Artificial Intelligence, Pattern Recognition, Decision Analysis, Stock market Analysis and Resource Scheduling. Due to versatile features of genetic algorithm such as easy interfacing with the existing simulations and models, this algorithm has been widely utilized and rapidly developed [13].

A GA consists of chromosomes which represent the complete solutions i.e resource allocations. Chromosomes consist of a complete set of genes. A gene is the basic data structure of genetic algorithm and represents as a task. Genetic algorithm consists of five steps, namely, Initialization, Fitness evaluation, Population selection, Genetic operators (population crossover, population mutation) and Termination [15].

1. Initialization
   In this step, the initial population is selected randomly allowing the entire range of possible solutions (the search space) which are encoded into fixed binary strings.
2. Fitness Evaluation
   In this step, the fitness values are evaluated of the solutions obtained. The fitness function is the function which measures the quality of the represented solution.
3. Population Selection
   In this step, best solutions are selected based on fitness values and better ones survive to the next generation with their genetic material passed on.
4. Genetic Operators : Crossover and Mutation
   In this step, possible second generation population of solutions are generated from those selected by the use of the combination of genetic operators. This method is continuous until a new a population of appropriate size is generated. In Crossover, possible generated solutions are matched to for new generation and in mutation allocations are swapped.
5. Termination
   This steps executes when a fixed number of generations with a solution that satisfies minimum criteria.



In this paper, we have studied and evaluated the performance of the Efficient Genetic Algorithm (EGA) proposed by Shekhar Singh et al. [13] in different cloud computing environments. In this algorithm, they have initialized the population by using Enhanced Max-Min Algorithm and compared the performance with other existing algorithms such as Improved Max-Min, Efficient Max-Min, GA-LCFP and IGA.

III. RELATED WORK

Genetic Algorithm (GA) was first introduced in 1975 by Holland [7]. It is a heuristic search technique which uses the process of natural evolution based on a population of candidate solutions. It is normally used to generate useful possible solutions to the optimization problems [8].

In GA, each chromosome consists of a group of genes. A gene represents the task. In this algorithm, first step to start the algorithm is initialisation in which initial population is taken randomly and a fitness function is defined which checks the suitability of chromosome with the environment. On the basis of fitness value, the quality of each offspring produced for the new population is evaluated and genetic operators are applied. This is repeated until all possible optimal solutions are obtained. Many researches have studied this algorithm and tried to improvise the performance of the genetic algorithm [15].

S.C. Esquivel et al. [12] has discussed the problem of allocating of non-identical tasks in a multiprocessor or microcomputer systems. They have taken all schedules and tasks non – preemptive and their model consists of number of identical processors executing one task at a time. The results on the selected test suite revealed two important facts. Firstly, GA provides a set of possible optimal solutions, providing fault tolerance when system dynamics must be considered. Secondly, GA is free of the List Scheduling Algorithm anomalies.

Jing Liu et al. [6] has established a task scheduling model with the deadline constraint. They proposed a task scheduling model based on multi-objective GA for cloud computing. The model is focussed on encoding rules, crossover operators, selection operators and the method of sorting Pareto solutions. This research compared the proposed algorithm with the existing ones on the CloudSim Platform. MOGA algorithm minimizes energy consumption and maximizes the profit if service provided under the constraint of deadlines.

Scheduling of independent task using modified GA is proposed by Shekhar Singh et al. [14]. They have used the advanced version of Min-Max for the initial population which is to be generated. The performance of this algorithm has been evaluated with the existing algorithms. The results revealed that it outperforms in the performance with minimum makespan. Another approach for independent tasks is proposed by Pardeep Kumar et al. [9] in which improved genetic algorithm is developed and compared the performance with the standard genetic algorithm. The Improved genetic algorithm outperforms better than the standard algorithm.

Chun li et al. [3] introduced GA-ACO algorithm which aims at solving the convergence problem caused by the lack of initial pheromone of ACO. This algorithm effectively has improved the searching efficiency to solve task scheduling.

Few researchers have considered heterogeneous environment. The main problem in for heterogeneous computing is how to assign computation and communication resources to tasks and to schedule the order of their execution to meet some performance criterion. In a heterogeneous computing environment, a suite of different machines is interconnected to provide a variety of computational capabilities to meet the computational demands of large, diverse groups of tasks [1, 4].

Ryan Friese et al. [11] analyze the trade-offs between Makespan and Energy Consumption in Heterogeneous Environment. In this approach, they have used bi-objective genetic algorithm and with the help of Pareto, they were able to generate possible solutions. Hence, the performances of these solutions are discussed with respect to makespan and energy consumption.

Arash Ghorbannia Delavar et al. [2] have proposed a hybrid heuristic algorithm based on Genetic algorithm in heterogeneous environment. The proposed algorithm performs better optimization than other existing algorithms.

Kai Zhu et al. [7] proposed a hybrid algorithm of GA called MAGA, which is designed to solve load balancing problem on the basis of virtualization resource management. The proposed algorithm is compared with Min-MIN and achieved better performance of load balancing.

ISSN: 2229-6913 (Print), ISSN: 2320-0332 (Online)

A new resource scheduling strategy based on GA was proposed by Jianhua et al. [5] in which load variation of system virtual machine were analysed and an average load distance is introduced to measure the overall load balancing effect of the algorithm. The result revealed that this algorithm is able to solve the problem of high migration cost and problem of load imbalance after system VM being scheduled with a good global astringency and efficiency.

A performance evaluation have been done by Poonam Panwar et al. [10] in which they have evaluated the performance of the proposed genetic algorithm on different environments i.e homogeneous and heterogeneous environments on Multiprocessor systems. The results revealed that task scheduling in heterogeneous environment outdoes better than in homogeneous environment.

To throw more light on the performance of scheduling algorithms, our work has been focussed on the comparative analysis of Efficient Genetic Algorithm (EGA) in homogeneous and heterogeneous environment. To best of authors' knowledge, comparative analysis of performance of EGA scheduling algorithm has not been reported in literature.

IV. RESULTS AND DISCUSSIONS

We have used CloudSim simulator for analyzing the performance of the Efficient Genetic Algorithm (EGA) in different cloud environments.

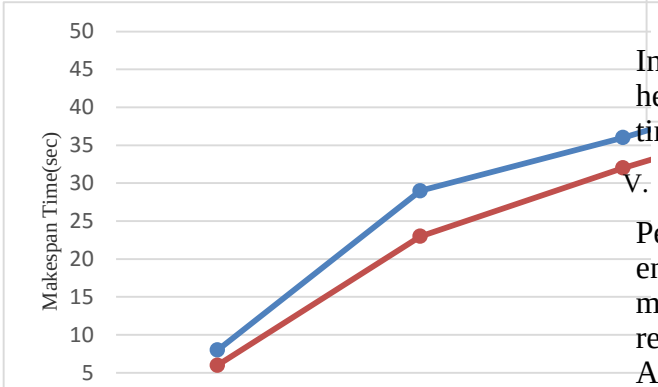


Fig.1 Performance evaluation with fixed number of VMs

We have evaluated the performance on the basis of makespan time. The maximum number of iterations is 1000, crossover probability is 0.8 and mutation probability is 0.5. We have considered two cases:

Case 1: In this case, VMs are fixed to 5 and tasks are varied with increment of 5.

The Fig.1 depicts the performance evaluation of EGA in different cloud computing environments with fixed number of VMs. The results revealed that the EGA performed better in heterogeneous environment as compared to homogeneous.

Case 2: In this case, tasks are fixed to 40 and VMs are varied with increment of 5.

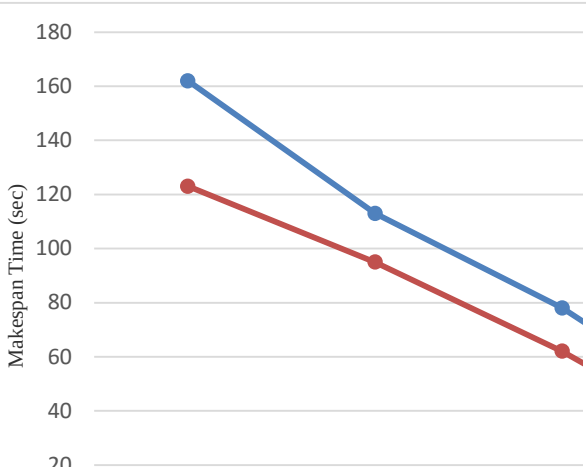


Fig.2 Performance evaluation with fixed number of tasks

In Fig.2, the results observed that EGA in heterogeneous environment has less makespan time than in homogeneous environment.

V. CONCLUSION

Performance of different cloud computing environments has been compared by using makespan time of EGA. The experimental results had shown that the EGA Scheduling Algorithm outperforms in heterogeneous environment as compared to homogeneous environment. Thus, algorithms in

ISSN: 2229-6913 (Print), ISSN: 2320-0332 (Online)

heterogeneous environment can have effectively minimized makespan time as compared to those in homogeneous environments because of the computational capabilities of heterogeneity.

REFERENCES

1. Andrei Radulescu, Arjan J.C. van Germund, "Fast and Effective Task Scheduling in Heterogeneous Systems", in Proc. of 9th Heterogeneous Computing Workshop (HCW 2000), IEEE, pp. 229 - 238, 2000.
2. Arash Ghorbannia Delavar, Yalda Aryan, "HSGA: a hybrid heuristic algorithm for workflow scheduling in cloud systems", Journal of Cluster Computing, Springer, 2012.
3. Chun-Yan Liu, Cheng-Ming Zou, Pei Wu, "A task scheduling algorithm based on genetic algorithm and ant colony optimization in cloud computing", In Proceedings of International Symposium on Distributed Computing and Applications to Business, Engineering and Science, IEEE, pp. 68-72, 2014.
4. Husnu S. Narman, Md. Shohrab Hossain, Mohammed Atiquzzaman, "h-DDSS : Hetrogeneous dynamic Dedicated Servers Scheduling in Cloud Computing", In Proceedings of International Conference on Communications (ICC), IEEE, pp.3475-3480, 2014.
5. Jianhua Gu, Jinhua Hu, Tianhai Zhao, Guofei Sun, "A New Resource Scheduling Strategy Based on Genetic Algorithm in Cloud Computing Environment ", Journal of Computers, Vol. 7, No. 1, pp. 42-52, 2012.
6. Jing Liu, Xing-Guo Luo, Xing-Ming Zhang, Fan Zhang, Bai-Nan Li, "Job Scheduling Model for Cloud Computing Based on Multi-Objective Genetic Algorithm", In Proceedings of International Journal of Computer Science Issues, Vol. 10, No. 3, pp. 134-139, 2013.
7. Kai Zhu, Huaguang Song, Lijing Liu, Jinzhu Gao, Guojian Cheng, "Hybrid Genetic Algorithm for Cloud Computing Applications", In Proceedings of International Conference of Asia Pacific Services Computing, IEEE, pp.182-187, 2011.
8. Kousik Dasgupta, Brototi Mandal, Paramartha Dutta, Jyotsna Kumar Mondal, Santanu Dam, "A Genetic Algorithm (GA) based Load Strategy for Cloud Computing, In Proceedings of International Conference on Computational Intelligence: Modeling Techniques and Applications (CIMTA), ELSEVIER, pp. 340-347, 2013
9. Pardeep Kumar, Amandeep Verma, "Scheduling Using Improved Genetic Algorithm in Cloud Computing for Independent Tasks", In Proceedings of International Conference on Advances in Computing, Communications and Informatics (ICACCI'2012), pp. 137-142, 2012.
10. Poonam Panwar, A.K. Lal, Jugminder Singh, "A genetic Algorithm Based Technique for Efficient Scheduling of Tasks on Multiprocessor System", In Proceedings of the International Conference on SocProS 2011, Springer, pp. 911-919, 2012.
11. Ryan Friese, Tyler Brinks, Curt Oliver, Howard Jay Siegel, Anthony A. Maciejewski, "Analyzing the Trade-offs Between Minimizing Makespan and Minimizing Energy Consumption in a Hetrogeneous Resource Allocation Problem", In Proceedings of Second International Conference on Advanced Communications and Computation INFOCOMP 2012, pp. 81-89, 2012.

ISSN: 2229-6913 (Print), ISSN: 2320-0332 (Online)

12. S.C. Esquivel, C. R. Gatica, R.H. Gallard, "Solving the Parallel Task Scheduling Problem By Means of a Genetic approach", In Proceedings of Latin American Network Operations and Management Symposium, LANOMS,1999.
13. Shekhar Singh, Mala Kalra, "Scheduling of Independent Tasks in Cloud Computing Using Modified Genetic Algorithm", In Proceedings of, International Conference on Computational Intelligence and Communication Networks (CICN), IEEE, pp.565-569, 2014.
14. Shekhar Singh, Mala Kalra, "Task Scheduling Optimization of Independent Tasks in Cloud Computing Using Enhanced Genetic Algorithm", International Journal Of Application or Innovation in Engineering and Management (IJAIEM), Vol. 3, No. 7, pp. 286-291, 2014.
15. Zhi-Hui Zhan, Xiao-Fang Liu, Yue-Jiao Gong, Jun Zhang, Henry Shu-Hung Chung, Yun Li, "Cloud Computing Resource Scheduling and a Survey of its Evolutionary Approaches", ACM Computing Surveys, Vol. 47, No. 4, Article 63, pp. 1-33, 2013