Genetic Based Task Scheduling Algorithms in Distributed Environments- Its Strengths, Weaknesses, Opportunity and Threats

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ABSTRACT

In the Present's Competitive era computing has become prime element for every system and Distributed system has become the soul computing environment. With the development various avtars of Distributed Systems has come into existence like Cloud Computing and Grid Computing. To gives the better result in term of resource utilization, execution time and cost various task scheduling has been proposed by various eminent researchers such as heuristic and meta- heuristic techniques. All of these techniques are proposed to achieve the optimum results. Genetic algorithm is one of the Meta-heuristic algorithms which derived with the feature of human genetic. Genetic algorithm deals with which type of problem they are known as NP-Hard problem. This paper trace the strength, weakness, opportunity and Threats of few prominent Genetic algorithm based approaches by comparing the prime elements of these algorithms to find out the scope for the further research in these prominent areas.

Keyword: Cloud Computing, Genetic Algorithms, Distributive Environment, Resource Utilization, Makespan

I. INTRODUCTION

With the development of Internet, the concept of Distributed Computing gives the birth to various types of technologies like Grid Computing and Grid Computing. Before the development of Internet in the decade of 60's Distributed computing come into existence first time in the form of Main frame IBM system. With the time Grid computing and Cloud computing became the soul of today's computing applications. Cloud computing is interactive and Grid is work in the non-interactive environment but both of applications works with better utilization of available resources and provide the better results in terms of execution time, load balancing and the cost.

Basically, Virtual Network of Super Computers is loosely knot to perform the length tasks form the Grid, which is one of Avtar of distributed computing. On the other hand, Cloud computing is an emerging tool that offer diverse variance of services [1] software on demand, infrastructure to perform high computation intensive applications and other various applications which are high on cost but required by enterprises to perform their non-routine but important activities. Cloud can also be defined as a distributed computing prototype and it is a compilation of interconnected and virtualized computers that are provisioned and offered enthusiastically [1] as cohesive computing resources, who offer the services on pay-per use basis.

The basic aim of all Distributed computing is optimum utilization of available distributed resources and performs the large computational problems to achieve the extensive results from the system. To achieve the optimum result scheduling of available resources and task is important, this process of resource management is known task scheduling and resource scheduling. Mainly two types of scheduling techniques are used for this purpose i.e. Independent task scheduling, workflow task scheduling [2].

Independent task scheduling deals with the task without any precedence means task can be allocated to any of the machine without bothering about flow of any running task. On the other hand, workflow based task scheduling where all tasks are interdependent, they have precedence relations to each other, so while assigning the task to resources it is important to take consideration precedence before allocation. This type of application deals with the real type situations [3].

As we further classified, it can be categorized into three categories i.e. Heuristic, Meta- Heuristic and Hybrid task scheduling algorithms. Heuristic task scheduling algorithm perform for particular type of problem and better for simple type applications on the other hand Meta- Heuristic task scheduling algorithms are the practical methods which provide ease to schedule the task and provide the best possible solutions, it lead to the optimal result and these methods can be used to speed up the process of finding a satisfactory results. Hybrid algorithms are emerged with the feature of heuristic and meta-heuristic to achieve the optimum result. There are various prominent researchers who proposed renowned algorithms.

The rest of the paper is organized as follows. Section 2 gives the introduction about the SWOT analysis and section 3 provides the extensive study of various Genetic based task scheduling algorithms in term of SWOT Analysis to find out the scope for further research work and section 4 gives the conclusion about the complete study.

II.   INTRODUCTION TO SWOT ANALYSIS

Every element have its strength, weakness, opportunity and threats, which is known as SWOT Analysis, it is technique to evaluate the capability of any element. Strength define the basic capability of specific element and weakness explore that features which need to improve to achieve the optimum result in the real system. Opportunity presents that elements which can be great chance to achieve the best result on the other hand threat explore that element which can lead to degrade the system.

So we have chosen the SWOT Analysis to assess the capability of research work till date in the field of task scheduling in distributive environment. As above described above that lot of work has been purposed by various researcher, so there is need of SWOT analysis of these works. In the next section is related to the extensive SWOT Analysis of few prominent Meta-Heuristic Task Scheduling Techniques.

III. SWOT ANALYSIS OF GENETIC BASED TASK SCHEDULING TECHNIQUES:

In the age of 1950 various computer scientist thought that design an tool for optimization related problem based on natural genetic variation and natural selection. In this decade's lot of research work has been done by various researches like Box (1957), Friedman (1959), Bledsoe (1961), Bremermann (1962). Out of which some has

given good idea, which is further used by researchers. In the 1960, these researches get their real form as Genetic algorithms (GAs) which was finally invented by John Holland [4].

Genetic Algorithms (Gas) is meta-heuristic technique which is used to achieve the optimum result for various problems of optimizations such as task scheduling. Idea of Genetic algorithm comes out from the concept of human genetic system. As evolution of human being it improved its gene from one generation to another generation. This algorithm tries to find out the best result from each iteration to achieve the optimum result. In this technique, at very first stage it generates initial population or selects the population and a fitness function is defined to check the suitability of the chromosome for the environment. After the selection of chromosome/population, it performs the two important operations crossover and mutation on it to get the optimal solution. As the result obtained after the implementation of operators fitness function will check the quality of result that it gives betterment otherwise it will discard the result. With this process it will get the modified gene/ optimum or nearest to optimum result.

In the Standard Genetic algorithms basic initial population is normally generated on random basis. To achieve the best possible results different renowned researchers proposed to use the heuristic to generate the population. In [48], further, Best-fit and Round-Robin methods are used to select noble candidate resources for tasks. Fitness function is used to calculate fitness value of chromosomes. Fitness function may be based on makespan, flowtime or execution cost.

In the field of Genetic Algorithms a large set of research work has been done. Many of selection, cross over and mutation operator has been proposed. Selection operators are applied to select chromosomes for implication of crossover. Roulette wheel strategy and Binary Tournament Selection are some of the commonly used selection procedures even Elitism Selection and rank selection operators are also proposed my some researchers. The process of crossover is used to interchange genes between chromosomes to create offspring (Children). On the other hand Mutation process will change the value of randomly selected gene to get the genetically modified gene. A number of crossover operators and mutation operators have been proposed. One-point crossover, Two-point crossover operators and uniform crossover are basic types of crossover operation which can be used to create offspring. Simple Swap and Swap and Move are commonly used mutation operators to get the mutant.

In this research Paper [6] researchers has designed a algorithm based on agent technology named as Multi-agent genetic Algorithm(MAGA) for the load balancing of resources with the help of management of virtual resources. As comparative to standard Genetic Algorithm MAGA gives better results with help of modified parameters such as Neighborhood competition, orthogonal crossover, mutation, self-learning. Proposed algorithm maintains the balance between CPU utilization and memory usage among virtual machines. In addition, the MAGA scheduling algorithm can result in a lesser single-point breakdown rate.

With the change of time researcher find there is need to combine the feature of genetic algorithm with other meta-heuristic techniques to get the optimal result. For this purpose Chenhonget. al.[7] proposed an optimized algorithm based on genetic algorithm to manage the dynamic independent tasks. Algorithm gives the better results in term of time and resources. But it doesn't suitable of global optimization so there is need to lead for extensive research on this area.

Shekharet. al. [8] has proposed an algorithm named as Modified Genetic Algorithm (MGA), it generate the initial chromosome through enhanced max-min technique to achieve the optimum value in term of Makespan. In this techniques they have selected the population size is 100 to get minimum makespan. In Enhanced Max-Min, a selection criterion for task has been changed to average execution time as compared standard Max-Min algorithm. In the field of cloud computing Service Management Index (SMI) has defined the various parameters of QoS which play vital role in task scheduling but this research paper has not taken consideration to these elements.

Till the date lot of research has been done on task scheduling but most of the proposed algorithms are based on one of the technique but to get the better result, now researcher has realized that there is need to emerge the capability of various techniques. On this idea Chun-Yan et. al.[9] has proposed a new algorithm Ant colony based genetic algorithm to makes use of the global search ability of genetic algorithm to solve the optimal solution quickly, and then converts it into the initial pheromone of ACO and gets best possible scheduling through positive opinion of ACO. This technique gives the minimum makes span by adding the capability two renowned meta-heuristic techniques

Mohammad et. al.[10] has proposed a hybrid approach named as FUGE (Fuzzy based Genetic Algorithm) to get the optimal result in term of load balancing, minimum time and cost. In this technique researcher design the algorithm which allocate the resource by taking the consideration of virtual machine (VM) processing speed, VM memory, VM bandwidth, and the job lengths. For designing the initial population and cross over researchers has designed the rules with the help of FIS means it get the fitness value with the help of fuzzy theory. At the last it provides the best optimal result. For the optimal result algorithm also considered the Qos Factor and assign jobs to resources by considering the job lengths and resource capacities to get better result.

Juntaoet. al [11] proposed a novel dynamic task scheduling technique by modifying the standard genetic algorithm by dynamically monitoring the bandwidth of network and priority factor recommended on the SLA. It gives the better result in term of minimum execution time with improved genetic algorithm. This algorithm has taken three factors into consideration while scheduling the task, number of process running in the queue, currently running task size of system resources and network bandwidth utilization[12].

S. No.	Performance Parameters	Algo Type	Platform Used	Strengths	Weaknesses	Opportunity	Threat
5	1. Minimum Execution Time 2. Load Balancing	W	C++	1.Manage the idle time of processor 2. Communication delay reduced	Proposed (CPGA) Algorithms is restricted to used one point Crossover	Can be used in the cloud environment	Proposed (TDGA) Algorithm can lead to wastage of Memory space because it's based on Task duplication
6	Load Balancing CPU Utilisation	I		comprehensive load Balancing effect can be achieved by adjusting weighting factor. Minimum single-point failure rate	It works only for Load balancing not considering the other parameters like cost, Execution time	Due to weighting factor capability it can be use in low to heavy load based applications	It ignore the influence of the memory which can lead to inefficiency of algorithm at heavy load
7	Time Utilisation Resource Utilisation	I	Different Platform	Optimal fitness value utilization of resources	Inefficient for Global optimization	Reduce the solution space in GA integration of innumerable resource and task	Task flow in Uncertain Resources are Uncertain
8	Makespan	I	CloudSim	MGA gives the minimum makespan	Not considering the various elements like priority and security	QoS parameters defined by SMI can used for Global optimization	Initial Population generated based on Enhanced Max-Min so result based on working of Heuristic Algorithm
9	Execution Time	W	Cloud IM Simulator	1.strong positive feedback due to ACO 2. Quick result due to quick search ability of Genetic.	It is based on the GA which is sensitive to get initial population so difficult to obeying equality constraints.	It can be easily used in large distributive environments.	Wrong assessment of chromosome can lead to inefficiency of the algorithm's performance
10	Execution Time Execution cost Load balancing	W	CloudSim MatLab	It increases the quality of service in term of minimum execution time and cost with load balancing and gives the mathematical proof with complete General architecture.	It become complex with emerges of FIS to the Genetic Algorithm.	This work can be further extended to consider energy consumption to make consistence power saving model.	It is emergence of Fuzzy with Genetic Algorithm so it difficult to get global optimization.
11	1. Execution Time 2. Response Time		CloudSim	It improves the throughput of the system and reduces the execution time.	It introduces additional Master node which increasing the complexity of the system,	It can be used in large scale distributed environments	It considers the bandwidth of system but doesn't consider the cost of transmission which can lead to high cost.

Table 1: SWOT Analysis of Genetic Algorithm based Task scheduling Algorithms

IV. CONCLUSION

In this research paper we have perform the extensive survey of various Genetic based Algorithms with SWOT Analysis. After the complete study of research work given by eminent research in the form of their strength, weakness, opportunity and threat of their work, it has come out that all of the techniques are giving better results better there is scope to achieve the optimum result. There are various meta-heuristic techniques like simulated annealing optimization techniques, these techniques can be emerged with genetic algorithm to achieve the optimum results.

REFERENCES

[1] R. Buyya, C. S. Yeo, S. Venugopal, J. Broberg, and I. Brandic, "Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility," Future Generation computer systems, vol. 25, no. 6, pp.599-616, 2009.

[2] Buyya RK, Kotagiri R, Yu J. Workflow scheduling algorithm for grid computing. In: Meta-heuristics for scheduling in distributed computing environment, vol. 146. Berlin Heidelberg: Springer; 2008. p. 173–214.

[3] Barrionuevo JJD, Fard HM, Prodan R, Fahringer T. A multi-objective approach for workflow scheduling in heterogeneous environment: cluster, cloud and grid computing. In: 12th IEEE International conference; 2012. p. 300–309.

[4] An Introduction to Genetic Algorithms, Mitchell Melanie, A Bradford Book The MIT Press, Cambridge, Massachusetts • London, England Fifth printing, 199

[5] Fatma A. Omara, Mona M. Arafa, "Genetic algorithms for task scheduling problem", J. parallel Distrib. Comput. 70 (2010) 13_22 pp.

[6] Zhu K, Song H, Liu L, Gao J, Cheng G. Hybrid genetic algorithm for cloud computing applications. In: IEEE Asia- Pacific serv comput conf; 2011. p. 182–7. http://dx.doi.org/10. 1109/APSCC.2011.66.

[7] Chenhong Zhao, Shanshan Zhang, Qingfeng Liu, "Independent Tasks Scheduling Based on Genetic Algorithm in Cloud Computing", 5th International Conference on Wireless Communications, Networking and Mobile Computing, 2009. WiCom '09. pp: 1-4.

[8] Shekhar Singh, Mala Kalara, "Scheduling of Independent Tasks in Cloud Computing Using Modified Genetic Algorithm", Sixth International Conference on Computational Intelligence and Communication Networks,2014, pp: 565-569.

[9] Chun-Yan LIU, Cheng-Ming ZOU,Pei WU, "A task scheduling algorithm based on genetic algorithm and ant colony optimization in cloud computing", 13th International Symposium on Distributed Computing and Applications to Business, Engineering and Science, 2014, pp: 68-72

[10] Mohammad Shojafar, Saeed Javanmardi , Saeid Abolfazli , Nicola Cordeschi, "FUGE: A joint meta-heuristic approach to cloud job scheduling algorithm using fuzzy theory and a genetic method", Cluster computing: Springer, June 2015, Volume 18, Issue 2, pp 829-844

[11] Juntao Ma, Weitao Li, Tian Fu, Lili Yan and Guojie Hu, "A Novel Dynamic Task Scheduling Algorithm Based on Improved Genetic Algorithm in Cloud Computing ",Volume 348 of the series Lecture Notes in Electrical Engineering pp 829-835

[12] GAN Guo-ning, HUANG Ting-Iei, GAO Shuai, "Genetic Simulated Annealing Algorithm for Task Scheduling based on Cloud Computing Environment" International Conference on Intelligent Computing and Integrated Systems (ICISS), 2010, pp. 60 – 63.