A Novel Task Scheduling Algorithm In A Cloud Computing Environment Using Hybrid DE-PSO Algorithm

SenthilKumar Avinashi Malleswaran, K. Parthiban

Abstract: Cloud computing offers computational resources as a service to users using a cloud network. In cloud computing, the tasks are executed with the needed resources to distribute the services. There are many task scheduling techniques are used to schedule the user tasks to the resources. In this paper, another effective hybrid task scheduling algorithm is proposed to enhance the performance of task scheduling. In this proposed hybrid algorithm, the Differential Evolution (DE) algorithm and Particle Swarm Optimization (PSO) algorithm are combined. The output of the differential evolution algorithm is enhanced by the PSO algorithm. The Hybrid DE-PSO algorithm results are better than the standard PSO algorithm results.

Index terms: Cloud computing, Task scheduling, Differential Evolution algorithm, Particle Swarm Optimization algorithm

1. INTRODUCTION

Nowadays, Cloud computing plays an important role in the computing model [1]. Cloud computing is evolved from distributed computing, parallel computing and grid computing [2]. Virtualization used to share the cloud computing resources among the cloud users. It allows various remote applications to run on servers in an optimized manner. [3]. Task scheduling plays a vital role in cloud computing. Based on the user needs, the tasks are allocated to the suitable resources. This is known as an NP-hard problem [4]. Various researchers are working with the scheduling in a cloud computing environment. Ineffective task scheduling may lead to the problems like revenue loss, poor performance and Service Level Agreement (SLA) violation. There are various rule-based task scheduling algorithms [5-7]. They are easy to implement and perform poorly during complex task scheduling problems [8]. The various metaheuristic techniques are applied in the task scheduling problems in cloud computing environment are Genetic Algorithm (GA) [9-10], Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO) and Differential evolution (DE) [11-14] .PSO works faster and obtains optimal results than GA and ACO. Due to higher exploratory nature, PSO can perform better than ACO and GA. Due to its exploratory capability for finding optimal solutions [15-16], PSO is hybrid with the DE algorithm to enhance the DE solutions. Differential Evolution (DE) and Particle Swarm Optimization (PSO) algorithms are used in various heuristic global search-based applications. The DE algorithm was invented in 1995 by Storn and Price [17]. DE generates a candidate solution over several generations using operators like mutation, crossover and selection to find an optimal solution [18].

- *SenthilKumar Avinashi Malleswaran, K. Parthiban*
- *senthil1185@gmail.com*
- *Dept. of CSE, Koneru Lakshmaiah Education Foundation, Vaddeswaram, Guntur, Andhra Pradesh, India*
- *Dept. of CSSE , Sree Vidhya Nikethen Engineering College, Tirupathi, Andhra Pradesh, India*

DE has great convergence and needs fewer control parameters. PSO was invented by Kennedy and Eberhart in 1995 based on the social behavior of fish schooling and bird flocking. PSO is faster and very effective in diverse set optimization problems. This paper contributes a new hybrid algorithm combined differential evolution and particle swarm optimization (HDE-PSO) for task scheduling problem in a cloud computing environment. The proposed algorithm has been simulated in a cloudsim and results have been compared with PSO algorithm. The results show that the proposed algorithm is more efficient than other algorithms. This paper contents are organized as follows: Section 2 discusses the various literature reviews, Section 3 explains the proposed algorithm and section 4 details the results. Section 5 gives the conclusion of the proposed work.

2. RELATED WORK

Metaheuristic algorithms [19-23] have been used in task assignment problems to minimize response time and makespan. These algorithms are used to find an efficient scheduling of tasks to resources in order to optimize computation and improve resource utilization. In a cloud computing environment, algorithms like ACO, PSO and GA are mostly used to perform task scheduling. PSO performs better than GA and ACO in many cases [15-16] and it has faster execution time when compare to other metaheuristic algorithms. Scheduling algorithms using PSO algorithm are proving that they ensure minimum makespan [24-28]. PSO algorithms were improved and developed as hybrid versions [8, 13, 21, 27-29] to propose task scheduling in the cloud computing environment and the results obtained using these algorithms are better than ACO and GA.In this paper, by observing the advantages of PSO algorithm, it is hybrid with Differential Evolution (DE) algorithm to improve the results of standard DE.

3. PROBLEM FORMULATION

An effective task scheduling algorithm should minimize the makespan. The goal is to find the efficient task scheduling to the nodes. The objective of the task scheduling problem in a cloud computing environment is to minimize the

makespan. Makespan is the summation of waiting time and waiting time.

$$\text{Min } \{f(x) = \sum_{i=1}^{M} \sum_{j=1}^{N} RT_{ij} + Et_{ij} \quad (1)$$

Subject to

i , j <=1

i $\in M$

j $\in N$

Where RT_{ij} is a response time which is the summation of waiting time and waiting time.

Et_{ij} is an execution time which is the subtraction value of task finish time and task start time.

4 OVERVIEW OF PROPOSED HYBRID DIFFERENTIAL EVOLUTION PARTICLE SWARM OPTIMIZATION TASK SCHEDULING ALGORITHM

The proposed algorithm work flow is shown in figure 1. Differential Evaluation (DE) and Particle Swarm Optimization (PSO) are integrated together. DE algorithm is initialized and the population is generated randomly. The population vectors are encoded based on the scheduling problem. Then, the population vectors are evaluated against the fitness function. The elite vectors are selected for the further process. Mutation is applied by adding two elite parent vector differences with the third elite parent. The resulting vector is crossed over with parent vector and new trail vector is created. Trail vector is compared with the parent's vector in the population and it will be considered as next-generation population vector when it is better. Otherwise, the process will be repeated until finding an optimal trail vector. Then the optimal solution will be transformed as the PSO algorithm's initial population. Particle velocities are updated and the new particle positions are found. Local best and global best values are updated at each iteration until found the optimal solution. The final optimal solution provides the better schedule for the given details.

The procedure of the proposed hybrid DE-PSO algorithm is as follows

Step 1: Initial Population is randomly generated

Step 2: Encoding the vector values based on the scheduling problem

Step 3: Evaluating the population based on the fitness function and elites is selected

Step 4: Mutation operation creates a mutation vector by adding two parents difference vector with the third vector

Step 5: Trail vector is generated by crossing over using mutant vector and parent vector

Step 6: Compare trail vector with parent vector

Step 7: If trail vector is better than parent vector, fix the trail vector as next-generation population, else repeat from step 3

Step 8: Repeat steps 3 until found optimal solution

Step 9: Transform the optimal solution to the initial population of the PSO algorithm

Step 10: Updating velocity of particles

Step 11: Calculating the position of new particles

Step 12: Perform local and global Update

Step 13: Repeat steps from steps 10 until finding the optimal solution

Step 13: Choose the optimal solution

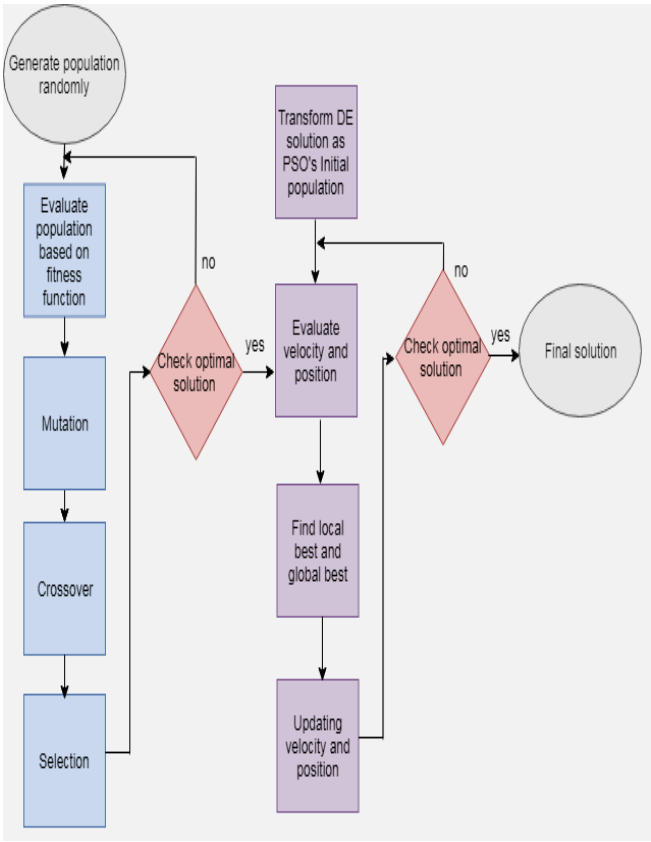

Figure 1. *Hybrid DE-PSO algorithm*

5. Simulated Results and Analysis

In this section, simulated environment setup details and simulated result analysis are presented. The results are analyzed using Cloudsim simulator tool. For simulation, single data centre is considered. The simulation details are shown in table 1.The Hybrid DE-PSO algorithm is implemented and results are evaluated based on makespan. The proposed algorithm Hybrid DE-PSO results are compared with Particle swarm optimization algorithm and results are shown that the proposed Hybrid DE-PSO algorithm is better than PSO algorithm.

Table1. *Simulation environment details*

4. Type	5. Parameters details	
Resource	Range	0-25
	MIPS	500
	Image size	1000 mb

	Ram	1024 mb
	Bandwidth	2000 B/S
	Pes number	5
Task	Range	50
	Input	600
	output	900

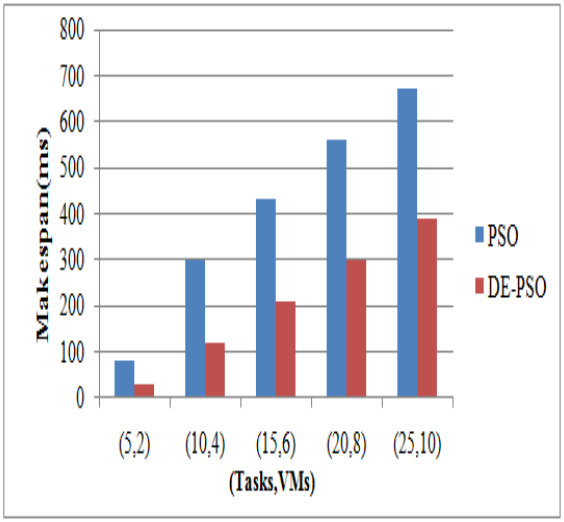

Figure 2 Makespan

Figure 2 depicts the makespan of proposed DE-PSO and PSO algorithms. Makespan is measured using milliseconds. PSO algorithm helps DE to obtain optimum results in makespan due to its rapid execution nature. From figure 2, it is noted that makespan of DE-PSO is lesser than PSO when tasks range from 5 to 25.

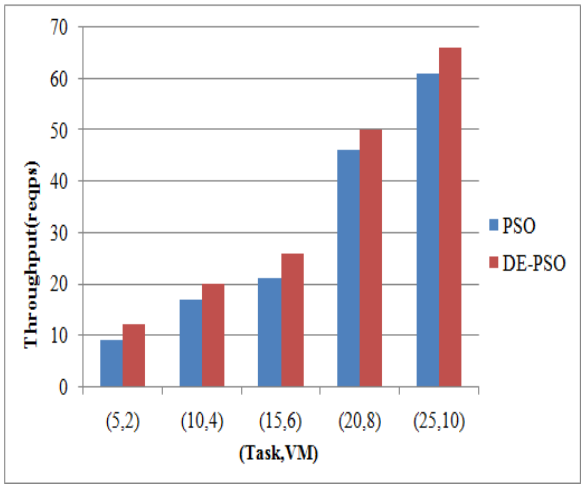

***Figure 3** Throughput*

Figure 2 shows the throughput of the proposed DE-PSO and PSO algorithms. Throughput measurement is represented using number of tasks processed per second. From figure 3, it is observed that throughput of proposed DE-PSO is higher than PSO algorithm when tasks values vary from 5 to 25. Throughput of the DE-PSO is higher by 5 requests per sec when compared to PSO algorithm.

6 CONCLUSION

Task scheduling plays an important role in the cloud computing environment. In this paper, Hybrid DE-PSO based task scheduling algorithm is proposed. Differential Evolution and Particle Swarm Optimization algorithms are combined together to schedule the tasks to the resources. In the proposed algorithm, the makespan is minimized when compared to Particle Swarm Optimization algorithm. Further, more Quality of Service parameters can be considered and implemented as future work.

REFERENCES

[1] C. T. Ying, J. Yu, Energy-aware genetic algorithms for task scheduling in cloud computing, Proceeding of the 7th China Grid Annual Conference (ChinaGrid), IEEE Press, Sept. 2012, pp. 43-48.

[2] X. Y. Hua, J. Zheng, W. X. Hu, Ant colony optimization algorithm for computing resource allocation based on cloud computing environment, Journal of East China Normal University (Natural Science), vol.1, 2010, pp.127.

[3] Avram, M.G., Advantages and Challenges of Adopting Cloud Computing from an Enterprise Perspective. Procedia Technology, 2014. 12: p. 529-534.

[4] H. L. Shi, Research of job scheduling on cloud computing, Nanjing: Nanjing University of Science and Technology, 2012.

[5] Gao Ming and H. Li, An Improved Algorithm Based on Max-Min for Cloud Task Scheduling. Recent Advances in CSIE 2011, LNEE, 2012. 125: p. 217–223.

[6] Upendra Bhoi and P.N. Ramanuj, Enhanced Max-min Task Scheduling Algorithmin Cloud Computing. International Journal of Application or Innovation in Engineering and Management, 2013. 2(4): p. 259-264.

[7] Ehsan ullah Munir, Jian Zhong li, and S. Shi, QOS sufferage Heuristic for Independent Task Scheduling in Grid. Journal of Information Technology, 2007. 6(8): p. 1166-1170.

[8] Tsai, C.-W., et al., A Hyper-Heuristic Scheduling Algorithm for Cloud. IEEE Transactions on Cloud Computing, 2014. 2: p. 236-250.

[9] Fei Taoa and L.Z. Ying Fengb, T.W. Liaoc, CLPS-GA: A case library and Pareto solution-based hybrid genetic algorithm for energy-aware cloud service scheduling. Applied Soft Computing, 2014. 19: p. 264–279.

[10] Zhu, Y. and P. Liu, Multi-dimensional constrained cloud computing task scheduling mechanism based on genetic algorithm. International Journal of Online Engineering, 2013. 9(SPECIALISSUE.6): p. 15-18.

[11] Senthil Kumar A M ,Venkatesan M ,Task scheduling in a cloud computing environment using

HGPSO algorithm, Cluster Computing, 22(Suppl 1)pp- 2179-2185,2019
[12] Senthil Kumar A M ,Venkatesan M , Multi-Objective Task Scheduling Using Hybrid Genetic-Ant Colony Optimization Algorithm in Cloud Environment, Wireless Personal Communications, (2019) 107(4)pp.1835-1848
[13] A.M.SenthilKumar, M. Venkatesan, A. Rajivkannan , ERAM2-Energy Based Resource Allocation With Minimum Reckon And Maximum Reckon, - Journal of advances in chemistry, vol.12(23).pp- 5485-5493 2016
[14] A.M. SenthilKumar, M. Venkatesan ,A Novel Based Resource Allocation Method on Cloud Computing Environment Using Hybrid Differential Evolution Algorithm - Journal of Computational and Theoretical Nanoscience, vol.14(11),pp- 5322-5326 2017
[15] Wang, M., W. Zeng, and Ieee, A comparison of four popular heuristics for task scheduling problem in computational grid. The 6th International Conference on Wireless Communications Networking and Mobile Computing. 2010.
[16] Hongbo Liua, Ajith Abraham, and A.E. Hassaniend, Scheduling jobs on computational grids using a fuzzy particle swarm optimization algorithm. Future Generation Computer Systems, 2010. 26: p. 1336–1343.
[17] R. Storn, K. Price, Differential evolution –a simple and efficient adaptive scheme for global optimization over continuous spaces, Journal of Global Optimization 11 (4) (1997) 341–359.
[18] R. Storn, On the usage of differential evolution for function optimization, in: Proceedings of Biennial Conference of the North American Fuzzy Information Processing Society (NAFIPS), Berkley, 1996, pp. 519–523.
[19] Wu, L., Y.J. Wang, and C.K. Yan, Performance comparison of energy-aware task scheduling with GA and CRO algorithms in cloud environment, in Applied Mechanics and Materials. 2014. p. 204-208
[20] Fei Taoa and L.Z. Ying Fengb, T.W. Liaoc, CLPS-GA: A case library and Pareto solution-based hybrid genetic algorithm for energy-aaware cloud service scheduling. Applied Soft Computing, 2014. 19: p. 264–279.
[21] Chitra, S., et al., Local minima jump PSO for workflow scheduling in cloud computing environments, Lecture Notes in Electrical Engineering. 2014. p. 1225- 1234.
[22] A.M.Senthil Kumar, M Venkatesan, An Efficient Multiple Object Resource Allocation Using Hybrid GA-ACO Algorithm, Australian Journal of Basic and Applied Sciences, vol.9(31),pp-53-59, 2015
[23] Tong, Z., et al., H2ACO: An optimization approach to scheduling tasks with availability constraint in heterogeneous systems. Journal of Internet Technology, 2014. 15(1): p. 115-124.
[24] Wang, J., F. Li, and L.Q. Zhang, Apply PSO into cloud storage task scheduling with QoS preference awareness. Journal on Communications, 2014. 35(3): p. 231-238.
[25] Yang, Z., et al., Optimized task scheduling and resource allocation in cloud computing using PSO based fitness function. Information Technology Journal, 2013. 12(23): p. 7090-7095.
[26] Zhan, S. and H. Huo, Improved PSO-based task scheduling algorithm in cloud computing. Journal of Information and Computational Science, 2012. 9(13): p.3821-3829
[27] A.M.SenthilKumar, M. Venkatesan, A. Rajivkannan, A Novel Approach for Multiple Object Resource Allocation Using Hybrid Algorithm, Middle-East Journal of Scientific Research,vol.23(10),pp-2586-2591 2015
[28] Wang, J., F. Li, and L. Zhang, QoS preferenceawareness task scheduling based on PSO and AHP methods. International Journal of Control and Automation,2014. 7(4): p. 137-152.
[29] Verma, A. and S. Kaushal. Bi-Criteria Priority based Particle Swarm Optimization workflow scheduling algorithm for cloud. Recent Advances in Engineering and Computational Sciences, RAECS 2014. 2014.