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An Improved Particle Swarm Optimization Algorithm for Meta Task Scheduling In Cloud Environment

R. Jemina Priyadarsini [1], Dr. L. Arockiam [2]
Research Scholar [1], Associate Professor [2]
Department of Computer Science
St.Joseph's College (Autonomous)
Tiruchirapalli
TamilNadu - India.

ABSTRACT
Task to resource mapping is a challenging issue in cloud computing environment. Computing resources are provided to user based on the demand of the user. The aim of user is to achieve maximum usage time. Task scheduling algorithms plays a vital role in this resource allocation based on the demand or supply of resources. The use of swarm algorithms in optimization problem helps to achieve better solution with global and fast convergence rate and also improves the efficiency. The aim of this paper is to come out with an Improved Particle Swarm Optimization (IPSO) algorithm for independent (meta) task scheduling in cloud computing with a proposed fitness function. The parameters considered are make span and resource utilization. Simulations are carried out using CloudSim simulator. Particle Swarm Optimization (PSO) is considered because of its simplicity, effectiveness and faster convergence. Simulation results show that the proposed IPSO algorithm minimizes *make span when compared to standard PSO algorithm.*

***Keywords*:-**Task scheduling, Swarm Algorithms (SA), Makespan, Resource Utilization and Particle Swarm Optimization (PSO).

I. INTRODUCTION

Cloud computing is a recent computing technology that delivers Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). These services are made available as a pay-as-you-go model to the user. Scheduling is nothing but mapping of task with the available resource to complete the task execution. The optimum utilization of the available resource is a challenging task and it's known that task scheduling is a NP-hard problem. Makespan is simply defined as the time that taken till the last task is executed. The aim of this work is to minimize the makespan. To solve this problem several approaches are used. In recent years heuristics approach finds to be widely used. Under heuristics optimization there are various algorithms like evolutionary algorithms and swarm based algorithms. Task scheduling is a key process for IaaS. That is, it assigns the requests to resources in an efficient way, considering cloud characteristics. It takes Virtual Machine (VM) as scheduling units for mapping physical heterogeneous resources on tasks. Some of the scheduling algorithms based on Swarm Intelligence (SI) are Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), Artificial Bee Colony (ABC), Artificial Fish School Algorithm (AFSA), etc. They are called Swarm Algorithms (SA).One of the newest meta heuristics approach which comes under SA is PSO.

The PSO algorithm was developed by Kennedy and Eberhart [1] which simulates social behavior of flock of birds or group of fishes towards their desired destination. Some general parameters considered for optimization by these algorithms for scheduling are make span, time, cost, speed, scalability, throughput, resource utilization, scheduling success rate, Quality of Service (QoS), load balancing finishing time etc [2]. Computing algorithms can be broadly categorized as centralized or decentralized, static or dynamic , or the hybrid also [3]. All information is known in advance in static load balancing algorithm and tasks are allocated according to the prior knowledge and will not be affected by the state of the system. In case of dynamic load-balancing mechanism tasks are allocated to the available resources dynamically as and when they arrive. When some processors become overloaded redistribution of tasks has to take place [4]. Due to overload of user request there is

a decrease in performance of cloud system and there is a need for task scheduling in cloud environment [5].

The rest of the paper is structured as follows: Section 2 describes the related work. Section 3discusses the proposed approach and Section 4 gives a brief overview of the conducted experiments and interpretations and this paper is concluded in Section 5.

II. RELATED WORKS

In cloud computing QoS (Quality of service) is an important issue. For an efficient cloud system QoS must be improved, for this waiting time must be reduced and tasks should be scheduled properly. There are various optimization algorithms to solve the tasks allocation and scheduling related problems. Here different soft computing techniques, genetic algorithm, particle swarm optimization, ant colony optimization, and bee colony optimization algorithm, etc are used to schedule tasks to resources [6].

A survey on various scheduling algorithm including the PSO algorithm was conducted by Simsy Xavier & S.P.JenoLovesum [7]and the study revealed that there is a need for new scheduling algorithm that minimizes the execution time and improves the efficiency of resource utilization. The work proposed for task scheduling in cloud computing environment by Savitha. P et al.[2] reveals that there is a need for scheduling independent task in cloud environment. This proposed algorithm is well tested and results are compared with the existing genetic algorithm based workflow scheduling techniques. The results of proposed method outperform the existing methods.

LizhengGuo et al. [8] proposed a Particle swarm optimization techniques for multi objective task assignment in cloud computing environment. The proposed technique optimizes the time as well as cost for all tasks. This technique also includes time of processing, transferring and process cost.

PSO can properly balance the workflow and saves the cost when compared to existing technique like Best Resource Selection (BRS). This was studied by SurajPandey et al [9]. They have proposed a heuristic based Particle Swarm Optimization for task scheduling to optimize the cost associated with computation and communication. The proposed work gives better performance when compared to existing BRS.

Sheng-Jun Xue et al. [10] proposed a hybrid particle swarm algorithm for workflow scheduling in cloud environment. This newly proposed algorithm is named as GHPSO, a QoS based hybrid PSO technique. In GHPSO PSO is embedded with some part of Genetic Algorithm like crossover and mutation and hill climbing approach. So the performance of this new methodology is better than the standard PSO. It minimizes the execution time and cost.

Assignment of task based on PSO for optimization of multiple objectives was proposed by Gou et al., with less number of parameters and also scalability is enhanced [11]. A revised discrete PSO is proposed to schedule the applications among cloud services which considers both data transmission cost and computation cost. This was proposed by Zhangjun Wu et al. [12]. The proposed system is compared with standard PSO. The proposed work focuses on minimizing the execution time, but resource utilization is not considered.

Wang et al., [13] presented a combined approach known as SIWPSO; the main idea of this approach is to get the optimal allocation of cloud service resources to improve the overall outcome of cloud manufacturing. The particle swarm optimization with stochastic inertia weight strategy (SIWPSO) was adopted for the proposed model. Its efficiency is compared with other three particle swarm optimization algorithms. Simulation results showed its effectiveness and superiority to solve cloud service resources scheduling and assignment problem.

Verma&Kaushal [14] proposed Bi-Criteria Priority based Particle Swarm Optimization (BPSO) to schedule workflow tasks over the available cloud resources that minimized the execution cost and the execution time under given the deadline and budget constraints. Comparison has been done with Budget Constrained Heterogeneous Earliest Finish Time (BHEFT) and standard PSO. The simulation results showed that the proposed scheduling algorithm significantly decreasing the execution cost of schedule. Shaobin et al. [15] proposed an improved PSO which shortens the average operation time and proper supply of resource to user. It has been proved that PSO has better searching ability.

Performance of famous task scheduling algorithms like Min-Min, Max-Min [17] and BCO, PSO [18] are done and the simulation is carried out for the same. The results are given in Table.1. However in earlier works independent task scheduling in cloud environment is not considered. So there is a need for independent task scheduling. This paper presents an independent task scheduling algorithm named as Improved Particle Swarm Optimization (IPSO) by making changes to the fitness function used in the algorithm.

III. PROPOSED IMPROVED PARTICLE SWARM OPTIMIZATION (IPSO)

The basic idea of the proposed approach is to minimize the makespan and there by improve the resource utilization. The steps followed are the same as that of standard PSO algorithm with the change in the fitness value. The standard PSO considers makespan alone in the fitness criteria. The proposed approach takes into account the success rate and the reliability for calculating fitness. The algorithm is given below.

1. Initialize the swarm X_i, (X is the position of particles which are randomly initialized).
2. Evaluate the performance F of each particle(using the proposed fitness), for its current position $X_i(t)$.
3. Compare the performance of each individual to its best performance so far: if $F(X_i(t))<F(P_{ibest})$:

   $F(P_{ibest})=F(X_i(t))$

   $P_{ibest}= X_i(t)$
4. Compare the performance of each particle to the global best particle: if $F(X_i(t))<F(P_{gbest})$

   $F(P_{gbest})=F(X_i(t))$

   $P_{gbest}= X_i(t)$
5. Change the velocity of the particle.
6. Move each particle to a new position.
7. Go to step 2, and repeat until convergence.

The algorithm starts with initialization of swarm, X={x1,x2,……xi}. The performance of each particle is computed until t^{th} iteration. P_{ibest} and P_{gbest} are the local and global best values.

IV. EXPERIMENTAL RESULTS INTERPRETATIONS

Experiments are conducted with different number of tasks set varying from40 to 640 assigned to Cloud with 4 resources. The resources are located at two data centres. Each resource has 1 CPU with 1 Gb RAM. Each task is of size ranging from 1-7 units.The proposed IPSO algorithm is simulated using CloudSim and MATLAB. Also the resource utilization for the same task set is tabulated and compared with the existing works. It is found that the proposed IPSO achieves better performance in resource utilization than the existing algorithms. For each task set the Make span (in Sec) is tabulated and compared with existing algorithms. Make span is minimized with improved resource utilization.

Table.1. Makespan in Secs

No.of Tasks	MIN-MIN (Secs)	MAX-MIN (Secs)	PSO (Secs)	IPSO (Secs)
40	47	44	44	43.7
80	94.4	88.4	87.7	86.3
160	190.2	177.7	176.2	175.9
320	382.9	357.1	352.1	347.1
640	769.6	718.7	716.2	714.2

Table.1and Table.2 shows the value of Makespan (in Seconds)and resource utilization (in percentage) for the considered task sets. And it is observed that the proposed IPSO shows lower Makespan and better utilization of resource when compared with the existing algorithm like Min-Min, Max-Min and standard PSO. Figure.1 shows the graphical representation of number of task versus makespan. The comparison are done for the proposed IPSO results with the existing standard algorithm simulated results. The same way Figure.2 gives a comparison on the resource utilization of the existing algorithms with the proposed IPSO.

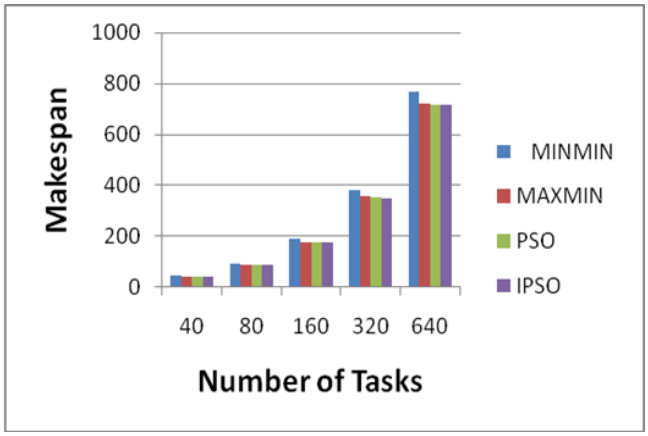

Figure.1. No. of .Task Vs Makespan

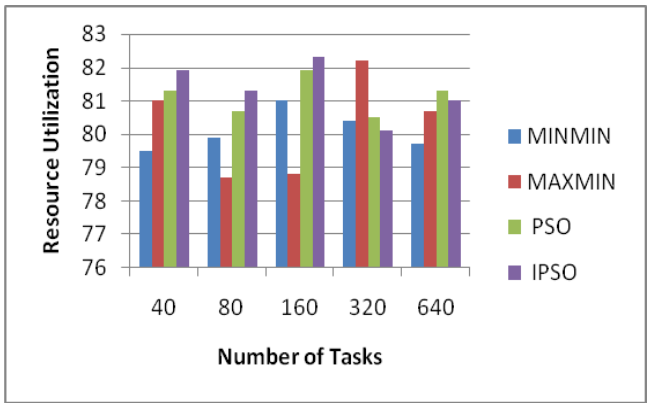

Figure.2. Tasks vs Resource Utilization

Table.2. Resource Utilization

NUMBER OF TASKS	MIN-MIN (%)	MAX-MIN(%)	PSO(%)	IPSO(%)
40	79.5	81	81.3	81.9
80	79.9	78.7	80.7	81.3

160	**81**	**78.8**	**81.9**	**82.3**
320	**80.4**	**82.2**	**80.5**	**80.1**
640	**79.7**	**80.7**	**81.3**	**81**

V. CONCLUSION

Cloud Computing is continuously expanding for more users, applications and devices therefore the scheduling and resource allocation of tasks should be efficient and in a sustainable manner. As we know that a good scheduling method would enhance the performance of cloud system, it is of much need to propose a better scheduling strategy. Thus the paper explains a new approach named as IPSO which optimizes a problem by iteratively trying to improve a candidate solution with respect to the given measure of quality. The parameters considered are Make span and Resource utilization. It is seen that the proposed IPSO algorithm achieves better resource utilization and lower Make span when compared with the existing standard algorithms. In future hybridization could be done to improve the results further. Also optimization of some more parameters like cost would be considered.

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