SURVEY OF VARIOUS PSO VARIANTS USED FOR CLOUD COMPUTING TASK SCHEDULING

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Abstract :   Cloud environment requires scheduling of independent tasks with the available resources to minimize the total execution time and to optimize the resource utilization . Scheduling in cloud computing belongs to the NP-hard category of problem. Scheduling in the cloud computing is difficult because of the complex task requirement and heterogeneous, distributed and dynamic nature of the request as well as resources. As it becomes critical to find the exact solution, various meta-heuristic techniques are used to attain the approximate solution. Several research studies have been done to improve the cloud task scheduling using PSO approach. This paper presents the Particle Swarm Optimization algorithm and various variants of PSO which are used for cloud task scheduling.

IndexTerms – **Cloud computing, Task Scheduling, Particle Swarm Optimization, Meta-heuristic Algorithms.**

I. INTRODUCTION

According to National Institute of Science and Technology "Cloud computing is a model for enabling convenient, on demand network access to shared pool of configurable computing resources (e.g. network, storage, servers, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." [1] Virtualization is the main technology for cloud computing which separates the single physical machine into multiple virtual machines. A VM allows both the isolation of the applications from the underlying hardware or other VMs, and the customization of the platform to suit the needs of the end user. Normally, a cloud service provider presents these facilities and is charged based on the pay per use model. [2]

Three different kinds of services are provided by cloud computing i.e. SaaS (Software as a service), PaaS (Platform as a Service), IaaS (Infrastructure as a Service). SaaS provides the end user with the capability to use the services offered by cloud vendor mainly through web browser. End user does not have authority to change the application software but can customize that. Examples of SaaS include GoogleDocs, Gmail, SalesForce etc. PaaS is used by the service developers where developers can develop the applications to deploy them on the cloud. Examples include Force.com, Google App Engine etc. IaaS offers the consumer virtual machines to utilize storage, networks from the provider. Examples of PaaS include Amazon's EC2, Rackspace etc.[3]

II. CLOUD SCHEDULING

Scheduling is a vital research area in the cloud computing aimed at mapping the appropriate tasks or jobs to the most appropriate available resources, by considering constraints such as cost, deadline, Quality of service (QoS), high throughput, etc. [2] The scheduling in cloud computing is important because it not only affects the performance of the cloud system but also have direct effect on the cost issue for the cloud users who run their applications because without the proper cloud scheduling the resources are not properly utilized. [2] Scheduling in the cloud computing belong to NP-hard category of problem. Exact solution is hard to achieve in cloud task scheduling due to various optimization criteria , various meta-heuristic approaches are proposed which finds the near optimal solution.

Various met heuristic based algorithms and its variants such as Ant colony optimization (ACO)-based, Genetic Algorithm(GA)-based, Simulated Annealing-based, Particle Swarm Optimization (PSO)-based tasks or workflow scheduling algorithms for the cloud environment are proposed by many researchers. PSO is one of the interesting heuristic algorithms used by various schemes to solve many problems such as task/workflow scheduling problems in cloud computing. Initially, PSO is given with a population of random solutions, and then it searches for optima by updating generations. However, unlike some other meta-heuristic algorithms, standard PSO has no evolution operators such as crossover and mutation.[2] In PSO, the potential solutions are called particles which fly through the problem space by following the current optimum particles.

Particle Swarm Optimization (PSO) has been used in a wide range of complex applications including combinatorial optimization problems such as finding optimal routes, scheduling, structural optimization, image analysis, data mining, bioinformatics, finance and business. This paper presents the overview of various variants of PSO algorithm in cloud task scheduling.
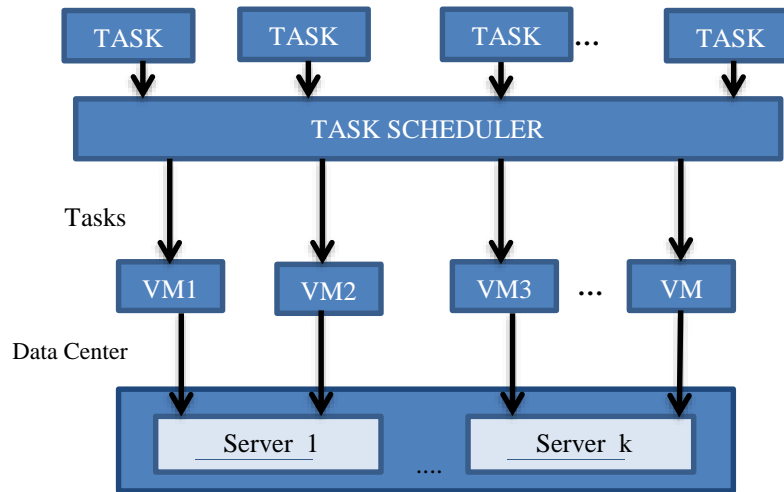
Fig 1: Task Scheduling in Cloud Computing Environment

III. PSO ALGORITHM

Particle Swarm Optimization is cooperative, population-based global search swarm intelligence met heuristic, presented by Kennedy and Eberhart in 1995. Furthermore, it is a powerful optimization technique for solving multimodal continuous optimization problems. In this algorithm, the swarm of particles is randomly generated initially, and each particle position represents a possible solution.

Each particle is positioned in the search space and has a fitness value and velocity to determine the speed and direction of its moves. Particles move around in the search space based on the particles' updated position and velocity to get an optimized solution. After the repeated advances, which are also called iteration, particle swarm gradually approaches the optimal location. Then, the optimal solution will be reached.

Each particle changes its searching direction in each iteration, based on the previous velocity (v^t_{id}) and the two best values or experiences, personal best (p^t_{id}) and global best (p^t_{gd}) The best searching experience of the individual so far is called personal best or pBest, and the best result obtained so far by all particles in the population is called global best or gBest. In PSO, each particle changes its position according to Eq. 1:

$$x_{id}^{t+1} = x_{id}^{t} + v_{id}^{t+1} \qquad (1)$$

In Equation 1, xi = (xi1, xi2, …, xiD)^t is the original position of i-th particle, t is the iteration number, x_{id}^{t+1} is the new position of i-th particle, vi = (vi1, vi2,…,viD)^t is the original velocity of i-th particle, and v_{id}^{t+1} is the new velocity of i-th particle.

Also, each particle tunes its movement direction according to Eq. 2:

$$v_{id}^{t+1} = \omega v_{id}^{t} + c_1 r_1 * (p_{id}^{t} - x_{id}^{t}) + c_2 r_2 * (p_{gd}^{t} - x_{id}^{t}) \qquad (2)$$

In Equation 2, ω is the inertia weight, c1 and c2 are the acceleration constants, r1 and r2 are the random numbers ranging between 0 and 1 in t-th iteration, p_{id}^{t} is the best position of particle and p_{gd}^{t} is the best position of the whole particles in the population.

In each iteration, pBest for each particle will be updated by Eq. 3:

$$p_{id}^{t} = \begin{cases} x_{id}^{t+1}, & if\ f(x_{id}^{t+1}) < f(p_{id}^{t}) \\ p_{id}^{t}, & otherwise \end{cases} \qquad (3)$$

In Equation 3, f is fitness function which returns the fitness value, p_{id}^{t} is the best position of i-th particle in the previous iteration, x_{id}^{t+1} is the current position and p_{id}^{t} is the best position of i-th particle in the current iteration.

IV. PSO VARIANTS

Aditi Jain and Raj Kumari[3] proposes an Integration of Particle swarm optimization technique by means of max-min algorithm for optimize the task scheduling. The scheduling is performed using a set of independent tasks as an input. In this

paper, the focus is to reduce the makespan and maximize the resource utilization. As in conventional PSO algorithm, due to random population initialization sometimes it takes longer to converge over global optima solution. So, author have integrated the max-min algorithm with the PSO algorithm. The outcome of this combined effect of PSO and max-min algorithm shows reduction in makespan and improvement in CPU utilization.

Yuping Zhang and Rui Yang [4] proposed a task scheduling algorithm based on particle swarm optimization algorithm. In this Total completion time is treated as a fitness function in the algorithm by embedding the chaotic disturbance strategy. In this first the position of the particle is encoded by the natural number and the population is initialized randomly in the solution space. Then the particle is repaired to reduce the probability that the particle runs out of the solution space and the particle velocity is limited after each iteration. The outcome achieves good performance to optimize resources and reasonable scheduling resources.

Entisar S. Alkayal, Nicholas R. Jennings, Maysoon F. Abulkhair [5] presents a new model of resource allocation that optimizes task scheduling using a multi-objective optimization (MOO) and particle swarm optimization (PSO) algorithm. Author have developed a novel multi-objective PSO (MOPSO) algorithm, based on a new ranking strategy. The developed algorithm satisfies the three confliction objectives : Expected completion time, Task execution cost and VM Processing. The experimental output shows reduction in execution time of, reduction the waiting time and shows improvements in throughput.

Hicham, Said and Abdellah[6] proposes a novel architecture to schedule the tasks in cloud computing on the basis of a new Dynamic Dispatch Queues Algorithm (DDQA) and Particle Swarm Optimization (PSO) algorithm. The proposed algorithm DDQA-PSO gives full consideration to the dynamic characteristics of the cloud computing environment. The output of the proposed architecture minimize the waiting time as well as the length of queue, reducing the make span and achieve a high utilization of resources.

Ali Al-maamari and Fatma A. Omara[7] proposes Dynamic Adaptive Particle Swarm Optimization algorithm (DAPSO) to enhance the performance of the basic PSO algorithm to optimize the task runtime by minimizing the makespan of a particular task set, and in the same time, maximizing resource utilization. A task scheduling algorithm has been proposed to schedule the independent task over the Cloud Computing. The proposed algorithm is considered an amalgamation of the Dynamic PSO (DAPSO) algorithm and the Cuckoo search (CS) algorithm; called MDAPSO.

Awad, Hefnawy, Abdel_kader[8] propose mathematical model using Load Balancing Mutation (balancing) a particle swarm optimization (LBMPSO) based schedule and allocation for cloud computing that takes into account reliability, execution time, transmission time, make span, round trip time, transmission cost and load balancing between tasks and virtual machine .LBMPSO can play a role in achieving reliability of cloud computing environment by considering the resources available and reschedule task that failure to allocate.

Priyadarsini and Arockiam[9] proposes work that adopts a parallel approach that considers Bee Colony Optimization (BCO) in parallel with Particle Swarm Optimization (PSO) for cloud task scheduling. The proposed approach is named as Parallel Bee Colony Optimization Particle Swarm Optimization (PBCOPSO). The proposed hybrid PBCOPSO enables improved search in the solution space due to the parallel execution of BCO and PSO leading to better final solution quality and lower execution time. The outcome shows that the proposed approach minimizes makespan with optimized resource utilization.

Table 1 : PSO algorithm variants for Cloud computing task scheduling

Sr. No.	Paper	Methodology Adopted	Advantage	Future Scope	Tool Used
1.	An Efficient Resource Utilization Based Integrated Task Scheduling Algorithm	An integration of Particle swarm optimization technique by the means of max-min algorithm	The make span parameter improves by 5.01% and CPU utilization gets improves by a factor of 3.63%	Work can be done to compare effectiveness of other parameters like cost, turnaround time, energy utilization	CloudSim-3.0.3
2.	Cloud computing task scheduling based on Improved Particle Swarm Optimization Algorithm	Total completion time is treated as a fitness function in the algorithm by embedding the chaotic disturbance strategy.	Good performance to optimize resources and reasonable scheduling resources.	Work can be done to compare effectiveness of other parameters like cost, turnaround time, energy utilization	CloudSim-3.0.3
3.	Efficient Task Scheduling Multi-Objective Particle	Developed a novel multi-objective PSO algorithm,	Reduction in execution time of	Work can be done to consider task priority	CloudSim-3.0.3

	Swarm Optimization in Cloud Computing	based on new ranking strategy based on three confliction objectives : Expected completion time, Task execution cost and VM Processing	20%, reduction the waiting time of 30%, and shows improvements of up to 40% in throughput	and task deadline	
4.	A Novel Architecture for Task Scheduling Based on Dynamic Queues and Particle Swarm Optimization in Cloud Computing	Proposed a novel architecture for task scheduling based on proposed Dynamic Dispatch Queues Algorithm (DDQA) and Particle Swarm Optimization (PSO) algorithm. Proposed algorithm take in account the load balancing when distributing tasks to available resources	Minimize the waiting time as well as the length of queue, reducing the make span and achieve a high utilization of resources	The proposed work can be enhanced so as to consider and adding more QoS parameters	CloudSim-3.0.3
5.	Task Scheduling Using PSO Algorithm in Cloud Computing Environments	This new algorithm is considered an amalgamation of the DAPSO and CS algorithms, called MDAPSO algorithm, where DAPSO algorithm is used to improve the inertia weight and CS algorithm is used in the local search where the performance is improved by changing inertia weight and trapping on local search has been improved.	Optimize the task runtime by minimizing the make span of a particular task set, and in the same time, maximizing resource utilization	The proposed work can be enhanced so as to consider and adding more QoS parameters	CloudSim-3.0.3
6.	Enhanced Particle Swarm Optimization For Task Scheduling In cloud Computing Environments	Proposes mathematical model using Load Balancing Mutation (balancing) a particle swarm optimization (LBMPSO) based schedule and allocation	Achieves reliability of cloud computing environment by considering the Resources available and reschedule task that failure to allocate.	The proposed work can be enhanced so as to consider and adding more QoS parameters	--
7.	PBCOPSO: A Parallel Optimization Algorithm for Task Scheduling in Cloud Environment	Parallel approach that considers Bee Colony Optimization (BCO) in parallel with Particle Swarm Optimization (PSO) for cloud task scheduling.	Optimizes make span and resource utilization	The proposed work can be enhanced so as to consider and adding more QoS parameters	CloudSim-3.0.3

V. CONCLUSION AND FUTURE WORK

Increasing applications from the public or enterprise users run in a Cloud, generating diverse sets of workloads regarding resource demands, performance requirements, and task execution, Job scheduling is a major activity in all computing

environments. To increase the working of cloud computing environments efficiently, scheduling is performed to gain maximum profit. The paper gives the brief overview about various PSO variants of scheduling strategy work in cloud task scheduling. Although all the methods gives the optimized make span and resource utilization, in future some more parameters could be considered to increase the performance and provide better quality of service by considering conflicting objectives.

VI. REFERENCES

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