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A Resource Allocation Strategy using PSO in Heterogeneous Cloud

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***Abstract* - The most important problem in the cloud service provider is to maintain the elastic property of the cloud in such a way that user will pretend the cloud as limitless. So the challenge is how to make the limited sources unlimited. Every task must be granted what it requires by any mean otherwise it will degrade the performance of cloud. So resource allocation has a lot of solution. Resource allocation is an NP-hard problem so no particular solution can perform well always. But these kinds of problems are solved by nature in many ways such that such as ant colony optimization (ACO) algorithm, particle swarm optimization (PSO) algorithm and firefly algorithm. In this paper, a particle swarm optimization technique has been used to resolve the most critical problem of the cloud service provider at cloud data centre. This technique is basically taken from the collective and collaborative nature of the nature swarm. This technique can be used to allocate the resource to the task request by minimizing the makes span, flow time and task execution cost. The simulation and test results show the better efficiency than the other similar existing technique.**

1. INTRODUCTION

Cloud computing is a long term result of the 'utility computing' or on demand computing. It simplifies the goal of achieving high scale computing without the maintenance pitfalls and IT expertise. It provides the model of pay as per use like other utilities used in day today life. So performance is always a challenge for the cloud service provider (CSP) which includes availability of the demanded resource at that instant of time. So CSP must have a strategy to making resources available as per demand at any point of time.

A CSP must provide pool of heterogeneous, virtualized, highly available, dynamically-scalable, and configurable and reconfigurable computing resources (e.g. storage, applications, networks, computing units, data) can be rapidly provisioned and released with minimal management effort in the data centres [1] so that a QoS must be maintained in the cloud. A scheduling system required efficient allocation of task, security, reliability and fault tolerance. In cloud computing different user have various demands like real time assurance, low cost , strong stability. So there is different parameter to satisfy the different needs of users. In this paper a resource scheduling algorithm is proposed based on PSO.

Rest of the paper is organised as follows: section 2 describe the related research done by the researchers in the task scheduling using PSO. Section 3 formulates the job-resource scheduling problem. Section 4 will discuss the proposed algorithmic solution of the resource allocation problem. Section 5 will describe simulation result and section 6 will conclude the results.

2. RELATED WORK

In paper [1] new job scheduler presented by using particle swarm optimization (PSO) by minimizing execution cost by meeting the timestamp required for the execution. Its shows better simulation results as compared to different genetic algorithms. In paper[2] proposed approach gives random generation of the particles which represents the no of resource which lies between 1 to M. random selection gives equal chance of selection of every resource and every job will get the sufficient amount of the resource to get executed. Paper [3] gives the comparative solution of the task scheduling by embedding the PSO with small position value (SPV). PSO algorithm embeds in crossover and mutation (CM-PSO), PSO algorithm embeds in local search (L-PSO) to compare with the PSO metric [3]. Another solution is proposed in the paper [4] in which set of task-service pair is represented as a candidate set. Each particle will learn from each feasible pair of different dimension. The position building technique guarantees every position is reasonable. This scheme significantly minimizes the search space and improves the algorithm performance. The new algorithm produces outstanding performance on job scheduling–resource allocation schemes in cloud environment.

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3. JOB-RESOURCE SCHEDULING MODEL

The task scheduling is represented by the Directed Acyclic Graph (DAG) where G:{V,E}. The set of nodes are called vertices which are a set of task V= {V_1, V_2, V3…..V_n} represents in workflow application. The edge which is connecting the task node represents the exchange of information between the tasks. The swarm can be represented as Xi=X_{i1},X_{i2},……..X_{iD} . every iteration update the particle position and draw it to the its best position which helps the every particle to provide the best solution of the task scheduling. Figure 1 depicts the edge weight E_{ij} denote the edge between node i and j which share the information. The weight is the simply work capacity of node and edge.

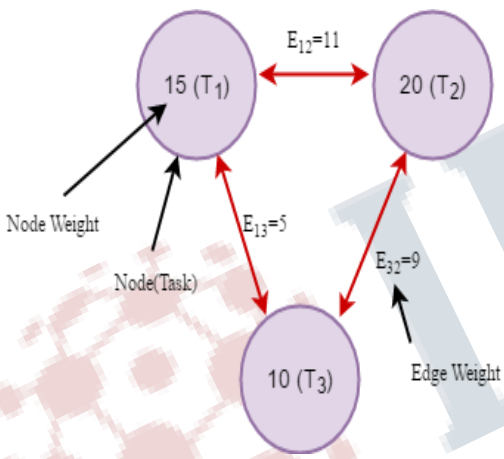

Figure 1. A DAG example on Heterogeneous Cloud

Paper [9] describes the other QoS parameter like minimizing the execution by applying the multi-objective task scheduling algorithm. More than one objective of task scheduling have been discussed and implemented successfully. The same concept of multi objective task scheduling framework is implemented in paper [10] using PSO algorithm. This strategy works on the different work flow modules of the cloud like network, image, pricing and certification module.

The paper consider that data centre has different capacity of processor (Resource) and different types of tasks demanding for resource having heterogeneous constraints like execution time, cost, priority and resource reservation. So in this variety of the task this paper focuses on the minimization of execution cost so. To implement this strategy smallest task must be allocated to the lowest capacity processor (Resource).

4. RESOURCE ALLOCATION ALGORITHM USING PSO

Kennedy and Eberhart proposed particle swarm optimization algorithm in 1995 [6].PSO is used to optimize the problem. It is inspired by the self-guided nature of the flocks of birds. In this strategy each particle is considered as path of solution in an evolutionary algorithm. In the first distribution the particle are positioned randomly. Each particle has a position vector (Xi) which is updated on the regular interval. Based on proposed algorithm by Kennedy and Eberhart [9] the formula that exists for updating position vector is:

$$X^i_{k+1}=X^i_k+V^i_{k+1} \quad (1)$$

Figure 2 simply describe the PSO algorithm which states that that each particle contributes to find the optimal solution of the problem. Initially random matrix is taken as position of particle so that every particle must be selected. Then the current position and velocity matrix is updated.

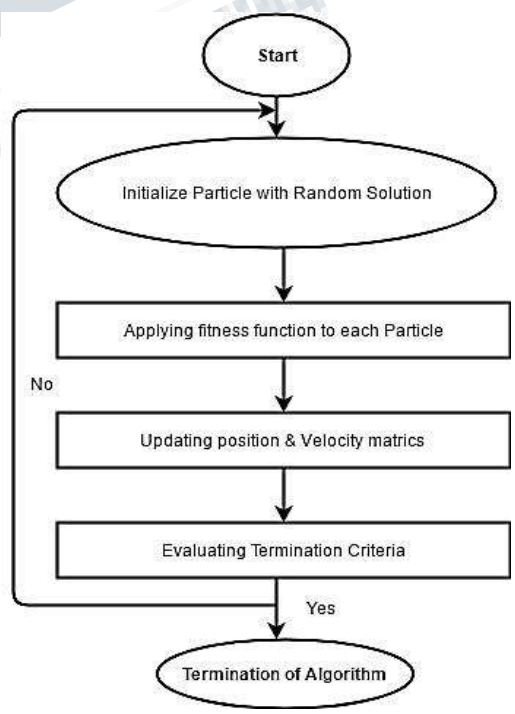

Figure 2: flowchart of PSO algorithm

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Following algorithm merged the extended particle swarm optimization with the shortest job to smallest processor. The vectors simply determine the current position of the particle which directly participate the solution of the scheduling of the task. So that every particle can guide it successive particle and can affect the result.

EPSO Based Task-Resource Scheduling Algorithm

1. Begin
2. Initialize the particle based on SJSP Algorithm
3. Apply fitness function on each particle.
4. Update position and velocity matrix
5. Evaluate termination criteria
6. Calculate fitness value
7. If (Fitness value ==Null) goto step 3
8. Terminate algorithm

Firstly existing PSO is optimized into extended PSO then it is merged with SJSP so that the cost of smallest job must be minimum because of assigning of smallest processor (processor having minimum processing power). By this strategy total cost of processing the task can be reduced.

5. EXPERIMENTS AND RESULT

Cloudsim 3.0.3 is an open source simulator which has been developed by Gridbus project team and the grid Laboratory of the University of Melbourne in Australia. The Cloudsim can run on Linux and Windows systems [7] [8]. It creates suitable simulation environment for the implementation and analysis of the modified task scheduling algorithm. A cloudsim 3.0.3 was taken with core i5 2.4GHz processor and Eclipse Jee Oxygens used to run the cloudsim. It is used to implement extended PSO and SJSP algorithm and a comparative study is also been done to evaluate the performance proposed algorithm.

Task-Resource Scheduling Algorithm	No. of Task	No.of Resource	Task/Time	Improvement
GA	100	6	6.23	2.06
PSO			5.97	
EPSO+SJSP			5.36	
GA	200	6	13.03	9.13
PSO			12.86	
EPSO+SJSP			12.16	
GA	400	6	26.8	3.27
PSO			26.31	
EPSO+SJSP			24.94	

Table: 1 Result Analysis of Proposed Algorithm

There are 4 VM and 30 GB of hard disk and 1 up to 4 cores of processor. Before examining the proposed algorithm the slandered PSO and Genetic Algorithm (GA) have been tested and results are collected for comparison with the proposed one. In the table 1 and figure 3 there are three types of algorithms have been analysed GA, traditional PSO and hybrid (EPSO+SJSP). Three range of task have been taken 100, 200 and 400 and 6 resources. This scenario is implemented on the cloudsim and criteria which is taken for consideration is makespan, and cost of execution (number of the task executed per unit time)

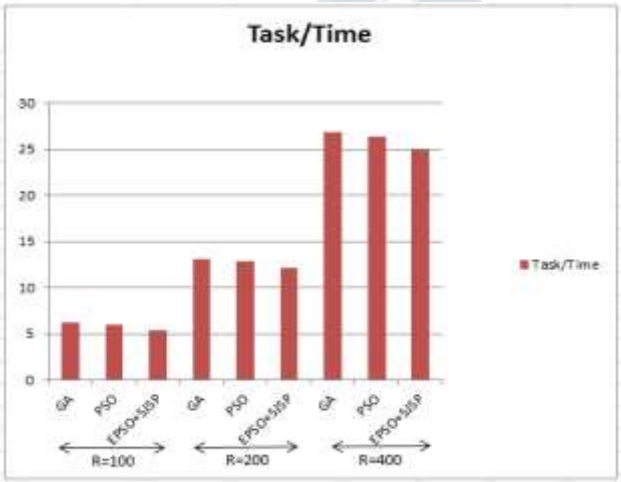

Figure 3 Results and Analysis of Proposed Algorithm

As it can be observed that as we increase the number of task on the fix amount of resource (VM) it is producing an optimum result than a traditional PSO and GA.

6. CONCLUSION AND FUTURE SCOPE

The evaluation of the PSO is done with the genetic algorithm and it is observed that the proposed combinations of two strategies are performing better together. As we increase the number of resource and the available VM remains the same still it is giving the better results. The parameter was taken was makespan and total cost of execution. In future the other parameter like load balancing, VM allocation strategy and optimizing energy efficiency. There may be other major objective which can be targeted using this hybrid PSO algorithm.

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