

A MULTI-OBJECTIVE HYBRID ACO-PSO OPTIMIZATION ALGORITHM FOR VIRTUAL MACHINE PLACEMENT IN CLOUD COMPUTING

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Abstract

Cloud computing is made possible through virtualization technology which makes virtual machines (VMs) to be placed in physical servers. The process of assigning VMs to servers is called virtual machine placement. VM placement in cloud is done by focusing on many objectives like VM allocation time, energy consumption, SLA violation, utilization of resources, etc. In this paper, a multi-objective hybrid ACO-PSO optimization algorithm is proposed for minimizing resource wastage, minimizing power consumption and for load balancing in physical servers. Simulation results show that the proposed algorithm reduces resource wastage and power consumption and also provides load balancing in servers when compared to the existing multi-objective ant colony system algorithm.

Keywords: Cloud computing, Multi-objective optimization, Virtual machine and Virtual machine placement

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1. INTRODUCTION

Cloud computing is a paradigm for computing and delivering services over the internet [1]. Three major service models of cloud computing are Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). In cloud infrastructure, virtualization enables hardware resources on one or more servers to be divided into multiple execution environments called virtual machines (VMs) through hardware or software partitioning. In virtualization, placement of VMs in physical servers is one of the research problems in cloud.

Several research works [2-5] addressed VM placement problem by considering different objectives like reducing VM allocation time, reducing number of physical servers needed, reducing resource wastage and improving power efficiency. Some research works did VM placement by considering one of the above objectives (i.e., single objective) or more than one objective which is mentioned above (i.e., multiple objective). Static Server Allocation Problem (SSAP) algorithm [2], Static Server Allocation Problem with variable workload (SSAPv) algorithm [2], Dynamic Server Allocation Problem (DSAP) algorithm [2] and Novel Vector Based Approach for Static VM Placement algorithm [4] are single objective algorithms for reducing the number of servers required. Multi-objective Ant Colony Optimization (ACO) algorithm [3] is a multi-objective algorithm for reducing resource wastage (CPU, memory, bandwidth), power wastage and Service Level Agreement (SLA) violation. VM Scheduler algorithm [5] is also a multi-objective algorithm for reducing VM allocation

time and improving resource utilization. Yongqiang et al. [6] proposed a multi-objective algorithm named Virtual Machine Placement Ant Colony System (VMPACS) algorithm for improving power efficiency and resource utilization in each server. In this paper, hybrid ACO-PSO optimization algorithm is proposed for reducing resource wastage and power consumption and also to provide fault tolerance through load balancing. The performance of the proposed algorithm is compared with the VMPACS algorithm.

This paper is organized as follows. Section 2 describes proposed hybrid algorithm for VM placement in cloud. Section 3 explains the results. In Section 4, the conclusion is given.

2. PROPOSED HYBRID ACO-PSO ALGORITHM

The goal of the proposed hybrid ACO-PSO algorithm is to find VM placement solutions which will reduce total resource wastage (i.e., CPU and memory wastage) and power consumption in physical server and to provide fault tolerance through load balancing. VM placement solution tells us which VM has to be placed in which server.

2.1 Description

In proposed hybrid ACO-PSO algorithm, hybridization is done sequentially [7] i.e., the VM placement solutions obtained by ACO algorithm are given as input to PSO algorithm. ACO algorithm finds VM placement solutions by considering resource wastage and power consumption in each server and PSO algorithm finds VM placement solution when

considering fault tolerance through load balancing in each server. ACO algorithm and PSO algorithm are used as local search algorithm and global search algorithm respectively in this proposed hybrid algorithm. Two phases in the proposed hybrid ACO-PSO algorithm are initialization phase and iteration phase. In initialization phase, all parameters in ACO and PSO algorithm are set. In iteration phase, each ant receives all VM requests and assigns physical server for each VM according to its requirements. Power consumption (P) of each server is calculated according to equation (1).

$$P = y * (P^{busy} - P^{idle}) \tag{1}$$

Where y is a binary variable which indicates whether the server is in use or not P^{busy} and P^{idle} are power consumption values when the server is fully utilized and idle respectively.

The resource wastage (W) in each server is calculated by the equation given in (2).

$$W = y * (| (T_{pi} - (\sum_{i=1 \text{ to } n} (x_i \cdot R_{pi}))) - (T_{mi} - (\sum_{i=1 \text{ to } n} (x_i \cdot R_{mi}))) |) / (\sum_{i=1 \text{ to } n} (x_i \cdot R_{pi}) + \sum_{i=1 \text{ to } n} (x_i \cdot R_{mi})) \tag{2}$$

Where n is the number of VMs and y is a binary variable which indicates whether the server is in use or not. T_{pi} and T_{mi} are threshold of CPU utilization and memory utilization in each server respectively. R_{pi} and R_{mi} are CPU and memory required by each VM respectively. x_i is a binary variable which indicates if VM i is assigned to this server.

The VM placement solutions obtained by ACO algorithm are updated in pheromone-particle table and given as input to PSO algorithm. PSO algorithm generates particles (i.e., VM placement solutions) and fitness of each particle (i.e., calculation of load in each server) is calculated by equation (3).

$$f = \sum_{j=1 \text{ to } k} u_j \tag{3}$$

Where u_j denotes CPU utilization of VM j in a server and k is the number of VMs placed in that particular server.

After calculating fitness of each particle (i.e., VM placement solution), best position of each particle is found. Both particle's position X_i^{t+1} and particle's velocity V_i^{t+1} is found using the formula given in (4) and (5) respectively.

$$V_i^{t+1} = V_i^t + (X_{lbest}(t) - X_i^t) + (X_{gbest}(t) - X_i^t) \tag{4}$$

Where V_i^t is velocity of particle i and X_i^t is position of particle i. $X_{lbest}(t)$ denotes velocity of local best particle i and $X_{gbest}(t)$ denotes velocity of global best particle.

$$X_i^{t+1} = X_i^t + V_i^{t+1} \tag{5}$$

where X_i^t is position of particle i and V_i^t is velocity of particle i.

After the calculation of particle's velocity and position, VM placement solutions obtained by PSO algorithm are updated in pheromone-particle table. The above process is repeated until a maximum number of iterations.

2.2 Steps in Hybrid ACO-PSO Optimization Algorithm

Step 1: Collecting the inputs.

- Set of servers with its resource capacity.
- Set of VMs with its resource requirements.

Step 2: Initialization.

- Particle population size, number of ants and maximum number of iterations MAX_ITER are initialized.

Step 3: Generate initial population by VM placement solutions based on power consumption and resource wastage of each server.

Step 4: Update particle-pheromone table with solutions obtained from ACO.

Step 5: Generate new particles.

Step 6: Calculate the fitness of all particles and obtain local best position of every particle.

Step 7: Update the particle's velocity.

Step 8: Update the particle's position.

Step 9: Update particle-pheromone table with solutions obtained from PSO.

Step 10: Find the global best solution.

Step 11: Go to step 3 if the iteration value is less than MAX_ITER or go to step 12.

Step 12: Output the global optimal solution for VM placement

3. RESULTS

The proposed algorithm is simulated in cloudsim. The performance of the proposed hybrid ACO-PSO optimization algorithm is compared to multi-objective ant colony system (ACS) algorithm Yongqiang et al.[7].

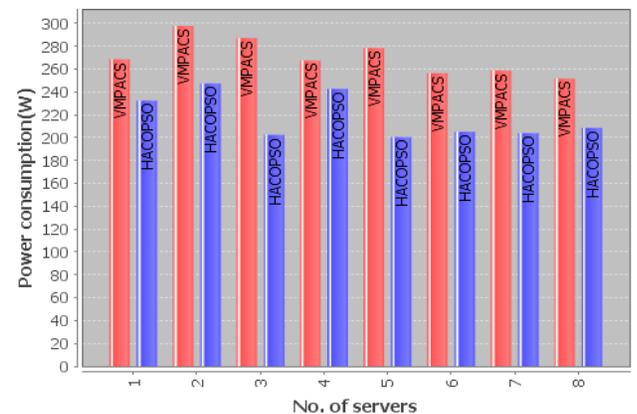


Chart -1: Power consumption in each server

Chart 1 compares the total power consumed in each server when proposed hybrid ACO-PSO (HACOPSO) algorithm and Virtual Machine Placement Ant Colony System (VMPACS) algorithm are used. From the graph, we can understand that the total power consumption in each server is reduced when the proposed HACOPSO algorithm is used.

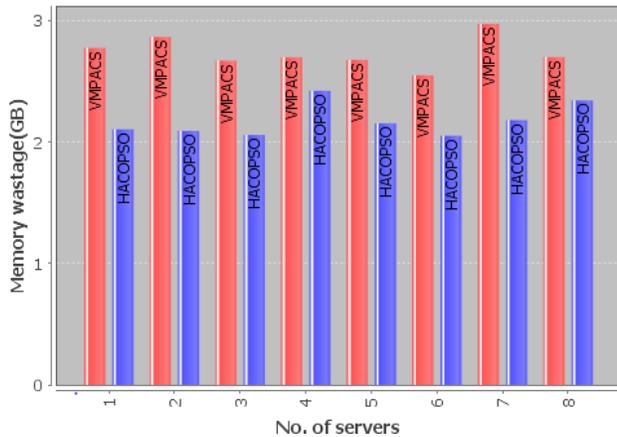


Chart -2: Memory wastage in each server

Chart 2 compares the total memory wastage in each server when proposed HACOPSO algorithm and VMPACS algorithm are used. From the graph, we can understand that the total memory wastage in each server is minimized when the proposed HACOPSO algorithm is used.

4. CONCLUSIONS

In cloud environment, the placement of VMs in available servers is one of the research problems. In this paper, a multi-objective hybrid ACO-PSO algorithm is proposed for VM placement. The proposed hybrid algorithm gives VM placement solution which reduces the total resource wastage and power consumption in servers and provides fault tolerance through load balancing in servers. By this, the overall server cost is reduced. In our future work, we will propose a VM placement algorithm for reducing SLA violation.

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