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Crow search based virtual machine placement strategy in cloud data centers with live migration☆

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ABSTRACT

Cloud computing has emerged as the most revolutionary technology in the field of computing. The cloud service providers (CSPs) have high computational facilities called data centers (DCs) at their disposal. CSPs provide services to the users through virtual machines (VMs). VM placement is the mapping of VMs onto physical machine called hosts. In this paper, we propose a two-tier virtual machine placement algorithm. Firstly, we propose a queueing structure to manage and schedule a large set of VMs. Secondly, a multi-objective VM placement algorithm called crow search based VM placement (CSAVMP) is proposed to reduce the resources wastage and power consumption at the data centers. VM migration is an indispensable part of any cloud platform for activities like maintenance, load balancing, fault tolerance etc. Three different migration strategies namely serial, parallel, improved serial have been tested and a comparative result has been produced.

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1. Introduction

Cloud computing is defined as a shared pool of virtualized resources that can be used on-demand. The emergence of cloud computing has propelled the idea of utility computing and has made it realizable. Computing resources can be accessed on demand by the users [1,2]. There are many popular cloud service providers e.g. Amazon, Google, Microsoft etc. One of the basic building block of cloud computing is virtualization. In-fact the users access the resources of the cloud using an independent executable unit called virtual machine (VM). These VMs are hosted on physical servers in huge computational infrastructures called as data centers (DCs). These data centers can be defined as a virtualized pool of resources that provide users with almost infinite computing resources in the form of CPU, memory, disk space etc. VM placement problem denotes an optimal mapping of VMs onto physical servers such that it maximizes the service providers revenue and minimizes operational parameters like power consumption, thermal dissipation, physical space etc. [3]. A cloud infrastructure provides a shared platform for hosting user applications. Each application can use its own VM which can be provisioned on-demand. Thus data center management is a complex, time consuming task and cannot be handled by humans. A naive

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approach to placement can hurt the application performance if user demands are not met, and if it fails to achieve power and resource efficiency.

In this paper, we propose a two-tier VM placement algorithm. At the first level we propose a queueing model to handle a large number of VM requests. The queuing model is easy to implement and helps in validating complex simulation model, such as cloud. It also suggests an alternative way of ordering a system to allocate task to servers. Secondly, a multi-objective VM placement algorithm is proposed using a meta - heuristic crow search algorithm (CSA). It aims to strike a balance between the resource wastage i.e. unused resources, and power consumption at the servers. There are many optimization techniques that have already been used to solve the VM placement problem but the motivation to use crow search has been discussed in detail in Section 3. The performance of the proposed algorithm has been compared with optimal techniques like first fit decreasing (FFD) [4], grouping genetic algorithm (GGA) [5]. Thirdly a migration framework has also been used to migrate VMs. Since VM migration is an indispensable tool and is being used at every DC for load balancing, maintenance, recovery etc. A detailed study about different migration techniques namely parallel, serial and improved serial strategies has been carried out.

1.1. Our contribution

The contribution of the paper is three fold:

(i). Firstly, a queueing model is proposed to manage and schedule a large set of VM requests. Since a queueing model helps us to easily implement, validate and analyse complex models like cloud.

(ii). Secondly, a novel multi - objective virtual machine placement algorithm is proposed. A meta- heuristic crow search algorithm (CSA) is used to solve the multi-objective VM placement problem. The solution aims to strike a balance between the resource wastage i.e. unused resources and power consumption at the servers. The performance of the proposed algorithm has been compared with many optimal techniques first fit decreasing (FFD) [4], grouping genetic algorithm (GGA) [5].

(iii). Thirdly, a migration framework has been studied. Various techniques for migration reported in the literature like parallel, serial and improved serial strategies have been simulated and tested.

The remainder of the paper is organized as follows. In Section 2, work reported in the literature for VM placement is discussed. Section 3, discusses reasons for choosing CSA as a VM placement strategy. Section 4, discusses the system model for VM placement. Section 5, explores different migration strategies. Section 6, discusses the results obtained, and finally Section 7 concludes the paper.

2. Related work

The problem of virtual machine placement has been studied and analysed by a substantial number of researchers. The problem of VM placement is similar to that of a bin packing [13]. Maximization of the profits as well as the minimization of power consumption and SLA violations of hosted applications is studied in [5]. In [6], a genetic algorithm and fuzzy logic based technique has been used to simultaneously minimize total resource wastage, power consumption and thermal dissipation costs for VM placement. In [7], an optimal virtual machine placement (OVMP) algorithm to minimize the total cost due to buying reservation and on-demand plans of resource provisioning has been proposed. In [8], ACO has been used to find an optimal solution to VM placement that simultaneously minimizes the resource wastage and power consumption. In [14], an approach to handle requests along different dimensions that are stochastic and time varying in nature is studied. In [9], a modified best fit decreasing (MBFD) algorithm has been proposed, which aims to reduce the number of active servers to obtain a stable host for every VM, such that, the number of unnecessary migrations and the total power consumption can be reduced. In [10], a balanced approach has been proposed, to maintain the tightness of packing, as well as, the stability of the VMs by minimizing the number of physical machines and unnecessary migrations. A bio-geography based optimization (BBO) technique has been proposed to optimize the VM placement that simultaneously reduces the resource wastage and the power consumption [11]. In [12], authors have proposed a technique to optimize the energy consumption in communication networks deployed at data centers. The overview of all the existing virtual machine placement strategies have been studied in [15].

The objectives of the work reported in the literature that we have reviewed is summarized in the Table 1.

3. Why crow search ?

There are many popular optimization algorithms like genetic algorithm (GA), particle swarm optimization (PSO) that makes use of a population of seekers to explore the search space. CSA is also one such algorithm. By using a population based search the chances of finding a good solution increases [16]. Population size, number of iterations are some of the important parameters associated with the optimization techniques. Along with these parameters there are some adjustable parameters that must also be set. The setting up of such parameters is a cumbersome task. Algorithms which have fewer adjustable parameters are the ones that are easier to implement and test. This is where CSA beats other benchmark optimization techniques such as GA, PSO. The number of parameters involved in many popular optimization techniques is shown in Table 3.

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