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A Swarm Intelligent Algorithm for Optimizing Cloud Computing

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By

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Abstract

Cloud computing became existing in every domain of life, enhancing their functionality and adding new opportunities to it. It is the mechanism of moving the processing effort from the local devices to the data center facilities. Its exponential growth gained it a huge focus towards solving its challenges. Quality of service is one of the main challenges of cloud computing which are known as: 1) security and privacy, 2) portability, 3) reliability and availability and 4) quality of service (QoS). Quality of service is maintaining the proper management of resources in order to fulfill the Service Level Agreements (SLAs), which is the agreement between the cloud providers and the cloud users. Considering the massive demand to handling Cloud Computing challenges, research has been continuously performed in this area especially in load balancing.

Load balancing is the process of distributing load over servers to keep the system steady without overloaded or under-loaded ones which maximize resource utilization. The load can be network load, memory or CPU loads. The Load balancing of any cloud system is dependent on its scheduler either task scheduler or resource scheduler. Research on it assists in improving one of these elements: 1) makespan, 2) response time, 3) migration time, 4) energy consumption, 5) throughput or 6) cost. It is branched to two types of work: Static Load Balancing (SLB) and Dynamic Load Balancing (DLB). Static Load Balancing runs from the start with prior knowledge of the system, while Dynamic Load Balancing depends on the progress of the system as it runs when overload state or imbalance occurs. It is considered a NP-hard problem so to solve it many research was done using heuristic and Meta heuristic Algorithms.

This thesis proposes the use of selected swarm algorithms: Ant-Lion optimizer (ALO) and Grey wolf optimizer (GWO) in task scheduling of a cloud computing system as they are known for their high avoidance of local optima and high exploration of the search space in comparison to other intelligent algorithms. Upon experimenting with ALO against the traditional algorithm Round Robin (RR) in the small-scale simulation of ten task and five VMs, it outperforms RR in tasks executing time, but it was slow in scheduling because of its random walk of ants in each iteration. As such, this thesis proposes two modification to speed up the random walk of ALO: ALO2 and ALORW.

Additionally, experimenting and comparing the results with GWO and commonly known Meta heuristics Algorithms in task scheduling such as: Particle Swarm Optimization (PSO) and Firefly Algorithm (FFA). In testing the algorithms in large scale of 20 to 30 VMs and 1 to 2 DCs, the results present that, ALO2 and grey wolf optimizer (GWO) are strong adversary to particle swarm optimization (PSO), and better than firefly (FFA) and they both have potential in load balancing.

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List of Abbreviations

Abbreviation	*Name*
ABC	Artificial Bee Colony
ACO	Ant Colony Optimizer
ALO	Ant Lion optimizer
APIs	Application Programming Interfaces
AWS	Amazon Web Services
BI	Business Intelligence
CSP	Cloud Service Provider
DC	Data Center
FA or FFA	Firefly Algorithm
FCFS	First Come First Serve
GA	Genetic Algorithm
GWO	Grey wolf Optimizer
IaaS	Infrastructure As A Service
LJF	Longest Job First
MbaaS	Mobile "Backend" As A Service
MCT	Minimum Completion Time
MET	Minimum Execution Time
PaaS	Platform As A Service
PSO	Particle Swarm Optimizer
RA	Random Allocation
RR	Round Robin
SaaS	Software As A Service
SI	Swarm Intelligence
SJF	Shortest Job First
SLAs	Service Level Agreements
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
VM	Virtual Machine
QoS	Quality of Service
SDK	Software Development kit
NP	Nondeterministic polynomial

BRS	Best Resource Selection
RSA	Random Scheduling Algorithm
IPSO	Improved Particle Swarm Optimization
LSF	Longest Job First

Chapter 1

Introduction

Chapter 1. Introduction

1.1 Overview

Cloud computing is the process of renting computation and storage facilities and services to interested third parties. Cloud computing revolutionized the IT industry. It impacted the business intelligence (BI) landscape heavily, pretty much everything else it touches. It emerged from the need to outsource computing and storage facilities to clients. Its rapid growth is because of the huge enhancement of communication technologies and virtualization technologies that lead most of its systems nowadays to become essential in day to day activities especially the trending mobile cloud computing.

Any cloud system differentiates itself by the enhancement of one of their main challenges. These challenges are: security, network cost, reliably, portability and quality of service. The importance of cloud led its challenges to be a hot research points. The focus of this thesis mainly on quality of service specifically load balancing problem.

Cloud Load balancing is improving performance by the distributing tasks equally on resources utility. It mainly divided to static and dynamic load balancing. Static load balancing is scheduling of tasks fairly on available resources. However, dynamic load balancing is dealing with overloaded or failure VM by migration of either the VM or the overloaded tasks.

Cloud scheduling has always been a research subject whose goal is to ensure that every computing resource is distributed fairly and effectively. It is challenging to reliably schedule tasks because any individual instance may become unavailable due to auto-scaling or network partitioning. Therefore, there have been many Algorithms introduced.

Intelligent Algorithms are often introduced in scheduling as simple heuristic algorithms hardly seem effective in dynamic environments. From those researched Algorithms are Swarm intelligent algorithms like PSO, ACO, ABC and other. As they are imitates the intelligence of natural group behavior, they show flexibility in dynamic internal or external changes and fast adaptation when some individuals fails.

1.2 Problem definition

To work on load balancing, traditional algorithms aren't sufficient and the meta-heuristic algorithms like evolutionary algorithms and swarm intelligent algorithms were explored. Additionally, swarm intelligent algorithms are known for their self-organizing properties thus can work well in a dynamic scalable environment like cloud systems [3, 14]. Moreover, as new swarm intelligent algorithms emerge like grey wolf optimizer (GWO), firefly algorithm (FA) and ant lion optimizer (ALO) and many others, so is the need to explore these algorithms in cloud computing depending on no free lunch theorem [7].

1.3 Thesis objectives

The objective of this thesis is to introduce an efficient task scheduler to work as load balancing mechanism, minimizing the makespan and try to minimize dynamic load balancing work of migrating overloaded VMs. Accordingly, minimize the cost of migration and give better performance than other intelligent algorithms. This is done by exploring, implementing and analyzing the results of the new swarm intelligent algorithms grey wolf optimizer (GWO) and ant lion optimizer (ALO).

1.4 Methodology

In this thesis, the task scheduler is implemented on cloud simulator called CloudSim and its graphical extension CloudReports. Moreover, the experiment is done with various scales of tasks and resources to properly examine the scheduling algorithms. Grey wolf optimizer (GWO) and ant lion optimizer (ALO) are researched as scheduling algorithms as they are known for their avoidance of local optima. Furthermore, they are compared with other acknowledged swarm algorithms particle swarm optimizer (PSO) and firefly algorithm (FFA).