Swarm Intelligence Based Load Balancing Techniques

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: cloud computing load balancing swarm intelligence algorithms

1. Introduction

Cloud computing is a metaphor for the internet that provides computing as a utility to end-users. It is referred to as the systematic storage, computing, and access of data through the internet rather than one's hardware or office network. It is a computational paradigm providing various resources, software platforms, etc., hosted at vast data centers to users in order to enhance their productivity [1]. Providers of cloud computing deliver their "services" according to various models. Infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), and software-as-a-service (SaaS) are the three common models [2]. These models provide growing abstraction; thus, they are mostly depicted as layers in a pyramid i.e., infrastructure, framework, and software-as-a-service. Several cloud commercial services providers have achieved users' trust despite the growing concern about relying on a third-party need for the computational purpose by end-users. The obvious reason is their user-friendliness, accessibility, and secure environment [3]. This includes Microsoft Azure, Google Cloud, and Amazon Web services, etc. In the past few years, some other academic and commercial service providers, viz., Jetstream, Helix Nebula, Open Science Data Cloud, etc., have achieved fame by introducing their services at lower rates with higher rates of proficiency [4]. As the creation and usage of big data continually increase, cloud computing has emerged in a significant role, grasping users' attention and promoting several financial activities over it. It has been engaging many users who use its resources who pay a respective amount as per the required period [5].

Load balancing allows the facility to assign the workload such as the resources accessible. Its goal is to provide continuous service by providing and divesting the application instances along with proper use of resources in the event of failure of any service portion [6]. The goal of load balancing is to reduce the response time for operations and to maximize the usage of resources, which increases device efficiency at lower costs [7]. At the same time, it also targets providing scalability and versatility for applications in which its size will increase in the future and require more resources, as well as to prioritize tasks that need immediate implementation compared to others. Another main requirement in order to adapt load balancing [8] is that it decreases energy consumption, avoids bottlenecks, provides support, and meets QoS criteria with respect to improving load balancing.

Even though several algorithms are available for load balancing in cloud computing such as conventional algorithms, machine learning algorithms, and heuristics algorithms. This paper specifically targets swarm intelligence-based approaches to load balancing. As compared to heuristics algorithms, the benefits of swarm intelligence-based algorithms are discussed in the next paragraph.

Normally, when historical or traditional procedures are too expensive or fail to uncover accurate solutions, a heuristic is used to solve issues more rapidly. As a result, it is often referred to as approximation algorithms. The goal of heuristic techniques is to find a solution to a specific problem in an acceptable amount of time [9]. The results may not be the best, but they can come close to being the best. With a strategic estimate, this algorithm discovers the potential results. It can provide results on its own or in combination with other optimization strategies to improve efficiency. Heuristic approaches could not produce a near-optimal result; instead, they could only produce a small number of distinct alternatives. The major drawback of heuristic approaches is that they tend to halt at low-quality local optima when looking for a solution, which resulted in the invention of SI, an iterative optimization technique [10]. SI aims to combine relatively high approximate techniques to guide local optimization strategies in order to explore a solution space successfully and efficiently.

2. Load Balancing in Cloud Computing Using SI

In this survey, SI techniques for load balancing are divided into two basic categories (as shown in **Figure 4**): One is a traditional algorithm, and the other is a Modern algorithm. The details of their variations are presented below.

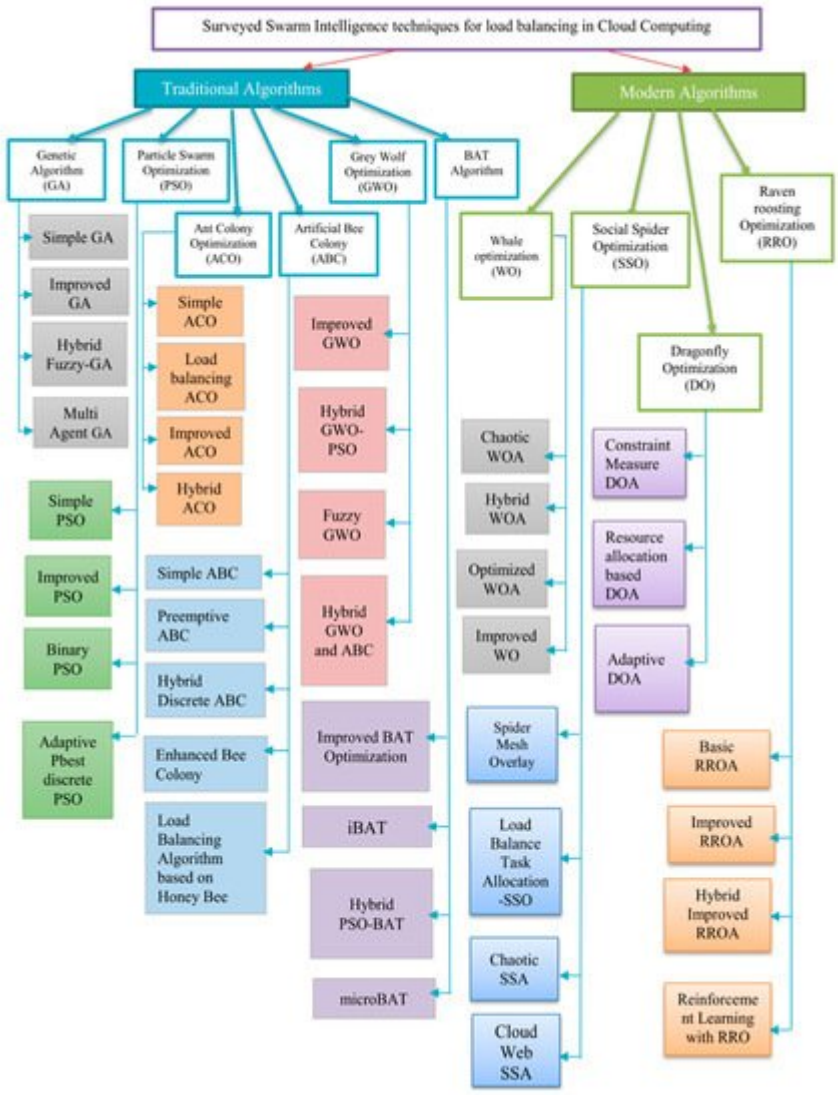

Figure 4. Swarm intelligence algorithms under discussion.

2.1. Traditional SI Algorithms for Load Balancing

The idea to apply “collective intelligence” inspires the study of swarm intelligence. This intelligence is decentralized, coordinated, and distributed in an atmosphere [11]. Using swarm-based load balancing algorithms can efficiently solve the problem of load balancing in cloud computing environments [12].

Various selected types of algorithms based on Swarm Intelligence for load balancing are shown in **Figure 4**:

(a) Genetic Algorithms;

(b) Particle Swarm Optimization;

(c) Ant Colony Optimization;

(d) Artificial Bee Colony;

(e) Grey Wolf Optimization;

(f) BAT Algorithm.

3. Modern SI Algorithm for Load Balancing

As we have discussed in the last sections, adequate work is performed on traditional swarm intelligence algorithms to cope with the issues of load balancing in cloud-based task allocation [13]. There are certain issues associated with these algorithms that ultimately limit the pertinence of utilizing the best of them. Therefore, due to slow convergence, intricacy in implementation, and complexity to ensure scalability, some state-of-the-art techniques are highly required. In this section, the most increasingly competitive swarm intelligence-based load balancing strategies in the cloud include the whale, spider, dragonfly, and raven; roosting optimization algorithms are discussed.

4. Summary of the Reviewed SI Algorithms

All this demonstrates that SI based algorithms neither ensure the cloud to be neither one nor decentralized by maintaining migrations in the cloud. These algorithms exploit the capabilities of heterogeneous resources; consider the priority to obtain real-world virtualization by minimizing makespan; increasing throughput; reducing the response, waiting, and processing time; and improving the convergence rate with increased performance. This efficient utilization of resources makes the fitness function improve premature converge, and this fast convergence ultimately satisfies the QoS metrics.

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