

# An Energy-Aware Task Scheduling in the Cloud Computing Using a Hybrid Cultural and Ant Colony Optimization Algorithm

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## ABSTRACT

In a cloud environment, computing resources are available to users, and they pay only for the used resources. Task scheduling is considered as the most important issue in cloud computing which affects time and energy consumption. Task scheduling algorithms may use different procedures to distribute precedence to subtasks which produce different makespan in a heterogeneous computing system. Also, energy consumption can be different for each resource that is assigned to a task. Many heuristic algorithms have been proposed to solve task scheduling as an NP-hard problem. Most of these studies have been used to minimize the makespan. Both makespan and energy consumption are considered in this paper and a task scheduling method using a combination of cultural and ant colony optimization algorithm is presented in order to optimize these purposes. The basic idea of the proposed method is to use the advantages of both algorithms while avoiding the disadvantages. The experimental results using C# language in cloud azure environment show that the proposed algorithm outperforms previous algorithms in terms of energy consumption and makespan.

## KEYWORDS

Ant Colony Optimization Algorithm, Cultural Algorithm, DAG, Task Scheduling

## 1. INTRODUCTION

Cloud computing is a popular phenomenon (Chiregi & Navimipour, 2016; Sheikholeslami & Navimipour, 2017) in which shared resources are prepared to end-users in an on-demand fashion that brings many advantages, including data ubiquity, the flexibility of access, high availability of resources, and scalability (Bouarara, Hamou, Rahmani, & Amine, 2014; Kumar, Ashok, & Subramanian, 2012). Cloud computing focuses on commercial resource provision and allows customers to use the computing resources presented by multiple service providers (Kim & Jo, 2016; Mohammadi, 2017). It is a model of service delivery and access mechanism where virtualized resources are provided as a service over the Internet (Milani & Navimipour, 2016; Anil Singh, Dutta, & Singh, 2014; Sood, 2013). It follows a pay-per-use model and can be dynamically reconfigured to satisfy user requests via on-the-fly virtual resources (Navimipour, Rahmani, Navin, & Hosseinzadeh, 2015; Vakili & Navimipour, 2017).

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The main problems of cloud computing are dynamism, requiring continuous monitoring of requests and resources, handling of ever changing requirements, schedules and prices, selecting appropriate services and plans to meet overall objectives of the cloud (Aznoli & Navimipour, 2017; Chowhan, Shirwaikar, & Kumar, 2016). Cloud computing presents many services to users (Alami Milani & Jafari Navimipour, 2016; Ezugwu, Buhari, & Junaidu, 2013) such as Software as a Service (SaaS) (Alkhanak, Lee, & Khan, 2015), Infrastructure as a Service (IaaS) (Mehta & Gupta, 2013), Platform as a Service (PaaS) (Shao, Wang, & Mei, 2012) and Expert as a service (EaaS) (Navimipour et al., 2015). These services can then be accessed through a cloud client which could be a web browser, mobile app, and so on (Chong, Wong, & Wang, 2014).

On the other hand, task scheduling on distributed computing environments such as cloud computing is an interesting issue (Keshanchi, Souri, & Navimipour, 2017). In order to arrange the performance of the task in a cloud, an efficient task scheduler is requested in which applications should divide into subtasks (Navimipour, 2015a, 2015b). These subtasks are shown as a directed acyclic graph (DAG). The type of task scheduling greatly affects the energy consumption of a cloud datacenter, if the task is not properly scheduled can increase energy consumption, therefore an energy aware task scheduling can save lots of energy. In the cloud computing environment, various types of users perform their tasks (Aarti Singh & Malhotra, 2015). Each of them has entirely different resource requirements (Habibi & Navimipour, 2016).

By considering the important role of task scheduling in cloud computing, this paper is aimed to propose an efficient task scheduling algorithm including two important criteria, the makespan, and energy consumption. During the last few years, the high price of energy consumption has become a critical issue (Koomey, 2011) and cloud providers faced with the pressure of minimizing their energy consumption as well as their amount of CO<sub>2</sub> emissions. Since ant colony optimization (ACO) algorithm has long iteration time and convergence time is uncertain. On the other hand, the cultural algorithm has been successfully applied to optimization problems and has advantages in overcoming some weaknesses of conventional optimization methods (Yang & Gu, 2014), the ACO algorithm is combined with a cultural algorithm to improve the performance of the task scheduling algorithm and deal with that issues. Briefly, the main purpose of this paper is proposing a new hybrid algorithm using the cultural algorithm and ACO algorithm for minimizing makespan and energy consumption.

The rest of this paper is organized as follows. Related mechanisms are reviewed in Section 2. An introduction to ACO algorithm, cultural algorithm, and the proposed algorithm are discussed in Section 3. Empirical experiments of evaluating the improved algorithm are conducted in Section 4. Finally, the paper concludes in the last section.

## 2. RELATED WORK

Since task scheduling is an NP-hard problem, many researchers presented the nature-inspired optimization algorithms for task scheduling in cloud environments. In this section, some state-of-the-art mechanisms are discussed and analyzed.

Zuo (2015) has proposed a multi-objective optimization method for solving the task scheduling problem in cloud computing. They proposed a resource cost model that defines the demand of tasks on resources with more details. This model reflects the relationship between the user's resource costs and the budget costs. A multi-objective optimization scheduling method has been proposed based on the proposed resource cost model. This method considers the makespan and the user's budget costs as limitations of the optimization problem, to achieve multi-objective optimization of both

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