Business Process Driven Trust-Based Task Scheduling

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ABSTRACT

The demand for agile and flexible business application systems has sparked interest in using cloud computing technology to respond quickly and effectively to a dynamic business environment. The authors classify the appropriate cloud services as a multi-objectives task scheduling problem in a hybrid cloud service system. In this article, the authors propose a business process (BP) driven task scheduling system that supports multiple clouds, including private ones. A trust-based non-dominated sorting genetic algorithm (NSGA2) is developed to solve the multi-objective task scheduling problem. By sorting populations into different hierarchies based on the ordering of Pareto dominance, they identify a Pareto-optimal multi-dimensional frontier that permits managers to reconcile conflicting objectives when scheduling tasks on cloud resources. The authors illustrate the usability and effectiveness of their approach by applying it to a case study conducting simulated experiments.

KEYWORDS

Cloud Computing, Multi-Objectives, NSGA2, Task Scheduling, Trust Mechanism

1. INTRODUCTION

With globalization and today’s competitive business environment, organizations are seeking flexible and agile application systems that can respond quickly and effectively to changing business requirements. Firms recognize that meeting rapidly changing requirements is difficult when using traditional development technologies (Stathopoulos, 2017). Application developers need to be flexible and use agile approaches that can leverage rapidly evolving software technology and deployment mechanisms. The ubiquitous growth of Internet access from various devices has resulted in the proliferation of cloud computing in industry, academia, and society (Airaj, 2017; Tooti, Calheiros, & Buyya, 2014). Cloud service providers offer resources such as virtual machines, storage resources, data services, platforms for application development and deployment, and application software. A common cloud service model is a layered structure that consists of infrastructure as a service (IaaS), platform as a service (PaaS), and software as a service (SaaS) (Dikaiakos, 2009). Organizations can use full applications or partial applications that support specific business tasks such as credit card validation from a SaaS cloud. Additionally, they can use PaaS for application development and

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deployment or IaaS to get access to computing and storage resources (Zhan et al., 2015). Moreover, they have the option of connecting these public cloud resources with their own computing platform or infrastructure (i.e., a private cloud). This mix of cloud services, known as the hybrid cloud, is becoming popular throughout the world. The hybrid cloud mode represents a promising option, because it provides increased flexibility and allows IT personnel to respond quickly to the changing needs of business by tailoring a solution to user needs.

This paper focuses on the business and management aspects of the BP-driven task assignment and scheduling problem in hybrid clouds. Since SaaS is designed to support a single task or a full application system, SaaS cloud resources can be used to support only specific tasks. On the other hand, PaaS can support the development and deployment of multiple applications that are used by different types of tasks. Therefore, we focus on task scheduling in hybrid PaaS cloud, which can support an enterprise’s multiple business processes. We formulate the task scheduling problem as a multi-objective model.

The framework for supporting multiple business processes is based on Service-Oriented Architecture (SOA). A series of data templates for specifying tasks and resources are designed to help collect required information in standard form. We propose a multi-objective optimization model to address the problem of task scheduling in a hybrid cloud platform that considers time, cost, and trust as three objectives. Next, we develop an innovative non-dominated sorting genetic algorithm (NSGA2), which can quickly search the Pareto frontier in the solution space, to solve the multi-objective model. The algorithm uses a non-dominated sorting operator to improve the search efficiency for multi-objective problems with Pareto front constraint. Finally, we use a case study of the drop-ship business process to illustrate the applicability of our model. Several simulation experiments are conducted to test the validity of our model, and the performance of our model is compared with other leading models available in the literature.

The paper is structured as follows: Section 2 reviews the related literature. Section 3 presents the architecture of the task scheduling system. The methodology and problem formulation are presented in Section 4. Section 5 introduces the trust-based BP-driven task scheduling algorithm. The case study and the results of simulated experiments conducted to validate the algorithm and comparison with other models are presented in Section 6. Section 7 concludes the paper with a discussion of limitations and directions for future research.

2. RELATED WORK

Cloud computing technologies allow dynamic provisioning of services, with billing based on actual use. This helps organizations reduce response time and cost and improve the quality of service (Armbrust et al., 2010; Yang et al., 2017). The challenge of selecting appropriate services from a large number of available services for supporting tasks in business processes is known as a task scheduling problem. Many theoretical and empirical research works have examined this problem. They generally focus on process decomposition, service selection, and task scheduling. We summarize the main work of their research and describe the key points of our paper.

2.1. Process Decomposition

A business process represents a collection of structured business activities or tasks, which include actors and resources to help achieve organizational goals (Chopra & Singh, 2013). Process decomposition is defined as dividing business processes into service-oriented tasks that reflect the demand and action of the business processes. Therefore, the problem of process decomposition is to find an executable sequence of tasks of a business process that when executed satisfy a set of constraints such as timing, causality, and resource constraints (Ahmed, Wu, & Zheng, 2015). Graph theory is the main approach used to model the structure of tasks in the BP. With graph theory, the
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