A Hybrid Meta-Heuristic Approach for QoS-Aware Cloud Service Composition

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ABSTRACT
Cloud is evolving as an outstanding platform to deliver cloud services on a pay-as-you-go basis. The selection and composition of cloud services based on QoS criteria is formulated as NP hard optimization problem. Traditionally, many optimization techniques are applied to solve it, but it suffers from slow convergence speed, large number of calculations, and falling into local optimum. This article proposes a hybrid particle swarm optimization (HPSO) technique that combines particle swarm optimization (PSO) and fruit fly (FOA) to perform the evolutionary search process. The following determines a pareto optimal service set which is non-dominated solution set as input to the proposed HPSO. In the proposed HPSO, the parameters such as position and velocity are redefined, and while updating, the smell operator of fruit fly is used to overcome the prematurity of PSO. The FOA enhances the convergence speed with good fitness value. The experimental results show that the proposed HPSO outperforms the simple particle swarm optimization in terms of fitness value, execution time, and error rate.

KEYWORDS
Cloud Computing, Fruit Fly Optimization, Particle Swarm Optimization, Quality of Service, Service Composition

1. INTRODUCTION
Cloud computing has emerged as a robust computing paradigm, which helps for the seamless composition of business applications to create new value added services (Jula et al., 2014). The virtue of cloud promotes a remarkable increase in number of functionally equivalent services and service providers. As the services are self-contained, loosely coupled process deployed over a standard cloud platform can be described, published, discovered and invoked on basis of pay per use. The selection of services and service providers is based on evaluating QoS parameters and user preferences, which is formulated as NP-hard optimization problem.

In this paper, we consider QoS parameters such as availability, reliability, price, response time, throughput and reputation (Luo et al., 2012). Many researchers have identified that QoS parameter value should be real number, language value and interval (Yu et al., 2007). Normally, a new service is published along with functional and non-functional parameters, where the functional parameter specifies “what exactly the service is going to perform” and non-functional parameter specifies “how
the service performance is”. The various service providers will publish a large number of similar services which have different levels of quality of service. As QoS aware service composition is a hot research topic in the field of cloud computing and networks. The improper selection and composition of services can affect the service level agreements and which leads to user dissatisfaction. Service composition is a three step process: (1) Handling user composite request (2) Service request (3) Composing selected services. In the first step, the user submits his preferences in terms of weights. In the second step, the proposed approach will select the best service from several possible similar services and those composed results will return to the user in the final step.

In past few years, the researchers proposed various techniques to solve the QoS aware service composition problem, but user dissatisfaction or violation of SLA is major problem. Linear integer programming (LIP) model is adopted by few scholars to solve service matching, ranking and selection problem by maximizing the objective value. As the number of candidate services increases the linear integer programming model suffers from increase in computational cost. As our problem is multi-constraint multi objective problem, the effective and efficient particle swarm optimization algorithm is applied to solve it. PSO has been applied in various ways to solve the service selection problem, but it attains sub-optimal solution because of its premature convergence nature (Liao et al., 2011). So, to improve the accuracy of PSO the fruit fly optimization algorithm is incorporated.

The artificial, evolutionary and classic algorithms have been used extensively to solve service composition problem (Liu et al., 2012a; Gabrel et al., 2012; Torkashvan & Haghighi, 2012). But the traditional approaches follow the global optimization approach to solve service composition problem by considering all possible candidate service combinations. This approach attains optimal combination with decent fitness value and execution time by meeting global constraints, but still it suffers from poor performance. To enhance the performance, we integrated local optimization approach which evaluates the QoS of a service among similar service set. This integrated approach attains an optimal combination with good fitness value, execution time and minimal error rate. This work divides the QoS aware service composition problem into two stages: PSO and FOA. The particle swarm optimization is used to meet global constraints and the smell, vision operators of FOA is included to find optimal weights by which we attain good performance by user satisfaction. The advantages of FOA are fewer parameters, faster convergence speed and less running time.

In this paper, we proposed a hybrid optimization algorithm based on PSO and FOA. First, we generated initial populations which are initial optimal weights for the resultant services from pareto applied on initial candidate services. Then it finds an optimal composed service based on user preferences attains good fitness value, execution time and error rate. In second phase, we applied vision and smell operators of FOA to achieve better optimal weights by overcoming premature convergence of PSO. Finally, the experimental results of proposed HPSO are more effective than the simple PSO.

The contribution of this research as follows:

1. It reduces number of candidate services;
2. A significant increase in fitness value;
3. It reduces the root mean square error with decent execution time;
4. It will ensure optimal service selection with minimal SLA violations.

The rest of the paper is organized as follows: related work about the QoS aware service composition in section.2. In section.3 the problem is formally defined. Section.4 focuses on our proposed methods: simple PSO and Hybrid PSO in detail, including the pareto approach, fitness evaluation, initial weights and the applied vision, smell operators of FOA. Experimental results and discussion are presented in section.5. Finally, we concluded our work in section.6.
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