OPTIMAL QOS-AWARE MULTIPLE PATHS WEB SERVICE COMPOSITION USING HEURISTIC ALGORITHMS AND DATA MINING TECHNIQUES

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Abstrak

Matlamat penggubahan perkhidmatan sedar-QoS (kualiti perkhidmatan) adalah untuk menjana perkhidmatan gabungan yang memenuhi keperluan QoS yang ditetapkan oleh pelanggan. Walau bagaimanapun, adalah sukar untuk menjana satu perkhidmatan gabungan yang dapat mengoptimakan semua laluan yang terlibat dengan serentak apabila penggabungan tersebut mempunyai lebih daripada satu laluan pelaksanaan. Pada masa yang sama juga penggabungan itu mesti memenuhi keperluan QoS. Ini adalah masalah yang dikaji dalam penyelidikan ini, yang juga dikenali dengan masalah pengoptimuman. Cabaran lain ialah untuk menetapkan ciri QoS yang boleh dikelaskan sebagai kriteria pemilihan. Thesis ini mengusulkan kaedah penggubahan perkhidmatan sedar-QoS. Matlamatnya adalah untuk menyelesaikan masalah di atas melalui mekanisma pengoptimuman berdasarkan kombinasi kaedah jangkaan laluan masa larian dan algoritma heuristik. Mekanisma ini melibatkan dua langkah. Pertama, kaedah jangkaan laluan pelaksanaan yang menjangka laluan pelaksanaan yang mempunyai potensi untuk dilaksanakan, seketika sebelum pelaksanaan penggubahan sebenar dibuat. Kedua, prosedur konstruktif (CP) dan prosidur pelengkap (CCP) dalam algorithma heuristik digunakan untuk menghitung pengoptimuman dengan mengambil kira hanya laluan pelaksanaan yang telah dijangka oleh kaedah jangkaan laluan masa larian. Untuk kriteria pemilihan, lapan ciri QoS diusulkan selepas menganalisis hasil penyelidikan terdahulu. Seterusnya, diusulkan juga supaya kriteria terpilih tersebut disusun mengikut keutamaan bagi memudahkan pelanggan membuat pilihan. Ujikaji melalui alatan WEKA dan prototaip digunakan untuk membuat simulasi bertujuan menilai kedua-dua kaedah yang digunakan. Bagi kaedah jangkaan laluan masa larian, keputusan menunjukkan kaedah ini dapat mencapai tahap ketepatan jangkaan yang memberasangkan dan ketepatan tersebut pula tidak dipengaruhi oleh bilangan laluan yang terlibat dalam jangkaan. Bagi mekanisma pengoptimuman, penilaian dijalankan dengan membandingkan mekanisma ini dengan teknik pengotimuman yang relevan. Hasil simulasi menujukkan bahawa mekanisma pengoptimuman yang dicadangkan mengalahkan teknik lain kerana ia dapat (1) menjana penyelesaian nisbah QoS tertinggi, (2) menggunakan masa pengkomputeran yang terendah, dan (3) menghasilkan peratusan terkecil bagi bilangan kekakangan yang dicabuli.

Kata kunci: Penggubahan perkhidmatan web, QoS, Pemilihan perkhidmatan, Algorithma heuristik, Perlombongan data.

Abstract

The goal of QoS-aware service composition is to generate optimal composite services that satisfy the QoS requirements defined by clients. However, when compositions contain more than one execution path (i.e., multiple path's compositions), it is difficult to generate a composite service that simultaneously optimizes all the execution paths involved in the composite service at the same time while meeting the QoS requirements. This issue brings us to the challenge of solving the QoS-aware service composition problem, so called an optimization problem. A further research challenge is the determination of the QoS characteristics that can be considered as selection criteria. In this thesis, a smart QoS-aware service composition approach is proposed. The aim is to solve the above-mentioned problems via an optimization mechanism based upon the combination between runtime path prediction method and heuristic algorithms. This mechanism is performed in two steps. First, the runtime path prediction method predicts, at runtime, and just before the actual composition, execution, the execution path that will potentially be executed. Second, both the constructive procedure (CP) and the complementary procedure (CCP) heuristic algorithms computed the optimization considering only the execution path that has been predicted by the runtime path prediction method for criteria selection, eight QoS characteristics are suggested after investigating related works on the area of web service and web service composition. Furthermore, prioritizing the selected QoS criteria is suggested in order to assist clients when choosing the right criteria. Experiments via WEKA tool and simulation prototype were conducted to evaluate the methods used. For the runtime path prediction method, the results showed that the path prediction method achieved promising prediction accuracy, and the number of paths involved in the prediction did not affect the accuracy. For the optimization mechanism, the evaluation was conducted by comparing the mechanism with relevant optimization techniques. The simulation results showed that the proposed optimization mechanism outperforms the relevant optimization techniques by (1) generating the highest overall QoS ratio solutions, (2) consuming the smallest computation time, and (3) producing the lowest percentage of constraints violated number.

Keywords: Web service composition, QoS, Service selection, Heuristic algorithm, Data mining.

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List of Abbreviations

ACO	Ant Colony Optimization
ARFF	Attribute Relation File Format
BPI	Business Process Intelligence
BPMS	Business Process Management System
CACO	Continuous Ant Colony Optimization
CIAC	Continuous Interacting Ant Colony
CCP	Complementary Constructive Procedure
CP	Constructive Procedure
CSV	Comma Separated Value
DAG	Directed Acyclic Graph
ESGA	Elitist Selection Genetic Algorithm
FN	False Negative
FP	False Positive
FS	Feasible State
GAELS	Genetic Algorithm Embedded Local Searching
GA	Genetic Algorithm
GSA	Gravitational Search Algorithm
HGA	Hybrid Genetic Algorithm
HR	Harmony Research
IDE	Integrated Development Environment
ILP	Integer Linear Programming
IP	Integer Programming
ISO	International Organization for Standardization
IT	Information Technology
MCDM	Multiple Criteria Decision Making
MCOP	Multi-Constraint Optimal Path
MILP	Mixed Integer Linear Programming
MMKP	Multi-dimensional Multi-choice Knapsack Problem
NB	Naïve Base
NP	Non-deterministic Polynomial-time
OASIS	Organization for the Advancement of Structured Information Standards

PACA	Particle-Ant Colony Algorithm
PAIS	Process-Aware Information System
PSO	Particle Swarm Optimization
QoE	Quality of Experience
QoS	Quality of Service
QP	Quadratic Programming
QQDSGA	Quality of Experience (QoE)/Quality of Service (QoS) Driven Simulated Annealing-based Genetic Algorithm
SA	Simulated Annealing
SAW	Simple Additive Weight
SLA	Service Level Agreement
SMO	Sequential Minimal Optimization
SN	Solution
SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SOC	Service Oriented Computing
SVM	Support Vector Machines
TN	True Negative
TP	True Positive
TS	Tabu Search
UDDI	Universal Description Discovery and Integration
URL	Uniform Resource Locator
US	Unfeasible State
W3C	World Wide Web Consortium
WEKA	Waikato Environment For Knowledge Analysis
WFMS	Workflow Management System
WS-BPEL	Web Services Business Process Execution Language
WSDL	Web Service Description Language
WSQM	Web Service Quality Model
XML	Extensible Markup Language

CHAPTER ONE
INTRODUCTION

1.1 Introduction

Service Oriented Computing (SOC) recently has gained a considerable momentum from both industry and academia as a new emerging paradigm to develop rapid, low cost, and loosely coupled software systems. This vision is captured by Service Oriented Architecture (SOA) through the provision of an architectural style (Michlmayr, Rosenberg, Platzer, Treiber & Dustdar, 2006). SOA is “a way of designing a system so that it can provide services to end users and/or other applications in the network” (Baryannis et al., 2008).

The SOA model illustrated in Figure 1.1 consists of three core entities: service provider, service consumer (also called requester), and service registry. The service provider implements the web service and describes it using a standard format. And then it publishes the description in the service registry. The service consumer queries the registry about a specific web service. The service registry checks, whether the requested web service is available or not. If it is available, the registry returns descriptions of the matched web services back to the service consumer. The service consumer obtains the location of the selected web service from the returned descriptions. Finally, the service consumer binds and invokes the web service.

The contents of the thesis is for internal user only

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