

An Interpretation of Qos-Aware Web Service Composition Using Metaheuristics Method

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Abstract:

Web has become the most distributed, largest and well-accepted computing platform ever since web services existed while service composition giving ways to many more value-added services by aggregating the sets of new with the existing services. There are many candidate services with the same functionality but different quality of service (QoS) properties in satisfying the needs of requirements from the users. QoS-aware web service composition is concerned to select those candidates that best fit with the expected composition focusing on optimizing the overall QoS value of the composition. Current literature has emphasized that using bio-inspired metaheuristic methods such as Particle Swarm Optimization (PSO), Simulated Annealing (SA), Genetic Algorithms (GA), Ant Colony Optimization (ACO), Bee Algorithms (BA) and Firefly Algorithms (FA) is a promising approach in QoS-aware composition. The metaheuristic approach is very useful to the user with the diversification of the requirements that is intensified to be a near-optimal solution. Thus, this paper provides a crucial review of existing web service composition works that using the metaheuristics approach to overcome the needs and different kind of features. The reviews develop a classification of approaches based on QoS-aware web service composition using metaheuristics and discuss the future research directions.

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1. INTRODUCTION

Web services are software applications that being created and published via the internet for public or private consuming, where it is being described using any standard web protocols such as XML-based which can be accessed by the requesters of the services anytime anywhere, Barry et al. (2008). Web service composition on the other hand is the process of combining web services using any mechanism or approaches to create a better and value added aggregated services. The discovery and selection of web services which

are part of the service composition as stated by W3C is “the act of locating machine-process able description of a web service-related resource that involves matching a set of functional and other criteria with a set of resource descriptions to find and select an appropriate web service-related resource”, Hugo et al. (2004).

In particular, semantic web as an evolutionary field tends to be the dominant technology in the current century. Web services are not exception from these evolutions. The traditional syntactic

approaches of describing web services are obsolete since the accuracy of web service related operations is not good. For example, finding a web service may produce irrelevant results due to the huge amount of published services and the poor way of describing them. These issues of discovering and selecting web services can be solved if their descriptions are based on semantics ontology, an explicit formal specification of the terms in the domain and relations among them.

Metaheuristics are parts of the ontology-based approach in composing services, where the web service will be specified with the semantic interface description along with the aspect of the service quality. This approach is randomized optimization method that tries to locate the optimal solution to one or multiple objective functions. Metaheuristics coordinate the interaction between higher level strategies and the local improvement procedures, enabling a process that perform a robust search of solution space as a solution to escape the local optima, Gendreau et al. (2010). This practice exploit the strategies for overcoming the complex solution spaces trap of local optimality. It focusing in the procedures that create a constructive processes solutions or destructive processes solutions, by utilizing single or more area as a means of defining move to progress from one solution to another, Veerabhadrapa et al. (2016). This makes the metaheuristics approach as the most attractive approaches when dealing with the QoS-based composition.

The paper is organised in 4 sections where section II of this paper presents the background study of web service composition. Related works on web service composition using metaheuristics being discussed in Section III while in Section IV the discussion focus on the work being done

so far. Finally, Section V presents the future work and the conclusion.

2. BACKGROUND STUDY

Service-based application is the result of the service engineering, comprising of the composition of services from various sources that will become the solution to the requirement. Service Engineering defined the overall process of software engineering that involved with the composing of various services, from the requirement gathering to the development and deployment of the services, including the adaptation process to satisfy the functionality requested by the service requester, Papazoglou et al. (2010). This is a process of creating loosely-coupled services as the software solutions from a very low-level of technical aspects that provide the based to the solution to the complete business processes that comprises of the needed functionality. SOAP, WS-BPEL and WSDL are amongst the standard web services related to the realization of the service oriented application, which builds the service engineering.

A. Service Composition

Composability of the services to be used in a service-based application is the most important property. By defining this, services that are being composed in an interoperable way, should be based on their component that can be described to be discovered and composed. This is done to achieve some pre-described goal by combining several services as a service composition, Papazoglou et al. (2010).

By saying that the functionality of a single web service is limited, the true functionality of the web services can be achieved by combining multiple services that will leads to a much functional and powerful

applications through the process of service composition. There exists lifecycle that common being refer to when it comes to the composition of services. Figure 1 is the model that describes the whole web service composition lifecycle. It begins with the Goal Specification that provides the abstract tasks, which will be used in the Service Selection process after the service being identify in the Service Discovery. The last process will be the Composite Service where the composition of the services being assemble and executed for the deployment, Bouguettaya et al. (2014).

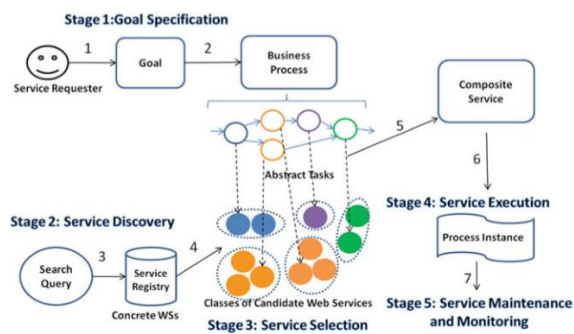


Figure 1. Web service composition lifecycle

B. QoS-Aware Web Service Composition

QoS-based on the other hand changes the paradigm of the composition process by making the QoS parameters as the objective functions, Abdelmaboud et al. (2015). This makes the service composition to be a combination of constraints with the functional and the non-functional aspects from the requirements. The composition of such services usually linked the QoS with the semantic approach. Depending on the complexity of the composition needed, the most feasible ways of finding the near optimal solutions is by using the metaheuristics optimization algorithm. They will return more than one solutions in one algorithm processes which allow the service composer to choose the most suitable one.

Service selection process that involves with the semantic ways of describing the services, to facilitate the discovery and the selection process usually will use the ontology, Wang et al. (2011). In this approach, the web service will be specified with the semantic interface description along with the aspect of the service quality. There are several approaches being used such as uninformed / non-heuristic, informed / heuristic, AI / planning, metaheuristic and agent-based.

Solving the problem of service composition is not as easy as separating the discovery and the selection process. For a more robust and feasible solutions, the composition must consider the functional and the non-functional requirements. This will allow the solution of the composite service to provide the best function to the service requester. The approaches seems to be prominent by the ways of each approach that can traverse multiple environment to find the services but by restriction of the constraint on the needs of multiple device and surely more time for the service to be composed as a solution.

C. Metaheuristics

Metaheuristics is the approach of randomized optimization method that tries to locate the optimal solution to one or multiple objective functions, Blum et al. (2003). Metaheuristics coordinate the interaction between higher level strategies and the local improvement procedures, enabling a process that perform a robust search of solution space as a solution to escape the local optima, Gendreau et al. (2010).

This practice exploit the strategies for overcoming the complex solution spaces trap of local optimality, focusing in the procedures that create a constructive processes solutions

or destructive processes that destroy the solutions, by utilizing single or more area as a means of defining move to progress from one solution to another, Veerabhadrapa et al. (2016). This makes the metaheuristics approach as the most attractive approaches when dealing with the QoS-based composition.

Metaheuristics approach is the most suitable ways to perform the composition process by allowing both the functional and non-functional requirements to be considered. This approach will not provide the optimal solution but it will be very useful to the requester with the diversification of the solution that is intensified to be near-optimal solution. More than one solution can be made that give the requester the ability to choose the best composition to be used.

3. RELATED WORKS AND DISCUSSION

Over the years, research and effort has been done to make use of the bio-inspired metaheuristics algorithm in composing the web services. The reviews done through the completion of this writing take into account several aspect including the method/technique used, is it consider as single method or hybrid by different method/algorithm, what are the QoS being consider, what are the measurement criteria or the evaluation method use to evaluate the proposed algorithm as well as the data or input of the evaluation process. Table 1 listed all the article with the respective aspect being study for the reviews.

Table 1. Comparison of method or technique used for service composition using metaheuristics.

Year	Title	Author	Method/ Technique	Hybrid/ Single	QoS	Measurement criteria / evaluation method	Input / dataset
2018	QoS-aware cloud service composition using eagle strategy	S. K. Gavvala et al.	Eagle Strategy with Whale Optimization Algorithm (ESWOA)	Hybrid	Availability, Response time, Reliability, Throughput	Benchmark functions – validate. Comparison of ESWOA and other contemporary algorithms. Analysis in statistical ways of ESWOA and other contemporary algorithms.	QWS dataset - From: 2007, QoS-based Discovery and Ranking of Web Services, E. Al-Masri et al. Actual web services implementation available from XMLLogic StrikeIron.com
2018	Optimal Fitness Aware Cloud Service Composition using an Adaptive Genotypes Evolution based Genetic Algorithm	C. Jatoth et al.	Genetic Algorithm - Adaptive Genotype Evolution based Genetic Algorithm (AGEGA)	Single	Availability, Security, Accessibility, Cost, Integrity, Throughput, Response time, and Reliability	Scalability and effectiveness Average fitness values – evaluation, varying number of abstract services. Process completion time evaluation through computational complexity – varying number of abstract services.	Synthetic data set - Based on QoS Data Set from: 2008, Investigating Web Services on the World Wide Web, E. Al-Masri et al. Tested using Shapiro-Wilk test to determine whether the dataset is normally distributed or not
2017	Integrating modified cuckoo algorithm and credibility evaluation for QoS-aware service composition	H. Wang et al.	Cuckoo Algorithm – Modified Multi-objective Cuckoo Search (MMOCS)	Single	Response time, Availability, Cost, Reliability	Based on credibility evaluation, service selection and execution time	QWS dataset, MSR-Bing, Synthetic data set
2017	QoS-aware Big service composition using MapReduce based evolutionary algorithm with guided mutation	C. Jatoth et al.	Genetic Algorithm – MapReduce-based Evolutionary Algorithm with Guided Mutation (MR-EA/G)	Single	Availability Response time Reliability Price Throughput	Feasibility, scalability, and optimality	Synthetic data set - 100 abstract services and each consisting 10000 candidate services. Tested using Shapiro-Wilk test to determine whether the dataset is normally distributed or not
2015	Dynamic Web Services Composition using Optimization Approach	K. J. Modi et al.	Genetic Algorithm	Single	Execution Duration, Availability, Reputation, Execution cost, Successful execution rate	Effectiveness, Execution time and fitness value	Randomly generated web services repository and web service challenge (WSC) test sets. From: 2007, WSC-07: Evolving the web services challenge, Blake et al
2015	A Web Service Composition Method Based on Merging Genetic Algorithm and Ant Colony Algorithm	Z. D. Zhao et al.	Genetic Algorithm and Ant Colony Optimization – Merging Genetic Algorithm and Ant Colony Algorithm (MGAACA)	Hybrid	Execution time, Execution price, Security	Comparison of the execution time and success rate	Synthetic data set – 10 service class with 40 web services each, quality indicator is randomly generated
2014	Exploring the Selection of the Optimal Web Service Composition through Ant Colony Optimization	V. R. Chifu et al.	Ant Colony Optimization	Single	Not mention	Comparison by / through average of - number of processed solutions - percentage of explored search space - simulation time - fitness value.	Enhanced Planning Graph Topologies

From the review being done in Table 1, by adapting the metaheuristics with the considerations of the selection criteria based on the QoS attributes, it is suggested that the similarity of the semantic definition of the services can boost the process of web services composition, Jatoth et al. (2018). These bio-inspired metaheuristics is said to be suitable in the process of optimizing the composition of web services semantically as it identifies the optimal or the near optimal solution in a short time without processing the entire searching space while solving complex optimization problem, Chifu et al. (2014).

In another approach, it is also noted that the merging of more than one of the metaheuristics can provide a better architecture of finding the optimal web service composition. While each of the method have their own purpose especially in solving the multi-objective optimal selection and composition problem, it is also defined that by adapting such approaches into one combination, the falling of composition result into local optimum can be avoided thus improving the efficiency of the composition, Zhao et al. (2015), Gavvala et al. (2018).

Other research defines that the used of metaheuristics with the optimization approach can provide a dynamic web services composition. The optimization approach is intended to discover optimized web service composition plan based on user QoS requirements by improving the fitness function, pre-requisite of the algorithm, Modi et al. (2015).

The crucial part of solving the composition problem is to comply with the Quality of Service, QoS of each service candidates to be analysed, Wang et al. (2017). This will be the main factor in selecting the best services with the same

functionality that ideally qualified within the available standards defining the services. Table2 describe the QoS definition that frequently and commonly being used to helps the selection of the services when same functionality provided by multiple candidate solutions, Modi et al. (2015).

Table2. QoS Description based on the QoS Parameter defines by the researcher.

QoS Parameter	QoS Description
Price	Fee received by service provider from service requester for each execution.
Execution duration	Difference between the time when a request is sent and time when the result are received
Reputation	Average reputation score of a web service evaluated by the Clients
Success execution rate	It is the percentage of requests which a web service performs successfully when web service is available and accessible
Availability	It is the degree that a web service is accessible and ready for immediate use

QoS-awareness becoming the main focus in this bio-inspired metaheuristics approach in solving the composition problem. This approaches through most of the article being reviewed concluded that it will usually consider response time and composition time, rate or price, reliability or availability of the services as well as the reputation of the provider.

4. CONCLUSION

Based on the review by the researches done so far, metaheuristics approach being the most attractive ways to solve the composition problems that involves with the functional and the non-functional requirements. Semantic description helps along with the usage of ontology to facilitate the discovery and the selection of the services. The approach needs to be further analyzed in enhancing the optimization that includes more reliable semantic and ontology approach thus

help more with the discovery and the selection process.

The discovery and the selection method within the metaheuristics will need to be improved by the formation of the adjustable parameters as well as the fitness function related to the approach that can also be combined with the semantic definition of the services. Making the QoS parameters as the objective functions lead to the changes of the paradigm for composition process. The main factor is selecting the best services with the same functionality that ideally qualified within the available standards defining the services to comply with the non-functional or the Quality of Service, QoS.

Further research needs to be done in the metaheuristic's way of solving the composition problem. This will generate better understanding to come out with the required results for any research, which is to comply with the objectives of the research. Result in the future work of this research will be the model of the web service discovery and selection method for the web service composition framework that utilizes the metaheuristic through the usage of semantic description and the ontology approach.

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