

## QUALITY OF SERVICE AND PERFORMANCE EVALUATION OF WEB SERVICES

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### ABSTRACT

As Web Service Providers (ASPs) proliferates, the need for Quality Assurance about the services offered becomes more apparent and inevitable. This paper appraises various available Quality of Web Service Compositions (QWSC) in order to determine the most effective and efficient along five well researched and E-Commerce relevant Quality of Service Attributes / factors namely: Availability, Cost, Response time, Reputation and Confidentiality.

**Keywords:** QoS, Web Service, E-Commerce, Performance & Evaluation

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### 1. INTRODUCTION

Quality of Web Services (QWS) has of recent become an attractive research area particularly on Service Oriented Architecture. However, quality of Web Service Composition, QWSC is a combinatorial NP-Hard problem where the number of possible composition plans, the search space grows exponentially based on the size of the composite plan and the exhaustive search Algorithms had proved ineffective and limited. Numerical Method Algorithms had also proved ineffective since they are limited to only small search space sizes. The growing proliferation of the use of Web services rendered these algorithms obsolete. Besides, QWSC is a soft real-time problem and this point had mostly been overlooked in literature. It is necessary to have a holistic consideration of all these stated challenges if we are to come up with a recommendation for an algorithm that meets customer's deadline.

As the web moved from web1 (static web, www) to web2 (social networking web) onto the modern trend of web3 (ubiquitous computer) the need to monitor the type and quality of service offered and evaluate over time and periodically on a regular basis their performance about their acclaimed services using relevant domain specific and consumer-benefiting parameters. The goal of such quality of service (QoS) and performance evaluation is to ensure value for pay service, prevent undue and harmful service provider monopoly, come up with a standard basis of encouraging effective and efficient services, stimulate competitive positive development and innovation, encourage and give awards to outstanding service providers and provide continuous basis for service regulation. Such effort will result not only in good service delivery across platforms even but just-in-time (JIT) and adhoc service deliveries will not pose a threat to the systems. Universally accepted parameters of QoS measurements include cost, reputation, availability, response time and confidentiality associated with such service. Algorithms existing for measuring such parametric factors include: Genetic Algorithms (GA), Integer Programming (IP), Statistical Techniques and Hybrid method (i.e. GA combined with other techniques).

The focus of this paper is to analyze these existing algorithms to the end of being able to deterministically select and recommend appropriate algorithm for domain specific QoS evaluation of particular web service. The remaining part of this paper is arranged as follows: Related works comes next. This is followed by brief overview of web service as a concept, Quality of Service (QoS) as a concept is defined next while discussion of the parameters for measuring QoS are discussed next in brief. Each of the algorithms considered are then tested analysed on its merit and discussed accordingly. A barchart showing the result graphically for the average Normalised Compositipon Aggregated Quality of Service (NCAQ) for all the five algorithms as computed by Pedro F. et al is attached as well. This is followed with conclusion and recommendations..

## 2. RELATED WORKS

Pedro (2013) proposed five different algorithms to solve the QoS aware Web Service Composition (QWSC) problem in ten different search space sizes. They used five QoS attributes listed above within a deadline of 1,000 milliseconds defined for each of the algorithms for ten different search space sizes in a well planned performance evaluation experiment and were able to analyse the optimization degree of each of the algorithms selected for the QWSC problem. They found in the design of experiments that the performance evaluation can be used to determine which algorithm have better performance according to the different search space sizes and the established deadline. Canfora et al (2005) proposed Genetic Algorithm (GA) for solving this problem. In an empirical study, Genetic Algorithm(GA) and Integer Programming(IP) were compared. Their result showed that GA is better than IP for QWSC problems. Ko et al, 2008 compared IP based algorithm with GAs and concluded that GA is a better alternative. Fanjiang et al used hybridized Genetic Algorithms too to solve this problem of Quality of Web Services. Liu reiterated that it is crucial to meet deadline even if the solution found is not optimal but only approximation to the optimal solution.

Bravetti et al 2004, pointed the soft real-time E-Commerce out as the conspicuous beneficiary of the use of Web Service (WS) because in complex e-commerce applications, different companies interact, each with its own peculiar platform and languages for their systems. According to Menasc'e 2011, e-commerce applications must guarantee customer satisfaction in order to prevent them from migrating away to other better service providers, of course at a loss to the abandoned. Ai 2011, compared different algorithms using just two factors namely: average response time and Average QoS of them and according to Jain, this are too few and he opined that standard deviation and confidence interval should have been included.

## 3. WEB SERVICES

World-Wide Web Consortium (W3C), defined Web Service as: “a software system designed to support interoperable machine-to-machine interaction over a network. Its interface must be defined in a machine processable format (following Web Service Description Language - WSDL standard) and should allow others systems to interact with the web service as prescribed in its prescription by using SOA – Service Oriented Architecture messages conveyed in HTTP with an XML serialization in conjunction with other web related standards.

### 3.1 Quality of Service (QoS) of Web Applications

**QoS** - This is the set of measurable performance properties associated with a web service. Such properties include: availability, cost, reliability, and security. The need for measuring QoS properties emanates from the proliferation of web services offering similar functionalities (such as Gmail and Yahoo mail, Bebo, Twitter and FaceBook, several public clouds etc). Thus QoS assessment enables us to differentiate and classify web services based on performance merits, and the clients patronizing them is better guided.

### 3.2 Parameters for Measuring QoS

Below are some of the parameters for measuring QoS of Web Services:

- ❖ **Availability** – The 2009 Microsoft Encarta Dictionary of English language Words defined availability as the condition of being available, especially of being easily accessible or obtainable. Thus, availability of a web service is understood in the context of its readiness for immediate use as a Web service. It is represented as the percentage of time available for a service in an observation period and its related to its reliability. A web service that is not ready when needed cannot be said to be available and its ultimately not available.
- ❖ **Cost** - This is the amount of money charged by the service provider in order to grant access for the use of the service. The less the cost for a value added quality service, the better for the client and the provider. The client feels good for spending less for good service and recommends the service to other clients for the benefit of the service provider.
- ❖ **Response Time (RT)** – It is the time interval between the moment the request for the service is made and when the service is made available to the client for use. It can be very frustrating when the precious time of a client and the access cost is increased as a result of slow or non responding service applied for. Such protracted RT will dispel clients interest and patronage and that ultimately translates to poor QoS on the part of the service provider. The shorter the RT, the better for the service providers and his clients.
- ❖ **Reputation** – Reputation is built over time. It emanates as a function of the level of satisfaction derived by the client from the use of a service.
- ❖ **Confidentiality** – It is the measure of the assurance given by the service provider that only the intended receiver and the sender will be able to understand the content of the transmitted message and that no unauthorized third party will be able to make sense of the transmitted message if at all they gained access to it.

### 3.3 Choice of Composition Plan of QWS

QWSC can be either be QoS-aware selection OR orchestration creation. The latter is also known as ‘Use of Business Process Execution Language (BPEL)’ for the creation of the execution. Of the two, QoS-Aware Selection is adopted for this appraisal work with consideration to the selected five search algorithms.

### 3.4 Considered Algorithms for the Web Service QoS Parameters

In the light of the QWS, advantages and disadvantages of each algorithm are highlighted..

#### 3.4.1 Exhaustive Search (ES) Algorithm

**Brief description:** it analyses all search space. For QWS, it compares all QoS obtained by all possible combinations of composite plans and returns the best one, that has the highest QoS

**Advantages:** Global optimum is always guaranteed

**Demerit:** It has exponential computational complexity

**Discussion:** Exhaustive Search Algorithm is not good for searching big search space such as a composite 10 abstract WS with 200 concrete WS per abstract which results in  $10^{200}$  number of points in the search space which will probably take 200 years to calculate. ES will only be good for small search space because of the soft real-time nature of QWSC problem.

#### 3.4.2 Utility Function (UF) Algorithm

**Brief description:** UF was developed by Yu et al in 2007. It uses heuristic utility function (i.e. ability of a computer program to modify itself in response to the user) to map out the best Web Service (WS) composite plan. It associates each concrete WS to a unique QoS value that represents all the QoS attributes of that concrete WS. Then it selects the corresponding concrete WS with the highest QoS for each abstract WS of the attributes of that concrete WS.

**Advantages:**

- It does not need to analyse the entire search space
- Its computational complexity is not exponential
- As such it can be used in any search space size(n)

**Disadvantage:**

- It is a deterministic algorithm and thus cant benefit from larger deadline. E.g. QoS obtained for both 1000 millisecond and 100 seconds will be the same.
- It does not guarantee global optima

#### 3.4.3 Greedy Heuristic (GH) Algorithm

**Brief description:** it was originally proposed by P. F. do Prado et al. For each abstract WS in the composite state, it evaluates all concrete WS available for that abstract WS, selects the one with higher aggregate QoS to its respective abstract WS. Suppose a composite load of 4 abstract WS is to be evaluated, each with 100 concrete WS per abstract, the total of concrete WS will be 400. GH will however calculate the aggregate QoS of 400 instead of  $100^4$  unlike in ES algorithm.

**Advantages:** it is very fast because it is directly relating to the number of total concrete WS.

**Disadvantages:** it is also a deterministic algorithm that cannot benefit from larger deadline.

#### 3.4.4 Random Search (SE) Algorithm

**Brief Description:** It is based on a technique of denominated Random Walk through the search space while maintaining the best solution found. It finishes search when the stop condition is reached, that is deadline in this case.

**Advantage:** it can benefit from larger deadlines, thus using the spare available time to search for a proper solution.

#### 3.4.5 Double Hybrid Genetic Algorithm (DHGA)

**Brief Description:** Originally proposed by P. F. do Prado et al. It combines GA with UF and GH. It runs the UF first and saves its result in a ‘chromosome’. Next it does the same thing to GH algorithm. Having initialised a random population of chromosomes, it then include the two chromosomes created before in this initial population. Genetic operators used in this algorithm is tournament with 16 players, one-point crossover and elitism operator activated.

**Advantages:** It guarantees a solution as good as the best obtained from UF and GH due to elitism operator that preserves the best solutions through the generations. There is the possibility of obtaining better results when the deadlines increases

**Disadvantages:** It does not guarantee global optimality and it is a slow algorithm for small space search

#### 4. FINDINGS

Among ES, UF and GH, all guaranteed optima for 33100 search spaces, 1000ms deadline 10 replications and 95% degree of confidence. However only ES algorithm always guarantee global optima. This agrees with the work of Pedro F. do Prado et al as summarized in the NCAQ plot in the figure1 below.

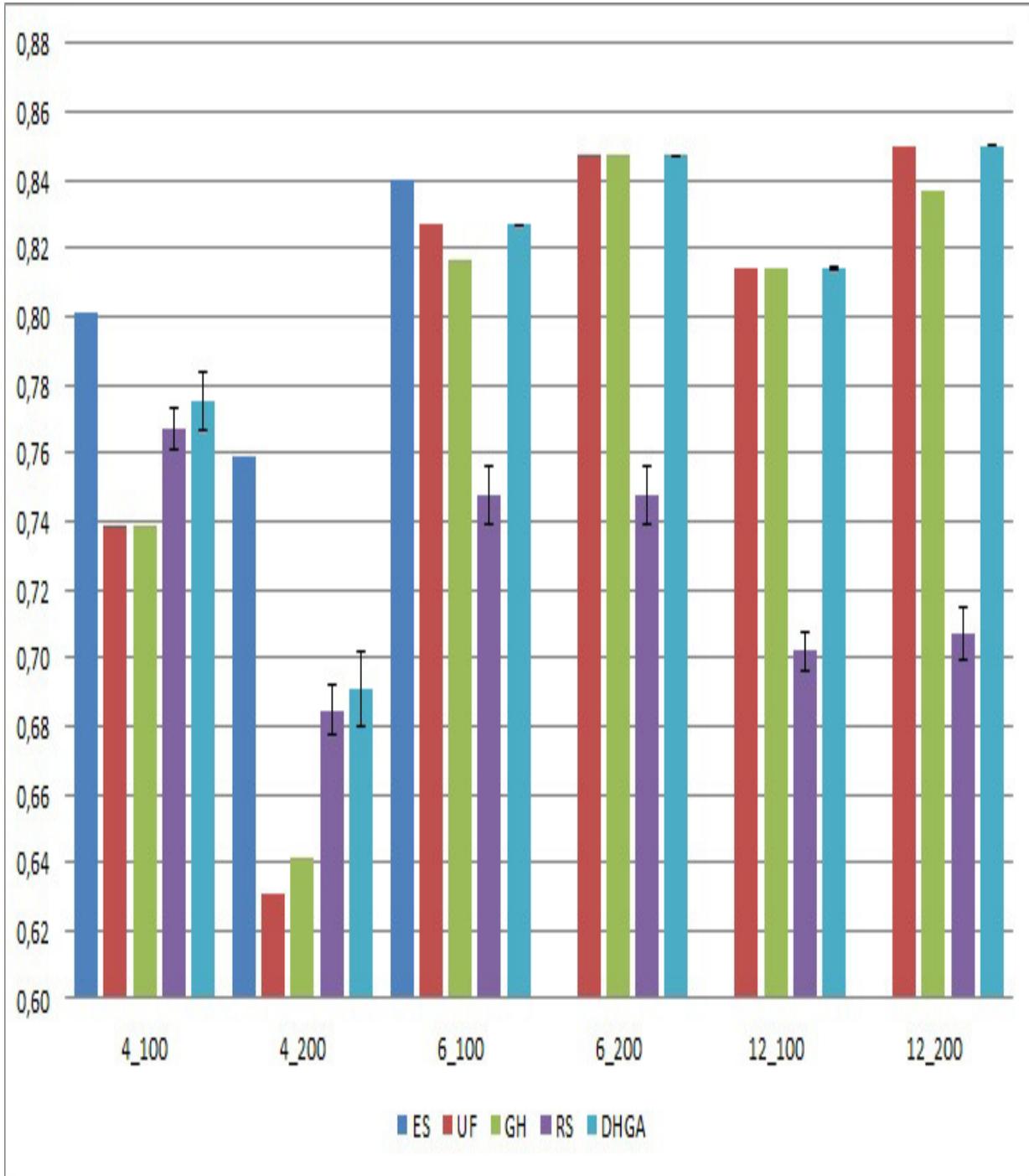


Figure 1. The average (Normalized Composition Aggregated QoS(NCAQ).) of all the five algorithms.  
 Source: Pedro F. do Prado et al, ICDS, 2013

## 5. CONCLUSION AND RECOMMENDATIONS FOR FURTHER STUDIES

It is good thing that yardsticks for measuring QoS of Web Services are coming up and getting improved dynamically with time as web expands exponentially and particularly now that we are into Web 3, the ubiquitous computing web . While the rate of web explosion outrun that of QoS Assessment Tools, QATs. The continuous refinement will someday deliver to us a perfect tool that will help prevent abuse and undue monopoly of web based services by any service provider. For the time being however, it will be necessary to consider in addition factors such as number of abstract WS in the composition workload and number of concrete WS per abstract. By doing that, it would be possible to determine which algorithm is the best one for each search-space size. Design of new QoS Assessment tools should inculcate more pro-activity taking into consideration the major developments and paradigm shifts currently enveloping the world and rapidly changing the way we live, communicate and manage information, talking about: Big data, Internet of Things (IoT) and the Cloud. These three are impacting and will continue to impact the planet more into the future.

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