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Adaptive and Optimized Meta-Heuristic Framework for Establishing QoS and Transaction Properties-based Dynamic Web Service Composition

N.Arunachalam' A. Amuthan

Abstract— The dynamic web service composition based on QoS and transactional properties is considered to be the most important challenging research issues. Most of the works explored in the area of dynamic web service composition have mainly focused on some specific QoS parameters, which avoid potential factors from utilization. Further, the transaction properties also play a vital role in handling uncertainty which introduces most vital functionalities into the reactive environment. In this paper, an Adaptive and Optimized Meta-Heuristic Framework (AOMHF) is proposed for establishing dynamic web service composition based on QoS and transaction properties. This proposed AOMHF framework considered the user preferences and unpredictable service QoS for achieving reliable dynamic web service composition. This proposed AOMHF framework is developed as a dual staged web service composition scheme which incorporates the merits of monitoring mechanism which improves the possibility of improving and guaranteeing reliability and availability under reliable web service composition.

Keywords — Dynamic Web Service Composition, QoS factors, Transactional properties, Unified QoS value, Rate of Convergence

I. INTRODUCTION

From the recent past, the web services are considered to dominate the software industry [1]. Majority of the organizations publish the World Wide Web applications through the utilization of web services [2]. Further, service oriented architecture comprises of web service technology for satisfying the needs of the web application [3]. As per the definition of W3C, a web service is defined as the software system formulated for supporting the machine interoperation to machine cooperation on the network [4]. QoS factor is the main attribute of web services for discriminating the main operation likely to the web services. The core objective of QoS properties is impacted based on the parameters of execution cost, availability, average response time, successful execution rate, frequency, and reputation [5].

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* Correspondence Author
N.Arunachalam*, Research Scholar, narunachalam85@gmail.com Dr. A. Amuthan, Professor,Department of Computer Science and Engineering, Pondicherry Engineering College, Puducherry, India, amuthan@pec.edu

The proposed AOMHF framework is contributed for ensuring significant service composition process through the integration of feasibility in adopting services [5]. This proposed AOMHF framework is reliable in cooperating and handling the advent of changes in the network over the recent decades [6].

It is capable in resolving the services which are included in the service composition process [7]. It is utilized to introduce the properties of the wireless communication depending on the number of web demands emerged in the network [8]. It is potent in accurate classification of the collection of candidate service set based on the user requirement tasks [9]. It is capable in retrieving the service composition based on dynamic process of rehabilitation based on the enforcement of greedy algorithm [10]. This proposed framework plays a significant role in effective and efficient replacement of services [11].

Moreover, the proposed framework is responsible for service replacement process with enhanced quality introduced into the composition process [12].

II. RELATED WORKS

In this section, some of the predominant frameworks contributed in the literature over the recent years are detailed as follows.Initially, an Enhanced Particle Swarm Optimization Framework EPSOF [13] was proposed for establishing reactive dynamic web service composition with the merits of transaction and QoS factors. However, EPSOF possess the limitations of stagnation that leads to premature convergence. The optimality value of EPSOF is also not excellent based on the evaluations consulted with different web services, workflow count and candidate tasks in workflows. Further, Particle Swarm Optimization Framework PSOF[14] was also proposed as the reactive dynamic web service composition with the merits of transaction and QoS factors. It possessed the benefits of PSO for elucidating diversified factors that could be contextually applied for service change management with any possible service reposition processes. However, the unified QoS value of the proposed scheme is not maximal enough. In addition, Genetic Algorithm-inspired Framework (GAIF) [15] was contributed for maintaining high degree of web composition even under different user preferences. It possessed the benefits of GA for examining different contextual parameters that could be possibly enforced with important rehabilitation process.

However, the unified QoS value of the proposed scheme, optimal value and convergence rate is not maximum or optimal.

III. Proposed Adaptive and Optimized Meta-heuristic Framework (AOMHF)

The proposed AOMHF framework includes six steps such as, i) service repository process, ii) interface matching process, iii) requirements elucidation-based integrated service composition process, iv) Service selection enforcement using likelihood function, v) transaction and QoS computing-based adaptive meta-heuristic process and vi) process of managing predominant service change as depicted in Figure 1. This AOMHF framework focuses on facilitating an effective process of dynamic service composition by modeling the workflow and candidate workflows as a hybrid network.

i) Service Repository Process

In this first step, the service repository is made to store different number of integrated services which could be enforced during web service composition. This step also used the benefits of Axis 2 approach for attaining significant generation of WSDL. This method of Axis 2 is responsible for initiating WSDL for highlighting input interfaces, output interfaces and service functions. Further, the QoS and transactional value of the interface is attained through the inclusion of a MySQL database. This inclusion of database is mainly combined with the services for estimating it in the registered platform.

ii) Interface Matching Process

In the second step, the interface matching process is applied for exploring the input and output interfaces pertaining to each individual service which are aggregated in the service repository. This interface matching process is enforced when the necessary requirements of the integrated reactive service composition is estimated. This process is achieved through Java-based service discovery platform which plays an anchor role in exploring the steps involved in complete analysis of function matching. This process delivers the collection of candidate services as the output as a result, since it is considered as input to the successive process in the requirements elucidation process of integrated reactive service composition.

iii) Requirements Elucidation-Based Integrated Service Composition Process

In this third step, the integrated service composition is mainly utilized for data and behavior modeling which is highly utilized during QoS and transactional properties extraction process. In particular, the data model includes the BPEL structure for demonstrating the workflow as the result of the expected behavior. On the other hand, the behavioral models utilize the process of data interface matching only after the exploration of interface set features are estimated potentially.

iv) Service Selection Enforcement using Likelihood Function

In this step, the activity of Service Selection Enforcement using Likelihood Function is enforced. The Likelihood Function is mainly incorporated for choosing optimal and potential services using the essentialities of web service composition. This selection process completely verifies the individual services for comparing with integrated tasks. This selection process is mainly for selecting optimal service set that integrates a number of candidate services that remains indispensable in the service composition process. This process of selection completely focuses on the integration of feasible services that are used for comparative exploration of the functionalities associated with each individual task. This integration of feasible services is responsible for establishing dynamic web service composition. Further, the collection of services which copy with the feasible solutions of composition are labeled and determined as the group of services. Moreover, this Service Selection Enforcement using Likelihood Function process is responsible for estimating two significant outputs which are required for complying with the tasks of business that attribute towards user requests.

v) Transaction and QoS computing-based Adaptive Meta-Heuristic Process

In this step, this adaptive and integrated approaches-based on transactional and QoS properties is included for determining the plans of service composition. This service composition plan concentrates on the estimation of optimal composition plan. This Adaptive Meta-Heuristic step utilized parameters such as price, reputation, availability, execution time and reliability. Moreover, the transactional properties such as Functional Requirement's Count (FRC), Weight-based User Recommendation (WUR), Distinct Constraints for Global User QoS (DCGUQ), Transactional Characteristics (TC) and QoS-oriented Contextual Weight (QCW) are utilized. Then, the QoS and transaction factors of the proposed AOMHF framework is estimated explored based on the contextual adaption of the existing WSC-CSF-IABCO scheme, WSC-EABC-DSB-FL and WSC-IABCO-PMS-SAR scheme-based dynamic web service composition. This AOMHF framework includes the contextual application that aids in individual local and global optimization in order to facilitate multi-objective optimization process.

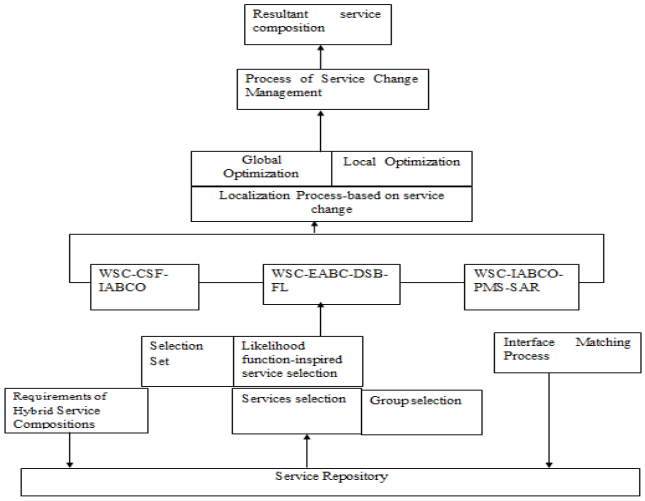

Figure 1: Adaptive and Optimized Meta-heuristic Framework (AOMHF) for dynamic web service composition

vi) Process of managing predominant service change

In this final step, the service change management process helps in determining the deviation which are possible in the service repository based on service configurations. The managing service process plays an anchor role in achieving flexible adaptation of indispensable service composition plan. This service management scheme is responsible for verifying and localizing the service change based on the limits of transaction and QoS constraints determined based on the user demands. This process of managing predominant service change need to consider the scope of the global or local composition, such that the proposed WSC-CSF-IABCO scheme [19], WSC-EABC-DSB-FL scheme [20] and WSC-IABCO-PMS-SAR schemes with local greedy method is enforced for facilitating effective dynamic web service composition. In addition, the classification of service is mainly used for process acceleration with the mechanism of service retrieval.

IV. Simulation Results and Discussions

The proposed AOMHF framework is implemented using Visual Studio 2010 and C++ programming language. This experimental investigation is performed over a desktop that incorporates an Intel 17-4710MQ, 8GB memory and 2.50 GHz CPU. The test data are derived and organized from the set of services data. This experimental analysis is based on three experiments viz., i) unified QoS value under different number of services, workflow count and candidate tasks in workflow, ii) rate of convergence under different number of services, workflow count and candidate tasks in workflow and iii) optimality rate under different number of services, workflow count and candidate tasks in workflow.

Figure 2 and 3 demonstrates the predominance of the proposed AOMHF framework with the compared EPSOF, PSOF and GAIF frameworks evaluated using unified QoS value under different number of services and workflow count. The unified QoS value of the proposed AOMHF framework is determined to be superior than the benchmarked frameworks independent to the number of services and workflow count. The unified QoS value of the proposed AOMHF framework under different number of service is determined to be improved by 10%, 12% and 15%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks. The unified QoS value of the proposed AOMHF framework under different number of workflow count is determined to be improved by 11%,13% and 17%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks. Figure 4 presents the predominance of the proposed AOMHF framework with the compared EPSOF, PSOF and GAIF frameworks evaluated using unified QoS value under different number of candidate tasks in the workflow count. The potential of the proposed AOMHF framework is also excellent in terms of unified QoS value independent to the number of candidate tasks in the workflow flow. Thus, the optimality rate of the proposed AOMHF framework under different number of candidate tasks in workflow count is determined to be improved by 10%, 13% and 16%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks.

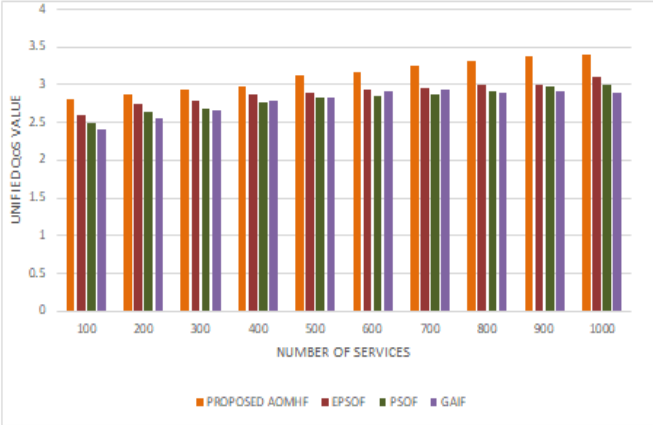

Figure 2: Proposed AOMHF-Unified QoS value under different services

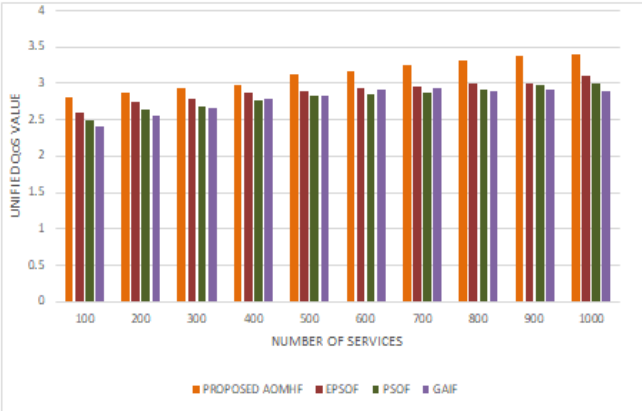

Figure 3: Proposed AOMHF-Unified QoS value under different workflow count

Figure 4: Proposed AOMHF- Unified QoS value under different candidate services in workflow count

Further, Figure 5 and 6 demonstrates the predominance of the proposed AOMHF framework with the compared EPSOF, PSOF and GAIF frameworks evaluated using rate of convergence under different number of services and workflow count. The rate of convergence of the proposed AOMHF framework is determined to be superior than the benchmarked frameworks independent to the number of services and workflow count. The rate of convergence of the proposed AOMHF framework under different number of service is determined to be improved by 9%, 11% and 14%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks.

The rate of convergence of the proposed AOMHF framework under different number of workflow count is determined to be improved by 6%, 9% and 11%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks. Figure 7 presents the predominance of the proposed AOMHF framework with the compared EPSOF, PSOF and GAIF frameworks evaluated using rate of convergence under different number of candidate tasks in the workflow count. The potential of the proposed AOMHF framework is also excellent in terms of rate of convergence independent to the number of candidate tasks in the workflow flow. Thus, The rate of convergence of the proposed AOMHF framework under different number of candidate tasks in workflow count is determined to be improved by 11%, 14% and 19%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks.

Figure 5: Proposed AOMHF-Rate of convergence under different services

Figure 6: Proposed AOMHF- Rate of convergence under different workflow count

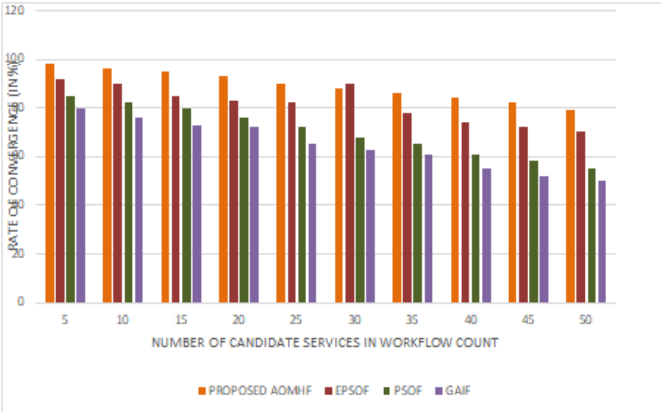

Figure 7: Proposed AOMHF- Rate of convergence under different candidate services in workflow count

Figure 8: Proposed AOMHF-Optimality Rate under different services

Figure 9: Proposed AOMHF- Optimality Rate under different workflow count

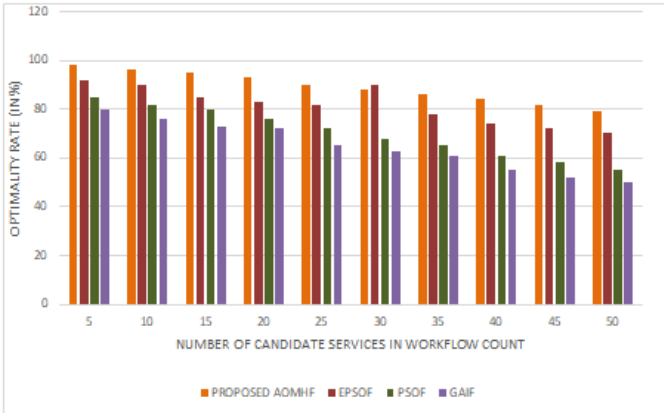

Figure 10: Proposed AOMHF- Optimality Rate under different candidate services in workflow count

In addition, Figure 8 and 9 demonstrates the predominance of the proposed AOMHF framework with the compared EPSOF, PSOF and GAIF frameworks evaluated using optimality rate under different number of services and workflow count. The optimality rate of the proposed AOMHF framework is determined to be superior than the benchmarked frameworks independent to the number of services and workflow count. The optimality rate of the proposed AOMHF framework under different number of service is determined to be improved by 8%, 10% and 13%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks.

The optimality rate of the proposed AOMHF framework under different number of workflow count is determined to be improved by 7%, 9% and 12%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks. Figure 10 presents the predominance of the proposed AOMHF framework with the compared EPSOF, PSOF and GAIF frameworks evaluated using optimality rate under different number of candidate tasks in the workflow count. The potential of the proposed AOMHF framework is also excellent in terms of optimality rate independent to the number of candidate tasks in the workflow flow. Thus, the optimality rate of the proposed AOMHF framework under different number of candidate tasks in workflow count is determined to be improved by 10%, 13% and 16%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks.

V. CONCLUSION

The proposed Adaptive and Optimized Meta-heuristic Framework AOMHF is an attempt for establishing QoS and transaction properties-based dynamic web service composition. This proposed AOMHF Framework is significant in the process of facilitating the process of candidate service filtering which wide opens the possibility of preventing duplicate and redundant web services. It is also potent in minimizing the degree of response time through the inheriting process of inverted index method. The simulation results proved that rate of convergence of the proposed AOMHF framework under different number of service is determined to be improved by 9%, 11% and 14%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks. The rate of convergence of the proposed AOMHF framework under different number of workflow count is determined to be improved by 6%, 9% and 11%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks. The optimality rate of the proposed AOMHF framework under different number of candidate tasks in workflow count is determined to be improved by 10%, 13% and 16%, excellent to the benchmarked EPSOF, PSOF and GAIF frameworks.

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AUTHOR PROFILE

N. Arunachalam Research Scholar,
Department of Computer Science and Engineering,
Pondicherry Engineering College,
Puducherry – 605014, India
narunachalam85@gmail.com,
Mobile: +919944342292Fax: 0413-2655101

Dr. A. Amuthan
Professor,
Department of Computer Science and Engineering,
Pondicherry Engineering College,
Puducherry – 605014, India amuthan@pec.edu
Mobile: +919444104373Fax: 0413-2655101