ABSTRACT

The advancements in the area of web services have enabled the business organizations to conveniently publish, find, and invoke them across the web. Hence those organizations conceal their core business and reveal other application services over the web. The proliferation of such inter-organizational services increases its search space and requires efficient mechanisms to locate and invoke them. Web service composition is the ability to integrate and assemble individual web services into business processes. It improves reusability, lessens duplication, and improves modifiability of the web services. The key challenge in web service composition lies in the ability to correctly identify and compose web services at runtime that satisfies the functional and non-functional requirements of the user. The research focus on web service composition has gained its popularity and strives to cater to these challenges.

Web services are self-contained, modular applications, accessible via the Web through Open Standard languages, which provide a set of functionalities to businesses or individuals. Web service descriptions are used to advertise service capabilities, behavior, and quality. It serves as the basis for the discovery and composition of services. Web service discovery means finding a web service that could solve the user request. When a web service is inadequate to satisfy the request it is required to combine and link existing

web services to create a new process which is called as the web service composition.

The major issues related to web service composition are identified as follows: (i) Discovery of relevant web services from a massive repository, (ii) Standardization of the description of web services and (iii) Detection of dynamically created and updated web services. An enhanced Artificial Intelligence (AI) planning that handles complex control structures, provides a rich specification of the flow logic and models the new objects created at runtime is recommended as a solution for automated web service composition by researchers.

The objective of this research is to investigate the above issues and provide solutions to enhance web service composition using ontology. This research focuses on the discovery of the semantic web services required for composition, creation of service composition plans, verification of those plans, selection of an optimal plan and modification of the plan in the case of QoS constraint violation.

In this research, web service is semantically represented using OWL-S which is a semantic web service standard. A semantic web service will possess two essential aspects namely functional and non-functional. The functional aspect is used to discover the services and the non-functional aspect is used to select the best from the services discovered for the composition. This work considers the functional and non-functional aspects of the semantic web services. Those services are orchestrated into a composition

plan using AI planning for web service composition. A Logic Programming approach called Fluent Calculus is used to employ AI Planning for service composition. The verification of the generated plan is carried out using Labeled Transition Systems and it is identified to be partial. Further survey leads to the usage of Colored Petri Nets for simulation and state space analysis of the generated plan.

The first investigation deals with the enrichment of the semantic web service discovery to find the services that are utilizable by the web service composition. This leads to the identification of a data structure to maintain the relationship among services and a justification for the inclusion of precondition and effect.

The second investigation deals with the automation of plan generation which finds the possible order of the discovered web services. This leads to the identification of progression based Fluent Calculus as a solution to plan generation.

The third investigation deals with the verification of the correctness of the generated plan to check the functional and parameter consistencies of the plan. This leads to the identification of Colored Petri Nets for simulation and state space analysis of the generated plan.

The fourth investigation deals with the selection of an optimal plan from the set of verified plans. An optimal plan consists of a set of web services that collectively complies with the non-functional requirements of

the user. This leads to the identification of an optimization technique, Particle Swarm Optimization for evaluating the constraint compliance of the plan.

The fifth investigation deals with the replanning strategy when the web service selected for execution violates the QoS constraints. It leads to the inclusion of error handling and failure recovery mechanism for the successful completion of web service composition.

Finally an analytical model evaluates the performance of the enhanced semantic web service composition based on two metrics namely precision and time taken for composition. The performance evaluation indicates that even though there is an increase in the time taken for automated planning and verification, the results obtained are more precise. The time taken for selecting a plan also increases the overall composition time. However the services selected for an optimal plan adhere to both the functional and non-functional requirements of the user.