CHAPTER 2

LITERATURE OVERVIEW OF METAHEURISTIC BASED OPTIMIZED SELECTION AND ORCHESTRATION OF WEB SERVICES

2.1. INTRODUCTION

Internet has become a storehouse of information; from which it is possible to obtain solutions to any problem. Web services play a vital role in this process. Web services are software components that provide a particular functionality to the user. A single functionality is not as such useful to the user. A chain or workflow of such functionalities that can be utilized to perform a task is called service composition. Ordering such services in appropriate sequences is known as service orchestration.

2.2. TECHNIQUES DEALING WITH SERVICE SELECTION/ORCHESTRATION

Service composition and service orchestration tend to be the most widely used mechanisms for workflow creation (Fan 2005). Several major functionalities are associated with web service composition such as, composition design or orchestration, maintenance, failure handling, monitoring, failure diagnosis, substitution, adaptation etc., (Alhosban 2013; Ardagna 2006; Ding 2013). This above mentioned papers also deals
with mechanisms for identifying web services and creating effective workflows using the selected services.

A user preference based automatic orchestration of web services using multiple agents is presented in (Vaithiyanathan 2015). This method uses two agents, one for selection and the next for orchestration. A failure handling mechanism that reduces the failure rates of service workflow sequences is presented in (Tibermacine 2015).

This method uses substitution mechanism by identifying the next most appropriate web service and substituting it with the failed service. A similar substitute identification method was presented in (Azmeh 2011) that identifies substitutes on the basis of preliminary comparisons.

A service orchestration method that uses branching cells to perform QoS aware orchestration is presented in (Benveniste 2014). Context based guarding of service calls serves as the basis of this method. It uses Asymmetric Event Structures (AES) and contextual nets as a framework for creating web service orchestrations. AES uses several QoS metrics and their composition to perform this process. A service selection and orchestration method that helps in dynamic execution of business process is presented in (Fahad 2015). A Semantic Based Business Process Execution Engine (SBPEE) is proposed, that helps in dynamic business process execution.

The project domain ontology captures user’s specifications and SWRL rules, to classify the user and their requirements. The semantic engine then selects appropriate services from the repository. A service selection method that generates services matching the service request of
the user using fuzzy formal concept analysis is presented in (Fenza 2010). This method obtains the user’s input and models the queries on the basis of conceptual terms rather than strict syntactic formats.

These service match the input/ output specifications of the web service specifications, which makes it easier for the retrieval process. Similar such retrieval methods are presented in (Constantinescu 2003; Fenza 2008; Fujii 2004). A negative selection algorithm that utilizes both the polarity terms to obtain the best service from the repository is presented in (Zhao 2014).

In contrast to the regular approaches, this method identifies worst solutions and iteratively removes such solutions from the search space to obtain the final best solution. A method that checks the behavior of a service orchestration is presented in (Michaux 2013). This method presents an algorithm to check in-case a service orchestration behaves according to its declared types.

An auction based approach dealing with quality aware service selection for service based systems is presented by (Qiang 2014). It deals with providing solutions for complimentsaries between services and competition among service providers. It provides approaches that provides solutions for providing offers to customers depending on the multi dimensional quality of services. A Quality of Experience (QoE) driven service selection process is presented by (Upadhyaya 2014).
This method considers non functional attributes and provides them with equal importance alongside the QoS properties. An end to end QoS mapping and aggregation for selecting services in a cloud is presented by (Karim 2014). This work stresses the use of non functional attributes along with their functional counterparts for enabling efficiency in the service selection process.

It provides mapping rules to map user’s QoS requirements with service levels to perform an efficient matchmaking process. A similar quality based service selection is presented by (Negi2014). This method uses a service negotiator for the selection process. A stability analyzer calculates the stability score of the web service and the services are ranked. This technique performs ranking using Analytic Hierarchy Processing (AHP) and TOPSIS.

A preference based semantic selection of web services is presented by (Iordache 2014). This method uses the conventional service selection process, however, it tends to incorporate tradeoffs in the selection process. A rigid rule cannot provide an effective selection mechanism, as a result the flexibility introduced here tends to improve the overall selection process.

A network aware QoS prediction for service composition is presented by (Wang 2013). It uses the geolocation of the user to provide effective predictions. According to X. Wang, geographically similar routes tend to have similar latencies and bandwidth similarities. Hence, this is also a prediction based approach that tends to improve the prediction efficiency and overall composition efficiency.
A similar location based method is proposed by (Chen 2014). In contrary to the previous approach, X. Chen uses the location information in their service selection process rather than in their routing process. A service is selected by the user based on their location information. User’s access details along with their location preferences are stored in the system. This data is then clustered and personalized preferences are obtained using region analysis.

A technique that considers multiple users while performing service selections is presented in (Wang 2014). This technique is also proposed to handle missing QoS values to provide optimal solutions. Other techniques considering multiple users during the selection phase include (Shahand 2010), (Dyachuk 2006). Fuzzy based service selection technique that performs service query optimization is presented in (Chouiref 2016). This technique uses a priority based scheme to aggregate elementary similarities and the top-k results are passed to the user for final selection.

A case based reasoning technique that identifies similarity between components to identify the appropriate web services is presented in (De Renzis 2016). This technique uses three different similarity function for analysis and uses case based reasoning for processing. Other similar techniques for appropriate service selection includes (De Renzis 2014) and (Finlayson 2014). A Social Spider algorithm based service selection technique is proposed in (Mousa 2016). This technique was proposed with the main concern for reducing the time consumption during the selection process. Several heuristic based techniques have been proposed to tackle the service selection issue.
Some of them include (Hai 2012), (He 2013) and (Zhang 2013). They tend to tradeoff time or optimization for the benefit of the other, making them unreliable for real-time operations. A multi agent based distributed optimization technique for QoS based service selection is proposed in (Temglit 2016). This technique uses an algorithm called Synch4QoS that operates on a multi-user architecture to provide real-time service selection. A Mixed Linear Programming (MLP) based optimal component selection technique was proposed in (Zeng 2004).

However, this technique has scalability issues. Genetic Algorithm (GA) has been a major favourite heuristic for this process. Studies incorporating GA includes (Gao 2007), (Vanrompay 2008), (Wu2011), (Sasikaladevi 2012) and (Fanjianga 2016). A context aware QoS based service selection system was proposed in (Xu 2016). User preference based techniques for service selection are currently on the raiseare (Wang 2015) and (Iordache 2014).

2.3. SERVICE COMPOSITION METHODS

This section describes various methods and pre-processing techniques available for efficient web service composition. In general, composition techniques are divided into three categories. Web service ranking and selection mechanisms, workflow design and semantic analysis of web services. Table 2.1 presents a composition of the web service selection methods.
Table 2.1 Web Service Selection Strategies

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
<th>Method Used</th>
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| Rathore (2013) | Web Service Selection Algorithm for Dynamic Service Composition using LSLO Approach | • Local selection of local optimization based on linear programming  
• Best web service from each class is selected  
• Linear programming is used |
• Global QOS constraints are decomposed to local QOS  
• Local constraints are taken in user dimension  
• Overall optimal QOS utility within global constraints |
• Dependency & conflict constraints are considered  
• Genetic Algorithm for Web Service Selection  
• Local optimize to remove individuals in the population  
• Knowledge based crossover |
| Cao (2013)   | Hybrid Collaborative Filtering algorithm for bidirectional web service recommendation | • Cube model. Relationships between providers, consumers and web services  
• Three 2D matrixes  
  1. Consumer service QOS matrix  
  2. Provider Service Binary matrix  
  3. Consumer Provider matrix |
<table>
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<tr>
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| Esfahani (2012) | Application of Social Harmony Search Algorithm on Composite Web Service Selection based on Quality Attributes | • Social harmony search used for obtaining best web service  
• Simple & less no of parameters  
• Uses stochastic random searches  
• Elimination of local optimum |
• Proposes behavioral extracting algorithm  
• Obtain behavioral signature model from a service composition plan  
• Ensures best optimal solution  
• Preserves external observable behavior of composition plan |
| Júnior (2013) | A semantic approach for QoS specification of communication services using QoE parameters | • Provides methods to translate QoE (easy for users) parameters to QOS (easy for service providers) parameters  
• Provides rules for publishing QoS/QoE parameters  
• Fixed set of parameters are used to specify quality level  
• Do not deal with problem of heterogeneity  
• No standardized SLA/SLS  
• No universally adopted QOS parameters |
2.3.1. **Web Service Ranking and Selection Mechanisms**

Ranking a web service refers to fixing an importance level to it such that the specific web service occupies the highest priority during the next selection request. (Skoutas 2010) presented a ranking algorithm working on relationship based measures. This algorithm provides dominance, dominated and dominating score based ranking for the services. Further, request ranking is also provided.

It uses the process of approximate skyline and heuristic skyline clustering. The downsides of this process is that there is no optimal match criteria. Reduction of scores will lead to information loss. While, fixing weights requires user preferences, due to the implicit nature of the web services, user feedback is not available. Hence, there is a possibility of elimination of good candidates. An efficient method of keyphrase extraction is presented in (Sarkar 2010).

Keyphrases help understand information in a document’s metadata. Keyphrase extraction is in general considered as ranking problem. (Sarkar 2010) uses Multilayer perceptron neural network to perform the process of extraction. Keyword phrase identification is performed using phrase frequency, phrase link and inverse document frequency.

The problem in this method is that ranking the training data manually is not possible. Selection of the appropriate number of hidden neurons cannot be easily performed. Considering too many neurons will
lead to an increase in training times, while with inadequate number of neurons, the network cannot model complex data.

A Genetic algorithm based service selection approach was proposed in (Jin 2012). It also incorporates the concept of Ant Colony Optimization (ACO), which is a heuristic based optimization approach. The global QoS constraints presented to the system are decomposed into local QoS for further processing.

Local constraints are taken in user dimension, hence it can be used for large scale multi user service selection. Overall optimal QoS utility within global constraints are used to satisfy user’s preference. Service candidate resources are limited, hence web service overload occurs.

Chen (2010) presents a globally decentralized and locally centralized architecture for web service orchestration. It is an affinity based scheme that performs the composition of web services using a central server.

An actor based language unification scheme for orchestration and choreography AB-WSCL is presented in (Wang 2012). Message transfer is carried out in an asynchronous manner, while synchronization is performed among the actors. The activity actor models an activity, while being managed by the Web Service Orchestration (WSO). The relationship between the WSO and Web Service Choreography (WSC) is described here.
An optimal QoS based web service selection scheme is presented in (Angus 2009). This is a flexible scheme to help service requesters perform the service selection based on a single QoS and performs QoS based optimization of the service composition.

It uses Multi Criteria Decision Making (MCDM) and Integer Programming to provide service composition results. (Lin 2011) provides a fuzzy based clustering technique for performing the similarity analysis. QoS consensus decision making is performed for efficient results.

A hybrid filtering algorithm for web service filtering recommendation is proposed in (Cao 2013). It constructs a cube model that builds relationships between providers, consumers and web services. Collaborative Filtering (CF) cannot capture relationships between web services and providers, hence a cube model is used. It contains three matrices; consumer service QOS matrix, provider service binary matrix and consumer provider matrix.

It provides web service recommendation to active users and active users are recommended to providers. The two basic process performed in (Cao 2013) are similarity computation; weight incorporation to solve overestimation and k-nearest neighbor selection that helps in elimination of dissimilar users from top k neighbors and web services with same provider.

A social harmony search algorithm is proposed in (Esfahani 2012). It helps in the selection of individual web services based on the quality attributes required for making the web service composition. The
most important advantage of this method is that it is simple and uses less number of parameters. Stochastic random search is used and the child is generated based on all available values (not just one).

Random feasible solutions are initialized and variable generation is performed based on solutions in HM or randomly. Elimination of local optimum is performed. (Esfahani 2012) uses normal distributions for updating positions. Functions are designed to perform global search initially and local search in final iterations. Elimination is performed using a constant value.