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Ant Colony Optimization Algorithm for Composition of Web Service using Mobile agents based Semantic, WSDL and QOS analysis

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Abstract: Building a composite web service as per the user's complex need requires using the multiple online web services available. Selecting the best web service for composition will become combinatorial problem leads to be the NP complete problem. To solve this problem we are proposing a framework for composite web service using ant colony optimization algorithm. For choosing the proper path selection in ACO, we are negotiating with individual web service to select it for the participation during composite web service. For negotiation we are using intelligent agents for analyzing web services for based on semantic, WSDL and QOS description. As per the profile of the users the negotiation agents are built for building composite web services.

Keywords: Mobile agent, web service composition, QOS, SOA, ACO, WSDL.

1. INTRODUCTION

Aim of building composite web service is to satisfy the customer's complex need. To fulfill the customer's complex need, single webservice will not be sufficient. So single composite web service may require multiple numbers of abstract web services. And for the single basic requirement multiple numbers of abstract web services are available. So it is challenging to select the best abstract web service out of these.

Also building a composite web service is not the straightforward .It is a combination of different abstract web services together. And these abstract web services are combining together in sequence, parallel or in combination. So to build such composite web service we have to construct directed acyclic graph (DAG) to combine different abstract web services in sequence/parallel/ combination.

To construct a DAG, we are proposing Ant colony optimization algorithm. And to select the proper abstract web service for participation in composite web service and to move forward during DAG creation using ACO, we are building agents to analyze abstract web service based on its features like WSDL Contents, Semantics and QOS parameters.

2. WEB SERVICE COMPOSITION

Sometime need of the end user will not be satisfy by the single abstract web service, so we need to combine multiple number of abstract web services together.The process of building such composite web service is called as web service composition (Fig, 01).

While building such composite web services, the combination of various abstract web services together are in sequentially one after the other or they may be combining in parallel or in combination of both.

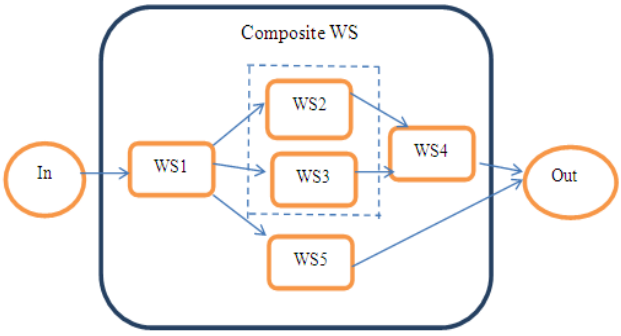

Fig.01: Composition of Web Service

3. SOFTWARE AGENTS [06]

A **Software Agent** is a computer program that acts for a user or other program in a relationship of agency.
Software agents possess the following properties:

1. Locality Affiliation: Agents are locality affiliated. Mobile agents are moved from one place to another during run time and task execution.
2. Role, Service Capacity: Describes the kind of result an agent can produce It represents its functionality for task execution. It is sub divided into action type and task type.
3. Communication Behavior : Each agent belonging to an instance of an agent system can communicate within its name space according to its behavior at any moment. The behavior of an agent determines whether it carries out tasks delegated to it in co-operation with other agents or whether it is capable of doing this on its own.
4. Negotiation Ability : Negotiation ability describes the properties of an agent to execute a task collaborating with other agents and to negotiate this co-operation.
5. Delegation Ability: Taking into consideration authority, agents can place and take on tasks. Delegation means that

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partial tasks can be passed on to agents. Agents execute these tasks according to the results they can deliver and execution control.

6. Learning Adaptability: An agent learns by executing tasks and uses the acquired knowledge during task execution.

7. Re-usability : Processes or subsequent instances can require to keep instances of the class 'agent' for an information hand-over or to check and to analyze them according to their results (e.g While acquiring information). The re-usability of agents can take place in various agent systems and by agents of a different authority.

4. INTEGRATION OF SOFTWARE AGENTS AND WEB SERVICE FOR COMPOSITION OF WEB SERVICE

In our framework (Fig.04) we are taking the advantage of the facility of seamless integration of web services and agents together [02]. So we are building following software agents for different purposes.

1. Web service Agent: to collect the information of respective web services from the RSS feed and JASON Object.
2. Analyzing Agent: To analyze the web services for the selecting to participate in composite web service. Individual web services are analyzed based on the following parameters

a. Semantic Analysis (Using KMP Algorithm)
b. WSDL Analysis (By parsing an WSDL)
c. QOS Parameters (Computation of Availability, reliability, throughput etc….)

3. User Agent: To collect the user information based on the Questions and Answers with users. Also set an expectation of users from the web service with respect to Semantic, WSDL Information and QOS parameters.
4. Coordinating Agent: To negotiate between user agent and analyzing agents.

5. ANT COLONY OPTIMIZATION

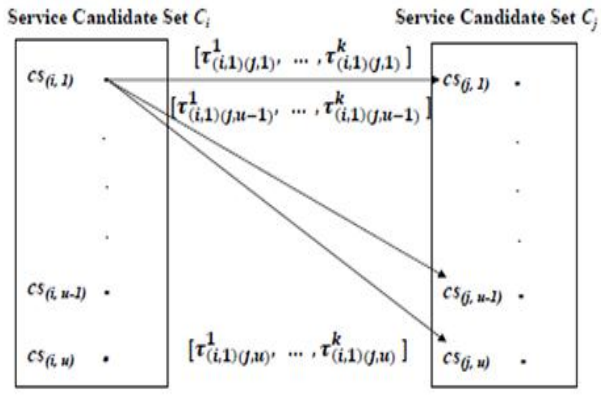

Fig 02: Abstract Web Service selection using ACO

$$\Delta\tau_{A,B}^{total} = \Delta\tau_{A,B}^{1} + \Delta\tau_{A,B}^{2} + \Delta\tau_{A,B}^{3} + \Delta\tau_{A,B}^{4} + \Delta\tau_{A,B}^{5}$$

$$p_{ij}^{k}(t) = \begin{cases} \left[\dfrac{[\tau_{ij}(t)]^{\alpha}[\eta_{ij}]^{\beta}}{\sum_{k \in allowed_k}[\tau_{ik}(t)]^{\alpha}[\eta_{ik}]^{\beta}} \right] & \text{if } j \in \text{allowed}_k \\ 0 & \text{otherwise} \end{cases}$$

Current composition standards focus on building the processes based on the interface description of the participating services. The limitation of such a rigid approach is that it does not allow businesses to dynamically change partners and services. We enhance the current Web process composition techniques by using Semantic Process Templates to capture the semantic requirements of the process.

Web services are a solution to semantically describe and discover Web services. Most of the composition standards build on top of Web service description standards. Hence semantically describing a service could help in composing a process whose individual components are semantically described. When all the tasks involved in a Web process are semantically described, we may call such process as Semantic Web Processes (SWP)

6. SERVICE RANKING AND SELECTION [05]

Formula for Calculating Overall Semantic Matching Value

$$M_s = \frac{\sum_{i=1}^{5} M_i W_i}{\sum_{i=1}^{5} W_i}$$

M_s : Overall Semantic Matching Value
i : Index of the assigned weights (1-5)
M_i : Semantic Matching value of the i^{th} semantic part
W : Weight of the i^{th} part

Formula for Calculating Overall QoS Matching Value

$$M_Q = \frac{\sum_{i=1}^{4} M_i W_i}{\sum_{i=1}^{4} W_i}$$

M_Q : Overall QoS Matching Value
i : Index of the assigned weights (1-4)
M_i : Semantic Matching value of the i^{th} QoS criterion
W : Weight of the i^{th} QoS criterion

Using Ant colony optimization algorithm, following steps are follows for the composition.

1. All the candidate web services are analyzed for current sub task.
2. Next sub task will analyze and respective web service will be selected based on
   a. next possible weighted matrix calculation with negotiating matrix
   b. Pheromone will be the weighted sum of the current web services.
3. Step 1 and 2 follows to create DAG.

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7. Proposed Model

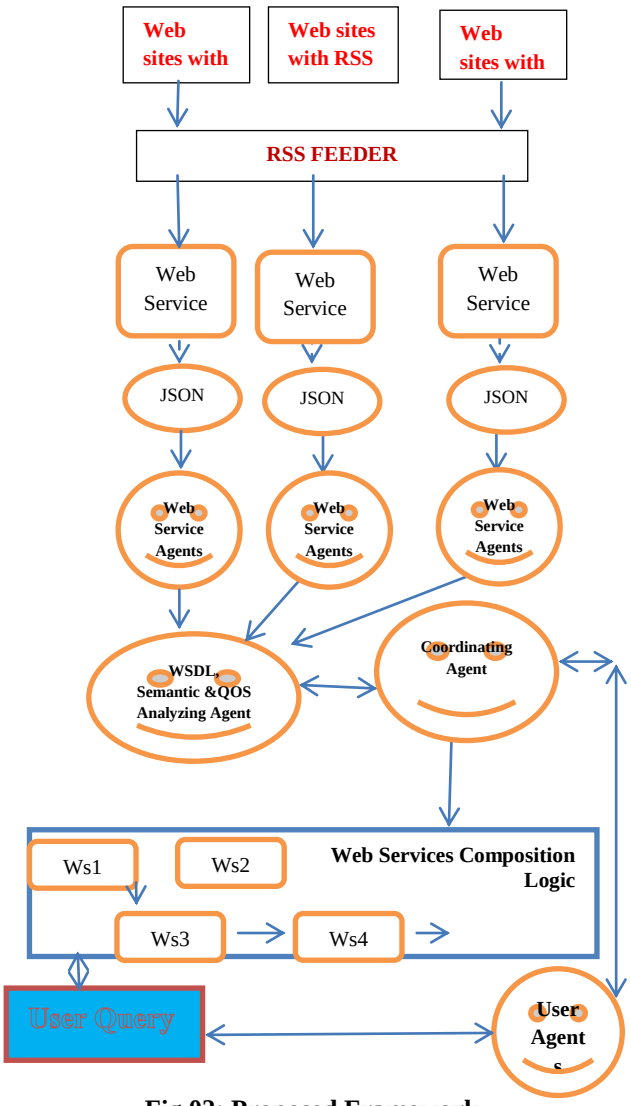

Fig.02: Proposed Framework

Steps for Proposed Model:
Following steps are followed for building the composite web service based on negotiations on the WSDL, Semantic and QOS parameter.

1. **WSDL Analysis**: The web services are analyzed based on the different basic information like Type, messages, Name, etc.
2. **Semantic Analysis:** Relevance of web service with given semantic contents will be analyzed to find the exact web service as per the need of the composite web service.
3. **QOS Parameters**: Availability, reliability, Latency, Throughput, performance parameters are captured of each web service using agents. Matrix of QOS parameters are build
4. **Normalized Matrix:** Normalized matrix will built as per the priorities set for WSDL, Semantic and QOS parameters Respectively at Analyzing agent
5. **Negotiation Matrix**: Negotiation matrix will built at user agents based on the question and answer between user and their respective agents. Both Normalized matrix and Negotiating matrix supplied to coordinating agents, at coordinating agents based on the negotiation matrix the most suited web service as per the requirement will be selected..
6. Selected web service of step 5 will take part in building the Directed Acyclic graph of composite web service using Ant colony optimization algorithm.
7. Final Directed Acyclic Graph will be our finalized composite web service.

8. EXPERIMENTAL RESULTS

To build a composite web service, let's assume that 4 abstract web services are required.

Out of these four web services first web services will be selected from following two tables

Normalized Matrix:

		Ws 1	Ws 2	Ws 3	Ws 4
WSDL Analysis	Name (Must be 1)	1	1	1	1
	Message (0 if duplex 1 if simplex)	1	0	0	1
	Type (0 for complex type 1 for simple)	1	1	0	1
WSDL INDEX	**Sum of WSDL Parameter**	3	2	1	3
Semantic Analysis	Partial Match (Value 1 for Partial Match)	0	0	1	1
	Exact Match (Value 3 for Partial Match)	3	3	0	0
Semantic INDEX	**Sum of Semantic Parameter**	3	3	1	1
QOS Analysis (Value 0 for Poor, 1 for Average, 2 for Good and 3 for Excellent achievement of QOS parameters)	Availability	0	1	1	2
	Reliability	0	1	1	2
	Performance	3	3	1	2
	Latency	2	2	2	3
	Throughput	2	2	2	3
	Cost	1	1	2	3
QOS INDEX		8	10	9	15
Normalization INDEX		14	15	11	19

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Negotiation Matrix:

	Q 1	Q 2	Q 3	Q 3	Q 4	Q 5	**User Negotiation INDEX**
User1	0	1	2	2	2	4	11
User2	2	3	4	4	4	4	21
User3	1	2	3	4	4	4	18
User4	4	4	4	4	4	4	24
User5	1	4	2	4	3	1	15
User6	2	4	3	1	4	2	16
User7	3	1	4	2	0	3	13

Every user will be asked 5 set of question having the answer and corresponding value Poor =0 , Average =1, Good=2,Very Good=3, Excellent =4 So in this example user and web service pair will be as follows.

	User Negotiation Index	**Web service (Normalized Index)**
User1	11	Ws3 (11)
User2	21	Ws4(19)
User3	18	Ws4(19)
User4	24	Ws4(19)
User5	15	Ws2(15)
User6	16	Ws2(15)
User7	13	Ws1(14)

Similar procedure will be followed for selecting different web services for different sub tasks. Then using Ant colony optimization proper pair of web services with users will be selected to form the optimized directed Acyclic Graph.

9. CONCLUSION

Due to the proposed model, all the features of agents are exploited and use to solve the composite web service building process. Different agent's helps here to localize the decision, delegation of the decisions, Role and capacity of the agents are defined and finally the agents are used to negotiation as well

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