Volume 3, Issue 1, January 2013 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Semantic Web Modelling using Rank Based Agent

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Abstract— ***This paper purpose a novel model for rank oriented rank based service model for semantic web. We have taken into consideration the autonomous, reactive, proactive and social nature of agent and multi-agent system. We presented the model in conjunction with the other relevant models available for the same purpose. The results are presented and compared on time, space and relevancy parameter, which clearly shows results improvement of using rank based agent over conventional models for searching keywords in semantic web.***

Keywords— Semantic Web, Personal Agent, Service Agent, Rank Agent

I. INTRODUCTION

Agents act on behalf of the entity (human user in most cases) and perform the tasks requiring specified domain knowledge [1]. While the software agents existed long before the semantic web [14] idea came up, the following characteristics owned by the software agents make them fit perfectly on the semantic web [2]:

- Autonomous: An agent has authority to autonomously act on behalf of the user and without continuous guidance from the user. In addition to accomplishing assigned tasks, as a web service program usually does, the agent is able to activate action and create new tasks. The web is a massive information collection. People don't have the opportunity or desire to review all the details. The ideal model for a human is first saying: "I want an air ticket to Boston next Monday", then making some selections and approving the purchase of the travel package. The agent fills the gap by collecting information, extracting knowledge, organizing, planning and committing the tasks based on rules of behaviors. Additionally, the agent is able to react faster than the human. This is useful in case like rescheduling after being notified by the airline agent that the plane being canceled;
- Cooperative: In addition to communicating with the environment to collect data and take action, an agent has the ability to communicate [5], cooperate and negotiate with other agents to solve problems that are beyond its capacities and knowledge. On the semantic web, a task is usually composed of a set of small tasks accomplished by the service programs spatially distributed around the Internet. The service requester must be smart enough to recognize opportunities for action/inaction, infer new knowledge, and know where and how to look for services. This is possible only with the agent. Given the ability to communicate with other agents, the agent can automatically accomplish extremely intense tasks for the user;
- Adaptive: An agent has the ability to adapt behavior to optimize performance. The web is an extreme unstable environment. New content is added every second. The web server or web pages may be pulled off or changed in any minutes. The agent with adaptive mechanisms (self-monitoring and online learning) ensures robustness and may ultimately accomplish the tasks [3];
- Social: An agent supports the policies to constrain the agent behaviors and can manage conflicting obligations. The confliction and contradiction on the free-styled web, where anybody can say anything, is accepted and can be resolved by the agent [4].

II. PROBLEM STATEMENT

The human browses a web page and understands what it is talking about easily and naturally because the human has a thinking brain. How can a human agent understand the talk announcing web page?

The knowledge in a semantic web page is represented as ontology using the semantic web language like OWL. The agent downloads the web pages, learns the ontology and later inferences about the knowledge. It is clear that learning the ontology is an important step toward understanding the web page. XML, the data exchange language, is based on the assumption that both parties of the communication use the same DTD or Schema file. The understanding of XML content is achieved by matching string and keyword. Similarly, the agents use a common ontology to define the vocabulary with which queries and assertions are exchanged. However on the semantic web, a common ontology may not exist, because web sites owned by different organizations or people geography distributed around the world are very unlikely to agree on the same vocabulary or knowledge [6]. Even using the same vocabulary, web pages with different context may have different meaning. Pragmatically, the agent-understandable web page based on the agent's ontological

commitments is not a good model for the open web environment. So, there is a need of some kind of page ranking system where the user interest are captured for a particular page and ranking is done automatically based on historical database. Pages relevant to the user query must be given high ranking and in future searches only relevant page should be displayed. The pages with lower rankings must be omitted to improve time and space efficiency along with proper relevant data.

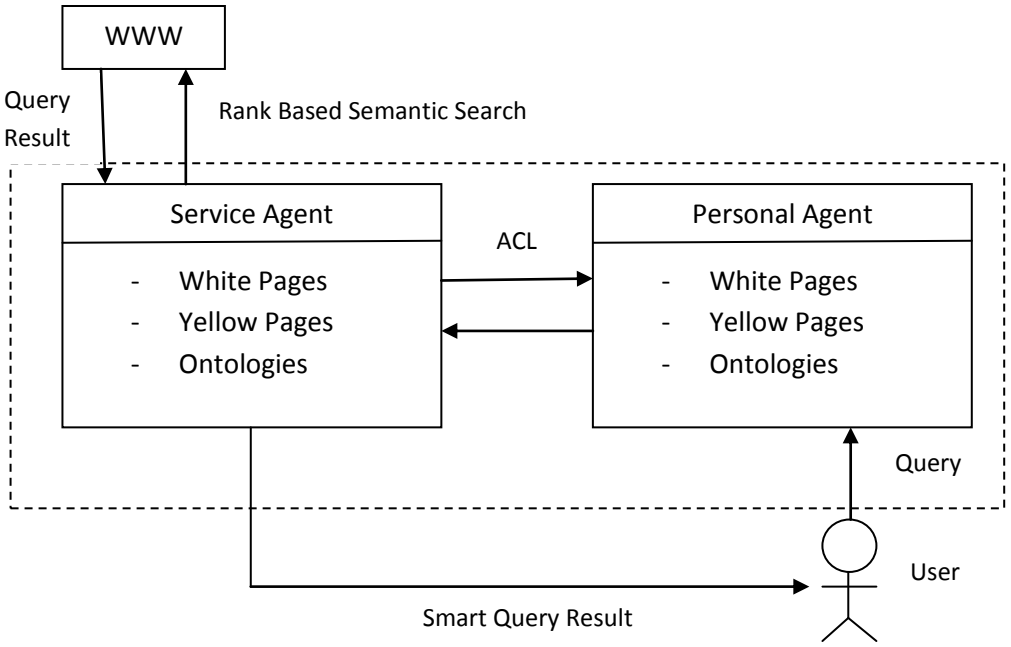

Figure 1: Rank Based Semantic Search Model

III. PROPOSED MODEL (RBSS)

Agent play important role while searching contents in semantic web environment [12]. We introduce a new rank based searching model with the name RBSS (Rank Based Semantic Search) to improve time and space efficiency as shown in Fig. 1. We will make use of three types of agents viz. Personal Agent, Service Agent and Ranking Agent.

The function of the personal agent is to assist the human user, such as maintaining a personal calendar, finding the best price or booking an air ticket. The function of the service agent is to provide specified services to other agents, such as announcing a talk or selling the airline ticket [13].

The personal agent communicates in Agent Communication Language and cooperates with other agents [7] to finish tasks based on predefined rules or policies. It is capable of learning and inserting new facts into its knowledge base. The personal agent is a "special" service agent in the sense that it provides service to only one customer: its human owner. The research of personal agent is primarily focused on human interface and intelligence.

The service agent publishes "white page" services description content and registers its services at a "yellow page" site so that other agents can search and find it. It is capable of understanding ontology and answering queries related to it [8]. A semantic web server is linked with a service agent and pushes information to other agents through it.

The Ranking agent provides ranking to the searched keywords and will assist Personal Agent and Service Agent to improve time and space efficiency. Every time a keyword is searched as per user's need, the ranking agent will update the ranking of the searched items as per data available in the user account of Personal Agent Knowledge base.

Ranking Agent will also help makes smart decision [9] to Service Agent while publishing White/Yellow Pages. The overall working of three agent system will enhance the overall experience of the searching by reducing time and space efficiency. To solve a given task, the service agent may contact other semantic web sites and cooperate with other agents to learn an unknown ontology or agent interaction protocol.

The personal agent can learn new knowledge from the semantic web pages; however this learning may be insufficient for the personal agent to make a decision. The personal agent may have additional questions about the ontologies and knowledge on the web pages. A dedicated service agent with reasoning ability, being part of the services web site, can answer questions about a semantic web page because it knows more about the web site and has better understanding of the knowledge than any outside agents. The service agent also supports accepting comments and assertions about the web pages, and publishes those comments as a semantic web page.

The question remain unanswered that how does the Personal Agent find the correct source out of the huge web data. We propose a model in which the Personal Agent goes to search the website and web pages not by its own but with the help of ranking figure associated with each of the field available on the website. Lower the ranking depicts more usefulness of the field as per the user requirements. Higher the ranking number depicts the field is not useful for the user. Initially the ranking counter will contain dummy values. As the user goes on and search the field and found them suitable, the ranking

counter will be updated accordingly. The Personal Agent will keep track of the ranking counter and will coordinate with the Service Agent to provide meaningful information to the user.

The features of this model include:

- There is no centralized agent to search all web pages and understand every ontology. The service agent in the distributed agent environment only need knowledge about a set of common ontologies and its domain ontologies;
- Owned by the semantic web site, the service agent can be trusted to access privacy-sensitive file or content, and can act as a proxy interface for outside agents;
- By ranking up web pages, the best field searched can be easily located. This is a good amendment to the web services discovery and the agent services searching;

The user will search for a specific keyword. The keyword will be passed on to the Personal Agent [15]. Personal Agent will be having the knowledge base of the particular user. The keyword will be passed to Service Agent using ACL by Personal Agent. The Service Agent will publish the appropriate White/Yellow pages considering the available ontologies. Further the Service Agent will perform a semantic search into the WWW. The search results is passed to the user and user will accept or discard the available results. Again the user interest will be passed on the Personal Agent. The discarded result's ranking field will be downgraded and accepted results ranking field will be upgraded into the Personal Agent's knowledge base.

The subsequent search by the particular user will be again through Personal Agent and Service Agent. Due to the unique ranking mechanism the Personal Agent will not pass the full search criteria to the Service Agent, rather based upon the updated KB appropriate White/Yellow pages will be published by the Service Agent.

IV EXPERIMENTAL SETUP

We have simulated Retsina Calender Agent (RCAL) [10] and ConGolog [11] along with the RBSS model. We have compared time, space and relevancy efficiency of two models prescribed in the literature with the proposed RBSS (Rank Based Semantic Search) Model. We have simulated the RCAL Model and ConGolog Model on the basis of specific keyword. We have chosen these two models to compare because both of them make use of agents for web discovery, execution and query results. We will take into consideration top five pages only corresponding to the search condition. The RBSS model will be having additional attribute i.e. RANK of the web page. The Personal Agent will keep track of user history and will maintain a database as per users' interest.

The RBSS Model is having a rank counter which is updated every time the user searches the web. Greater the relevancy of the web page, higher the ranking will be. The RBSS simulator will perform n simulations
until the results get redundant. Unlike ConGolog and RCAL model RBSS keep track of the updated user interest with the help of Personal Agent and inform Service Agent accordingly.

Algorithm

User HISTORICAL DATABASE (PA)← NULL
User PAGE RANK (PA) ← DUMMY
Step 1. User input keyword to PA
Step 2. Keyword analysis with page ranking by PA
Step 3. If High Rank (PAGE) then
Pass USER DATABASE to SA
Increment or decrement rank counter
else
keep user database in local buffer
Step 4. SA publish yellow/white pages
Step 5. Search WWW
Step 6. Present query result to user. GO TO Step 2

V RESULTS AND OBSERVATIONS

Time Efficiency (in secs.) (Cycle I)				
Keyword Search: "You are making the Coffee"				
Web Pages	**Rank**	**RBSS**	**RCAL**	**ConGolog**
P1	10	0.67	0.66	0.80
P2	10	0.72	0.68	0.72
P3	10	0.78	0.69	0.74
P4	10	0.69	0.72	0.68
P5	10	0.74	0.73	0.73

Table 1: Time Efficiency (in secs.) cycle I

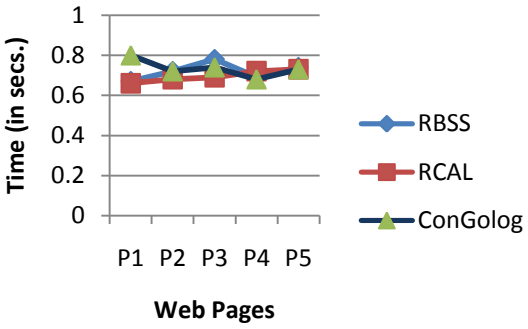

Figure 2: Comparative Analysis (Time Efficiency) cycle I

Time Efficiency (in secs.) (Cycle II)				
Keyword Search: "You are making the Coffee"				
Web Pages	**Rank**	**RBSS**	**RCAL**	**ConGolog**
P1	10	0.67	0.66	0.80
P2	8	0.54	0.68	0.72
P3	8	0.56	0.69	0.74
P4	7	0.49	0.72	0.68
P5	9	0.65	0.73	0.73

Table 2: Time Efficiency (in secs.) cycle II

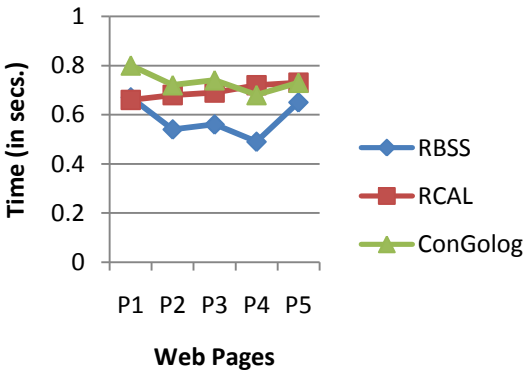

Figure 3: Comparative Analysis (Time Efficiency) cycle II

Time Efficiency (in secs.) (Cycle III)				
Keyword Search: "You are making the Coffee"				
Web Pages	**Rank**	**RBSS**	**RCAL**	**ConGolog**
P1	10	0.67	0.66	0.80
P2	6	0.34	0.68	0.72
P3	4	0.22	0.69	0.74
P4	1	0.11	0.72	0.68
P5	7	0.49	0.73	0.73

Table 3: Time Efficiency (in secs.) cycle III

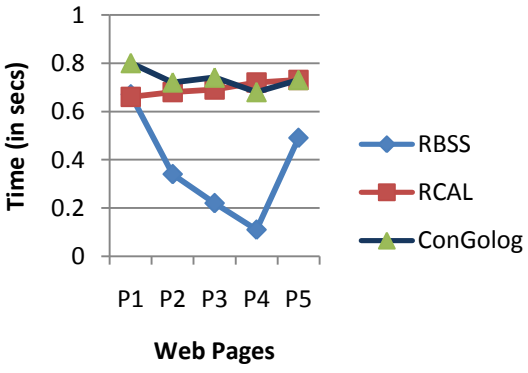

Figure 4: Comparative Analysis (Time Efficiency) cycle III

Space Efficiency (in KB) (Cycle I)				
Keyword Search: "You are making the Coffee"				
Web Pages	**Rank**	**RBSS**	**RCAL**	**ConGolog**
P1	10	9	12	11
P2	10	10	9	10
P3	10	15	13	12
P4	10	10	11	9
P5	10	11	8	12

Table 4: Space Efficiency (in KB) cycle I

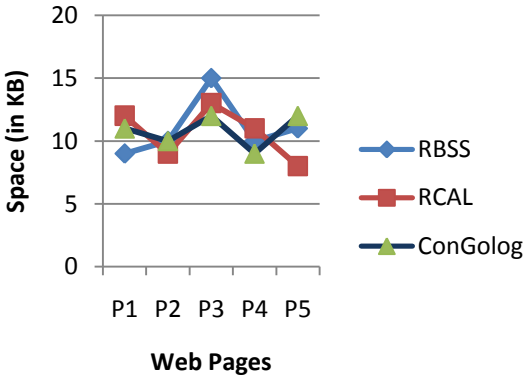

Figure 5: Comparative Analysis (Space Efficiency) cycle I

Space Efficiency (in KB) (Cycle II)				
Keyword Search: "You are making the Coffee"				
Web Pages	**Rank**	**RBSS**	**RCAL**	**ConGolog**
P1	10	9	12	11
P2	8	8	9	10
P3	8	12	13	12
P4	7	8	11	9
P5	9	9	8	12

Table 5: Space Efficiency (in KB) cycle II

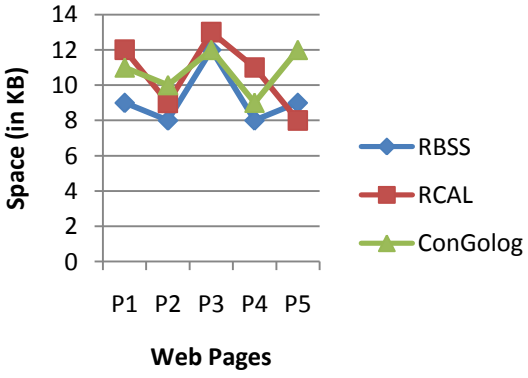

Figure 6: Comparative Analysis (Space Efficiency) cycle II

Space Efficiency (in KB) (Cycle III)				
Keyword Search: "You are making the Coffee"				
Web Pages	**Rank**	**RBSS**	**RCAL**	**ConGolog**
P1	10	9	12	11
P2	6	5	9	10
P3	4	3	13	12
P4	1	2	11	9
P5	7	8	8	12

Table 6: Space Efficiency (in KB) cycle III

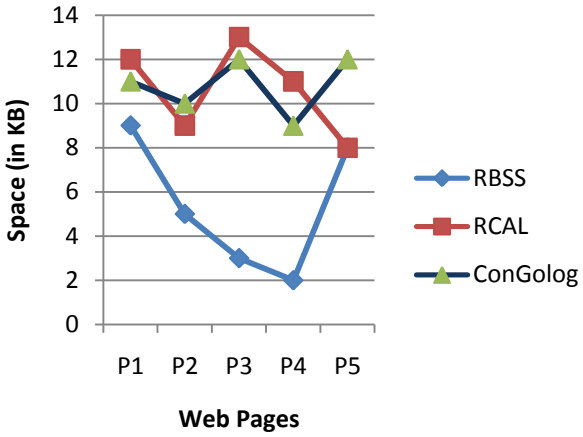

Figure 7: Comparative Analysis (Space Efficiency) cycle III

Relevancy (Max 100) (Cycle I)				
Keyword Search: "You are making the Coffee"				
Web Pages	**Rank**	**RBSS**	**RCAL**	**ConGolog**
P1	10	10	30	39
P2	10	10	45	41
P3	10	10	67	61
P4	10	10	48	54
P5	10	10	56	52

Table 7: Relevancy cycle I

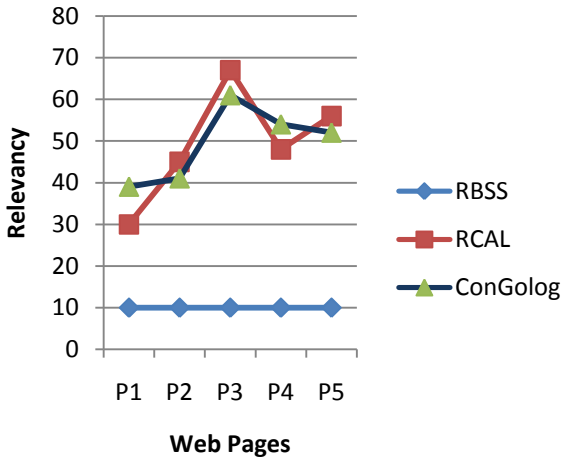

Figure 8: Comparative Analysis (Relevancy) cycle I

Relevancy (Max 100) (Cycle II)				
Keyword Search: "You are making the Coffee"				
Web Pages	**Rank**	**RBSS**	**RCAL**	**ConGolog**
P1	10	30	30	39
P2	8	44	45	41
P3	8	44	67	61
P4	7	52	48	54
P5	9	32	56	52

Table 8: Relevancy cycle II

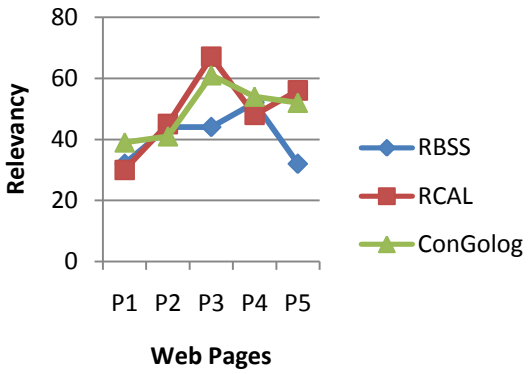

Figure 9: Comparative Analysis (Relevancy) cycle II

Relevancy (Max 100) (Cycle III)				
Keyword Search: "You are making the Coffee"				
Web Pages	**Rank**	**RBSS**	**RCAL**	**ConGolog**
P1	10	30	30	39
P2	6	59	45	41
P3	4	75	67	61
P4	1	100	48	54
P5	7	52	56	52

Table 9: Relevancy cycle III

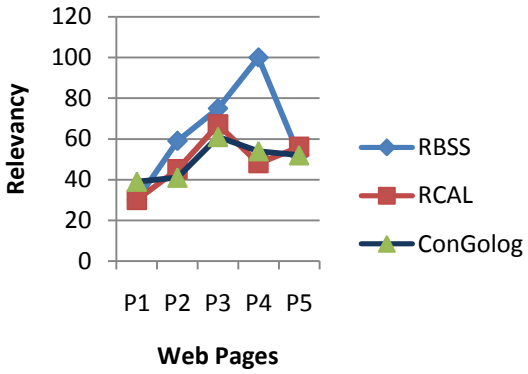

Figure 10: Comparative Analysis (Relevancy) cycle III

As shown in Figure 2, 3, & 4 and Table 1, 2, & 3 the initial results are not satisfactory as the Personal Agent database and web page ranking are having NULL/DUMMY data. In subsequent cycles, due to presence of relevant data presented to the user, the Personal Agent database and web page ranking improves, resulting in time efficiency. Same is the case with the local spatial efficiency as shown in Figure 5, 6, & 7 and Table 4, 5, & 6.

We have also considered the relevancy of query results presented to user on a scale of 100. Figure 8, 9, & 10 and Table 7, 8, & 9 presented the improvements of user relevant data in subsequent cycles.

VI CONCLUSION

The first cycle depicts poor result for RBSS model because of the dummy values in the ranking column. As the cycle goes on and ranking of the web page improves as per Personal Agent database, the Service Agent presents relevant web pages to the user resulting in some sort of improvement by RBSS model over the other two models in Cycle II. Cycle III clearly shows considerable improvement in terms of time efficiency over the other two available models.

The experiment doesn't only show the relevancy in terms of time but in terms of local spatial efficiency also. In cycle I, when there is no ranking data available, the Personal Agent use to store all the necessary information and irrelevant information also. Moreover the Service Agent provides relevant and irrelevant data both to the system resulting in wastage of local space and thus making the system inefficient. Cycle II & III clearly shows improvement of RBSS model over the other models due to constant updation of ranking position of web pages in the Personal Agent database.

We also benchmarked the relevancy of web pages on a scale of 100 in each cycle. For experimental sake, in cycle I, we assumed the relevancy value in RBSS model for each page to be 10. As the cycle goes on the Personal Agent provides only relevant data unlike the other models, where the users' interest are not updated constantly. Experiment shows that using RBSS model, the user is able to find the best web page he/she looking for.

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