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Semantic Web and Intelligent Mobile Agent Based Architecture for Intelligent e-Learning System

Gopal Sakarkar,Dr.S. P. Deshpande,Dr.V. M. Thakare

Abstract— e-Learning is an in-demand area of educational society. To provide the user friendly and personalize learning content is challenging task for such application. Semantic web is next step of web technology which provides interoperability and re-usability of content. Software Agent is an entity which is an advances version of object oriented programming's paradigm. Agent has an ability to read and understand the content of web which is till date understood by human only. It helps to make a communication between machine to machine with an effective manner. The main focus of this paper to propose an innovative architecture of e-Learning system with the help of Semantic web technology and Mobile Agent based system and discuses the performance of proposed semantic web and mobile agent based approach.

Index Terms— Semantic Web, Ontology, Artificial intelligence, Agent, Mobile Agent, e-Learning, Architecture

1 Introduction

E-LEARNING refers to the way in which the learning content is provided by means of electronic technology. Agent based e-Learning can manage the information overload, serve as academic experts, and create programming environments for the learners. There are several characteristics species to e-Learning system such as Interaction, Personalization, Adaptation, Intelligence, Interoperability, Accessibility and Security. The function of Agent based architecture for e-Learning system to support curricular design, to retrieve relevant learning materials, to process and analyze data to enable meaningful e-Learning recommendations [1].

Artificial intelligence plays an important role in providing more effective, advanced e-learning systems. Artificial intelligence based evaluation mechanism is able to determine advance material according to students' basic learning levels [2].

An intelligent prediction model is used for learner's outcome forecasting approach, which helps facilitators and users to discover more interesting knowledge information and predict the learning outcomes. It is useful to overcome a traditional machine learning technique that includes objective prediction and subjective forecasting methods [3].

Use of games application design model in E-learning is an innovative idea proposed by authors [4]. The inference is that using android games in e-learning process, it was increases the cognition of students in online learning and they easily learn hard topics through games application.

To provide augmented reality of e-learning system authors used various type of student personality models including Myers-Briggs Type Indicator (MBTI), Kolb's model and tested the final result using t-test. As a result, students demonstrated shown an improvement in engagement and commitment to the online courses [5].

To develop an effective e-Learning system required a different parameters, like query expansion, learner's profile, web log preprocessing, web knowledge discovery, and opinion, self-motivation, self-discipline, communicative, ability to work in multitasking[6].

SMAC (social, mobile, analytics and cloud) and ANN are the two major key factors for success of any e-Learning platform in today modern technological era. They use Internet to stimulate teacher student interaction over the Internet beyond college hours [7].

The proposed Intelligent Tutor System for JAVA has improved the student learning productivity by 10%. The system automatically produces exercises and during the process of exercising it uses feedback information from the student performance. It has a capability of evaluating and monitoring of student learning process[8].

Bayesian Network is one of the strongest probabilistic graphical models which can handle any kind of statistical data. Chakraborty and Sinha used this Bayesian Network as students evaluation model that is correctly detect the knowledge level of each student based on their feedback [9].

The proposed system consists of ontology for the e-learning process, such as teaching methods, learning styles, learning activities and course syllabus. The feature of which are gaining user adaptability, performance scalability and concept reusability. It also has ability to act in an intelligent manner by evaluating the academics initially and then provide personalized suggestions to the academics by indicating their weaknesses and strengths [10].

- *Gopal Sakarkar, MCA Dept., GH Raisoni College of Engineering, Nagpur, Research Scholar S B G Amravati University , Amravat,Indiai E-mail:g.sakarkar@gmail.com*
- *Dr. S P Deshpande, PGDCS&T,HVPM, Amravati, India*
- *Dr. V M Thakare, SGB Amravati University,Amravati,India*

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2 RELATED WORK

2.1 SEMANTIC WEB

The idea of the Semantic Web is the invention of the original mastermind of the World- Wide Web, Tim Berners-Lee. The inspiration behind the Semantic Web is 'to weave a Web that not only links documents to each other but also recognizes the meaning of the information in those documents [11], in other words, to transform the current Web from a series of interconnected, but ultimately semantically isolated data islands into one gigantic, personal information storage, manipulation and retrieval database.

Nowadays, there are a huge amount of resources on the Web, presented in HTML files which are useful in some contexts but meaningless under other conditions. HTML cannot provide description of data encapsulated in it. For example, someone wants to find an address' details and know its postcode. Since the names of the postcode system are different in many countries and the Web doesn't represent this relationship, it may not get what we expect. By contrast, in the Semantic Web, it can indicate this kind of relationship such as zip code is equivalent to postcode. So when the majority of data on the Web are presented in this form, it will increase intelligence in the web technology, but it is difficult to use such data on a large scale [12].

2.2 ONTOLOGY

The role of ontologies on the Semantic Web is to help data integration when, ambiguities may exist on the terms used in the different data sets, or when a bit of extra knowledge may lead to the discovery of new relationships.

Agarwal [13] states that "an ontology is the manifestation of a shared understanding of a domain that is agreed between a number of agents and such agreement facilitates accurate and effective communications of meaning, which in turn leads to other benefits such as inter-operability, reuse and sharing", where it plays a crucial role in enabling Web-based knowledge processing, sharing, and reuse between applications. .

The term ontology has been widely used in recent years in the field of Artificial Intelligence, computer and information science especially in domains such as, cooperative information systems, intelligent information integration, and information

Retrieval and extraction, knowledge representation, and database management systems [14].

Any Semantic web is based on an explicitly specified ontology, so when two different semantic web applications can communicate by exchanging their ontology's. Several representation schemes have been defined for the ontology layer. The most popular one, the Ontology Interchange Language (OIL), combined with the DARPA Agent Mark-up Language (DAML), DAML+OIL, provides a rich set of language structures with which to create ontology and to mark-up information so that it is machine understandable [15].

Ontology for the e-Learning processes can be set up in various ways, but ontology will include a dictionary with explanation of the terms, and indications of how the terms are related to another. This approach will give a valid tool for the learning process [16].

The role of ontology's in e-learning is often underestimated; they can be useful for e- Learning systems [17].

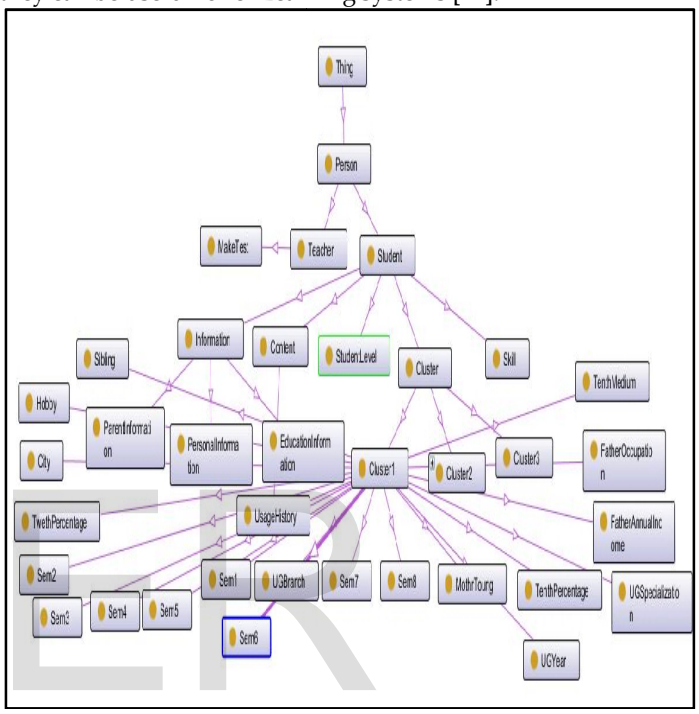

Fig 1: Student and Teacher ontology graph

```
<owl:NamedIndividual rdf:about="&imsaa2;student1">
    <imsaa2:dob rdf:datatype="&xsd;string">02/08/1990</imsaa2:dob>
    <imsaa2:familymember rdf:datatype="&xsd;string">3</imsaa2:familymember>
    <imsaa2:fatherannualincome rdf:datatype="&xsd;string">50000-100000</imsaa2:fatherannualincome>
    <imsaa2:eightpercent rdf:datatype="&xsd;string">60.00</imsaa2:eightpercent>
    <imsaa2:country rdf:datatype="&xsd;string">India</imsaa2:country>
    <imsaa2:engineeringunivercity rdf:datatype="&xsd;string">Mumbai University</imsaa2:engineeringunivercity>
    <imsaa2:skills rdf:datatype="&xsd;string">C++ C#.net ASP.net</imsaa2:skills>
    <imsaa2:engineeringstream rdf:datatype="&xsd;string">Computer Science</imsaa2:engineeringstream>
    <imsaa2:studentlevel rdf:datatype="&xsd;string">Experience</imsaa2:studentlevel>
    <imsaa2:lastname rdf:datatype="&xsd;string">Pawar</imsaa2:lastname>
    <imsaa2:state rdf:datatype="&xsd;string">maharashtra</imsaa2:state>
    <imsaa2:gender rdf:datatype="&xsd;string">female</imsaa2:gender>
    <imsaa2:eightmedium rdf:datatype="&xsd;string">English</imsaa2:eightmedium>
    <imsaa2:eightboard rdf:datatype="&xsd;string">State Board</imsaa2:eightboard>
    <imsaa2:city rdf:datatype="&xsd;string">Nagpur</imsaa2:city>
    <imsaa2:fatherawareofinternate rdf:datatype="&xsd;string">no</imsaa2:fatherawareofinternate>
    <imsaa2:fatheroccupation rdf:datatype="&xsd;string">Private Service</imsaa2:fatheroccupation>
    <imsaa2:hobby rdf:datatype="&xsd;string">Singing</imsaa2:hobby>
    <imsaa2:firstname rdf:datatype="&xsd;string">Priyanka</imsaa2:firstname>
    <imsaa2:emailid rdf:datatype="&xsd;string">piyapawar@gmail.com</imsaa2:emailid>
    <imsaa2:internatehome rdf:datatype="&xsd;string">yes</imsaa2:internatehome>
    <imsaa2:study rdf:resource="&imsaa2;student1"/>
</owl:NamedIndividual>
```

Fig. 2 Student data representation using RDF and OWL ontology language

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2.3 Personalization

Personalization is a process of meeting the user's needs more effectively and efficiently, making interactions faster and easier and, consequently, increasing user satisfaction and the likelihood of repeat visits.
Internet of Things (IoT) is a new approach put forward by Soumya Kanti Datta et.al. [18], for personalized healthcare in smart homes. To achieve this , they proposed healthcare system is in Mobile2Mobile data processing using M3(Machine-to-Machine Measurement (M3))framework , that employs a semantic reasoning engine to generate actionable intelligence from wearable sensor data and combine that with smart home sensors to create cross domain scenarios.
Setting a learning path of user in e-learning system according to his profile is one of novel approach put forward by Lidia BĂJENARU et.al. [19] .They used domain ontology, learning objects, student knowledge and developing an ontology-based system for competence management allows a complex interaction which is providing intelligent interfacing.
The proposed personalize system[20] supports learners by providing them recommendations about learning objects within the course which are more useful for them, by considering the learning object they are visiting as well as the learning objects visited by peer learners with similar profiles. This kind of personalization can help in improving the overall quality of learning by providing recommendations of learning objects that are useful but it may be overlooked or intentionally skipped by learners. Such personalization can increase learners' performance and satisfaction during the course. A massive open online course (MOOCs) supports design and delivery of personalized learning paths that is aimed at developing competencies in the technology entrepreneurship domain [21].

3 Proposed Four Level Architecture

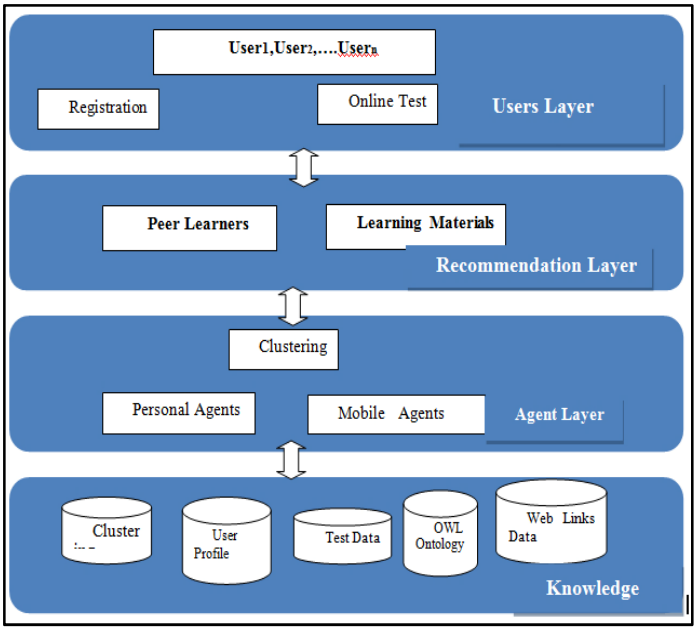

Fig3. Proposed Semantic Web and Mobile Agent based e-Learning Architecture

a) **User Layers**: This is first layer of architecture, which is access by user/learners and provides the GUI. This layer provided a registration of new user, and online C test
b) **Recommendation Layer:** This is second layer of architecture , it recommend the peer learners to user as per his/her profile information and it also recommends the subject web links as per user's knowledge level.
c) **Agent Layer**: It is core layer of this architecture, which contains the personal agents and mobile agents. The personal agent takes basic information from user's database and sends this data to mobile agent using agent communication language. Here the clustering of new user is performed as per the personal information as well as technical information which are found out by taking C Test.
d) **Knowledge DB Layer**: This layer contains clustering data, which divide users in basic four clusters. User profile data, which has all information of user including personal information, parental information to educational information.OWL Ontology data, contain the semantic representation of user's data as well as subject data. Web link data store all links visited by users with rating information for individual link.

4 Efficiency of Proposed Approach

To check the efficiency of our proposed approach, C language test was carried out for 25 students. In this work, out of 200+ registered students in IMSAA system, 25 were randomly selected for the test and they appeared for C online test without used of any recommended web links provided by system, i.e. R' is a result of C test without used of recommended web links.

Then they were allowed to read maximum information from the recommended web links as per the personalization of each student [29].

After they were provided information from IMSAA system, and they were allowed to take the second test and now allowed them for re-appearing for C Test, i.e. R'' is a result of C test after a used of recommended web links.

C test is design in such way that, it shows the C language questions to leaner from four different table, tbl_beginner_test, tbl_fresher_test, tbl_experience_test and tbl_expert_test. Each table has 25 questions and four answers with one correct answer. Students have to solve 5 questions each from these four question table, i.e. total 20 questions in 30 minute duration. Where the beginner table has 1 mark questions, fresher table has 2 marks questions, experience table has 3 marks questions, and expert table has 4 marks questions.

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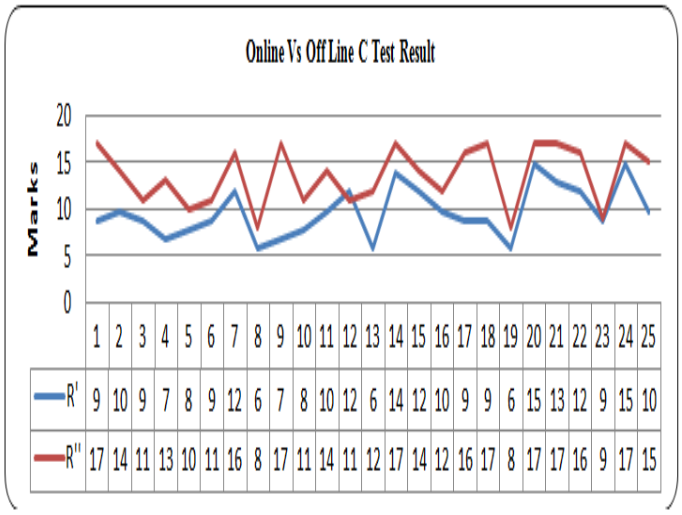

Fig 4. Online vs. Off Line Test Result

From the figure 4, as a graph is clearly shown that, when students did not used any system's recommended information, they had got low level of marks i.e. R', but when they used personalized and recommended web links that are provided by personal agent and mobile agents, they got an accurate information from WWW as well as a peer –students. After reading this information, student's result of test shown as increase, i.e. R''.

5 Proposed Ontology Based Searching,Ranking and Re-Ranking algorithms

Finding information on Internet is a common approach used by any learner but providing an appropriate and accurate essential information as per the requirement is a challenging task. To overcome this, an ontology, semantic web and mobile agent based searching approach has been proposed.

In this technique, mobile agent is worked on behalf of learners. This mobile agent collected a learner's personal and technical information which is stored in form of OWL semantic web based file format and gather all accurate and appropriate information needed for learner at real time.

The comparative analysis is done, using Apriori Algorithm, FP-Growth, Genetic Algorithm with the proposed approach by implanting these algorithms on IMSAA e-Learning generate dataset and standard AMBIENT data set.

1.Apriori Algorithm

The Apriori Algorithm is an influential algorithm for mining frequent item sets for Boolean association rules. Apriori uses a "bottom up" approach, where frequent subsets are extended one item at a time (a step known as candidate generation), and groups of candidates are tested against the data.

2.FP-Growth Algorithm

The FP-Growth Algorithm, proposed by Han, is an efficient and scalable method for mining the complete set of frequent patterns by pattern fragment growth, using an extended prefix-tree structure for storing compressed and crucial information about frequent patterns named frequent-pattern tree (FP-tree).

3. Genetic Algorithm

A genetic algorithm (GA) is a metaheuristic inspired by the process of natural selection that belongs to the larger class of evolutionary algorithms (EA). Genetic algorithms are commonly used to generate high-quality solutions to optimization and search problems by relying on bio-inspired operators such as mutation, crossover and selection.

4.Our Proposed Approach

In this proposed approached, semantic web and ontology using mobile agent based searching approached is used. This searching approach is based on leaner's ontological historical information. When the user enter keyword for searching , a mobile agent gets an information from learner's OWL file, using this information mobile agent find the accurate and relevant information from WWW.

The result of these approach make a comparison on the basis of Accuracy of recommended information, Memory Utilization by each algorithms and Time duration required by each algorithms.

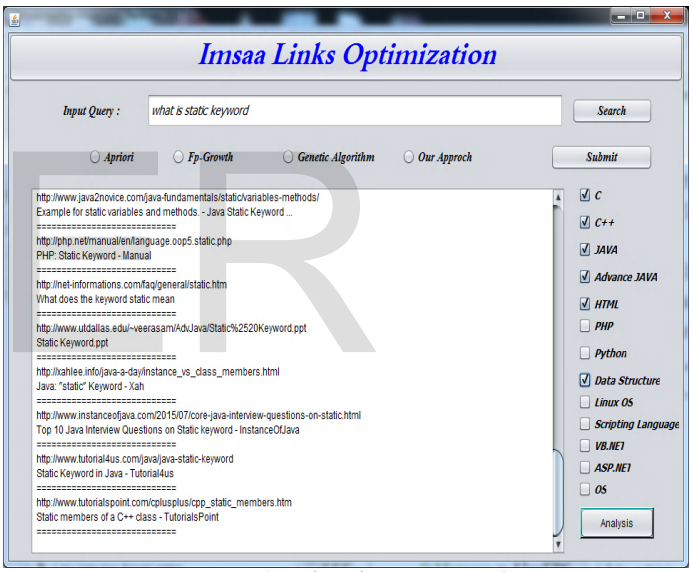

Fig. 5 Searching for information on web.

Form fig. 5, in which a query is inserted to get information from web. This query is sent to Google using Google's searching API. A bulk amount of information is return by this search engine and the accuracy of information required is very less. In the next step, different algorithms are used by selecting radio button on screen and by selecting various skill sets for which leaner search the information on Internet.

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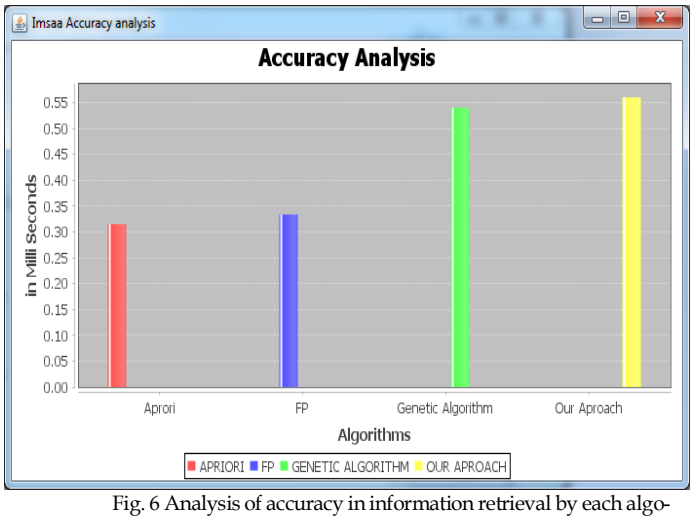

Fig. 6 Analysis of accuracy in information retrieval by each algorithm

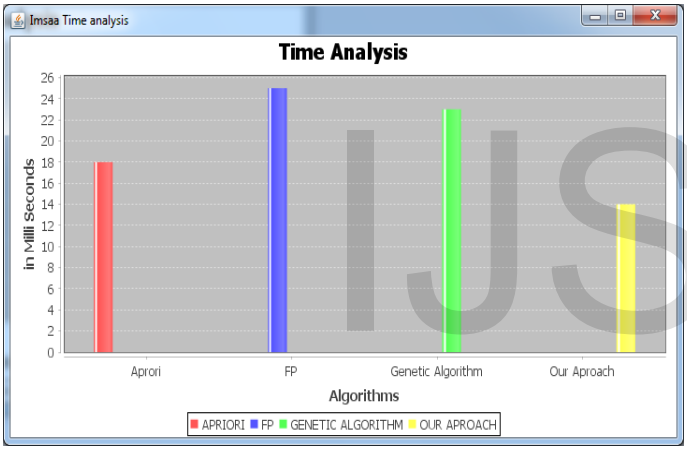

Fig. 7 Analysis of time required by each algorithm for execution

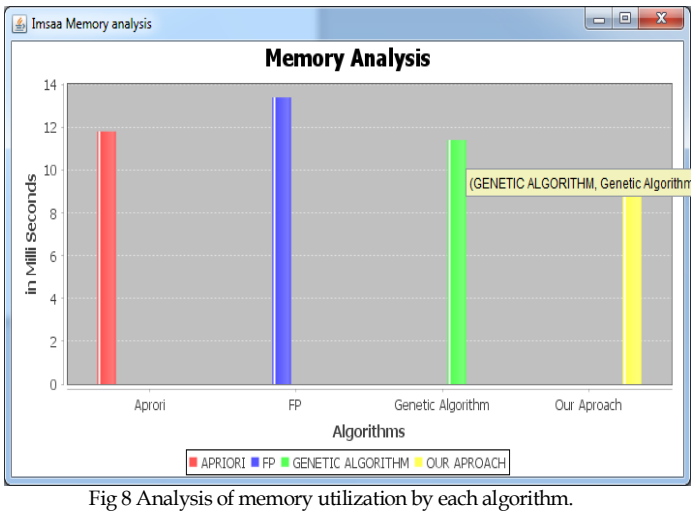

Fig 8 Analysis of memory utilization by each algorithm.

From Fig.6 , it has been observed that as compare to Apriori , FP-Growth and Genetic algorithm , the proposed 'our approach' provided more accuracy in information retrieval, as the mobile agent move to web and searching only those information that is required by leaner . From Fig.7, it has been observed that time require for execution and for the retrieval of information is also very less as compared to other algorithm. From Fig 8. Indicate that memory utilization of each algorithm and again utilization of memory is less by our proposed searching algorithm. To check this proposed comparative approach, it is also tested on standard dataset AMBIENT (AMBIgous ENTries) [30, 31].

This dataset consists 44 topics, each with a set of subtopic and list of 100 ranked documents and 4450 resultant data links.

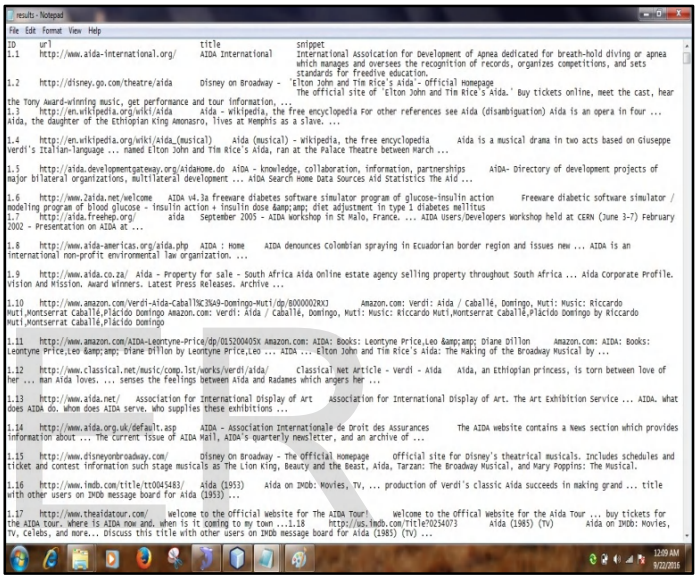

Fig. 9 AMBIENT Dataset

This AMBIENT dataset has 4450 web links that contained URL, title and snippet information. This dataset having those keywords which have ambiguous meaning and storing all those web links information having these ambiguous words in title or in snippet.

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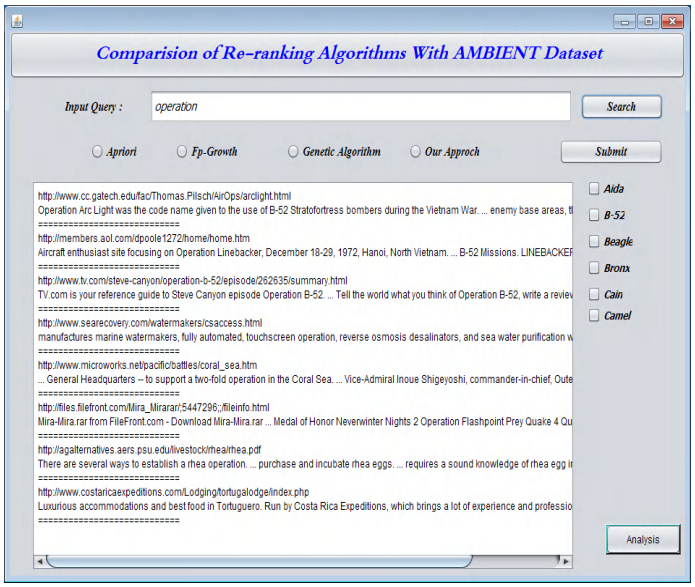

Fig. 10 Comparison with AMBIENT dataset

Form fig 10, the query is input for searching proposes. This key-word is check with all available data links in dataset and returns all those web link having a matching keyword.
By selecting various Apriori, FP-Growth, Genetic Algorithm and 'our approach' algorithm, following analysis has been done.

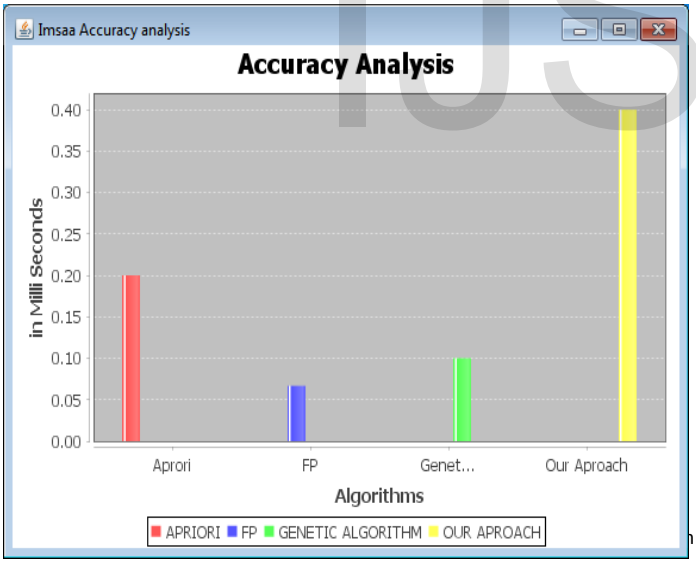

Fig. 11 Analysis of accuracy in information retrieval by each algorithm

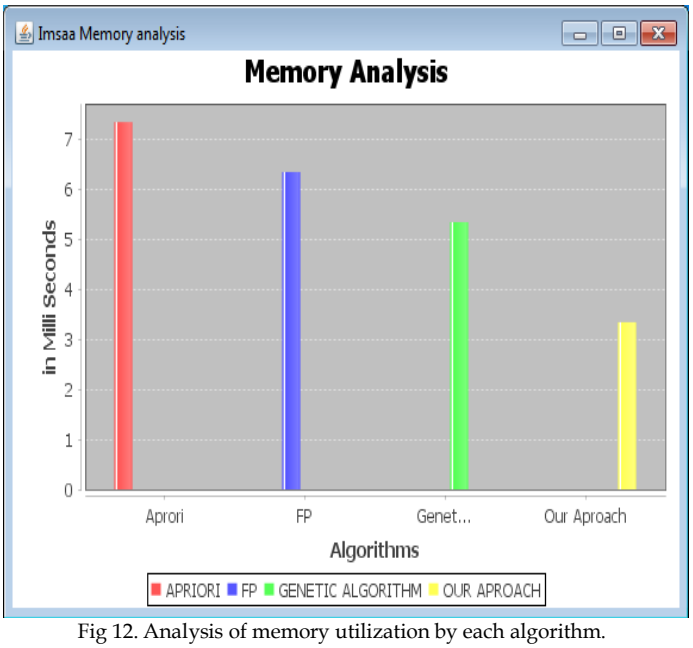

Fig 12. Analysis of memory utilization by each algorithm.

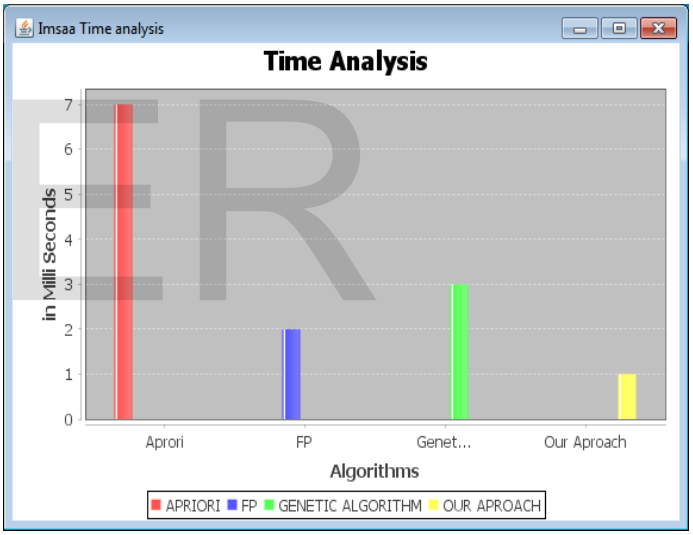

Fig 13. Analysis of time required by each algorithm for execution

This comparative study shows that the proposed 'our approach' algorithm work more accurate in real time searching approach and in off line searching approach.

6 Conclusion

Personalization and recommendation are demanding techniques in today's e-learning system. The proposed architecture assist to fulfil all need of students by providing real time personalization and recommendation using very demanding technologies like Semantic web and Agents. As a result, it is shown that the system suggests and recommends the web links from his peer students and from WWW,so that learner will get exact and accurate information in minimum time and utilize web based e-learning system without wasting time on

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randomly searching and scrutinizing the web links result that are provided by search engines.

Hence, it is concluded that proposed architecture of e-Learning system works efficiently to provide personalize recommendation as per student's personal and technical knowledge.

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