Adaptive e-learning using Granulerised Agent Framework

Priya Sahai, Manuj Darbari

Abstract— In this paper we propose a mutli-agent approach to the problem of recommending relevant and adequate course work to the student in e-learning environment. Our framework illustrates granulerised approach that provides dynamic binding of various course mixes stored in the form of data sets providing the user with relevant data work in real time. A flexibility , adaptability and interactiveness is achieved through agents that autonomously and intelligently uses fuzzy relational models to generate decisions from imperfect input sources. We also suggests a right course selection and pace setting algorithm that agent uses to provide best course mix for the student depending on various parameters such as his/her skill set, learning pace and others.

Index Terms— Adaptive, cluster, dynamic binding, e-learning, fuzzy, information modeling, granules, granulerisation ,multi- agents.

1 INTRODUCTION

THERE are number of e-learning methodologies developed so far, but all the e-learning models developed so far lack the interactiveness where a student can set its learning pace as well as right course to be delivered according to the student's previous educational record.

E-Learning, the new technology of supporting education and training, recently has been gaining a lot of attention. Content retrieval in e-learning refers the process by which the learning content is provided by means of an electronic medium. It is an effective web-based learning paradigm, where many agents can be assigned with unique responsibilities to cope-up with the content retrieval and content delivery to various users. Multi- Agent based system[15,16, 17] can manage the information stored in the e-learning environment, access permissions and granting access to various data content. Each tasks are carried out by an autonomous agent and various such agents are grouped to form a multi-agent based system.

To allow a better educational experience it is necessary to develop systems which are able to offer specific and personalized contents to the students in an intelligent way, i.e. systems capable of making decisions about which is the most suitable educational content at every time for each student.

That's why we have chosen this topic to propose a model which can be able to suggest to each student specific tasks to achieve his/her particular learning objectives, based on several parameters related to existing learning paths and the student's profile.

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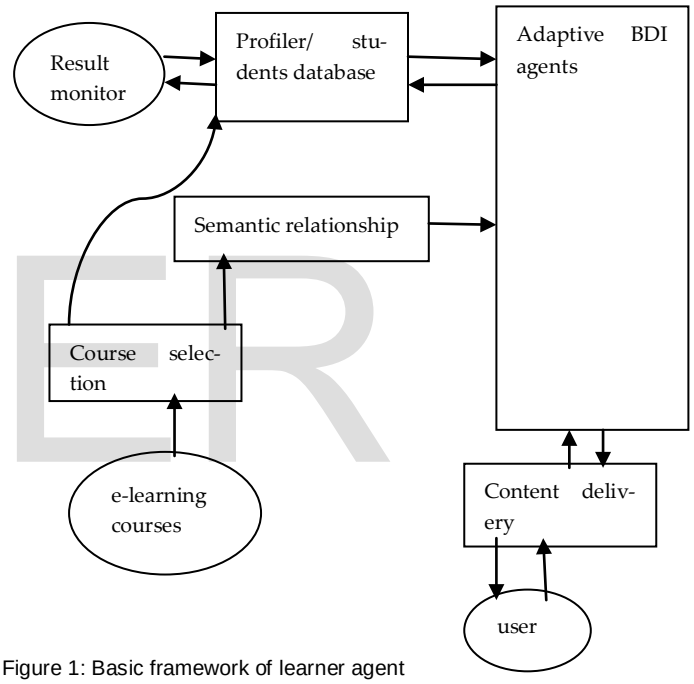

Figure 1: Basic framework of learner agent

2. LITERATURE SURVEY

We are motivated by the work of Dawn G. Gregg on E-learning agents[1].This paper illustrates the advantages of using intelligent agents to alleviate the location and customization of appropriate e-learning resources and to foster collaboration in e-learning environments. It utilizes a set of social Agents that can personalize instructions based on user's prior knowledge , skill set as well as as their cognitive and learning requirements.

The paper, E-learning adoption intention and its key influence factors based on innovation and adoption theory by Lingxian Zhang, Haojie Wen, Daoliang Li, Zetian Fu∗, Shuang Cui [2] explores innovation adoption perspective, investigates people's perceptions and their attitudes towards adopting e-learning as a teaching module behavior. The result shows that some factors of perceived innovative attributes, such as cost, quality, agility, schedule control, certification of degree, personal demands and so on, have more influence on peoples'

adoption of e-learning.
We are motivated by the work of Fernando A. Micki Fonte, Juan C. Burguillo in An intelligent tutoring module controlled by BDI agents for an e-learning platform[3]. This paper proposes a functional prototype of an intelligent learning platform called INES(INTELLIGENT EDUCATIONAL SYSTEM) Including several tools and techniques.
In order to meet the personalized learning Sun Duo, Zhou Cai Ying has developed a model that highlights the work in Personalized E- learning System Based on Intelligent Agent[4].The proposed system is presented in three perspectives to provide the domain specific content to the learner based on the effort prediction according to their background details. The personalized domain specific content is generated and can be modified according to the learners and teacher perspectives.
The paper Tutor as an important e-learning support, by Blanka Frydrychova Klimova*, Petra Poulova[5] attempts to examine e-courses and how the traditional role of a teacher changes in this environment .It states the preconditions that are pivotal for the tutoring of such courses. Morever, it describes a creation of e-learning courses from the pedagogical point of view.
We have used the concept of Abdel-badeeh M. Salem, Sarma Cakula of E-Learning Developing Using Ontological Engineering [6] to study an efficient methodology for knowledge representation and management in many domains and tasks. Ontology design, approaches and methodologies are very important issues for building ontologies for specific task. This paper presents the application of the ontological engineering methodology in e-Learning domain. Bhavani Sridharan, Hepu Deng, Brian Corbitt work in an ontology -driven topic mapping approach to multi-level management of e-learning resources [7] highlights the Topic maps that addresses to the problem of representation, storage and extraction of information in a distributed environment. To fulfill this objective, this paper has proposed a multi-level ontology-driven topic mapping approach. It facilitates effective global authoring, visualization, classification and interoperability of learning resources in e-learning environment.
In order to build an application of intelligent techniques we referred the paper, An application of intelligent techniques and semantic web technologies in e-learning environments By Anatony Gladun, Julia Rogushina, francisco Garcia Sanchez[8]. It suggests that Students are prompted to build their respective ontologies corresponding to each discipline and then each of the so- build ontologies are compared to the reference one.
This paper by jaber el. Bouhdidi, Mohammad Ghailani, Otman Abdoun [9] proposes a model of e-learning based on a process of coupling ontologies and multi-agent system to increase the potential of e-learning technology. It illustrates a new approach based on a multi- ontologies and multi-agents system to generate customized learning paths in e-learning platforms.It ensures that learner/student can follow the training on his own pace according to his preferences, either individually or jointl sessions with other learners. It automatically builds courses via software agent in cooperation with human agents.
Defta (Ciobanu) Costinela – Luminitaa has highlighted on the topic Information security in E-learning Platforms[10] which highlights Security as an important emerging issue in the actual educational context where e-learning increases as it's gaining popularity and more and more people are attracted to online courses. It describes some key security issues that must be taken into consideration while developing and using an e-learning platform. It also examines security aspects of one of the most popular available open-source of e-learning systems that is, Moodle.
We have used the concept of An intelligent multi-agent Recommender system for human capacity building by Vukosi N. Marivate [11] to develop a multi-agent approach to the problem of recommending recommending training courses to students. In this paper through user modeling and data collections from a survey , collaborative filtering recommendation is implemented using intelligent agents. This method of recommendation is scalable and adaptable.
We also implemented the concepts of Rough Set theory and its applications by Zdsilaw Pawlak[12] to derive relevant granules from various course content combinations. Rough set theory discussed in this paper has an overlap with many other theories dealing with imperfect knowledge ,e.g. fuzzy sets, Bayesian inference and others.

3. OUR PROPOSED MODEL

Our model deals with Adaptive learning methodology using multi-agent systems. The basic idea is to develop a framework which can provide intelligent learning[17,18]. Depending on some set of basic questions attempted by the students the course content is delivered to him. These course contents are generated during runtime in the form of granules and delivered to the student . We have created an Intelligent Agent named as Learner granule generator, library granule generator agent, learner granule agent and recommender granule agent.

The granules are to be intelligently managed for providing the adaptive learning. The use of granulerisation provides flexibility in summarizing the information and keeping a good cohesion information modeling. Granulerisation is a way of assimilation of information without getting into its details. In order to develop an information granule we use the concept of fuzzy sets.
Witold Pedrycz [13] has classified the mechanism of granulerisation into four tuple form

$< X, G, S, C >$

Where

X=Universe of discourse
G=Formal framework of granulation
S=Collection of information granules
C=Transformation mechanism

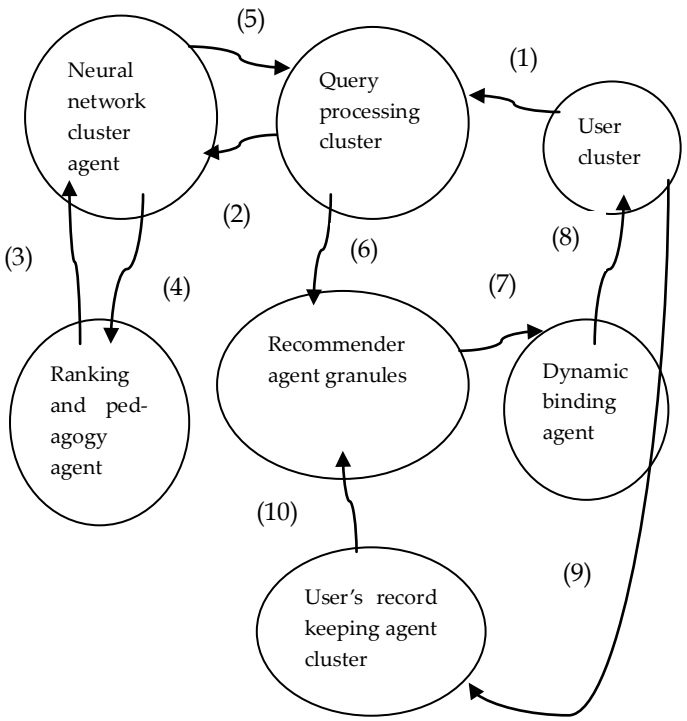

Figure 2: Granule based dynamic learning management system

The use of granular data of modeling the information helps to group the linguistic variables into a collection. The concept of Fuzzy helps in generating the numerous output responses. Figure 2 illustrates dynamic learning management system.
In order to make the model adaptive we use the concept of fuzzy rule based system using 'if-then' statements where fuzzy sets occur in their condition and conclusions i.e. :
" if condition1 is A and condition2 is B and….. and conditionn is W, then conclusion is Z" , where A,B,C…W,Z are fuzzy sets defined according to the particular domain.

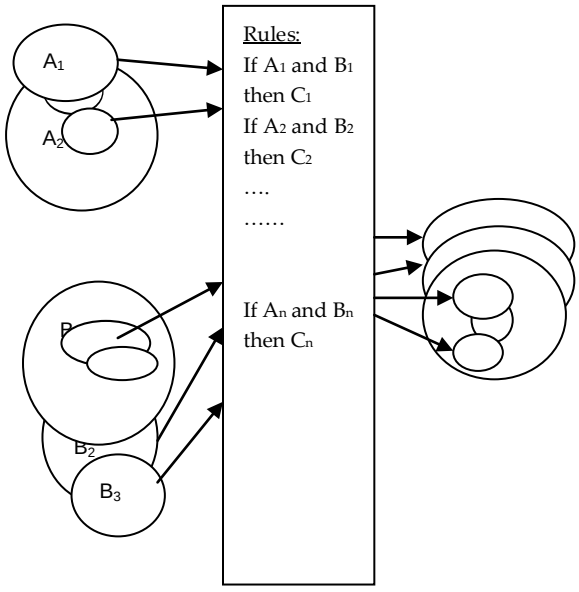

Figure 3:Rules formed at several levels of granularity of fuzzy sets.

Depending on the selection of course from the course granules (An) and pace setting granules (Bn) we generate a relationship between the two data sets .The final outcome generated is a set of granules which is according to the course selected by the students level. The process for generation of granules in real time mode is done by using fuzzy relational models and its associative training set(Figure 4).
The Delivery cum Association Generator Agent assumes that proper course mix assigned to the Real Time Granule Instance generator agent combines the User's level and the granular output assigned by the User's level.
To generate the granular structure of courses we use the concept of indiscarnibility relation with upper and lower bound relationships as:

$$B*(X) = \{x \in U : B(x) \subset X\}$$
$$B*(X) = \{x \in U : B(x) \cap X \neq \emptyset\}$$

- The lower approximation of a set x with respect to B is set of all objects which can be for certain classified as X using B.
- The upper approximation of set x with respect to B is the set of all objects which can be possibly classified as X using B.
- The boundary region of set x can be said to belong to neither X nor B.

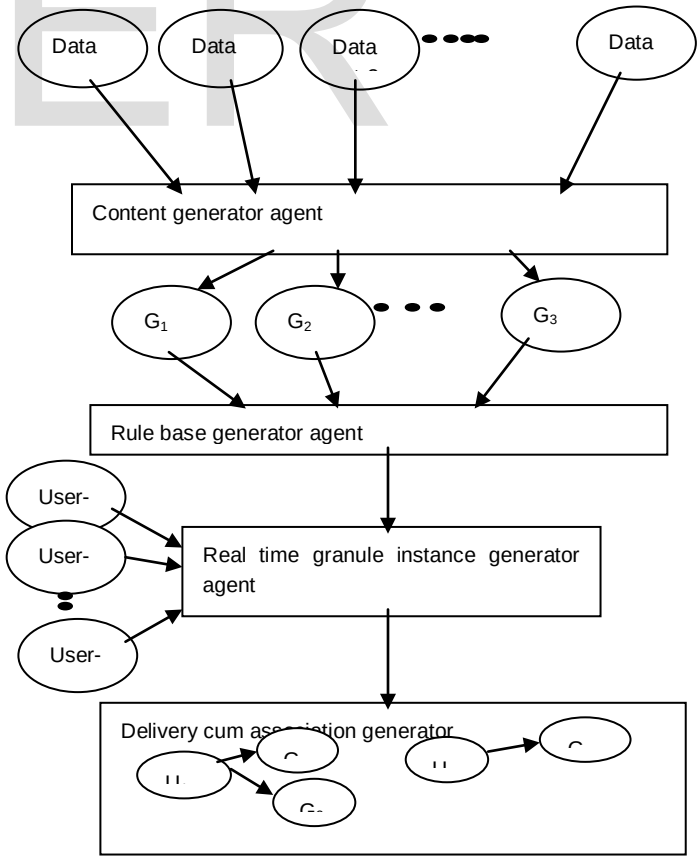

Figure 4:Granule Agent Architecture for e-learning

•Rough set theory deals with combination of several theories where the system has to generate decision from imperfect input source. Same situation arises with our case where the formation of granules depends on number of course content combinations. Such that higher level course content do not mix-up with lower –level course content.

Based on the above condition we develop a decision rule for the above situation as shown in table-1.

TABLE 1:LEARNING CLUSTER SEGMENTS

Learning cluster	Course level	Course Overlapping	Student satisfaction level	Student's numbers attempting content of granules
C1	medium	low	high	100
C2	low	medium	low	400
C3	high	high	high	300
C4	high	low	low	100
C5	high	low	low	50

This leads to the following interpretations:

Set {C1,C3} can be clubbed by a same segment as the satisfaction level is certainly high.

Set {C4,C5} can be clubbed by low student's satisfaction .

Set {C2} is categorized by low level of satisfaction with level of course overlapping is also medium.

Based on the rough set theory we have clusters C1-C5, every cluster agent has access to its own source of information and knowledge as well as sources shared by group.

The agent will use our Right Course Allocation and Pace Setting Algorithm to decide for the best optimum course mix based on each user's skill set, grade and requisites. It is illustrated in the following algorithm :

```
Active user Session
Matching of Learning Phase
Recommendation set s = (Course, Pre- requisites)
Prerequisites=(Ci , Pi)
Initial Learner Set i={Ci ,Skill_Setij , Gradeij}
Threshold  σ=0.5
Ontology w={Ci,Pi,Skill_Setij,Gradeij}
Ontology w={w1, w2,w3,w4,-------,wn}
For each user Si having Skill_Set w3
{
    if(w2= = w3 && w4>=0.5)
    {
        Assign_Course(w1);
    }
    else
    {
        if(w4  <0.5 && w2= =w3)
            then Request_for_Lower_Course ( );
        else if (w2 != w3)
            Select_New_Course ( );
    }
}
Learning Algorithm after Course Allocation
begin
    Session=Session_Id
    begin (1)
    t=0;
    Initialize_Course_Object (t);
    Evaluate_ Course_ Object (t);
    No_ of_ Modules_ in_ Course_ Object=n;
    while (n >=0) do
    begin (2)
        t=t+1;
        Select (New_ Course_ Module) from (Remaining_Course_Module);
        Evaluate (New_ Course_ Module);
    end (2);
    end (1);
end;
```

4 CONCLUSION

The multi-agent system using granulerisation approach for solving the recommendation problem is successful in reducing the recommendation overload while recommending relevant courses to users in real time. The system achieves high level of interactiveness and adaptability using dynamic binding of clusters to form granules which ensures right course delivery to the student/user based on his previous educational record, choices and helps in setting his learning pace.

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