Research on Personalization E-Learning System Based on Agent Technology
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Abstract- Adaptive e-learning system, deal with appropriate personalization and adaptation techniques in order to maximize the effectiveness of learning. Customer preference and personality are going to be more and more important to e-learning. This paper first hopes to explain the grid agent e-learning model, whose main actions including registry, directory and discovery. Through these actions, the manager’s agent will find out the suitable learning services. Secondly, to implement the adaptability of the Grid agent model, the method of Artificial Psychology and how to realize adaptive personalized e-learning by this method so that are the student’s agent can employ the learning material matched to their own personality type are also emphasized. The experiment data also supported our assumption that the learners may perform better if they use our adaptive grid agent model.

Key-Words: - Personalization System; Adaptive System; E-learning; Grid Agent; Artificial Psychology

1 Introduction

In the age of the new Information and communication technology, it should be possible to learn not only by a locally available electronic support, i.e. an interactive CD-ROM, but even “far away” from the teaching source. E-learning is an aspect of distant learning, where teaching materials are accessed through electronic media and where teachers and students can communicate electronically (email, chat rooms ...).

There are many e-learning or e-education tools/platforms, such as SMART EDU[1], JADE[2], etc. Usability is the vital role of e-learning and online game systems. But there are more works can be done[3]. Adaptive E-learning Systems, deal with appropriate personalization and adaptation techniques (smart curriculum sequencing, navigation guidance, intelligent problem generation and analysis of solutions, adaptable interfaces, adaptive contents, etc.) in order to maximize the effectiveness of learning. Adaptation system is the central component of any e-learning system and is responsible for tailoring learning materials or contents according to the learners' style, profile, interest, previous knowledge level, goal, pedagogical method etc to provide highly personalized learning sessions. Customer preference and satisfaction are going to be more and more important to both e-learning and online game. Computer Science, together with Psychology and Education, has been trying to refine teaching computational tools towards individual-centered or personalized self-learning[2][3][4][5]. Every day, new approaches to the use of computer and education are bringing new perspectives to this area. The evolution of computer and education became computational teaching environments an excellent choice for distance learning, by bringing new vigor to this field of science.

E-learning projects must take into consideration that there are different classes of users. A simple result can be[6]: the non-cooperative, those who act in a passive way or even try to frustrate the program’s objective; the cooperative, who follow orientations, but do not necessarily know where to go; and the pro-active students, who know very well their objective, and search for aid to relief the task burden. Obviously this method is too cursory, especially to arts e-learning and online games. Study about cognitive expansion of queries aims at the implementation of a knowledge-based query builder that allows complex query building in tight cooperation with the user. Due to the cognitive knowledge involved, these complex queries are expected to return more relevant results than traditional database queries or classifications[6][7]. Besides advanced techniques in personalization (preference modeling, etc.) research issues will have to focus on results from sociology and psychology to include implicit knowledge about human behavior and social expectations in the retrieval process.

The learner uses learning resources for the achievement of his educational goal. The e-learning environment can be considered as a virtual organization that supplies the learning resources. Its
objective is to ensure a flexible, coordinated resource sharing among dynamic collection of learners and cooperative use of resources. Since the reusability, resource sharing and virtual organization are characteristics of a grid organization, the conceptual computer system (e-learning environment) can have grid architecture [8]. The learning resources are presented as learning objects, since the grid organization bases on a homogeneous e-learning environment. The interface between the user and the conceptual computer system ensures the learner’s access to the grid services, which implement a usage of available learning resources.

The teaching methodology employed in each case is different and there must have a clear concern by the technological environment on the profile of the user that will use the system. In order to reach this goal, cognitive student’s modeling is required, and it must make a clear specification of him or hers, including his or her psychology.

This paper presents a grid agent model based on artificial psychology to realize personalized e-learning. One main purpose of Artificial Psychology technologies is to imitate human psychology with computer, meanwhile, to provide some subjective evaluations for the objective things. This kind of research in e-learning is still at the beginning.

In this article, we first hope to explain in section 2 which model can resolve such kind of problems that we mentioned before, including three kinds of agents: student’s agent, manager’s agent and teacher’s manager. Then to implement the adaptively of the Grid agent, in section 3, we describe how the grid agent is able to seek for the knowledge services according to the student’s characteristics automatically and precisely. In section 4, the experiment data also supported our assumption that the learners may perform better if they can employ the learning material matched to their own personality type in the learning process. The conclusions are stated in Section 5.

2 The architecture for personalized grid agent e-learning model

Our project proposes a development and implementation of Distribute Intelligent Learning Environments, based on the approach of grid agent architecture towards Distance Education, for multiple domains.

Our architecture encompasses a grid agent environment composed of three kinds of agents responsible for the system general control (student’s agent), and a communication manager (manager’s agent) and knowledge service (teacher’s agent), where each agent may have its tasks specified according to its goal. A grid agent is any agent in the grid space. Each grid agent acts independently with other automatically find out each other on the grid and form one or many units called Grid unit which is similar to classroom. Grid member will self-organize into grid unit. Any grid agent will register with grid space manager to publish the service description of him and it can join or leave the grid unit at any time. A grid member provides services that can be used by other grid members. A grid agent can contain behavior rules, and interacts with other grid agents using specialized communication language. Every grid unit has just one communication manager (see fig 1.).

All actions of student’s data accessing are taken by the Student’s agent, thus when a teacher agent is required to update the student’s historic, this agent sends to the Student agent data to be updated, as well as any other change in the student’s state of teaching. The tasks performed in teaching are decomposed and performed individually or in groups of agents. How the task will be decomposed is defined by the content of messages exchanged between agents. In our work, we aim at generates an educational course in accordance with understanding of a student. The teacher agent dispensable and the student model agent cares more about the experimental knowledge than traditional tools [9], and one additional work of the communication agent is cognitive query.

The knowledge base plays an important role in personalized e-learning systems. User psychology, a kind of implicit knowledge, is quantified in our work and a new adaptive model involving artificial psychology is presented in chapter 3. It communicates by exchanging information about the knowledge base of the whole system.
There are many services provided by the adaptive grid agent e-learning model, the main services are:
Agent registration service: it provides a mechanism to register services of various resources, including student, teacher and knowledge.
Agent directory service: it is used to publish the attributes of all grid agent services registered in the grid.
Agent discovery service: grid agent members to search for resources use the agent discovery service. The aim of the agent discovery service is to find out the best service even if the seekers just specify little parameters of interest. The discovery services first look up the directory service for a set of services that satisfy the requestor’s need, then filters the set of services according to the criteria in the request.
An enquiry to a manager’s agent will not only find the knowledge that the service request agent need but also the data processing techniques and the computing power to carry them out before sending to the service request agent the results.

The main actions involved in grid agent service discovery process are registry, directory and discovery. When any grid agent wants to enter in the grid unit, it must register its presence by publishing its services descriptions with the grid space manager. First, the service request agent (student’s agent) needs a certain mount of descriptions to specify the services. And so, when any student’s agent wants to search for learning service, it just needs to send asking signal with the request services descriptions to the manager and the manager will find out services by its descriptions, various grid service agents can be located. If the service request agent decides to access the service then it requires a set of information to ensure successful operation of the service.

3 The process of adaptive service
To implement the adaptively of the grid agent, every grid agent should remember the evaluation of the former cases made by user, and analysis the evaluation to gain experience. Every grid agent has a repository to record the evaluation of former cases. The grid agent use Artificial Psychology (AP) to analysis the preference of user. We will illustrate this process in details as following. First, the grid agent collects the adjectives used by user to describe his or her requirements of the service, such as “advanced-primary”, “hard-easy”. However, not all the adjectives pairs are necessary; some adjective pairs have close correlation. So the representative pairs should be abstracted by factor analysis. The repository will record the numeric evaluation value of every case corresponding to the adjective pair. Second, the user should fill a questionnaire to describe the service that he needs. At last, the grid agent will select the appropriate service according with the user’s preference.
For example, a learner want to learn a computer course in the internet, firstly, there is a user preference value correspondence with the adjacent pair, and we call them average of the inquired samples, such as table 1. We can get the value like this, for instance, for advanced-primary, 0.1 represent lowest grade, 0.5 represent medium grade, 0.9 represent highest grade. Then we select red, green, blue, lightness, cold or warm as the items.

<table>
<thead>
<tr>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>hard-easy</td>
<td>0.1</td>
<td>0.7</td>
<td>0.3</td>
</tr>
<tr>
<td>advanced-primary</td>
<td>0.3</td>
<td>0.5</td>
<td>0.8</td>
</tr>
<tr>
<td>basal-professional</td>
<td>0.5</td>
<td>0.6</td>
<td>0.8</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Table 1 Average Table

<table>
<thead>
<tr>
<th>Sample</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Sample 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>red</td>
<td>55</td>
<td>108</td>
<td>234</td>
<td>199</td>
</tr>
<tr>
<td>green</td>
<td>123</td>
<td>111</td>
<td>67</td>
<td>9</td>
</tr>
<tr>
<td>blue</td>
<td>233</td>
<td>122</td>
<td>101</td>
<td>200</td>
</tr>
<tr>
<td>lightness</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>70</td>
</tr>
<tr>
<td>cold or warm</td>
<td>30</td>
<td>70</td>
<td>50</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 2 Numerical Representation
measure the colour value (0-255) by PHOTOSHOP; the value of lightness and the value (0-100) of cold or warm are obtained by the questionnaire. The result is given by table 2:

The corresponding reactor matrix:

\[
X = \begin{bmatrix}
55 & 123 & 233 & 20 & 30 \\
108 & 111 & 122 & 30 & 70 \\
234 & 67 & 101 & 40 & 50 \\
199 & 9 & 200 & 70 & 30 \\
23 & 100 & 255 & 10 & 10
\end{bmatrix}
\] (1)

With the help of Quantification Theory 1, each case can be written in the form of reactor matrix. According to the formula of Quantification Theory 1:

\[
b = (X'X)^{-1}X'Y
\] (2)

We obtain the quantification relationship of the adjective pairs and the case, with \( Y \) is a column vector and its value is the average of the previously evaluation corresponding to an adjective pair, like table 2. \( X \) is the reactor matrix. All values of \( b \) correspond with the adjective pairs are obtained. By replacing \( b \) with its expression, we can calculate the evaluation \( Y \) of case with the help of the predictive formula:

\[
\hat{Y} = Xb
\] (3)

The evaluations are stored in the grid agent’s repository. When a service request agent begins its requesting, it will depend on its repository to decide its next behaviour, we understand easily why it is more and more accurate over time. The consequence is an improving self-organization process between all grid agents in the grid space.

A new grid agent does not have enough cases in its repository, but it can use the existing ones that have already been evaluated by the other grid members, it can use the knowledge transitorily, and then adjust the knowledge in its repository. When a service request agent asks for service, the preference will go along with the service request description, so that the service request agent can implement the adaptively of the grid agent in information retrieval.

4 The experiment

An experiment was conducted to examine the relationship between learner’s personality type and their preferred learning content structure. 30 participants took part in this experiment. They were all homogeneous in terms of their previous learning outcomes in other courses. Firstly, all the participants underwent the MBTI test\(^{[11]} \) to identify their personality types, revealing 9 were non-cooperative, 13 were cooperative and 8 were pro-active. All the participants were undergraduate students (aged 18-25), who had enrolled in the Computer Science course. Whilst the validity of MBTI is still under the criticism from the psychometrics community, we simply choose this test as it has been widely used and extensively validated in the education domain. Table 3 and table 4 summarize the task performance of traditional e-learning model and our model respectively. Comparing the performance between the non-cooperative, the cooperative and the pro-active learners in traditional model, it seems that the pro-active learners read all the contents very quickly and they get best grades. The cooperative spend more read time than pro-active and few time than non-cooperative, but It probably led to a fewer number of correct answers. In contrast, the non-cooperative learners spent considerably more time on reading materials, so it would result in more correct answers than the cooperative learner.

<table>
<thead>
<tr>
<th>Personality type</th>
<th>Reading time (Mins)</th>
<th>Number of Correct answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pro-active</td>
<td>6.5</td>
<td>15.01</td>
</tr>
<tr>
<td>cooperative</td>
<td>8.9</td>
<td>12.55</td>
</tr>
<tr>
<td>Non-cooperative</td>
<td>11.34</td>
<td>13.09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Personality type</th>
<th>Reading time (Mins)</th>
<th>Number of Correct answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pro-active</td>
<td>5.9</td>
<td>16.72</td>
</tr>
<tr>
<td>cooperative</td>
<td>8.1</td>
<td>14.41</td>
</tr>
<tr>
<td>Non-cooperative</td>
<td>10.09</td>
<td>13.32</td>
</tr>
</tbody>
</table>

We also analyzed the performance of our model in the same way as shown in Table 4. In this case, it appeared that the pro-active outperformed the cooperative and the cooperative outperformed the non-cooperative. This implies that when the pro-active and cooperative learners were being taught by our model, which seems to match with their personality type, they tend to adopt a holistic approach to the learning process. These results also supported our assumption that the learners may perform better if they can employ the learning material matched to their own personality type in the learning process.
5 Conclusion
E-Learning is meant for learner communities, which may vary significantly in terms of accessibility, hardware and technical proficiency. Hence, Instructors must design the courses keeping in mind the learners' technical limitations so that they may use e-learning tools effectively.

Adaptation system is the central component of any e-learning system and is responsible for tailoring learning materials or contents according to the learners' style, profile, interest, previous knowledge level, goal, pedagogical method etc to provide highly personalized learning sessions.

In this paper, advanced adaptive personalized approach using grid agent and artificial psychology techniques is investigated. In the process of the model construction, we synthesize grid agent techniques and AP mathematics theories, and integrate them to form the Architecture for personalized e-learning System. From the two empirical analyses, we have identified that our adaptive e-learning model which matching learner’s personality with the learning material designs outperforms than traditional model.

References: