A Personalized Agents Platform Design and Implementation for Personalized Education

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Abstract: Personalized Education (PE) addresses the opportunities and necessities of integrating a diverse range of technologies to support individualized learning. This paper introduces a multi-agents architecture, based on the Smart Platform [1] and the detailed agent design for a PE System (PES). Specifically, to deliver personalized education services, PES consists of seven personalized education agents (PEAs) that coordinate with each other to provide a range of supportive functions that include personalized content search, static and dynamic user modeling, learning plan generation, as well as recommendations and communication services. A prototype of PES has been implemented using a combination of JAVA and .NET technologies and experimental results show that the proposed framework of personalized agents are able to deliver the required services in a flexible and efficient manner in terms of functionality, scalability, load-balancing and robustness.

Keywords: Personalized Education, Multi-Agents, Web-based Learning

Introduction

With increasingly easy access to advanced software and hardware technologies at a reducing costs, it is possible for us to reap the potential benefits and integrate a diverse range of technologies to enhance our education and learning experience – to learn whatever, wherever and whenever we need to learn and in our preferred ways. Our proposed Personalized Education System (PES) framework [2] applied technologies that were originally motivated by the commercial needs to capture and retain customers’ loyalty in e-commerce. The core technologies that enable PE include personalized content search and recommendation, dynamic user profiling and modeling, ontology-based study plan generation and content annotations. In [3], we have introduced and evaluated the rationale and the feasibility of applying personalization technologies in education; the potential impacts of PE to education and its relations with teaching and learning; and a conceptual and functional model of a Personalized Education System (PES).

Briefly, as a web-based environment for supporting individual learning – The Personalized Education System (PES) assists in collecting, filtering, organizing and sharing educational resources. It also provides a platform to examine the relationship between educators, learners and the technologies; and to investigate whether
personalization can alleviate the problem of match or lead to the development of new and special pedagogies. Through PES and the associated technologies, we can deliver traditional instruction with dynamic and immediate feedback, foster learning through person-to-person communication and collaborative work, and provide learners with a vast library of textual, visual, and auditory materials for self-directed or individual learning activities.

In this paper, we focus on the system design and development of PES that aims to encourage knowledge sharing and content re-use, personalized information delivery, more importantly, to build a natural learning environment that provides multiple learning experiences. Section 1 introduces a multi-agents approach in PES. In Section 2, we present the seven core agents and their functionalities in PES. Section 3 describes an implementation of the agent-based PES. We conclude with a short summary of our work.

1. A Personalized Agent-Based Approach in PES

Previous research towards personalized education has been focused on the issue of “Adaptivity” – the authoring and delivering of hypermedia content that are adaptive to the learners’ learning goals [4] while others contributed towards user modeling [5]. Here, we use the term ‘Personalized Education’ to distinguish our focus on school-based education. We pay particular attention to the design and development of a system architecture that provides the communication infrastructure for the various personalized support services and functions in a Personalized Education System (PES).

1.1 PES Architecture

From the PE perspective, the five main features of personalization support are personalized interface, intelligence search, personal planner, recommendations, and personal communities. The PES architecture is illustrated in Figure 1.

![Figure 1: The PES Architecture](image)

PES has been designed to influence the FIVE most important learner behaviors on web-based learning: (i) Recognizing relevant resources when information is needed, (ii) selecting appropriate sources from the daily increasing unpredictable amount of available hypermedia resources, (iii) evaluating the accuracy and pertinence of the retrieved information/resources, (iv) organizing the information to form reasonable/logical/rational facts for decision making and reasoning, and (v) creating knowledge through scaffolding – associating new information with previous knowledge and experiences, and construct personal knowledge himself. Its value in education, in turn, can be measured by the following key operating metrics: (i) The participation rate and material usage rates; (ii) identification of learning patterns; (iii) identification of instructional design patterns (i.e. content design); (iv) identification of learner communities (i.e. peer groups); and (v) conversion rate and abandonment rate. Based on these observable measures, we can evaluate and examine the effectiveness and usefulness of the PES in a quantitative manner.
2. The Personalized Education Agents (PEAs)

As shown in Figure 1, the work is distributed among SEVEN core agents: Delivery Agent, Planning Agent, Searching Agent, Filtering Agent, Procedural/Principles Agent, Profile Agent and Content Agent. The criterion of splitting the task into several agents are: (i) The tasks costing a great amount of CPU and memory resources are divided among several agents, e.g. Filtering Agent, Planning Agent; (ii) The common information needed by several agents is maintained and updated by an agent, e.g. Profile Agent; (iii) Tasks tightly related to users and those have strict requirement on real time or interactive responses are accomplished by the web server (Delivery Agent). Examples of such tasks are: dispatch messages, monitor the study process of the learners, and users’ on-line communications with each other; and (iv) If the cost of adding a new agent out-weights the benefits, it will not be done. The communication or message paths for the seven PEAs in PES are illustrated in Figure 2.

![Figure 2: The message paths between the PEAs in PES](image)

Specifically, Delivery Agent acts as a web server and provides personalized interface, dispatches messages between the users and other agents, monitors the study process of the learners (users’ situation such as click count, time spent on the materials will be captured for the Profile Agent to form the user profile), provides real time communication platform and accepts teachers’ uploading lesson plans and study materials. Planning Agent helps users (teachers and students) to make a personalized plan. Searching Agent provides personalized or customized search services, and periodically searches for useful materials on the web. Based on the user profiles, the Filtering Agent filters the search results using four types of filtering technologies, namely collaborative filtering, content-based filtering, demographic filtering and collaborative via content filtering. The filtering results will be sent to the users via the Delivery Agent. Principles Agent provides the learning related pedagogical rules for the Planning Agent to construct a study plan. Profile Agent stores and provides users’ profiles to other agents so that personalization could be achieved. Content Agent records local learning objects’ metadata as LOM and dynamically updates them.

3. Implementation of PES

Among the Multi-Agents System (MAS) platforms, the Smart Platform [1] is a software infrastructure for Smart Space. Due to its loosely coupled infrastructure, good support for hybrid network communication, and light weight characteristic, we adopt it as the infrastructure of the implementation of PES in which the seven personalized agents (PEAs) run in parallel. The run-time system of the Smart Platform is illustrated in Figure 3. Each participating computer that makes up the Smart Platform hosts a container
component, which provides a local runtime environment for agents reside on that host. Globally, a DS (Directory Service) component is responsible for agent registration, message dispatch and system management [6]. The agents in Smart Platform communicate with each other via publishing messages to some message groups and processing the received messages in callback methods.

![Figure 3: Run time structure of the Smart Platform](image)

The Delivery Agent in PES, plays not only the role of web server but it also delivers user’s requests to the other agents to work on as well as delivers the results to the user. The other agents, either provide service to accomplish specific tasks or provide the information needed by other agents, serves to distribute the load of the web server among themselves. The runtime structure of PES is shown in Figure 4.

![Figure 4: Runtime structure of PES](image)

4. Conclusion

In this paper we have presented the functional model of a Personalized Education System (PES) and give a specific agent-based design of PES and implemented it on the Smart Platform which is a typical MAS system. We have defined the functional roles and the message paths for the seven core Personalized Education Agents (PEAs) used in PES. These agents run in parallel and collaborate with each other to provide the personalized study plan, search, recommendation and communication services and achieve the system overall goal—Personalized Education.

References