Business goal oriented approach for Adaptive Learning System

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Abstract
Several adaptive learning systems are currently available. Nevertheless, most existing e-learning platforms lack efficient alignment to decision makers. Our approach is two-fold. Firstly, we aim to integrate business goals in the selection process of learning concepts. Secondly, we make use of Case Based Reasoning (CBR) approach to learn from past experiences and construct effective adaptive system.
Keywords: *adaptive learning systems, business goal, CBR.*

1. Introduction

Web development in recent years has resulted in a number of increasingly important users of web applications. The characteristics of these users, their preferences and objectives are often distinct and variable over time. It is in this context that adaptive Web based systems are born. E-learning is the most concerned field by such systems [1] [2] [3] [4]. It revolves around a central objective is that learning process should be adapted to learner profiles in order to promote knowledge construction. The field of Adaptive Learning Systems (ALS) is the meeting point of these two areas: the adaptive hypermedia and the e-learning.

Several stakeholders with different perspectives on ALS services are decisive in making such project succeed. In our study, we looked more closely at the problem of developing adaptive learning systems that deal with business goals.

The principle of "one size fits all" is generally the basis of traditional learning materials [5]. The same course is addressed to a number of heterogeneous learners. Now adaptivity aims to provide personalized learning that is intrinsically linked to learner profiles. These systems can be used in the context of digital campus university, distance learning courses for enterprises employees or individual initiative simply. The goals of this training are quite different, ranging from the simple acquisition of knowledge, to the obtention of qualification or certification. Satisfy both decision makers expectations who are responsible for initiating the training and learners who actually follow this training is essential to ensure the success of these systems. Learning materials provided to learners often are not aligned with either individual skills or organizational objectives [6]. One factor that prevents the integration of adaptive learning system in the business world is the non-alignment of these systems with the customers business objectives.

During the nineties adaptive hypermedia systems for e-learning have attracted growing interest at the individual, organizational and social scale's. A decade later, a lot of frustration and dissatisfaction have been reported. Multiple failures in the field have been identified in recent years [7]. In 2006, for example, the initiative of prestigious universities as Stanford University, the University of Oxford, Yale University and Princeton University failed, and the project Alliance for Lifelong Learning, established in 2000, was officially closed in March 2006. This high failure rate, dropout before the end of the course and the low return on investment, are all symptoms reflecting the immaturity of these pedagogical devices.

The paper introduces a new approach that consider business goals in adaptive selection process of learning concept. In the following section we will

introduce adaptive hypermedia reference model.

2. Adaptive hypermedia reference model

The field of adaptive hypermedia systems can be seen as the most representative type of adaptive systems. Several reference models have been developed in this area. As it is described in the Munich Reference Model [8] (figure 1), adaptive hypermedia system is based on a three explicit models: the domain model, the user model and the adaptation model. The user model separates the attributes into two categories depending on whether they depend on the domain (knowledge, learning outcomes, etc.) or not (preferences, career, etc.). The domain model represents concrete elements of the domain. The adaptation model is based on the rules of type condition / action. The conditions that trigger rules are events perceived by the system such as an action performed by the user. Actions include updating the information stored in the user model and selecting appropriate documents that will be presented to the user.

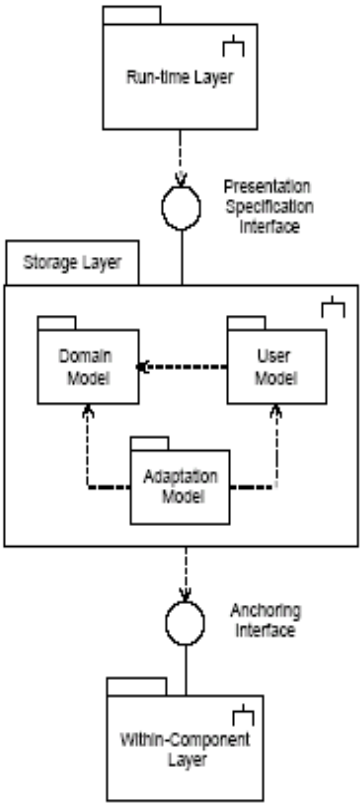

Fig. 1 Adaptive hypermedia model [8]

"Run-Time" layer describes the mechanisms supporting the user interaction with the system. A set of functions are included to ensure the presentation of pages, constructed by a set of adaptation rules and using the concepts in the domain model. These pages are adapted according to the individual user model. "Within-Component" layer describes the concrete implementation of the content and structure in hypertext nodes. This layer was introduced to isolate the other layers details of specification data and media.

3. Business goal oriented approach

Our solution is two-fold. First, we aim to deal with business goals during the adaptation process. Secondly, we adopt Case Based Reasoning (CBR) approach to capitalize from past experiences in order to construct effective adaptive system.

3.1 Business goals

The business side in adaptive learning process is essentially companies which undertake distance learning for their employees in order to achieve strategic goals. The Business Motivation Model (BMM) is an OMG standard [9] which models means, ends, action plans and factors that influence a business process. We are interested in our work in the part called "End" of the meta-model (see figure 2). The end may be either a vision or desired result. Vision is an overall image of what the organization wants to be or become. Desired Results are Goals and Objectives target that the enterprise intends to maintain or sustain. Business actors in a system of e-learning are, on the one hand, policy makers which initiate the formation, on the other hand, employees which are the end users of the system. Compared to an objective, a goal tends to be a longer term, more qualitative than quantitative and general rather than specific. The goal is usually a business strategy, expressed by policy makers. Compared to a goal, an objective tends to be short-term, quantitative rather than qualitative and specific rather than general. It is the way to achieve the goal so it is done by the learners. An objective must be measurable and completed within a predetermined time space.

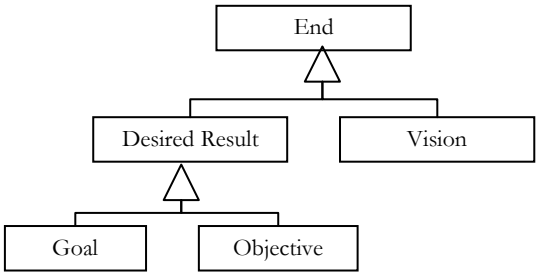

Fig. 2 Business meta-model [9]

Meeting the client's goals is an essential criterion for the sustainability of developed systems. In many cases, e-learning market has failed to meet the expectations of customers. Therefore, measuring the extent to which

adaptive learning systems are suitable is crucial. We propose to construct "Goal Alignment Degree" (GAD) measure. For that reason we consider the meta-models associated with the two concepts "Achieved Business Goal" and "Desired Business Goal" in order to identify quantifiable elements.

GAD measure is the ratio of achieved performance for one targeted knowledge level related to the organization learners (Ach_Goal), compared to the rate of desired success for this targeted knowledge level (Desired_Goal_Rate). This is expressed by the following formula:

$$GAD = \frac{Ach\_Goal}{Desired\_Goal\_Rate} \quad (1)$$

Meta-model based approach is adopted in order to identify quantifiable elements used for "Achieved Business Goal" and "Desired Business Goal" description.

3.1.1 Desired Business Goal

In an e-learning system, policy makers' goals are mainly related to learner outcomes. As shown in figure 3, the desired business goal is described by a desired achievement which is characterized by quantifiable elements that are success rate and targeted knowledge level throughout a learning session. Learning objective can be certification or a qualification. As it can be an informational learning that basically aims to improve learner's knowledge. In both cases it is a knowledge acquisition related to one or more learning concepts.

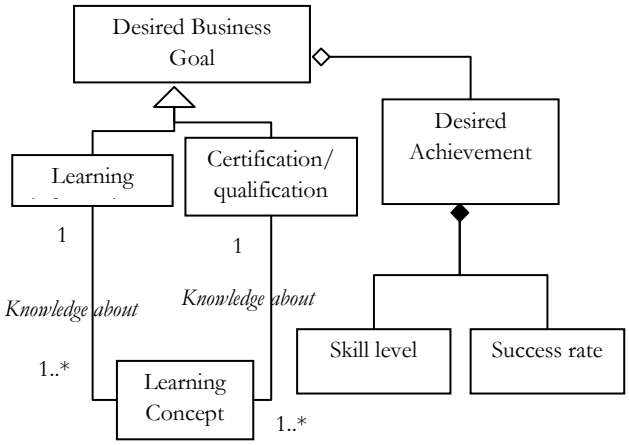

Fig. 3 Desired business goal concept

3.1.2 Achieved business goal

A learning goal is actually realized through a set of objectives that must be achieved during a learning scenario. The latter describes the learning unit that can be of variable granularity [10]:

- A basic activity is the finest granularity of a learning situation. An elementary activity can pursue a specific learning objective or contribute to it when integrated within a structured sequence; Example: Call web page, post a contribution to a forum or a problem solving through a simulation.

- Activities sequence corresponds to an average size of a learning situation in which several basic activities or sequences are organized to achieve a specific learning in terms of knowledge or skills. This structure must be able to express the relationship of sequence and parallelism, to describe the sequence and conditions or to specify the flow data process associated, Example: "classical" Sequence <Following a presentation, do application exercises, self evaluate>.

- Pedagogical unit is the highest granularity of learning situation in which a set of learning sequences are assembled to form a logical unit on a given learning theme. Example: A course, a module, a license, a master, etc.

Achieved goal is described in terms of accomplished success state regarding to decision makers targeted level. These elements are described by the meta-model in Figure 4:

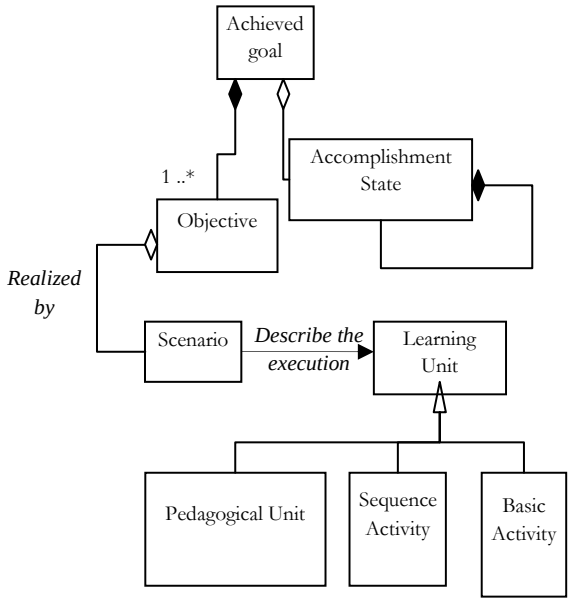

Fig. 4 Achieved goal meta-model

To assess the accomplishment state for a given goal we propose to apply propagation rules that describe the state reached by the goal in terms of its objectives accomplishment. Rules are described in first-order logic and the following predicates are used:

State_Obj(Obj, E) : shows the status E of an objective Obj for the whole learners' session. Two states are possible: "realized" or "unrealized".

Participate(Goal, Obj) : illustrates that an objective Obj contribute to the achievement of Goal.

State_Goal(Goal, Ui): returns the accomplishment value of a goal for a user Ui.

State_Acc_Obj(Obj, Ui) : returns objective achievement state related to a user Ui.

The propagation rule is triggered when the objective reaches the state "realized". The term "Cont_Obj" indicates the objective contribution proportion to achieve goal. This rule is used to assess a goal achievement state.

∀ Ui ∀ Obj
State_Obj(Obj, realized) =>
(∀ Goal Participate(Goal, Obj) =>
(State_Goal (Goal, Ui) = (State_Goal(Goal, Ui) + Cont_Obj * State_Acc_Obj(Obj, Ui)))

The goal achievement state (Ach_Goal) is the success rate realized by all learners involved in the training session and this regarding to knowledge level required by the decision maker. The goal of the decision maker is not bound to a single learner, but to all learners.

Assessment of business goal achievement provides feedback about ALS alignment with business needs and then adaptive behavior should be triggered accordingly. Case Based Reasoning (CBR) can be adopted to enhance the adaptation performance and learn from past experiences.

3.2 Adaptive behavior based on CBR approach

CBR is based on knowledge reuse and past experience capitalization to solve problems. As described in [11], a new problem is solved by finding a similar past case, and reusing it in the new problem situation. Past experiences are stored in a Case Base. One case is composed by both problem situation and past experienced solution. A new solution is obtained by comparison between new situations and past cases. In the following section, we describe a learning situation in an adaptive learning system context.

Measures characterize the learning situation. One situation is related to one session launched by a learner. It is described first by user model state which reflects the learner knowledge about concepts of the application domain and the Goal Alignment Degree (GAD).

Adaptive learning system presents functionalities fitting user needs. Each function corresponds to a set of orchestrated Web Services. Figure 5 illustrates UML class diagram describing adaptive learning situation.

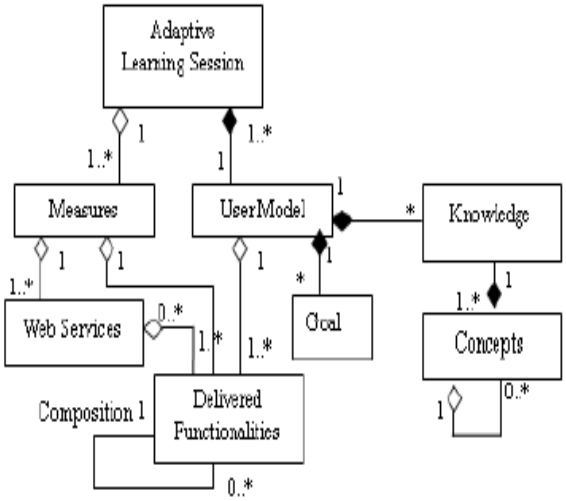

Fig. 5 Adaptive Learning Situation

Different learning scenarios are possible. Measurement criteria characterize each specific situation and reflect the validity of delivered functionalities adaptation. Solutions to resolve possible failures are proposed. Adjustments results are stored as a new case in the CBR system.

In the context of our research, we have implemented an automated case creation tool. Information from the current state of the user model, the delivered functionalities and related Web services are stored automatically in the Case Base.

This CBR project aims to develop a system that is able to create cases using a mostly automated process, and to develop a Java-based case-based reasoning engine that can be integrated to any adaptive Web-based educational system. The cases capture the adaptation performance expertise of learning system and best adjustment practices that can be reused in similar situation.

4. Conclusion

This paper has introduced a business goal centered-approach for adaptive learning system. The objective is to align the system to the decision makers needs. We propose to reinforce the adaptation process by adopting Case-Based Reasoning. Adaptive learning situations are stored in the Case Base. Measures related to delivered adaptive functionalities and to business goal alignment characterize each situation. CBR allows learning from past experiences and enhances adaptation decision making. Currently, we are studying

the integration of automated and real-time case creation in adaptive e-learning environment.

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