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Adaptation based on machine learning, user modelling and planning for complex user-oriented tasks: ADAPTAPlan (TIN2005-08945-C06-00)

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Abstract

This project has two main objectives. On the one hand, to analyze the capability of automatically solving tasks that need the integration of planning, machine learning and interaction with different agents (human or software) to ubiquitously and dynamically adapt to the evolving needs of the context. Thus, we have defined a set of scientific goals related to user modelling, machine learning, planning, multi-agent systems, and ubiquitous computing. On the other hand, we would like to benefit from either experiences of the project researchers, both as users and developers, in a specific application domain: university education. Here, tools that integrate aforementioned techniques are strongly needed. This applied objective consists in the design and development of an architecture that provides services to both students and lecturers in the new education tasks that are defined by the European Space for Higher Education. To date, nearly approaching the project midterm, and according to the scheduled work programme, requirement analysis (P1) and architecture design (P2) work packages have been successfully completed. Furthermore, ongoing progress on ontologies, user model and adaptation (P3), task planning and learning (P4), and application development (P5) has already produced significant advances on major project challenges, which can be traced through published papers on national and international workshops, conferences and journals.
Keywords: planning, user modelling, machine learning, multi-agent systems, educational technology standards, learning management systems, and ubiquitous computing

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1 Project goals

In ADAPTAPlan we assume as a starting hypothesis that there are applications domains which share common features (such as workflow management, space missions, or the full life cycle of learning/teaching tasks) and pose open issues from the scientific and technological viewpoints. In particular, the problems to be solved in these domains require the integration of temporal planning, machine learning, and interaction with several agents (human / software), modelling tasks for diverse items (e.g., users, tasks …) and ubiquitous computing supported by different types of devices.

From the scientific viewpoint it is necessary to solve problems such as: (*i*) collaborative, dynamic and automatic user modelling, which are integrated with collaboration and application models, (*ii*) developing analysis measures focus on recommending tasks, (*iii*) monitoring and automatic updating of modelling techniques, (*iv*) planning under domain uncertainty, (*v*) representing planning knowledge in terms of ontologies, (*vi*) machine learning in planning with plan quality measures, (*vii*) selecting plan monitoring techniques and replanning, as well as (*viii*) studying, within ubiquitous computing scenarios, relative improvements on effectiveness and efficiency in the task at hand depending on the device.

Moreover, to investigate the aforementioned hypothesis the project applied objective consists in the design and development of an architecture that provides services to both students and lecturers in the new education tasks that are defined by the so called European Higher Education Area (EHEA). In this new framework it is expected that eventually, for instance, a particular student, without having to wait for tutors' feedback, will be able to go through a personalised learning path full of learning activities that will be readily adjusted to cope with the current learner situation. Furthermore, students will receive automatic feedback when reaching un-predicted learning impasses that could come up while going forward in a specific learning path. Faculty staff as well will have to update their current tasks to face the authoring of learning activities that will be eventually performed by many different learners in various settings. Accordingly, to support the authoring process, qualitative and quantitative reports will be provided to authors, highlighting on predefined assessment features. These reports will include, for instance, what type of students have had problems while coping with a particular learning task, or the percentage of learners' goals that have been successfully achieved in a specific learning situation, in a course, or even in a study programme. Thus authors will be provided with relevant information to improve the course design.

The main objectives of the project can be grouped into the following four development areas:

1. **User Modelling**. Different methods will be considered for developing and managing user models in a semi-automatic way. In particular, the work focuses on building stereotypes, user models, group models and user roles; machine learning based modelling combined with predefined standard-based modelling; interaction mechanisms between the user model and planning processes; mixed-initiative planning; dynamic update of models based on the executed plans record; and interactive access to models and related scrutability issues.

2. **Task planning**. A wide range of open planning problems will be addressed – from knowledge engineering issues such as automatic acquisition of planning domains

(including hierarchical models) and their validation; to acquiring knowledge on planner inputs uncertainty, and defining and extracting heuristics in planning (manual or automatic); to adjusting and developing plan monitoring techniques for detecting internal failures and contingencies, and state monitoring by means of replanning and applying probabilistic methods; to solving execution problems.

3. **Multi-agent systems**. Issues to be covered include defining heterogeneous agents with dynamic knowledge update and managing their coordination; interacting with different types of agents such as helpers, recommenders, interface, cognitive and reactive agents; dynamic updating of every agent to adapt to changing conditions in the domain and in the behaviour of other agents as well.

4. **Educational adaptive systems**. A general architecture that draws on the entire life cycle of e-learning (i.e., design, publication, use and monitoring) and combine every scientific result will be developed. The running system will provide personalised learning support for each user and user group, planning of activities to support students' learning, plan execution monitoring, extraction of heuristics to speed up the planning process, and adaptation support throughout the entire life cycle. This framework will be developed with a pervasive use of technological and educational standards to increase flexibility and sustainability of developments.

To achieve the aforementioned objectives the project management approach is supported by the ADAPTAPlan collaborative framework, which was set up by UNED, and consists in a collaborative space on top of the dotLRN[1] platform. The workgroup layout of that space resembles the structure of the project itself (i.e., subgroups per work package, common areas with forums for transversal issues such as meetings and technical support, documents area with general folders per work package and specific folders for each task, calendar per group and subgroups to support the synchronisation of tasks, etc.). Furthermore, all the objects (messages, forums, documents, events) have notifications incorporated so that all the work in ADAPTAPlan can be traced though the collaborative framework and can be supervised by email, a very important feature in a distributed environment.

The project work plan, which is to be carried out in the 36 months of the project, has been organised around 5 work packages: Analysis (WP1); Architecture design (2); Ontologies, user modelling and adaptation (WP3); Tasks planning (WP4) and Application development (WP5). The relation among project phases, work packages, including their breakdown in subtasks is depicted in the project chronogram (Fig. 1) and in the succeeding description of work packages.

The overview of the project work plan is as follows. **Analysis (WP1)** is in charge of analysing the integration, in a multi-agent framework, of the user modelling and the different planners. To this we draw on our previous related experience in SAMAP project (TIC2002-04146-C00) [UGR-1]. In particular, as a starting point we investigated the integration of SAMAP and aLFanet project approaches. The former was built as a multi-agent system, consisting of three main agents: user modelling and interface agent, CBR agent, and planning agent, and the application domain was electronic tourism. The latter consisted in an adaptive learning management system (LMS) based

[1] http://www.dotlrn.org /

on a pervasive use of educational standards (IMS family will be commented below) [UNED-1]. The result of this task clarifies technical and scientific integration issues as well as the expected problems we will be facing over the project life cycle. This wok package covers the following tasks: objectives and tools developed in both projects (T1.1), system architecture requirements (T.1.2), user modelling needs (T1.3), and a detailed analysis of the planning problem typology (T1.4).

<table>
<tr><th>Tasks</th><th>Participants</th><th>First year</th><th>Second year</th><th>Third year</th></tr>
<tr><td>P1. Analysis</td><td></td><td></td><td></td><td></td></tr>
<tr><td>T1.1 Objectives analysis</td><td>ALL</td><td>X|X|X|X|X| | | | | | |</td><td>| | | | | | | | | | |</td><td>| | | | | | | | | | |</td></tr>
<tr><td>T1.2 Architecture analysis</td><td>ALL</td><td>| | |X|X|X|X|X|X| | |</td><td>| | | | | | | | | | |</td><td>| | | | | | | | | | |</td></tr>
<tr><td>T1.3 User model analysis</td><td>ALL</td><td>| | |X|X|X|X|X|X| | |</td><td>| | | | | | | | | | |</td><td>| | | | | | | | | | |</td></tr>
<tr><td>T1.4 Planning problem analysis</td><td>UC3M, UGR, UPV</td><td>| | |X|X|X|X|X|X| | |</td><td>| | | | | | | | | | |</td><td>| | | | | | | | | | |</td></tr>
<tr><td>P2. Architecture design</td><td></td><td></td><td></td><td></td></tr>
<tr><td>T2.1 Agents platform design</td><td>ALL</td><td>| | | | |X|X|X|X|X|X|X</td><td>| | | | | | | | | | |</td><td>| | | | | | | | | | |</td></tr>
<tr><td>T2.2 Agents communication protocols design</td><td>ALL</td><td>| | | | | | | |X|X|X|X</td><td>X|X|X|X|X|X| | | | | |</td><td>| | | | | | | | | | |</td></tr>
<tr><td>P3. Ontologies, user modelling and adaptation</td><td></td><td></td><td></td><td></td></tr>
<tr><td>T3.1 Application domain ontologies</td><td>ALL</td><td>| | |X|X|X|X|X|X|X|X|X</td><td>X|X|X|X|X|X|X|X| | | |</td><td>| | | | | | | | | | |</td></tr>
<tr><td>T3.2 User modelling</td><td>UNED, UdG, UCLM</td><td>| | | | | | | | | | |</td><td>| | | | | | | | |X|X|X</td><td>X|X|X|X|X|X|X|X|X|X|X|X</td></tr>
<tr><td>T3.3 User interface adaptation and recommender system</td><td>UdG, UCLM, UNED</td><td>| | |X|X|X|X|X|X|X|X|X</td><td>X|X|X|X|X|X|X|X|X|X|X|X</td><td>X|X|X|X|X|X|X|X|X|X|X|X</td></tr>
<tr><td>P4. Tasks planning and learning</td><td></td><td></td><td></td><td></td></tr>
<tr><td>T4.1 Planning knowledge acquisition and representation</td><td>UGR, UPV, UC3M</td><td>| | | | | | | |X|X|X|X</td><td>X|X|X|X|X| | | | | | |</td><td>| | | | | | | | | | |</td></tr>
<tr><td>T4.2 Techniques Specification and design for uncertainty, probabilistic, conditional and hierarchical planning</td><td>UGR, UPV, UC3M</td><td>| | | | | | | | | | |</td><td>| | |X|X|X|X|X|X|X|X|X</td><td>X| | | | | | | | | | |</td></tr>
<tr><td>T4.3 Execution mechanisms, monitoring and replanning</td><td>UPV, UC3M</td><td>| | | | | | | | | | |</td><td>| | | | | | | | |X|X|X</td><td>X|X|X|X|X|X|X|X|X|X|X|X</td></tr>
<tr><td>T.4.4 Learning control knowledge in planning</td><td>UC3M, UGR</td><td>| | | | | | | | | | |</td><td>| | | | |X|X|X|X|X|X|X</td><td>X|X|X|X|X|X|X|X|X|X|X|X</td></tr>
<tr><td>P5. Application development</td><td></td><td></td><td></td><td></td></tr>
<tr><td>T5.1 Component interface specifications</td><td>ALL</td><td>| | | | | | | | | | |X|X</td><td>X|X| | | | | | | | | |</td><td>| | | | | | | | | | |</td></tr>
<tr><td>T5.2 Components construction</td><td>ALL</td><td>| | | | | | | | | | |</td><td>|X|X|X|X|X|X|X|X|X|X|X</td><td>X|X|X|X|X|X| | | | |</td></tr>
<tr><td>T5.3 Components integration</td><td>ALL</td><td>| | | | | | | | | | |</td><td>| | | | | | |X|X|X|X|X|</td><td>X|X|X|X|X|X|X|X| | |</td></tr>
<tr><td>T5.4 System testing</td><td>ALL</td><td>| | | | | | | | | | |</td><td>| | | | | | |X|X|X|X|X|</td><td>X|X|X|X|X|X|X|X| | |</td></tr>
<tr><td>T5.5 Functionality, usability and accessibility valuation</td><td>ALL</td><td>| | | | | | | | | | |</td><td>X|X|X|X|X|X|X|X|X|X|X|X</td><td>X|X|X|X|X|X|X|X|X|X|X|X</td></tr>
</table>

Fig. 1 Project Chronogram

Architecture design (WP2) provides clear identification of each module and its interfaces, which in this project deals with a heterogeneous and distributed collaborative framework based on interoperable services supported by agents with different roles in complex and dynamic problem-solving scenarios. As can be seen in Fig. 1, this WP tasks take place in parallel with those carried out in WP3 and WP4, where functionalities to different agents are developed. Central in the architecture is the final user, whose interaction with the system and its components is one of the major challenges of this project. The types of agents to be developed includes *interface agents* (they provide the middleware between the system agents and the user actions, including those in charge of managing the multi-agent infrastructure), *information agents* (they gather external and internal information in order to model user knowledge, domain knowledge and planning domain via machine learning and knowledge-based methods), *cognitive agents* (they support user model acquisition, intelligent task planning and learning domain control knowledge), *reactive agents* (they follow up the plans designed by cognitive agents so that they control if there are problems while executing the plan as well as the management of recommendations). WP2 consist of two tasks: T2.1 Agents platform design and T2.2 Communications protocols design. In turn, the later comprises the following subtasks: T2.2.1 Definition of agents directory, T2.2.2 Definition of communication language between internal and external agents, T2.2.3 Definition of management policy, T2.2.4 Definition of communication protocols, and T2.2.5 Design of interfaces to support the integration with the LMS.

Ontologies, user modelling and adaptation (WP3) focuses on developing user modelling techniques, user interface adaptations, and recommender systems, which are to be integrated, sharing a domain ontology, with the solutions of complex activity-based planning problems. All this is framed in ubiquitous computing learning settings. Ontologies will be based on reusing domain standard resources. Moreover, in this project the user modelling approach, which is central for providing adaptations, considers the following key issues: (1) defining an extended user's ontology which comprises individual needs, preferences, background, collaborative features, devices and interaction modes (T3.1 and T3.2); (2) defining and acquiring stereotypes from observable and inferable features (T3.2); (3) developing user models in terms of domain expert rules and machine learning techniques (T3.2); and (4) making up the user model considering collaborative, device and context features (T3.2). The later includes adaptations according to access and network conditions (T3.3). Furthermore, because of the modelling techniques to be applied a layered evaluation, which considers the different stages of adaptations, will be carried out [1]. This relates to the recommender system, which will be evaluated according to measures that take into account the utility factor of recommendations [2]. This WP includes three main subtasks: application domain ontologies (T3.1), user modelling (T3.2) and user interface adaptation and recommender system (T3.3). Furthermore, the user modelling task (T3.2.1) consists of the following subtasks: user model analysis and definition (T3.2.1), data gathering (T3.2.2), constructing the formal specification of the user model (based on standards)(T3.2.3), automatic updating of user model features (T3.2.4) (including different ML techniques such as clustering, classification, supervised and unsupervised, and content and collaborative filtering…), user model evaluation (T3.2.5). In turn, the user interface adaptation and recommender system (T3.3) comprises: content adaptation (T3.3.1), interaction adaptation (T3.3.2), and recommender subsystem (T3.3.3). The later is in charge of characterising when and how tasks and plans should be carried out.

Tasks Planning (WP4) main goal is to analyse and develop planning and learning techniques for problem solving. This WP will extend the techniques previously developed in related projects [UGR-1], providing new features on hierarchies and abstractions, temporal criteria, sharing of resources, optimization, uncertainty management, learning and control rules. In particular, some of the main challenges of this WP are the following: (1) Designing dynamic planning processes for tasks where diverse agents, within a collaborative and distributed framework, have to develop complicated solutions in which is difficult to foresee the most appropriate sequence of activities for each person or groups of persons (T4.1 and T4.3).; (2) Solving a wide range of tasks, from the most complex to simple ones, taking advantage of compositional and taxonomical hierarchy representations of complex problems (T4.1 and T4.2); (3) Developing methods that deal with: automatic acquisition of planning domains, improvements of expert-based predefined domains through detecting representation errors, or heuristics extraction to speed up the planning process (T4.1 and T4.4); (4) Designing machine learning (ML) techniques for planning in order to: eliciting domain control knowledge in a planning independent way, defining strategies for sharing control knowledge among several planners, integrating different domain knowledge ML techniques, using reinforcement learning (including relational) in order to improve plan robustness, learning domain control knowledge with numeric conditions, and acquiring knowledge on planner inputs uncertainty (T4.4); (5) Developing techniques for dynamic adaptation of domain independent heuristics in planners, as well as studying non-admissible or p-admissible heuristics (T4.4); and (6) Adjusting and developing plan monitoring techniques for detecting internal failures and contingencies, and state monitoring by means of replanning and applying probabilistic methods (T4.3). The work in this WP comprises four stages: (1) planning problem analysis (included in WP1), (2) knowledge acquisition, (3) architecture design and planning techniques, (4) execution, monitoring and learning. More specifically, the following tasks make up WP4: planning knowledge acquisition and representation (T4.1); specification and design of planning techniques (including hierarchical, conditional, uncertainty and probabilistic techniques) (T4.2); execution, monitoring and replanning (T4.3); learning control knowledge in planning (T4.4). The later includes different ML techniques, such as control rules, macro-operators and cases, as well as reinforcement learning for improving robust planning under uncertainty. All these tasks in turn include different subtasks. For instance, T4.1 is made up of T4.1.1 Defining the representation framework for domain and planning knowledge based on PDDL and OWL-S; T4.1.2 Defining the support framework to help end-users in developing domain and planning problems; T4.1.3 Classifying uncertainty inputs for the planner and defining techniques to support their management; T4.1.4 Defining semantics for planner control rules and developing interfaces between languages such us Inductive Logic Programming (ILP) or Prodigy knowledge specification language (PDL).

Application development (WP5) deals with the development of the end-user application which, on the one hand fulfils the requisites identified in WP1, and on the other hand follows the conceptual and architectural design principles established in WP2, WP3 and WP4, as well as those issues related to system deployment, functional validation and end-user evaluation focused on usability and accessibility requirements. This WP will provide an application software which includes the interoperation with a LMS based on standards and supports a personalised support to the user via the combination of techniques coming from WP2, WP3 and WP4. In other words, this WP is in charge of developing and deploying the multi-agent architecture, the user modelling system, the planning component and the recommender system, altogether supporting a personalised interaction with an open source LMS based on standards. The final system will be evaluated in real conditions with end-users. This WP consists of five interrelated tasks with various subtasks. T5.1 Interface specifications between components comprises the selection of technologies and standards (T5.1.1) and the construction of the interfaces between components (T5.1.2). T5.2 Components construction includes: construction and deployment of the multi-agent architecture (T5.2.1), construction of the user modelling component (T5.2.2), and construction of the planning component (T5.2.3). T5.3 Component integration requires installing and configuring the hardware (T5.3.1) and deployment and integration of components (T5.3.2). T5.4 System testing comprises component functional testing (T5.4.1) and integration functional testing (T5.4.2). Last but not least, T5.5 Functionality, usability and accessibility evaluation is a critical task in this project., considering that the main practical hypothesis to be validated consist in helping en-users (course authors and students) to improve their interaction over the entire life cycle of e-learning. T5.5 includes a formative evaluation (T5.5.1), usability and accessibility evaluation (T5.5.2) and evaluation in real conditions (T5.5.3).

A more detailed analysis related to project tasks and their level of achievement is provided in the following section.

2 Project success

In order to clarify the work that has been carried out to date this section presents the work packages and their level of achievements, including references to outcomes produce from each subproject.

WP1 Analysis

The main objectives that have been reached according to the participation of the different research groups in the aforementioned tasks of this WP are as follows:

The Analysis WP was completed according to project plan (see Fig. 1).

T1.1 Objetive analysis

- Taking into account our previous experience in SAMAP project [UGR-1], where planning and user modelling techniques were combined to provide adapted routes to visit a city, and aLFanet project (IST-2001-33288), where an adaptive learning management system based on a pervasive use of standards (IMS-MD, IMS-LD, IMS-CP, IMS-QTI and IMS-LIP) and several user modelling was developed [UNED-1], in ADAPTAPlan we focus on providing dynamic assistance to authors in developing adaptable standard based courses and ask the author to focus on those elements that require the author's experience and expertise.

- In ADAPTAPlan we come up with a new scenario where the author is requested to provide simple information about the course structure, pedagogy and restrictions that together with the user model can feed the planning engine to generate the personalized IMS-LD course suited to each learner. To deal with this approach, first we have identified the data to be filled in by the author for the planning engine. With those data an IMS-LD skeleton is built and stored as the course model. Next, the planning engine can use the user model (IMS-LIP preferences) and the course model (IMS-LD skeleton) to generate the IMS-LD course design adapted to the learner. 5. If the plan reaches an impasse the planner modifies the initial plan taking into account the runtime information and guides the learner in the course based on the runtime information. Finally, when the course ends, the interactions of all the learners are analyzed and used to build a generic IMS-LD (see Fig. 2). The details of this approach are described elsewhere [UNED-2, UNED-3].

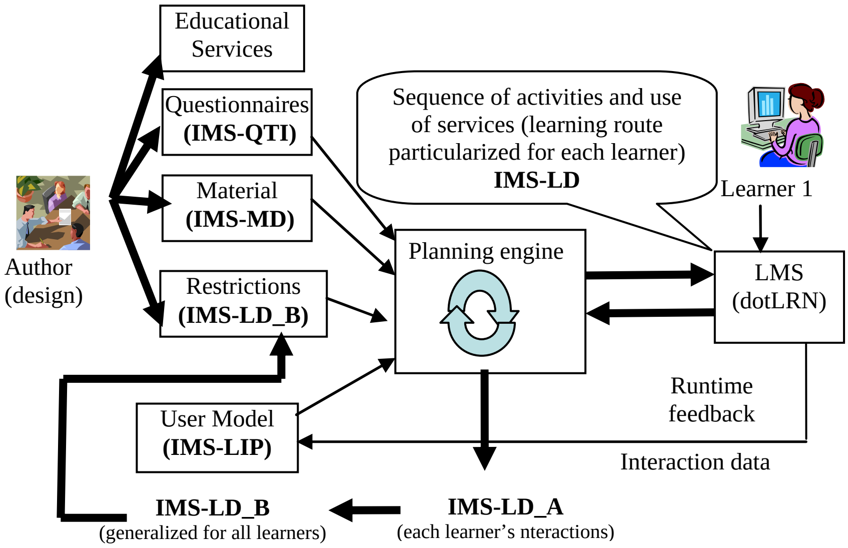

Fig. 2 General overview of the ADAPTAPlan approach

- All groups were involved in this task.

T1.2 System architecture requirements

- From the aforementioned task T1.1 requirements for the architecture were worked out. In particular, some meetings allow us defining the ADAPTAPlan architecture and specifying the different technologies and strategies of participation of each group in the implementation of the architecture. In Fig. 3 the architecture is presented.

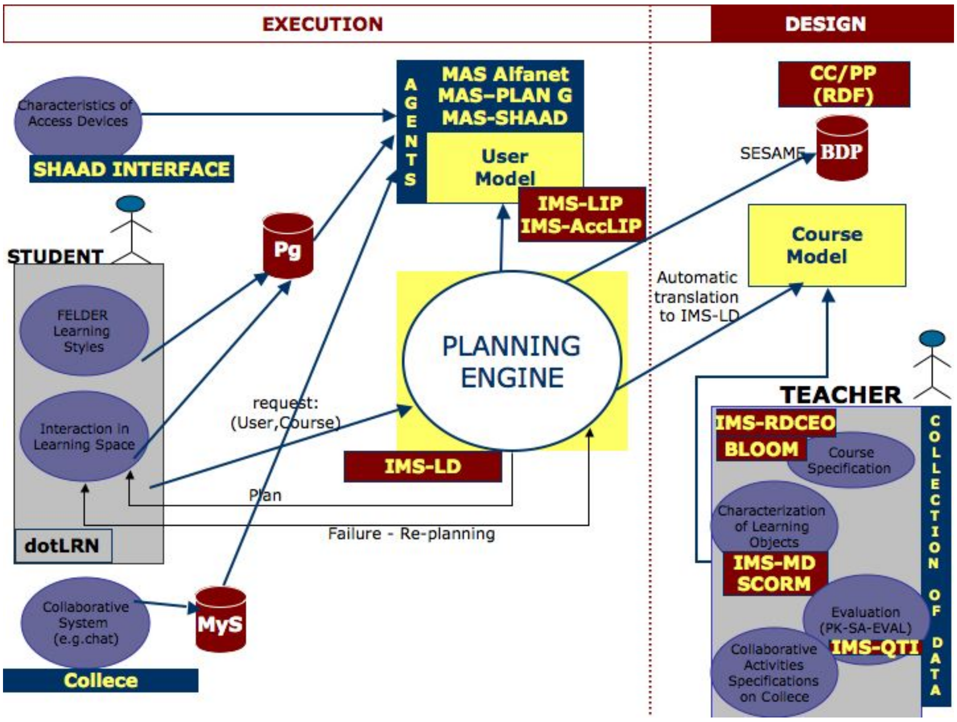

Fig. 3 ADAPTAPlan architecture layout

- Several strategies were defined
  - Use of dotLR such as basic LMS to implement the architecture. This strategy is based in the experience of the ADENU Group in use of the platform and the characteristics of technical quality of dotLRN
  - Integration of different tools developed by project members. In this respect, project groups point out that their approaches focus on developing systems architectures based on open source resources
  - Usage of standards and specification technological in education (IEEE standards, IMS specifications, CC/PP profiles) in order to model different aspects of the learning process
  - Usage of agent technology to aggregate intelligence to the proposal

- All research groups participated in this task

T1.3 User modelling needs

- From tasks T1.1 and T1.2 user modelling needs were studied and a detailed description of the results of this task is provided elsewhere [UNED-14].

- Aiming at defining the different kinds of user characteristics to model user in ADAPTAPlan, each project group presented their works in this specific topic. This allow us defining three different types of user characteristics:
  - Personal Characteristics
  - Context Characteristics
  - Collaborative Characteristics

- Specifically, the personal characteristic considered are learning style and competency of knowledge, access device to model de context of users and the level of collaborative competency identified thought the user interaction. UNED is focused on personal and collaborative characteristics. UdG is focused on context characteristics, including devices and network connections. UCLM is focused on collaborative characteristics.

- This task was developed by UNED, UdG and UCLM groups

T1.4 Problem planning analysis

- From task T1.1 and task T1.2 planning problem needs were studied. The analysis covered the study of applicable hierarchical models, uncertainty and its management, automatic extraction of heuristics, probabilistic methods, replanning scenarios, etc.

- This task was developed by UC3M, UPV and UGR groups

WP2 Architecture design

The main objectives that have been reached according to the participation of the different research groups in the aforementioned tasks of this WP are as follows:

T2.1 Agents platform design (ADA+)

- The purpose of the so called ADA+ [UNED-13] is to provide dynamic recommendations to learners on what to do in a course. These recommendations are offered in the course interface. Therefore, when the LMS needs to provide this information, it sends a request to ADA+ and waits for the list of recommendations.

- ADA+ can provide recommendations and advises to learners while interacting with a course based on the experience derived from previous users' interactions, on the user model (IMS-LIP), the course structure (IMS-LD), the contents characterization (IMS-MD) and the questionnaires results (IMS-QTI). All this information is stored in the LMS data model and is available from the corresponding APIs. The data is captured from different sources:
  - User's actions recorded by the system, such as access to a learning activity, posting of messages in the forums, etc
  - Results from questionnaires, which can be of different types, such as questionnaires to gather the user learning styles or to evaluate the performance in the course

- The architecture integrates two different multi agent system:
  - aLFanet Multi Agent System (developed by UNED), which generates recommendations considering personal and collaborative users' characteristics [UNED-10]
  - MAS-SHAD (developed by BCDS Group – Girona University): generate recommendations consider context characteristics of users, specifically the access device [UDG-10]

- The architecture integrated consider different kinds of agents:
  - Collaboration agent: in charge of providing recommendations to promote the collaboration among the course members
  - Pedagogical agent: in charge of suggesting activities and learning objects which are not mandatory according to the IMS-LD but can be relevant for the learner in the current situation (e.g. lack of knowledge or high interest)
  - Presentation agent: in charge of selecting the content to be presented to the learner, taking into account several features, such as the device capabilities or accessibility requirements

- The architecture was designed considering JADE platform and it will be linked with dotLRN through web services. In [UNED-22] a detailed explication on the architecture is presented (see also Fig. 4).

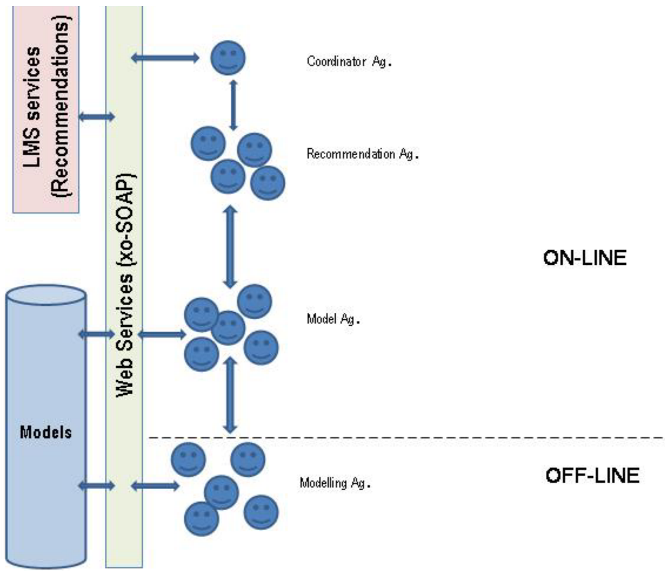

Fig. 4 Agents architecture

T2.2 Communications protocols design

- The design mechanisms to communicate the different kinds of agents in the above architecture are based on FIPA-QUERY and FIPA-REQUEST protocols. These protocols are implemented in JADE platform.

- UGR has defined a SOAP based protocol to allow the communication of the UGR planner SIADEX with an existing Learning Management System ILIAS (http://www.ilias.de/ios/index-e.html) [UGR-8] and, therefore, to allow for a rich interchange of prior to the planning stage of the project.

- All research groups participated in this task

WP3 Ontologies, user modelling and adaptation

The main objectives that have been reached according to the participation of the different research groups in the aforementioned tasks of this WP are as follows:

T3.1 Application domain ontologies

- In order to generate adequate user, learning object and learning process data models, the analysis of different learning technology specifications has been analysed, specifically:
  - IEEE LOM, characterisation of learning objects.
  - IMS Learner Information Profile, user characterisation.
  - IMS Question and Test Interoperability.
  - IMS Reusable Definition of competency and Educational Objectives
  - IMS Learning Design, learning process definition

- These specifications support modelling three types of user's characteristics we have established to generate adaptations: i) Felder learning styles, ii) the knowledge competency level and iii) collaborative competency levels

- The model that was built to link the different specifications can be considered an ontology of the learning process domain, which supports the adaptation process. This model is widely explained elsewhere [UNED-14].

- In particular, UCLM has been working with the rest of the participants defining a set of general ontologies capable to represent a vast list of educational applications. The case study in which UCLM is making the test is Programming Learning using previous developments of the CHICO Group such as the COLLECE system (See references [UCLM-1], [UCLM-3], [UCLM-4], [UCLM-5], [UCLM-7], [UCLM-10], [UCLM-11])

- With the participation of all research groups, and according to schedule, the ontologies of the domain are quite defined at this stage (80%).

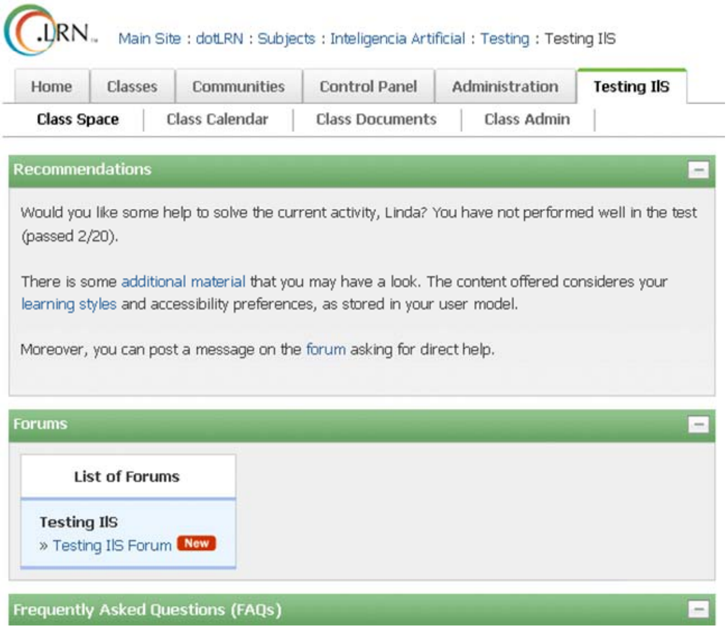

Fig. 5 Recommendation example

T3.3 User interface adaptation and recommender system

- The user interface adaptation is generated throughout the recommendation portlet that has been built by UNED on top of the dotLRN platform. An example with the recommendation display is shown in Fig. 5.

- Thanks to their experience in [UGR-3, UGR-9] on planning and web services, UGR has modified the web services available at the ILIAS LMS so that all the information about user profiles (IMS-LIP) is readily available thru its WSDL interface. This extension is later used by the SOAP interface to bring all the available knowledge to the planner/scheduler. In addition to this, after the SIADEX HTN planner [UGR-1, UGR-2] is executed and a plan is obtained, it is imported into ILIAS LMS. Since ILIAS does not support IMS-LD specification yet and in order to make the plan available to student, we have translated the plan into a follow up guideline that appears over the student' ILIAS desktop [8]. In particular in [UGR-4] and [UGR-7] special emphasis is put on the role of end users and their integration into the planning and execution loop.

- The main objective of this task in the UCLM team was the definition of a notation and a methodology in order to design the user interfaces providing the necessary adaptability to the user and the group. We used the CIAN Notation and the CIAM Methodology to do this, both developed by the CHICO Group of the UCLM. (See references [UCLM-23, [UCLM-24], [UCLM-25], [UCLM-26], [UCLM-27], [UCLM-28], [UCLM-29], [UCLM-30], [UCLM-31])

- To date the following research groups have participated in this task: UNED, UdG, UCLM and UGR

WP4 Tasks planning and learning

The main objectives that have been reached according to the participation of the different research groups in the aforementioned tasks of this WP are as follows:

T4.1 Planning knowledge acquisition and representation

- UGR has leaded a great step in T4.1 by defining an automated knowledge extraction procedure [UGR-8] able to obtain a full HTN planning domain from a learning objects repository just by examining and analyzing the metadata defined by the instructor. This is a great achievement towards the integration of AI Planning and Scheduling tools into a LMS with a very low cost, since instructors do not have to get involved in the design of planning domains or knowledge extraction processes.

- T.4.1.1 Definition of courses based on PDDL. UC3M has defined a course on AI using PDDL, and generalized it to a common language for specifying other courses. This requires describing what are the predicates and fluents that are commonly used in courses definition, what are the common types of activities that are carried out (actions in PDDL), what are the preconditions and effects of those activities, and how we can specify a problem (initial state and goals) in terms of the previous formalization.
  Also, UC3M has defined a translator from PDDL courses specifications to IMS-MD, by transforming each action in PDDL to a learning object. Since other groups have defined the inverse translator, from IMS-MD to PDDL, we can create courses in any of the two standards.
  Finally, UC3M has also generated a translator of plans into XML, so that the output can be reused by any IMS-based software.

- T.4.1.2 Definition of a planning tool that can help the user select a planner, domain and problem and run it, in order to obtain solutions, learn from the problem solving episode, or compare different planners (UC3M).

- T.4.1.3 Definition of different kinds of uncertainty associated to the execution of actions (students doing activities) that lead to different types of execution systems as described below (UC3M).

- T.4.1.4 Definition of planning as a meta-search process that explains in a standard way all planning systems. The main output of this meta-model has been the definition of two transfer learning systems. The first one from a Graphplan-based planner to a total-order means-ends analysis planner, which has yield a publication at IJCAI. The second one is current work on transferring knowledge from a means-ends analysis to a forward search planner. These processes require a common language for specifying control knowledge that is being designed bottom-up (UC3M).

- UPV has designed an instructor-oriented graphical authoring tool to model the key elements of a course. The instructor defines the elements of a course such as learning concepts, tasks, teaching materials, required resources, etc. The tool exports the information about the course design to different standard formats, such as PDDL (planning language used by the planner to find an adequate plan, i.e. a learning route), IMS-LD (to represent the learning routes) and XML (to save both the visual information and the elements of the course design in a plain-text file). A snapshot of our graphical tool can be seen in Fig. 6.

- UPV has designed and an automated planner to compute a learning route for a specific student profile or a customised learning route for a group of students.
    - A first, AI planning process is applied over the course structure defined in the graphical authoring tool so as to obtain a generic learning route for a given student profile. This learning route is composed of a set of partially-ordered activities which contemplates teaching goals at different levels of competence. The purpose of this generic learning route is to validate the course design described by the instructor in the authoring tool and check the existence of a feasible implementation for the course.
    - Second, AI planning process permits to obtain a customised learning route for a specific group of students. This learning route is a course of actions allocated in time which accounts for the available resources and temporal constraints of the particular teaching context where the course will be taught.

- A translator from standard IMS-MD to the planning language PDDL is currently under development. This activity complements the work of other groups who have produced the inverse translator.

- Additionally, UPV has designed a general planning formalism based on constraint programming and adapt it to an e-learning setting (see publication [UPV-11]. In fact, generating a learning route represents a planning activity with the following elements: learning goals to be attained, profile-adapted tasks with their prerequisites and learning outcomes (i.e. preconditions and effects, respectively), non-fixed durations, resources, ordering and synchronisation constraints, and collaboration/cooperation relations. A CSP approach fits very well for solving this kind of problem.

- UPV is still working on the second AI planning process as well as developing specific heuristics for e-learning problems.

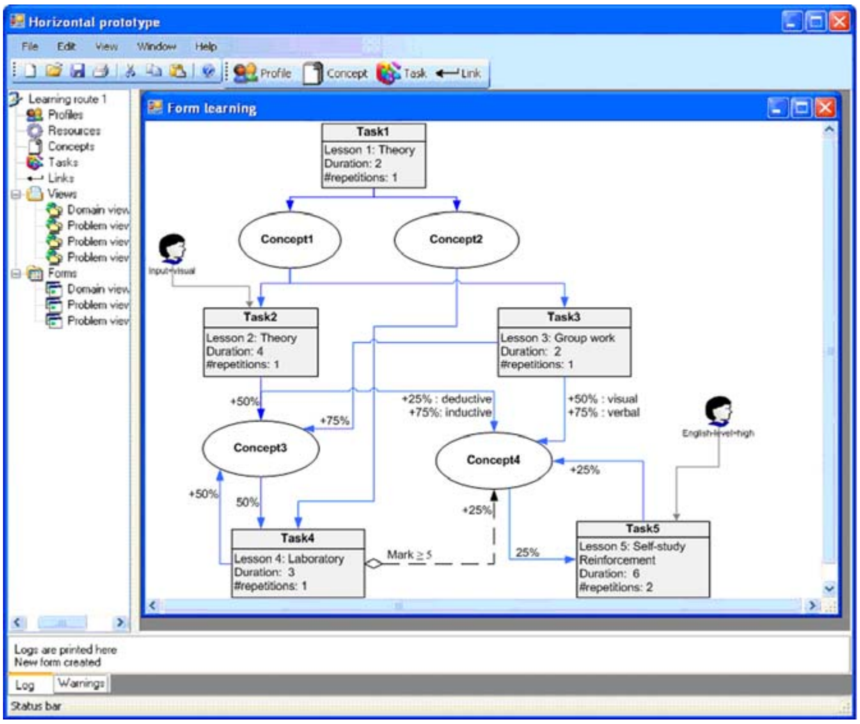

Fig. 6 Instructor-oriented graphical authoring tool

T4.2 Specification and design of planning techniques (including hierarchical, conditional, uncertainty and probabilistic techniques)

- The Hierarchical Task Network planner of the UGR group [UGR-1, UGR-5] has been adapted to work on the specific domain of distance learning by including an expressive language for integrating existing protocols and a rich set of temporal constraints [UGR-2]. In addition to this, in [UGR-6] a new paradigm of temporal planning with flexible constraints has been explored to adapt it to the needs of a dynamic and real environment like the one considered in the project..

- T.4.2.1 Definition of a new approach for case-based planning based on case-based recommendation of node orderings, and probabilistic planning, based on compiling probabilistic models into costs (UC3M).

- T.4.2.4 Definition of a closed-loop of planning, execution and learning, that allows to automatically generate uncertainty models associated to planning domains from execution by integrating Inductive Logic Programming techniques with different kinds of probabilistic planners (UC3M).

- T.4.2.6 Definition of different kinds of learning systems working on top of planners: case-based learning for node recommendation; transferring learned control knowledge among planners; prototype-based learning for control knowledge learning in means-ends analysis and forward search planners; transferring knowledge for reactive planning; and learning actions models from execution (UC3M).

- T.4.2.7 Definition of new cost-based heuristics for forward search planning (op top of Metric-FF) that improve over existing cost-based planners. Also, we have explored different kinds of search techniques for forward search planners that can improve current commonly used techniques (UC3M).

T4.3 Execution, monitoring and replanning

- This is an onging research though UPV can point out some advances: we have used the CSP model (see publication [UPV-11]) to schedule the plans obtained for each student in order to meet the defined context constraints. Customised plans for all students in a course are globally scheduled to accomplish the temporal and synchronization constraints (as for example, in-person lessons which all students must attend). Plans are composed of a set of tasks until an assessment point is reached, that is the instructor introduces the mark obtained by the student after a set of tasks have been accomplished. This way, we can simulate the execution of a plan. The planner is then activated to obtain a new plan according to the mark obtained by the student.

T4.4 Learning control knowledge in planning

- The work described in [UGR-8] is the basis for a knowledge extraction procedure able to infer new HTN planning domains from a database of learning objects and metadata in IMS-MD. We are studing its use in non HTN domains so that other type of planners may be used as well. This process is the perfect complement of the achievements of the UC3M group who are able to do the inverse translation from a PDDL specification, we can create courses in any of the two standards.

- In tasks T.4.3 and T.4.4 UC3M has been working in the previously mentioned research directions.

WP5 Application development

The main objectives that have been reached according to the participation of the different research groups in the aforementioned tasks of this WP are as follows:

T5.1 Interface specifications between components

- This task has been successfully completed providing the interfaces for the components of the proposed architecture, which are the following:
    - Planning Engine, which generates the learning path adjusted to the user's characteristics in PDDL and convert this plan in a IMS LD.

  - dotLRN – OpenACS: is the learning management system used to deliver activities and contents to users. Main dotLRN package utilised so far are as follows:
    - GRAIL: IMS Learning Design player
    - Assessment: IMS QTI player
    - Felder: implementation of Felder Learning Style
    - Collaborative tools such as forums, logical frame, storage devices
    - Competency Package
  - ADA+: multi agent systems architecture introduced above

- All research groups participated in this task

T5.2 Components construction

- Planning Engine: under construction.

- dotLRN – OpenACS: is the learning management system used. Main packages to be considered:
  - GRAIL: constructed, developed by dotLRN community
  - Assessment: constructed, developed by dotLRN community
  - Felder Package: constructed, developed by aDenu Group - UNED
  - Collaborative tools: constructed, developed by dotLRN community
  - Learning objects repository: under construction, developed by aDenu Group - UNED
  - Competency Package: under construction, developed by BDCD Group – UdG with technical support by aDenu Group - UNED

- ADA+:
  - Integration of aLFanet Multi agent system and MAS-SHAAD Multiagent system: under construction.

- Task execution percentage: 25%. All research groups are participating in this task

T5.5 Functionality, usability and accessibility evaluation

- UNED has developed a usability and accessibility studies in the framework of two related European projects: ALPE and EU4ALL [UNED-7, UNED-19]. In these studies some usability and accessibility aspects were considered:
  - In ISO 9241-11 standard "Guidance on usability", usability is defined as the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.
  - ISO 9241-171 "Guidance on software accessibility" defines accessibility as the usability of a product, service, environment, or facility by people with the widest range of capabilities.

- The methods is based on the following issues:
  - Continuous monitoring of user interactions in order to provide essential information about the platform usage.
  - Assessments by experts, which focus on a thorough analysis of the collaborative environment according to expert criteria. These assessments and the underline methodology was reviewed by the TENUTA project (eTEN project nr: 517347), which is devoted to help other European projects make their product and services as usable as possible and accessible to the widest possible user base. A paper that reports the methodology and all the findings has been sent.

- The conclusions from the TENUTA assessment on platform usability and accessibility are as follows:
  - To improve the accessibility of the website:
    - Ensure all forms elements have labels
    - Make tables more accessible
    - Improve colour contrast
    - Make sure the accessibility features provided are easily identifiable and are explained"

  - The most important recommended changes about usability are:
    - Format dates consistently throughout the website
    - Make sure that all the terms used on the website are meaningful to users
    - Ensure pages can be printed
    - Ensure that portlets can be easily minimised and maximised

- This task has been developed so far by UNED. Task execution percentage: 25%

3 Progress indicators

The progress indicators to be covered in this section comprise the following subjects:

- Level of achievement of planned goals
- Relevance and originality of results
- Scientific and technological outcomes
- Utility of results and relationships with socio-economic environment
- Human resources training
- Coordination
- Collaborations with other European or International scientific teams
- Project development and management

Above progress indicators are presented in a different section for each subproject.

3.1 UGR

Objectives

We have reached all goals previously planned for this stage of the project.

Relevance of results

We have we have published several papers related to the project goals in international conferences, workshops and some journals.

[UGR-1] L. Castillo, J. Fdez.-Olivares, O. García-Pérez, F. Palao. Bringing users and planning technology together. Experiences in SIADEX. 16th International Conference on Automated Planning and Scheduling (ICAPS 2006). Awarded as the "Best Application Paper" of the 2006 edition.

[UGR-2] L. Castillo, J. Fdez.-Olivares, O. García-Pérez, F. Palao. Efficiently handling temporal knowledge in an HTN planner. 16th International Conference on Automated Planning and Scheduling (ICAPS 2006).

[UGR-3] F. Palao. Improving planning techniques for web services. Working notes of the ICAPS 2006 Doctoral Consortium. 16th International Conference on Automated Planning and Scheduling (ICAPS 2006).

[UGR-4] L. Castillo, J. Fdez.-Olivares, O. García-Pérez, F. Palao, T. Garzón. Planning process from a user perspective. Working notes of the ICAPS 2006 Workshop on plan analysis and management. 16th International Conference on Automated Planning and Scheduling (ICAPS 2006).

[UGR-5] L. Castillo, J. Fdez-Olivares, O. Garcia-Perez, and F. Palao. Plan Design, Execution and Monitoring for Crisis Episodes: the
SIADEX Environment. Working notes of the ICAPS 2006 Systems demonstration. 16th International Conference on Automated Planning and Scheduling (ICAPS 2006).

[UGR-6] M. de la Asunción, L. Castillo, J. Fdez.-Olivares, O. García-Pérez, A. González, F. Palao. Handling fuzzy temporal constraints in a planning environment. To appear in Special Volume of Annals on Operations Research on "Personnel Scheduling and Planning".

[UGR-7] Luis Castillo, Juan Fdez-Olivares, Oscar García-Pérez, Francisco Palao, Tomas Garzon. Reducing the Impact of AI Planning on End Users. Working notes of the ICAPS 2007 Workshop on Moving Planning and Scheduling Systems into the Real World. 16th International Conference on Automated Planning and Scheduling (ICAPS 2007).

[UGR-8] Luis Castillo Vidal, Lluvia Morales Reynaga, Arturo González Ferrer, Juan Fernandez Olivares, Óscar García Pérez. Knowledge engineering and planning for the automated synthesis of

customized learning designs. Actas de la XII Conferencia de la Asociación Española de Inteligencia Articial, CAEPIA 2007. To appear in a special volume of Lecture Notes of Artificial Intelligence.

[UGR-9] Juan Fernandez Olivares, Tomás Garzón, Luis Castillo Vidal, Óscar García Pérez, Francisco Palao. A Middleware for the automated composition and invocation of semantic web services based on HTN plan. Actas de la XII Conferencia de la Asociación Española de Inteligencia Articial, CAEPIA 2007. To appear in a special volume of Lecture Notes of Artificial Intelligence.

Human resources

Several PhD thesis are being carried out in the context of this project.

Oscar J. García Pérez. PLANIFICACIÓN EN DOMINIOS TEMPORALES USANDO TÉCNICAS HTN. Phd. These currently in deposit at the University of Granada. To be defended in September 2007. Advisors: Luis Castillo Vidal and Juan Fernández Olivares.

Lluvia Morales Reynaga. Has just started its PhD period on ``Knowledge acquisition procedures for the automatic extraction of planning domains from LMS databases" with a very good publication [UGR-8] that will appear in LNAI.

Arturo González Ferrer is also about to present is DEA in his PhD program on ``Workflow management and metaplanning for adaptive course configuration assistance".

Coordination

The coordination with the rest of partners has been achieved using the standard methods of the collaborative platform based on dotLRN, and meetings.

Technology Transfer

Creation of the spin-off of the UGR ``IActive Intelligent Solutions" (www.iactive.es) whose main goal is to bring to a comercial use the technology being developed at the UGR group, that is, intelligent planning and scheduling applied to intelligent business management processes (BPM). IActive centers its activity in areas like civil and military crisis episodes, e-learning processes, customized fitness and wellness plans. It is worth to note that one of the clients of this spin-off is the EPO of the current project: Grupo Tadel Formación.

3.2 UdG

Objectives

We have reached all goals previously planned for this stage of the project.

Relevance of results

We have we have published several papers related to the project goals in international conferences and workshops.

We have we have published several papers related to the project goals in international conferences, workshops and some journals:

[UDG-1] Silvia M. Baldiris, German D. Moreno, Iván A. Guarín, Ricardo Llamosa, Ramon Fabregat and Juan A. García Fraile. Adaptación de caracteristicas de usuario en SHABOO. Submitted to Revista Gerencia Tecnológica Informática del Centro de Innovación y desarrollo para la investigación en Ingeniería del Software (CIDLIS). December 2007.

[UDG-2] Silvia M. Baldiris and Ramon Fabregat. Evolución de la web y su incidencia en el desarrollo de sistemas tecnológicos de aprendizaje", Submitted to Revista Tecknos. December 2007.

[UDG-3] Carlos Cobos, Miguel Niño, Martha Mendoza, Ramon Fabregat and Luis Gomez. Learning Management System Based on SCORM, Agents and Mining. Submitted to WISE 2007. Nancy (France). 3-7. December 2007.

[UDG-4] Olga C. Santos, Silvia Baldiris, Jeimy Velez, Jesús G. Boticario and Ramón Fabregat. Dynamic Support in ADAPTAPlan: ADA+. Accepted at Conferencia de la Asociación Española para la Inteligencia Artificial (CAEPIA). Salamanca. 12-16. November 2007.

[UDG-5] Jeimy Vélez and Ramón Fabregat. SMAW Sistema Multiagente para la Adaptación de contenido Web. Accepted at Reunión Nacional de Facultades de Ingeniería. Cartagena de Indias (Colombia). October 2007.

[UDG-6] Silvia Baldiris, Olga C. Santos, Jesús G. Boticario and Ramón Fabregat. Modelado de cursos mediante el uso intensivo de estándares educativos para dar soporte a adaptaciones dinámicas. Accepted at Simposio Nacional de Tecnologías de la Información y las Comunicaciones en la Educación (SINTICE 2007). Zaragoza. 11-14. September 2007.

[UDG-7] Jeimy Vélez, Ramón Fabregat., Gustavo González and Carlos Arteaga. Servicios Ofrecidos en Entornos de Aprendizaje Virtual a partir de un Modelo de Usuario Integral", Accepted at Simposio Nacional de Tecnologías de la Información y las Comunicaciones en la Educación (SINTICE), Zaragoza, España. 11-14. September 2007.

[UDG-8] Jeimy Vélez, Ramon Fabregat and Gustavo González. Entornos de Aprendizaje Virtual Adaptativos soportados por Máquinas de Soporte Vectorial. Accepted at Congreso Internacional de Inteligencia Computacional (CIIC 2007). Bogotá. 5-7. September 2007.

[UDG-9] Silvia Baldiris, Olga Santos, Carmen Barrera, Jeimy Velez, Jesús G. Boticario and Ramon Fabregat. Linking educational specifications and standards for dynamic modelling in ADAPTAPlan. Accepted at International Workshop on REpresentation models and Techniques

for Improving e-Learning: Bringing Context into Web-based Education. Roskilde University, Denmark, 20-24. August 2007.

[UDG-10] David Mérida, Silvia Baldiris, Ramon Fabregat, Jeimy Vélez, David Huerva. A User Model that incorporates characteristics of Access Devices in MAS-SHAAD", Accepted at UM'07-Workshop Towards User Modelling and Adaptive Systems for All (TUMAS-A). 24. June 2007.

[UDG-11] Silvia Baldiris, Ramón Fabregat and Olga Santos. Modeling Competencies upon dotLRN. Accepted at OpenACS and .LRN Spring Conference. Viena. April 2007.

[UDG-12] Jeimy Vélez and Ramon Fabregat. Arquitectura para la Integración de las Dimensiones de Adaptación en un Sistema Hipermedia Adaptativo. Published at Proceedings of Research report Institut d'informàtica i aplicacions (IIiA 07-01-RR). March 2007.

[UDG-13] David Mérida, David Huerva, Ramón Fabregat, Jeimy Vélez, Teodor Jové. Adaptación de contenidos web considerando las características de los dispositivos de acceso. Published at Quinta Edición Revista Enlace Informático - Universidad del Cauca. ISSN. 1692-374X. December 2006.

[UDG-14] Jeimy Vélez Ramos, David Mérida and Ramón Fabregat. Sistemas Hipermedia Adaptativos Educativos considerando las características tecnológicas. Published at Proceedings of SIIE 2006. Vol. 2. pp. 245-252. ISBN 84-9773-302-9. León. 24-26. October 2006.

[UDG-15] Carlos Arteaga, Ramón Fabregat and David Mérida. Implementación del ambiente de aprendizaje ASCIL usando MOODLE. Published at Proceedings of SIIE 2006. Vol. 2. pp. 1-8. ISBN 84-9773-302-9. León. 24-26 . October 2006.

[UDG-16] David Mérida, Ramón Fabregat, Tim Rosseel and José Luís Marzo. X-SHAAD: User Modeling with CC/PP and Recovering Data from a LOM Format Data Repository. Published at Proceedings of 17th EAEEIE Annual Conference on Innovation in Education for Electrical and Information Engineering. ISBN 973-742-350-X. Craiova. Rumania. 1-3. June 2006.

[UDG-17] Montse Tesouro, Joan Teixidó, Enric Corominas and Joan Puiggalí. Elaboración de un cuestionario sobre el proceso de acceso a la dirección de centros educativos públicos no universitarios.", Published at IX Congreso Interuniversitario de Organización de Instituciones Educativas (CIOIE).pp 1-9. ISBN: 84-8317-577-0 Oviedo. November 2006.

[UDG-18] Montse Tesouro and Joan Puiggalí. The computer helps in the acquisition of educational knowledge. Published at Interactive EducationalMultimedia, 14 (April 2008), pp102-115. May 2007.

Utility of results

Many of the research is not only applicable to education, but also to many other areas in which adaptive hipermedia systems is or can be applied.

Human resources

Several PhD thesis are being carried out in the context of this project as the ones by: David Merida, Carlos Arteaga, Jeimy Velez, Silvia Baldiris, Josep Sole, and German Moreno.

Coordination

The coordination with the rest of partners has been achieved using the standard methods of the collaborative platform based on dotLRN, and meetings.

Collaborations

Two research exchanges have been done within the context of this project until now: Silvia Baldiris and Jeimy visited UNED on 2007.

An internal project of Universidad Pontificia Bolivariana (Cordoba-Colombia) has just been approved, and one project with Unicauca (Popayan - Colombia) has been submitted.

Collaboration in publications with the ÒCentro de Innovación y desarrollo para la investigación en Ingeniería del Software (CIDLIS). Universidad Industrial de Santander (Colombia). The Cientific Director is Dr. Ricardo Llamosa. Also BCDS group has established collaboration with Dr. Juan Antonio Garcia Fraile (Complutense University of Madrid) and Dr. Miguel Angel Sicilia (Alcala de Henares University) in the topic of modelling competencies.

3.3 UCLM

Objectives

We have reached all goals previously planned for this stage of the project.

Relevance of results

We have published several papers related to the project goals in international journals indexed by ISI-JCR and also presented our research in international conferences and workshops.

[UCLM-1] Bravo, C. (2006). Protocols of Coordination and Structured Communication in Synchronous CSCL Environments. Computers and Education: Towards Educational Change and Innovation, Springer Science.

[UCLM-2] Bravo, C., M. A. Redondo, et al. (2006). Group Learning of Programming by means of Real Time Distributed Collaboration Techniques. HCI related papers of Interacción 2004. R. Navarro and J. Lorés, Springer: 289-302.

[UCLM-3] Bravo, C., M. A. Redondo, et al. (2006). "Collaborative Distributed Environments for Learning Design Tasks by Means of Modelling and Simulation." Journal of Network and Computer Applications 29(4): 321-342.

[UCLM-4] Bravo, C., M. A. Redondo, et al. (2006). "Collaborative environments for the learning of design: A model and a case study in Domotics." Computers and Education 46(2): 152-173.

[UCLM-5] Collazos, C. A., L. A. Guerrero, et al. (2007). "Evaluating Collaborative Learning Processes using System-based Measurement." Educational Technology & Society Journal.

[UCLM-6] Collazos, C. A., M. Ortega, et al. (2007). Tracing CSCL Processes. Intelligent Educational Machines. Methodologies and Experiences. N. Nedjah, M. L.., M. N. Borges and d. A. N. N., Springer. 44: 103-116.

[UCLM-7] Duque, R. and C. Bravo (2007). A method to classify collaboration in CSCL systems. 8TH International Conference on Adaptative and Natural Computing Algorithms. (ICANNGA_$(B07_(B). B. Beliczynski, A. Dzielinski, M. Iwanowski and B. Ribeiro. Warsaw, Poland, Springer-Verlag. Lecture Notes in Computer Science 4431.

[UCLM-8] Duque, R., C. Bravo, et al. (2006). Definición de dominios, tareas y actos conversacionales en sistemas CSCW: el caso de SPACE-DESIGN.

[UCLM-9] Duque, R., C. Bravo, et al. (2006). Analyzing Collaborative Problem Solving with Bayesian Networks. SGAI 2006.

[UCLM-10] Gallardo, J., C. Bravo, et al. (2007). An ontological approach for developing domain-independent groupware. 5th IEEE International Workshop on Distributed and Mobile Collaboration (DMC 2007), París, IEEE

[UCLM-11] Jurado, F. and M. A. Redondo (2006). "Using XSLT for developing event driven software from an XML-based intermediate specification language." Modelling and Simulation in Engineering.

[UCLM-12] Jurado, F., M. A. Redondo, et al. (2006). Modelo de referencia para especificación de tareas colaborativas con IMS-LD. International Simposium on Computers in Education SIIE'06, León, Spain, Universidad de León.

[UCLM-13] Jurado, F., M. A. Redondo, et al. (2006). Specifying Collaborative Tasks of a CSCL Environment with IMS-LD. Cooperative Design, Visualization, and Engineering. Y. Luo. Mallorca, Spain, Springer Berlin. Lecture Notes in Computer Science 4101: 311–317.

[UCLM-14] Jurado, F., M. A. Redondo, et al. (2007). Aplicación de Técnicas de Razonamiento Aproximado para la Evaluación de Algoritmos en Sistemas Tutores Inteligentes Orientados al Aprendizaje de la Programación. SINTICE’2007 - CEDI’2007, Zaragoza, Thomson.

[UCLM-15] Jurado, F., M. A. Redondo, et al. (2007). An architecture to support programming algorithm learning by problem solving. Procc. of Hybrid Artificial Intelligence Systems (HAIS 07 - CAEPIA 2007). Burgos, Spain, Springer Berlin. Lecture Notes in Computer Science.

[UCLM-16] Jurado, F., M. A. Redondo, et al. (2007). Enabling distributed eLearning environments integrating ICEbased services. International Technology, Education and Development (INTED'2007), Valencia (Spain), International Association of Technology, Education and Development (IATED).

[UCLM-17]. Jurado, F., M. A. Redondo, et al. (2007). Fuzzy Algorithm Representation for its Application in Intelligent Tutoring Systems for the Learning of Programming. EATIS, Faro (Portugal), ACM DL.

[UCLM-18] Martínez-Acuña, M. I., F. Jurado, et al. (2006). AULA_IE: aproximación al uso de estándares educativos en los sistemas de aprendizaje mejorados por la tecnología. Actas del III simposio Pluridisciplinar sobre Objetos y Diseños de Aprendizaje Apoyados en la Tecnología (od@06).

[UCLM-19] Molina, A. I., R. Duque, et al. (2006). Applying machine learning techniques for the analysis of activities in CSCL environments based on argumentative discussion. International Simposium on Computers in Education SIIE'06, León, Spain, Universidad de León.

[UCLM-20] Molina, A. I., F. Jurado, et al. (2007). Especificando tareas colaborativas en entornos CSCL con IMS-LD y CIAN. IX Simpósio Internacional de Informática Educativa (SIIE'2007), Oporto (Portugal).

[UCLM-21] Molina, A. I., M. A. Redondo, et al. (2006). Analysing and modelling user task in DomoSim-TPC system for adapting to mobile devices. HCI related papers of Interacción 2004. R. Navarro and J. Lorés, Springer: 217-228.

[UCLM-22] Molina, A. I., M. A. Redondo, et al. (2006). Applying Pattern-Based Techniques to Design Groupware Applications. The Third International Conference Cooperative Design, Visualization and Engineering (CDVE2006). Y. Lou. Mallorca, Springer-Verlag. Lecture Notes in Computer Science 4101: 225 – 233.

[UCLM-23] Molina, A. I., M. A. Redondo, et al. (2006). CIAM: Una Aproximación Metodológica para el desarrollo de Interfaces de Usuario en aplicaciones groupware. VII Congreso Internacional de Interacción Persona-Ordenador (INTERACCIÓN'2006) - Diseño de la Interacción Persona-Ordenador: Tendencias y Desafíos, Puertollano, Comité Organización de Interacción 2006.

[UCLM-24] Molina, A. I., M. A. Redondo, et al. (2006). Conceptual and Methodological Framework for Modeling Interactive Groupware Applications. Groupware: Design, Implementation, and Use: CRIWG 2006. Y. A. Dimitriadis. Valladolid, Springer-Verlag. Lecture Notes in Computer Science 4154: 413 – 420.

[UCLM-25] Molina, A. I., M. A. Redondo, et al. (2006). Using Patterns in Reengineering Processes for Mobile Learning User Interfaces. 6th IEEE International Conference on Advanced Learning Technologies (ICALT 2006), Kerkrade, IEEE Computer Society Press.

[UCLM-26] Molina, A. I., M. A. Redondo, et al. (2007). "Applying Task Modeling and Pattern-based techniques in Reengineering Processes for Mobile Learning User Interfaces: A case study " Journal of Computers(4).

[UCLM-27] Molina, A. I., M. A. Redondo, et al. (2007). An approach for modelling interactive and collaborative aspects in CSCL systems. Computers and Education: E-learning, From Theory to Practice. B. Fernández and J. M. Sánchez, Springer: 111-121.

[UCLM-28] Molina, A. I., M. A. Redondo, et al. (2007). "CIAM: A methodology for groupware user interface development." Journal of Universal Computer Science.

[UCLM-29] Molina, A. I., M. A. Redondo, et al. (2007). "A methodological approach for designing collaborative and interactive applications: a case study." Information & Software Technology.

[UCLM-30] Molina, A. I., M. A. Redondo, et al. (2007). A proposal of integration of the GUI development of groupware applications into the Software Development Process. 13th International Workshop on Groupware (CRIWG'2007), Argentina, Springer Verlag.

[UCLM-31] Paredes, M., A. I. Molina, et al. (2008). "Developing Collaborative User Interfaces for Ubiquitous Applications Using CIAM: The AULA Case Study." Journal of Universal Computer Science.

[UCLM-32] Redondo, M. A. and C. Bravo (2006). "DomoSim-TPC: Collaborative Problem Solving to Support the Learning of Domotical Design." Journal Computer Applications in Engineering Education 4(1): 9-19.

[UCLM-33] Redondo, M. A., C. Bravo, et al. (2006). Contextualized Argumentative Discussion for Design Learning in Group. HCI related papers of Interacción 2004. R. Navarro and J. Lorés, Springer: 317-328.

[UCLM-34] Redondo, M. A., C. Bravo, et al. (2007). "Providing adaptation and guidance for design learning by problem solving. The DomoSim-TPC approach." Computers and Education 48(4): 642-657.

Utility of results

All the results of our research are directly applicable to the main areas of research of our group: in Computers and Education and Human – Computer Interaction.

Human resources

Several PhD Thesis are being carried out in the context of this project such as the ones by: Francisco Jurado, Rafael Duque, Jesús Gallardo, William J. Giraldo, Asunción Sánchez and Manuel

I. Martínez. All these researchers achieved the Master thesis in this period. The doctoral thesis of Maximiliano Paredes, Ana I. Molina and Pedro P. Sánchez VIllalón were realized in the framework of this project in 2006 and 2007.

Coordination

The coordination with the rest of partners has been achieved using the standard methods of the collaborative platform based on dotLRN, and meetings.

Collaborations

Several research exchanges have been done within the context of this project until now. Crescencio Bravo visited the University of Twente (The Netherlands) for three months. Pedro P. Sánchez Villalón visited Oxford Brooks University also for three months. Manuel Ortega visited the University of Maryland in May-June of 2007. Ana I. Molina, Francisco Jurado and Manuel Ortega will visit the University of Essen – Duisburg (Germany) in October – December 2007.

Additionally César Collazos from the University of Cauca (Colombia) made a postdoctoral stay of three months in the UCLM and Professor Ulrich Hoppe made a research stay of 1 month with the CHICO Group.

All these research exchanges will produce some research collaborations between the universities involved in the future.

3.4 UC3M

Objectives

We have reached all goals previously planned for this stage of the project.

Relevance of results

We have we have published several papers related to the project goals in international conferences, workshops and some journals.

[UC3M-1] Susana Fernández, Ricardo Aler, and Daniel Borrajo. Transferring learned control-knowledge between planners. In Manuela Veloso, editor, Proceedings of IJCAI'07, Hyderabad (India), 2007. IJCAI Press.

[UC3M-2] Tomás de la Rosa, Angel García-Olaya and Daniel Borrajo, Using Cases Utility for Heuristic Planning Improvement, In Proceedings of the International Conference on Case-Based Reasoning, Springer Verlag, Lecture Notes in Artificial Intelligence, 2007

[UC3M-3] Tomás de la Rosa, Angel García-Olaya, and Daniel Borrajo. Case-based recommendation of node ordering in planning. In Douglas D. Dankel II, editor, Proceedings of the 20th International FLAIRS Conference, Key West, FL (USA), 2007. AAAI Press.

[UC3M-4] Jesús Lanchas, Sergio Jiménez, Fernando Fernández and Daniel Borrajo, Learning action durations from executions, In Proceedings of the ICAPS'07 Workshop on Planning and Learning, Providence, Rhode Island (USA), 2007

[UC3M-5] Francisco Javier García and Fernando Fernández Rebollo, Reinforcement Learning in the RoboCup-Soccer, in Actas de la Conferencia de la Asociación Española para la Inteligencia Artificial (CAEPIA'07), 2007

[UC3M-6] Raquel Fuentetaja and Daniel Borrajo. Improving control-knowledge acquisition for planning by active learning. In Johannes Fuernkranz Tobias Scheffer and Myra Spiliopoulou, editors, Proceedings of 17th European Conference on Machine Learning (ECML'06), volume 4212 of Lecture Notes in Computer Science, pages 138-149, Berlin (Germany), 2006. Springer Verlag.

[UC3M-7] Rocío García, Fernando Fernández, and Daniel Borrajo. Combining macro-operators with control knowledge. In Ramón Otero, editor, Proceedings of Inductive Logic Programming (ILP'06), Lecture Notes on Artificial Intelligence, Santiago de Compostela (Spain), 2006. Springer Verlag.

[UC3M-8] Raquel Fuentetaja, Daniel Borrajo, and Carlos Linares. Improving relaxed planning graph heuristics for metric optimization. In Ariel Felner, Robert C. Holte, and Hector Geffner, editors, Working notes of the AAAI'06 Workshop on Heuristic Search, Memory Based Heuristics and Their Applications, Boston, MA (USA), July 2006. AAAI Press.

[UC3M-9] Tomás de la Rosa y Raquel Fuentetaja. Integrating Actions Precondition Difficulty within the Relaxed Plan Heuristic Measure. Working notes of the AAAI'06 Workshop on Heuristic Search, Memory based Heuristic and their Applications, Boston, MA (USA), July 2006. AAAI Press.

[UC3M-10] Tomás de la Rosa and Daniel Borrajo and Angel García-Olaya. Replaying Type Sequences in Forward Heuristic Planning. Working notes of the AAAI'06 Workshop on Learning for Search, Boston, MA (USA), July 2006. AAAI Press.

[UC3M-11] Raquel Fuentetaja and Daniel Borrajo. Some active learning schemes to acquire control knowledge for planning. Working notes of the AAAI'06 Workshop on Learning for Search, Boston, MA (USA), July 2006. AAAI Press.

[UC3M-12] Susana Fernández and Ricardo Aler and Daniel Borrajo. Transfer of Learned Heuristics among Planners. Working notes of the AAAI'06 Workshop on Learning for Search, Boston, MA (USA), July 2006. AAAI Press.

[UC3M-13] Sergio Jiménez, Fernando Fernández, and Daniel Borrajo. Inducing non-deterministic actions behavior to plan robustly in non-deterministic domains. In Christophe Guettier, editor, Working notes of the ICAPS'06 Workshop on Planning under Uncertainty and Execution Control for Autonomous Systems, pages 67-74, Ambleside (U.K.), June 2006.

[UC3M-14] David Manzano-Macho, Asunción Gómez-Pérez, and Daniel Borrajo. HOLA: A hibrid ontology learning architecture. In Steffen Staab and Vojtech Svatek, editors, Proceedings of the 15th International Conference on Knowledge Engineering and Knowledge Management (EKAW2006), Podebrady (Czech Republic), October 2006

[UC3M-15] Susana Fernández, Roberto Adarve, Miguel Pérez, Martín Rybarczyk, and Daniel Borrajo. Planning for an AI based virtual agents game. In Ruth Aylett and Michael Young, editors, Working notes of the ICAPS'06 Workshop on AI Planning for Computer Games and Synthetic Characters, pages 14-20, Ambleside (U.K.), June 2006

Utility of results

Many of the research is not only applicable to education, but also to many other areas in which planning is or can be applied, such as workflow management, crisis management, or transport planning.

Human resources

Several PhD thesis are being carried out in the context of this project as the ones by: Raquel Fuentetaja, Sergio Jiménez, Tomás de la Rosa, Rocío García, Javier Ortiz, Daniel Pérez, and Alejandro Vallejo.

Coordination

The coordination with the rest of partners has been achieved using the standard methods of the collaborative platform based on dotLRN, and meetings.

Collaborations

Three research exchanges have been done within the context of this project until now. Sergio Jiménez visited Univ. of York and Univ. of Strathclyde on 2006, while Carlos Linares has just finished on 2007 a visit to Univ. of Alberta at Edmonton. Also, Daniel Borrajo will be visiting for a year Carnegie Mellon University on 2007-08. A CENIT project has just been approved, and two more projects have been submitted.

3.5 UPV

Objectives

We have reached all goals previously planned for this stage of the project.

Relevance of results

We have published several papers related to the project goals (see list of Publications below). We would like to highlight the paper submitted to the European Conference on E-Learning, whose extended abstract has been accepted (see publication [UPV-10]).

JOURNALS INDEXED IN JOURNAL CITATION REPORT (JCR).

[UPV-1] O. Sapena, E. Onaindía. Planning in highly dynamic environments: an anytime approach for planning under time constraints. Applied Intelligence,(in press), 2007. Springer. ISSN: 0957-4174

[UPV-2] L. Castillo, E. Armengol, E. Onaindía, L. Sebastiá, J. Glez-Boticario, A. Rodríguez, S. Fernández, J. D. Arias, D. Borrajo. SAMAP. An user-oriented adaptive system for planning tourist visits. Expert Systems with applications, Vol. 35(2), (in press), 2007 Elsevier. ISSN: 0957-4174

[UPV-3] A. Garrido, E. Onaindía. Domain-Independent Temporal Planning in a Planning-Graph-Based Approach Artificial Intelligence Communications (AICOMM). The European Journal on Artificial Intelligence, Vol. 19(4), pp. 341-367, 2006. IOS Press. ISSN 0921-7126

[UPV-4] L. Sebastiá, E. Onaindía, E. Marzal. Decomposition of planning problems. Artificial Intelligence Communications (AICOMM). The European Journal on Artificial. Intelligence, Vol. 19(1), pp. 49-81, 2006. IOS Press. ISSN 0921-7126

BOOK CHAPTERS

[UPV-5] Marín, Roque; Palma, José (editors). INTELIGENCIA ARTIFICIAL Y SISTEMAS INTELIGENTES. McGraw Hill. (Febrero 2007). ISBN-10: 8448156188. Chapter: PLANIFICACIÓN. Authors: Eva Onaindía, Antonio Garrido

[UPV-6] A. Garrido, E. Onaindía. Extending classical planning for time: research trends in optimal and suboptimal temporal planning. Artificial Intelligence for Advanced Problem solving Techniques Idea Group Publishing. ISBN: in press

SERIES LNCS/LNAI

[UPV-7] E. Marzal, E. Onaindía, L. Sebastiá. Scheduling a plan with delays in time: a CSP approach CAEPIA-06 (post-proceedings). Lecture Notes in Artificial intelligence. Current Topics in Artificial Intelligence. LNAI 4177, pp. 399-408, 2006. Springer-Verlag. ISBN: 3-540-45914-6

[UPV-8] O. Sapena, E. Onaindía. An on-line approach for planning in time-limited situations IEA/AIE-06. Lecture Notes in Artificial intelligence. Advances in Applied Artificial Intelligence LNAI 4031, pp. 383-392, 2006. Springer-Verlag. ISBN: 3-540-35453-0

[UPV-9] A. Garrido, E. Onaindía, Mª Guadalupe García-Hernández. An Integrated and Flexible Architecture for Planning and Scheduling. IEA/AIE-06. Lecture Notes in Artificial intelligence.

Advances in Applied Artificial Intelligence LNAI 4031, pp. 1179-1188, 2006. Springer-Verlag. ISBN: 3-540-35453-0

INTERNATIONAL CONFERENCES

[UPV-10] E. Onaindía, O. Sapena, A. Garrido. An AI Planning-based approach for automated design of learning routes. European Conference on E-learning. (submitted)

[UPV-11] A. Garrido, E. Onaindía, O. Sapena. Constraint Programming for planning routes in an e-learning environment. Workshop Constraint Satisfaction Techniques for Planning and Scheduling Problems. ICAPS 2007.

[UPV-12] O. Sapena, E. Onaindía, A. Garrido, M. Arangú. A Distributed CSP approach for solving multi-agent planning problems. Workshop Constraint Satisfaction Techniques for Planning and Scheduling Problems. ICAPS 2007.

[UPV-13] L. Sebastiá, E. Marzal, E. Onaindía. Extracting Landmarks in Temporal. ICAI-2007 Proc. International Conference on Artificial Intelligence, Las Vegas, EEUU, 2007

[UPV-14] A. Garrido, E. Onaindía. Interleaving planning and scheduling: a collaborative approach. Proc. ICAPS-2006 Workshop on Constraint Satisfaction Techniques for Planning and Scheduling, pp. 31-38, Cumbria, UK, 2006.

[UPV-15] A. Garrido, E. Onaindía, M. Arangu. Using constraint programming to model complex plans in an integrated approach for planning and scheduling. PLANSIG 2006. Proc. of the 25th Workshop of the UK Planning and Scheduling Special Interest Group, pp. 137-144, 2006

[UPV-16]. J.A. Álvarez, L. Sebastiá, E. Onaindía. Planning under temporal uncertainty in durative actions. CCIA-06. Frontiers in Artificial Intelligence and Applications. Vol. 146, pp. 195-202, 2006

Utility of results

The graphical tool is currently being used by several instructors to define learning routes for the courses "Programming" and "Data structures". This feedback will help us validate the utility and the necessary improvements in the graphical tool.

Human resources

Two graduate students have joined the research group and working in the development of the instructor-oriented graphical and the automated planner. In particular, they are doing their "Final Studies Project" within the context of ADAPTAPLAN.

Additionally, we have incorporated two training grant students in the project to collaborate in the development of the automated planner. (see complementary projects)

One PhD is being carried out in the context of the project (Doctorate student: Marlene Arangu).

Coordination

The coordination with the rest of partners has been achieved using the standard methods of the collaborative platform based on dotLRN, and meetings.

Collaborations

We have been granted a project from "Generalitat Valenciana" as a complementary economic support to the current McyT project. This economic aid has been used to hire the two training grant students for a year (partial time).

We have also been granted a CONSOLIDER project (Agreement technologies, Carles Sierra, CSIC, URJC1, UPV).

3.6 UNED

Objectives

We have reached all goals previously planned for this stage of the project.

Relevance of results

We have we have published several papers related to the project goals in international conferences, workshops and some journals.

[UNED-1] J. G. Boticario, O. C. Santos. An open IMS-based user modelling approach for developing adaptive learning management systems. Journal of Interactive Media in Education (JIME), KMI, UK, 2007 (in Press). ISSN: 1365-893X

[UNED-2] O. C. Santos, J. G. Boticario. Supporting Learning Design via dynamic generation of learning routes in ADAPTAPlan. Proceedings of the 13th International Conference on Artificial Intelligence in Education (AIED'07). IOS Press, Los Angeles, USA, July 2007. ISBN: 978-1-58603-764-2

[UNED-3] J. G. Boticario, O. C. Santos. A dynamic assistance approach to support the development and modelling of adaptive learning scenarios based on educational standards. User Modelling 2007: Supplementary Proceedings: A3H: Fifth International Workshop on Authoring of Adaptive and Adaptable Hypermedia. Eds by A. Cristea and R. Carro. Corfu, Greece, June 2007

[UNED-4] C.R. Blesius, P. Moreno-Ger, G. Neumann, E., Raffenne, J. G. Boticario, C. Delgado. .LRN: E-Learning Inside and Outside the Classroom: Supporting Collaborative Learning Communities using a Web Application Toolkit. In Computers and Education. E-learning, From Theory to Practice. Spriger Verlag, 2007. ISBN: 978-1-4020-4913-2

[UNED-5] O. C. Santos, J. G. Boticario, E. del Campo, M. Saneiro. IMS-LD as a workflow to provide personalized support for disabled students in Higher Education institutions. User Modelling 2007: Supplementary Proceedings: Towards User Modelling and Adaptive Systems for All. Eds by J.G. Boticario and O.C. Santos. Corfu, Greece, June 2007

[UNED-6] Castillo, L., Armengol, E., Onaindía, E.,. Sebastiá, L., Boticario, J.G., Rodríguez, A., Fernández, S., Arias, J.D., Borrajo, D. SAMAP. A user-oriented adaptive system for planning tourist visits. International Journal of Expert Systems With Applications. Vol. 35(2), (in press), 2007 Elsevier. ISSN: 0957-4174

[UNED-7] Olga C. Santos, J. G. Boticario, A. Fernández del Viso, S. Pérez de la Cámara, C. Rebate and E. Gutiérrez y Restrepo. Basic skills training to disabled and adult learners through an accessible e-Learning platform. Proceedings of the 12th International Conference on Human-Computer Interaction: HCI Applications and Services. Eds. Julie Jacko. Lecture Notes in Computer Science (LNCS 4556). Springer-Verlag. ISBN: 978-3-540-73109-2

[UNED-8] O. C. Santos, J. G. Boticário. Meaningful pedagogy via covering the entire life cycle of adaptive eLearning in terms of a pervasive use of educational standards: the aLFanet experience. Innovative Approaches for Learning and Knowledge Sharing. Lecture Notes in Computer Science (LNCS, Volume 4227/2006). Springer Verlag. ISBN: 978-3-540-73109-2

[UNED-9] O. C. Santos, J. G. Boticário. Requirements for building accessible web-based communities for people with special needs. International Journal on Web Based Communities. IEL Editorial (in Press), 2007. ISSN: 1477-8394

[UNED-10] O.C. Santos, J. G. Boticario. Issues in developing adaptive learning management systems for higher education institutions. International Workshop on Adaptive Learning and Learning Design (ADALE). The International Conference on Adaptive Hypermedia and Adaptive Web-Based Systems (AH2006). Dulin (Ireland), June, 2006.

[UNED-11] O.C. Santos, J. G. Boticario. Building Virtual (Learning) Communities to Support People with Special Needs upon ALPE Platform. 4th International Conference on Multimedia and Information and Communication technologies in Education. San Sebastián (Spain), February 2006. ISBN: 972-8924-10-0.

[UNED-12] O.C. Santos, J. G. Boticario. Computational Intelligence in adaptive and accessible learning environments. Actas del II Simposio de Inteligencia Computacional, SICO'2007 (IEEE Computational Intelligence Society, SC). Congreso Español de Informática (CEDI 2007), Zaragoza, septiembre 2007. (in Press)

[UNED-13] O. C. Santos, S. Baldiris, R. Fabregat, J. G. Boticario. Modelado de cursos mediante el uso intensivo de estándares educativos para dar soporte a adaptaciones dinámicas. Actas del Simposio Nacional de Tecnologías de la Información y las Comunicaciones en la Educación (SINTICE 2007). Congreso Español de Informática (CEDI 2007), Zaragoza, septiembre 2007. (in Press)

[UNED-14] S. Baldiris, O. C. Santos, C. Barrera, J. G. Boticario, J. Velez, R. Fabregat,. Linking educational specifications and standards for dynamic modelling in ADAPTAPlan. Proceedings of the International Workshop on REpresentation models and Techniques for Improving e-Learning: Bringing Context into Web-based Education (ReTIeL'07). Denmark, August 2007. (in Press)

[UNED-15] S. Baldiris, R. Fabregat, and O.C. Santos, Modelling Competencies upon dotLRN. International Conference and Workshops on Community Based Environments: OpenACS and .LRN Spring Conference, Vienna, April 2007.

[UNED-16] A. Bayón, O. C. Santos, J. G. Boticario. Implementing a collaborative task in dotLRN web-based learning environment. International Conference and Workshops on Community Based Environments: OpenACS and .LRN Spring Conference, Vienna, April 2007.

[UNED-17] O. C. Santos, J. G. Boticario, E. Raffenne, R. Pastor. Why using dotLRN? UNED use cases. Proceedings of the FLOSS (Free/Libre/Open Source Systems) International Conference. Jerez de la Frontera, Spain, March 2007. ISBN: 978-84-9828-124-8

[UNED-18] J. G. Boticario, M. Cooper, L. Montandon, K-J van Dorp. Towards an Open, Standard-based, Reusable and Extensible Architecture of Services for Accessible Lifelong Learning: An Introduction to the EU4ALL Project. EADTU Annual Conference: Widening participation and opportunities by e-learning in Higher Education. Tallinn, Estonia, November 2006.

[UNED-19] O. C. Santos, J. G. Boticario, A. Rodríguez, E. Gutiérrez y Restrepo and C. Barrera. Accessible and Reusable courses on ALPE Platform. Proceedings of the FLOSS (Free/Libre/Open Source Systems) International Conference. Jerez de la Frontera, Spain, March 2007. ISBN: 978-84-9828-124-8

[UNED-20] O.C. Santos, J. G. Boticario. European Unified Approach for Assisted Lifelong Learning. Proceedings of the 4th International Conference on Multimedia and Information and Communication technologies in Education (m-ICTE 2006). Sevilla, November 2006 ISBN: 84-690-2474-4

[UNED-21] O.C. Santos, J. G. Boticario. Lecciones aprendidas en aLFanet para desarrollar sistemas de gestión del aprendizaje innovadores. Proceedings of the 8th Simposium on Computers in Education (SIIE'06). León, octubre 2006. ISBN: 84-9773-302-9

[UNED-22] O.C. Santos, S. Baldiris, J. Velez, J. G. Boticario, R. Fabregat. Dynamic Support in ADAPTAPlan: ADA+. In Actas de la Conferencia de la Asociación Española para la Inteligencia Artificial (CAEPIA'07), 2007 Salamanca, noviembre 2007.

Utility of results

UNED research group is currently exploiting ADAPTAPLan outcomes in related European research projects where objectives go beyond the e-learning framework to cover all the different types of services, from administrative to research, that are usually provided in higher education institutions. The idea is to generalise the approach to deal with all the activities involving workflows.

Human resources

Several PhD thesis are being carried out in the context of this project.

Félix Hernández del Olmo. “Contributions to the evaluation of recommender systems”. Phd. 2005. Advisor: J. G. Boticario. This thesis set up the basis of the recommendation strategies to be considered and further develop by UNED in ADAPTAPlan and was finished while stating the project.

Olga Cristina Santos Martín-Moreno. “Contributions to the design, implementation, and evaluation of adaptive, standard-based, and accessible learning management systems which integrate instructional design with artificial intelligent techniques”. Ongoing work of this thesis has already produced a wide range of valuable publications. It will be completed by mid 2008.

Miguel Montero López. “PDINAMET: A tutoring system in secondary education with support to the teacher”. To be defended in October 2007. Advisors: J. G. Boticario, Elena Gaudioso.

Angel M. Buide Maroto has already present is DEA in his PhD program on “Academic and professional guidance by an intelligent support system”. This research work is exploiting and further developing the adaptation capabilities of the UNED’s adaptation framework.

Antonio Rodríguez Anaya. “Contributions to managing, monitoring and evaluating collaborative work in education”. This thesis is expected to be completed by end 2008.

Coordination

As project coordinators, the project management approach considered for ADAPTAPlan is based on the previous organisation and management plans which have been successfully applied in previous coordinated projects where several of the research groups of the project have been involved. In particular, in our previous experience in SAMAP project. The primary aim of the management structure that has been established is to be capable of responding to the needs of a coordinated project without being intrusive or costly. In order to support the required flexibility as well as guaranteeing an optimal co-ordination and follow-up procedures for monitoring tasks progress and allocation of resources to the project activities, tasks as well as responsibilities and groups involvement we have set up a collaborative space on top of the dotLRN platform, which is an enterprise-class software for supporting e-learning communities developed on top of OpenACS toolkit for building scalable, community-oriented web applications.

UNED group has contributed and continuous contributing to OpenACS/dotLRN community and has developed and maintained the ADAPTAPlan collaborative workgroup, which resembles in terms of working groups and subgroups the structure of the project itself.

Collaborations

UNED group is currently working on two related European research projects.

- Title: EU4ALL: European Unified Approach for Assisted Lifelong Learning
  - Funding organism: European Commision (Priority 2 “Information Society Technologies”, 6th Framework Programme, Call identifier: FP6-2005-IST-5)
  - Proyect type : IP – Integrated project
  - Reference: IST-2005-034778
  - Duration: 48 months, from: 01/10/2006 to: 30/09/2010
  - UNED role: scientific and technological coordination
  - Expected outcomes: Define and construct an extensible “architecture” of European-wide services to support Lifelong Learning for all. The architecture will be based on a standards-based framework which supports services that are open, secure, standards-compliant, accessible and interoperable. Moreover, the project will address advanced research issues in the various fields that impact on ALL, namely standards, user modelling, Design4ALL, semantic web, adaptive interfaces, and human science related fields such as psychology (motivation and support), cognitive sciences, and the educational sciences. To demonstrate the project benefits, this framework will be validated on a large scale via the involvement of key stakeholders on both the demand and supply sides including the mega-universities (the Open University based in the UK and UNED in Spain) and the European Association of Distance Teaching Universities.
  - Partners: Atos Origin S.A. (ES), UNED (scientific and technological coordination) (ES), The Open University (UK), Fraunhofer Institute for Applied Information Technology (FIT) (Germany), University of York (UK), Soluziona SA (ES), Cambridge Training and Development Ltd (UK), Information Society Open To ImpairmentS (GR), GIUNTI Interactive Labs S.r.l. (IT), European Association of Distance Teaching Universities (EADTU) (NL), 11 Centro Interuniversitario di Ricerca per lo Sviluppo Sostenibile (IT), University of Natural Resources and Applied Life Sciences, Vienna (AT), Disabled Peoples International Italia (IT)

- Title: ALPE: Accessible e-Learning Platform for Europe
  - Funding organism: eTEN European Commission Programme (eTEN-029328)
  - Proyect type : Strep
  - Reference: 029328
  - Duration: 18 months, from: 01/01/2007 to: 30/06/2008
  - UNED role: scientific and technological coordination
  - Expected outcomes: The objective of the ALPE service is to improve the human computer interaction (HCI) of disabled and adult learners using an e-learning platform to access a range of basic skill courses on literacy, numeracy and ICT. For this purpose, the ALPE project has set up an open source, standards based, accessible e-learning platform that delivers courses from a repository of accessible, multilingual, SCORM-compliant courses on basic skills, which draws on the practical lessons learned on pedagogical and organisational issues relating to accessible e-Learning. These courses will eventually be provided in a personalised way according to the preferences and needs of the user.
  - Partners: SOLUZIONA, UNED, Open University (UK), Panhellenic Association of the Blind (PAB)

Moreover, due to the nature of the ALPE project UNED has already contacted major stakeholders in accessible learning in Spain and is expected to provide services through the ALPE platform from next October to various institutions and companies such as EOI and Laborla.

I addition, UNED has submitted different proposals to European Life Long Learning Programme, PROFIT and Plan Avanza and is currently preparing a FP7 proposal.

4 Additional references

[1] Paramythis, A. & Weibelzahl, S. (2005). A decomposition model for the layered evaluation of interactive adaptive systems. In: *Proceedings of the 10th International Conference on User Modeling* (Lecture Notes in Computer Science LNAI 3538). Berlin: Springer
[2] Adomavicius, G. and A. Tuzhilin (2005). "Toward the Next Generation of Recommender Systems: A Survey of the State-of-the-Art and Possible Extensions." Knowledge and Data Engineering, *IEEE Transactions on Knowledge and Data Engineering*. 17(6): 749