Personalized Learning and Personalized Tours: Two Sides of the Same Coin

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Abstract. Visiting a real or virtual museum or an archaeological site could be a hard task, especially for large sites provided with many works of art or ancient ruins. For this reason most historical sites propose guided tours, helping visitors to improve their satisfaction and stimulate interests. In this work we explore the use of an e-learning environment, called LECOMPS5, in order to provide museums or other cultural sites with the capability of automatically planning personalized tours, according to visitors needs and interests. LECOMPS5 allows a domain expert, through a suitable GUI, to build a pool of learning components concerning a particular site. Subsequently the system, by means of an embedded planner, automatically generates a personalized tour through the works of art, on the basis of the visitor's artistic interests and needs. We propose a first application of this system to an ancient archaeological site called Lucus Feroniae, showing how an e-learning platform can be successfully used for guiding visitors as well.

1 Introduction

Personalized learning and personalized tours are two very important objectives that are not so far apart. In both cases, people are requested to navigate in a knowledge domain, composed either of virtual Learning Objects (LO), such as it happens for distance learning, or of real works of art, such as it happens when visiting a museum. Artificial Intelligence provides many techniques to deal with the problem of performing personalization and adaptation through automatic systems and with Cultural Heritage domains in general [1][2][3]. For example the PEACH project [8], is concerned with developing a novel integrated framework for museum visits. The authors propose a multifaceted system for

accompanying visitors, augmenting, in this way their overall museum experience. In [4] adaptation in a mobile museum guide is addressed, investigating the relationships between personality traits, such as the emotional state and the attitudes towards some basic dimensions of adaptivity, such as Cognitive State and Learning Styles.

In this work we explore the use of an e-learning platform for the automatic generation of tours in real or virtual Cultural Heritage domains. In particular, we use the LECOMPS5 e-learning system [6, 5] capable to generate automatically personalized learning paths, by means of its embedded Pdk planner [7], to allow the learner to acquire a *Target Knowledge* on the basis of her *Starting Knowledge* [5]. As well as in the learning context, also in Culture Heritage domain a suitable GUI allows the domain expert to build a pool of *Learning Components*, such as pictures or ancient Roman ruins.

The main idea of our work is that a tour in a museum or in an archaeological site can be dealt with an e-learning approach where the works of art are part of the concepts taught through the LO, and a personal learning path is a sequence of LOs that mirrors an actual tour in the cultural site. We propose a case study based on an archaeological site called *Lucus Feroniae*, an ancient place located near Rome. The interests and personal traits of the visitor, intended either as a single person, or as a whole group, are modelled by the system through an initial questionnaire. Then the system can generate a personalized tour tailored on such interests. Visitors, by a suitable technological interface, based for example on GPS technology, are guided during their site tour. Here we present a first application of this approach, generating different tours for different visitors.

This paper is structured as follows: in Section 2 we show the main characteristics of *Lucus Feroniae*. In Section 3 the characteristics of the LECOMPS5 system together with the analogies between personalized learning and personalized tours are illustrated. Section 4 shows an example of tour personalization. Finally, conclusion are drawn in Section 5.

2 Lucus Feroniae

In this Section we show a brief description of the archaeological site we chose for our case study. Lucus Feroniae stands on a travertine platform located in *Capena*, a little old town near Rome. It has very ancient origins as ancient as the origins of worship of the *Feroniae Goddess*, a testimony of an italic cult like those discovered in sanctuaries of *Trebula Mutuesca*, *Terracina*, and *Amiterno*.

The shrine is located at the 18*th* Mile of *Via Tiberina*, at *Scorano*, and the exact location was identified only in 1953, when Prince Victor Maximus, owner of the *Scorano Castle*, and surrounding lands, signaled to the Southern Etruria Superintendency the outcropping, during some works, of the archaeological findings. In Figure 1 we can see a snapshot of the ancient *Via Tiberina* where the site is located, while in Figure 2 the *Amphitheater* is shown.

As we enter the archaeological site, we immediately meet a crossroad between the old *Via Tiberina* and the road to join the sanctuary to *Capena*: the *Capenate*

Fig. 1. A Section of the ancient Via Tiberina.

Fig. 2. The Amphitheatre.

Road where we can see the remains of an ancient gate. This crossroad was a very important road junction and in this place were found the *Cippi Miliari*, dated to the third century B.C., which is the dating of the most recent restoration of these roads. At this crossroad it overlooks a small environment that many have identified as a public latrine. Continuing along the *Via Tiberina*, we immediately notice on our right some not very large environments, which have been identified as meeting and refreshment points, perhaps *Tabernae*. After we meet a rectangular square with an East-West orientation where there is still a part of the ancient pavement made with rectangular slabs of limestone. Another interesting characteristic is the *Amphitheater* of which the load-bearing structures remained. It has a very unique form: it is almost circular, but, although very small, it presents all the characteristic aspects of a true *Amphitheater* with its doors still very well preserved, with the *Vomitoria*, that is, exits for the public, and service environments below the stairs. Finally, the south side is less preserved

and recently, precisely in this area, came to light some structures certainly of the Republican Roman era. On the North there is the purely religious area, the focal point of the ancient political life and administration of worship in the city.

3 The System

In the following, after a brief description of the LECOMPS5 platform, we show the analogies between the generation of personalized e-learning courses and the personalized tour generation in cultural sites.

3.1 Lecomps5

LECOMPS5 [5] is a web-based e-learning environment supporting funtionalities for teachers, students, and administrators, capable to generate personalized and adaptive courses on the basis of the students' starting knowledge on the domain of interest, and on the basis of the student's learning styles. A personalized course, related to a given subject matter, is characterized by the Target Knowledge (TK), that is the knowledge to be acquired by the student through the course, and by the Starting Knowledge (SK), that is the student's knowledge about the topic before taking the course. The knowledge is represented by atomic elements, called Knowledge Items (KI). A course is composed by a set of Learning Components (LC), i.e., learning objects enriched with the specification of the Required Knowledge (RK, prerequisites) and the Acquired Knowledge (AK), related to the learner's fruition of the component's learning content (both expressed as sets of KI); a value for the effort needed by the learner to study the material contained in the LC is also specified. The effective acquisition of the AK of a given LC can be evaluated through questions, included in the LC and related to the concepts explained there. All the LCs related to a given subject matter are collected together into a pool, that is a sort of knowledge database. The teacher defines prerequisite relationships among LCs. This task is made easy by the graphic visualization of such relationships. LECOMPS5 configures the personalized course for a given student on the basis of her SK, measured by a pre-test, of her TK, pre-defined by the teacher, and on the basis of LCs, as arranged by the teacher in the graph. LECOMPS5 selects the LCs such that the AK of all such selected components, together with the SK, covers the TK. The automated configuration of the course is performed by means of the Pdk planner, described in the following.

3.2 Tour Generation

In order to put the e-learning environment on trial, for generating personalised tours, we have to highlight some similarities and differences we think do exist between didactic courses and cultural tours. The main differences are in that visitors are not evaluated during their tours, while students are evaluated during their learning process and the relationships among works of art are not necessary

prerequisite relationships. Then, the path of a cultural tour is actually a sequence of "stations", i.e., steps, each one modelled by one of the learning components in the sequence.

Besides these differences, cultural sites tours can be thought as learning problems as well, as shown in Tab. 1.

	e-learning domain	**Cultural Heritage domain**
SK	starting knowledge	interests and prior knowledge
TK	target knowledge	the set of works of art to be visited
KI	knowledge item	the work of art
RK	required knowledge	the work of art that should have been visited
AK	acquired knowledge	the work of art visited during a step of the tour (acquisition of the step)
LC	learning component	a model of a step in the tour
effort	cognitive load of the learning component	estimated time to visit the work of art

Table 1. LECOMPS5: analogies between personalized learning and personalized tours.

The domain expert defines a set of relationships among the learning components, that is the works of art describing the cultural site. Tour generation corresponds to plan a sequence of actions leading to a personalized goal, that is, to visit all the places and works of art, on the basis of the visitors interests as indicated in the initial questionnaire. When a visitor executes an action of the plan, she is offered the description, according to her user model, of the part of the site (or the work of art) she is looking at. In order to perform tour generation we need to use a tool that allows to specify the requirements of domain experts and visitors in an easy way. To this aim, we focus our attention on logic-based planners, which can exploit some important functionalities such as: domain validation, redundant actions detection or control knowledge specification, i.e., additional information that can enrich the planning domain (given as mere list of actions with their preconditions and effects) and guide the plan synthesis. For instance, once a pool is arranged, the domain expert might want to specify that if a given work of art has to be visited, it is necessary to see another one before, or that a visitor prefers to see only works of art with a given theme, or that a visitor is already expert and she wants to know only elaborations about a given work, or that a visitor does not know anything about the place she is visiting, or she is a child, and the explanation has to be as simple and direct as possible. What is needed is a language that allows the domain expert to specify such kind of "control knowledge". The Pdk planner conforms to the "planning as satisfiability" paradigm, and the logic used to encode planning problems is the propositional Linear Time Logic (LTL) [9]. The related planning language PDDL-K [7] guides the domain expert for the specification of control knowledge.

Pdk accepts PDDL-K as input language, parses the problem description into its LTL representation and reduces planning to model search.

4 The Case Study

Our example is inspired by the archeological site of *Lucus Feroniae*, described in Section 2. Let us suppose that a visitor does not want to see all the works of art at the site, but she is interested in a special "theme track", e.g.: she wants to see all the epigraphies, or all the tombs or all the statues and so on.

In order to plan a desirable tour for a given visitor, LECOMPS5, through its GUI, allows the domain expert to configure the location of the works of art and the preferences of the visitors in an easy and expressive way.

In our case study, there are two visitors, with different preferences. The first one, with specific historical interests, wants to examine epigraphies, while the second one wants to see more in general fountains, statues, marbles and columns. The personalized tours, as generated by the system, are shown in Tab. 2, while in Figures 3 and 4 are illustrated directly by the LECOMPS5 system.

Visitor A epigraphies	**Visitor B Statues, fountains marbles and columns**
Ingresso sito archeologico	Ingresso sito archeologico
Anfiteatro	Tabernae
Foro	Basilica
Augusteo	Foro
	Augusteo

Table 2. The two different generated tours.

The generated tours are compatible with the preferences of the two different visitors. In fact, in the domain description, the learning components present the following characteristics:

- Anfiteatro: epigraphies
- Tabernae: marbles
- Terme: ceramics and mosaics
- Foro: columns, epigraphies, fountains and aqueduct
- Augusteo: statues, epigraphies, marbles and mosaics
- Basilica: columns

From the previous Tab. 2, we can see that none of the two visitors have to visit the *Terme*, since they are not interested either in ceramics or mosaics.

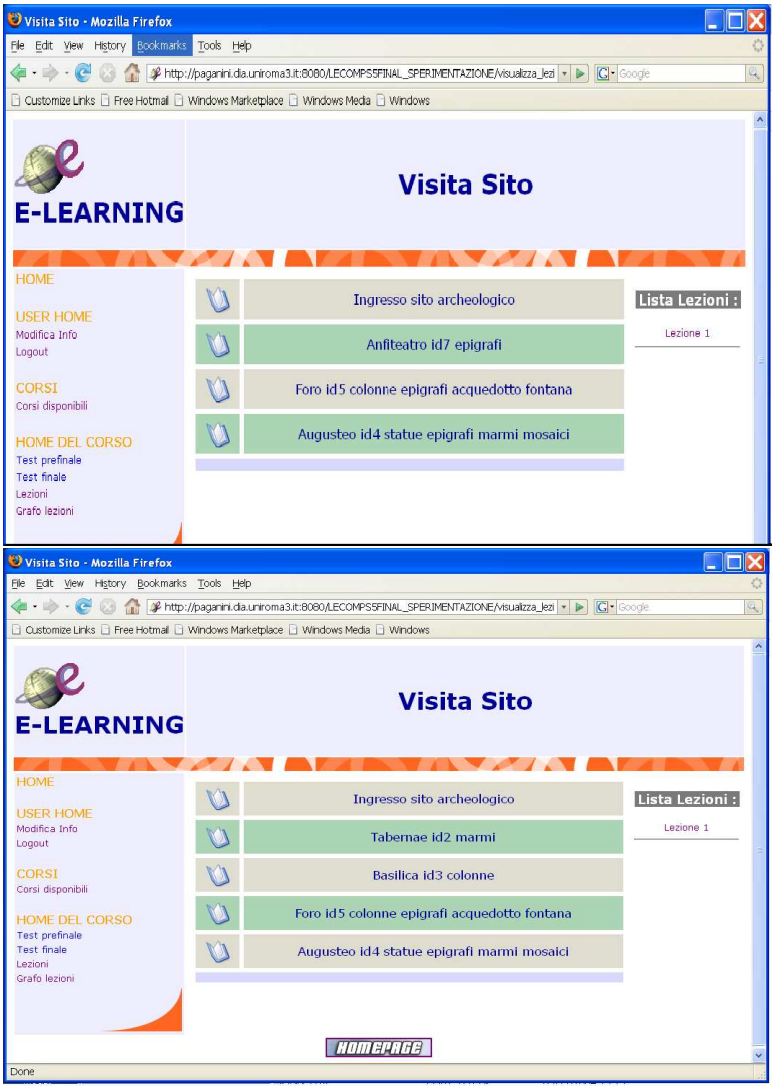

Fig. 3. The LECOMPS5 system window with the proposed tour for the second visitor

5 Conclusions

In this paper we presented an application of the LECOMPS5 e-learning environment, to the automatic generation of personalized tours. The main idea of this work was the exploration of an e-learning environment, used for distance learning, for personalizing tours in museums or archaeological sites automatically. We showed that there are many analogies between personalized learning and personalized tours so allowing the same environment to be used. In particular, the examples illustrated in Section 4 showed the possibility to define personalized tours for visitors with different interests. However, the PDDL-K language, together with LECOMPS5 system, can offer many other ways of personalization, like the explanation level, depending on the user's background, actually already provided for e-learning courses.

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