Ariadne, a guiding thread in the learning process's labyrinth

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In traditional learning teachers are the responsible for changing and adapting course resources depending on the evolution of the students. After several years of teaching they are able to know which way is the most effective to learn something specific or which exercise is the most didactic for a particular student. In general, they are able to adapt course contents to each student in order to make it more effective. With the aim of adding the human teacher's experience to the e-learning systems we are developing Ariadne, a system that adapts to the student based both on the student previous knowledge and on the results obtained by other previous students to whom the same activity was recommended. As Ariadne is in its early stages, this article shows a 'To-Do list' to make this level of adaptation possible. Different tasks such as storing large amount of data about the interaction with the system; and applying a Knowledge Discovery in Databases (KDD) process have to be done. Furthermore, we have to put special care on the data mining and feature subset selection techniques used during the KDD process to ensure we have obtain all the knowledge hidden in the data in an optimal way. Once the system has information about 'previous learning experiences' it can recommend the students which way they should follow to obtain better results during the learning process.

Keywords E-learning; Adaptive systems; Data mining; Feature subset selection; Knowledge Discovery in Databases; Guided navigation

1. Introduction

Teaching and learning techniques are evolving rapidly and web-based learning has become very popular in last years as many web-based learning environments such as Virtual-U [1], Web-CT [2] and Moodle [3] have successfully been developed and adopted as an effective learning mode. This kind of systems takes advantages of what the World Wide Web offers to e-Learning and tries to overcome its disadvantages [4 - 5].

As described in [5] many times the loneliness of the self-learning systems causes the student getting unmotivated and finally giving up the studies. So, it is almost compulsory to design appealing contents to maintain student's attention in order to obtain better results in their learning process. But contents, understood as every lesson or activity of the learning system, should be not only attractive for the student but also useful. A very amusing activity does not have sense in a learning system if it does not content a minimal pedagogical background. Without this background it can be understood as a time consuming and null benefit content and that implies the student wastes time and it is more prone to get tired and abandon.

Besides its design, content has also to be well located in the system, following a learning path where the knowledge is acquired in an incremental way [6]. Otherwise, the learner could get lost trough the learning process. So contents should be designed to help the student achieve the better results in the quickest way.

But content design for an E-learning system is not easy at all and many times what the course designer thinks is a very good resource turns out to be not as useful as planned. How can we measure the usefulness of a concrete resource for learning a concrete concept?

One of our objectives is to develop a method to quantify that usefulness and provide the designer a way of knowing if created resources are really doing what they have been designed for. And once we know

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which resources are the most useful to learn a concrete concept, we can advise the students which way they should follow to acquire that knowledge in the most efficient way and guide them through their learning process. That is the reason we have named our system Ariadne, who guided Theseus out of the labyrinth after killing the Minotaur in Greek mythology. Our students would be Theseus, and the learning process their own labyrinth.
But as a human teacher knows, each student is different, and answers differently to the same stimulus, so if we want Ariadne to be really helpful it must adapt its advices to the type of the student as a teacher would do.
In this paper we will explain the method we are designing nowadays, which implies the usage of Knowledge Discovery in Databases (KDD) and data mining techniques. In the first section we will describe the main objectives of our system; in the second one, the proposed way to reach these objectives is exposed; and finally a section with the extracted conclusions finishes the paper.

2. Ariadne's main objectives

As said in the introduction of this paper, the main purpose of our work is to make the learning of a student more effective in measures of time and knowledge, that is, help the students learning the concepts they do not know without distractions of the other resources in the e-learning system. This way we hope to change the appreciation of the e-learning by the student, making it an attractive and effective way of education.
But determining the effectiveness of a resource is not trouble-free because learning process depends on various variables as previous knowledge, type of student, etc. [7]. So, all these variables have to be taken into account in order to estimate if the resource is really helpful or not.
Once we are able to know which resource is more useful to learn a concept for a certain kind of student, we will be able to detect those resources that are useful for nobody. Then, giving this feedback to the course designer, we are helping to design more effective courses, getting rid of the resources than more than help; they consume student's time without a real pedagogical gain. This feedback will make our system a low effort – big reward system where the course designer gets lots of useful information without having to spend a big amount of time looking for it.
To achieve all these objectives we will work in a concrete e-learning system, yet to determine, but we expect the results to be exportable, and as a consequence get a generic system or at least a set of techniques applicable to any e-learning system.

3. Ariadne's scheme

In this part of the paper, we will layout the steps we are following to design our advising system. As Ariadne will work over an existing e-learning system, the part of defining the domain of the e-learning system, the concepts to study, the resources' definition, etc., is left apart of this paper and it could be done through any of the existing ways of defining learning domains as concept maps [8], CommonKADS [9] or ontology's [10] among others.

3.1 Student's clustering

Trying to advice people which way they should follow to learn something is not an easy task. Each person is unique and different from all others, and each one has a way and capability of learning than no other one has. Having this into account, it is true that although everyone is different, we can group students based on their characteristics expecting them to have a similar behaviour. This method is called supervised classification [11 - 12]
The classification we are going to make will be based on those student characteristics that can affect learning. [7 - 13]. As all the students in a group will have similar characteristics their needs for learning a concept are expected to be very similar, so we will guide them through a similar way.

But, people change as time goes by and the student that was right located into a group, time before could be better located into another group. That is the reason why this student clustering needs to be done quite often in the system. This will allow us to have the students into the right groups and advise them the better we can as much time as possible.

3.2 Data collection

As Ariadne will be the responsible for advising the student the path to follow as a teacher would do in a traditional class, it is obvious that it needs the same background the human teacher has, this is, previous experience. In order to acquire that experience what we need is students working with the e-learning system without the guiding help of Ariadne. This way the data we get from these students is clean and neutral and has no influence of someone telling the student what to do next.
Among the data we have to collect in this training period are all the data referred in section 3.1 that affect the student behaviour and learning, and obviously the data concerning to the path followed by the learner, the resources visited and the results obtained on the proposed tests and activities.

3.3 Knowledge extraction

With the students classified into different groups as said in section 3.1, and with the data collected in the Data collection process, we can apply different KDD techniques to extract the knowledge we want from the data. For example, using some feature subset selection techniques [14 - 15], we can determine which ones of the registered data affect to the learning of a concrete concept. Moreover, we can establish which resources are the most effective to study a concept for a concrete type of students.
As the system refines itself reclassifying students along the time, the extracted knowledge will be more accurate each time.

3.4 Advice / Feedback

Once we know the group a student is into, and the resources useful for that group to learn a subject, we will be able to tell the students which resources from those not visited yet, are the most helpful for them. Thus, we will guide the learners through the system according to their necessities and trying to shorten the amount of time spent learning.
But the extracted knowledge is not only useful for the students but for the course designer as well. As the system will determine how important a resource for learning a concept is, the designer will be able to check if that resource really does what it was designed for. And based on that data the course could be redesigned with new contents or activities to achieve better results, just like traditional teachers would do if they see that an activity proposed in classroom has no the desired effects on the students.

4. Conclusions

In this paper a proposal to develop a guiding system for E-learning systems has been shown. This guiding help, called Ariadne will be a method applicable to any E-learning system that fulfils a series of requisites of stored data and course definition.
Ariadne will allow the students to learn in a more effective way, reducing to its minimum the time expended with the e-learning system and making them the e-learning experience more attractive because they feel they have made the most of their time.
As Ariadne refines itself with the data of new students and the new data generated by old students, it will give better advices as time goes by.

Moreover, our e-learning process's guide helps the course designers letting them know which resources are really useful and which are not. Thus, the designer can redesign a learning resource in order to make

it more useful or can decide erase it from the system because it is not worthy maintaining it and it is a good for nothing resource.

Some ideas of similar systems have been proposed over the years [16 - 17 - 18] but some of them let the knowledge extraction work to the teacher, so the teacher must be a Data-Mining expert to understand the extracted information. Others, take into account only obtained results in previous activities done by the students, and do not adapt to the type of student. Our proposal tries to overcome all these problems and does all the work in an automatic way to give the teacher/course designer the information without a work charge for them.

Nowadays we are working on the first steps of the system, detailing the involved processes, determining the techniques to be used and designing the implementation. The future work we have to face now is to completely develop all this work putting a special emphasis designing a hard test period to validate our theories. All this work will be part of the author's PhD thesis.

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