

Chapter X

Knowledge Discovery from E-Learning Activities

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ABSTRACT

This chapter presents a study applied to the analysis of the utilization of learning Web-based resources in a virtual campus. A huge amount of historical Web log data from e-learning activities, such as e-mail exchange, content consulting, forum participation, and chats is processed using a knowledge discovery approach. Data mining techniques as clustering, decision rules, independent component analysis, and neural networks, are used to search for structures or patterns in the data. The results show the detection of learning styles of the students based on a known educational framework, and useful knowledge of global and specific content on academic performance success and failure. From the discovered knowledge, a set of preliminary academic management strategies to improve the e-learning system is outlined.

INTRODUCTION

This chapter contains a case study on knowledge discovery research carried out on data of graduate and undergraduate courses at the Universidad Politécnica Abierta (UPA) site. This university is a virtual campus at Universidad Politécnica de Valencia and currently it has more than 6,000 students registered in about 230 courses. Figure

1 shows a general schema of the virtual campus learning environment at UPA. The study pursued to obtain knowledge about academic performance success and failure of the students and analyzing the e-learning event activity at the campus Web to recognize patterns on learning styles of the students. Events covered the personal and collaborative use of the Web resources in course activities, including content consulting, e-mail

exchange, forum participation, and so on. The underlying hypothesis was that there is useful hidden knowledge in data from e-learning Web activities for academic management and evaluation of the e-learning system.

The chapter describes an integrated methodology to extract knowledge from quantitative and qualitative data; the results obtained its evaluation and a strategic action outline derived from the discovered knowledge. Different data mining techniques were used to exploit the e-learning data through a knowledge discovery approach (Cabena, Hadjnian, Stadler, Verhees, & Zanasi, 1997; Fayyad, Piatetsky-Shapiro, Smyth, & Uthurusamy, 1996; Maimon & Rokach, 2005). Those techniques included, independent component analysis (ICA), neural networks (NN), clustering, linear regression, and decision trees. ICA allowed distinguishing the independence of the events and detecting learning styles; NN was used to obtain patterns of the student behaviour; linear regression was employed for numeric analyses of the relationship between the student performance and the event activity levels. Quantitative clustering and qualitative conceptual clustering algorithms were applied for grouping data in homogeneous datasets. To enable qualitative analysis of the data, continuous numeric data were converted to discrete value data and descriptions for their interpretation were obtained. Finally, on the descriptive datasets, a mining association rule process was made by applying the C4.5 decision tree algorithm. The obtained decision rules involved global and specific content knowledge that was evaluated by academic experts taking into account their validity, novelty, and simplicity. The results were considered as useful for e-learning academic management.

Data from the use of the UPA Web facilities included the following Web log statistics about e-learning event activities: course access, agenda using, news reading, content consulting, e-mail exchange, chats, workgroup document,

exercise practice, course achievement, and forum participation. Date and time for each event also were available. Besides of the information on the Web activity, the exercises achieved and grades obtained by the UPA's students were tried in the knowledge discovery process. The data were collected from the virtual campus Web in the period from January 2002 to March 2005, totalizing 2,391,003 records.

The process of knowledge discovery covered the following stages:

- Building a reliable data warehouse, by filtering data inconsistencies, solving data heterogeneity problems, and processing data.
- Obtaining and interpreting patterns of the student behaviour in e-learning activities by using independent component analysis, neural networks, and linear regression analysis.
- Obtaining homogeneous data groups by applying clustering processing and selecting data groups, sorted out by research topics, for the definition of decision rules.
- Applying a knowledge representation on selected groups using decision trees to obtain the decision rules of the factors that influence on academic achievement success and failure.
- Evaluating knowledge findings by experts, from the point of view of their validity, novelty, and simplicity.
- Outlining strategies for the improvement of academic processes.

The following sections describe the background and context of this work, the results obtained in each stage of the knowledge discovery process showing partial findings from the data mining techniques. Final sections include the global and particular conclusions about academic performance and learning styles and future work.

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