

COURSE ON ARTIFICIAL NEURAL NETWORKS: DIGITAL EDUCATION

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ABSTRACT: This paper presents a course on Artificial Neural Networks (ANN) in the e-learning environment offered with the tools that the new communication and information technologies provide. The course is based on the classical topics of an ANN course. The new technologies available allow the use of new features of the teaching-learning process including the video delivery of the lectures, the permanent access to the course materials, the utilization of the computer as teaching tool, and others. The main goal of the paper is to describe a valid and useful model of course delivery to provide higher education over Internet to different academic and professional groups.

KEYWORDS: Neural Networks, e-Learning, On-Line Education, Asynchronous Learning, Distance Learning, Multimedia Streaming, Internet Broadcast, Broadband Applications.

INTRODUCTION

On-line education is today a reality in many sectors of the society, especially in educational centres such as colleges and universities, increasingly high schools, and also professional groups demanding continue access to education. Several years ago this new educational method was considered an experimental approach with more disadvantages than advantages. However, today it should be considered not only a complementary educational resource but also a serious alternative that competes to conventional and now classical methods.

Both methods will coexist and the logical initial inertia to ignore the new opportunities provided by the new media should be reduced and be faced sooner better than later in the same manner in which many others areas were modified throughout history since the industrial revolution.

Obviously the adaption to the new features and services of the e-learning environment it is not immediate and requires experience, time, investment, pedagogical and technical resources, and government or campus administration support.

The work presented in this paper is the result of the research of the multimedia group at the School of Engineering in Bilbao. This group has been working since 1997 in the area of on-line education, integrating video transmission and educational environments over Internet. Recent works, Basogain (2000), Olabe (2000), describe the creation of the technological infrastructure (hardware, software and communications) and the academic infrastructure (course materials, teacher-student communication) for the delivery of courses over Internet.

The course on Artificial Neural Networks offered in the e-learning environment presents the required elements of a traditional course: a) course material including syllabus, lectures of the topics in a video format, textbook, slides and class notes in a image format, access to download the simulation software of laboratory, bibliography and relative links over internet b) students tools (grades, progress, homepages, presentations) c) communications tools (e-mail, chats, discussions) to facilitate the student-teacher relationship, and d) evaluation tools as assignments and self-tests for each topic. All these elements are integrated in a system and they are accessible via personal computers over Internet (<http://bixm177.bi.ehu.es>) with a friendly interface both for instructors and students.

COURSE TOPICS

The e-course 'Artificial Neural Networks and their Applications' has been designed using as a reference course imparted in a traditional class environment at the School of Engineering of Bilbao. The traditional was first taught in the Spring 1992 as an elective course in the doctoral program of Basque Country University (UPV-EHU). The course was taught during the Fall of 2000 in a bimodal mode (in the classroom and over Internet) as a transition in preparation for the year when the course will be completely delivered over Internet according to the educational policies of the UPV-EHU, Campusa (1999).

The main goal of the course is to describe the field of neural computation as a serious alternative method in those applications where the classical computational methods do not achieve success results. For this reason, the contents of the course have been selected and organized in order to show clearly to the students the following subjects: a) the foundations of neural networks, b) the architectures and learning rules, c) the computation potential for research and applications, d) their design and simulation. This main goal requires leaving out areas of interest included in more comprehensive programs of other universities, Braham(1994).

The course has been planed including both theory and practice parts. Table I shows the main topics and the number of hours assigned to them.

TOPIC	Number of Lectures	Laboratory
Chapter 0.- Presentation	1	
Chapter 1.- Introduction to the Neural Computation	3	
Chapter 2.- Fundamentals of Artificial Neural Networks	2	
Chapter 3.- Neural Networks Selection	1	2
Chapter 4.- First Artificial Neural Networks	2	2
Chapter 5.- Backpropagation Network	2	2
Chapter 6.- Self Organizing Map & Counterpropagation Networks	2	2
Chapter 7.- Hopfield & Bidirectional Associative Memory Networks	2	1
Chapter 8.- Adaptive Resonance Theory Network	1	1
Chapter 9.- Artificial Neural Networks Applications	2	
Chapter 10.- Fuzzy Logic & Artificial Neural Networks	2	

Table I.: List of Lectures per Topic

The first lecture is the presentation of the course where the global perspective and goals are given. Chapter 1 is the longest and describes in a synoptic manner the basic areas of the neural computation, including the human brain characteristics, biological inspiration, traditional computation versus neural computation, relevant authors of the neural networks history, real applications, and the software and hardware implementation.

Chapter 2 introduces the biological principles of the neural computation and presents the artificial model and their organization in networks. This chapter describes the different learning rules to perform the training process. Chapter 3 points more than twenty paradigms according to the type of application, as prediction, classification, data association, data conceptualization, data filtering and optimization.

Chapter 4 is dedicated to the first networks, Perceptron and Adaline/Madaline, in order to present the main features and characteristics of the neural networks that will be present in the majority of the feed-forward networks; the linear separability limitation is described to understand the impulse to neural computation performed by the Backpropagation algorithm presented in chapter 5.

Chapter 6 shows the architecture and the learning rule of non-supervised networks and their combination with supervised layers present in the hybrid networks. Chapter 7 describes the recurrent network configurations. Chapter 8 describes a neural network that integrates architectures and learning rules in order to solve the stability-plasticity dilemma. Chapter 9 is dedicated to several real applications in research and industrial areas, including communications routing, power load prediction, non-destructive evaluation and others.

The last chapter, chapter 10, gives a panoramic vision of the intelligent control methodologies paying special attention to Fuzzy Logic and its cooperation with the artificial neural networks. The practice part is based on software package NeuralWorks.

DIGITAL EDUCATION

The technology to deliver full-length courses over the Internet is in its infancy, and the future advances will create substantial changes in the education system. Schank (2001) points three areas susceptible to change: new role for teachers, new role for schools, and finally, centralization of curriculum and instructional development.

The multimedia research group at the Engineering School of Bilbao has created the e-course ANN based on the technological and academic infrastructures that integrate the video transmission of lectures over Internet and a support educational environment. The video delivery of lectures adopted by others universities, Stanford (2001), Whashington (2001), allows students to have an adequate time control of the content with the corresponding better understanding of the class material. The implementation of the streaming media system (method of making audio, video and other multimedia available in real-time, with no download waiting time, over the Internet or corporate intranets) appears in the Figure 1.

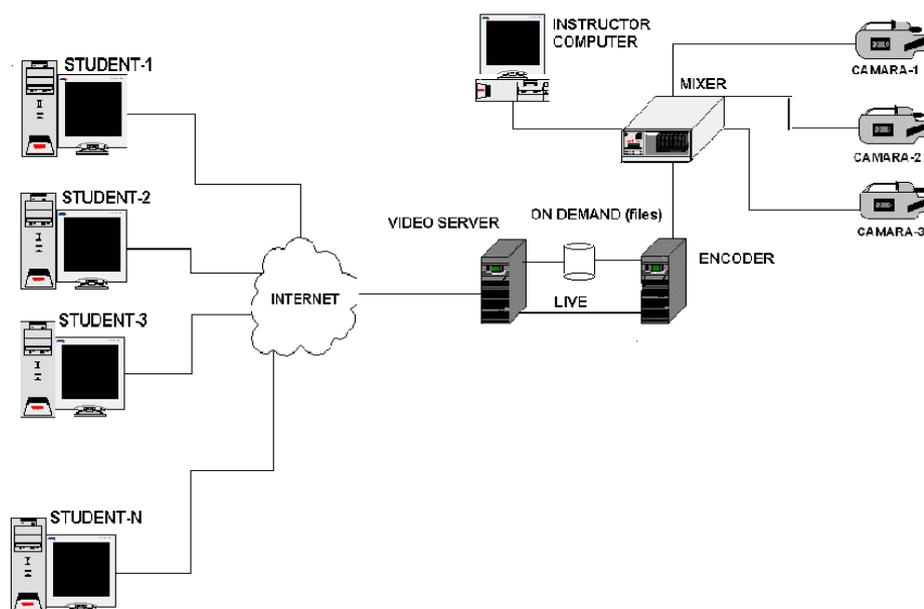


Figure 1: Video Streaming Delivery System

The three basic steps in this approach are: a) creation of the streaming media; b) broadcast the data types; and c) playback of data at end-user's computer. The lecture event in the classroom is recorded by a set of cameras. An operator selects the appropriate video input based on the activity of the professor. An additional video signal was obtained from the instructor's monitor to provide access to his notes or his use of computer programs in class.

The learning environment selected is WebCT, WebCT (2001), which has the most comprehensive, most advanced, most diverse base of course management tools available. The company is the preferred partner of educators in more than 2,100 colleges and universities in 75 countries.

The WebCT software resides on a server and using a web browser, such as Internet Explorer or Netscape, users can gain access to it. In addition it enables the instructor to make changes to his/her course readily from any point of the Internet and to make these changes available to any user at the same time.

This software offers a set of tools designed specifically to accomplish different goals considered in a course design. Table II summarizes the tools with a brief description of them.

Tool	Description	Group
Assignments	Tool to create and distribute course assignments to the students, and download, evaluate, and assign a grade to the completed work	Evaluation
Calendar	Tool to post dates, and provide information about course-related events. You can include links to course content and to relevant websites.	Content
Chat	Tool to have real-time conversations	Communications
Content Assistant	Tool to search or browse the e-Learning communities to find content for the course.	Content
Content Module	Tool to create and organize course material such as lecture notes and assignments. To assist students with their studies can provide additional tools such as learning goals, references, glossary entries, and multimedia presentations, all within a Content Module	Content
Discussions	Tool to create topic areas for discussion. Topics can be public or private.	Communications
Glossary	Tool to create a fully searchable glossary of terms	Content
Goals	Tool to provide students with learning objectives for a Content Module	Content
Image Database	Tool to create databases of images for the students	Content
Mail	Tool to send private mail messages to each user.	Communications
My Grades	Tool to view the students their own grades for the course	Evaluation
My Progress	Tool to see the parts of the course the students have accessed	Study
Quiz	Tool to create and administer online quizzes and surveys	Evaluation
Search	Tool to conduct a search for text within any course	Content
Self Test	Tool to create a multiple choice test that students can use to gauge their knowledge	Evaluation
Student Homepages	Tool set the students need to create a personal Web page	Study
Student Presentations	Tool for the groups create their presentation in HTML as linked web pages	Study
Syllabus	Tool to create a customized course outline. Contains pre-defined sections such as course information and instructor information, and allows you to add custom sections	Content & Basic
Whiteboard	Tool to draw during an online discussion	Communications

Table II.: List of WebCT tools

The WebCT software allows the customization of each course with the tools that the teacher consider necessary for the course. The tools selected for e-course ANN are grouped in the following areas: a) course materials, b) communications, c) evaluation and d) video- lectures as shown in Figure 2.

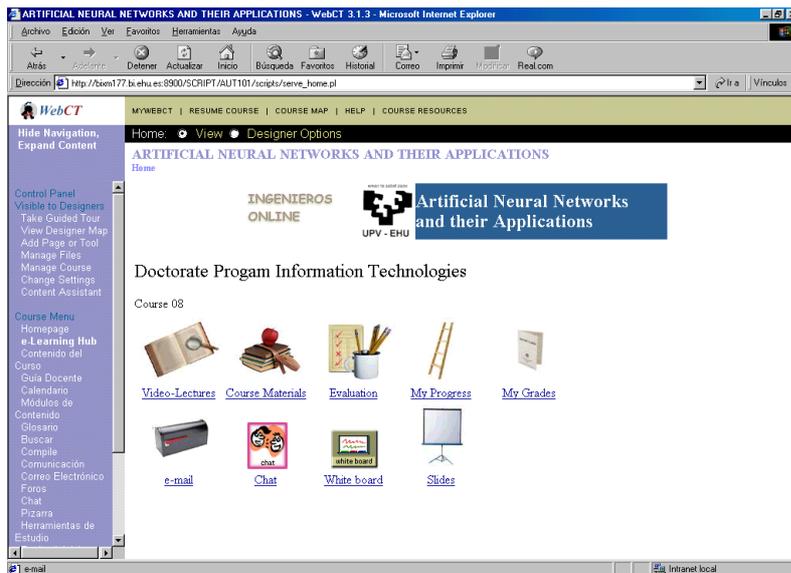


Figure 2: ANN course Homepage

The course materials offer the students the syllabus, the module content, the notes and slides, the software for design and simulation and finally a calendar. The commonly used method to communicate with the student is the e-mail, and for appointed sessions the chat, discussion, and blackboard tools are used. In order to help the learning of the topics in the course, there are available ten self-test with more than two hundred question of multiple choice.

The design of the lecture video screen includes three parts, class window, index window and slide window, as illustrated in Figure 3. The class window is in the upper left corner and students see and hear the professor presenting the lecture. The index window, below the class window, allows the student to address the part of the lecture desired avoiding sequentially access. The large window to the right corresponds to the slide zone. The design aspects of the screen have been selected considering many technological, audiovisual and pedagogical characteristics in order to facilitate the learning process.

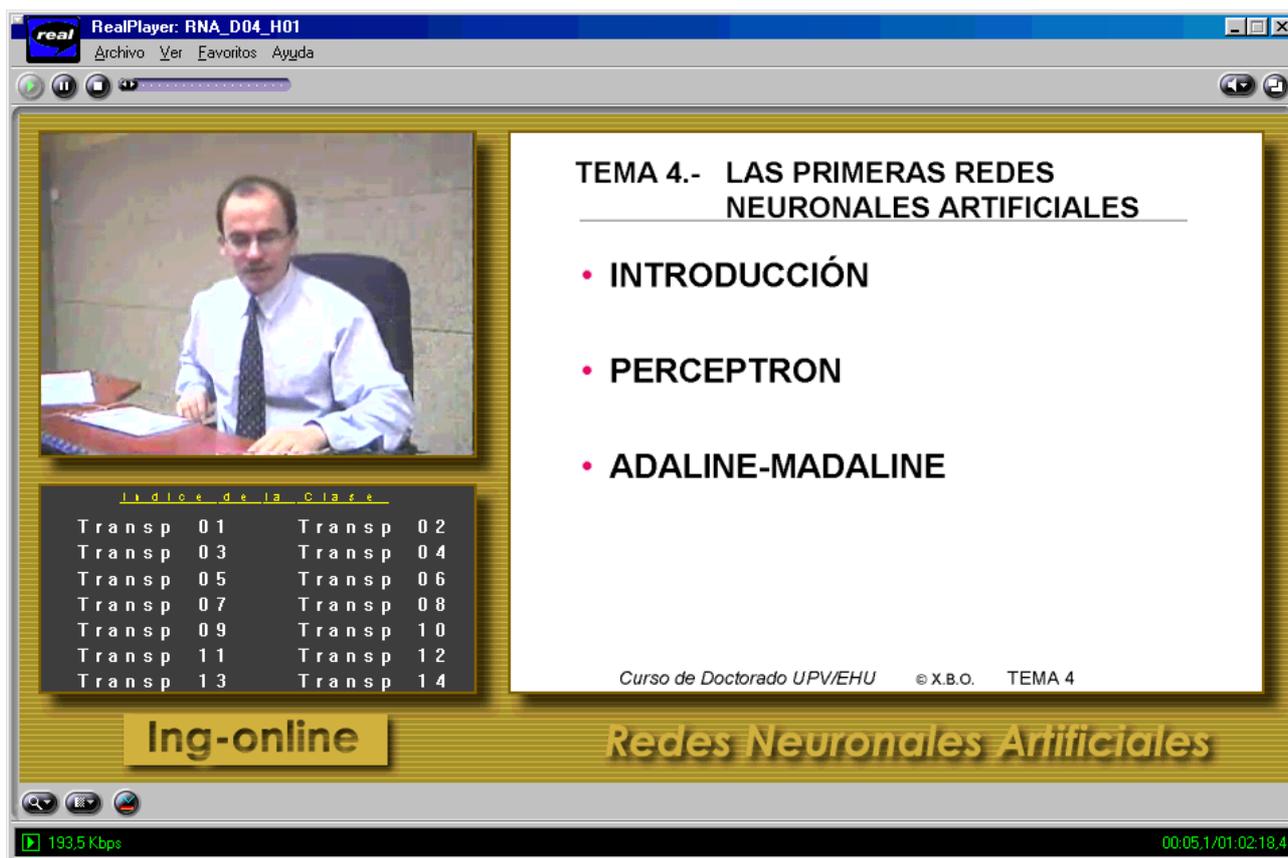


Figure 3: Lecture Video Screen

CONCLUSIONS

This paper describes the work relative to the e-course 'Artificial Neural Networks and their Applications' offered by the UPV-EHU Basque Country University. This e-course has been implemented by a hardware infrastructure (generation and delivery lectures video) and a software infrastructure (learning environment and course materials) that illustrates how the current technology allows the delivery of high-quality full courses online improving on the quality of conventional courses.

The course has been designed to introduce the area neural computation and illustrate its potential both in research and in general applications. Online education will have the impact of allowing group efforts in the development of top-quality courses once, rather than having each university individually produce their courses.

The e-learning experimented in this course of ANN provides some special advantages for teachers: a) supply of a large quantity of course material permanently, such as class notes, slides, content module, references links, software

download, and others. b) improvement of teaching: the format of recorded video lectures requires a scripted and well planned set of contents, examples, problems, and a good visual presentation c) course management: individual student tracking d) on-line changes: any changes in the e-course are immediately available to all students. In addition, there are others advantages for the student: a) distance education: from any site each student has access to the course 24 hours/day and 7 days/week. b) quality of the course: the student could register in many universities offering quality courses.

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