

NEW EXPERIENCES IN A VIRTUAL ENVIRONMENT: E-LEARNING IN THE STATISTIC OF THE FUTURE

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Abstract

Within the context of the new education system in Higher Education, the e-learning is a powerful tool, which is gaining prominence. The use of new technologies of information and communication (NTIC) for distance education makes possible that more people can achieve their educational goals. Depending on the European Credit Transfer System (ECTS), the students' personal work is going to be increasingly important. In fact, each European credit is equivalent to 25-30 hours of study in all countries and is used to facilitate transfer and progression throughout the European Union. Thus, virtual education promotes the students take responsibility for their own learning resulting in a proactive and participatory attitude under the guidance of the teacher-tutor. On the other hand, Statistics is a science in which practice with computer is very important, so that people thought learning-teaching in a virtual environment would be very difficult. To achieve these aims is fundamental to offer suitable material and activities. In this paper, we present the satisfactory learning-teaching experiences in different statistical courses of the virtual Master in Applied Statistic of the University of Granada (Web <http://www.ugr.es/~moea/>).

Keywords: e-Learning, virtual education, SCORM, ECTS, self-learning tutorials.

1 INTRODUCTION

The virtual learning programs (e-learning) are gaining more importance. They are very necessary in the high education environment. The NTIC used for the online formation and teaching is going to do possible more people can get their educational goals. For this reason, the European Union authorities proposed the action plan e-learning [1]. Its objective is to introduce the NTIC () in the European educative system. Nowadays, most universities have a virtual campus with a wide range of online courses. In the university framework, the most used learning platforms are WebCT and Moodle, this last is free license.

According to the ECTS, each course of the virtual Master in Applied Statistic of the University of Granada has four European credits that are equivalent to 100–120 hours of study of the student. The teaching and learning of the contents of these courses are offered by the University of Granada into a virtual learning environment based on an online Moodle platform. To promote the student's self-learning and interaction among them it has been developed useful materials and resources.

We are going to present our experience about the subject Functional Data Analysis (Análisis de Datos Funcionales in the Spanish translation) whose main topics can be studied in the books [3, 4]. The main objective of this course is to present the main statistical methodologies recently developed to analyze functional variables whose observations are a set of curves instead of vectors as in multivariate data analysis. Presentation of this course in Moodle platform can be seen in figure 1.

The screenshot shows the Moodle course page for 'Análisis de Datos Funcionales 09-10'. At the top left is the logo of the 'centro de enseñanzas virtuales de la Universidad de Granada'. The course title 'Análisis de Datos Funcionales 09-10' is prominently displayed. Below the title, the user is logged in as 'Ana María Aguilera del Pino'. The interface is divided into three main sections: a 'Course Menu' on the left listing topics from 'Tema 1' to 'Tema 6', a central 'Diagrama de temas' area showing a list of course resources like 'Bienvenida', 'Guía didáctica', and 'Organización del curso', and a 'Calendario' on the right showing the month of May 2010 with a 'Clave de eventos' legend.

Figure 1: Moodle platform for the virtual course “Análisis de Datos Funcionales” (Máster Estadística Aplicada. University of Granada).

For each topic the lecturer provides the student different material as theoretical contents, in both PDF and HTML format (SCORM (Sharable Content Object Reference Model)), didactic guide, examples of real data applications [3] using appropriate statistical software, self-learning tutorials, evaluation activities and other learning resources as real data sets, video conferencing and links to outside resources in libraries [4] and on the Internet.

To promote knowledge sharing among professors and students the Moodle platform [2] offers also essential communication tools as a notice board for up-to-date course information, and forum, chat and e-mail to display and solve the different doubts. With intent of encouraging discussion between all participants, some interesting questions are raised by professor. An example of those tools is provided in the Figure 2.

The screenshot shows the resources for 'Tema 2: Representación de datos funcionales mediante bases de funciones'. The resources listed are: 'Temario' (with a folder icon), 'Temario en formato pdf' (with a PDF icon), 'Foro tema 2' (with a forum icon), 'Libros electrónicos sobre FDA' (with a book icon), 'Actividad Tema 2' (with a folder icon), 'Chat Tema 2' (with a chat icon), and 'RecursosTema 2' (with a folder icon).

Figure 2: Resources of topic 2 of “Análisis de Datos Funcionales” virtual course.

In the sections 2 to 5 we will describe each one of the materials and tools provided by the professor for each topic. Some aspects of the evaluation procedure are presented on section 6. Conclusions about this teaching-learning experience are given in section 7.

2 DIDACTIC GUIDE

All information about the organization of the course is provided by the lecturer at the beginning of the course in the didactic guide of the subject. As example, we present the index of this didactic guide (see figure 3).

Dpto. Estadística e I.O. Universidad de Granada	Índice
	1. Presentación del curso.....3
Guía Didáctica	2. Ficha técnica.....4
Análisis de Datos Funcionales	3. Sobre la profesora coordinadora.....4
Máster Oficial en Estadística Aplicada	4. Forma de estudio de un curso virtual.....5
	5. Prerrequisitos y recomendaciones.....5
	6. Objetivos.....6
	7. Programa Teórico.....6
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	10. Criterios de evaluación.....12
	11. Evaluación del profesor y de la asignatura.....12
	12. Plan de trabajo.....13
	ANEXO 1. Guía Práctica del Estudio Eficaz.....13

Figure 3: Didactic guide of “Análisis de Datos Funcionales” virtual course.

The different topics contained in the guide are

- Presentation of the course
- Factsheet
- About the teacher-coordinator
- How to study in a virtual course
- Prerequisites and recommendations
- Goals and skills
- Theoretical program
- Practices
- Bibliography
- Methodology
- Evaluation criteria
- Professor and subject evaluation
- Work plan and schedule

3 THEORETICAL CONTENTS: SCORMS

In context of the new teaching, in which students are taking responsibility for their own learning, theoretical material is very important. For this reason, we have prepared a complete list of topics, which is the principal tool for the students. This syllabus has been provided in different format, PDF and HTML format. The innovation in those courses of the Master in Applied Statistic is to use SCORMs to present the theoretical material.

A SCORM package is a block of web material, which is packed according to the standard SCORM of learning objects. This packages could include web pages, Javascript programs, graphics, Flash presentations, among others similar things. In Figure 4 we show an example of syllabus by SCORM.

Let us observe that the contents are written in English. There were two main reasons to choose this language. The first is that this is an introductory course to research in Functional Data Analysis and most publications on the subject are written in English. The second is that this is a completely virtual master involving international students and the use of English enables participation to students of any nationality.

The screenshot shows a SCORM interface for the course 'Análisis de Datos Funcionales 09-10'. The header includes the logo of the 'centro de enseñanzas virtuales de la Universidad de Granada' and the course title. Below the header, there is a navigation bar with 'CEVUG > ADF0910 > SCORMs > Temario' and a 'Salir de la actividad' button. A status bar indicates 'Usted se ha autenticado como Ana María Aguilera del Pino (Salir)' and an 'Actualizar SCORM' button.

The main content area is titled 'Modo Revisión' and contains the following text and equations:

The orthogonal basis of trigonometric functions in $L^2(T)$ is given by

$$T_1(t) = \frac{1}{T^{1/2}}$$

$$T_{2i}(t) = \left(\frac{2}{T}\right)^{1/2} \sin\left(\frac{2\pi it}{T}\right)$$

$$T_{2i+1}(t) = \left(\frac{2}{T}\right)^{1/2} \cos\left(\frac{2\pi it}{T}\right) \quad i = 1, \dots,$$

If we denote by $t_0 < \dots < t_m$ the observation knots of a sample path, the B-spline functions of r degree are iteratively defined in the following way by extending the partition as $t_{-3} < t_{-2} < t_{-1} < t_0 < \dots < t_m < t_{m+1} < t_{m+2} < t_{m+3}$:

$$B_{j,1}(t) = \begin{cases} 1 & t_{j-2} \leq t < t_{j-1} \\ 0 & \text{other case} \end{cases}, \quad j = -1, 0, 1, \dots, m+4$$

$$B_{j,r}(t) = \frac{t - t_{j-2}}{t_{j+r-3} - t_{j-2}} B_{j,r-1}(t) + \frac{t_{j+r-2} - t}{t_{j+r-2} - t_{j-1}} B_{j+1,r-1}(t) \quad (2)$$

$$r = 2, 3, \dots; \quad j = -1, 0, \dots, m - r + 5.$$

Figure 4: SCORM about topic 2 of *Análisis de Datos Funcionales* virtual course.

4 RESOURCES: EXERCISES AND SELF-LEARNING TUTORIALS *

The implementation of the European credit in higher education gives greater importance to student's personal work. All this has induced the implementation of a teaching methodology based on the student's discovery learning.

With object to encourage the student's self-learning of each topic, we have presented several resources as a set of exercises and a self-learning tutorial. The self-learning tutorial allows students to check their level of understanding about each topic. They also reinforce self management and responsibility of the student, while respecting the different skills, time availability, needs and rhythms of student learning. A self-learning guide consists of a series of varied activities (readings and personal reflexions, short questions, proposed examples, application exercises, web search,...) that the student will do based on the materials and sources provided by the teacher, in order to learn for himself.

Tema 1. Introducción al Análisis de Datos Funcionales

- 1.1. Ejemplos de datos funcionales
- 1.2. Desarrollo del curso
- 1.3. Aprender más sobre FDA
- 1.4. Bibliografía

Justificación del Tema 1

En este tema se introduce el concepto de variable funcional cuyos valores observados son curvas. Se revisará diferentes ejemplos analizados en la estadística reciente en los que se resuelva un problema real mediante alguna técnica de análisis de datos funcionales. Se fijarán además los objetivos del análisis de datos funcionales que son comunes a los que cualquier técnica de análisis estadístico de datos.

Objetivos del Tema 1

- Familiarizarse con el concepto de dato funcional que procede de la observación de funciones aleatorias.
- Manejar distintos conjuntos de datos funcionales procedentes de distintos campos de aplicación como la economía, el medioambiente, las ciencias de la salud o la quimiometría.
- Distinguir entre series temporales en tiempo discreto y los datos funcionales asociados a las observaciones en tiempo discreto de un proceso estocástico continuo.
- Ver las herramientas del análisis de datos funcionales como una generalización de los métodos de análisis multivariante y de regresión al caso en que los datos son un conjunto de funciones en lugar de vectores.

Actividades del Tema 1

1. Hacer una lectura comprensiva de los apuntes del Capítulo 1 y del Capítulo 1 del libro de Ramsay y Silverman (2005) para obtener una visión global del tema.
2. Definir formalmente una variable funcional en términos matemáticos.
3. Pensar en ejemplos de datos funcionales sacados de la vida

Figure 5: Example of self-learning tutorial.

5 PRACTICES WITH STATISTICAL SOFTWARE

In Statistics, the most important is to apply the theoretical concepts to solve real problems. For this reason, we provide to the students a lot of tools which help them to work with statistical software. For each topic students must solve some practical problems. Then, we include resources as solved exercises and examples of real data applications using appropriate statistical software as the fda package of the free license R program [6]. The fda package is so powerful and it has implemented a lot of functions about the functional data analysis (FDA) treatment. There is a manual [7] where we can find much information about these functions.



6 CONNECTION AND RELATIONSHIP TEACHER – STUDENTS



In virtual education, the relation between teachers and students is very important. There are several kinds of communication tools: e-mail, CHAT and FORO. In the FORO it is possible to discuss student's answers to the activities of the self-learning tutorials. Any participant in the subject can expose additional questions to help to get the goals of the topics (see an example in Figure 6).

Tema	Comenzado por	Respuestas	Último mensaje
Datos funcionales y procesos estocásticos	 Oscar Molina Molina	1	Jose Luis mar, 16 de mar de 2010, 20:33
Abriendo boca	 Ana María Aguilera del Pino	1	Juan jue, 11 de mar de 2010, 17:21

 Datos funcionales y procesos estocásticos
de Oscar jueves, 11 de marzo de 2010, 12:23

Hola compañeros,

He leído el tema 1 y tengo una duda, ¿en qué se diferencian los datos funcionales de los procesos estocásticos? Supongo que los procesos estocásticos son datos funcionales con ciertas restricciones (estacionariedad, igualmente espaciados...) pero no estoy seguro...

Espero vuestra respuesta, Gracias!

[Editar](#) | [Borrar](#) | [Responder](#)

Re: Datos funcionales y procesos estocásticos de Jose Luis martes, 16 de marzo de 2010, 20:33

Figure 6: FORO session.

Virtual tutorials are carried out via CHAT, in which students doubts and curiosities will be solved by the teacher in real time. In the chat sessions, teacher will propose additional topics with object to encourage the debate between all participants (Figure 7).

 12:23 Ana María: Tanto en las series como en los datos funcionales los datos están ordenados cronológicamente. La diferencia es que las series suelen ser por naturaleza discretas y los datos funcionales se observan continuamente en el tiempo. Por ejemplo, si lo que medimos son las temperaturas medias mensuales se trata de una serie temporal mientras que si es la temperatura diaria es un dato funcional

 12:23 Ana María: Ahora respondo a Jackeline.

 12:24 Juan : vale gracias

 12:24 Ana María: Los datos espaciales se pueden ver como un tipo particular de datos funcionales porque las observaciones son funciones de las coordenadas espaciales (latitud, longitud, altura, ..) y del tiempo.

 12:25 Ana María: Siempre que las observaciones sean funciones tenemos un dato funcional. En el caso de los datos espaciales son funciones de más de una variable. En nuestro curso consideraremos el caso más simple de datos funcionales en el que las observaciones son funciones de una sola variable

 12:27 Jackeline: Ok, podría decirse que el análisis de datos funcional es una tecnica estadística robusta que nos da herramientas por ejemplo de series temporales que bajo los supuestos clásicos no obtendríamos?

 12:28 Ana María: Correcto. Es una herramienta de análisis de datos con otro enfoque diferente del de las series o los procesos espaciales que permite resolver problemas similares. La forma de trabajo es la de análisis de datos funcionales

 12:30 Ana María: Perdón, quería decir que la forma de trabajo es la del análisis de datos multivariantes

Figure 7: CHAT session.

Moreover, it is possible the connection via email, through virtual platform. Finally, we want to remark that the use of self-learning guide is encouraging the participation of students in FOROS and CHATS.

Those tools are doing possible the good relationship between the teacher and each student and among students, favoring the self-learning and the acquired knowledge reinforcement.

7 EVALUATION

Currently, in virtual learning there are different ways of evaluation. Some teachers prefer to evaluate their students through portfolios. The portfolio consists of a planned collection of work that the student contributes to show the personal progress in a specific area.

In our case, we provide a lot of resources which help to students to reinforce their knowledge. As we have said before, self-learning tutorials help students to achieve the objectives and develop the skills proposed in the course. We propose to discuss the self-learning activities in the FOROS but do not

require their solution as part of the evaluation. The final grade of the students is based on the mark obtained on a set of exercises (summaries, applications, presentations, etc.) about each topic (60%) and their participation in FOROS and CHATS (20%). Moreover, at the end of the course, there will be a final work with real data where students must apply all their acquired knowledge about this subject (20%).

8 CONCLUSIONS

In recent years, Statistic was a degree with few students. For this reason, it was so important to adapt the teaching tools to the new student's necessities. In this course about FDA, we have provided a lot of useful material, using the latest and modern technologies. We have given much importance to work with real data, showing and highlighting the great importance of statistics in modern society.

Currently, with this virtual experience, we are motivating a lot of students learning in a flexible, modern and effective work environment.

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