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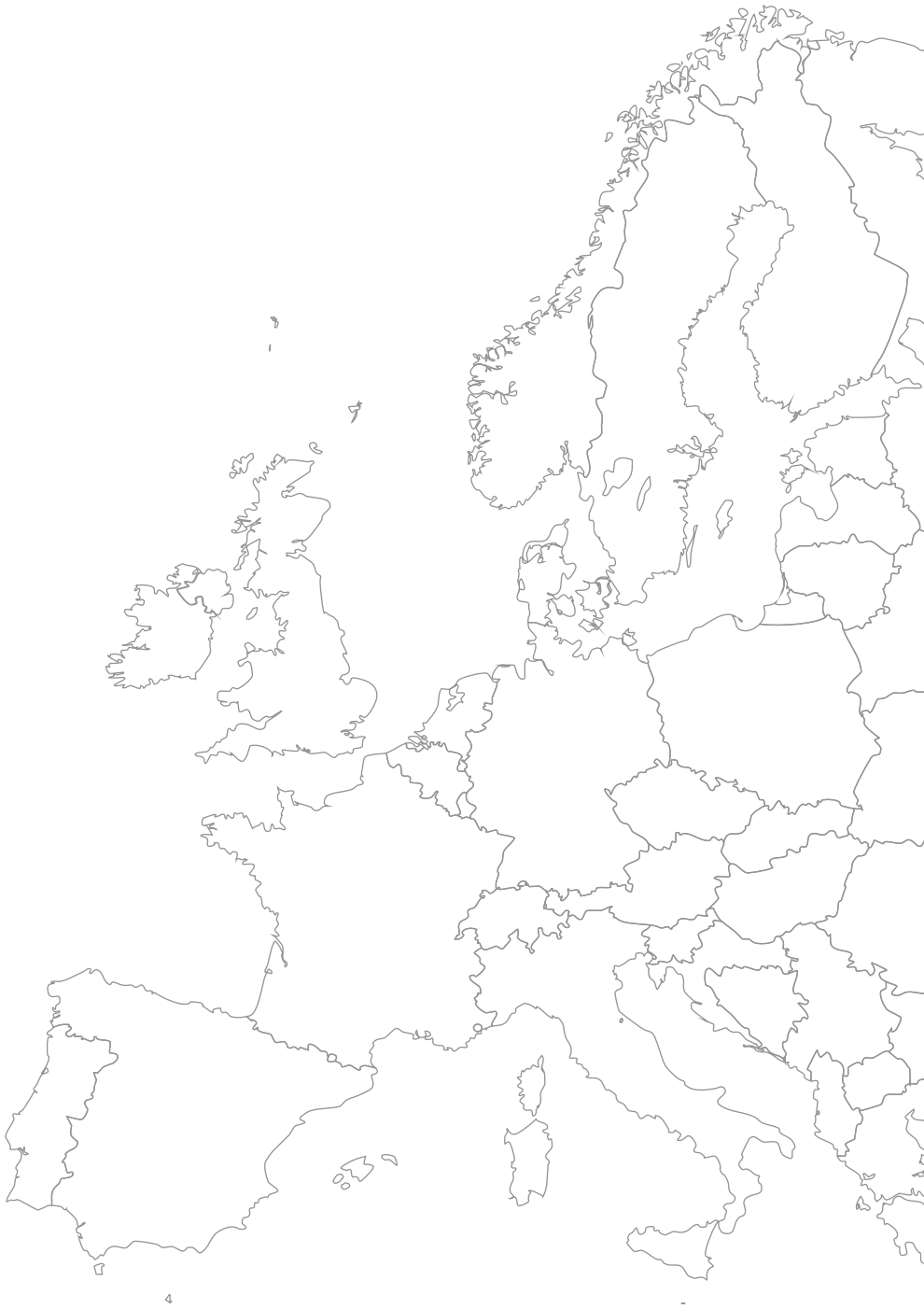

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The V Modelling Week at the Complutense University of Madrid

The fifth Modelling Week took place at the Universidad Complutense de Madrid (UCM), Spain from June 13 to June 21, 2011. The event has been organized within the Master in Mathematical Engineering by the Faculty of Mathematics of the UCM in cooperation with the Institute for Interdisciplinary Mathematics. The UCM Modelling Weeks are open for students from other mathematically oriented master programmes worldwide. On its fifth edition, it was attended by 41 students coming from ten countries: Spain, Italy, United Kingdom, Finland, India, China, Russia, Belgium, Ireland, and Montenegro, studying at 8 different master programmes run by European universities.

Participants of the V UCM Modelling Week.

The main purpose of the UCM Modelling Weeks is to promote the use of mathematical methods and models in research, industry, innovation, and management in the knowledge economy. At the fifth edition we collected seven problems proposed and formulated by different companies working in different sectors of the economy. On June 13 during a public conference representatives of the participating companies presented their problems to the audience. Then the students were divided into seven working groups, six participants per each. The division of students into groups was made taking into account their earlier expressed preferences but trying to mix students from different universities/nations. The working groups have been provided with discussion rooms, computing facilities, and all necessary software for mathematical modelling, data analysis, text processing, etc. From June 14 to 20 students intensively worked in groups, each supervised by one or various highly qualified instructors, experts in the fields. On June 21 each group delivered a report describing results and conclusions reached and made a public presentation to a wide audience with participation of representatives from companies and Faculty's members. Representatives of the participating companies highly rated several results obtained by the working groups and expressed their wish to participate in forthcoming modelling weeks. From the other side students have got a stimulating chance to work in small international groups on real industrial problems. At the end of the Modelling Week instructors have evaluated the participation of local students with a mean mark 8 out of 10. Further details, extended problem description, and students' reports are available at http://www.mat.ucm.es/congresos/mweek/.

Problems studied during the V Modelling Week

Signal propagation in nonlinear optical fibre

Coordinated by Luigi Barletti (Universtità degli Studi di Firenze, Italy)

We study a fundamental problem in the telecommunication industry, the propagation of an electromagnetic signal in an optical fibre. In general, such propagation can be described by Schrödinger equation with cubic nonlinearity, where the roles of space and time variables are inverted with respect to the quantum mechanics case. The concomitant effects of chromatic dispersion and of nonlinear refraction lead to a signal distortion. Besides, the signal traveling over a long distance passes periodically through optical amplifiers, which also introduce noise. Signal and noise nonlinearly mix up during the propagation, and this contributes to the degeneration of the output. Modelling of such phenomena is crucial for the correct interpretation of the output signal. In the project we introduce a mathematical model including input data and boundary effects and provide numerical solution for the deterministic and semi-classical cases.

Forecasting prices in electricity markets

Coordinated by Juan Tejada (Universidad Complutense de Madrid, Spain) and Hugo Marrao (Indizen)

Forecasting electricity price is important for all industry stakeholders. It is a challenging task due to the price uncertainty and, most importantly, because of the particularities of how the price is formed. The process of price formation in electricity markets follows in essence the basic rule of microeconomic theory by which the price should reflect the relative scarcity of the supply for a given demand level. At low demand suppliers with higher incremental costs must step out of competition and give way to suppliers with the lowest incremental costs. This process results in relatively low equilibrium prices. On the other hand, as the demand increases expensive suppliers offer the increasingly scarce commodity, raising the equilibrium price. The influence of the demand on the electricity prices is, however, far from being deterministic. In Spain the wind power is the most important factor to know electricity prices. The aim of this project is the development of a predictive model of the hourly generation program and price in the Spanish power market.

Obtaining an analytical approximation for the calculation of capital for credit risk

Coordinated by Begoña Vitoriano (Universidad Complutense de Madrid, Spain)

The credit risk of an institution arises from the failure of third parties to repay loans. The progress of statistical and computational techniques has permitted the development of mod-

els that can be used to calculate losses based on internal information of each financial institution. The legislation also encourages the use of internal models for the calculation of provisions and capital. The estimation of risk parameters is performed for the different risk segments so that all portfolio operations have related risk parameters. Thus an expression is established for the different segments, from which the capital requirement over a one-year time horizon is obtained for each operation. The objective of this project is to define an analytical expression for the portfolio of companies, which would allow the estimation of capital based not only on internal estimation of parameters, but also on the internal estimation of the loss distribution of each institution. In the study fictitious loan samples with real characteristics provided by Management Solutions are used.

Biological control of rabbits

Coordinated by Cameron Hall (University of Oxford, United Kingdom)

After rabbits were introduced into the wild in Australia in 1859, their population rapidly increased and they quickly became a pest species. Several techniques have been used to control the rabbit population. Most notably, the deliberate introduction of the myxoma virus to Australia in 1950 and the release of Rabbit calicivirus in 1995 led to significant decreases in the rabbit population. The most effective and promising method for controlling rabbits appears to be biological control using viruses. In this project we construct mathematical models for healthy and infected rabbit populations, and explore the relationship between different properties of an infective agent (lethality, communicability, incubation time, etc.) and its effect on the rabbit population.

Forecasting the demand for bread

Coordinated by Conrado Manuel, Enrique González and Javier Castro (Universidad Complutense de Madrid, Spain)

An accurate prediction of the daily demand for bread has a significant economic impact on the income of distribution companies. Forecasting the number of units that will be sold in each point of sale allows controlling the two major costs: returns factor and out of stock factor. The aim of this project is to design a basic model for the treatment of time series of bread daily demand and prediction. The model should have a common structure adjustable for a particular point of sale. The best fitting is not necessarily the one that minimizes the error, because it makes no account for losses associated with underestimate of the demand and the cost of returns. To simplify the problem, we assume that if a unit is not sold one day, the return is done that very same day. For model fitting historical data from a sale point are used.

Direct load decision model applied to electric vehicle charging points

Coordinated by Andrés Ramos and Pedro Sánchez (Universidad Pontificia de Comillas, Spain)

Summary: Electric vehicles are becoming an alternative to combustion engines. One of the main difficulties for their expansion is long battery charging process. Fixed charging stations provide a possible solution when the plug-in vehicles number is reduced. However, to cope with an increasing number of plug-in vehicles it is necessary to reinforce the electric cable installation providing individual electric infrastructure per plug-in vehicle at parking garages. In this project we design charging management policies to deal with simultaneous vehicle loadings at high concentrated charging points. The following objectives are taken into account: time schedules of arrival and departures; power discharging rates; capacity of the charging point; optimization of the charging costs based on hourly energy price, etc.

Estimation of orientation of distribution of fibres

Coordinated by Jouni Sampo (Lappeenranta University of Technology, Finland)

Summary: The properties of paper depend essentially on how wood fibres are distributed in a sample. For example, orientation difference between surface and middle layers affects bending stiffness. With proper placement of light sources, the normal reflectance images taken from paper surface can reveal information about fibres on the surface. Another approach is to illuminate the paper from one side and take image from the other. Off-line imaging offers high resolution, whereas on-line control over running paper provides much lower resolution. However, the question remains the same: how to estimate the orientation of fibres from an image? In the project we explore theoretical possibilities and limitations of different types of imaging techniques and develop mathematical methods to estimate distribution of fibre's orientation.

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