III MODELLING WEEK UCM

Master in Mathematical Engineering - UCM

Madrid, June 22-30 , 2009

http://www.mat.ucm.es/momat/2009mw/2009mw-e.htm

Newsletter 1
Updated on
June 18, 2009

Contents

Welcome

On behalf of the Organizing Committee, we welcome you to the III Modelling Week UCM.

This event is organized, within the framework of the Master in Mathematical Engineering at Universidad Complutense de Madrid, by the Faculty of Mathematical Sciences, the Research Group "Mathematical Models in Science and Technology: Development, Analysis, Numerical Simulation & Control" (MOMAT) and the Interdisciplinary Mathematics Institute (IMI).

The objective is to promote the use of Mathematics as a tool to solve problems arising from the industry. The presentations and exhibitions will take place on 22nd and 30th and attendance is free for all interested people.

The Event will build on the success of the previous edtions, which were held in 2007 and 2008, while incorporating new features to enhance your experience.

The conference venue is in the heart of Madrid, Spain. In June, Madrid weather is at its finest. Please join us at the III Modelling Week and enjoy the beauty of Madrid. We look forward to seeing old friends and meeting new ones.

Juan Tejada
Facultad de Ciencias Matemáticas, UCM

Ángel Manuel Ramos
MOMAT Research Group

Marta Arregi
Interdisciplinary Mathematics Institute

Collaborators

Universities

UNIVERSITY OF OXFORD

OLLSCOIL LUIMNIGH UNIVERSITY OF LIMERICK

Università degli Studi di Furenze

UNIVERSITAT POLITÈCNICA DE CATALUNYA

UAB Universitat Autònoma de Barcelona

UNIVERSIDAD COMPLUTENSE MADRID

Instituto de Matemática Interdisciplinar

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

Companies

ManagementSolutions Making things happen

Enel

STEREOCARTO

cement & concrete institute

Public administration

GOBIERNO DE ESPAÑA MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

Research teams

momat

Others

i-math ingenio mathematica

Programme

The event will have 4 parts:

- PRESENTATION OF THE PROBLEMS: by problem coordinators and by companies representatives, on June, 22, Monday.
- WORK GROUPS: each group of students, coordinated by one or various coordinators, will work on a problem from 16:00 h. to 21:00 h. until June 29, Monday.
- PRESENTATION OF RESULTS AND CONCLUSIONS: each group will deliver a report describing the results and conclusions reached and one or more of its members will make a public presentation on June, 30, Tuesday.
- WRITTEN REPORTS: each Working Group will write a paper setting out the results and conclusions reached.

Monday 22-06-2009

- 16.00 - 16.10h Introduction and opening of the III Modelling Week, UCM
- 16.10 - 16.30h Exposition of Problem 1 Tomás Fernández de Sevilla, Stereocarto, S.L.
- 16.35 - 16.55h Exposition of Problem 2 Dr. José Manuel Sánchez-Vizcaíno Rodríguez. Facultad de Veterinaria - Universidad Complutense de Madrid
- 17.00 - 17.20h Exposition of Problem 3 Dr. Alessandro Speranza. Innovazione Industriale Tramite Trasferimento Tecnologico - Università degli Studi di Firenze.
- 17.25 - 17.45h Exposition of Problem 4 Dr. Sarah Mitchell. University of Limerick
- 17.50 - 18.10h Exposition of Problem 5 Dr. Juan García Cascales. Management Solutions.
- 18.25 - 21.00h Working Groups at the laboratories.

Tuesday 23-06-2009 to Monday 29-06-2009

- 16.00 - 21.00h Working Groups at the laboratories

Tuesday 30-06-2009

- 16.00 - 16.45h Preparing final details of each group in the laboratories
- 17.00 - 17.20h Presentation of Results and Conclusions of Group 1
- 17.25 - 17.45h Presentation of Results and Conclusions of Group 2
- 17.50 - 18-10h Presentation of Results and Conclusions of Group 3
- 18.15 - 18-35h Presentation of Results and Conclusions of Group 4
- 18.40 - 19-00h Presentation of Results and Conclusions of Group 5
- 19:00h Closing of the III Modelling Week, UCM

PROBLEM 1:

Efficient interpolation of LiDAR Altimeter datasets in the obtention of Digital Surface Models (DSM).

Problem proposed by Stereocarto, S.L.

Coordinators

Dr. Pilar Romero (Facultad de Matemáticas, UCM, Spain)
Dr. Roberto Antolín (Stereocarto, S.L. and Facultad de Matemáticas, UCM, Spain)

Exposition of the problem

The Airborne Laser Scanning (ALS) technology is based on the ground survey from an airborne laser telemeter. The telemeter measures the distance between the emission point, A, and the echoing point, B, which is a generic ground point hit by the laser ray. Thus, the laser telemeter measures the distance between the instrument and the echoing surface .However, the ground point coordinates are actually wanted. The measure of these coordinates implies the knowledge of the airplane position and attitude at each instant. For this purpose, an integrated sensor GPS/INS (Global Positioning System/Inertial Navigation System) is provided. This instrumentation basically consists of an inertial sensor which is composed of three accelerometers and three gyroscopes, a GPS receiver and an electronic device to synchronize and to archive the data of the instruments. The accelerometers and the gyroscopes are lead to measure the linear acceleration and angular velocity. Once the measuring session is over, the data is pre-processed by a Kalman filter to calculate the aeroplane position and attitude at each singular moment of the flight.
Thus, the GPS/INS sensor is able to determine the aircraft coordinates and its normal vector direction. The point distance from the telemeter and the angle between the emitted ray by the telemeter and the aircraft normal vector are also known. Thus, the coordinates of the surveyed point can be achieved.

Some of the most important laser scanning capabilities are:

1. High accurate measurements: 30cm in planimetric components; and 15cm in height component.
2. High resolution, (function of the height and velocity of the flight, and the scanning frequency) between 0.5 and 5 point/m2.
3. High velocity survey. From a few up to 50km2/h.

The final data from a LiDAR survey is a great amount of planimetric coordinates, sorted by the points retrieved instant, and the corresponding ellipsoidal heights. Since LiDAR is often able to measure the intensity echo, this kind of signal attribute is also archived. From LiDAR data, it is easy enough to develop a Digital Surface Model (DSM) as a simple raw data interpolation. DSM just represents the trend of the terrain and of the objects over it. However, the principal aim is to develop a Digital Terrain Model (DTM) by filtering (or .removing) points that represent objects (buildings or vegetation) and performing an interpolation.

However, filtering LiDAR data automatically is not the main problem of this technology, there are different commercial software that perform these analysis with very good results. But some specifications for LIDAR are demanding for point densities about 5 points/m2. This leads to two main problems.

The first is how to manage such volumes of data without an increase in resources consumption and therefore without an increase of costs.

The second is that such a density of a data automatically implies a more restrictive flight in terms of height and time of survey, and therefore it also implies a more expensive project.
However, solving one problem leads to solve the other.

Scheme of the work to be done

Thus, the following problem can be presented: is there a way to reduce the density of the data so that data loss does not represent? Or, is it possible to get the same data to perform a flight to capture a smaller number of points thus reducing the cost?
Hypothesized that a lower point density does not affect the LiDAR data filtering in order to obtain digital terrain models, we consider how the loss of density affects digital models obtained by the different interpolations (maximum, minimum, average, polynomial or spline interpolation and stochastic methods such as kriging).

Participants

- Francisco Aguilera Orihuela (Universidad Complutense de Madrid)
- Silvia Castellani (Università degli Studi di Firenze)
- Diego Gómez Sanz (Universidad Complutense de Madrid)
- Juan Carlos Luengo López (Universidad Complutense de Madrid)
- Xavier Santallusia (Universitat Autònoma de Barcelona)
- Rodrigo Torres Gallego (Universidad Complutense de Madrid
- Ana Valeiras Jurado (Universidad Complutense de Madrid)

PROBLEM 2:
Impact of the climatic changes on animal diseases spread

Problem proposed by

GOBIERNO DE ESPAÑA
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO

Subdirectorate General for Health in Primary Production Ministry of the Environment and Rural and Marine Affairs

Coordinators

Dr. José Manuel Sánchez-Vizcaíno Rodríguez (Facultad de Veterinaria, UCM, Spain)
Dr. Beatriz Martínez Lopez (Facultad de Veterinaria, UCM, Spain)
Dr. Benjamin Ivorra (Facultad de Matemáticas, UCM, Spain)

Exposition of the problem

Climate change is affecting the ecosystem and many of the factors associated with human and animal diseases. In particular, it has been demonstrated important changes in the insect-borne diseases. The clearest example of this has been observed in Europe in relation to bluetongue virus, a disease of ruminants transmitted by insects, which traditionally occurred only below parrallel 40 and now has expanded its geographical distribution affecting the countries of northern Europe. The increase of temperature has been shown to affect the insect colonization, presence and survival and to its susceptibility of the bluetongue virus. Moreover, it is also important to highlight the role of the wind in the bluetongue virus spread, because as well as the vast majority of insect-borne diseases, bluetongue can be spread from endemic areas to free areas through the movement of insects by the wind. Furthermore the presence of more insects due to the increase of temperature amplify the probability that these insects are vehiculated by the wind.

This work aims to study the potential impact that potential changes in temperature due to climate change could have on the spread of these insect-borne diseases, especially in the Spanish case. To reach this objective a numerical and stochastic model will be developed, taking into account the data of wind speed and temperature distribution in the area of interest, and with coefficients that will be determined from a real database provided by the Ministry of the Environment and Rural and Marine Affairs. The model will be validated by considering the particular case of bluetongue in Spain.

Scheme of the work to be done

- Reading and analysis of several articles related to climate change and its effects on insect-borne diseases such as bluetongue.
- Developing a hybrid model with differential equations and stochastic.
- Implementation and numerical simulation of the model developed.
- Validation of the model considering actual data for the case of Bluetongue in Spain.

Participants

- Claudia Cianci (Università degli Studi di Firenze)
- Rafael Granero Belinchón (Universidad Autónoma de Madrid)
- Rocio Picado Álvarez (Universidad Complutense de Madrid)
- Francisco Javier Pino Carrasco (Universidad Complutense de Madrid)
- Nuria Rodrigo Campos (Universidad Complutense de Madrid)
- Elena Tamayo Mas (Universitat Politécnica de Catalunya)

PROBLEM 3:
Simplified mathematical modelling of geothermal reservoir

Problem proposed by ENEL, Regione Toscana

Coordinators

Dr. Alessandro Speranza (Università degli Studi di Firenze, Italy)

Exposition of the problem

The proposed problem concerns a simplified model of geothermal wells.
In general, a geothermal reservoir can be modeled as a multiphase fluid flowing in a porous medium. In fact, the medium is more like a fractured area of hard rocks, rather than a typical porous medium. However, the Darcy approximation is generally considered acceptable. The fluid generally consists of a mixture of brine (solution of salts in water) and a certain set of so called "non condensible gases", such as CO_2, N_2, H_2S and so on. The fluid can be found in one (gas or liquid) or two coexisting. In the first case, we have a "vapour or water dominated reservoir". For instance the two main geothermal reservoirs in Toscany, Larderello and Amiata are, respectively known as vapour dominated and water dominated. However, a thermodynamic analysis shows that while Larderello could actually contain gas only, Amiata is in two-phase coexistence conditions, in terms of typical pressure and temperature.
The actual geometry of the reservoir is generally non known in details. However, this is a strongly three dimensional problem, in the sense that, generally, it is not easy to use any rotational or translational invariance to model effectively the fluid flow in the reservoir, unless one wants to limit the model to a small area in the nearby of the production well.
The proposed model, is limited to a simple one dimensional approximation of the geothermal reservoir. The geothermal fluid is assumed to be pure water H_2O. Furthermore, temperature is assigned as varying linearly with depth. In spite of its drastic reduction, this simple model allows to draw some useful information on the real problem. Furthermore, in spite of the presence of a free boundary at the interface between the gas and liquid region of the well, the model allows both some analytical considerations as well as a numerical solution.

Scheme of the work to be done

1) Introduction of the general problem and reduction to the simplified 1D model. Set up of the set of equations, and of boundary conditions. As a first step, one can assume the well to be isolated, and solve the dynamic problem, to find when the well reaches its exhaustion, in the sense that inside pressure has reached the outside value, and no more energy can be exctracted from it.

2) Introduction of a positive source term in the mass balance equation, for instance assuming a recharge of the extracted fluid at the boundary. In this case, one can look for the condition to impose at the boundary, in order to have an equilibrium solution

3) Numerical solution of the dynamic problem with a source term in the mass balance equation, in order to verify whether and when the problem actually reaches equilibrium, given the right choice for mass extraction from the top and fluid recharge at the lateral boundary.

Participants

- Juan Carlos Armenteros Carmona (Universidad Complutense de Madrid)
- Javier Hernández Cano (Universidad Complutense de Madrid)
- Begoña Hernández Pérez (Universidad Complutense de Madrid)

- Iakovos Kakouris (University of Oxford)
- Andrea Laruelo Fernández (Universidad Complutense de Madrid)
- Javier Rico Illueca (Universidad Complutense de Madrid)

PROBLEM 4:
The cooling of concrete slabs using water pipe networks

Problem proposed by Cement and Concrete Institute, Midrand, Gauteng, South Africa.

Coordinators

Dr. Sarah Mitchell (MACSI, Department of Mathematics and Statistics, University of Limerick, Ireland)
Assistant: Nadia Smith (Facultad de Matemáticas, UCM, Spain)

Exposition of the problem

The proposed problem concerns a simplified model to describe the removal of hydration heat from concrete dams during construction using piped water.

As part of the construction of dams, large concrete slabs are poured (usually of the order of 10x10x3m). The chemical process taking place within the concrete can cause extreme temperature rises which often leads to internal cracking and therefore weakening of the dam structure. One way of preventing these high temperatures is to embed an array of pipe networks into the concrete blocks. Then cold water is pumped through the pipes and at a later time these are filled in with concrete.

The aim of this study is to estimate the temperature within the concrete slab and to analyse the effect of pumping water through it. Ultimately, the engineer is concerned with reducing the maximum temperature in the concrete to an acceptable level whilst using a minimal (i.e. least expensive) pipe network. It is clear that the efficiency of heat removal from the slab will decrease as the water temperature increases. Of course, a good pumping system should be able to perform close to this design limit but these are likely to be expensive and so there needs to be an appropriate balance between thermal efficiency and cost. It is hoped that this study will provide a measure for the efficiency of practical water network designs and to estimate the optimal spacing of pipes and pipe length.

Scheme of the work to be done

1) Begin by setting up a simple cylindrical model where a single pipe cools in an insulated concrete cylinder. This will determine a system describing the temperatures in both the concrete and pipe.

2) Perform a dimensional analysis and use this information to obtain a simplified model. Use appropriate mathematical techniques to solve the resulting equations to analyse the thermal variation in the concrete/water system.

3) Examine the effect of including the neglected higher order terms (by performing a perturbation analysis and solving the resulting system numerically).

4) Extension to a more realistic model which has an array of pipes in order to allow for the fact that the geometry is in practice not cylindrical: a periodic array of pipes would be far more realistic. Another extension would be to analyse the fact that the pipes tend to loop back and forth throughout the slabs meaning that the flow in adjacent pipes is usually in opposite directions.

Participants

- Paloma Álvarez Sánchez (Universidad Complutense de Madrid)

- Yudy M. Bolaños (Universitat Autònoma de Barcelona)
- Ignacio González Andrés (Universidad Complutense de Madrid)
- Michele Marini (Università degli Studi di Firenze)
- Berta Mendoza Juez (Universidad Complutense de Madrid)
- Alfonso Rodríguez Morales (Universidade de Vigo)

PROBLEM 5:
Modelling default risk through macroeconomic factor evolution

Problem proposed by Management Solutions

Coordinators

Dr. Ignacio Villanueva (Facultad de Matemáticas, UCM, Spain)
Dr. Juan García Cascales (Management Solutions Spain)
Mr. Fernando Prieto (Management Solutions Spain)

Exposition of the problem

In a highly changing macroeconomic environment, and quite particularly in times of severe financial distress like observed at the moment, it is essential for financial firms and investment banks to model the financial strength of their clients, in order to estimate the probability of recovering their investment.

One way of modelling the default probability of counterparties is by means of evolution index functions that describe dicotomic events in terms of systemic and idiosyncrasic variables. These functions may as well be decomposed as linear combinations of macroeconomics factors, leading to the default probability conditioned to a macroeconomic scenario.

Relating index function to macroeconomic factors has several open issues to be treated during the week, such as the modelling itself of macroeconomic factor evolution, alternatives to the conditioning function to take into account multi-period estimation or how to take into account credit quality migrations.

Scheme of the work to be done

- Reading of basic papers to get familiar with the underlying default modelling and identifying fundamental macroeconomic factors.
- Modelling, by means of linear regression or similar structural equations, the relation of macroeconomic factors to the default probability. Analysis of macroeconomic time series.
- Adjustment of ARMA models to describe macroeconomic evolution, and implementation of a macroeconomic factor simulator, both conditioned to actual macroeconomic distress or using a random initial point.
- Implementation of the complete process: simulation of multiple macroeconomic scenarios and evaluation, on each, of transformation function to obtain a distribution of default probabilities

Participants

- Asgeir Birkisson (University of Oxford)
- Duccio Brogi (Università degli Studi di Firenze)
- Ana Guerra Guaza (Universidad Complutense de Madrid)
- Carmen Elena Guaza Picallo (Universidad Complutense de Madrid)
- Iglesias Daniel Laorden González (Universidad Complutense de Madrid)
- José Miguel Rodríguez Delgado (Universidad Complutense de Madrid)

2. Collaborators, problems, programme, participants

Confirmed Instructors:

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Management Solutions
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Dr. Roberto Antolín Sánchez
Stereocarto, S.L.
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Facultad de Ciencias Matemáticas
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Dr. Pilar Romero Pérez
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Innovazione Industriale Tramite Trasferimento Tecnologico
Italy

Dr. Beatriz Martínez López
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Facultad de Veterinaria
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Dr. Sarah Mitchell
Department of Mathematics & Statistics
University of Limerick
Ireland

Dr. Ignacio Villanueva Díez
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Facultad de Ciencias Matemáticas
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2. Collaborators, problems, programme, participants

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Paloma Álvarez Sánchez (Universidad Complutense de Madrid, Spain)
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Asgeir Birkisson (University of Oxford, United Kingdom)
Yudy M. Bolaños (Universitat Autònoma de Barcelona, Spain)
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Silvia Castellani (Università degli Studi di Firenze, Italy)
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Berta Mendoza Juez (Universidad Complutense de Madrid, Spain)
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Nuria Rodrigo Campos (Universidad Complutense de Madrid, Spain)
José Miguel Rodríguez Delgado (Universidad Complutense de Madrid, Spain)
Alfonso Rodríguez Morales (Universidade de Vigo, Spain)
Xavier Santallusia (Universitat Autònoma de Barcelona, Spain)
Elena Tamayo Mas (Universitat Politécnica de Catalunya, Spain)
Rodrigo Torres Gallego (Universidad Complutense de Madrid, Spain)
Ana Valeiras Jurado (Universidad Complutense de Madrid, Spain)

3 Participation costs

The organization will cover, for agreed participants

Travel. For non UCM participants whose costs are covered by UCM, flight ticket has been bought by the organization and will be sent to the participant by e-mail.

Accomodation. For non UCM participants whose costs are covered by UCM: in shared double rooms for students and single room for instructors, at Residencia Galdós (see below).

Meals (breakfast, lunch, dinner, to be made at Residencia Galdós).

Residencia Galdós

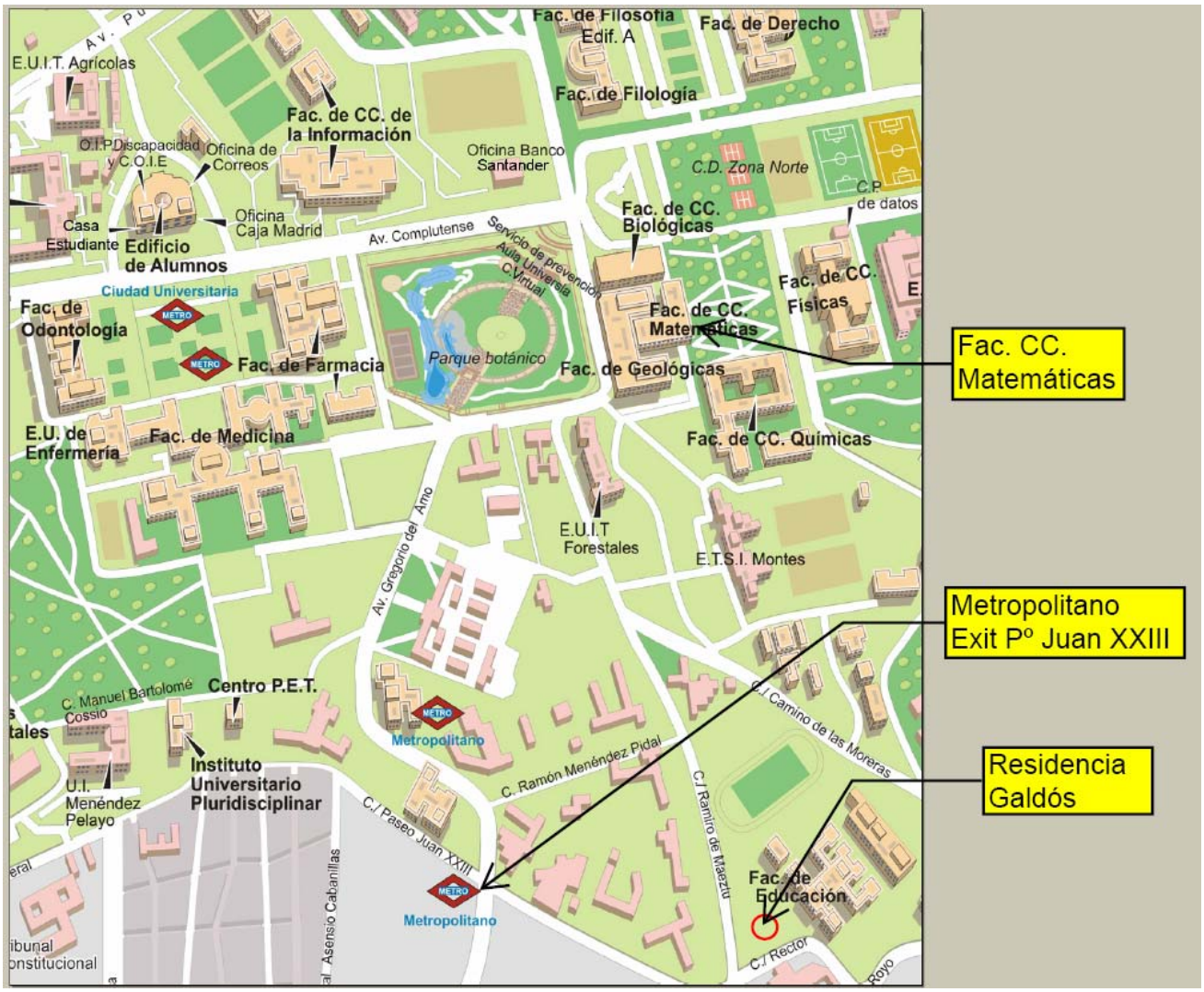
The residence is located at the campus of the University. The address is Ramiro de Maeztu, number 2, and telephone number is (+34) 912062900. The closest underground stop is Metropolitano. Buses connect the residence with Moncloa (132 and C), many points in the University campus (132 and F), Cuatro Caminos and Guzmán el Bueno metro stops (C and F), ...
The webpage of the residence is www.residenciagaldos.com

Meals hours at Residencia Galdós:

	Monday to Friday	Saturday and Sunday
Breafkast	7:00 to 10:00	7:00 to 11:00
Lunch	13:00 to 16:00	13:00 to 17:00
Dinner	20:00 to 22:00	20:00 to 23:00

4 Practical info

Facultad de Ciencias Matemáticas and Residencia Galdós at Moncloa Campus:



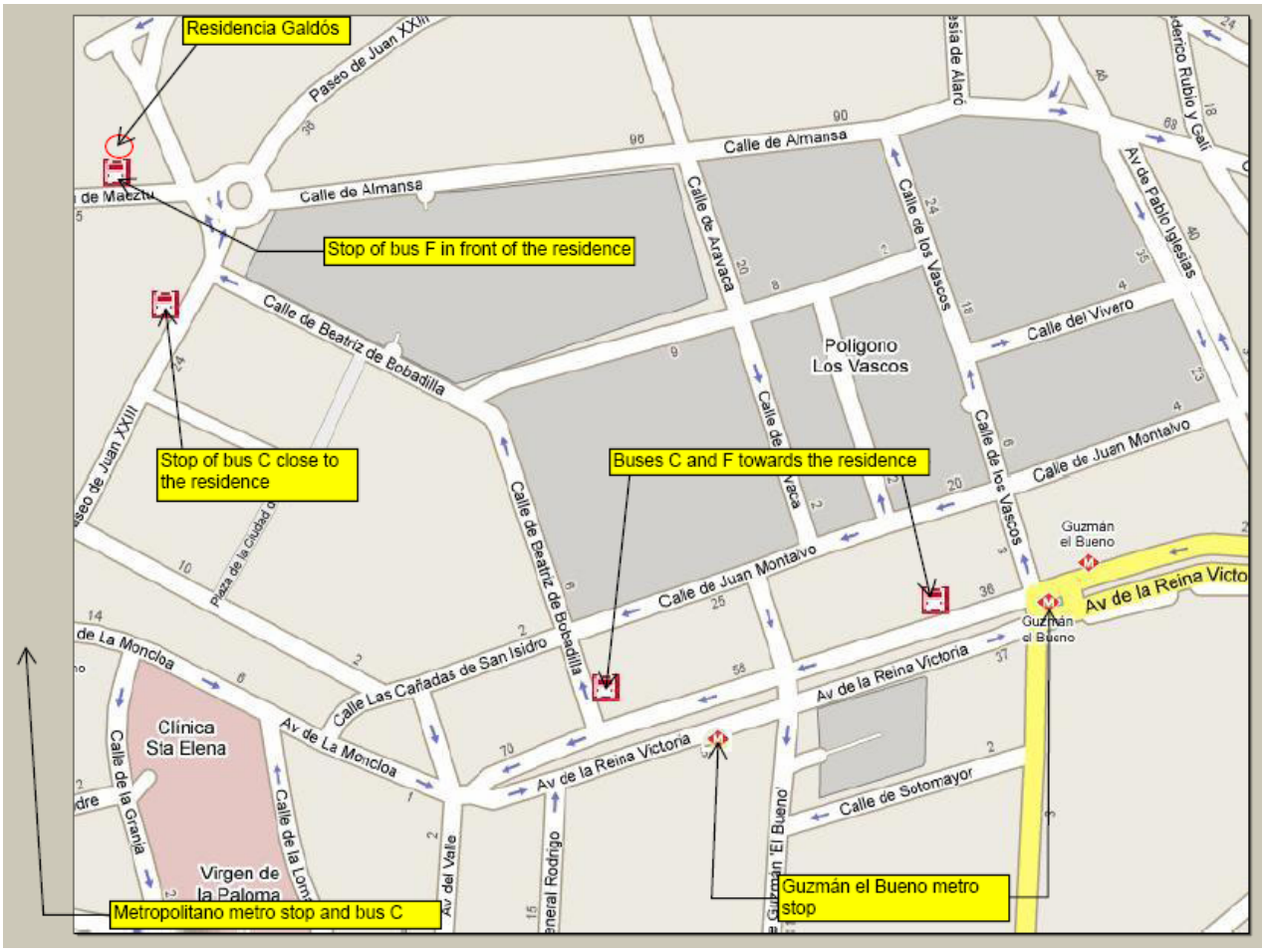
(Attention: this map is not north oriented)

How to arrive from the airport

There are two underground (Metro) stops at the airport, depending on the terminal. A single trip costs 2 euro from the airport to the city:

A taxi would cost around 25 euro from the airport to the residence. Tipically the taxi driver will not know how to find the street, so you could print the map to show them.
Handicapped people should not use Metropolitano metro stop since it's not very accessible. They can use Guzmán el Bueno metro stop instead, and then take bus F or bus C (map in the next page):

Bus stops near Residencia Galdós:



Moving around

You can find some information at:

Transport Information System: http://www.ctm-madrid.es/
and
Metro de Madrid (underground): www.metromadrid.es/en/index.html
EMT (local buses): http://www.emtmadrid.es/index.html?lang=eng
Cercanías (regional train): http://www.renfe.es/cercanias/madrid/

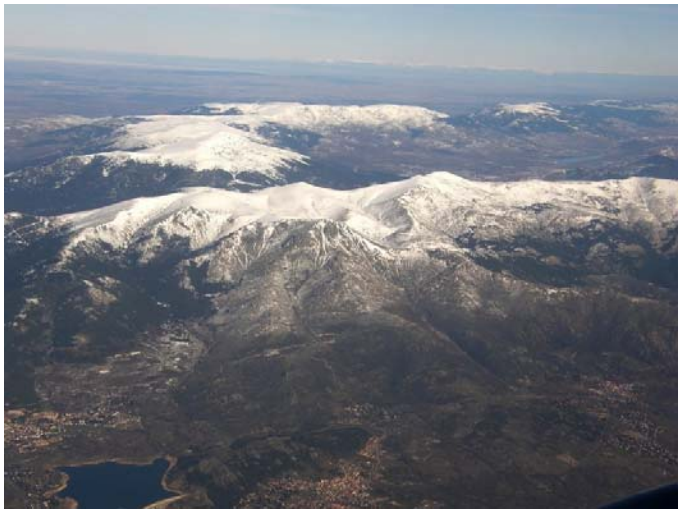
Tourism

Madrid City: http://www.esmadrid.com/en/portal.do
Madrid City and Region: http://www.turismomadrid.es/index_INGL.aspx

The University

Universidad Complutense de Madrid: www.ucm.es
Faculty of Mathematics: www.mat.ucm.es
Instituto de Matemática Interdisciplinar: www.mat.ucm.es/imi/IMI_english.htm

Communication Tower and Cuatro Torres Business Area, Madrid



Mountains, Madrid