VIII MODELLING WEEK UCM

Master in Mathematical Engineering - UCM

Madrid, June 9-13, 2014

http://www.mat.ucm.es/congresos/mweek/

Newsletter
June, 2014

Contents

Welcome

We are delighted to announce the seventh Modelling Week, which will be held from June 9 to June 13, 2014 at the Faculty of Mathematics of Universidad Complutense de Madrid, Spain.

The VIII Modelling Week is organized within the Master Program of the Faculty of Mathematics of UCM in cooperation with the Institute of Interdisciplinary Mathematics (IMI).

The main purpose of the VIII Modelling Week is to promote the use of mathematical methods and models in research, industry, innovation, and management in the knowledge economy.

The Modelling Week is open to the students of the Master in Mathematical Engineering at UCM and to participants from other mathematically oriented master programs worldwide.

Students will work in small groups on real industrial problems proposed by companies under supervision of one or two qualified instructors.

The official language of the event is English.

Valeri Makarov Modelling Week Coordinator	Marta Arregi Institute of Interdisciplinary Mathematics

2. Collaborators, programme, problems, participants

Supported by:

Faculty of Mathematics, UCM

MBDA missile systems

Instituto de Matemática Interdisciplinar

Univ. Complutense de Madrid

MS ManagementSolutions Making things happen

accenture Alto rendimiento. Hecho realidad.

Conento

Attendants and instructors from:

University of Oxford

CTB center for biomedical technology

Università degli Studi di Firenze

Univ. Complutense de Madrid

Faculty of Mathematics, UCM

Lobachevsky State University of Nizhni Novgorod National Research University

Instituto de Matemática Interdisciplinar

Problems proposed by:

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Conento

MONDAY 09-06-2014. Opening session (open to the public)

Room: Miguel de Guzmán (S118A, floor -1)

- 16:00 - 16:20. Introduction and opening of the VIII Modelling Week, UCM
- 16:20 - 16:40. Exposition of Problem 1. Fernando Prieto, Management Solutions, Spain
- 16:40 - 17:00. Exposition of Problem 2. Ebrahim Patel, University of Oxford, United Kingdom
- 17:00 - 17:20. Exposition of Problem 3. José M. García Queipo, MBDA, Spain
- 17:20 - 17:40. Exposition of Problem 4. José Antonio Villacorta Atienza, CTB, Spain
- 17:40 - 18:00. Exposition of Problem 5. Jorge Sueiras, Accenture Analytics, Spain
- 18:00 - 18:20. Exposition of Problem 6. Macarena Estévez, Conento, Spain
- 18:30 - 20:30. Working Groups at laboratories.

TUESDAY 10-06-2014 TO THURSDAY 12-06-2014. Working in groups

Labs distribution:

- Problem 1: Room Informática 1 (S217A, floor –2)
- Problem 2: Room Informática 2 (S218, floor –2)
- Problem 3: Room 112 (floor 1)
- Problem 4: Room 113 (floor 1)
- Problem 5: Room Informática 3 (S115, floor –1)
- Problem 6: Room Informática 0 (S217A, floor –2)

Working hours:

- Tuesday 10/06 and Thursday 12/06: 9:00 - 14:00 and 16:00 - 20:30
- Wednesday 11/06: 16:00 - 20:30

FRIDAY 13-06-2014. Closing session (open to the public)

Room: Miguel de Guzmán (S118A, floor -1)

- Morning. Groups at laboratories. Preparing final reports and presentations
- 17:00 - 19:30. Each working group gives a public presentation describing main results
- 19:30. Closing of the VIII Modelling Week

PROBLEM 1:

Impact of model estimation on model risk

Problem proposed by Management Solutions

Instructors
Juan Tinguaro Rodríguez González, Complutense University, Madrid

Exposition of the problem
Fernando Prieto, Management Solutions

Banks rely heavily on quantitative analysis and models in most aspects of financial decision making. They routinely use models for a broad range of activities, including underwriting credits; valuing exposures, instruments, and positions; measuring risk; managing and safeguarding client assets; determining capital and reserve adequacy; and many other activities. In recent years, banks have applied models to more complex products and with more ambitious scope, such as enterprise-wide risk measurement, while the markets in which they are used have also broadened and changed.

The expanding use of models in all aspects of banking reflects the extent to which models can improve business decisions but, what if models are misused or not well-defined?

Within this framework, models can also be considered as a source of risk. The possible adverse consequences (including financial loss) of decisions based on models that are incorrect or misused is called **model risk.**

Scheme of the work to be done
The tasks to be completed are:
☐ Statistical treatment of data from a fictitious retail portfolio provided by Management Solutions:
o Perform a univariate analysis for every variable so as to check whether variables are sufficiently informed (percentage of missing values), whether their values are within the expected range, etc.
o At the sight of these analysis results, carry out a treatment for the missing and outlier values.
☐ Fit the all provided variables once they have been treated to a logistic regression to obtain the scoring model.
☐ Identify potential sources of error in the built model. As an example we could take into account:
o The inherent error of the model
o Confidence intervals
o Lack of sample
o Model use
☐ For every source of error, analyze possible solutions to avoid them or mitigate them.
☐ Estimate a formula that quantifies the actual error made.

Participants
Aita, Antonio
González Marquina, Marta
Mellado Fernández, Lorena
Pérez Mazuela, Cecilia
Swierczynski, Piotr

PROBLEM 2:

Efficient railway timetabling using max-plus algebra

UNIVERSITY OF OXFORD

Problem proposed by Oxford Centre for Industrial and Applied Mathematics

Instructor
Ebrahim Patel, University of Oxford, United Kingdom

Exposition of the problem
Ebrahim Patel, University of Oxford

Whilst current railway timetables are in abundance and have been operational for well over a century, we will consider a different way to construct such timetables. In particular, we will use a fairly new type of mathematics - *max-plus algebra* - to develop and optimize timetables that can also handle (the inevitable occurrence of) delays. It is anticipated that such novel ways of looking at 'old' problems can provide further insight into optimization schemes; indeed, max-plus algebra has been applied in this sense to successfully describe the comings and goings of the Dutch railway system.

Assumptions
We will work at a simplified level, so that a functional railway timetable satisfies the following criteria:
1. Fixed travel times (between stations)
2. High frequency of departures at each station
3. Regular departures: one might call this "periodic" with departures occurring from a station every 30 minutes, say
4. Trains scheduled to depart must wait for all arriving trains before departing (to allow for changeover of passengers)
5. Departures occur as soon as possible, once item 4 is satisfied.

Work to be done
The items below will be punctuated by background work to familiarise the student with max-plus algebra.

- Abstract the Spanish railway network into a simple graph theoretical interpretation
- Find total number of trains on the current Spanish railway network
- Allocate 1 train per track and find performance measure
- Delay consideration: How does the timetable respond to varying levels of delay?
- Discuss possible improvements, find new performance measure, and new response to delays
- Repeat above as far as feasible (bearing in mind the upper limit for number of trains that the network can accommodate)
- Discuss practicality of results obtained; compare with actual Spanish timetable

Participants
Della Santa, Francesco
Suárez, Beatriz
González Ortega, Jorge
Valverde Castilla, Gabriel Antonio

PROBLEM 3:

Regresion models for LAR generation

Problem proposed by MBDA, missile systems

Instructors
Jose M. García Queipo and Gerardo Oleaga, Complutense University, Spain

Exposition of the problem
Jose M. García Queipo, MBDA

During the integration of a weapon system in a platform one of the key parameters that the weapon system must provide to the platform is the Launch Acceptability Region (LAR). The LAR defines a region of launch conditions where a weapon can be launched to reach its target, for any platform it is important to obtain this region and show to the controller so he can steer the platform into a position from where a successful engagement could be attained. The region attainable by the weapon is dependant upon factors like the kinematics, flight conditions, weather, impact angle restrictions...This means that an easy parametric model for the in-flight calculation of this region is needed, and that the parameters introduced in the model should be measured by the platform sensors.

The usual approach is generate the Weapon Attainability Region (WAR) of the munition and after that generate the LAR.

The WAR is defined as the area that a weapon can reach given its kinematics characteristics and the initial condition, that means that is weapon dependant.

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The WAR is defined as the area that a weapon can reach given its kinematics characteristics and he initial condition, that means that is weapon dependant.

This WAR could be made by means of the simulation of the fly-out of a given weapon for each launch and environmental conditions, and for each target point. This means that the in flight simulation of the WAR is not possible. One solution is to simulate on ground all the possibilities and load it into airborne equipment. The other is to prepare a model which generates it in flight. Normally this model is based on regression techniques [1] and recently some effort has been made to use neural networks [2 ,3].

When the zone attainable by a weapon has been determined the LAR could be calculated to indicate the platform operator where to steer the platform to engage the target. This is based on the target speed and bearing. Fig 2 shows an example of LAR. In zero wind conditions the LAR could be obtained from the WAR by a rotation and an axis transformation. In case that the wind is non zero the two surfaces have different shape.

Participants
Becera Clemares, Daniel
García Segador, Pedro
Huete Oliva, Álvaro
De Lucas Téllez de Meneses, Ana
Romero Triviños Yakelin Lizbeth

PROBLEM 4:

Cognitive manipulation in robots and artificial agents

Problem proposed by CTB

Instructor
Jose Antonio Villacorta Atienza, CTB, Spain

Exposition of the problem
Jose Antonio Villacorta Atienza, CTB

Nature has provided living beings with cognitive skills for proper interaction with the environment to ensure their survival. In this sense *cognition* can be defined as a set of mental abilities permitting the decision-‐making based on the processing of perceived and acquired information. Among cognitive abilities understanding, learning, and memory are main subjects of theoretical and experimental investigation. The importance of our comprehension and modeling of cognition relies on the wide social application of this knowledge, ranging from technological Implementation in robots, brain-‐‐machine interfaces, and assistive devices to the clinical use for diagnostic and treatment of mental diseases and syndromes.

The main context of cognition (both in biology and robotics) is the interaction of an agent with the real world.

During the last decades Neuroscience has revealed the main brain mechanisms involved in the understanding of *static* (i.e. time-‐‐invariant) environments, e.g. a maze. In brief, there exist different neuronal populations that code distinct spatial attributes of the environment such as the subject's position (place cells), location of obstacles (boundary cells), metric of the space (grid cells). Then neuronal structures créate an internal representation of the environment called a *cognitive map*. Cognitive maps allow the brain to answer questions like: Where am I? Where is the closest obstacle? Which is the free path?

Our reality is essentially *dynamic*, i.e. time-‐changing. If we consider a dynamic situation as a set of consecutive static situations (as frames in a movie) the amount of information to be processed could increase explosively. However, our brain constantly deals with complex dynamic situations in a fast, reliable, and robust way. Therefore, it uses a different paradigm for information processing to be able to deal with the big amount of information originated in the time dimensión of a situation.

Participants
Álvarez Liebana, Javier
Calvo Tapia, Carlos
Gómez, Michael
Llaneza González, Francisco
Mironov Vasiliy

PROBLEM 5:

Promotion mix optimization

Problem proposed by Accenture

Instructors
Federico Liberatore, Complutense University, Spain

Exposition of the problem
Jorge Sueiras, Accenture Analytics

The use of promotions to increase sales of consumer products is very common. For a products company it is very important to maintain and, if possible, increase market share. To achieve this companies spend a very high budget in advertising, promotions and discounts. An optimal use of this budget is essential to increase sales sustainably. In the proposed problem we must optimize the promotions strategy of a products company to achieve a maximum ROI (return of investment) and a maximum amount of the product sold. We circumscribe the problem to optimize the promotions strategy in only one retailer in a given quarter. We don't loss generality whit this approach because the promotions strategy is determined separately by retailer and quarter.

The main problem to perform this type of optimization in a products company is that we need a quantification of the relation between a concrete promotion and the increase of sales. In this case Accenture provides a dataset with the expected increases, costs, and income for the available promotions which can be used to build the objective function and constraints For confidentiality reasons, the name of the products company, retailer and products in this dataset will be anonymized.

Problem description
General goal: define the promotions plan i.e determine what promotion should be made in what product in what time slot (two week slots) to maximize the amount of product sold and/or maximize promotions plan ROI. The promotions comply with some business constraints about combinations of promotions, products and periods of time, and budget.
To perform this task the following data will be available:
- A table at product-package-slot-promotion level with the expected the increase in litres, cost of the promotion, revenue obtained by the increased sales and the ROI = (revenue-cost)/cost, separated in numerator and denominator
- A list of business constraints about some specific combinations of promotions, products/ packaging and time slots.
- Promotion budget for the given retailer-quarter.

Participants
Bermúdez Gallardo, José Carlos
Fossi, Margherita
Garro Moreno, David
Pérez García, Lucía

PROBLEM 6:

Building an optimal premium model for an insurance company

Problem proposed by Conento

Instructors
Benjamín Ivorra, Jorge Herrera, Complutense University, Spain

Exposition of the problem
Macarena Estevez, Conento

Introduction
Information relating to each individual client can help companies make better decisions in the future, and consequently, analysing information at client level is becoming more ecessary than considering it at aggregated level. For example, telecommunication companies need to know the main reasons why clients are abandoning their companies, what they can do to reduce the customer churn, which clients are more likely to buy a product, etc. CRM models need to be developed to answer these types of questions. CRM (Customer Relationship Management) models focus on improving the efficiency and profitability of strategic, commercial and marketing activities.

Problem description
We are interested in solving a CRM problem for an insurance company. The tasks to be achieved are:

- Finding the ideal target, in this case, people who are more likely to contract their insurance products.
- Identifying the premium we should offer to each client, that is to say, the optimal price that should be offered to each client.
- Calculating the difference between offering the premium randomly and optimally, using the information obtained in the model.

Participants
Ambrona Castellanos, Miguel
Bernal Navarro, Carlos
De Diego, Gómez, Carlos
Hadjittofis, Andreas
Martínez Marín, Alberto

Instructors:

Problem 1: *Impact of model estimation on model risk*

Juan Tinguaro Rodríguez González
Complutense University, Spain

Problem 2: *Efficient railway timetabling using max-plus algebra*

Ebrahim Patel
University of Oxford, United Kingdom

Problem 3: *Regression models for LAR regeneration*

Jose M. García Queipo (up)
Gerardo Oleaga (down)
Complutense University, Spain

Instructors:

Problem 4: *Cognitive manipulation in robots and artificial agents*

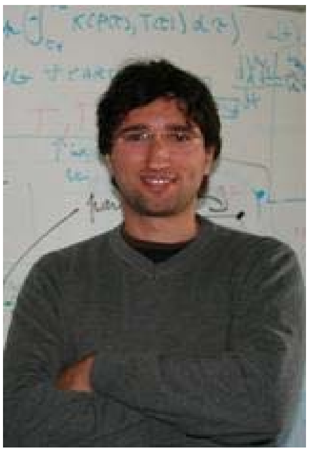
Jose Antonio Villacorta Atienza
CTB, Spain

Problem 5: *Promotion mix optimization*

Federico Liberatore
Complutense University, Spain

Problem 6: *Building an optimal Premium model for an insurance company*

Benjamín Ivorra (left)
Jorge Herrera (right)
Complutense University, Spain



Participants:

Problem 1: *Impact of model estimation on model risk*

Aita Antonio	Univ. Complutense de Madrid, Spain
González Marquina Marta	Univ. Complutense de Madrid, Spain
Mellado Fernández Lorena	Univ. Complutense de Madrid, Spain
Pérez Mazuela Cecilia	Univ. Complutense de Madrid, Spain
Swierczynski Piotr	Univ. of Oxford, United Kingdom

Problem 2: *Efficient railway timetabling using max-plus algebra*

Della Santa Francesco	Univ. of Florence, Italy
Frade Suárez Beatriz	Univ. Complutense de Madrid, Spain
González Ortega Jorge	Univ. Complutense de Madrid, Spain
Valverde Castilla Gabriel Antonio	Univ. Complutense de Madrid, Spain

Problem 3: *Regression models for LAR regeneration*

Becerra Clemares, Daniel	Univ. Complutense de Madrid, Spain
García Segador, Pedro	Univ. Complutense de Madrid, Spain
Huete Oliva, Álvaro	Univ. Complutense de Madrid, Spain
De Lucas Téllez de Meneses, Ana	Univ. Complutense de Madrid, Spain
Romero Triviños Yakelin, Lizbeth	Univ. of Florence, Italy

Problem 4: *Cognitive manipulation in robots and artificial agents*

Alvarez Liebana Javier	Univ. Complutense de Madrid, Spain
Calvo Tapia Carlos	Univ. Complutense de Madrid, Spain
Gómez Michael	Univ. of Oxford, United Kingdom
Llaneza González Francisco	Univ. Complutense de Madrid, Spain
Mironov Vasiliy	Univ. of Nizhni Novgorod, Russia

Problem 5: *Promotion mix optimization*

Bermúdez Gallardo José Carlos	Univ. Complutense de Madrid, Spain
Fossi Margherita	Univ. of Florence, Italy
Garro Moreno David	Univ. Complutense de Madrid, Spain
Pérez García Lucia	Univ. Complutense de Madrid, Spain

Problem 6: Building an optimal Premium model for an insurance company

Ambrona Castellanos Miguel	Univ. Complutense de Madrid, Spain
Bernal Navarro Carlos	Univ. Complutense de Madrid, Spain
Diego Gómez Carlos de	Univ. Complutense de Madrid, Spain
Hadjittofis Andreas	Univ. of Oxford, United Kingdom
Martínez Marin Alberto	Univ. Complutense de Madrid, Spain

For non UCM participants the following costs will be covered:

Travel. Flight tickets have been bought by the organizing committee and sent to the participants by e-mail.

Accomodation. Shared double rooms for students and single room for instructors at Colegio Mayor Antonio de Nebrija (see information below).

Meals: at Colegio Mayor Antonio de Nebrija: breakfast, lunch and dinner are included in the accomodation from Sunday night (June 9th) to Saturday morning (June 14th).

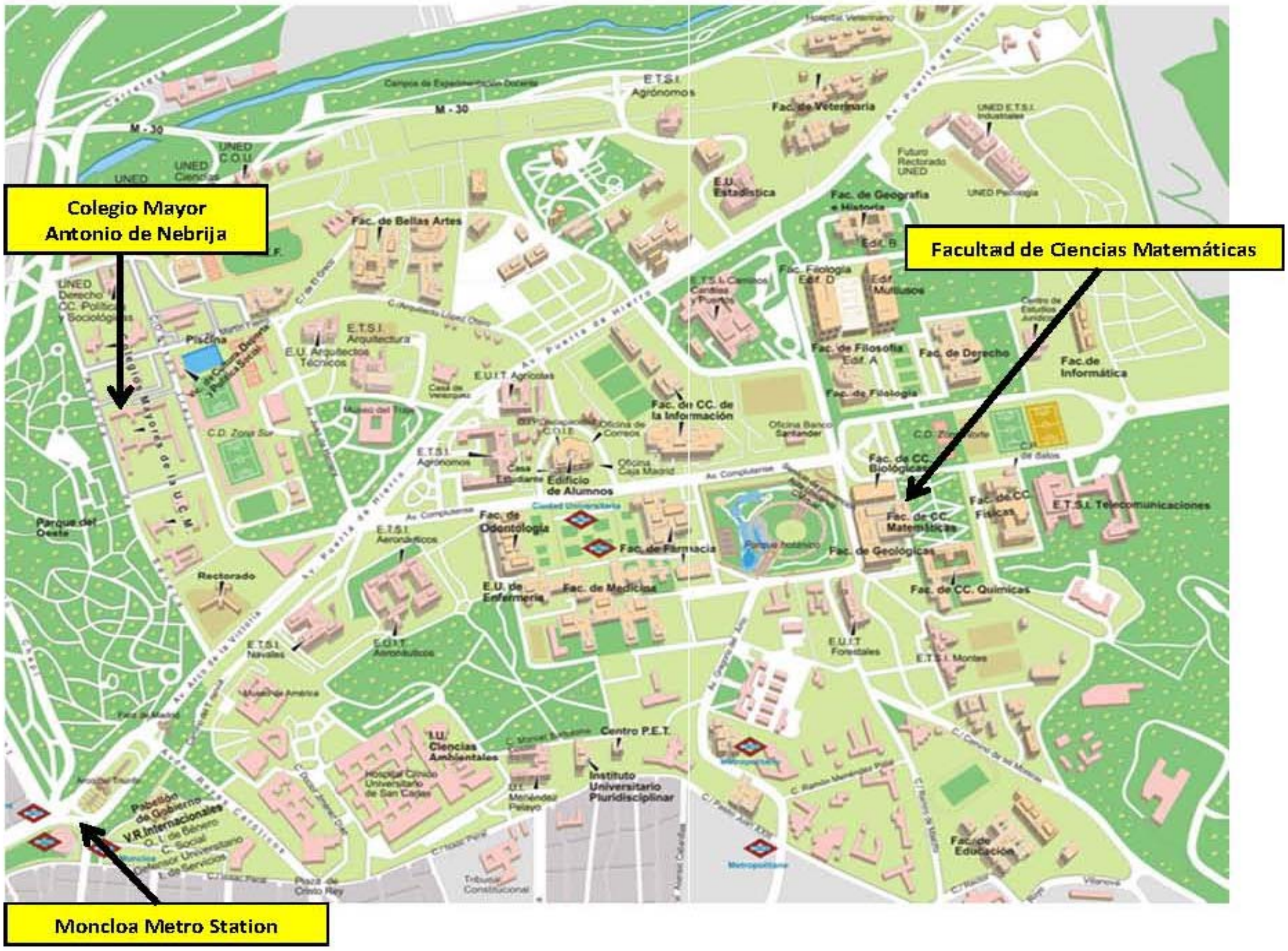
Colegio Mayor Antonio de Nebrija

It is located in the University Campus. The address is Avenida Séneca, 8. Phone number: (+34) 91 550 43 00. The closest underground stop is Moncloa. Buses connect the residence with Moncloa (160, 161 and A) and many locations at the University campus (U).

The webpage of the residence: http://www.cmuantoniodenebrija.es/

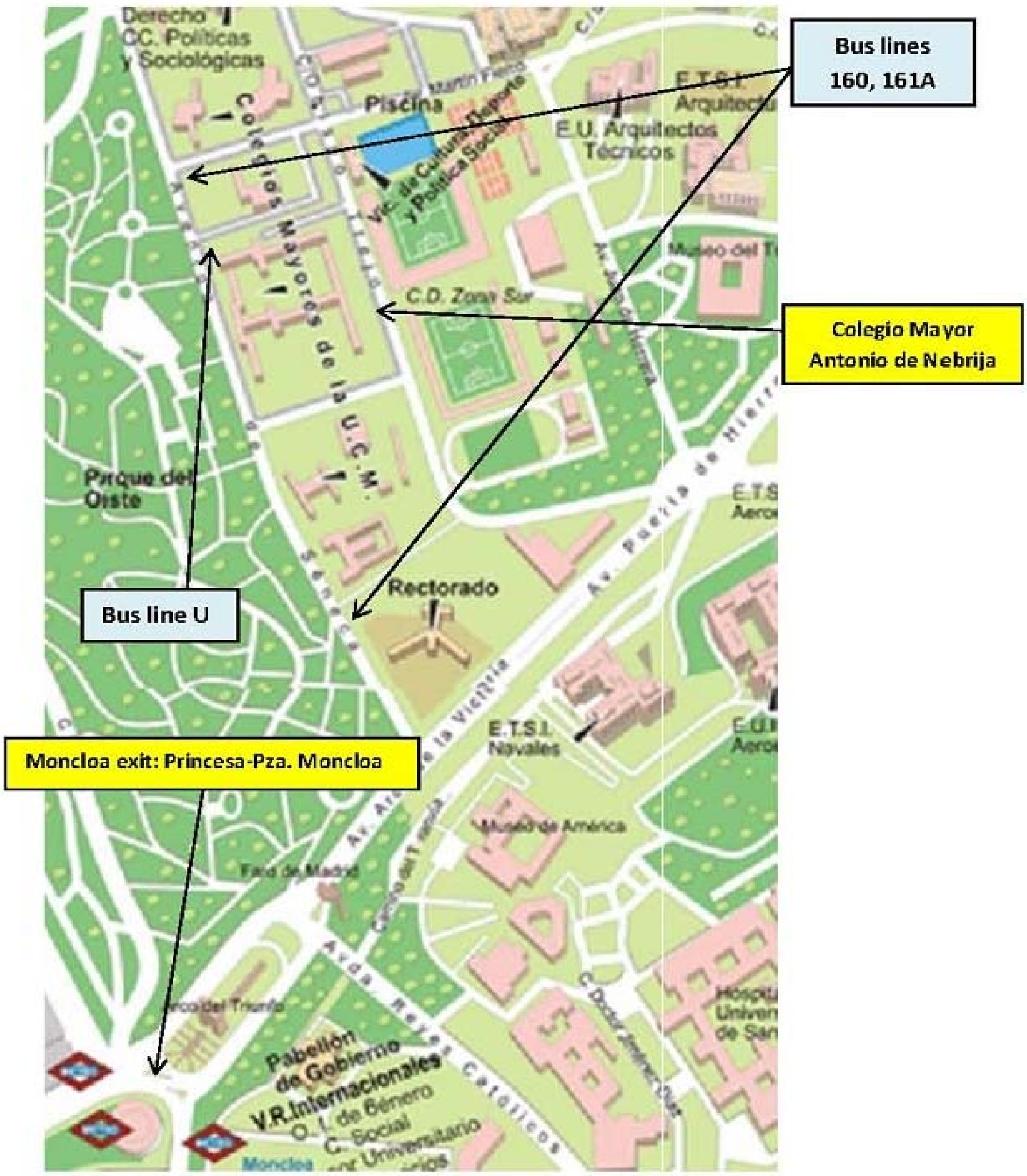
Campus Map

Facultad de Ciencias Matemáticas and Colegio Mayor Antonio de Nebrija at Moncloa Campus:



(Attention: this map is not north oriented)

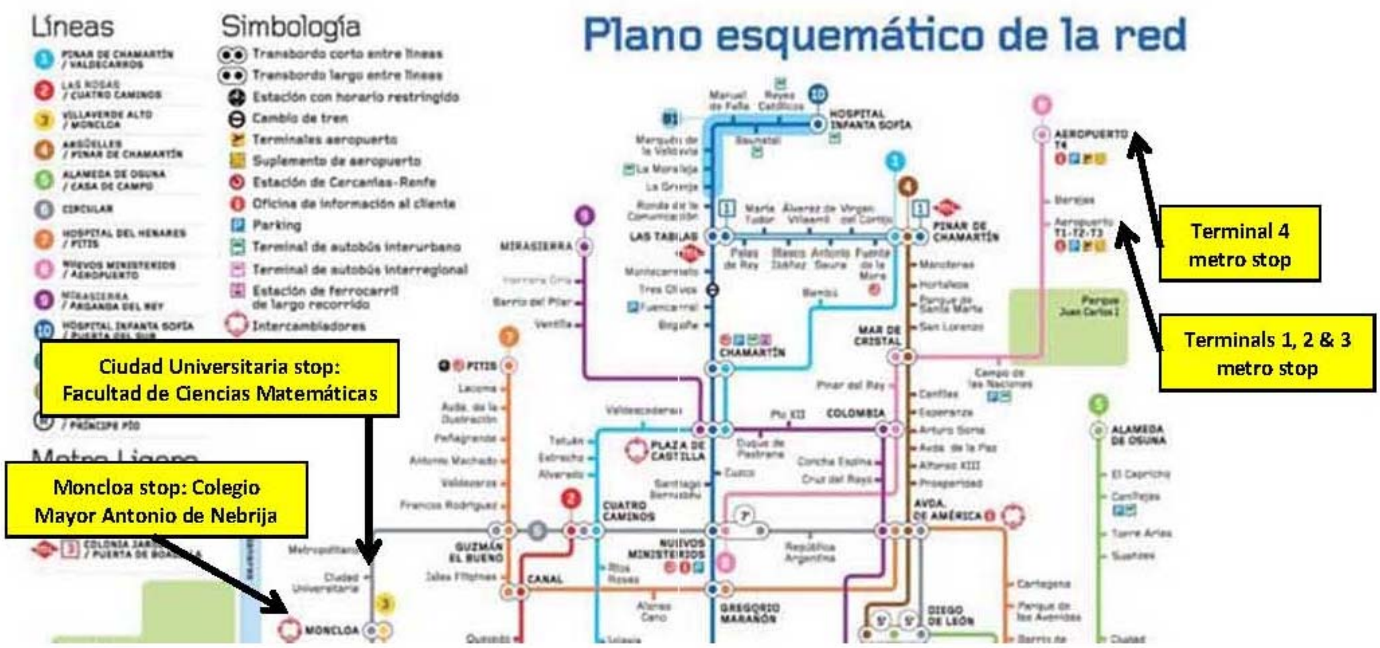
Bus stops near Colegio Mayor Antonio de Nebrija



How to arrive from the airport

There are two underground (Metro) stops at the airport, depending on the terminal you arrive. A single trip costs 5 euros from the airport to the University.

A taxi cost may vary between 40 and 60 euros from the airport to the Colegio Mayor. Tipically a taxi driver will not know how to find the place, so you better print out the map before the trip.



Directions: from the airport you can take the metro line 8 bound for Nuevos Ministerios, stop at Nuevos Ministerios station and then change to line 6 (counterclockwise) towards Moncloa stop.

Moving around

You can find some information at:

Transport Information System: http://www.ctm-madrid.es/
Metro de Madrid (underground): www.metromadrid.es/en/index.html
EMT (local buses): http://www.emtmadrid.es/
Cercanías (regional trains): http://www.renfe.com/EN/viajeros/index.html

Tourism

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

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/

Cibeles Square, Madrid

Puerta de Alcalá, Madrid