**XXX EURO mini Conference
"Optimization in the Natural Sciences"**

February 5–9, 2014

Aveiro, Portugal

PROGRAM

Dep. de Matemática Universidade de Aveiro

Aveiro, Portugal

http://minieuro2014.web.ua.pt/

Sponsors:

UA — *"University of Aveiro"*

DMat-UA — *"Department of Mathematics, University of Aveiro"*

EUROPT — *"The Continuous Optimization Group of EURO"*

EURO — *"The Association of European Operational Research Societies"*

FLAD — *"Luso-American Foundation for the Development"*

CIDMA — *"Center for Research & Development in Mathematics and Applications"*

FCT — *"Foundation for Science and Technology"*

INE — *"National Statistics Institute"*

APDIO — *"Portuguese Association of Operations Research"*

SPE — *"Portuguese Society of Statistics"*

Fábrica — *"Science Center Fábrica"*

CME — *"Major House of Estarreja"*

RAÍZ — *"RAÍZ Research Institute"*

Special Thanks to:

"Hotel Moliceiro,"
"Hotel Aveiro Palace"
"Hotel Alboi"
"Hotel Afonso V"
"House Museum Egas Moniz"
"Theatre Aveirense"

GENERAL INFORMATION

Introduction

On behalf of the Organizing and Program Committees, we are very pleased to welcome you to the XXX EURO mini-conference "Optimization in the Natural Sciences", MEC XXX- Aveiro, Portugal-2014, hosted by the Mathematics Department of the University of Aveiro.

Our mini-conference is the 30th event in the series initiated in 1984 by EURO, Association of European Operations Research Societies. Among the latest editions of EURO mini-conferences we can mention MEC XXIX - Graz-2013, Austria, (October 17-19, 2013), MEC XXVIII - Herceg Novi, Montenegro 2012, (October 4-7, 2012), MEC XXVII - Nottingham, UK 2012 (September 13-15, 2012), MEC XXVI- Poznan, Poland 2011 (September 6-9, 2011), and one more mini-conference in Portugal, MEC XXV - Coimbra, Portugal 2010 (April 15-17, 2010).

The project of organizing MEC XXX in Aveiro, was designed in EUROPT, *EURO Working Group on Continuous Optimization* and supported by EURO, *Association of European Operations Research Societies* and CIDMA - *Center for Research and Development in Mathematics and Applications* of the Mathematics Department of the University of Aveiro. This led to the choice of the theme of the mini-conference – Optimization in the Natural Sciences that in turn reflected three directions of research that are being developed in EUROPT and CIDMA: Dynamical Systems, Optimization and Statistics with special attention to their applications in Natural Sciences and Bioinformatics. One of the aims of the conference is to inspire cooperation between researchers from different areas of fundamental and applied science.

More than 90 abstracts have been submitted to our meeting and 100 participants from 21 country are registered. This is the result of the hard work of the international Program Committee to whose members we are very grateful. Scientific program consists of 23 sessions divided in three streams: Optimization and application; Dynamic systems; and Statistics, bioinformatics and health sciences.

We are very thankful to all the participants and express our special gratitude to Invited Speakers who have accepted our invitations: Giuseppe Buttazzo (University of Pisa), Leonid Bunimovich (Georgia State University, Atlanta), Alexander Dudin (Belarusian State University), Michael Greenacre (University Pompeu Fabra, Barcelona), Gueorgui Smirnov (University of Minho, Portugal) and Sergei Tabachnikov (Pennsylvania State University). We also would like to appreciate very much the kind offer of two tutorial lectures by Yaroslav D. Sergeyev, from University of Calabria.

The Organizing Committee composed of our colleagues from the Mathematics Department of the University of Aveiro has made its best to offer to the participants an interesting social program during the meeting, present the University of Aveiro and the beautiful region of Portugal where it is situated. We have included in the program a visit to the house-museum of Egas Moniz, neurologist, researcher, teacher and writer, the Nobel Prize winner of 1949, still today considered to be the forerunner of modern brain imaging techniques and psychosurgery, not only because his research is also connected with the Natural Sciences, but also since the house designed by the famous Portuguese architect Korrody in 1915 as well as the neighboring Quinta do Marinheiro can be places of interest for our participants. We also offer to our participants an excursion to RAIZ, a private non-profit institute of forestry research situated in the beautiful Quinta de São Francisco. Thanks to our colleagues from the Organizing Committee for their time, energy, creativity and readiness to help that we always felt in our everyday work.

We hope that all the efforts of the Program and Organizing Committees will result in a reach, productive, dynamic and interesting scientific forum. We do believe that the variety of topics of our conference will stimulate fruitful interdisciplinary contacts between the participants.

Finally, we thank our sponsors that made the conference possible. The conference was supported by the University of Aveiro and is included in the list of 40 events commemorating 40 years of the University. We received support of Portuguese funds through the CIDMA - *Center for Research and Development in Mathematics and Applications*, and FCT– *Portuguese Foundation for Science and Technology*, within project PEst-OE/MAT/UI4106/2014 CIDMA. Special thanks to EURO, EUROPT, FLAD –Luso-American Foundation, INE –National Institute of Statistics, APDIO –Portuguese Association of Operations research, SPE –Portuguese Society of Statistics, Science Center "Fábrica", RAIZ – Institute of forestry and paper research and Municipality of Estarreja.

<div align="center">

Aveiro, February 2014

Co-chairs: Adelaide Freitas, Alexander Plakhov,
and Tatiana Tchemisova.

</div>

Committees:

Program Committee

- Adelaide Freitas (University of Aveiro, Portugal)
- Adil Bagirov (University of Ballarat, Australia)
- Adilson Elias Xavier (Federal University of Rio de Janeiro, Brazil)
- Alexander Plakhov (University of Aveiro, Portugal)
- Anna Guerman (University of Beira Interior, Covilhã Portugal)
- Andreia Hall (University of Aveiro, Portugal)
- Boris T. Polyak (Institute of Control Problems, Moscow, Russia)
- Delfim F. M. Torres (University of Aveiro, Portugal)
- Domingos M. Cardoso (University of Aveiro, Portugal)
- Gerard Wilhelm Weber (Middle East Technical University, Institute of Applied Mathematics, Turkey)
- János D. Pintér (Proprietor & Research Scientist Pintér Consulting Services, Inc., Canada)
- Joaquim Júdice (Universidade de Coimbra, Portugal)
- José Fernando Mendes (University of Aveiro, Portugal)
- Julius Žilinskas (Vilnius University, Lithuania)
- Kathrin Klamroth (University of Wuppertal, Germany)
- Leonidas Sakalauskas (Institute of Mathematics, Vilnius University, Lithuania)
- Lisete de Sousa (FCUL, Lisboa, Portugal)
- Luís Nunes Vicente (University of Coimbra, Portugal)
- Luzia Gonçalves (IHMT, Portugal)
- Mourad Elloumi, (University of Tunis-El Manar, Tunis)
- Olga Kostyukova (Institute of Mathematics, Belarusian Academy of Sciences, Belarus)
- Oliver Stein (Karlsruhe Institute of Technology, Germany)
- Purificación Galindo (University of Salamanca, Spain)
- Sven-Åke Gustafson (University of Stavanger, Norway)
- Tatiana Tchemisova (University of Aveiro, Portugal)
- Vera Roshchina (University of Ballarat, Australia)
- Vladimir Bushenkov (University of Évora, Portugal)

Organizing Committee (University of Aveiro)

- **Co-Chair:** Tatiana Tchemisova
- **Co-chair:** Alexander Plakhov
- **Co-chair:** Adelaide Freitas
- Vera Afreixo
- Isabel Brás
- Paula Carvalho
- João Pedro Cruz
- Jorge Sá Esteves
- Pedro Macedo
- António Pereira
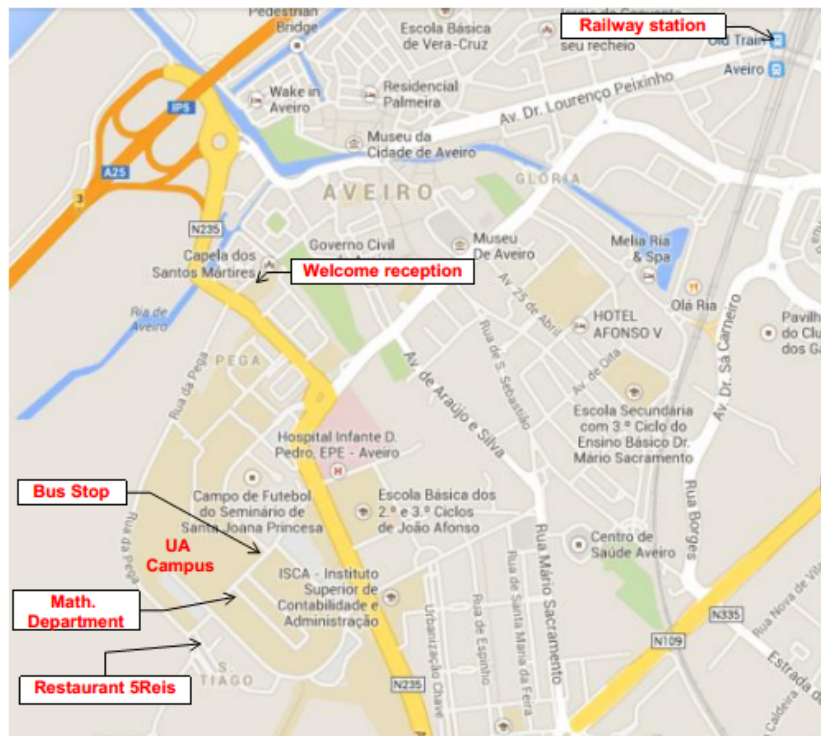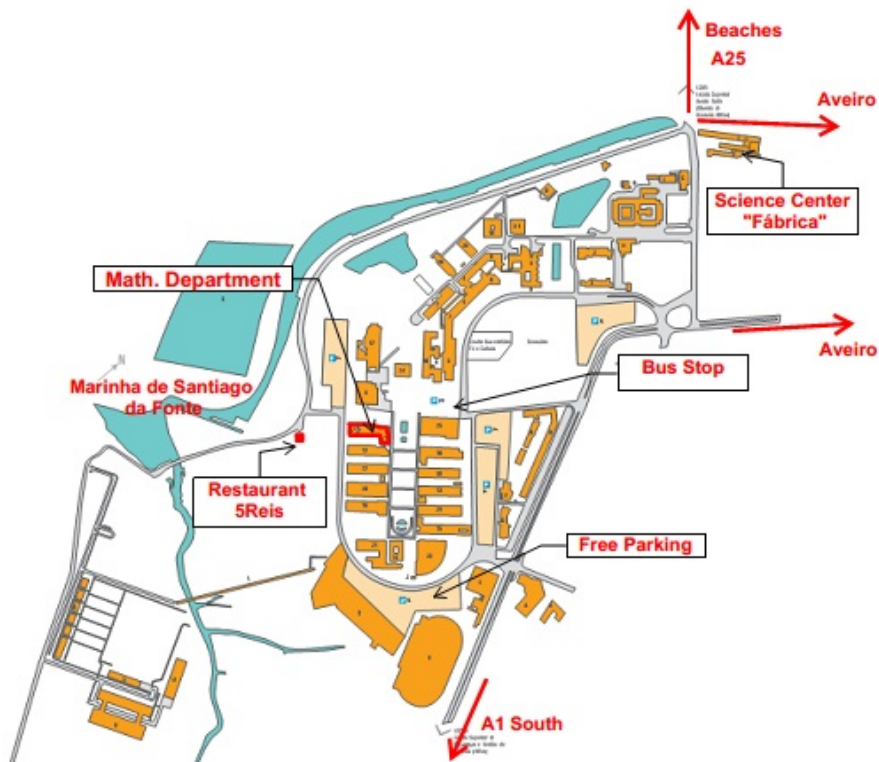- Ricardo Pereira
- Paula Rama

Secretary

- Neusa Lagarto

Conference Venue

University of Aveiro, Campus de Santiago, Department of Mathematics – building 11

Map of Aveiro

Map of the University Campus of Santiago

SCIENTIFIC PROGRAM

Wednesday, February 5:

The Opening Session and Plenary I will take place at Science Center *"Fábrica."*

Address: Rua dos Santos Mártires, Aveiro.

Thursday, February 6 to Saturday, February 8:

Plenary, tutorial and contributed sessions will take place in the following rooms *("Salas"):* 11.1.2, 11.1.3, and 11.1.12 situated at the first floor of the Math Department.

Registration Desk

The registration desk will be opened on Wednesday, February 5 from 14:30 to 17:30 at Science Center *"Fábrica"* and from Thursday, February 6 to Saturday February 8 at the Math Department of UA.

Timetable of the Registration Desk:

Wednesday	February 5	14:30 – 17:30		
Thursday	February 6	08:30 – 13:00	and	14:00 – 18:00
Friday	February 7	08:30 – 13:00	and	14:00 – 16:00
Saturday	February 8	08:30 – 13:00		

Presentations

Audio/Visual Equipment

Conference rooms are equipped with PC running Windows 7 and connected to LCD projectors. The computers contain up-to-date software for the main presentation formats (Microsoft Power Point, PDF Adobe Acrobat Reader) and have USB connections for memory cards. You can either use your own laptop or copy the file with your presentation onto the desktop of the computer in your room. Overhead transparency projectors will be provided if needed.

Speakers Information

Please make sure to arrive at your session at least ten minutes before it is scheduled. Before the session begins, all speakers should test their presentation and the connection with the LCD projector. In case of any technical problem, you can ask for the help of any member of staff. The location of your session is indicated in the Technical Sessions Chapter and related Indexes. Time your presentation to fit the allotted time, allowing time for questions and audience participation. The time allotted for contributed presentations is about 20 minutes.

Session Chairs

The role of the session chair is to ensure the smooth execution of the session. Please, make sure to:

- Contact all the speakers before the session, to verify their presence and to pre-empt any technical problems.

- Begin the session on time. The sessions of 3 talks last 1 hour, and the sessions of 4 talks last 1h 30 minutes.

- Keep presentations in the order indicated in the programme, to allow participants to enter and leave the room during the breaks between the talks.

- If the speaker announced in the programme has not arrived, make a break and start the next presentation in its scheduled time. This break can be used for some relax and/or discussion.

- Introduce the speaker and the title of each presentation.

- Ensure that the presentations, including questions, do not overstep their time frame.

- At the end of each presentation ask for questions and comments and thank the speaker.

Free Wireless Internet and Free Access Computer Room

The University of Aveiro has a very reliable EDUROAM WLAN (Wireless Local Area Network) access covering all the area of the *"Campus de Santiago"* including open spaces, amphitheaters and rooms inside the buildings. Apart from that, a limited number of PCs wire-connected to the internet will be available in Room 11.2.8 (second floor of Math department). For both types of connections you should use the following username and password:

Username: `minieuro@visit.uaveiro.eu`

Password: `minieuro`

Restaurant *"5 Reis"*

Lunches will be served at the restaurant *"5 Reis"* behind the Math Department building close to the salines of Aveiro. The price of lunch tickets is included in the registration fee. (Note: There are several canteens and the University Restaurant at the Campus. For more information please contact our staff).

The registration fee for a delegate covers:

- Participation in conference;

- The bag with conference materials;

- Welcome reception in Science Center *"Fábrica"* (Wednesday, February 5, 15:00–18:30);

- Visit to the Research Institute *"Raíz" and Quinta de Santo António;* (Thursday, February 6, 16h15);

- Guided visit to the *"Marinha de Santiago da Fonte,"* with bird watching. This *"marinha"* is a traditional saline which is property of University of Aveiro. The visit will take place only if weather conditions allow it. Two guided visits are scheduled for February 6 from 7:55 AM to 8:35 AM, and February 7 from 7:55 AM to 8:45 AM. There is a maximum number of participants in these visits, so that each person should make the registration. For the enrollment and further information, please contact the organization, Isabel Brás (`ibras@ua.pt`) or the Registration Desk until February 5.

- Visit to House Museum Egas Moniz and the Conference Dinner at Hotel Eurosol (Friday, February 7, 16:30–23:00);

- Coffee Breaks for all the days of the conference;

- Lunches on Thursday, Friday and Saturday at the Restaurant *"5 Reis"*.

SOCIAL PROGRAM

Wednesday, February 5, 17:00

Welcome Reception at Science Center "Fábrica"

A Welcome Reception will be held at Science Center *"Fábrica"* at 17:00 and followed by guided visit to the center.

Address: Science Center *"Fábrica"*, Rua dos Santos Mártires, Aveiro.

The *"Fábrica Centro Ciência Viva (FCCV)"* is an initiative that results from a partnership between the University of Aveiro and the National Agency for Scientific and Technological Culture. The main objective of the FCCV is to promote scientific and technological culture by encouraging experimentation, and its dissemination to the general public. It also aims to foster the creation of a suitable framework for training of youth workers and teachers, school support, cooperation between scientific institutions, enterprizes, municipalities and educational institutions and the development and production of content and resources for formal and non-formal education.

Thursday, February 6, 16:15

Visit to Raíz — Research Institute

Address: Quinta de S. Francisco, Eixo.

Transportation by bus from the campus of UA (16:15).

"Raíz" is a private, nonprofit research institute whose members are Portucel Soporcel, the Universities of Coimbra, Aveiro and Lisbon. The main objective of the center is to strengthen the competitiveness of forestry and papermaking industries through research, technological support and specialized training.

Friday, February 7, 16:30

Visit to Museum House of Egas Moniz

Address: Professor Egas Moniz Street, Avanca.

Transportation by bus from campus.

Egas Moniz (1874 – 1955), was a Portuguese neurologist and the developer of cerebral angiography. He is regarded as one of the founders of modern psychosurgery, having developed the surgical procedure leucotomy - known better today as lobotomy - for which he became the first Portuguese national to receive a **Nobel Prize in 1949** (shared with Walter Hess). He held academic positions, wrote many medical articles and also served in several legislative and diplomatic posts in the Portuguese government. In 1911 he became professor of neurology in Lisbon until his retirement in 1944. At the same time, he pursued a demanding political career.

The house, projected by architect Korrody in 1915, as well as the neighboring Quinta do Marinheiro, was converted in a Museum-House and a Handicraft School, according to the will written by Egas Moniz. In addition to its Artistic Section, House Museum Egas Moniz has its Scientific Section which presents the objects relating to their scientific discoveries, e. g. angiography, an exceptional graphical display of the successive stages of the investigations that led to the first radiological visualization of the cerebral arteries of Man live and Pre-Frontal leucotomy, the kind of exhibition that was presented at the International Congress of Neurosurgery.

Friday, February 7, 20:00

Conference Dinner at Eurosol Hotel, Estarreja

The Conference Dinner will take place after excursion to the Museu Egas Moniz at the restaurant of the Eurosol Hotel. Transportation by bus from the museum.

Address: Rua Marques Rodrigues, 36, Estarreja.

Eurosol Estarreja Hotel & Spa is built in an area of lush century old vegetation, with a convenient display, essential to an enterprize of this nature including *"Real Cozinha Velha"* restaurant. This proposes a perfect symbiosis of traditional Portuguese cuisine and authors cuisine.

Saturday, February 8

We suggest our participants to attend the Ute Lemper concert at *"Teatro Aveirense"* (21:30). Address: Rua Belém do Pará, Aveiro. The tickets should be bought in advance at the Ticket Office of the Theater or online at

`http://www.ticketbuster.net/Ticketbuster/Calendario.aspx?Ref=1&CodEspec=1442`

Sunday, February 9

Free Program

There will be no scientific program sessions on Sunday. Here there is one suggestion for our guests.

Boat Trip along the Channels of Ria de Aveiro

The company E.C.A. - Embarcações Clássicas de Aveiro suggests various trails of boat trips by the channels of Aveiro. Usually the trips start at the center boats berth of central channel near the Central Delegation of Tourism.

Address: Berth of boats in the central channel, Rua João Mendonça, (near the Central Delegation of Tourism), Aveiro.

USEFUL INFORMATION

Telephone Numbers

The country code of Portugal for telecommunications is **+351** and the Emergency National Number is **112**. The telephone number of the secretary office of the Mathematics Department of UA is **+ 351 234372543**.

Banks and Money

Official banking hours in Portugal are between 08:30 and 15:00 from Monday to Friday. Nearby the Math department there are two bank agencies opened in the period 09:30–16:00. The currency unit in Portugal is the Euro (€, EUR), which is subdivided into 100 Cents (Cent).

Transportation in Aveiro

If you arrive to Aveiro by train, you can take a taxi or bus just in front of the Train Station. You can also reach the Conference Venue or your hotel by foot (the biggest walking distance in the center of Aveiro is about 30 minutes).

Taxi

If you arrive to Aveiro by train, you can take a taxi at the taxi stop just in front of the Train Station. Otherwise you may call a taxi cab by the phone numbers below. The price of one trip from the Train Station to the conference venue as well as to the majority of the hotels indicated in our Website is about 10 €.

Train Station Taxi Telephone: +351 234 422 943
Central Radio Taxi Telephone: +351 234 385 799
Aveiro Plaza Taxis Telephone: +351 234 316 148

BUS

You may obtain complete information on the internet site **http://www.moveaveiro.pt/**. In the next page you can find a rough schematic circuit way of the Line 6 (Green Line) of the bus giving short distance connections between the conference venue and all other locations referred in the social program. The price of a ticket for one way trip is 1,85 €.

MOVEbus   **Line N.º 4 Bus Timetable**

linha 4	Estação » Hospital » Universidade														
	dias úteis (só se efectua em período de aulas)														
Estação	7:20	7:50	8:20	8:50	9:20	9:55	10:20	10:45	11:20	12:20	13:20	14:20	15:20
P.Praça	7:25	7:55	8:25	8:55	9:25	10:00	10:25	10:50	11:25	12:25	13:25	14:25	15:25
Universidade	7:30	8:00	8:30	9:00	9:30	10:05	10:30	10:55	11:30	12:30	13:30	14:30	15:30
ISCAA	7:32	8:02	8:32	9:02	9:32	10:08	10:32	10:58	11:32	12:32	13:32	14:32	15:32
Hospital	7:35	8:05	8:35	9:05	9:35	10:10	10:35	11:00	11:35	12:35	13:35	14:35	15:35
Estação	7:40	8:10	8:40	9:10	9:40	10:15	10:40	11:05	11:40	12:40	13:40	14:40	15:40

linha 4	Estação » Hospital » Universidade									
	domingos e feriados (só se efectua em período de aulas)									
Estação	17:20	17:45	18:20	19:20	19:45	20:20	20:50	21:20	22:20	23:20
P.Praça	17:23	17:48	18:23	19:23	19:48	20:23	20:53	21:23	22:23	23:23
Hospital	17:26	17:51	18:26	19:26	19:51	20:26	20:56	21:26	22:26	23:26
ISCAA	17:28	17:53	18:28	19:28	19:53	20:28	20:58	21:28	22:28	23:28
Santiago	17:30	17:55	18:30	19:30	19:55	20:30	21:00	21:30	22:30	23:30
M.Sacram.	17:32	17:57	18:32	19:32	19:58	20:32	21:02	21:32	22:32	23:32
Av.25 Abril	17:35	18:00	18:35	19:35	20:00	20:35	21:05	21:35	22:35	23:35
Estação	17:45	18:10	18:45	19:45		20:45	21:15	21:45	22:45	

linha 4		estação - hospital - universidade

percurso

estação   (Railway Station)
ponte de praça
universidade   (University Campus)
ISCIAA
hospital
estação   (Railway Station)

BUGA —- Free Urban Bicycles of Aveiro

In the entire urban area of the city (including the University Campus) you can use bicycles. The city bikes of Aveiro - BUGAs *("Bicicleta Urbana Gratuita de Aveiro")* are free of charges but their use is restricted to the period 09:00-18:00. To get a free bicycle you need to present your identification document.
One can pick a bike in the central BUGA parking *"Ponte-Praça"*, near Forum Aveiro shopping Center. For more information see the site

http://www.moveaveiro.pt/04mobilidade/movebuga/condicoes.htm

or contact the **BUGA Line: +351 967 050 441**.

Conference Program

	Wednesday 5/02/14 *Fábrica*	Thursday 6/02/14 Math Dep.	Friday 7/02/14 Math Dep.	Saturday 8/02/14 Math Dep.
09:00-10:00		Plenary II	FA-1, FA-2, FA-3	SA-3
10:00-10:30		Coffee break	Plenary IV	Plenary VI
10:30-11:00				
11:00-11:30		TB-1, TB-2, TB-3	Coffee break	Coffee break
11:30-12:00			FC-1, FC-2, FC-3	SC-1, SC-2, SC-3
12:00-13:00		Plenary III		
13:00-14:00		Lunch	Lunch	Lunch
14:00-15:00		Tutorial 1	Plenary V	SD-1, SD-2, SD-3
15:00-16:00	Opening Session	TE-1, TE-2, TE-3	FE-1, FE-2	SE-3
16:00-16:30	Plenary I	Raiz (excursion)	Museum Egas Moniz (excursion)	Coffee break
16:30-17:00				Tutorial 2
17:00-17.30	Welcome Reception (visit to *Fábrica*)			
17:30-18:30				Closing session
19:00 - ⋯			*Conference Dinner*	

Code example   :   TB-1 : **T**hursday, period **B**, room **1**

Room 1 : Mathematics Department, 11.1.2
Room 2 : Mathematics Department, 11.1.3
Room 3 : Mathematics Department, 11.1.12

TECHNICAL SESSIONS

Wednesday, 15:00 - 15:45

■ WA-04

Wednesday, 15:00 - 15:45
Science Center - Fabrica

Opening Session

Stream: Other Sessions
Plenary session

Wednesday, 16:00 - 17:00

■ WB-04

Wednesday, 16:00 - 17:00
Science Center - Fabrica

Plenary Talk I

Stream: Plenary Talks
Plenary session
Chair: *Domingos Cardoso*, Departamento de Matemática, Universidade de Aveiro, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal, dcardoso@ua.pt

1 - **Multi-dimensional Markov chains with special structures of generators and their application in natural sciences**
Alexander Dudin, Applied Mathematics and Computer Science, Belarusian State University, 4, Independence Ave., Minsk-30, 220030, Minsk, Belarus, dudin@bsu.by

Markov chains have found a lot of versatile applications for modelling various real world objects. Important particular example of continuous time Markov chain is so called birth and death process. The generator of a birth and death process is a three-diagonal matrix. From the early beginning, birth and death processes were applied for modelling the size of population of insects (this expains the name of such processes) in various biological studies. Currently, they are popular for modelling social systems (immigration and emigration), demography, ecology, genetics, molecular evolution, queue lengths in many physical, technical, economical and other systems. Evident shortcoming of application of a birth and death process to description of some population is an assumption that, during his/her life, each member of population can die or give a life to a child at a constant rate. Sure, in real life systems the birth and death rates essentially depend on the sex and age of the members of population. So, to have a more adequate model of dynamics of population, it is necessary to keep additionally track of this information about the sex and age. In such a way, the dynamics of population is described not only by its size (it is called sometimes as a level of a process), but also by the final set of some additional features. Thus, the process describing the dynamics of population is a multi-dimensional one. Under some proper enumeration of the components of this process, its generator has a three-block-diagonal structure. Such process is called in literature as quasi-birth-and-death process. The theory of quasi-birth-and-death processes with Toeplitz-like type structure of a generator and its generalizations to the cases of block-upper-Hessenberg and block-lower-Hessenberg Toeplitz-like structure of generator was developed by M. Neuts.

In this talk, well-known results by M. Neuts are shortly described and the original results relating to investigation of two particular structures of a generator of Markov chain are presented. One structure is block-upper-Hessenbergian with approaching to Toeplitz-like type when the level increases. Markov chains having such a structure of generator well fit for description of real world processes with the birth and death rates proportional to the number of a level, e.g., for description of queues with customers retrial and queues with impartient customers. The second structure is a combination of block-upper-Hessenberg Toeplitz-like structure and structure with equal block rows of a generator. Such Markov chains are suitable, e.g., for description of queueing systems with exhaustive group service or with disasters. Ergodicity conditions are presented. Numerically stable algorithms for computation of stationary distribution are derived.

Literature:

1. F.W. Crawford and M.A. Suchard Transition probabilities for general birth-death processes with applications in ecology, genetics, and evolution. Journal of Mathematical Biology. 2012. V. 65. P. 553-580.

2. M. Neuts Matrix-geometric Solutions in Stochastic Models — An Algorithmic Approach. USA, Johns Hopkins University Press, 1981.

3. M. Neuts Structured stochastic matrices of M/G/1 type and their applications, Marcel Dekker, 1989.

4. A.N. Dudin, V.I. Klimenok Multidimensional quasitoeplitz Markov chains. Journal of Applied Mathematical and Stochastic Analysis, 1999, V. 12. P. 393-415.

5. V.I. Klimenok, A.N. Dudin Multi-dimensional asymptotically quasitoeplitz Markov chains and their application in queueing theory. Queueing Systems. 2006. V. 54. P. 245-259.

6. A.N. Dudin, C.S. Kim, V.I. Klimenok Markov chains with hybrid repeated rows — upper-Hessenberg quasi-Toeplitz structure of block transition probability matrix. Journal of Applied Probability, 2008. V. 45. P.211-225.

Thursday, 9:00 - 10:00

■ TA-02

Thursday, 9:00 - 10:00
Room 11.1.3

Plenary Talk II

Stream: Plenary Talks
Plenary session
Chair: *Alexander Plakhov*, Department of Mathematics, University of Aveiro, Campus Santiago, 3810-276, Aveiro, Portugal, plakhov@ua.pt

1 - Optimal potentials for Schrödinger operators
Giuseppe Buttazzo, Department of Mathematics, University of Pisa, Largo B. Pontecorvo, 5, 56127, Pisa, Italy, buttazzo@dm.unipi.it

We consider the Schrödinger operator -Delta + V(x) on H_01(O) where O is a given domain of Rd. Our goal is to study some optimization problems where an optimal potential V >= 0 has to be determined in some suitable admissible classes and for some suitable optimization criteria, like the energy or the Dirichlet eigenvalues.

Thursday, 10:30 - 12:00

■ TB-01

Thursday, 10:30 - 12:00
Room 11.1.2

Multiobjective Optimization and applications

Stream: Optimization and Applications
Contributed session
Chair: *Vladimir Bushenkov*, Department of Mathematics, CIMA, University of Evora, CLAV, R Romao Ramalho, 59, 7000-671, Evora, Portugal, bushen@uevora.pt

1 - A new hybrid method for interactive multi-objective optimization based on NSGA-II and synchronous NIMBUS method
Ernestas Filatovas, Institute of Mathematics and Informatics, Vilnius University, Akademijos st. 4, LT-08663, Vilnius, Lithuania, ernest.filatov@gmail.com, *Olga Kurasova, Karthik Sindhya*

A new hybrid method is proposed for solving multiobjective optimization problems interactively. Here concepts from the reference point based synchronous NIMBUS interactive multi-objective optimization method are borrowed and combined with the NSGA-II algorithm. The proposed method uses preference information provided by a decision maker to find only desirable solutions satisfying decision maker's preferences on the Pareto front. In few steps, the decision maker can find a set of preferred solutions close to the Pareto front when solving complex multiobjective optimization problems.

2 - Network and Economic Trade-Off Performance Regions of the Slotted ALOHA Protocol using Multi-Objective and Portfolio Optimization
Ramiro Samano, Instituto de Telecomunicações, Portugal, ramiro@av.it.pt

The study of the Slotted ALOHA protocol is revisited using multi-objective and financial portfolio optimization tools. Each transmission is regarded both as a network resource and also as a financial asset with different values of return and risk (variance of the return). The work characterizes the Pareto optimal boundaries of different trade-off regions: throughput region, sum-throughput vs. fairness, sum-throughput vs. power, and return vs. risk. Fairness is given by the Gini-index, commonly used to measure wage inequality, while transmit power is directly linked to the transmission rate.

3 - Approximation of Pareto frontier in Multiobjective Integer Linear Problems of Forest Management
Vladimir Bushenkov, Department of Mathematics, CIMA, University of Evora, CLAV, R Romao Ramalho, 59, 7000-671, Evora, Portugal, bushen@uevora.pt, *Cristina Pimentel*

Decision problems with multiple criteria and integer or mixed integer variables often arise in forest planning and management, water resources management, etc. When multiobjective programming problems have integer variables, even if the restrictions are linear, the attainable set Y in the criterion space can be non-convex. We consider one approach for approximating the Pareto frontier of Y by pairs of interior and exterior estimates which converge each other during iterations. An example of application to the forest management in Portugal will be given.

4 - Material parameters identification in elasto-plasticity using an optimized loading path

Elisabete Ferreira, Engenharia Mecânica, Universidade de Aveiro, Campus Universitário de Santiago, 3810-193, Aveiro, Portugal, elisabetedsf@ua.pt, *Joaquim Pinho-da-Cruz, António Andrade-Campos*

Nowadays, the characterization of materials has received an increasing attention due to the manufacturing of new materials and computational analysis software. However, a large number of experimental tests are necessary to characterize all the mechanical properties which is very time and material consuming. To overcome this problem the presented methodology allows to evaluate the quality of the loading path and to find the most informative loading path in order to display normal and shear strains as distinctly as possible using optimization techniques.

■ TB-02

Thursday, 10:30 - 12:00
Room 11.1.3

Optimal control applied to biological models

Stream: Dynamical systems
Contributed session
Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Optimal Control of the Feed-Forward Loop in Neuronal Networks

Xuyang Lou, Jiangnan University, China, Louxy@126.com, *Qian Ye, Baotong Cui*

Most existing works focus on stability or synchronization of neuronal networks and its dependence on network topology. However, there have also been reports on optimal control problems in networks, little study has been performed for the optimal control of neuronal networks in small parts of networks known as motifs. In this work, we present an optimal control scheme for an important motif, the so-called feed-Forward loop (FFL), in Hindmarsh-Rose neuronal networks. In the framework Hamilton-Jacobi-Bellman principle, the proposed time optimal control scheme is applied to drive a Hindmarsh-Rose

2 - Advances on Optimal Control of Stochastic Hybrid Systems with Jumps in Science, Economics and Finance

Gerhard-Wilhelm Weber, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr, *Busra Temocin, Azar Karimov, Erdem Kilic, Fikriye Yilmaz, Hacer Öz*

Optimal Control of Stochastic Hybrid Systems with Jumps plays an increasingly important role for modelling and decision making in various fields. We present applications of such systems in biology, ecology, monetary systems and finance to account for regime switching dynamics. Stochastic models with a motion part and additionally a jump part are able to capture abrupt fluctuations that are a usual phenomenon in gene-environment networks and markets. We solve control problems in closed form and numerically, and show extensions via Ito-Taylor formulas and fractional Brownian motions.

3 - A Tuberculosis-HIV/AIDS model and optimal treatments for the reduction of co-infected individuals

Cristiana Silva, Mathematic, University of Aveiro, Rua Casal Cantiga, 16, Cela de Cima, 2440-158 , Batalha, Portugal, cjoaosilva@ua.pt, *Delfim F. M. Torres*

Tuberculosis (TB) is a major cause of death among people living with HIV, and HIV presents a big challenge to TB control. An estimate one-third of the 40 million people living with HIV/AIDS worldwide are co-infected with TB. We propose and analyze a model for TB-HIV/AIDS co-infection which considers single disease (TB or HIV/AIDS) and co-infection treatment. The basic reproduction number of the system model is computed and stability is analyzed. Optimal control treatment procedures are derived for the reduction of co-infected TB-HIV/AIDS individuals.

4 - Multiobjective approach to dengue disease transmission

Helena Sofia Rodrigues, CIDMA, Escola Superior de Ciências Empresariais, Instituto Politécnico de Viana do Castelo, Av. Miguel Dantas, 4930-678 , Valença, Portugal, sofiarodrigues@esce.ipvc.pt, *Roman Denysiuk, Lino Costa, Isabel Espírito Santo, M. Teresa Torres Monteiro, Delfim F. M. Torres*

A system of ordinary differential equations to model the dengue disease transmission is presented. A multiobjective formulation using evolutionary algorithms to find the most effective ways of controlling the disease is proposed. The obtained trade-offs provide a valuable information about dynamics of infection transmissions and can be used as an input in the process of planning the intervention measures by the health authorities. The multiobjective approach appears to be an effective tool to solve the problem when compared with the most common in literature.

■ TB-03

Thursday, 10:30 - 12:00
Room 11.1.12

Graph theory and applications 1

Stream: Optimization and Applications
Contributed session
Chair: *Enide Martins*, Mathematics, University of Aveiro, University of Aveiro, Campus Universitário de Santiago, 3810-193 , Aveiro, Aveiro, Portugal, enide@ua.pt

1 - On Randić Spread

Helena Gomes, Mathematics, University of Aveiro, 3810-100, Aveiro, Portugal, hgomes@ua.pt

A new spectral graph invariant, called Randić spread, is presented. This quantity is equal to the maximal difference between two eigenvalues of the Randić matrix, disregarding the spectral radius. Lower and upper bounds for this invariant are presented, some of which depending on the Randić index of the underlying graph.

2 - Strongly regular graphs: a Jordan-algebraic approach

Vasco Mano, CIDMA - Center for Research & Development in Mathematics and Applications, Faculty of Engineering of University of Porto, Rua António Fragoso, 386 Custóias, 4460-669, Custóias, Portugal, vascomocomano@gmail.com

Strongly regular graphs are an important class of graphs, characterized by a set of four parameters, with interesting

spectral properties. A difficult problem on the study of SRG is to find suitable admissibility conditions over their parameters. In this work we took on a Jordan-algebraic approach and associated a three dimensional Euclidean Jordan algebra to the adjacency matrix of a SRG. This approach lightened the way to generalize the Krein admissibility conditions associated to a SRG as well as to improve them, obtaining tight upper-bounds for some of the generalized Krein parameters.

3 - Spectral bounds for the k-regular induced subgraph problem

Sofia Pinheiro, Matemática, Universidade de Aveiro, Aveiro, Portugal, spinheiro@ua.pt, *Domingos Cardoso*

A maximum independent set and a maximum induced matching is a maximum cardinality 0-regular and 1-regular induced subgraph, respectively. In (Cardoso, Kamínski and Lozin, 2007) it was proved that finding a maximum k-regular induced subgraph is NP-hard, so it is crucial to find upper bounds determined in polynomial time as good approximations. We will present spectral upper bounds on the size of k-regular induced subgraph. These upper bounds are based on convex quadratic techniques and on adjacency, Laplacian and signless Laplacian spectrum. Finally we present some computational experiments.

4 - Conjecture about the extremal graphs for the geometric-arithmetic index with given minimum degree

Ljiljana Pavlovic, Department of Mathematics, Faculty of Natural Sciences and Mathematics, Radoja Domanovica 12, 34000, Kragujevac, Serbia, pavlovic@kg.ac.rs, *Milica Milivojevic*

The geometric-arithmetic index GA(G) of a graph G is defined as the sum of the weights of all edges. The weight of one edge is a quotient of the geometric and arithmetic average of degrees of its end vertices. The predictive power of GA for physico-chemical properties is somewhat better than the predictive power of other connectivity indices. We give a conjecture about structure of extremal graphs of this index for n-vertex graphs with given minimum degree.

Thursday, 12:00 - 13:00

■ TC-02

Thursday, 12:00 - 13:00
Room 11.1.3

Plenary Talk III

Stream: Plenary Talks
Plenary session
Chair: *Immanuel Bomze*, Dept. of Statistics and OR, University of Vienna, Oskar-Morgenstern-Platz 1, A-1090, Vienna, Austria, immanuel.bomze@univie.ac.at

1 - Variational Problems of Plastic Surgery

Georgi Smirnov, University of Minho, 4800-058, Guimarães, Portugal, smirnov@math.uminho.pt

Plastic surgery is an important area of medicine. Apart from the aesthetic surgery, it also includes many types of the reconstructive surgery. Many of these operations imply massive interventions and need careful preparation and planning. The computational simulation of plastic surgery, that is, the development and use of mathematical models for preoperative planning as well as for postoperative evaluation is becoming quite usual. The most challenging problem in surgery computer simulation is the modelling of soft tissue behaviour, as well as of the knitting conditions. From the mathematical point of view, soft tissue deformation is described by a map from the original domain to its deformed counterpart. Soft tissue can be modelled as a hyperelastic material, that is, a material satisfying the standard thermodynamic axiom of non-negative works in closed processes. In this model, the deformation is a minimizer of the stored energy functional. Consequently, calculus of variations turns out to be a natural tool to describe the soft tissue deformations. General Variational Problem of Plastic Surgery, introduced not long ago, is a problem of calculus of variations with unusual boundary conditions, known as knitting conditions. These conditions model suturing and are fundamental for surgery simulations. In this talk we discuss variational methods in plastic surgery modelling. The main problems addressed are the existence of solutions for problems of calculus of variations with knitting boundary conditions, necessary conditions of optimality, approximation of solutions, numerical methods for the knitting problem, and the optimization problema of data fitting in the framework of parameter estimation.

Thursday, 14:00 - 15:00

■ TD-02

Thursday, 14:00 - 15:00
Room 11.1.3

Tutorial I

Stream: Other Sessions
Tutorial session
Chair: *Tatiana Tchemisova*, Mathematics Department, University of Aveiro, Campus Universitario de Santiago, 3810-193, Aveiro, Portugal, tatiana@ua.pt

1 - **Deterministic Lipschitz global optimization**
Yaroslav Sergeyev, DIMES, University of Calabria, DIMES, Via P. Bucci, Cubo 42C, I-87036, Rende (CS), Italy, yaro@si.deis.unical.it

In this lecture, the global optimization problem of a multi-dimensional function satisfying the Lipschitz condition over a hyperinterval with an unknown Lipschitz constant is considered. It is supposed that the objective function can be "black box', multiextremal, and non-differentiable. It is also assumed that evaluation of the objective function at a point is a time-consuming operation. Many algorithms for solving this problem have been discussed in literature. They can be distinguished, for example, by the way of obtaining information about the Lipschitz constant and by the strategy of exploration of the search domain.

Different exploration techniques based on various adaptive partition strategies are analyzed. The main attention is dedicated to diagonal algorithms, since they have a number of attractive theoretical properties and have proved to be efficient in solving applied problems. In these algorithms, the search hyperinterval is adaptively partitioned into smaller hyperintervals and the objective function is evaluated only at two vertices corresponding to the main diagonal of the generated hyperintervals.

It is demonstrated that the traditional diagonal partition strategies do not fulfil the requirements of computational efficiency because of executing many redundant evaluations of the objective function. A new adaptive diagonal partition strategy that allows one to avoid such computational redundancy is described. Some powerful multidimensional global optimization algorithms based on the new strategy are introduced. Results of extensive numerical experiments performed to test the methods proposed demonstrate their advantages with respect to diagonal algorithms in terms of both number of trials of the objective function and qualitative analysis of the search domain, which is characterized by the number of generated hyperintervals.

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Thursday, 15:00 - 16:00

■ TE-01

Thursday, 15:00 - 16:00
Room 11.1.2

Data Visualization

Stream: Optimization and Applications
Contributed session
Chair: *Markus Loecher*, Economics, Berlin School of
Economics and Law, Germany, mloecher@hwr-berlin.de

1 - **Visualization of Routing Graphs to ease the Determination of problem-specific Cutting Planes in MILPs and Heuristic Enhancements**
Martin Bernroider, Computational Logistics Lab,
Salzburg Research, Jakob-Haringer-Strasse 5/3,
5020, Salzburg, Austria, Austria,
martin.bernroider@salzburgresearch.at, *Stefan Schneider*

Applications of mathematical programming solvers for
MILP need customization to enhance the solution process,
not least for real-world problems in a wide variety of fields and disciplines. Therefore research often focuses on
finding good problem-specific cuts and heuristic improvements — what frequently turns out to be quite challenging
even without any further insight into the search tree. In this
talk we will present our work on common routing problems,
using interactive visualization of the routing conflict graph
as well as vital information about the underlying decision
variables.

2 - **Decision Support for Multi-Objective Mixed-Integer Optimization: A Visual Exploration Tool**
Rui Borges Lopes, Dep. of Economics, Management
and Industrial Engineering, CIDMA / University of
Aveiro, Campus Universitário de Santiago,
3810-143, Aveiro, Portugal, rui.borges@ua.pt,
Carlos Ferreira, Beatriz Sousa Santos

A large number of Pareto optimal solutions often exist in
multi-objective optimization models. As a consequence,
finding the decision-maker's preferred solution is typically
a difficult task both from a computational and cognitive
point of views (e.g. in obtaining the several solutions and
comparing them). We present a prototype of a decision-support tool for multi-objective optimization using mixed-integer variables. This tool allows visually exploring solutions using commercial solvers.

3 - **Rapid Polygon Identification**
Markus Loecher, Economics, Berlin School of
Economics and Law, Germany,
mloecher@hwr-berlin.de

We address the problem of efficient spatial polygon search
in massive data sets. Given spatial partitions such as census blocks, ZIP codes or police district boundaries, we are
frequently faced with the need to spatially aggregate data.
Unless efficient data structures are used, this can be a daunting task. The standard algorithms (ray casting and winding
number)are computationally expensive and do not scale.
Here, we exploit two methods 1) kd-trees and 2) range-search to dramatically reduce the effective number of polygons being searched.

■ TE-02

Thursday, 15:00 - 16:00
Room 11.1.3

Optimization in dynamical systems

Stream: Dynamical systems
Contributed session
Chair: *Delfim F. M. Torres*, Department of Mathematics,
University of Aveiro, Universidade de Aveiro, Campus
Universitário de Santiago, 3810-193 , Aveiro, Portugal,
delfim@ua.pt

1 - **Necessary condition for an Euler-Lagrange equation on time scales**
Monika Dryl, Department of Mathematics,
University of Aveiro, Portugal, monikadryl@ua.pt,
Delfim F. M. Torres

We prove a necessary condition for a dynamic integro-differential equation to be an Euler-Lagrange equation.
New and interesting results for the discrete and quantum
calculus are obtained as a particular case. An example of
a second order dynamic equation, which is not an Euler-Lagrange equation on an arbitrary time scale, is given.

2 - **Necessary conditions for variational problems with dependence on a combined Caputo derivative**
Dina Tavares, Department of Mathematics,
University of Aveiro, Campus Universitário de
Santiago, 3810, Aveiro, Portugal, a20082@ua.pt,
Ricardo Almeida, Delfim F. M. Torres

We establish necessary conditions of optimality for variational problems, where the Lagrangian depends on a combined Caputo derivative, with variable fractional order. The
endpoint of the integral is free, and thus transversality conditions are proved. Several particular cases are considered.

3 - **Optimal control methods for model discrimination**
Hilke Stibbe, Mathematics and Computer Science,
University of Marburg, Hans-Meerwein-Strasse,
35032, Marburg, Germany,
stibbe@mathematik.uni-marburg.de, *Ekaterina Kostina*

If two or more model candidates are proposed to describe
the same process and information available does not allow
to discriminate between the candidates, new experiments
must be designed to reject models by lack-of-fit test. Mathematically this leads to highly structured, complex, multiple experiments, multiple models optimal control problems.
Special emphasis is placed on robustification of optimal designs against uncertainties in model parameters. New numerical methods and applications from chemistry and biosciences will be discussed.

■ TE-03

Thursday, 15:00 - 16:00
Room 11.1.12

Combinatorial optimization and heuristics

Stream: Optimization and Applications
Contributed session
Chair: *Cristina Requejo*, Mathematics & CIDMA,
University of Aveiro, 3810-193, Aveiro, Portugal,
crequejo@ua.pt

1 - Heuristic methods for the Weight-Constrained Minimum Spanning Tree Problem

Eulália Santos, CIDMA, University of Aveiro, 3810-448, Aveiro, Portugal, eulalia.santos@sapo.pt, *Cristina Requejo*

The Weight-Constrained Minimum Spanning Tree problem (WMST) is a NP-hard combinatorial optimization problem having important applications in the networks design and communication networks. With the goal to obtain near optimal solutions to the WMST problem, we use heuristic methods for finding an integer feasible solution. Extensive computational results show that the heuristic methods presented in this work are quite effective in finding integer feasible solutions and present small gap values.

2 - Improving solutions of the optimal diversity management problem

Sérgio Marques, Matemática, Universidade de Aveiro, Rua do Cruzeiro, 76 Ribeira, Ovar, 3880-181, Ovar, Portugal, serolmar@hotmail.com

New heuristic techniques to find and improve feasible solutions for the optimal diversity management problem are discussed. All the heuristics are based on mathematical programming approaches. Feasible solutions are derived from the linear programming relaxation solution using rounding schemes. To solve the linear relaxation we use a decomposition approach that is based on the fact that the underlying graph is not connected, and show that this decomposition approach dominates the usual linear relaxation. The feasible solutions obtained from the linear relaxation are compared against the greed

3 - Strategic Planning of Operating Room: an Optimal Approach

Ana Tavares, Instituto Superior de Contabilidade e Administração de Coimbra (ISCAC), Coimbra, Portugal, anacltavares@gmail.com, *Ana Amaro*, *Ricardo Mota*, *José Almeida*

The Portuguese National Health System is facing deep changes due to a whole reorganization of services, involving great managing challenges to hospitals, within a constraining budget. This proposal develops a decision model to help on the planning of hospital surgeries. Different capacities, medical criteria and priorities are evaluated in order to minimize surgery lists and improve services and its performance. A Mixed Integer Linear Programming formulation is proposed to the strategic planning in Operating Rooms (Inpatients/outpatients) of the Centro Hospitalar Universitário Coimbra,EPE.

Friday, 9:00 - 10:00

■ FA-01

Friday, 9:00 - 10:00
Room 11.1.2

Modeling and optimization in biology, chemistry and medicine

Stream: Optimization and Applications
Contributed session
Chair: *Ekaterina Kostina*, Department of Mathematics and
Computer Science, University of Marburg,
Hans-Meerwein-Str., 35032, Marburg, Germany,
kostina@mathematik.uni-marburg.de

1 - Numerical optimization methods for significance analysis of parameters and subsets of metabolic networks

Ekaterina Kostina, Department of Mathematics and
Computer Science, University of Marburg,
Hans-Meerwein-Str., 35032, Marburg, Germany,
kostina@mathematik.uni-marburg.de

We have developed an efficient numerical method, based on
sensitivity analysis for parametric optimization problems,
that can be used to identify the most important signaling
pathways and the key parameters and variables in a mathe-
matical model that is given by an ODE system. In the con-
text of metabolic pathways, our approach can be used to
guide experimental biologists in e.g. their choice which pro-
teins they should measure. We show the capability, reliabi-
lity, and efficiency of our approach using complex problems
from systems biology.

2 - Discrete approaches to the molecular distance geometry problem

António Pereira, Department of Mathematics,
University of Aveiro, Gab. 11.3.14, Campus
Universitário de Santiago, 3810-193, Aveiro,
Portugal, antoniop@ua.pt, *Agostinho Agra, Cristina
Requejo, Rosa Maria Figueiredo, Carlile Lavor,
Nelson Maculan*

The Molecular Distance Geometry Problem (MDGP) arises
in nuclear magnetic resonance spectroscopy analysis and
consists in finding an embedding in R3 for the atoms of a
protein, given a set of inter-atomic distances for certain pairs
of atoms. We propose and discuss three different approa-
ches to the MDGP based on a discretization of the solution
space: two integer programming technics and the third in-
volves constraint programming methods. We compare these
approaches for a set of small size instances and discuss how
they can be used to improve branch and prune schemes for
solving the MDGP.

3 - Robustness Criteria of Hybridization of double-stranded DNA Sequences

Hirotaka Ono, Kyushu University, 6-19-1 Hakozaki,
Higashi-ku, Faculty of Economics, 814, Fukuoka,
Japan, hirotaka@econ.kyushu-u.ac.jp

Predicting the behavior of DNA molecules in vitro is a fun-
damental issue on DNA computing and related areas, but is
also known to be quite difficult. Computational simulation
is one of the most reasonable approaches for the prediction.
However, simulation approaches are still time-consuming in
designing DNA sequences that hybridize in some preferable
way. In this paper, we propose simple criteria that are useful
to roughly predict the behavior of DNA sequence hybridi-
zation.

■ FA-02

Friday, 9:00 - 10:00
Room 11.1.3

Mathematical methods in mechanics and geometrical optics

Stream: Dynamical systems
Contributed session
Chair: *Giuseppe Buttazzo*, Department of Mathematics,
University of Pisa, Largo B. Pontecorvo, 5, 56127, Pisa,
Italy, buttazzo@dm.unipi.it

1 - Besicovitch's magic method and a problem of minimal resistance

Alexander Plakhov, Department of Mathematics,
University of Aveiro, Campus Santiago, 3810-276,
Aveiro, Portugal, plakhov@ua.pt

We consider the problem of least resistance for "dimples":
negative functions that are defined in a bounded domain, go
to zero near the domain boundary, and satisfy the so-called
single impact condition. The solution somewhat contradicts
the intuition. A part of the solution is based on Besicovitch's
construction solving the Kakeya problem: what is the mini-
mum area of a plane region in which a unit line segment can
be rotated continuously through 180 degrees.

2 - Sharp Weyl Law for Alternating Counting Function of Positive Interior Transmission Eigenvalues

Evgeny Lakshtanov, University of Aveiro, Portugal,
lakshtanov@ua.pt

We present a sharp weighted Weyl formula for the counting
function of the positive interior transmission eigenvalues.
We show that real interior transmission eigenvalues (ITEs)
in the scattering by inhomogeneous media are observable
together with some signs which are defined by the direction
of the motion of the corresponding eigenvalues of the scat-
tering matrix (when the latter pass through $z=1$). We ob-
tain a Weyl type formula for the counting function of ITEs
which are taken together with their signs.

3 - On modelling of dynamics of rough discs

Sergey Kryzhevich, Faculty of Mathematics and
Mechanivcs, Saint-Petersburg State University, 28,
Universitetskiy pr., Peterhof, Saint-Petersburg,
Russia, 198504 , Saint-Petersburg, Russian
Federation, kryzhevicz@gmail.com, *Alexander
Plakhov*

Two-dimensional dynamics if bodies with a pieceiwise
smooth boundary is studied. We concentrate on bodies,
close to balls in Hausdorff metrics. We study their laws
of motion, possible trajectories. Also, we give some new
examples of scattering billiards, discuss their laws of scat-
tering and relations with dynamics of corresponding rough
discs. Particularly, we demonstrate that any rectifiable curve
may be approximated by trajectories of rough bodies.

■ FA-03

Friday, 9:00 - 10:00
Room 11.1.12

Design Optimization

Stream: Optimization and Applications
Contributed session
Chair: *Cristina Requejo*, Mathematics & CIDMA,
University of Aveiro, 3810-193, Aveiro, Portugal,
crequejo@ua.pt

1 - Combinatorial Optimization for Loss Reduction in Power Distribution Networks

Christiano Lyra, Engenahria de Sistemas, Universidade Estadual de Campinas, C.P. 6101 FEEC, UNICAMP, 13083-970, Campinas, SP, Brazil, chrlyra@densis.fee.unicamp.br

Energy is continuously dissipated in electric power transmission and distribution networks. Reduction of these losses can be regarded as a source of energy; in Brazil, the reduction of each percentage point is equivalent to the average output of a 1000 MW power plant. The talk discusses combinatorial optimization problems that can provide alternatives to reduce losses in distribution networks, focusing on the problem of finding the best topology for the network operation. It studies the combinatorial properties of the problem, gives an overview of solution alternatives and fathoms new ideas.

2 - A Formulation to infer a tree topology using a distance matrix
Olga Oliveira, Mathematics, Universidade de Aveiro, Rua Principal, n.º 22, Martinhas, 3080-758, Bom Sucesso, Figueira da Foz, Portugal, olga.oliveira@ua.pt, *Cristina Requejo, Bernard Fortz*

Discovering the exact topology of networks knowing only the distances between a subset of nodes is a problem with applications in several areas. Namely, the inference of phylogenetic trees, modeling of traffic networks and the analysis of Internet infrastructures. We present a mixed-integer linear programming model to infer the topology of a network using a distance matrix and we discuss different solution procedures.

3 - The exact algorithm for a scheduling repairs on the railways.
Nail Khusnullin, ICS RAS, Russian Federation, nhusnullin@gmail.com, *Alexander Lazarev*

In this research it was consideres a particular case of railway problems, namely, the optimal scheduling of the train operation by a double-track railroad when one of the segments is under repair works. Also, it is suggested an exact algorithm based on dynamic programming.

Friday, 10:00 - 11:00

■ FB-02
Friday, 10:00 - 11:00
Room 11.1.3

Plenary Talk IV

Stream: Plenary Talks
Plenary session
Chair: *Gerhard-Wilhelm Weber*, Institute of Applied Mathematics, Middle East Technical University, ODTÜ, 06531, Ankara, Turkey, gweber@metu.edu.tr

1 - Tire tracks geometry, Menzin's conjecture, continuous and discrete bicycle transformation, and complete integrability
Sergei Tabachnikov, Pennsylvania State University, PA 16802, University Park, United States, tabachni@math.psu.edu

This talk concerns a simple model of bicycle motion: a bicycle is a segment of fixed length that can move in the plane so that the velocity of the rear end is always aligned with the segment. The trajectory of the front wheel and the initial position of the bicycle uniquely determine its motion and its terminal position; the monodromy map sending the initial position to the terminal one arises. This circle mapping is a Moebius transformation, a remarkable fact that has various geometrical and dynamical consequences. Moebius transformations belong to one of the three types: elliptic, parabolic and hyperbolic. I shall outline a proof of a 100 years old conjecture: if the front wheel track is an oval with area at least Pi then the respective monodromy is hyperbolic.

The rear wheel track and a choice of direction determine the front wheel track; changing the direction to the opposite, yields another front track. The two front tracks are related by the bicycle, or Backlund-Darboux, transformation which defines a discrete time dynamical system on the space of curves. This system is completely integrable and closely related with a well studied completely integrable continuous time dynamical system, the filament (or binormal, or smoke ring) equation. There is also a discrete version of the Backlund-Darboux transformation, acting on polygons, rather than smooth curves.

Friday, 11:30 - 13:00

■ FC-01

Friday, 11:30 - 13:00
Room 11.1.2

Global and Nonconvex Optimization

Stream: Optimization and Applications
Contributed session
Chair: *Immanuel Bomze*, Dept. of Statistics and OR, University of Vienna, Oskar-Morgenstern-Platz 1, A-1090, Vienna, Austria, immanuel.bomze@univie.ac.at

1 - Copositive relaxation beats Lagrangian dual bounds in quadratically and linearly constrained QPs
Immanuel Bomze, Dept. of Statistics and OR, University of Vienna, Oskar-Morgenstern-Platz 1, A-1090, Vienna, Austria, immanuel.bomze@univie.ac.at

Nonconvex quadratic optimization problems with quadratic and linear constraints are omnipresent in Natural Sciences, e.g. for Chromosome Packing in Cell Nuclei as studied recently by S.Wright and C.Uhler. Here we rephrase both the Lagrangian and the Semi-Lagrangian dual of these problems as conic optimization problems. It turns out that even the weakest approximation of the latter improves upon the former. The approach will also give rise to an apparently new approximation hierarchy based on SDPs of the original problem size, in sharp contrast to higher-order LMI-based hierarchies.

2 - IMRT beam angle optimization using a physics-guided derivative-free algorithm
Humberto Rocha, Inesc - Coimbra, Portugal, hrocha@mat.uc.pt, *Joana Matos Dias, Brígida da Costa Ferreira, Maria do Carmo Lopes*

Intensity Modulated Radiotherapy Treatment (IMRT) is a modern technique used in the treatment of cancer where the radiation beam can be modulated allowing the irradiation of the patient using non-uniform radiation fields from selected angles. Beam angle optimization (BAO) consists in the selection of appropriate radiation incidence directions which may influence the quality of the treatment plans. Due to the many local minima aspect of the of the highly non-convex BAO problem, we propose a derivative-free approach that uses a physics-guided pattern search methods framework.

3 - Algorithms for Solving Nonconvex Block Constrained Quadratic Problems
Shimrit Shtern, Industrial Engineering and Management, Technion-Israel Institute of Technology, 18 Sheshet Hayamim St., 38361, Hadera, Israel, shimrits@technion.ac.il, *Aharon Ben-Tal*

Non-convex Quadratically Constrained Quadratic Programs with block-separable convex constraints are generally NP-hard. These problems appear in many applications such as estimation and control, complex unimodular programming, and MAX-CUT type problems. SDP relaxation is the best known upper bound approximation for this problem. We suggest the Block Optimal Ascent (BOA) algorithm, which uses block hidden convexity, alternating minimization, and a 'good' initial point, to obtain a lower bound approximation. We prove sublinear convergence and show that BOA also performs well in simulations.

4 - Second-order symmetric duality in variational problems over cone constraints
Izhar Ahmad, Mathematics and Statistics, King Fahd University of Petroleum and Minerals, P.O. Box 728, 31261, Dhahran, Saudi Arabia, drizhar@kfupm.edu.sa

In the present paper, we introduce a pair of multiobjective second-order symmetric variational programs over cone constraints and derive weak, strong and converse duality theorems under second-order F-convexity assumption. Moreover, self duality theorem is also discussed. Our results extend some of the known results in literature.

■ FC-02

Friday, 11:30 - 13:00
Room 11.1.3

Optimization and statistical software

Stream: Optimization and Applications
Contributed session
Chair: *Jorge Sá Esteves*, Dep. of Mathematics, University of Aveiro, Campus Santiago, 3810-193, AVEIRO, Portugal, saesteves@ua.pt

1 - Matlab implementation of Eletromagnetism-Like Algorithm
Andreia Silva, de Informática, Universidade do Minho, Rua Quinta dos Orfãos, 4710-410, Braga, Portugal, andreia.matias.silva@gmail.com, *Ana Maria A.C. Rocha, Jorge Rocha*

The eletromagmetism-like (EM) algorithm is a population-based metaheuristic for solving bound constrained global optimization problems. The purpose of this paper to introduce the user to the functionality of the EM package developed in Matlab. This package consists of a collection of documented MATLAB functions for analysis and solution of global optimization problems. Illustrative examples show how easy is to use the EM package. Some metrics are presented in order to evaluate the performance and behaviour of the package when compared to other known implementations.

2 - Computational Tests on Nonlinear Least Squares Algorithms
Jorge Sá Esteves, Dep. of Mathematics, University of Aveiro, Campus Santiago, 3810-193, AVEIRO, Portugal, saesteves@ua.pt, *Agostinho Monteiro*

Nonlinear lest squares problems have many applications in physics, chemistry, engineering, and many other fields. In this talk, we will review some recent results on numerical methods for that problem, particularly on Levenbergh-Marquardt type methods and quasi-Newton methods. Several selected practical examples are used for testing those methods. Finally, based on those computational tests, a comparative analysis of the algorithms is made in order to highlight the advantages and disadvantages of the different methods.

3 - Predictor—corrector algorithm combined conjugate gradient with path following interior point for nonlinear optimization problem
El Amir Djeffal, Mathematics Department, University Hadj Lakhdar, Batna, Batna, Algeria, djeffalelamir@yahoo.fr

In this paper, we propose an algorithm to solve the general nonlinear optimization problem with lineair constraints. Path following method is used to construct a conjugate

gradient predictor—corrector tracking combined path following interior point algorithm. The global linear convergence of the algorithm is proved under the normal cone condition for the feasible region. For its numerical tests some strategies are used and indicate that the algorithm is efficient.

■ FC-03

Friday, 11:30 - 13:00
Room 11.1.12

Graph theory and applications 2

Stream: Optimization and Applications
Contributed session
Chair: *Paula Carvalho*, University of Aveiro, Portugal,
paula.carvalho@ua.pt

1 - How to solve the maximum matching problem determining (0,2)-regular sets

Maria F Pacheco, Instituto Politécnico de Bragança - ESTiG, Quinta de Santa Apolónia, Gab. 112, 5301-857, Bragança, Portugal, pacheco@ipb.pt, *Domingos Cardoso, Carlos J. Luz*

A (k,t)-regular set in a graph is a subset of vertices such that each vertex in the set has k neighbours in it and each vertex not in the set has exactly t neighbours in it. We present a new algorithm for obtaining (0,2)-regular sets in line graphs and also its application to the determination of maximum matchings in arbitrary graphs.

2 - A recursive determination of regular exceptional graphs by (k,t)-extensions

Inês Barbedo, Informatics and mathematics, Polytechnic Institute of Bragança, EsACT Rua João Maria Sarmento Pimentel. Apartado 128., 5370-326, Mirandela, Portugal, Portugal, inesb@ipb.pt, *Domingos Cardoso, Paula Rama*

In this talk, we propose to construct arbitrary families of regular graphs, by determining a regular graph from another one using a (k,t)-extension. This new recursive technique is used to construct the regular exceptional graphs and we show that it induces a partial order relation. The (k,t) — extension procedure is reduced to the construction of the incidence matrix of a combinatorial 1-design, considering several rules to prevent the production of isomorphic graphs. Finally, an algorithm based on this recursive construction and the Hasse diagram of the poset is also presented.

3 - The modified Schultz index of tricyclic graphs

Paula Rama, Department of Mathematics, University of Aveiro, Universidade de Aveiro - Departamento de Matemática, Campus de Santiago, 3810-193, Aveiro, Portugal, prama@ua.pt, *Paula Carvalho*

The topological indices are graph invariants much studied in both mathematical and chemical literature. In this talk, we present several results on the modified Schultz index, in particular, we determine a lower bound of the modified Schultz index of tricyclic graphs with three cycles and n vertices and we characterize all extremal graphs which attain this bound.

4 - On Some Bounds on the Group Betweenness Centrality and Their Algorithmic Use

Mustafa Kemal Tural, Industrial Engineering Department, Middle East Technical University, Ankara, Turkey, tural@metu.edu.tr

Finding the most important or central group of nodes in a graph has been studied for a long time in social network analysis. An important group centrality measure is the group betweenness centrality (gbc) which is defined (for a group of nodes) as the fraction of the shortest paths between the nodes of a graph that pass through at least one of the nodes in the group. We introduce upper and lower bounds for gbc that are easier to compute than the ones in the literature and show how these bounds could be employed to find the group (of a given size) with the highest betweenness centrality.

Friday, 14:00 - 15:00

∎ FD-02

Friday, 14:00 - 15:00
Room 11.1.3

Plenary Talk V

Stream: Plenary Talks
Plenary session
Chair: *Delfim F. M. Torres*, Department of Mathematics, University of Aveiro, Universidade de Aveiro, Campus Universitário de Santiago, 3810-193 , Aveiro, Portugal, delfim@ua.pt

1 - Some New Problems in Optimization Theory
Leonid Bunimovich, Georgia Institute of Technology, 30332, Atlanta, United States, bunimovh@math.gatech.edu

Recently some new optimization problems appeared in dynamical systems theory and its applications. Some of these problems are where to place a "hole"to achieve the fastest escape, how to find the most effective transmitter and which elements of a network are the most important. We will discuss these problems and corresponding (mostly counterintuitive) results.

Friday, 15:00 - 16:00

∎ FE-01

Friday, 15:00 - 16:00
Room 11.1.2

Mathematical methods in environmental control

Stream: Optimization and Applications
Contributed session
Chair: *Miguel E. Vazquez-Mendez*, Applied Mathematics, University of Santiago de Compostela, Escola Politecnica Superior, Campus Universitario, 27002, Lugo, Spain, miguelernesto.vazquez@usc.es

1 - An application of multi-criteria optimization to air pollution control
Miguel E. Vazquez-Mendez, Applied Mathematics, University of Santiago de Compostela, Escola Politecnica Superior, Campus Universitario, 27002, Lugo, Spain, miguelernesto.vazquez@usc.es, *Lino J. Alvarez-Vazquez, Néstor García Chan, Aurea Martinez*

In this work, we combine the classical control theory of partial differential equations (PDE) with multi-objective optimization techniques to study a typical problem in air pollution control. Particularly, we propose a mathematical model (a system of parabolic PDE) to simulate air pollution and, from this model, we formulate the environmental problem within the framework of multi-objective optimal control. Then, by using adjoint techniques, we change the problem into a multi-criteria optimization problem and we detail a complete method to obtain its Pareto-optimal frontier.

2 - Reducing toxicants in the diesel exhaust gas based on optimal fuel injection timing
Elena Pervukhina, Dept. of Information Systems, Sevastopol National Technical University, Universitetskaya Str., 33, 99053, Sevastopol, Crimea, Ukraine, elena@pervuh.sebastopol.ua

The fuel injection timing which provides the lowest concentration of toxic compounds in the diesel exhaust gas at the given crankshaft rotation speed and fixed load is determined. Minimized objective function connects the toxicants' concentration with diesel regime parameters and fuel injection timing. The optimal value is found by the linear programming method.

3 - On optimisation in environmental control
Sven-AAke Gustafson, University of Stavanger, Stavanger, 4036, Stavanger, Norway, sven4014@yahoo.no

Climate and composition of the atmosphere and oceans have changed over time. During the last 300 years a steady increase of carbon dioxide concentration in the atmosphere has been observed. This is a global phenomena and ascribed to the increased burning of fossil fuels.

An important task is to safeguard an acceptable environmental quality while minimising the total social cost of pollution abatement.We will describe several strategies for achieveing this by solving optimisation problems with a finite number of decision variables and a finite or infinite number of constraints.

■ FE-02

Friday, 15:00 - 16:00
Room 11.1.3

Dynamical systems and their applications in physics

Stream: Dynamical systems
Contributed session
Chair: *Natalia Dmitruk*, Optimal Control Methods
Department, Belarusian State University, Nezavisimosti, 4,
220030, Minsk, Belarus, dmitrukn@bsu.by

1 - Distributed Optimal Control of Large Scale Dynamical Systems

Natalia Dmitruk, Optimal Control Methods
Department, Belarusian State University,
Nezavisimosti, 4, 220030, Minsk, Belarus,
dmitrukn@bsu.by

We consider an optimal control problem for a set of linear
time-varying systems with disturbances coupled by their
aim, dynamics and constraints. It is assumed that centrali-
zed control is impossible and a communication delay is pre-
sent. An algorithm for distributed control of the systems is
proposed. The algorithm breaks the large scale optimal con-
trol problem into sub-problems optimizing only for the in-
puts of the associated system. Feasibility and suboptimality
of distributed control for the overall system is established
and relevant data to be exchanged between the systems is
analyzed.

2 - Fréchet curves and generalized minimizers for Lagrange variational problems with integrands of linear growth

Manuel Guerra, Mathematics, ISEG - University of
Lisbon, Rua do Quelhas 6, 1200-781, Lisboa,
Portugal, mguerra@iseg.utl.pt, *Andrey Sarychev*

We study Lagrange variational problems with convex in-
tegrand and control affine dynamics with non-commuting
controlled vector fields. We show that the input-to-
trajectory map of a control-affine system is a continuous
mapping between spaces of Fréchet curves. This map ad-
mits one unique continuous extension into a class of gene-
ralized controls, and the corresponding extension of the cost
functional is lower semicontinuous. If the boundary condi-
tions can be satisfied and the integrand has linear growth
with respect to control, then the problem admits a generali-
zed solution.

3 - Optimal Control for Fractional Nonlocal Dynamic Equations of Sobolev Type

Amar Debbouche, Department of Mathematics,
Guelma University, Algeria,
amar_debbouche@yahoo.fr

In this talk, we study the existence and uniqueness of mild
solutions for a class of Sobolev type fractional nonlocal
evolution equations in Banach spaces. We use fractional
calculus, semigroup theory, a singular version of Gronwall
inequality and Leray–Schauder fixed point theorem for the
main results. We present a new form of Sobolev type and we
extend previous works to investigate an existence result of
optimal control pairs. An example is also given to provide
the abstract results.

Saturday, 9:00 - 10:00

■ SA-03

Saturday, 9:00 - 10:00
Room 11.1.12

Statistical methods

Stream: Statistics, Bioinformatics and Health Sciences
Contributed session
Chair: *Pedro Macedo*, University of Aveiro, Portugal, pmacedo@ua.pt

1 - CDPCA for visualizing data

Eloisa Macedo, Department of Mathematics, University of Aveiro, Campus Universitário de Santiago, 3810-193 , Aveiro, Aveiro, Portugal, macedo@ua.pt, *Adelaide Freitas*

The analysis and visualization of large data sets is quite difficult and it is important to detect patterns on data to perform an analysis. Recently, a new technique called Clustering and Disjoint Principal Component Analysis (CDPCA) was presented. It permits to cluster objects along a set of centroids and partition variables into a reduced set of components, simultaneously. We implemented a R routine that performs the CDPCA methodology and turns possible the visualization of data patterns. Our aim is to test this technique in terms of visual representation of relevant characteristics of data.

2 - Genetic Algorithms for Multidimensional Scaling

Agnė Dzidolikaitė, Vilnius University, Lithuania, agne.dzidolikaite@gmail.com, *Julius Zilinskas*

The paper analyzes global optimization problem. Global optimization problem is nonlinear continuous optimization of the objective function in the feasible region. There are a lot of optimization algorithms. Exact algorithms may work for a very long time but they give an exact solution. Usually we want to get a quite good solution in appropriate period of time. In such case we use heuristic algorithms. One of the heuristic algorithms are genetic algorithms. Genetic algorithms mimics evolution which is seen in nature.

3 - Maximum entropy in the selection of the ridge parameter

Pedro Macedo, University of Aveiro, Portugal, pmacedo@ua.pt

Ridge regression plays a key role in ill-posed regression models and outperforms other competitors in many problems. However, the challenge in ridge regression remains the selection of the ridge parameter. Recently, based on the maximum entropy principle, the Ridge-GME parameter estimator appears in the literature as one of the best ridge parameter estimators, although requiring some subjective information from the ridge trace. In this talk, the Ridge-GME estimator will be developed so that no subjective information is needed to define the ridge interval or the supports for the parameters.

Saturday, 10:00 - 11:00

■ SB-02

Saturday, 10:00 - 11:00
Room 11.1.3

Plenary Talk VI

Stream: Plenary Talks
Plenary session
Chair: *Adelaide Freitas*, Department of Mathematics, University of Aveiro, 3810-193, Aveiro, Portugal, adelaide@ua.pt

1 - Compositional data analysis, correspondence analysis, and the log-ratio connection

Michael Greenacre, Universitat Pompeu Fabra, 08005, Barcelona, Spain, michael@upf.es

Compositional data analysis (CoDa) is concerned with analysing data tables that have the property of closure, i.e. the samples, usually rows of the table, have non-negative values that sum to a constant, usually 1 or 100%. This is often the case in chemistry and the geosciences.

Correspondence analysis (CA), popular in the social and environmental sciences, is concerned with analysing data tables of counts, but also "relativizes"the data by considering the counts relative to the row and column sums of the table – these relativized rows (or columns) are called profiles, also with non-negative values adding up to 1 - thus, correspondence analysis is also a method of compositional data analysis.

Thanks to the work of John Aitchison (1986) there developed a CoDa school based on the log-ratio transformation of the data. This transformation also relativizes the values in compositional data set, but not relative to the margins, but rather by looking at all the pairwise ratios, on a logarithmic scale. A principal component analysis type approach to CoDa was developed, summarized by Aitchison and Greenacre (2002).

These two approaches to analysing similar data sets, CoDa and CA, were unified by Greenacre (2009), who showed that they were members of the same family of methods, thanks to the Box-Cox transformation on data ratios, which converges to the log-transformation.

In this talk, I will explain this interesting log-ratio connection, demonstrate the implications for data analysis and emphasize how the connection with CA inspires the idea of weighting the components in CoDa. During the talk I will mention the interesting history behind these two approaches, including the historical connection to spectral mapping, a method not well-known in the statistical world, which was developed in the pharmaceutical industry by Paul Lewi already in the 1970s for analysing chemical spectra in drug research (Lewi 1976, Greenacre and Lewi 2009).

For background reading as an introduction to this talk, see chapter 7 of Greenacre (2010), freely downloadable from www.multivariatestatistics.org.

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Lewi, P. (1976). Spectral mapping: a technique for classifying biological activity profiles of chemical compounds. Arzneimittel Forschung 26, 1295-1300.

Saturday, 11:30 - 13:00

■ SC-01

Saturday, 11:30 - 13:00
Room 11.1.2

Mathematical Programming and applications

Stream: Optimization and Applications
Contributed session
Chair: *Evgeny Lakshtanov*, University of Aveiro, Portugal, lakshtanov@ua.pt

1 - Finiteness in the Beggar-My-Neighbor card game

Alena Aleksenko, Mathematics, University of Aveiro, Portugal, a40861@ua.pt

For card games of the Beggar-My-Neighbor type, we prove finiteness of the mathematical expectation of the game duration under the conditions that a player to play the first card is chosen randomly and that cards in a pile are shuffled before being placed to the deck. The result is also valid for general-type modifications of the game rules. In other words, we show that the graph of the Markov chain for the Beggar-My-Neighbor game is absorbing; i.e., from any vertex there is at least one path leading to the end of the game.

2 - Application of generation column methods

Farouk Benoumelaz, Mathematics Department, University Hadj Lakhdar, Batna, Mathematics Department, university Hadj Lakhdar, Batna, Algeria, Batna, Algeria, fbenoumelaz@yahoo.fr

The multiple container loading cost minimization problem (MCLCMP) is a practical and useful problem in the transportation industry, where products of various dimensions are to be loaded into containers of various sizes so as to minimize the total shipping cost. The MCLCMP can be naturally formulated as a set cover problem and solved using column generation techniques, which is a popular method for handling huge numbers of variables. However, the direct application of column generation is not effective because feasible solutions to the pricing subproblem is required, which for the MCLCMP is NP-

3 - An MPCC application in healthcare management

Teófilo Melo, Mathematics, ESTGF-IPP, Rua da Cachada - Margaride, 4610-250, Felgueiras, Porto, Portugal, tmm@estgf.ipp.pt, *João Matias*, *M. Teresa Torres Monteiro*

A public health provider, with a set of hospitals delivering the healthcare services to an urban population in a city region is considered. This application in healthcare management is formulated as Mathematical Program with Complementarity Constraints. The model can be applied for determining a price scheme, which enables the optimal resource allocation in different hospitals. The problem was codified in AMPL language and solved using nonlinear techniques from MATLAB optimization toolbox. Some numerical experiments are reported.

4 - A mixed-integer linear model to solve a distribution problem of a Portuguese company

Ana Moura, Economics, Management and Industrial Engineering, University of Aveiro, Campus Universitário de Santiago, 3810-193 , Aveiro, Portugal, ana.moura@ua.pt

This work presents two Mixed-Integer Linear model formulations to solve a distribution problem of a Portuguese company, which has suppliers whose material flow is performed in both directions. An integration of the Vehicle Routing Problem with Simultaneous Delivery and Pick-up with the Capacitated Vehicle Routing Problem with Time Windows is presented. Two formulations, namely a vehicle-flow and a commodity-flow model are presented. To prove the efficiency of the models, several tests were performed not only using real data from the company but also some benchmark problem instances.

■ SC-02

Saturday, 11:30 - 13:00
Room 11.1.3

Problems of variational calculus and applications

Stream: Dynamical systems
Contributed session
Chair: *Manuel Guerra*, Mathematics, ISEG - University of Lisbon, Rua do Quelhas 6, 1200-781, Lisboa, Portugal, mguerra@iseg.utl.pt

1 - A numerical scheme for fractional operators of variable order

Ricardo Almeida, Department of Mathematics, University of Aveiro, Campus Universitário de Santiago, 3810, Aveiro, Portugal, ricardo.almeida@ua.pt, *Delfim F. M. Torres*

We obtain approximation formulas for fractional integrals and derivatives of Riemann-Liouville and Marchaud types with a variable fractional order. The approximations involve integer-order derivatives only. An estimation for the error is given. We show how the obtained results are useful to solve differential equations and problems of the calculus of variations that depend on fractional derivatives of Marchaud type.

2 - Higher-order variational problems of Herglotz type

Simão P. S. Santos, Matemática, Universidade de Aveiro, Rua Luis de Camões, n.º 34 - 1.º esq, 3700-171, S. João da Madeira, S. João da Madeira, Portugal, spsantos@ua.pt, *Natália Martins*, *Delfim F. M. Torres*

The main goal of this talk is to present a generalized Euler–Lagrange equation and transversality optimality conditions for Herglotz-type higher-order variational problems. It is also presented an illustrative example.

3 - Variational problems of Herglotz type with time delay: DuBois-Reymond condition and Noether's first theorem

Natália Martins, University of Aveiro, 3810-193, Aveiro, Portugal, natalia@ua.pt, *Simão P. S. Santos*, *Delfim F. M. Torres*

The main goal of this talk is to extend the DuBois-Reymond necessary optimality condition and Noether's first theorem to variational problems of Herglotz type with time delay. Our results provide as corollaries the DuBois-Reymond necessary optimality condition and the first Noether theorem for variational problems with time delay proved recently by Frederico and Torres.

4 - Least square optimization on Euclidean spheres

Luís Machado, Department of Mathematics, UTAD, Vila Real, Portugal, lmiguel@utad.pt, *M. Teresa Torres Monteiro*

Approximating data in curved spaces is a common procedure that is extremely required by modern applications arising, for instance, in aerospace and robotics industries. Nevertheless, it can be sometimes very challenging not only theoretically but also computationally. A constrained optimization problem whose solutions are smooth curves on the Euclidean sphere that best fit a given set of points at given times is presented. This problem is solved by a numerical approach using routines from the MATLAB toolboxes to minimize the problem's cost functional.

■ SC-03

Saturday, 11:30 - 13:00
Room 11.1.12

Statistical and probabilistic modeling

Stream: Statistics, Bioinformatics and Health Sciences
Contributed session
Chair: *Vera Afreixo*, University of Aveiro, Portugal, vera@ua.pt

1 - Profit optimization for cattle growing in a randomly fluctuating environment

Patrícia Filipe, Department of Mathematics, University of Évora, Rua Romão Ramalho 59, 7000-671, Évora, Portugal, pasf@uevora.pt, *Carlos Braumann*, *Clara Carlos*

A class of stochastic differential equations models was applied to describe the evolution of the weight of cattle. We have determined the optimal mean profit obtained by selling an animal, using two approaches. One consists in determining the optimal selling age and the other consists in selling the animal when a fixed optimal weight is achieved for the first time. The profit probabilities can be computed for such optimal age/weight. For typical market values, the second approach achieves a higher optimal mean profit and, in most cases, even provides a lower standard deviation.

2 - Mining gene co-expression networks using weighted cliques

Pedro Martins, ISCAC, Polytechnic Institute of Coimbra and Operations Research Center, Quinta Agrícola - Bencanta, 3040-316, Coimbra, Portugal, pmartins@iscac.pt, *Luís Gouveia*

Most works in gene co-expression networks use clustering techniques for analyzing hierarchical relationships. Following a different direction, we propose using a maximum (edge-)weight clique (MWC) methodology for mining relevant information in these networks. This methodology may reveal strongly associated subsets of genes or strongly associated samples, which may indicate central relevant insights about the underlying biological system. We describe new and existing exact formulations for the MWC problem and discuss solutions taken from gene co-expression networks in the literature.

3 - Identification of DNA CpG islands using inter-dinucleotide distances

Vera Afreixo, University of Aveiro, Portugal, vera@ua.pt, *João Antunes*, *Carlos Bastos*

In this study we set to explore the potentialities of the inter-genomic symbols distance for finding CpG islands in DNA sequences. We propose a model to discriminate CpG islands based on some statistical properties of the inter-dinucleotide distances distributions in DNA sequences. The results of this exploratory study suggest that inter-CG symbols distance has strong ability to discriminate CpG islands.

4 - Spread model for portfolio of consumer credit: A new approach of Cape verdean bank.

José Moniz Fernandes, Departamento de Ciência e Tecnologia, Universidade de Cabo Verde and CMA/FCT/UNL., Praia, Santiago, Cape Verde, jose.fernandes@docente.unicv.edu.cv

we provide justification for the use of a simple expression giving the spread as a function of the default probability and the recovery rate in two models: the discrete, one period model, both in the actuarial and financial methodologies and the continuous time actuarial model. For estimating the recovery rate based on a beta regression model and the default probability is estimated with a logistic regression, depending on the socio-demographic, economic and financial, characteristics when granting such loan.

Saturday, 14:00 - 15:00

■ SD-01

Saturday, 14:00 - 15:00
Room 11.1.2

Semi-infinite optimization

Stream: Optimization and Applications
Contributed session
Chair: *Sven-AAke Gustafson*, University of Stavanger, Stavanger, 4036, Stavanger, Norway, sven4014@yahoo.no
Chair: *Kenneth O Kortanek*, Industrial Engineering, University of Pittsburgh, Industrial Engineering, 320 Ft Duquesne Blvd, 21C, 15222-1134, Pittsburgh, Pennsylvania, Afghanistan, ken-kortanek@uiowa.edu

1 - A Critique on the Essence of a Universal and Unifying Approach to Semi-infinite Programming

Kenneth O Kortanek, Industrial Engineering, University of Pittsburgh, Industrial Engineering, 320 Ft Duquesne Blvd, 21C, 15222-1134, Pittsburgh, Pennsylvania, Afghanistan, ken-kortanek@uiowa.edu, *Qinghong Zhang*

The claim of a Basu-Martin-Ryan(BMR) paper is the implication that the supporting hyperplane is implied by purely algebraic conditions. The authors state that they have taken the "desirability of omitting topological considerations to its logical conclusion; the method of projection is purely algebraic."We show that this statement is an exaggeration when applied to linear semi-infinite programs, and present existing proofs of key results in the paper. We review 21st century semi-infinite computational methods in contrast to those of the 60's cast as the only roles reported in the BMR paper.

2 - Simplifying Linear Semi-infinite Program Primal-Dual Pair

Qinghong Zhang, Northern Michigan University, Marquette, United States, qzhang@nmu.edu

Motivated by a recent Basu-Martin-Ryan paper, we obtain a reduced primal-dual pair of a linear semi-infinite programming problem by applying the Fourier-Motzkin elimination method to the linear semi-infinite inequality system. The reduced primal-dual pair is equivalent to the original one in terms of consistency, optimal values, and asymptotic consistency. Some existing results in the related literature are applied to this reduced pair and new characterizations of these existing results are obtained using the multi-dimensional sets generated through the Fourier-Motzkin elimination process.

3 - Optimality conditions for convex SIP problems with finitely representable compact index sets

Tatiana Tchemisova, Mathematics Department, University of Aveiro, Campus Universitario de Santiago, 3810-193, Aveiro, Portugal, tatiana@ua.pt, *Olga Kostyukova*

We consider a problem of convex Semi-Infinite Programming with arbitrary index sets defined by finite number of nonlinear inequalities. To this problem, we apply an approach developed in our previous publications and based on notions of immobile indices, their immobility orders and the corresponding properties. The main results of the paper consist in formulation of optimality conditions for the original SIP problem in terms of the optimality conditions for a specially constructed auxiliary nonlinear problem and in study of certain useful properties of this last problem.

■ SD-02

Saturday, 14:00 - 15:00
Room 11.1.3

Billiards

Stream: Dynamical systems
Contributed session
Chair: *Sergei Tabachnikov*, Pennsylvania State University, PA 16802, University Park, United States, tabachni@math.psu.edu

1 - On periodic orbits in complex analytic planar billiards

Alexey Glutsyuk, Mathematics, Higher School of Economics, 7, Vavilova street, 117312, Moscow, Russian Federation, aglutsyu@yandex.ru

A conjecture of Victor Ivrii (1980) says that in every billiard with smooth boundary the set of periodic orbits has measure zero. It is closely related to spectral theory. Its particular case for triangular orbits was proved by M.Rychlik (1989), Ya.Vorobets (1994) and other mathematicians, and for quadrilateral orbits in dimension two in our recent joint work with Yu.Kudryashov. We present the classification of complex counterexamples with four reflections from holomorphic curves and applications to Plakhov's Invisibility Conjecture and Tabachnikov's commuting billiard problem.

2 - Dissipative polygonal outer billiards

José Pedro Gaivão, CEMAPRE, Portugal, jpgaivao@iseg.utl.pt

We study dissipative polygonal outer billiards, i.e. outer billiards about convex polygons with a contractive reflection law. We prove that dissipative outer billiards about any triangle and the square are asymptotically periodic, i.e. they have finitely many global attracting periodic orbits. A complete description of the bifurcations of the periodic orbits as the contraction rates vary is given. For the square billiard, we also show that the asymptotic periodic behavior is robust under small perturbations of the vertices and the contraction rates.

3 - Hyperbolic Polyhedral Billiards

Pedro Duarte, Mathematics, CMAF/FCUL (Universidade de Lisboa), Lisboa, Portugal, pedromiguel.duarte@gmail.com

We show, under very general assumptions, that billiards on polyhedral tables of any dimension with a modified contracting reflexion law are non-uniformly hyperbolic. Furthermore, we provide sufficient conditions for this hyperbolicity to be uniform. This is a joint work with J.P. Gaivão, G. Del Magno and M. Soufi.

■ SD-03

Saturday, 14:00 - 15:00
Room 11.1.12

Statistical Methods in Biology and Medicine

Stream: Statistics, Bioinformatics and Health Sciences
Contributed session
Chair: *Pedro Sá-Couto*, Department of Mathematics, University of Aveiro, Portugal, Center for Research and Development in Mathematics and Applications (CIDMA), University of Aveiro, Portugal, Portugal, p.sa.couto@ua.pt

1 - Pre-Processing Microarrays Data: A Comparison of Methods

Joana Araújo, Universidade do Minho, Rua Nunes de Azevedo,prédio 90, 4970-461, Arcos de Valdevez, Portugal, joanaaraujo_avv@hotmail.com, *Ana Cristina Braga*

The high dimensionality of microarray data, becomes necessary the implementation of statistical methods for pre-processing. It requires the selection of genes with higher expression and reduction dimensionality, without losing information. The aim of this study is to compare some statistical methods for pre-processing. For this purpose were used flat patterns filters and some conventional methods applied to two data sets, AlonDS and Golub_Merge. The implementation of the presented methods was done using the R language.

2 - Global sensitivity analysis of a cardiovascular model

Pedro Sá-Couto, Department of Mathematics, University of Aveiro, Portugal, Center for Research and Development in Mathematics and Applications (CIDMA), University of Aveiro, Portugal, Portugal, p.sa.couto@ua.pt, *Carla Sa Couto*

A global sensitivity analysis of a cardiovascular (cv) model was performed, using Morris screening method, aiming to identify the most relevant parameters considered to have an overall and non-linear effects. Four relevant parameters (ex: total blood volume) in a total of 38, were identified as having an overall and non-linear effects on the cv outputs (ex: cardiac output). Relevant parameters with an overall effect on a specific output were also identified. The generated virtual population with 39000 individuals can be used to identify new patients for educational simulation and/or research.

3 - Protein conformational transition as a multibody minimum-energy trajectory

Carlos Leandro, ISEL, Rua Conselheiro Emídio Navarro, 1959-007, Lisboa, Portugal, carlos.miguel.leandro@gmail.com

It is well known that proteins in the folded state are not rigid, but instead can sample numerous conformations in the neighborhood of their native conformation. Our goal is to present a computationally efficient and physically realistic method to simulate the transition pathway based on a lumped mass formulation. Here a protein is modeled as a flexible multibody system. And dynamically feasible minimum-energy trajectories are computed using the Nudeged-Elastic Band method, on a statistical potential field extracted from a protein rotamer library.

Saturday, 15:00 - 16:00

■ SE-03

Saturday, 15:00 - 16:00
Room 11.1.12

Data mining

Stream: Statistics, Bioinformatics and Health Sciences
Contributed session
Chair: *Lisete Sousa*, Department of Statistics and Operations Research, Faculty of Sciences of Lisbon, University of Lisbon & CEAUL, 1749-016, Lisbon, Portugal, lmsousa@fc.ul.pt

1 - Virtual surgery of the carotid artery based on ultrasound imaging

José P. R. Gonçalves, MEB, Universidade do Porto, FEUP, Rua Doutor Roberto Frias, 4200-465, Porto, Portugal, meb12014@fe.up.pt, *Catarina F. Castro, Carlos C. António, Luisa C. Sousa*

Extra-cranial carotid Doppler ultrasound evaluation allows velocity sampling at different depths and positions that combined with B-mode ultrasound imaging leads to the identification of patients considered for surgery. A patient-specific carotid bifurcation reconstructed from ultrasound data is addressed here. The hemodynamic behavior before and after virtual removal of the stenotic plaque is simulated using an artificial neural network of configuration optimized via genetic algorithms. The performed research contributes towards the advancement of medical imaging and processing technologies.

2 - Optimal carotid bifurcation reconstruction based on ultrasound image and hybrid neural network

Catarina F. Castro, Departamento de Engenharia Mecânica, Faculdade de Engenharia da Universidade do Porto, Rua Dr. Roberto Frias, Campus da FEUP, 4200-465, Porto, Portugal, ccastro@fe.up.pt, *Carlos C. António, Luisa C. Sousa, José P. R. Gonçalves*

Carotid Doppler ultrasound scan is usually performed to assess the risk of stroke. A significant effort is being made in the study of accurate and reproducible techniques and indicators to monitor risk. The analysis of duplex ultrasound image data enables the optimization of feature reconstruction for normal and pathological bifurcations. The optimization methodology presented in this research considers the development of an artificial neural network optimized via genetic algorithms and contributes towards improvements on the widely performed diagnostic method based on free-hand 2-D ultrasound.

3 - Generalized Additive Neural Networks for mortality prediction: Model selection comparison

Carlos Bras-Geraldes, Bioestatistica e Informática, Faculdade de Ciências Médicas, Campo Martires da Patria nº 130, 1169-056 , Lisbon, Portugal, cgeraldes@gmail.com, *Ana Papoila, Patricia Xufre, Lisete Sousa*

A Generalized Additive Neural Network (GANN) can be implemented by automatic methods instead of using a visual inspection of the partial residuals plots (thereby reducing human intervention in the selection process model). Among the automated methods, AutoGANN stands out as being the first to be proposed for the search for a good GANN model. However, it can be slow, particularly for a wider search space. Thus, meta-heuristic methods such as Genetic Algorithm and Discrete Particle Swarm Optimization are introduced in this study and applied to an intensive care unit dataset.

Saturday, 16:30 - 17:30

■ SF-02

Saturday, 16:30 - 17:30
Room 11.1.3

Tutorial II

Stream: Other Sessions
Tutorial session
Chair: *Tatiana Tchemisova*, Mathematics Department, University of Aveiro, Campus Universitario de Santiago, 3810-193, Aveiro, Portugal, tatiana@ua.pt

1 - Infinity Computer and numerical computations with infinities and infinitesimals

Yaroslav Sergeyev, DIMES, University of Calabria, DIMES, Via P. Bucci, Cubo 42C, I-87036, Rende (CS), Italy, yaro@si.deis.unical.it

The lecture introduces a new methodology allowing one to execute numerical computations with finite, infinite, and infinitesimal numbers (see [1-14]) on a new type of a computer — the Infinity Computer (see EU, USA, and Russian patents [2]). The new approach is based on the principle 'The part is less than the whole' introduced by Ancient Greeks that is applied to all numbers (finite, infinite, and infinitesimal) and to all sets and processes (finite and infinite). It is shown that it becomes possible to write down finite, infinite, and infinitesimal numbers by a finite number of symbols as particular cases of a unique framework different from that of the non-standard analysis. The new methodology (see surveys [6,10]) evolves ideas of Cantor and Levi-Civita in a more applied way and introduces new infinite integers that possess both cardinal and ordinal properties as usual finite numbers (its relations with traditional approaches are discussed in [11,16]). It gives the possibility to execute computations of a new type and simplifies fields of mathematics where the usage of the infinity and/or infinitesimals is necessary (e.g., divergent series, limits, derivatives, integrals, measure theory, probability theory, fractals, etc., see [3-24]). Numerous examples and applications are given. A number of results related to the First Hilbert Problem are established.In the following there are listed both operations that the Infinity Computer can execute and traditional computers are not able to perform and some of new areas of applications. The new approach allows:

● to substitute symbols $+\infty$ and $-\infty$ by sets of positive and negative infinite numbers, to represent them in the memory of the Infinity Computer and to execute arithmetical operations with all of them numerically, as we are used to do with usual finite numbers on traditional computers;

● to substitute qualitative descriptions of the type 'a number tends to zero' by precise infinitesimal numbers, to represent them in the memory of the Infinity Computer, and to execute arithmetical operations with them numerically as we are used to do with usual finite numbers using traditional computers;

● to calculate divergent limits, series, and improper integrals, providing as results explicitly written different infinite numbers, to be possibly used in further calculations on the Infinity Computer;

● to avoid appearance of indeterminate forms (e.g., in situations where it becomes necessary to calculate difference of two divergent series);

● to evaluate functions and their derivatives at infinitesimal, finite, and infinite points (infinite and infinitesimal values of functions and their derivatives can be also explicitly calculated);

● to study divergent processes at different infinite points;

● to introduce notions of lengths, areas, and volumes of fractal objects obtained after infinite numbers of steps and compatible with traditional lengths, areas, and volumes of non-fractal objects and to calculate all of them in a unique framework.

The Infinity Calculator using the Infinity Computer technology is presented during the talk. Additional information can be downloaded from the page http://www.theinfinitycomputer.com

Selected references

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■ SG-02

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