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Editorial

Dear CIM Colleagues,

In the end of the cycle of this Executive Board of CIM, we especially thank Irene Fonseca for her scientific guidance and support. We thank all the collaboration and advices of the members of the Scientific Council: *Jean-Pierre Bourguignon*, *Luis Caffarelli*, *Rui Loja Fernandes*, *Rolf Jeltsch*, *João Queiró*, *Amílcar Sernadas*, *Pedro Silva*, *Maria Antónia Turkman*, *Marcelo Viana* and *Luís Nunes Vicente*. We thank all the collaboration and advices of the members of the board of the General Assembly: *José Francisco Rodrigues*, *Rafael Santos* and *Eugénio Rocha*. We thank all the collaboration and advices of the members of the Statutory Audit Committee: *Rui Cardoso*, *Carlos Braumann* and *Alfredo Egídio dos Reis*. We thank *Paulo Mateus* for coordinating the creation of the new website of CIM. We thank *Adérito Araujo* and *Sílvio Gama* for being the editors of the CIM bulletin. We thank *António Fernandes* for being the art editor of the CIM bulletin. *Alberto Pinto* thanks *Paulo Mateus*, *Henrique Oliveira*, *Sílvio Gama*, *Adérito Araújo* and *Jorge Buescu* for their contribution as members of the Executive Board of CIM. We thank all the effort and collaboration of the members of CIM.

This Executive Board of CIM signed with the University of Coimbra the protocol on the use of part of the Astronomical Observatory as its head office.

This Executive Board of CIM created the CIM medals that are awarded to mathematicians in recognition of meritorious contributions made during their scientific careers and to acknowledge their significant influence on the development of Mathematics in Portugal through affiliation with CIM. During the Opening Ceremony of the CIM Mathematics of Planet Earth Events, the President of CIM, together with State Secretary Queiró, awarded the CIM Medals to the following distinguished researchers: *José Perdigão Dias da Silva*, Universidade de Lisboa; *L. Trabucho de Campos*, Universidade Nova de Lisboa; *Joaquim João Júdice*, Universidade de Coimbra; *José Francisco Rodrigues*, Universidade de Lisboa.

This Executive Board of CIM launched the new CIM Series in Mathematical Sciences (CIM-MS) to be published by Springer-Verlag. The birth of the CIM-MS Series occurred during a meeting between the Executive Board of CIM and the Springer-Verlag Executive Editor Mathematics Martin Peters who honored us with a visit to the headquarters of CIM at University of Coimbra.

http://sqig.math.ist.utl.pt/cim/mpe2013/proceedings/11-12CIMSeriesMath__eng.pdf

CIM Series in Mathematical Sciences (CIM-MS)
Springer-Verlag

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The CIM-MS Series will contain proceedings of CIM events, consisting of expository articles, research monographs and lecture course notes, among others. Springer will develop a special book design for the CIM Series in close collaboration with CIM and will publish, distribute and sell the books in the CIM series worldwide in any medium, in particular, in electronic form. We are glad to announce that the Editorial Board of CIM-MS series will be announced soon.

We invite all the Scientific Community to propose volumes as authors or editors that will have an international recognized scientific impact in their research area to be published by the CIM-MS Series. If you are enthusiastic about it, please send an email to the CIM Executive Board.

The first and second volumes of the CIM series in Mathematical Sciences are entitled, respectively, *Dynamics, Games* and *Science and Mathematics of Energy and Climate Change*. These volumes consist mainly of review articles selected from the works presented in the *CIM Mathematics of Planet Earth International Conferences*, Foundation Calouste Gulbenkian, Lisbon. The Editorial board of both volumes is *Jean Pierre Bourguignon*, *Rolf Jeltsch*, *Alberto Pinto* and *Marcelo Viana*. The third volume of the CIM series in Mathematical Sciences is entitled *Coding Theory and Applications*. This volume consists mainly of review articles selected from the works presented in the *4th International Castle Meeting*, Palmela Castle. The Editorial board of this volume is *Raquel Pinto*, *Paula Rocha Malonek* and *Paolo Vettori*. The fourth volume of the CIM series in Mathematical Sciences is entitled *Modeling, Optimization and Industrial Organization*. This volume consists mainly of review articles selected from the works presented in the *XVIth Congress of APDIO*. The Editorial board of this volume is *João Paulo Almeida*, *José Fernando Oliveira* and *Alberto Adrego Pinto*. This Executive Board of CIM thanks all the editors of the volumes and authors of the articles their effort and collaboration.

http://www.springer.com/series/11745?detailsPage=titles

We recall that CIM organized the following *CIM International Conferences Planet Earth*: *MECC 2013 — International Conference Planet Earth*, *Mathematics of Energy and Climate Change*, 25–27 March 2013; and *DGS 2013 — International Conference Planet Earth, Dynamics, Games and Science*, 2–4 September 2013. Furthermore, CIM organized the following *CIM Advanced Schools Planet Earth* just before and after the corresponding International Conferences: *School MECC 2013 — Advanced School Planet Earth*, *Mathematics of Energy and Climate Change*, 21–23 March and 27–28 March 2013; and *School DGS 2013 — Advanced School Planet Earth, Dynamics, Games and Science*, 26–31 August and 5-7 September 2013.

http://sqig.math.ist.utl.pt/cim/mpe2013/

http://mpe2013.org/workshop/mecc-2013-international-conference-and-advanced-school-planet-earth-mathematics-of-energy-and-climate-change-portugal-18-28-march-2013/

http://mpe2013.org/workshop/dgs-2013-international-conference-and-advanced-school-planet-earth-dynamics-games-and-science-portugal-26-august-to-7-september-2013/

The CIM Mathematics of Planet Earth events followed from the participation of CIM as a partner institution of the *International Program Mathematics of Planet Earth 2013 (MPE 2013)*. We were pleased that the CIM-MPE events were announced, for example, at *ICIAM newsletter January 2013* and at *EMS newsletter March 2013*.

http://www.ems-ph.org/journals/newsletter/pdf/2013-03-87.pdf

http://www.iciam.org/news/ICIAMnewsletter2013jan.pdf

These events were enthusiastically supported by many Portuguese institutions, including: SPM; SPE; APDIO; CEMAPRE; CEAUL; CMA-UNL; CMAF-UL; CMUP; INESCTEC; ISR; IT; UECE FCUL; ISEG; Calouste Gulbenkian Foundation and Ciência Viva.

The two international Conferences were hosted in Calouste Gulbenkian Foundation (FCL). The Advanced School Planet Earth, Mathematics of Energy and Climate Change were hosted at Faculdade de Ciências, Universidade Lisboa (FCUL). The Advanced School Planet Earth, Dynamics, Games and Science were hosted at Escola Superior de Economia e Gestão, Universidade Técnica de Lisboa (ISEG-UTL).

In the previous editorial of CIM bulletin 33, January 2013, CIM thanked the keynote speakers, invited lecturers and session organizers of MECC.

http://www.cim.pt/files/publications/b33.pdf

See the proceedings of MECC 2013 in the link below:

http://sqig.math.ist.utl.pt/cim/mpe2013/docs/bookMECC2013.pdf

Now, CIM would like to thank the following 18 keynote speakers and lecturers of DGS 2013 for their wonderful presentations: *Elvio Accinelli*, UASLP, Mexico; *Michel Benaim*, Université de Neuchâtel, Switzerland; *Fabio*

Chalub, Universidade Nova de Lisboa, Portugal; *Jim Cushing*, University of Arizona, USA; *João Lopes Dias*, Universidade Técnica de Lisboa, Portugal; *Pedro Duarte*, Universidade de Lisboa, Portugal; *Marta Faias*, Universidade Nova de Lisboa; *Lorens Imhof*, University of Bonn, Germany; *Yunping Jiang*, City University of New York, USA; *José Martins*, I.P. Leiria, Portugal; *Bruno Oliveira*, Universidade do Porto, Portugal; *Jorge Pacheco*, Universidade do Minho, Portugal; *Joana Pais*, ISEG/Technical University of Lisbon, Portugal; *Alberto A. Pinto* Universidade do Porto; *Martin Shubik*, Yale University, USA (video lecture); *Renato Soeiro*, Universidade do Porto, Portugal; *Satoru Takahashi*, National University of Singapore; *Jorge Zubelli*, IMPA, Brasil.

CIM also appreciates the 117 invited speakers for their enlightening presentations and sincerely thanks the 27 session organizers for their effort, commitment and dedication that was so vital for the success of the events: *Luís Silva*, CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade dos Açores; *Ricardo Serrão Santos*, Centro do IMAR da Universidade dos Açores (IMAR-DOP/UAç) & LARSyS – Horta/Açores; *Ricardo Teixeira*, Departamento de Matemática da Universidade dos Açores; *Elvio Accinelli*, Facultad de Economia de la UASLP; *Bruno Oliveira*, FCNA – University of Porto; *João Paulo Almeida*, Instituto Politécnico de Bragança; *Alberto Pinto*, University of Porto; *José Martins*, School of Technology and Management, Polytechnic Institute of Leiria, LIAAD-INESC TEC; *Mario Bessa*, Universidade da Beira interior; *Jorge Freitas*, Universidade do Porto; *Paulo B. Vasconcelos*, Faculdade Economia Porto and Centro Matemática da UP; *Nico Stollenwerk*, CMAF, Universidade de Lisboa; *Isabel Pereira*, Universidade de Aveiro; *Ana Margarida Ribeiro* and *Rita Ferreira*, FCT-UNL and IST-UTL & FCT-UNL; *Célia Moreira*, University of Porto (CMUP); *Alexandre Rodrigues*, FCUP, CMUP; *Fátima Leite* and *Antonio Pascoal*, Universidade de Coimbra and Universidade Técnica de Lisboa; *Cláudia Nunes*, IST/CEMAT; *Orlando Costa Gomes*, ISCAL / IPL; *Juha Videman* and *Gonçalo Dias*, Instituto Superior Técnico/CAMGSD and CAMGSD/IST; *Edgard Pimentel*, Universidade Técnica de Lisboa; *Marta Faias*, FCT-UNL and CMA; *Domingos Cardoso*, CIDMA, DMat, Universidade de Aveiro; *José Leonel Rocha*, Instituto Superior de Engenharia de Lisboa – ISEL, IPL; *José Pedro Gaivão*, ISEG, UTL; *Alberto A. Álvarez López*, UNED; *Luís Silva*, ISEL; *Sara Fernandes*, Universidade de Évora; *Clara Grácio*, Universidade de Évora.

See the proceedings of DGS 2013 in the link below:

http://www.alunos.dcc.fc.up.pt/~up200405927/cim/bookDGS.pdf

In addition, CIM especially thanks *Antónia Turkman* for her assistance with the Calouste Gulbenkian Foundation, *Telmo Parreira* for organizing and compiling the proceedings, and *Paulo Mateus*, *Pedro Baltazar* and *Telmo Parreira* for developing and maintaining the conference website. CIM thanks the CGF staff and members of the local organizing committee as well as the Calouste Gulbenkian Foundation, for incredible hospitality, throughout the event and for providing the speakers and participants with the opportunity to experience the friendly ambiance in the beautiful city of Lisbon.

Alberto Adrego Pinto [President of CIM]
LIAAD-INESC TEC and
Department of Mathematics, FCUP

Editors
Adérito Araújo (alma@mat.uc.pt)
António Fernandes (amfern@math.ist.utl.pt)
Sílvio Gama (smgama@fc.up.pt)

Address
IIIUL-Universidade de Lisboa
Av. Prof. Gama Pinto, 2
1649-003 Lisboa

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Coming Events

2015 Workshop — Dynamical Systems Applied to Biology and Natural Sciences

Feb, 04–06, 2015

Centro de Matemática e Aplicações Fundamentais (CMAF), Lisbon University, Portugal

http://dsabns2015.fc.ul.pt/

Sixst Workshop Dynamical Systems Applied to Biology and Natural Sciences

The workshop has both theoretical methods and practical applications and the abstracts included in the program will cover research topics in population dynamics, eco-epidemiology, epidemiology of infectious diseases, molecular and antigenic evolution and methodical topics in the natural sciences and mathematics.

The program includes lectures by the invited speakers, contributed talks and poster session by the participants. The workshop does not charge registration fee.

Participants are kindly requested to register at

http://dsabns2015.fc.ul.pt/inscricao_frame.html

by January 31 2014

Workshop organizers

María Aguiar, Lisbon University
Jesus Vigo-Aguiar, Universidad de Salamanca
Boob Koi, Vrije Universiteit Amsterdam
Luis Mateus, Lisbon University
Nico Stollenwerk, Lisbon University
Ezio Venturino, Turin University

109nd European Study Group with Industry 2012
May, 11–15, 2015

School of Engineering—University of Minho, Guimarães—Portugal
http://www.norg.uminho.pt/esgi/home.htm

The 109th European Study Group with Industry, will take place from May 11th to May 15th, 2015, at the Department of Production and Systems of the School of Engineering, University of Minho. These meetings were created with the objective of renovating and reinforcing the links between Mathematics and Industry.

This meeting is part of the series of European Study Groups and will count with the participation of several European experts with a large experience in this type of events.

More information on study groups and related aspects is available at the International Study Groups website, the Smith Institute and the European Consortium for Mathematics in Industry.

Study group

At the beginning of the week, a representative from each company presents their industrial problem to the participating mathematicians. The academic participants, who are a diverse group of people with expertise in the mathematical sciences, including PhD students, postdoctoral fellows, and professors, allocate themselves to a group, each of which works in one of the proposed problems with the industrial partner. The work will be developed full-time over the next days. On the last day, each group will make a presentation of the results obtained and make suggestions for further work. After the study group, a report on each problem will be sent to the corresponding firm. Apart from the results obtained during the study group, this may contain suggestions for further collaboration.

Information for companies

If you think that your company might have something to gain from discussing a problem with us, do not hesitate to do so. We will be more than happy to visit you, at no cost and without any need for an immediate commitment, for an initial discussion about formulating such a problem. Almost all industrial problems have some mathematical aspect to them, although the mathematics is not always recognisable at first. Indeed, from our own experience, some of the most successful study group problems were not well-defined in mathematical terminology at the start of the study group.

The fee for a firm to present a problem at the study group will depend on the size of the enterprise as defined by the EU

Organizers

Senhorinha Teixeira [DPS-EENG-UMINHO]
Adérito Araújo [LCM-CMUC]
A. Ismael F. Vaz [DPS-EENG-UMINHO]
Manuel Cruz [ISEP-IPP and LEMA]
Rui Pereira (DMA-EC-UMINHO)
Pedro Freitas [FMH-UL and GFM-UL]

An Interview

with János D. Pintér

by **Tatiana Tchemisova** [University of Aveiro]

János D. Pintér is an applied mathematician, technical author, algorithm and software developer, as well as an entrepreneur. He holds an MSc specializing in Operations Research from the University of Sciences (ELTE) in Budapest, Hungary. He also holds a PhD in Probability Theory and Stochastic Optimization from Moscow State (Lomonosov) University; and a DSc in Mathematics awarded by the Hungarian Academy of Sciences. Dr. Pintér owns and runs Pintér Consulting Services (PCS) since 1994; his company is incorporated in Canada.

The research of Dr. Pintér is devoted to the development, computer based implementation and application of optimization models and algorithms which have been applied to tackle a broad range of decision problems. He is the author and editor of several books: he was awarded the INFORMS Computing Society Prize for his monograph Global Optimization in Action. He is also the author / co-author of over 200 book chapters, articles, proceedings volume contributions, and technical reports. Dr. Pintér serves or has served on the Editorial Board of the book series SpringerBriefs in Optimization, the Journal of Global Optimization, the Journal of Applied Mathematics & Decision Sciences, Algorithmic Operations Research, the International Journal of Modeling, Identification and Control and on the web-forums GAMS Global World and GAMS Performance World. Among many other affiliations, he is a former Chair

of the Managing Board of EUROPT (the Continuous Optimization Working Group of EURO), and a former Vice-Chair of the INFORMS Optimization Society. He is also a CORS and INFORMS Speaker, and he has worked and presented lectures in more than 40 countries of the world.

In September of 2014 Dr. Pintér visited Portugal as an invited lecturer at the EngOpt 2014 conference in Lisbon; he also presented a two-day intensive course on Global Optimization at the University of Aveiro (UA). The course was organized by APDIO, Portuguese Association of Operations Research and supported by the Department of Mathematics of the University of Aveiro and CIDMA, the Center for Research & Development in Mathematics and Applications. Dr. Tatiana Tchemisova, an Assistant Professor at the Department of Mathematics organized the course and interviewed Dr. Pintér. The following notes are based on this interview.

Tatiana: You have a long experience of living, studying and working in different countries. You were born in Hungary; studied and worked in Moscow (at the time of the Soviet Union); studied and worked in Australia, Canada, Hungary, Indonesia, the Netherlands, Turkey, the United States, and other countries. What had stimulated you to leave your country for the first time to study, and how do you feel now about this – I mean leaving and working so far from your country? Do you consider yourself Hungarian, Canadian, or a Citizen of the World?

Janos Pintér: Dear Tatiana, you have asked a complex question. I will try to answer it in a reasonably short, but truthful manner. First of all, I think that in this age, every sufficiently interested person is a Citizen of the World in many ways. Here I assume the intelligent use of the information sources and knowledge directly available to billions of people today. Unfortunately, there are still many among us who are deprived of the privilege of free-flowing information due to sheer poverty or dictatorial restrictions, but this will change – hopefully, sooner rather than later. My motivation to leave my homeland is based on a combination of personal and professional reasons, and probably also a desire for adventure. I lived in Hungary approximately the first half of my life, while lived elsewhere in the second half (so far). To be honest, although one never forgets his origins and the positive influences associated with these roots, I am probably more of a Citizen of the World than "just a Hungarian". This is reflected by my overall views; the way I try to live, to work, and to interact with people. My views and opinions are related also to many aspects of politics, economy, culture (arts, books, music), and even to culinary preferences.

Tatiana: You have received a "classical" academic education, and worked at several universities and research centers. How had it happened that you turned into an entrepreneur, started your own business? Did you have any support (organizational and financial)?

Janos Pintér: Here is another difficult question… The reasons for becoming an independent researcher and entrepreneur have probably a lot to do with my character, in addition to many good and some less fortunate circumstances. I enjoy working alone and independently (and I don't take too well instructions from people based on their perceived position or power). Having said that, I also have had the good fortune to work with many hard-working, professionally motivated, decent and kind colleagues. I did not have a lot of resources when I started my business, and my (in my own views) modest achievements and success are solely based on steady work, adaptation, and – arguably – also some luck.

Tatiana: Today Global Optimization is a very popular area of research. How could you characterize the State of the Art? How could you characterize the main directions where the research is more active nowadays: theory, applications, software development?

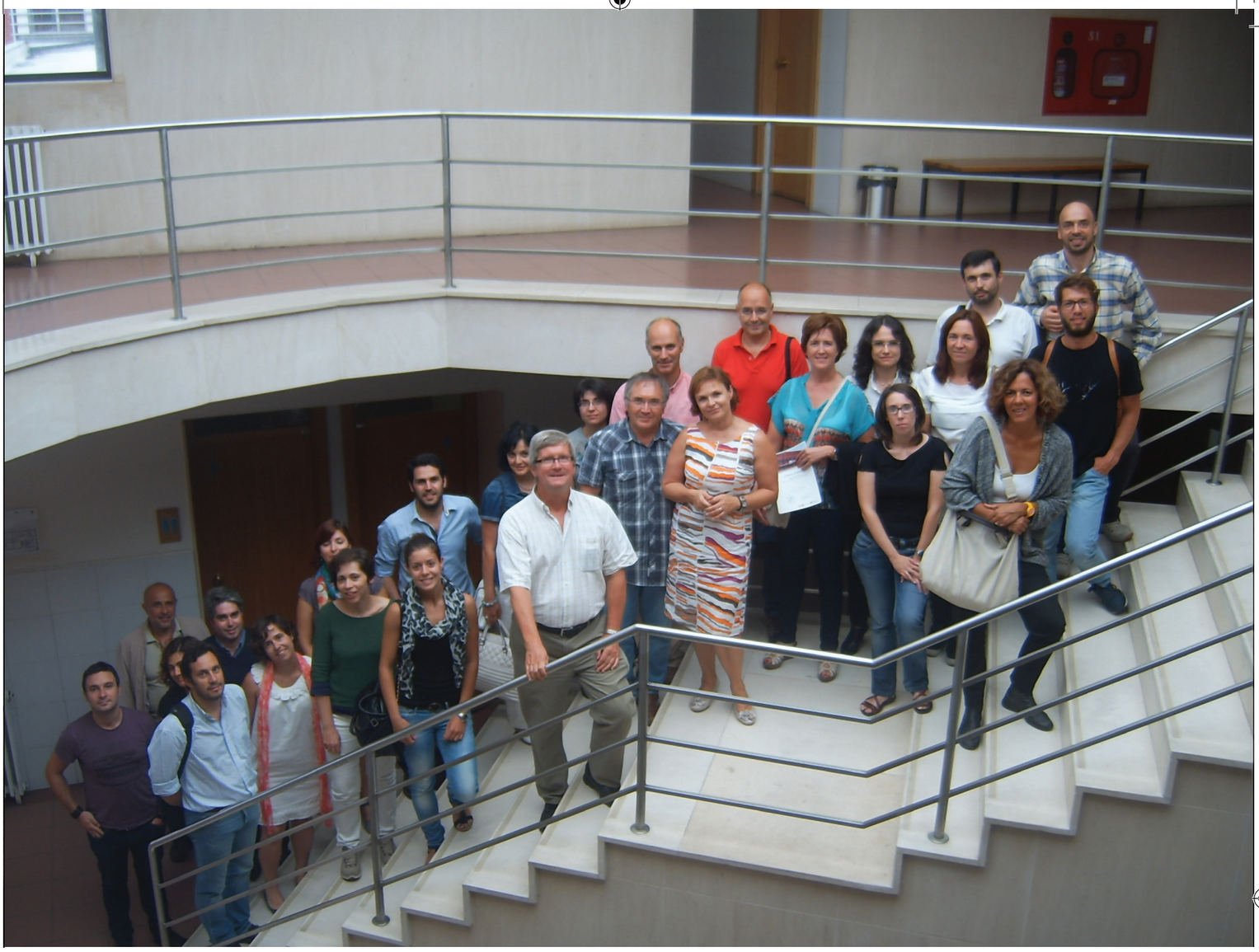
Janos Pintér: Global Optimization (GO) has been an almost non-existing "boutique discipline" of Operations Research and Optimization until recent decades, in spite of its obvious importance in many research areas and real-world applications. These days, GO is also a prominent and popular "academic research" area. Such recognition is great, of course, but in my opinion a purely "academic" approach to the topic can have also its negative side effects.

J.Pinter presenting his course "Optimization Models, Algorithms, Software". University of Aveiro, September 2014

When a subject – or tiny portions of a subject – becomes "baroque" or "rococo", then it is time to adjust the course of the ship and to move on. As the great George Dantzig said, "The final test for a theory is its capacity to solve the problems which originated it". In academia, it is too often considered more "glorious" to introduce another concept and to prove another fact that may or may not be that important in the true sense of scientific achievement, than to solve a really difficult GO problem arising e.g. in areas like cancer therapy, computational biology, facility location, industrial object packings and so on. In my opinion, GO theory and applications should proceed together in salient proportions; and topical software development is a key factor in tackling many real-world problems.

Tatiana: How can you describe the current situation in the (GO) software market? Is the competition tough? Are the needs of users met? In general, is it a good business?

Janos Pintér: In my opinion, the scientific-engineering software market is very competitive: the typical users of optimization software are clever colleagues and peers who demand high quality, in terms of robustness, reliability and efficiency. There exists also a range of freely available software products for nonlinear optimization: some of these can be very good, while others are inferior. People most typically purchase professional software products because they don't have the expertise and / or the resources to figure out things without proper technical support and user guidance. Selling optimization software and offering related services is



J.Pinter with the participants of the course. University of Aveiro, September 2014.

a good business if done properly; for me, it is also a professional and intellectual challenge – as well as some good fun.

Tatiana: How many people work in your company? Who are your clients? Do you collaborate with other software companies?

Janos Pintér: I am the sole proprietor and the only permanent employee of PCS – from president to janitor, not to mention other professional needs like legal, financial, marketing expertise, diplomacy and psychology.. There is never a boring moment which is arguably a good thing. I also work with a select group of developers on a regular basis, and with leading modeling language and computing system developers on links to their software products. As of today, our past and present clients come from about 500 academic, business, consulting, and industrial organizations around the world.

Tatiana: You are both researcher and businessman. Is it easy or difficult to combine these two activities? How do you manage your time and the work?

Janos Pintér: To work on a research topic or to discuss company finances, sign legal agreements etc. are very different activities. I don't find it too easy to combine these, hence my usual approach is to allocate time to all work as needed, in some order of preference. (This is not necessarily easy either.) On the positive side, I have considerable freedom and flexibility with respect to project selection and the allocation of my work hours – as long as I work in my own home office. Being on the road as a consultant or lecturer has its own challenges and rewards.

Tatiana: I imagine that the world of software development is very competitive, and it is important to keep certain "secrets" related to proprietary software. In science, on the contrary, it is important to share ideas, publish detailed results, while retaining the author's rights. Do you feel any imbalance because of this?

Janos Pintér: Indeed, this aspect makes the publication and presentation of results more difficult, since some of my favorite ideas in algorithm and software development can be presented only on a generic level. Having said the above, it is far from trivial to reproduce someone's (complex) ideas in a professional level software product.

Tatiana: Professional software development partnerships have been established between PCS and some well-known software companies such as AMPL Optimization LLC, the GAMS Development Corporation, Lahey Computer Systems, Maplesoft, Maximal Software, Paragon Decision Technologies, TOMLAB Optimization, Wolfram Research, and others. How do you manage the partnership?

Janos Pintér: As I said earlier, I am the designated legal expert of my company (since there is no legal department): hence, I have to work out and sign all legal agreements. Occasionally a morsel of diplomacy is also required, since my business / developer partners are also people.

Tatiana: Have your company felt the influence of the recent economic crisis and how have you resisted? What changes have you made in your work?

Janos Pintér: Quite frankly, I felt very little change in terms of real customer demand due to the economic downturn. The type of service offered by PCS and by similar companies is a range of professional software products that are not so easy to reproduce or surpass in quality. Nonlinear optimization software is not some "fashion fad"; it is vitally required by many real-world applications. The price of such software is typically a fraction of the resulting benefits for an organization.

Tatiana: I know that you are working on several book projects at this time. Which type of readers you have in mind: students, teachers, industrial users? Can you list three key features that will distinguish these books?

Janos Pintér: Indeed, I have several book projects in the works: each of these have been contracted by Springer Science + Business Media. To be more specific, I am working as time allows on three different, but obviously related books which discuss model development and optimization with Maple, Mathematica, and Matlab. I also work on a book project that discusses the practice of nonlinear — global and local — optimization. In addition, I also work on edited volumes as co-editor.

My main objective is to provide practical and actionable guidance to readers who wish to use nonlinear optimization in their work. I also attempt to write in a lively and engaging style that – hopefully – will make my books enjoyable to read and profitable to use. Hence, the readership could come from all walks of academia and practice with the type of mindset which is in synch with the objectives summarized above.

Feel free to contact Dr. Pintér at janos.d.pinter@gmail.com; and to visit www.pinterconsulting.com for further details.

The 101th European Study Group with Industry

by Paula Alexandra Amaral* and Jorge Orestes Cerdeira*

The Department of Mathematics of the Faculty of Science and Technology, Lisbon New University (http://www.fct.unl.pt) hosted, from May 5 to May 9, 2014, the 101th European Study Group with Industry (ESGI). This was the 8th ESGI edition held in Portugal.

The call launched by the organizers to companies was positively answered and four problems were selected for research during the week-long meeting:

- TAP Maintenance and Engineering (http://www.tapme.pt/), TAP-M&E was interested in developing a methodology for automatic generation of labouring timetabling for the airline maintenance technicians with the best adjustment to the predefined man work daily needs, and in accordance to labouring rules.
- EDP (http://www.edp.pt/en/Pages/homepage.aspx) — Using past information on published daily data identifying production and/or technologies offers by the different units for past supply curves, the goal is to match, in the daily publication of offers from various supply units, each block to the corresponding supply unit.
- SISCOG (http://www.siscog.pt/) — The challenge that SISCOG brought to ESGI101

* CMA and Department of Mathematics, FCT, New University, Lisbon

was to find an algorithm to solve a shortest path problem with additional constraints that could outperform the existing algorithm implemented in CREWS. CREWS is a product developed by SISCOG to perform the work assignments of drivers and guards on several European countries on a daily basis.

- SPIRALPACK (http://www.spiralpack.pt/) — In the context of tube manufacturing, there are certain processes that SPIRALPACK needed to improve. With a production totalling almost 17.5 million tubes/year, arising from more than 1500 different references corresponding to almost 100 tubes with different diameters, an important part of SPIRALPACK resources is assigned to the packing and shipping process. Optimizing these processes was the problem posed by SPIRALPACK.

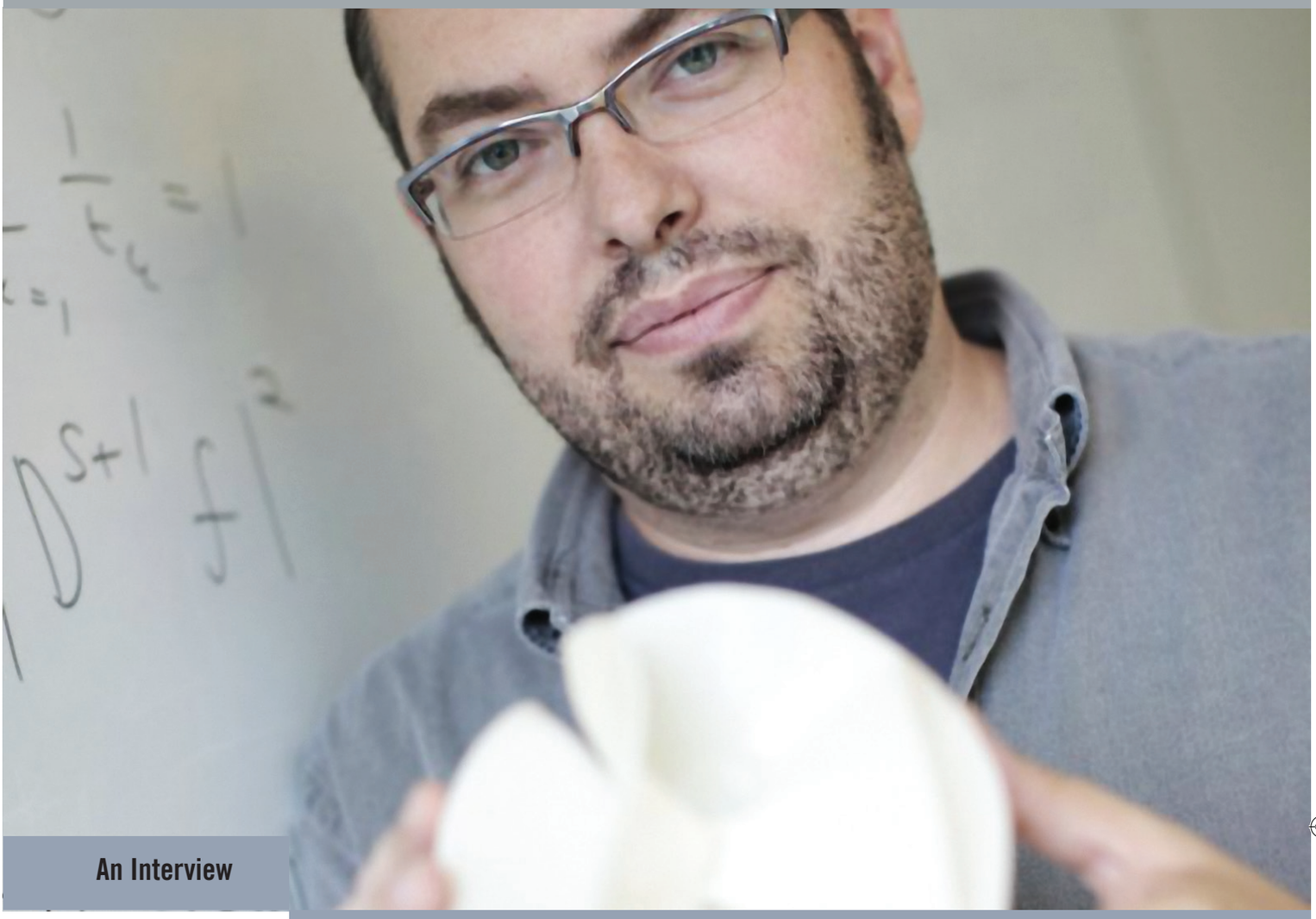
The companies deemed that improvements on current implemented solutions are possible and needed as this could bring significant impact on improving management and on reducing costs.

Although those problems were addressed mainly with tools from optimization, geometry, numerical analysis and classification, discussions benefited from contributions of participants with skills in other mathematical areas.

A definite solution was given to SPIRALPACK, while for the other problems, which were more involved, partial solutions were provide and perspectives for further improvements were presented and discussed.

The companies seemed to appreciate the results produced, and representatives from ESGIs TAP-M&E and SISCOG working groups were invited to present in the offices of these companies extensive and more detailed versions of the conclusions obtained at the end of the meeting.

We trust the 101th edition of the ESGI added a valuable contribution to strengthen ties between academia and industry in Portugal.



An Interview

with André Neves

André Neves one of the most distinguished world mathematicians was a member of the Scientific Organising Committee of the Geometric Analysis Conference, July 7-11, 2014, held at the Instituto Superior Técnico, Lisboa, Portugal organized by Miguel Abreu, José Mourão, João P. Nunes and Rosa Sena-Dias and partially sponsored by CIM

The questions presented here are based in several interviews; in particular, the interviews published in previous CIM's bulletins. CIM thanks Renato Soeiro and Alberto Pinto for organizing this interview.

The conference was a success. Among the speakers there were some of current the greatest geometers who came from Stanford, MIT, Princeton, Oxford, etc. Something you would like to highlight?

Many of them came to Lisbon for the first time and they absolutely loved it!

How important do you think that events like this are for students and researchers?

During my last year as an undergraduate at IST, many years ago, I remember having attended a conference in Geometry in which many of the speakers were famous mathematicians and this was highly inspirational/motivational to pursue a PhD in Mathematics. Hopefully, the event in Lisbon that I helped organize will also inspire some students to learn more Mathematics and write a PhD thesis.

On your research: Did you always want to be a mathematician?

Not always. I always enjoyed mathematics but only later I realized that being a mathematician was a ?real? job ! I began to study engineering and then switched to the math degree.

How did you start working in this area? What was the motivation? Could you tell us about your mathematical beginnings, and subsequent career development?

On my first year at Stanford, during my PhD, I attended a geometry course that I loved. As a consequence, I decided to do a PhD in that area with Richard Schoen, the lecturer of this course. After finishing my Phd I did a post-doc at Princeton and stayed there four years. Later, my family and I decided to go back to Europe and I went to the Imperial College in London, where I am now a professor.

How would you describe the essence of your own research to a young student?

The general idea behind of modern geometry is to understand the global shape of a given space knowing only local measures of that space. For example, if we know that the spatial universe has positive scalar curvature, what is its shape?

Which would you say are the most interesting/ challenging open (or recently solved) problems in your area, and what do you think the future reserves in your area and in your line of research?

My research area is going through a very exciting period because, in a short span of time, one has been able to solve several old problems (more than 50 years old) that could never be resolved by other methods. Examples are the Poincaré conjecture in Topology, the conjecture of Willmore in surfaces in theory, or the Penrose Inequality in general relativity.

From this point of view the future is promising because it indicates that the ideas in my field are still not exhausted and that there is plenty to explore.

Do you have a favorite result, yours and/or from others?

More than results, I am fascinated by brilliant ideas that gave great momentum to modern mathematics. For example, about 80 years ago Marston Morse realized that the question of the existence of critical points of a function on some space is closely linked to the topology of that space. In other words, analysis and topology go hand in hand! This idea had a deep impact in mathematics. Another idea that revolutionized mathematics was due to S.T. Yau in the 70s: he realized that certain general principles of analysis like the maximum principle, the heat equation, or integration by parts, can be naturally transported to geometry. This idea is the basis of the solution of the Poincaré conjecture by Perelman.

In terms of my research, the one result I am most proud of is the solution of the Willmore conjecture. For this we combined ideas from analysis, topology and geometry and that gave me a great satisfaction.

Do you have funny story, comment, on some result, or a research episode?

Before starting my PhD, 15 years ago, I went to IMPA, in Brazil, to attend a summer course. At the time, my idea was to study dynamical systems. I ended up not doing it (I went to Stanford to study Geometry) but while I was there, I met Alberto Pinto who showed me Rio de Janeiro. Since that time we became really good friends.

Interviews

MECC 2013

CIM thanks the participants **João Coelho** [LIAAD-INESC TEC, University of Porto], **José Cardoso** [Universidade de Trás-os-Montes e Alto Douro], **Ricardo Cruz** [University of Porto], **João Gama** [LIAAD-INESC TEC, University of Porto], **Ivette Gomes** [CEAUL and DEIO/FCUL, University of Lisbon], **Richard James** [University of Minnesota, USA], **Carlos Ramos** [Centro de Investigação em Matemática e Aplicações, Universidade de Évora], **Andrew Schmitz** [University of Florida, USA] and **Ana Soares** [Universidade do Minho] of the International Conference and Advanced School Planet Earth, Mathematics of Energy and Climate Change MECC 2013, Portugal, 21–28 March 2013, for sharing their ideas and points of view with us in this interview.

The questions presented here are based on several interviews, in particular, the interviews published in previous CIM bulletins. CIM thanks Renato Araujo and Alberto Pinto for organizing this interview.

On the meeting

What was your general impression of the MECC 2013 meeting?

Margarida Brito: In a word, the meeting, due to its interdisciplinary character and the outstanding quality of the participants was a success. The exchange was very prolific, in a purely scientific sense as well as with regard to possible institutional developments and the social impact in general.

José Cardoso: My overall impression of the meeting was very positive. It joined in the same space researchers from different areas with one important link between them: the planet earth. With talks involving important issues in the everyday life of all living beings of our planet, such as climate, energy, and sustainability, the researchers did not just focus on mathematics as an end in itself. Rather, they discussed, with a pragmatic approach to the implications of the new results, new ideas, and, consequently, new materials and new technologies, whether the participating community in this meeting, scientific and non-scientific, could become aware of the vast array of problems and challenges that nature incessantly provides us and that, in our own interests, we seek to solve to improve our well-being.

João Coelho: This meeting was fabulous. It provided a general view about what research areas the mathematical society is working on.

Ricardo Cruz: The meeting combined researchers from a wide range of intersectional mathematical areas. It was a great opportunity for M.Sc. and Ph.D. students to meet researchers in several fields, and a good opportunity for collaboration among the researchers.

João Gama: Conferences are meeting places and opportunities to present and discuss our work. In a conference we need to organize and explain in a coherent and comprehensive way the main ideas behind our results. However, sometimes the most relevant aspect comes from the informal contacts that the coffee breaks promote. The offline discussions and the personal contacts with authors whose work we are interested in allow us to enlarge

our scientific network, leading us to other scientific experiences.

Ivette Gomes: I organized a session on Statistics of Extremes in Society at CIM International Conferences and Advanced Schools Mathematics of Planet Earth 2013 (CIM-MPE 2013), and due to my schedule I could only attend two other organized sessions and two plenary talks. My overall impression was quite positive.

Richard James: I enjoyed it very much.

Carlos Ramos: The general impression was very good.

Andrew Schmitz: The meeting was excellent.

Ana Soares: Very good.

Something you would like to highlight?

Margarida Brito: It is difficult to choose. The meeting as such was extremely pleasant, with a nice atmosphere, partly due to the conference location, the Calouste Gulbenkian Foundation in Lisbon, which provided an ambience favorable to prolific interchange, not only during the sessions, but during the intervals and at the end of the sessions as well. It was also remarkable to see the great engagement of postgraduate students at the meeting.

José Cardoso: Just to mention a few examples and not pretending to be exhaustive, one heard interesting ideas and new background on the conversion of heat into electricity, the specific mathematics involved in extreme conditions such as in the polar zones, some issues related to photovoltaic dye sensitized solar cells, the relation between technology and bioeconomy, energy conversion on the nanoscale, some topics on biofuels for food crops, as well as more general and well-known questions such as how to reduce CO2 emissions, and wind power prediction, and also global questions related to climate change such as the role played by internal waves in the surface-atmosphere interface. Beyond all of this, anyone could find in the thematic sessions a variety of subjects where mathematics plays a crucial role.

João Coelho: I would like to highlight the quality of the speakers and the relevance of their research.

João Gama: MECC 2013 was an amazing multidisciplinary meeting. Conversations were more difficult due to the different languages of the attendees, but much richer for those who participate in the game of talking with people outside their borders.

Ivette Gomes: The large variety of topics presented.

Richard James: It was diverse and fascinating, and the venue of the Calouste Gulbenkian Foundation was superb.

Carlos Ramos: The place — the Calouste Gulbenkian Foundation — and the diversity of researchers and communications. The location is fantastic with very good conditions for communications and most of all for informal talks between researchers and students.

Andrew Schmitz: For me, a highlight was the in-depth questions and answers in the sessions I attended.

Ana Soares: The presence of a significant number of Portuguese researchers representing almost all areas of research.

How important do you think that events like this are for students and researchers?

Margarida Brito: In general, meetings like this are important for researchers to develop their ideas through exchange, especially in fields in which interdisciplinarity proves to be essential. Students who participate in these events are exposed to different approaches, open problems, and questions, which encourage and develop their own capacity of research. In particular, the Conference on Mathematics of Energy and Climate Change stands out due to its intrinsic interdisciplinarity, providing researchers with an absolutely necessary platform of exchange and discussion and providing a challenge for participating students.

José Cardoso: One important consequence of this type of meeting is that the general public will be aware of the fundamental role played by mathematics in nature and in the endless attempts to control it. Furthermore, it enables each researcher not only to display their own results and ideas but also to acquire a global overview of many interesting areas of research, and, possibly, to establish new links with other researchers.

João Coelho: They are very important because students and researchers can increase their knowledge and find new ideas and topics to work on.

Ricardo Cruz: The strong adhesion to the event shows there was a growing demand for a conference providing this spectrum of research fields.

Ivette Gomes: The talks I attended were indeed essentially devised for researchers or students at a

Ph.D. level, and not for students at an M.Sc. level.

Richard James: These meetings with an intentional flavor, and with a broad collection of viewpoints, are particularly valuable, because they introduce to students a variety of viewpoints that can never be represented in any single institution.

Carlos Ramos: These events are very important for providing a survey and a broad perspective of the area of dynamical systems and its applications within and outside mathematics. I think this is an appropriate type of conference to initiate advanced students in scientific communication and to provide a good opportunity for the students to meet very good active researchers.

Ana Soares: Very important for students in the sense that the meeting represents an opportunity to follow different topics and approaches.

How do you see the impact of this meeting on your field and outside of your field?

Margarida Brito: Well, it was in fact an interdisciplinary meeting, bringing together researchers in mathematics and science working in different fields. By this, I do not refer specifically to mathematical fields, but to different fields of science. Keeping in mind that mathematics, applied to a specific domain, does not mean just using a tool but rather reflecting this domain and its problems in mathematical terms, which may lead to the development of new mathematical methods or even theories, it becomes evident that the exchange which is promoted and facilitated by a congress such as this one is of great importance to the progress of scientific research. This meeting thus emphasizes the decisive role of mathematics in science. We can't overestimate the impact in the scientific field of research. Moreover, the meeting highlights the importance of mathematics in addressing planetary problems. The scientific fields in question are fields with direct connection to problems of humanity, and as these problems are the sort of problems that demand rapid solutions, we can't overestimate the impact of the meeting on society, as well.

Ricardo Cruz: Beyond the meeting itself, participants were invited to submit papers for a volume published by Springer, and the response was overwhelming.

Ivette Gomes: Mathematics is the sharp tool that allows us to describe, to understand, to forecast and to a certain extent to control all phenomena in the world, and even in the universe. Unfortunately, this idea is left behind in the formal teaching of mathematics, and there is the general misleading opinion that mathematics is an abstract science, and that beyond some elementary algebra, analysis, and differential equations used by engineers, it is a kind of useless puzzle. Therefore, periodic meetings on how mathematics intervenes in our way of dealing with reality are a very welcome initiative. I hope they will continue and attract an even wider audience and diversity of active participants.

Richard James: It is particularly valuable for people to see that mathematics has a lot to offer in the study of energy and the environment.

Carlos Ramos: What is, generally, the impact of these events on specific areas, areas they relate to, and on the interplay between different areas or fields of knowledge? The main impact is on the relation between subjects --- some very applied --- and the possibility of future work it opens.

Andrew Schmitz: The impact of this meeting is positive from a worldwide perspective.

Ana Soares: The impact is relevant on the field because several experts get together and discuss ideas and new problems. Outside the field, it is important because it shows the interdisciplinary character of mathematics.

What would you say is, generally, the impact of these events on specific areas, as they relate to and on the interplay between different areas or fields of knowledge?

Margarida Brito: Let us briefly look at just one problem as an illustration, taken from the main topics from this conference. The reliability of climate previsions is of high importance for a great number of decisions. Previsions depend on a large number of data. We need, besides other things, knowledge about the surface of the earth, which means the earth's crust and the oceans. We have to consider as well the respective consequences of a variety of possible political decisions, which will possibly interfere. So the model on which we elaborate is very complex. Currently, climate researchers know that the actual available data from geology and oceanology is still far from sufficient and that from sociology is minimal. Furthermore, to establish the theoretical bases for prevision, one must take into account that, vice versa, climate interferes at least

on the development of the behavior of the oceans. The fast development of electronic data processing in the last decades of the last century motivated the idea of the development of complete models, inducing a tendency to neglect a reflection of the specificity of models, the methods and forms of simplification. This was accompanied by a pushback of theoretical and analytical reflection of the observed phenomena. And, mainly due to mathematicians, the conscience of the inherent interdisciplinary approach was developed, as well as the conscience of the importance of the quality and quantity of data in order to achieve climate research progress. International meetings of this type are fundamental to identify the relevant questions and the different areas or fields involved.

Ivette Gomes: I have a very favorable and positive opinion on all these issues. The impact of the meeting on the broad area of mathematics, including statistics, is high. And due to the interdisciplinary character of the meeting, the impact of the talks is surely also high outside the field of mathematics.

Andrew Schmitz: At least in our session, additional knowledge was obtained from the impact of the US Ethanol Policy.

On your research

Did you always want to be a mathematician?

João Coelho: Yes.

Ivette Gomes: Indeed, I wanted to study architecture and not mathematics. But my marks in history at the secondary school were not high enough for a candidacy to architecture. Mathematics, a discipline where I had always had very high marks was thus my choice, and today I think this was the most sensible decision.

Richard James: Not at all. As an undergraduate, I was a biomedical engineer — it was a very broad program (at Brown University) that began with basic cellular and molecular biology and ended near physiology and medicine, and the engineering side included a particular focus on mathematics, mechanics, and thermodynamics. Though I was headed for a medical career, I fortunately realized at some point that I liked the quantitative, mathematical part much better, and I turned in that direction. I was (and still am) fascinated by the idea that, by purely mathematical reasoning, one can understand profound things about nature.

Carlos Ramos: I have always wanted to be a scientist (with mathematics).

Ana Soares: Yes, I did.

How did you start working in this area? What was the motivation? Could you tell us about your mathematical beginnings and subsequent career development?

João Coelho: Earlier in my life I started loving math. I liked to study the properties of the numbers and also to discover the methods of solving problems using mathematics. Now, I have a job in stock management, and I use mathematical methods to optimize the management. In the future, my ambition is to obtain a Ph.D. degree. And, who knows, perhaps I will present my future work at future editions of these meetings.

João Gama: My first research experience was in the context of an interdisciplinary European project. I learned a lot from the long discussions on problem formulation using different languages and approaches. The diversity of methods, assumptions, limitations, algorithms, and interpretations was fundamental in my obtaining a much deeper understanding about my own area. We know this to be true: mutiple views are always a plus.

Ivette Gomes: I got a degree in Pure Mathematics at the Faculty of Science of Lisbon (FCUL), and my major topic was algebra. I almost went to the USA to work for a Ph.D. in Goldie's ring theory or some similar topic. Indeed, by the end of my fifth year, Professor Almeida Costa was able to provide me with a grant from Gulbenkian Foundation and all the facilities to go abroad immediately after finishing my degree in Pure Mathematics. At the time I chose pure mathematics, and after getting my B.Sc. in Mathematics, I was absolutely sure about this choice. But in my fifth year I had to choose a few optional courses in the area of applied mathematics, and as far as I remember I have chosen courses in probability theory, mathematical statistics, and stochastic processes. Then, my field of interest changed, since dealing with uncertainty and risk is surely the ultimate challenge for a mathematician. I immediately decided not to go to the USA but to stay in Lisbon in order to get a degree in Applied Mathematics. I even found a job as a teacher at a secondary school. But Professor Tiago de Oliveira got to know this through some of my friends in applied mathematics, and he immediately offered

me a position at FCUL, in the Department of Applied Mathematics. It was really a tough but gratifying experience. I had to teach courses like Monte Carlo simulation and population dynamics, and I had to use the computer intensively, something that I had never done before. Tiago de Oliveira helped us in the decision of going to Sheffield for the Ph.D. Indeed, Tiago de Oliveira was a very good friend of Joe Gani, the founder of The Probability Trust in Sheffield. But Joe Gani was no longer at Sheffield when we arrived there in September 1975 — I only met him 30 years later, in 2005, at the ISI meeting in Sydney, and it was indeed very gratifying talking with him at the time. In Sheffield, I first began my M.Sc. study in Probability and Statistics. I had courses in probability, statistics, weak convergence theory, and data analysis, among others. But as both Dinis and I had Gulbenkian grants and got very high marks in the first term, they thought it sensible to transfer us immediately to the Ph.D. degree in January 1976. I had already had some exposure in Lisbon to statistics of extremes, indeed in the area of bivariate extremes and dependence function estimation, through the reading of an article by Tiago de Oliveira on the subject. I enjoyed the topic very much, but in order to diversify the topics under research at our university, Tiago thought it sensible and I agreed that it would be better to get a specialization in another area, like density estimation, non-parametric statistics, or inference on stochastic processes. But Clive Anderson was a lecturer there and was working in extreme value theory, and he invited me to work under his supervision in the area of extremes. Clive then provided me with several topics of research beginning with rates of convergence and penultimate approximations, extremes of random fields, concomitants of order statistics, and maxima of different types of weak dependent structures, among others. I am deeply indebted to Clive, a person who served as a thesis supervisor and has often helped me with suggestions but given me a lot of freedom, letting me go my own way. Indeed, I almost always followed this path with my Ph.D. students. If a student is bright enough to make his own way, I think we have no right to impose much on him. Back in the University of Lisbon, I started courses in computational statistics, order statistics, and also in applied areas such as statistical quality control. Although I enjoy teaching, my main interest has been research (and family life).

Carlos Ramos: I started with physics and naturally arrived to dynamical systems.

Ana Soares: I loved fluid mechanics and all mathematical problems motivated in physical and engineering applications. My Master's supervisor proposed that I study shock wave problems and combustion problems. I accepted and I am still working in mathematical physics.

How would you describe the essence of your own research to a young student?

Ivette Gomes: The majority of decisions can be made in terms of averages and their fluctuations, and thus with the "middle" observations, when we order the data available (something we could describe as central order statistics). A few, exceedingly important problems deal with extreme order statistics, either maxima or minima, since extreme down-crossings or up-crossings of thresholds can result in very severe losses (for instance floods, droughts, wild fires, and bankruptcy). Models for extreme events have been developed under a wide variety of assumptions, but the basic models are important guidelines in terms of successfully choosing shape, scale, and location. In the last few years, the focus of my research has been on strategies to choose the most reliable models to deal with concrete situations, working essentially under a semi-parametric framework.

Carlos Ramos: I work with the analogy between mathematical structures and other concepts from outside mathematics.

Ana Soares: I study mathematics which help to understand and explain many applied problems arising in real-world applications mainly related to physics and engineering.

Which would you say are the most interesting/ challenging open (or recently solved) problems in your area, and what do you think the future holds in your area and in your line of research?

Ivette Gomes: Although computational statistics has been used to "let the data speak for themselves," I strongly believe that science does not deal with singular data. In fact, what is useful is to abstract the characteristic features of the problem, and try to develop a general theory for that class of problems. One of the ways to do that is to fit useful models — useful because they are general, or mathematically tractable, or have simple characterizations. One way of doing this is to think on a large scale, in the sense that we try to devise what would be good for a large

dataset (and indeed in data analysis we may simulate pseudo-observations to observe the behavior of larger datasets than the one at hand). In other words, we develop asymptotic approximations. This requires a much deeper study on the rate of convergence towards these asymptotic behaviors. Much has been done in this field, but there is room for further developments. There is also a need to build up models under more realistic assumptions than the commonly used ones that in general do not go beyond weak convergence hypotheses and some mild form of parental homogeneity. On the other hand, as in many situations data gathering is drastically limited, behavior with small samples is also a crucial area of research. And the analysis of spatial and big data is also quite challenging.

Richard James: My area (applied mathematics) is not so much driven by longstanding hard problems that famous mathematicians could not solve. Rather, it is driven by the ideas that precede the problem. The formulation of the problem is typically the most fascinating and challenging part. This does not imply that the solution is easy! Some of the problems on the theme of the Advanced School on providing alternative methods of producing energy that do not rely on burning fossil fuels, and the reliable, accurate prediction of climate change are challenging. But simple, classical problems, like, "why are the planets of the solar system where they are?" also fascinate me.

Carlos Ramos: One of the biggest challenges is to develop mathematics taking into account biology (natural sciences generally speaking) and the social sciences. Reflecting on how mathematics has been developed since Newton, taking into account mainly physics. This process can help to theorize in the referred sciences.

How do you see your area in terms of its importance in mathematics and in other fields of knowledge, the impact on and from other areas, and how do you expect this interplay to develop further?

Ivette Gomes: Extreme value theory is an important area of probability/statistics, both because of its intrinsic beauty and inspirational value for emerging areas (for instance, stability in generalized convolution algebras) and because of its outstanding performance in dealing with extreme risks — for instance, the use of extreme high quantiles, known as value at risk (VaR) in finance. Statistics blends mathematics with the taming of uncertainty, it deals with using the rigor of deductive reasoning, applying it to uphold the use of induction in knowledge building, and I wouldn't agree with the view that statistical reasoning is no more than a subarea of mathematics. But a large share of statistical research, either in probability or stochastic processes, and is traditionally called mathematical statistics, uses deep results from many areas of mathematics, like numerical methods, analysis, algebra, functional analysis, and many others, to construct new deep rigorous knowledge on how to transform information in knowledge, and how to use randomness as an ally. Under this specific perspective, I feel that my field is a sophisticated and challenging area of mathematical research.

Richard James: Mathematics is the language of science. I always inherently liked mathematics, but, as an undergraduate, I also thought that it would certainly be a good idea to learn the language well, because of the inseparable relation between ideas and language. I'm now even more convinced. I suspect that the importance of mathematics in science will grow.

Carlos Ramos: In my opinion dynamical systems will become a cornerstone in mathematics, influencing all mathematics, conceptually, structurally and from a practice point of view. The area as a pure area will be maintained and will develop itself slowly, the interplay between other mathematical areas will explode, and regarding the scientific applications it will develop tools "ready to use" in a similar way as has happened with statistics. The most important thing is that conceptually DS can furnish the correct concepts and tools for the advance and effective synthesis in science.

Do you have a favorite result, your own and/or from others?

Ivette Gomes: This is a difficult question, since I am convinced that in general we are "infatuated" with our more recent results. So, I could answer that I am proud of my recent work showing that by simply using general definitions of a mean, the Hill estimator of the extreme value index can be much improved. But looking back to more ancient results, I like what I have done on pre-asymptotic approximations and domains of attraction of extreme stable models. Indeed, among the articles I read during my stay in Sheffield, UK (1975–1978), for my

Ph.D., the one that influenced me most was possibly the article by Fisher and Tippett (1928), on rates of convergence and penultimate approximations. And indeed I still think there is some kind of magic in this topic, because this, my first passion, has been intermittently revisited after my Ph.D. thesis, either individually or in co-authorship, first with Dinis Pestana, next with Laurens de Haan, and more recently with Luisa Canto e Castro, Sandra Dias, and Paula Reis, in a topic relating pre-asymptotic approximations and reliability of large and coherent systems. But in fact my main reward along my professional life has always been the continued pleasure provided by my research activity.

Concerning favorite results from others and outside the field of extremes, I think Jacques Bernoulli was right in naming his law of large numbers "his gold theorem." Indeed, the core of simulation is a clever use of the law of large numbers. And, also because of its many uses, from simulation to meta-analysis, the probability transform theorem, bringing the uniform to the limelight of probability, is also one of my favorite results. On the other hand, the very bright total probability theorem, which is Descartes's method translated into probability language, is a foremost result, and I would be happy to discover who deserves the credit to have first used it and understood its universal value.

Mathematical statistics is a recent field, and the pioneering achievements, K. Pearson's chi square criterion, Student's illuminating study on the error of the mean (which contains a lucid view of the uses of simulation), and Fisher's ANOVA and all its ensuing creation of experimental design are landmarks, and not only in the history of statistics, since they played a central role in changing the paradigm of scientific research.

Is it difficult to get funding for research in your area?

Ivette Gomes: Yes, indeed. In the preface of his book on probability, Kallenberg states that while circa 1950 Loève's book on probability covered the main results in the field, by the time he wrote his book, several shelves in a library were needed to provide a fair account of the field. I think that it was in a very interesting book by Ian Hacking that I read that per year more than 600,000 new theorems were published, and that a first-rate mathematician was able to incorporate around 100 of them in his toolbox. This difference between the advancement of science and the filtering of its essentials has a perverse effect on the understanding of the relevance of alien work, and the fact that in Portugal evaluation panels seldom have statisticians has had a very negative impact in funding probability and statistics research.

On research, more generally: What would you say are the most important things to keep a research group going?

Ivette Gomes: New scientists are trained by the example of the senior way of solving problems, so proximity and facilities for exchange of ideas are important assets for the future of science. Guidance in documentation is also an important step in educating young researchers. Incentives for the group, including funding for presenting and discussing ideas in workshops and seminars and for inviting researchers from other groups that are tackling similar problems, are also important. A peaceful life at the research unit is also something invaluable.

Richard James: It is not so easy in the US to achieve long-term continuity of a group, and this presents distractions and difficulties. But it should be appreciated that this has been true for the whole history of the mathematical sciences, as one can see from the letters of Euler and Newton. From the perspective of individual countries, the percentage of GDP spent on scientific research correlates extremely well with every measure of quality of life.

Andrew Schmitz: The importance of the subject and the competency of the researchers.

Ana Soares: The leadership and the team.

How do you see the relation between traveling and research?

Ivette Gomes: The capacity for imagining new problems and having inspirational ideas when listening to ideas that seem very far from the actual problems the group (or individual) is dealing with is one of the important assets in scientific life. The opportunity to contact others, to listen to their problems and methods, and to extract from this new, path-breaking ways of dealing with problems is something invaluable, and travel is one of the most direct ways of achieving it.

Richard James: I am a huge proponent of sabbatical leaves.

Andrew Schmitz: To carry out research, traveling to conferences along with giving papers is a must.

Ana Soares: It is important to leave, for short periods, the activity related to courses and administrative issues. Sometimes, it is easier to concentrate on a problem and to have new ideas.

On teaching:

What do you think about the relation between teaching and researching?

Margarida Brito: Teaching at the university level without researching seems problematic to me. We only really understand things if and when we are in a productive relation with them, I think. And what is more, if we want to motivate the students to do their own research, it helps to confront them with working problems. Also from the point of view of research, the relation of teaching and research persists. Teaching clarifies one's own thoughts.

José Cardoso: The relation between teaching and researching is sometimes difficult, but most of the time it is mutually beneficial for the student and for the researcher: the former can realize better the way science works, the latter can have the opportunity to clarify to himself the importance of his own research for other people as well as their utility.

João Coelho: It is fundamental. It is the way to guide students to success.

Ivette Gomes: This is one of the most difficult questions. I have met excellent researchers who are boring speakers. And one of my best professors at the Faculty of Science was a fine scholar, with a superb critical knowledge of many fields of mathematics, and as far as I am aware he did not publish many results in international journals. But in his classes, we were shown brilliantly how it was necessary to alter hypothesis to be able to prove statements, and hence the core of research activity in mathematics. A deep knowledge of the field is an important asset to alter the syllabus of basic courses to accommodate new knowledge (directly, or by preparing students to do it in more advanced courses). Providing appropriate documentation is essential to curtail the exposition of matters in the classroom, leaving to the students the "burden" of completing proofs and solving exercises. In tutorials, it is important to discuss strategies to solve the problem at hand, and to enlighten how a knowledge of the theoretical background is essential to gain from a singular problem the ability to solve many more of its class. Teaching at a more advanced level is simpler, both because the students have chosen this path of study because they have an interest in it, and because the emphasis can be placed almost exclusively on the mathematical explanation. And advanced courses can be much more gratifying when the lecturer has contributed to the field, and can give a lively explanation on how he developed his ideas and got the results, and whether there are open issues that need further developments.

Carlos Ramos: It is natural that they can develop simultaneously.

Andrew Schmitz: Those of us who are fortunate draw strong connections between teaching and research, especially if your research can be tied directly to your teacher. So often people teach classes that bear little relationships to the subjects they teach.

Ana Soares: It depends on the course level. In general, for basic courses, the research can help in finding pertinent examples or to show the students new streamlined methods related to some topics. For advanced courses, it is crucial to be updated and really involved in research activities.

Any thoughts on what's crucial for a university teacher and/or student?

Ivette Gomes: For a university teacher: to have a deep knowledge of the field, to be inventive by using well-chosen examples, to provide adequate documentation and guidelines for further reading, to listen to the students, to be fair. For a student: to understand that she or he is in the university to learn both in and out of class. To realize that it is necessary to quickly develop the capability of making hierarchies in knowledge, discerning what is essential and what is accessory, for the present time, but at the same time to respect all knowledge as a treasure, an asset that can be invaluable in the future.

Andrew Schmitz: An excellent teacher must have both knowledge of the subject as well as interest in the field.

What are your thoughts on the relation between high school and university in terms of education?

Ivette Gomes: High school should be a right for everyone, and hence the teaching there should emphasize what is useful for everyone. But as a large share of students will progress to university courses, and the time frames are shorter and shorter

(in my time graduation took five years, now it has been reduced to three), there is plainly the need to adapt the syllabus so that students leave with some operational capabilities in basic matters.

Do you have any advice for students starting their research?

João Coelho: Please don't give up, and always believe that success comes from work.

Ivette Gomes: Work hard, read a lot, ask questions to others but mainly to yourselves, when you cannot solve a problem try solving something similar, perhaps weaker in the sense that you either assume more hypotheses or reduce the scope of what you are trying to prove. Using simple examples to start with is a good choice.

Andrew Schmitz: Pick a subject that is of current interest and that you are keen about.

Ana Soares: Yes, please do not concentrate on only one problem. Do not leave important tasks for the last moment.

And for the ones who are hesitating between pursuing a Ph.D. and looking for a different job?

João Coelho: Look for a job, get experience (and money, of course), and then pursue a Ph.D. I will do the same.

Ivette Gomes: I listen and I ask questions, but I do not give answers, since in this matter I feel that the only plausible conduct is to help them to find their own answers, like in Socrates' maieutic method.

Ana Soares: If you like to investigate problems, if you like to develop understanding and to contribute to finding solutions of problems, if you like to do solitary work, pursue a Ph.D. If you like to obtain quick results, if you do not like to invest in studying problems, try another job.

Have all of your research students chosen academic careers?

Ivette Gomes: A great majority of my Ph.D. and M.Sc. research students are in academia. But some of them are also in Brazil, Canada, . . . for their choices, but essentially due to the crisis in Portugal, and to the fact that universities are not recruiting new people.

Carlos Ramos: Yes.

Andrew Schmitz: About 60% of my students have chosen academic careers.

Ana Soares: No.

On other issues:

Do you have hobbies?

João Coelho: Yes, photography, swimming, and agriculture.

Ivette Gomes: I collect owls, coins, and stamps. I enjoy traveling. I love swimming, cycling, and playing table tennis. I also love music, and occasionally I like to do embroidery and knitting.

Andrew Schmitz: My major hobby is farming.

Ana Soares: Yes, music, dancing, swimming.

Do you have a connection to Portugal? How do you see its development?

Ivette Gomes: Yes, I have a strong connection to Portugal. I am Portuguese, I live in Portugal, I felt the happiness of watching the rise of democracy, and now I feel with discomfort all the misfortunes caused by the abuses of some politicians whom we do not respect but that our constitutional laws, judicial power, and even the power of the media seem unable to control. Concerning research, after a favorable period, namely inspired by the late minister Veiga Simão, now there seem to exist guidelines to destroy whole areas of research. Concerning teaching, in my opinion there has been a general decline, mainly as a consequence of the implementation of what is called the Bologna agreement. The democratic regiment of our universities also changed drastically, and for the worse. Sincerely, I am a bit frightened about the developments in the last few years.

Ana Soares: The development of research in Portugal has been notable, but recently the researchers have fewer opportunities and so some notable researchers have had to leave Portugal.

Interview

DGS II 2013

CIM thanks the participants **Elvio Accinelli** [UASLP, Mexico], **Alberto Álvarez-López** [UNED, Spain], **Michel Benaim** [Université de Neuchâtel, Switzerland], **Mário Bessa** [Universidade da Beira interior], **Fabio Chalub** [Universidade Nova de Lisboa, Portugal], **Ana Dias** [Universidade do Porto, Portugal], **Orlando Gomes** [ISCAL/IPL, Portugal], **Clara Grácio** [Universidade de Évora, Portugal], **Filipe Martins** [LIAAD INESC TEC, Portugal], **Bruno Oliveira** [Universidade do Porto, Portugal], **Joana Pais**, Universidade de Lisboa, Portugal], **Alexandre Rodrigues** [Universidade do Porto, Portugal], **Luís Filipe Silva** [CIBIO Universidade dos Açores, Portugal], **Luís Silva** [ISEL Lisboa, Portugal], and **Paulo Vasconcelos** [Universidade do Porto, Portugal] of the International Conference and Advanced School Planet Earth, Dynamics, Games and Science II [DGS II], Portugal, 28 August to 6 September 2013, for sharing with us their ideas and points of view in this interview.

The questions presented here are based on several interviews, in particular, the interviews published in previous CIM bulletins. CIM thanks Renato Soeiro and Alberto Pinto for organizing this interview.

On the DGS II meeting

What is your general impression of the meeting?

Elvio Accinelli: These kinds of meetings are of great interest for making progress in different areas of applied mathematics, and they create networks on research topics of common interest.

Alberto Álvarez-López: I can talk about the DGS meetings II and III, held in Lisbon and in Porto, respectively. I found them very interesting. I met people who work in areas similar to mine, and I could hear some colleagues' opinions about my own work. In addition, I enjoyed them very much for their social aspects.

Michel Benaim: Very good. It was very friendly and gave me the opportunity to meet and discuss with researchers having different backgrounds and mathematical cultures.

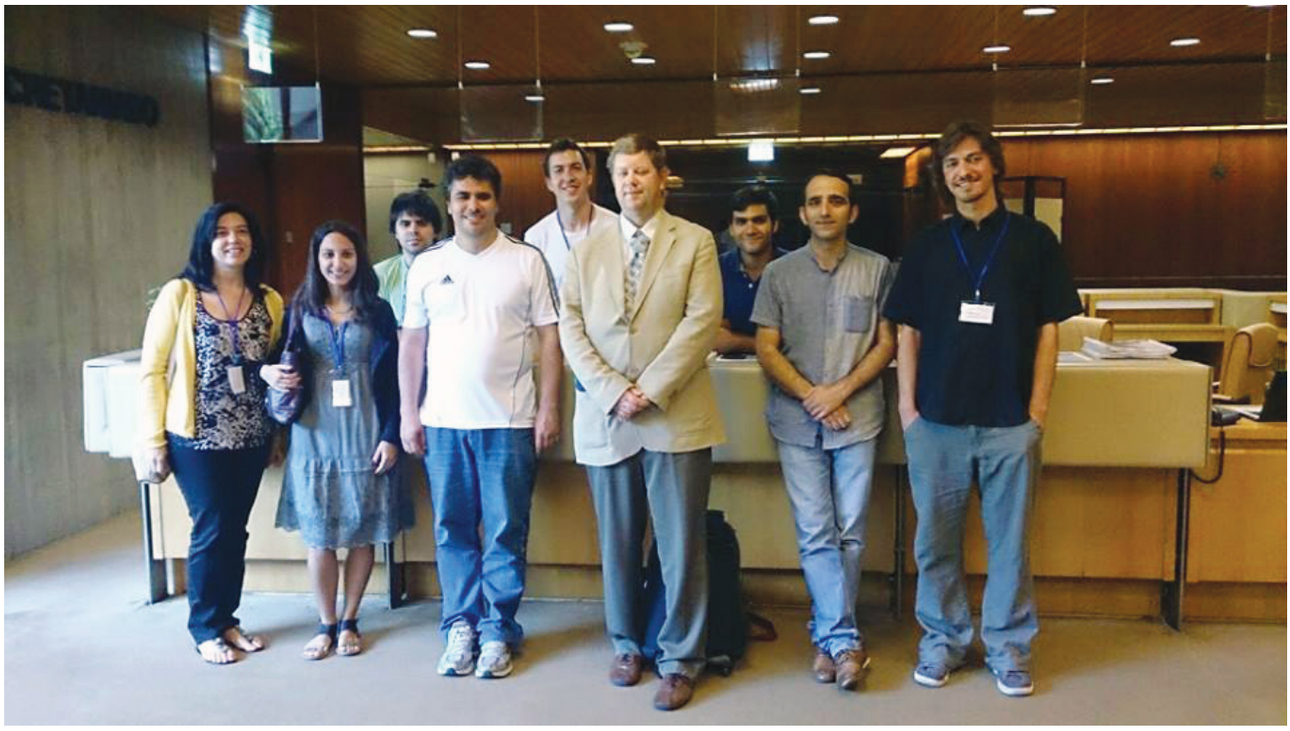
Mário Bessa: It was a good opportunity to meet several mathematicians working in related areas and develop some connections. I think that the Portuguese mathematical community should be more involved in this event.

Ana Dias: I found the meeting very interesting.

Orlando Gomes: The International Conference on Dynamics, Games and Science is, in my view, an extremely useful forum to discuss ideas and progress in research in a variety of fields concerning applied mathematics. In the events in which I have been present I have learned a lot about subjects on multiple areas ranging from evolutionary games to chaotic dynamics, stochastic optimization, and network analysis, just to cite a few.

Clara Grácio: I think this congress was an enjoyable opportunity to fulfill the objectives that I described in other questions as important for students and researchers who attended this event. I participated in the meeting held in September at the Calouste Gulbenkian Foundation. This meeting allowed us to talk to other colleagues, presenting our works in progress and discussing possibilities for continuing and improving that work, as well as future projects.

Filipe Martins: I think the Dynamics, Games and Science II conference was an amazing meeting featuring a wide range of topics and keynote speakers. My general opinion is that it was very well



organized and featured many brilliant presentations. I think these kinds of conferences are very important. For me, as a student, it was a huge boost in terms of encouragement to pursue a Ph.D., as I was finishing my Master's thesis at the time.

Bruno Oliveira: It was an excellent meeting where I had the opportunity to exchange ideas with many colleagues and learn from them.

Joana Pais: Very well organized. Amazing capacity of the organizers to put together an extremely interesting program, with a substantial group of well-known researchers. Very interesting talks, even though, in my opinion, they covered topics that were probably too diverse.

Filipe Silva: The importance of these types of meetings is the possibility of joining researchers who use mathematical tools in very different contexts, contributing to the transferability of knowledge between the different fields.

Luís Silva: The meeting was very interesting, bringing together an outstanding group of researchers, both domestic and foreign, in a fantastic and inspiring place.

Paulo Vasconcelos: The overall quality of the papers presented was great. The location was attractive, and the group lunches were full of life.

Something you would like to highlight?

Elvio Accinelli: These kinds of meetings are of great interest for making progress in different areas of applied mathematics and creating networks on research topics of common interest.

Alberto Álvarez-López: People from different "countries" of the world of mathematical applications could meet there, from pure mathematicians to biologists, economists, and engineers: a very interesting mixture. In addition, I would like to highlight the format of the sessions: short talks related to each other, which is perfect for cultivating interplay among senior and junior scholars. In fact, these events were a good opportunity for young researchers: they could show their own work and also listen to very relevant opinions from senior colleagues.

Ana Dias: The quality of the talks, the variety of the themes addressed at the talks, and the event

location, the Calouste Gulbenkian Foundation, all made these meetings very pleasant to experience.

Orlando Gomes: I believe that the strong feature of the Dynamic, Games and Science meetings is their interdisciplinary nature. With the use of mathematical methods as a unifying force, conferences offer a large variety of studies in a large variety of fields. Applications to economics and finance coexist with studies in themes relating to biology, ecology, or physics.

Luís Silva: I would like to highlight the quality of the plenary talks.

Paulo Vasconcelos: The intensive preparation by the organizing committee resulted in a smooth learning experience for the participants in a very pleasant setting.

How important do you think that events like this are for students and researchers?

Elvio Accinelli: Students in the process of completing their theses can find places to develop their research and to finish their work.

Mário Bessa: These types of meetings are quite important both for students and researchers because we have the chance of contact with related fields of expertise, thus gaining a deeper perspective on the application of our theoretical models in several different contexts.

Ana Dias: Very important not only for learning about new mathematical studies, but also for interchanging ideas, sometimes between mathematicians with different backgrounds.

Orlando Gomes: These events are a very good opportunity to share ideas, to learn, and to create networks among researchers. They are, of course, particularly important for young researchers who are starting a career by allowing them to present their work and establish the contacts they need to progress in their research effort. Graduate and undergraduate students have the opportunity at these events to have their first contact with the world of science.

Clara Grácio: In my opinion the scientific meetings are an excellent opportunity for researchers to present their work to their colleagues in order to receive feedback at an early stage of their research and are therefore an integral part of the process of science. These presentations also serve as informal reviews by peers, which may help researchers to develop, clarify, and improve their work and will no doubt help in the final phase of writing and submission to final publication. Also, and very important, the meetings allow researchers to hear about what others are studying, to develop relations with related disciplines by talking to colleagues from different institutions around the world, and to learn about new tools and research techniques that can be relevant to their work, other programs, and projects in common. These are truly scientific meetings arising in an academic environment where the questions and answers are natural, objective, honest, and fearless, and where the only goals are help, cooperation, and the development and dissemination of knowledge.

Bruno Oliveira: Events like this give researchers an opportunity to report their results to the scientific community. More importantly, in my opinion, they also open channels of communication between researchers, which enhances the work we develop. Regarding students, I think that these events give them a wonderful way of obtaining state-of-the-art knowledge from experts in these subjects.

Joana Pais: Very important. Research dissemination and networking are essential.

Filipe Silva: This might broaden their views, and make them see their daily research with different eyes.

Luís Silva: These kinds of events are extremely important both for students and for researchers. For the students they provide an excellent opportunity to make contact with senior researchers, learn about the most current issues, and even help them to decide about their future topics of research. These events allow the researchers to publicize their work and to exchange ideas with their colleagues.

Paulo Vasconcelos: The advanced school is an important meeting point for students with high level researchers, which can be a rare opportunity. Researchers enjoy the outstanding opportunity to publish proceedings within a prestigious and exigent editorial brand as well as participate in a book series devoted to applied mathematics.

How do you see the impact of this meeting on your field and outside of your field?

Michel Benaim: This type of meeting allows people with different backgrounds (game theory, dynamical systems, probability) but common interests (in the

present case "dynamics in games") to meet and is a good opportunity for cross-fertilization of ideas.

Fabio Chalub: Most of the meetings in the field of mathematics are "technique-based"; i.e., a number of professionals who have mastered the same techniques get together and discuss problems where these techniques were applied. This was a different kind of meeting in the sense that we had a large number of problems but no predefined mathematical technique. All areas of mathematics were represented in the conference, and the researchers could see where their expertise and abilities were required. This can forge a new generation of students who are more "problem-oriented" and who necessarily will learn more subjects, as opposed to the precocious specialization we see today.

Ana Dias: A good impact due, also, to the fact that some of the works will be published in a Springer book, which is a very good way of reaching readers from other fields.

Orlando Gomes: There are not many international quality scientific conferences or series of conferences in Portugal. This is a good example of a well-organized series of conferences that, I believe, has a good impact in promoting applied mathematics. As I see it, it is an interdisciplinary meeting with repercussions that go beyond mathematics; for instance, it is also an important event in my own research field, i.e., economics.

Joana Pais: I believe that, even though the impact on the field may be substantial, the outside impact is limited. This is not an exclusive feature of this particular event, but it is common to most (if not all) of the events of this nature. Clearly, it is a difficult exercise to translate the language of science into a language that the general public can understand. In fact, while there is no ambiguity in mathematics, when we translate mathematical language into words, our messages are probably not perceived the way we meant it. Still, disseminating scientific knowledge in the public sphere, particularly in the domain of social sciences, is important. It makes us think about why we believe that our research is necessary and useful.

Luís Silva: I think that this meeting may have a significant impact in the field, especially because this subject is relatively recent, and a meeting with this dimension of topics is not very common. In the particular case of Portugal, I think it presented a lot of subjects to several people.

What would you say is, generally, the impact of these events on specific areas, as they relate to and on the interplay between different areas or fields of knowledge?

Elvio Accinelli: These events are of great importance for creating networks between groups of different countries; consequently, they have a great impact on the work area as they allow one to learn about progress elsewhere.

Ana Dias: Good impact.

Orlando Gomes: This type of meeting is, as stated in previous answers, a way to promote the cross-fertilization of knowledge in various fields where game theory and dynamic processes matter. It is an extremely helpful event for all those who want to develop competence and explore new territories in applied science. New research projects, of an interdisciplinary nature, will certainly arise from the contacts researchers make in these conferences.

Bruno Oliveira: Of benefit to both students and researchers was the fact that this meeting covered a broad area of subjects in mathematics, in particular dynamical systems and game theory, and an even broader area of applications in the sciences, presenting research in several distinct topics of, for instance, economics and biology. This diversity can build bridges between different problems, allowing the attendees to further improve their work.

On your research:
Did you always want to be a mathematician?

Alberto Álvarez-López: Well, when I was a child, besides math I also liked language (I mean grammar and so on). But to tell you the truth, I always wanted to be a mathematician. Anyway, upon finishing my Bachelor's degree in Mathematics, I landed a position in a faculty of economics. Through the years I have discovered a wonderful field in which to apply mathematics that is very rich and interesting by itself!

Fabio Chalub: In fact, I graduated and received my Master's degree in Physics. During this time, I followed as many disciplines in mathematics as I could, and I got the impression that the most fundamental results in physics could only be entirely appreciated with a deep understanding of the mathematics behind them. In the end, I decided to do my Ph.D. in Mathematics involving the work on the border between math and physics.

Ana Dias: Looking back, my answer is yes.

Orlando Gomes: I am an economist, with research interests related to the mathematical modeling of economic phenomena. Economic processes have always fascinated me, and I believe that mathematics is necessarily the language through which economic events can be rigorously addressed and explained. My interest in modeling socio-economic events goes back to my undergraduate studies in economics (more than 20 years ago).

Clara Grácio: As we know, mathematics can be, sometimes, frustrating indeed, but it is in this struggle where the challenge itself lies. You experience a sense of accomplishment, even contentment, when you discover the missing piece of the puzzle, and mentally exclaim: That was it! Also, when you can establish unsuspected relationships between different areas of mathematics and/or other sciences, the coherence, connection, and immensity of mathematics emerge. I always liked the interconnection between the various areas of knowledge, from language or history to physics or biology, the wealth that allows us to move forward. And in order to advance in this way, mathematics is essential and indispensable. To the question of whether I always wanted to study mathematics, the answer is that mathematics has always been the first choice as long as the studies allow the monitoring of other areas.

Filipe Martins: I only thought of being a mathematician very recently. I decided to study mathematics as an undergraduate just two months before the start of the academic year. It was a pretty quick decision. I was trying to choose between mathematics and physics. The decision was taken completely by impulse, in 5 minutes.

Bruno Oliveira: It's a yes and no answer. Ever since I was young I had a fondness for mathematics. Later I gained an interest in physics, informatics and astronomy (from watching the TV series Cosmos by Carl Sagan). So, mathematics was always there, but linked to other sciences.

Alexandre Rodrigues: No, I did not always want to be a mathematician. In fact, I do not consider that I am a mathematician. I prefer to say that I am a researcher in mathematics. After completing my undergraduate degree I was convinced that I would like to be a high school teacher, but my desired career direction became clear while I was pursuing my M.Sc. degree. Even during that stage I considered exploring a different subject and switching to physics.

Filipe Silva: No, I always wanted to be a biologist, considering that life is probably the most complex and evolved form of matter/energy in the universe. However, during my research and teaching activities, I became progressively aware of the importance of using mathematical and statistical tools in biology, and in science in general.

Luís Silva: No. During most of my time in secondary school I was convinced that I wanted to be a psychologist.

Paulo Vasconcelos: Not always . . . but almost always!

How did you start working in this area? What was the motivation? Could you tell us about your mathematical beginnings and subsequent career development?

Elvio Accinelli: Motivated by social problems, I felt a vocation for economics. In the last year of primary school my teacher made me see that mathematics could be an excellent tool for thought. Later, when I was in prison as a political prisoner, I met José Luis Massera, who greatly influenced my thinking. Some years later, in the IMPA I had the opportunity to learn mathematical economics. Since then I feel real pleasure working in this area.

Michel Benaim: I have always worked at the interface of probability and dynamics. My interest in game theory started in Nefeli Cafe, a coffee shop located in Berkeley, near the math department, 20 years ago. At this time I was working with Moe Hirsch on some applications of topological dynamics for investigating the long-term behavior of certain stochastic processes called "stochastic approximations." A friend of mine, Paolo Ghirardato, at this time a Ph.D. student in economics, suggested that I look at a preprint by Drew Fudenberg and David Kreps on "stochastic fictitious play." It turned out that the techniques I was developing with Moe Hirsch proved to be very useful for analyzing stochastic fictitious play and more generally leaning processes in game theory.

Mário Bessa: After I finished my Bachelor's in Mathematics at the University of Porto, a colleague of mine asked me if I would like to go to some informal conversations about mathematics, taking place once a week, with Professor Jorge Rocha at the University of Porto. Since Jorge Rocha is a dynamicist, I started

learning about this area, and immediately I began to enjoy dynamics. Then, I finished my Master's thesis in dynamical systems with Jorge Rocha and I went to IMPA for a Ph.D. program with a thesis also in dynamical systems, supervised by Marcelo Viana. Finally, I returned to Portugal where I completed six years of a post-doc program and taught at the Polytechnic Institute of Coimbra. Now, I am an associate professor at the University of Beira Interior.

Fabio Chalub: During my Ph.D. study, I followed a course in the mathematical models used in ecology and, immediately after that, some colleagues and I started a discussion group in math-biology. I became fascinated with the topic and decided to work on it during my post-doc, in Vienna. I studied models for cell motility and had some relevant results during that time. I also enjoyed the fact that the math-biology group in Vienna is very well established, and I could learn new topics. At a meeting in Vienna, I met Jose Francisco Rodrigues, from the Lisbon University, and he told me about a post-doc position in Lisbon and his particular interest in starting a group in mathematical biology. I went to Lisbon intending to stay 2 years, but after a few months my wife and I were seeking opportunities for a longer stay. This was 12 years ago! In 2005, I got a position at Universidade Nova de Lisboa, and since then I have been there, first as an assistant professor, then as an associate professor, and now as an "investigador FCT" researcher.

Ana Dias: Professor Isabel Labouriau introduced me to the area of dynamical systems for my Master's thesis.I would say that the contact with Professor Isabel Labouriau in the Applied Mathematics Department and the job I got at the University of Porto were the main starting points in my becoming a mathematician. Any trip to any place for work has a story, and when we return we bring memories. For sure my period at Warwick University during my Ph.D. study was the most important period of my research, because during that time I found out what I really liked to work on, and my supervisor, Professor Ian Stewart, had a fundamental role in that discovery.

Orlando Gomes: My work in theoretical economic research started with my Master's course (1995--1996). The possibility of approaching economic processes through the use of mathematical tools, namely dynamic systems (linear and nonlinear, deterministic and stochastic, in discrete and in continuous time), fascinated me, and I have pursued studies in this area ever since. The first models that I approached related economic growth processes. Economic growth was the theme of my Master's thesis and of my Ph.D. thesis (which I completed in 2002). Later, I diversified my studies to areas that involve business cycles, monetary policy, international trade, individual decision-making, social interaction, and others. The common denominator of all this research is related to the use of tools of dynamic analysis and dynamic optimization.

Filipe Martins: After my undergraduate studies I had no real idea about the nature of research in mathematics, but after three years as an undergraduate, I decided to undertake a Master's degree in Mathematics, specializing in statistics and probability. Really, I only became more aware of research in mathematics when I was working on my Master's thesis. I liked it very much and noticed that to continue research in mathematics could be a good idea, and then I started thinking about taking a Ph.D. in the subject, and, happily, I got a Ph.D. scholarship. I would describe my areas of interest concisely as applied mathematics, which is what I like. What I studied for my Master's thesis was financial mathematics. Now I'm continuing on that topic, but I am also working on applications of dynamical systems to biology and economics. Again, the best way to designate it is applied mathematics. There is a wide range of topics for future work in this area. The rate at which work possibilities arise in applied mathematics is far greater than the rate at which you solve them. For each one you work on, a lot more appear as possible continuations. My favorite theorem in mathematics is possibly Banach's fixed point theorem.

Bruno Oliveira: After my degree in Astronomy, I completed a Master's degree in Applied Mathematics and, later, a Ph.D. in Applied Mathematics. My motivation has been a desire to understand how things work: from the universe to quantum mechanics, passing through humans in diverse subjects such as immune responses by T cells, price formation in random markets, firms competing with investment in R&D, children's growth, dietary patterns, or obesity treatment. And the tools that I have been using are rooted in mathematics, in particular, dynamical systems, game theory, and statistics, with links to computer modeling, and also requiring my knowledge of physics when studying interaction phenomena. In my career, I have taught subjects in astronomy, physics, and biostatistics. In particular, in these latter years I have been teaching biostatistics applied to nutrition and food sciences, which led me to do a Habilitation in Basic Sciences of Clinical Nutrition.

Alexandre Rodrigues: I really started my work in this area during my Ph.D. study, as after my M.Sc. it became clear to me that I really wanted to do research in dynamical systems. At the beginning, the motivation was the challenge of completing a Ph.D. in Mathematics. I remember quite well that I had two main concerns. (i) Could I discover something new in mathematics? (ii) Could I develop some important step towards an open problem? In fact, I do not know if I have achieved these goals. The main motivation was to complete a Ph.D. in Mathematics in a subject that I tried to pursue during my M.Sc. At the time, it seemed unattainable.

Filipe Silva: Working mostly in quantitative ecology, I became more and more interested in the use of statistical models to describe ecological phenomena. I became aware that statistical thinking evolved in close connection with biology and other sciences, and that its historical evolution had a parallel in the development of the other sciences. I also became involved in teaching biostatistics and quantitative methods to different student at levels, which further developed my interest in the area.

Luis Silva: My main motivation came from J. Sousa Ramos. He taught Introduction to Computation in my first year, and he had an uncommon point of view about that (and any other) discipline. He strongly believed that the students should be challenged from the beginning, so in the first classes he presented us with some of the most important math problems of that time: Fermat's theorem, Collatz, P/NP, and Poincaré's conjecture, etc., then he taught us Pascal and stimulated us to start exploring Julia sets, Mandelbrot sets, the Lorenz attractor, and so on. I think that he was mainly responsible for my decision of trying to be a mathematician instead of a high school teacher. Then I finished my undergraduate work and immediately got a job as assistant professor at FMH-UTL. At the same time I started a Master's study at IST-UTL and made my thesis with Sousa Ramos, then changed to the University of Évora, then finished my Ph.D. with Sousa Ramos again, and after ten years came back to Lisbon, to ISEL, where I am now.

How would you describe the essence of your own research to a young student?

Elvio Accinelli: Mathematical economics is both an intellectual challenge and an important tool for understanding the economy, for better social development.

Mário Bessa: Well, first I would describe how dynamical systems is not exactly an area but a confluence of several areas and so offers a good opportunity to study different aspects of mathematics. Then, I will emphasize that dynamical

systems problems are often easy to formulate and to understand, although they are usually hard to solve. I would also like to say that working in dynamics is quite amusing, because our objects are continuously changing when time evolves and we should be aware that intuition frequently tricks us. Finally, I really like to work with my co-authors, because we then enjoy enormous creativity. Indeed, when we try to explain to each other the questions, problems, solutions, and arguments that we are interested in, again and again we say to each other, "Imagine that . . .".

Fabio Chalub: I work in applied mathematics; therefore, I decide the problems I want to solve, but I do not decide the mathematical techniques necessary to solve them. My general interest is in population dynamics, and currently I work on two fronts: population genetics and epidemiology. In the former case, I am interested in exploring the mathematical richness of widely used models. In the latter case, we study the interaction between deterministic models and human behavior, in particular, how the course of an outbreak is affected by changes of behavior in the society. Sometimes, we find predictions in models that were not known; other times we find that some consequences do not follow from the models, contrary to the general belief; finally, we provide solid grounds for the models that appear in the literature and explicitly show their limitations. Our main goal is related to the conceptual understanding of the area, not to providing better models for specific problems.

Ana Dias: When we have interactions between units that are evolving with time, there are consequences for the dynamics that come just from the fact that there are interactions.

Orlando Gomes: I would say that economics is the field of knowledge where one can most successfully apply mathematical rigor to human decision and human action and that this is a fascinating combination independently of the type of phenomena under examination, this being of a micro or of a macroeconomic nature. Furthermore, I would say as well that my studies address dynamic processes in economics, because time is the most fundamental variable in this science; all economic issues necessarily involve a temporal dimension.

Alexandre Rodrigues: I work with dynamical systems. Roughly speaking, a dynamical system is a concept in mathematics where a rule describes how a point evolves (in time) in a geometrical space. The evolution rule may be given by the solution of a differential equation. Finding the explicit solutions of these equations is, in general, impossible. Sometimes these equations have some additional structures: algebraic symmetries which might help us to understand the qualitative behavior of the system. Heteroclinic cycles are a common feature of symmetric differential equations and persist under perturbations that preserve the symmetry. The dynamics near a heteroclinic cycle are well known and it is characterized by intermittency: a solution remaining near the cycle spends long periods of time close to a particular kind of sets and makes fast transitions among them. The rigorous analysis of the intermittent dynamics associated to the structure of the sets close to heteroclinic cycles is an exciting and challenging field of research. The characterization of the dynamics near these kinds of cycles is what I have been studying.

Filipe Silva: The fascinating idea of being able to see parts of the complexity of biological entities reflected in much more simple models, resulting from the systematic but creative activity of human mind.

Luís Silva: I work in symbolic dynamics; basically, I study the combinatorial aspects of dynamical systems.

Which would you say are the most interesting/challenging open (or recently solved) problems in your area, and what do you think the future holds in your area and in your line of research?

Elvio Accinelli: I think that understanding how the markets work could be helpful to obtain a sustainable development of mankind. The mathematical economy is a path toward that goal.

Alberto Álvarez-López: Roughly speaking, I work in elaborating mathematical models to describe some aspects of economic behavior, especially in the presence of uncertainty. Of course, there are many problems under this umbrella to be studied. I point out a very general one: we agree that the economic agent (a consumer, a firm, etc.) is not rational; well, I think a new non-rational theory describing his/her behavior is necessary — I mean a completely new theory, with a very different approach.

Mário Bessa: My preference goes to the well-known "closing lemma" problem. This is a question that dates back to seminal works of Poincaré on celestial mechanics. Like I told before, this is a good example of a problem that is easy to formulate

as you will see: if an orbit returns near to a place where it was before, is it possible to perturb the system in order to close the orbit? Of course, several aspects should be clarified; for example, what do we mean by "perturb"? Indeed, closing orbits requiring coarse approximations are well established; however, the problem is very hard when we demand finer approximations. If the requirements on the approximation increase too much, then it is known that the closing lemma has no solution!

Ana Dias: In my line of research on dynamics of coupled cell networks, I would say that it is important to have a theory for coupled cell networks like there is one for symmetric dynamical systems based on representation group theory.

Orlando Gomes: Since I study economic problems in general, I believe that although this is a very active science that has produced many meaningful results and advances in the last few decades, there are still many open questions. In macroeconomics, for instance, the permanent conflict between neoclassical and Keynesian economics and the difficulty in handling concrete aggregate problems (such as high rates of unemployment and deep recessions) reveal that much work still has to be developed in order to reach a unifying macroeconomic theory. At the micro level, a well-established theory of decision and individual behavior based on revealed preferences is now being challenged by advances in neuroscience, which indicate that one must go beyond the effective choices of economic agents and focus on the processes inside the human brain that trigger the decisions.

Alexandre Rodrigues: We do not know persistent classes of dynamical systems for which there is a set of positive measure which consists of initial points of orbits with historic behavior. For special dynamical systems, i.e., with boundary or with symmetry, historic behavior may persist. The main problem, however, remains open for dynamical systems without such constraints. In this context, R. Bowen described a system of differential equations on the plane whose flow has a heteroclinic cycle consisting of a pair of saddle equilibria connected by two trajectories. The eigenvalues of the derivative of the vector field at the two saddles are such that the cycle attracts solutions that start inside it. In this case each solution in the domain has historic behavior. Breaking the cycle, the flow loses this feature. This type of behavior may become persistent for dynamical systems in manifolds with boundary or in the presence of symmetry.

Filipe Silva: There is considerable excitement about the growing use of Bayesian statistics in different fields of biology. But, the future might bring new conceptual developments that will link or eventually merge frequentist and Bayesian statistics.

How do you see your area in terms of its importance in mathematics and in other fields of knowledge, the impact on and from other areas, and how do you expect this interplay to develop further?

Elvio Accinelli: I think that economic theory is in actuality a source of challenges for mathematics, whose resolution can achieve progress of both sciences. I would venture to say that economic theory, at present, can be as important for mathematics as it was physical in the nineteenth and early twentieth centuries.

Mário Bessa: Since the area of dynamical systems is a junction of several areas, there is intrinsically a large connection between mathematical subjects that are sometimes apparently unrelated. Moreover, its relation with other sciences (life, exact, social, computer, etc.) greatly enlarge these types of interactions. I believe that nowadays the classical nomenclature of dynamical systems is also used in other areas and turns out to be part of the language of these fields.

Fabio Chalub: The importance is growing a lot, in the world in general and in some particular countries like the USA, UK, France, the Netherlands, Spain, Germany, Sweden, and others. Fortunately, Portugal is no exception. It is still difficult to go from the theory to real applications, as this cannot be done by the same person or even the same groups. We have to talk to people with completely different backgrounds, and this is not easy. Generally, it is not difficult to get funding from government agencies, but for young Ph.D. graduates it is still difficult to find positions, as most of the mathematicians do not see "mathematical biology" as an area differently from "mathematical physics." It is seen as a topic of research, but not as a division of mathematics, like algebra, geometry, or analysis.

Ana Dias: As most real-world applications are governed by dynamics that can be interpreted as units interacting, any theory for coupled cell networks

that develops model-independent kinds of results is important and of interest for science in general.

Orlando Gomes: The nineteenth century philosopher Stanley Jevons once stated that if economics is to acquire the status of science, it needs to be a mathematical science. In fact, since then, the studies that contributed to the undeniable self-affirmation of economics as an autonomous scientific field have essentially adapted tools, concepts, and techniques from mathematics. Game theory, differential calculus, linear algebra, recursive analysis, optimal control, and other powerful instruments provided by mathematics have contributed to build what economic science is today. Moreover, some mathematical concepts were created and developed as specific tools of the economic theory and then served other fields of knowledge as well. The interplay between mathematics and economics is a fruitful one, and it will certainly be explored in more depth in the future.

Paulo Vasconcelos: Computational mathematics is crucial for applied mathematics. Bringing mathematics to solve problems is the ultimate purpose of our research. Other fields of knowledge depend on the knowledge transfer, and there is nothing like computers to help simulate natural, physical, chemical, or even human processes.

Do you have a favorite result, your own and/or from others?

Elvio Accinelli: Yes, my favorite result is the explanation of the economic crisis as the result of small perturbations on the fundamentals of so-called singular economies.

Ana Dias: My favorite result is on ODE-equivalent networks and concerns the idea of different graphs leading to the same kinds of dynamics — they just have be linearly equivalent: a nonlinear result that has a linear question. The part that I like more in my work is the fact that every time we have a problem, we have a challenge in hand that we try to address. When we have success, it is a good feeling: the feeling of contributing to science with something, even if it is a small contribution.

Orlando Gomes: There are many powerful and appealing results in economics. Personally, I am a fan of the so-called Ramsey growth model: a simple and elegant optimal control problem that indicates how a representative agent chooses, in an intertemporal perspective, how to optimally allocate resources between consumption and savings, in order to maximize expected utility.

Is it difficult to get funding for research in your area?

Ana Dias: Until now not so difficult. The amounts asked are not so much compared with other research areas, so that might help.

Orlando Gomes: In the last few years in Portugal it became, in my view, difficult to get funding for doing research in any scientific area.

Clara Grácio: Research and higher education have been maltreated in recent years, for decades, with an unacceptable government underfunding which translates into immense difficulties for both higher education institutions and research centers and institutes of state laboratories. Even with the dedication of Portuguese researchers, integrated or not, this policy did not allow the scientific development that would have been possible, resulting in wasted potential and resources. Combined with a real reduction in funds invested in vacancies for teachers or researchers in institutions of higher education, laboratories, and others, there has been a lack of coordination and a lack of transparency and programming in resources invested. Mathematics is no exception, and in this sense is not easy to get funds for the development of scientific work.

Filipe Silva: Yes, it's easier to get funding for applied research, such as the study of forest resources, than for more fundamental research, for instance that devoted to new methods. We thus try to mix both.

Luís Silva: Yes, but unfortunately that problem is not restricted to my specific area. On the contrary, in Portugal it is generalized to the majority of scientific activities.

Paulo Vasconcelos: Since part of my research depends on new computer architectures, yes, it is very difficult, especially in Portugal, where we do not have state laboratories or research centers with high-end machinery.

On research, more generally: What would you say are the most important things to keep a research group going?

Elvio Accinelli: A common interest in the research topics and the possibility for all team members to develop their lines of work.

Alberto Álvarez-López: Keeping in contact (personal if possible) for discussion, holding brain-storming sessions, a good coordination among members, deadlines to have the work done... I do not know if they are the most impotant things, but they are useful.

Fabio Chalub: All members should be engaged in the research, so it is crucial to find a topic of general interest that involves everybody in the production of results. We cannot think of our colleagues, even if we are leading the group, as a bunch of employees. Everybody should have autonomy to produce their own results, and be judged by the quality of the output produced. This is the case in mathematics and other more theoretical subjects; however, I am perfectly aware that we cannot apply this policy to run a lab.

Ana Dias: Not to stop and to have people that really like what they are doing. Another thing is that people have to respect each other's work.

Orlando Gomes: A common goal, the capacity to work with others and to accept their criticisms, and gaining the notion that one is contributing to the advancement of science.

Clara Grácio: Respect for the successes obtained by each of the elements of this group but fundamental support at certain times, less good, that each of the elements can benefit by. Transparency, quality, and consistency are important in defining the group's strategic line, making it a key element. When these features come together, the group is a team, it is a school. I had the privilege of belonging to one of those rare schools, coordinated by the very bright (in all these respects) Professor Sousa Ramos.

Bruno Oliveira: Motivation. People should like what they are doing and feel that their work is recognized within the group.

Filipe Silva: Leadership, commitment, cohesion.

Luís Silva: In the first place, people must trust and respect each other; then I think it is very important to define a leader for each task.

Paulo Vasconcelos: Focus, dynamics, and a good working environment.

How do you see the relation between traveling and research?

Elvio Accinelli: It is very important to travel and see the results that other people have obtained. Travel expenses are one of the better investments in research, even if the results are not displayed immediately.

Alberto Álvarez-López: Well, if you do not have an assistant to arrange the details . . . organizing travel consumes energy. Anyway, I find traveling a very good way to meet colleagues and interchange ideas. In

some workshops social aspects are very important: scholars are persons in the end, and they need to talk and share opinions and ideas with other persons.

Michel Benaim: Traveling is a good way to meet people and develop new research. It's often much easier to talk with someone in front of a blackboard rather than to read a math paper. However, with emails, skype, and other communication techologies things are changing rapidly, and traveling is not as important as it used to be.

Ana Dias: It is important, although now there ways to interact without having to travel that are also good, not expensive, and save time.

Orlando Gomes: Research is many times an individual and solitary effort that we make in our offices or homes, but no meaningful research contributions gain life without a discussion with others. Our colleagues can help us improve our original ideas and assist us in transforming them into relevant scientific results. The meeting between researchers in the same or in related fields is a fundamental stage of any scientific endeavor. Therefore, it is my opinion that the participation in conferences in seminars and conferences around the world is a key step for the progress of science.

Bruno Oliveira: Traveling to meet other researchers and present our results is the best way to get feedback from our research. I have made big steps in my work after speaking with others about what I have found and after hearing from others what they have found. The positive input can come from new results by others, different methodologies to apply to our work, or a simple change of perspective that will allow new insight into a problem.

Joana Pais: Even though technology for communicating with other researchers is available nowadays, so that communicating is extremely easy and virtually costless, I believe that traveling, whether to attend conferences or to visit other researchers, is essential.

Luís Silva: Particularly for young researchers, the contact with different research teams can be particularly beneficial, particularly when different skills can be developed in this way.

Filipe Silva: It is extremely important. Nowadays we have easy access to a huge quantity of information, but there are lots of things that are much easier to learn in a good conversation than by reading books or papers.

Paulo Vasconcelos: It is good in a very natural way. Research is widespread. A researcher needs to communicate with others, not only to share his research and to broadcast, but also to gather expertise from other colleagues in the field.

On teaching:
What do you think about the relation between teaching and researching?

Alberto Álvarez-López: I think there are three main aspects to our task as scholars: research, teaching, and simply studying (knowledge in itself). Every one of us shares these three aspects in some proportion. The system should allow someone with a strong proportion in one of them (any of them, with no prevalence) to feel comfortable. However, this is not always true. On the other hand, we sometimes have a fourth task: the administrative labor — and this is often the first task. Anyway, I do find that my courses are richer if there is a research related to them.

Ana Dias: Good.

Orlando Gomes: They are, undoubtedly, complements. The creation and the diffusion of knowledge are two sides of the same coin: without research, no knowledge would be available to pass to students; without any one to teach, research would be simply useless.

Joana Pais: I used to believe that research helped to improve the quality of teaching. While I still believe this can be true when we talk about teaching at the advanced/graduate level, it is certainly not the case at the undergraduate level, where we have very good teachers that do not do research. The positive effects of teaching on research are even more difficult to grasp.

Filipe Silva: It's crucial; it really is a dialectic relationship, with many ideas and skills developed in one activity, easily transferable to the other.

Luís Silva: I think that the majority of the fundamental research should be done in the universities and that all university teachers must do research and that the majority of the researchers also should teach. On the other hand, I think that the university career should be more flexible in the sense of permitting large periods for doing just one of these two things. Nowadays we feel permanently pressed to do both things simultaneously, and I don't think that this is good for either of the two activities.

Paulo Vasconcelos: A teacher without research cannot convey a message of future, of challenge.

Any thoughts on what's crucial for a university teacher and or student?

Alberto Álvarez-López: You have to find pleasure in studying. And you have to learn to say "wait a moment, and let me analyze that," instead of giving a quick "yes" or "no."

Ana Dias: A good and enthusiastic teacher and a good and enthusiastic student.

Orlando Gomes: For both, the curiosity, the will to learn, and not being afraid to make mistakes.

Filipe Silva: A never-ending curiosity and the will to continue learning.

Luis Silva: Planning.

Alexandre Rodrigues: In a few words, I would say that a teacher should view a classroom as a pool of potential researchers and honor students. Students bring enthusiasm and a fresh perspective to our research. There is always the possibility that questions that come up in class will inspire new directions for our research. I find that stimulating interaction, encouraging independent thought, and accepting criticism are crucial in a classroom. And one should have a sense of humor — students love it. Technically, I believe that a teacher should give to the student a sense of the field, its past, present, and future directions, and the origins of its ideas and concepts. He/she should present facts and concepts from related fields. Theoretically, these are achievable goals; nevertheless, I realize that combining all these points might be difficult.

Paulo Vasconcelos: The duality research/teacher is difficult to keep equilibrated. In reality, usually teaching hours may be counterproductive for academic progression.

What are your thoughts on the relation between high school and university in terms of education?

Alberto Álvarez-López: I do not find them, at least in my country, as close as they should be. In mathematics, for instance, there is a gap between the level in high school and the requirements in university, especially in some grades. This causes a delay in the correct evolution of students. The high school teacher is not necessarily the guilty party: from the university we must better connect with him/her. Anyway, a deep change in the educational scheme should be considered.

Ana Dias: So and so. There is not a smooth transition between the two.

Orlando Gomes: The university should, more than any other school level, be capable of showing to students that what they learn, how they learn, and what use they make of this learning are essentially in their own hands and dependent on their own will.

Bruno Oliveira: In Portugal, university admission is based on high school grades, and the method of evaluation places too much emphasis on memorization to the detriment of problem-solving skills. I think that the system should aim to guide the students to the degree that is more fitted to their skills.

Filipe Silva: In Portugal I presently feel a considerable gap between those two levels. It's probably not a matter of the amount of knowledge that students have, but it is the way that they face their studies. It takes them all of the first year at the university to adapt to their new habits and to eventually develop a new, more independent way of studying.

Luís Silva: Particularly in mathematics, the relation was too bad for too long. Over a long time, the high school programs changed, and the university programs for the first years took too long to adapt. At the same time students arrived at the university poorly prepared, and people from the two school systems have had great difficulty in getting together to talk about what to do.

Paulo Vasconcelos: Completely wrong. Schools tend to prepare their students to take exams so that they can enroll in good universities. But critical thinking and creativity are neither exploited nor encouraged.

Do you have any advice for students starting their research?

Elvio Accinelli: Courses must be completed within the scheduled time, and then one should begin and continue working on the thesis without interruption until it is finalized. In general, those who leave their thesis for a time will fail to finish.

Alberto Álvarez-López: Yes: prepare a question (or a list of questions) to be answered. The question should be interesting. The answer should be relevant as well as technically correct.

Mário Bessa: Be persistent, resilient, curious, patient, and especially be able to scribble through large amounts of paper with flaws, mistakes, and wrong computations. Never believe that your supervisor has a magic wand to answer your questions and solve all your problems. It is you who should make the magic wand!

Ana Dias: They should try to work in what they like.

Orlando Gomes: Enjoy it. If you plan to go into research thinking only about career or monetary rewards, do not do it. You will need to have a passion for knowledge, or else you will feel frustrated.

Bruno Oliveira: Having a degree or a Ph.D. in an area does not mean that you will do the same thing for the rest of your life. You can use the expertise you have obtained in one area and apply it to a different one. The interface you create can be extremely rich in content and very motivating to explore.

Alexandre Rodrigues: A Ph.D. in Mathematics takes several years, and unless you really want to do it for its own sake, you will probably drop out at some stage. The four years of Ph.D. work can be very frustrating — you need real determination to stick to a handful of projects and get the job done. You should be completely sure that you love doing research in that specific field. You will enjoy it sometimes, but other times it will be very frustrating. It is, in general, solitary work; you speak to a few people including your advisor, but it is still solitary. The results will be unconvincing many times; basically, you will end up with a thesis for which only a few individuals in the world can assess the exact value. If you have started your Ph.D., do not give up. Make an effort to make the difference; be really good. Even when the proof of a result is already given, try to do it by yourself.

Filipe Silva: I consider it a privilege to be able to devote our lives, or at least a part of them, to research, that is to try to better understand our world. Also, research activities have the potential to develop scientific reasoning and many other skills (e.g., persistence, creativity, statistical reasoning) that can be useful in other fields of activity.

And for the ones who are hesitating between pursuing a Ph.D. and looking for a different job?

Alberto Álvarez-López: Well, If you like to study, if you really like to work hard studying, go ahead with your Ph.D. The job of a scholar is one of the best you can choose, in the sense that almost everything you do is a direct "investment" in yourself. There are, of

course, several contras: the wages are usually low, labor promotion is sometimes difficult, you work a lot of hours, bureaucratic tasks often feed you . . . .

Ana Dias: They should try to do what they prefer.

Orlando Gomes: It is a matter of vocation. There are many appealing and well-paid jobs that do not require a Ph.D. It is all a matter of making the choices that we are most comfortable with.

Filipe Silva: I don't like to push students into academic activities, since the path to the Ph.D. is as important as the final result, so they have to be fully committed to endure (and enjoy) their own research voyage.

Have all of your research students chosen academic careers?

Alberto Álvarez-López: Most of them. I have to say that a few students were part-time students; they were also working out of the university.

Mário Bessa: Since academic jobs, in the area of mathematics, experienced a large decrease in supply in the last decade, Ph.D. students, after finishing their Ph.D. program, try to find business and finance jobs. Fortunately, my former students (Master and Ph.D.) are working as risk analysts in a bank. I point out that their employers are very satisfied with their skills and competence.

Ana Dias: I just have two and both are academics, although not yet with stable jobs.

Filipe Silva: No, several students have professions as teachers or in areas related to the environment. I think that the society, namely the private sector, should interact much more closely with researchers and they should eventually think how their skills can be put to work for the common interest, even if they are not directed to pure research. But it seems that we are still at a considerable distance from a complete integration of researchers in the society as a whole.

Luís Silva: Three out of four.

Paulo Vasconcelos: No, mainly lately they are finding jobs outside of academia.

On other issues:

Do you have hobbies?

Alberto Álvarez-López: I very much enjoy good literature, and reading and writing in general.

Ana Dias: Right now, maybe just cooking, due to the lack of time.

Orlando Gomes: I like to take long walks and to enjoy the company of my family.

Filipe Martins: I am a proud Portuguese, and enjoy my country very much. My main hobbies are reading, music, and playing the piano and watching Boavista F.C. play. I am an avid reader.

Filipe Silva: Jogging and swimming in the ocean. Fortunately, I can do it all the year round in the Azores.

Luís Silva: I am a big fan of enduro mountain biking.

Do you have a connection to Portugal? How do you see its development?

Elvio Accinelli: I have an excellent relationship with Portugal, especially with the group of applied mathematics from Porto. With my work group in México we could make many joint projects with the group led by Alberto Pinto. The development of joint work with this group is of particular interest to us.

Alberto Álvarez-López: I feel as if I had a brother in Portugal. My visits to this brother are not very frequent, but when I am with him, I always feel exactly as if I were at home.

Ana Dias: I am working at the University of Porto. I see that Portugal is progressing with many people working hard, and I hope they will not lose their enthusiasm.

Orlando Gomes: I am Portuguese. I think Portugal is a victim of a drifting European Union and of the poor quality of its own economic policies. Visible setbacks in the areas of culture and science are, for me, the most painful.

Filipe Silva: Living in the Azores islands, I am aware of the consequences that can arise from unplanned development. Development without knowledge will hardly be development at all, and surely not sustainable. That's why universities and other innovation/research institutions play a crucial role in training the new generations and in contributing to a development that will not compromise Earth's resources and future generations.

Interview

DGS III 2014

CIM thanks the participants **João Almeida** [Instituto Politécnico de Bragança, Portugal], **Carlos Braumann** [Universidade de Évora, Portugal], **Marta Faias** [Universidade Nova de Lisboa, Portugal], **Flávio Ferreira** [Instituto Politécnico do Porto, Portugal], **Penelope Hernandez** [University of Valencia, Spain, Spain], **Onesimo Hernandez-Lerma** [CINVESTAV-IPN, Mexico], **José Martins** [Instituto Politécnico de Leiria, Portugal], **Diana Mendes** [ISCTE, Lisboa, Portugal], **Diogo Pinheiro** [City University of New York, USA], **Edgard Pimentel** [Universidade de Lisboa, Portugal], **Jérôme Renault** [Université de Toulouse, France] of the International Conference and Advanced School Planet Earth, Dynamics, Games and Science III [DGS III], Portugal, February 17-21, 2014, on the occasion of the 50th birthday of Alberto A. Pinto, for sharing with us their ideas and point of views in this interview.

The questions presented here are based in several interviews; in particular, the interviews published in previous CIM bulletins. CIM thanks Renato Araujo and Alberto Pinto for organizing this interview.

On the meeting DGS III

What is your general impression of the meeting?

João Almeida: The meeting was well organized and the ambient at the conference was warm and friendly. The facilities were very comfortable and well equipped. Both plenary and parallel sessions were most interesting, reaching a wide variety of subjects and with a high scientific level.

Carlos Braumann: I quite enjoyed the meeting, particularly its focus on the usefulness of Mathematics and the nice and cozy environment that favors interaction.

Marta Faias: I personally think that the meeting was very well organized and quite interesting in the sense that there were a lot of topics that were covered.

Flávio Ferreira: The meeting was great!

Onesimo Hernandez-Lerma: I think the meeting was excellent. That is, the selection of topics, the speakers, the venue, and so forth, all were very good.

José Martins: DGSIII follows the second DGS at Calouste Gulbenkian Foundation and the first DGS conference realized in 2008 in Braga. The conference covers a wide range of topics, which is one of its greatest advantages. In my opinion, especially in what is concerned with Applied Mathematics, DGS is one of the most interesting conferences. I hope to attend many more DGS conferences.

Diana Mendes: My general impression of the meeting is quite positive. The meeting had high quality researchers and a very good environment. I really enjoy small/medium size conferences, where the people know each other easier and can exchange ideas. Due of these facts, I think it is very fruitful for our students to participate, to hear good mathematics and learn about respect and friendship. The scientific areas of the meeting are actual and interdisciplinary. There are few conferences /meetings in this area, so, I am quite sure that the impact it is at least reasonable.

Edgard Pimentel: This meeting put together several experts in the field of dynamical systems and its connections with problems in social and life sciences. Game theory was particularly emphasized. For me, as a young scientist, it was an amazing occasion to be in touch with senior scientists working on my field on interest. As the organizer of a special session, I could also bring together specialists whose work is closely related to mine. One of the speakers in that session also submitted an article to the volume edited in occasion of the meeting — it is always good to point out that, to have a volume of such an impact on the community as a byproduct of this meeting is a strong indicator of its scientific relevance.

Diogo Pinheiro: I was very well impressed. In particular, I would like to remark the quality of the communications presented the broad scope of scientific interests represented and the overall organization of the scientific program, allowing plentiful time for fruitful scientific interaction and a stimulating exchange of points of view concerning recent progress. I would also like to point out the wide range of interesting thematic sessions included in the meeting program.

Jérôme Renault: The meeting was nice and interesting, mixing interesting researchers from different fields of mathematics and science. I have had the pleasure to see again old friends like Penelope Hernandez or Frank Riedel, but also to meet new people doing Games and Dynamics, such as Sebastian Van Strien. Moreover, it was my first visit to the beautiful city of Porto, and despite the pretty rainy weather, I appreciated it very much! I believe such meetings are important for cross fertilization of domains and ideas, and for students to meet various active researchers and discover new fields.

Something you would like to highlight?

João Almeida: I would highlight the keynote lectures, where the talks on the selected topics were very deep and in the frontier of their research areas and the coffee break discussions were very fruitful.

Onesimo Hernandez-Lerma: Doing the meeting at the building of the Reitoria da U. Porto was a great idea. This is a beautiful, historical building, with very nice surroundings, and within walking distance to the city center.

José Martins: The quality of the research presented on a wide variety of topics. Something that is hard to find in a more general conference.

Edgard Pimentel: I would like to highlight the volume published in occasion of the conference.

Diogo Pinheiro: I would like to highlight the numerous relevant topics covered during course of the 3rd International Conference on Dynamics, Games and Science, ranging from more theoretical approaches to dynamical systems all the way to relevant applications of dynamics in biology, physics and the social sciences, without neglecting problems connected with game theory and optimization. I would also like to use this opportunity to highlight the presence at the conference of several internationally distinguished researchers.

How important do you think that events like this are for students and researchers?

João Almeida: Events like this are crucial to students and also to researchers. It's an excellent opportunity for students and researchers to meet top researchers in the various fields, to learn about their research and to fruitfully discuss and exchange ideas.

Marta Faias: This kind of event with such different topics is very worthy for the researchers since it is a good opportunity to see the recent research topics from several mathematical areas. For the students it is a good opportunity to become aware of the recent problems that are being handled by researchers and even a good opportunity to be in touch with open problems. In general, the conference environment was very propitious for discussions among young and senior researchers, which is essential for the students and also a good challenge for the senior researchers.

Flávio Ferreira: They are very important.

Onesimo Hernandez-Lerma: The meeting was a unique opportunity for all the participants, students and researchers, to meet professionally interesting people from many different countries and different fields, and interchange ideas. Personally, I learnt a lot of interesting things not only from the lectures but also from talking to other people.

José Martins: Conferences like DGS are an opportunity for students contact with the so many powerful applications of Mathematics and increase their curiosity in some fields of research. Hence, I strongly recommend this conference to students!

Diana Mendes: I really enjoy small/medium size conferences, where the people know each other easier and can exchange ideas. Due of these facts, I think it is very fruitful for our students to participate, to hear good mathematics and learn about respect and friendship. The scientific areas of the meeting are actual and interdisciplinary. There are few conferences /meetings in this area, so, I am quite sure that the impact it is at least reasonable.

Edgard Pimentel: These events are paramount. For they bring together scientists from several countries, working on distinct though related topics; they bolster interactions, potential collaborations and ultimately contribute for the advancement of the field. Also, because our profession reports its new developments through scientific, not rarely technical, papers - which take sometimes too long to appear — these events also play a major role in the dissemination of recent advancements.

Diogo Pinheiro: Attendance and participation at scientific events such as the 3rd International Conference on Dynamics, Games and Science are essential steps in the scientific development of research students, contributing also to an increased maturity and quality of the overall scientific research panorama. To be more detailed, while attending high quality scientific meetings such as the one mentioned above, research students have an opportunity to interact with and learn from distinguished researchers in their fields of activity, being exposed in a very direct way to novel ideas and concepts, while gaining further experience in what concerns presenting and discussing mathematics.

How do you see the impact of this meeting on your field and outside of your field?

João Almeida: The impact is very positive. These events should be made regular.

Flávio Ferreira: It's an excellent opportunity to exchange ideas.

Onesimo Hernandez-Lerma: This is a tricky question, because to answer it we would need, first, to define what "impact" means. And then, assuming we know what impact means, we would need to specify how to measure it. On a personal level, however, I would say that the meeting had a significant, quite positive impact on me because I had the fortune to meet many interesting researchers and hear their ideas, as well as the topics they are working on right now.

On your research:
Did you always want to be a mathematician?

Flávio Ferreira: Yes.

Onesimo Hernandez-Lerma: No. I spent several years in the Mexican Air Force and, probably because of this, I wanted to study Aeronautical Engineering. Nevertheless, when I could attend a university I decided to study Physics instead of Engineering. Finally, after a couple of years of studying Physics, I switched to Mathematics.

Penelope Hernandez: Yes, I loved numbers when I was child, I hated numbers when I was teenager and I loved numbers and structures all the time. It is the way of thinking that I love.

José Martins: Yes. When I went to the college I just want to be a high-school teacher. But now, I can say that I had the happiness of discover the pleasure of research on Mathematics and also the pleasure of being a lecturer in a polytechnic school.

Diana Mendes: Yes, I always want to be a mathematician.

Edgard Pimentel: As a matter of fact, I am an economist. Mathematics became a reality only after I had graduated from the School of Economics of the University of São Paulo. Somehow bored with the problems studied by the vast majority of the economists - which in turn made then bored with me — I decided to study mathematics and went to IMPA, Rio de Janeiro, for a summer program. The course on real analysis was, for me, like a one-way ticket to a realm of challenging problems. From that summer to the completion of my thesis, it took more or less six years. In December of 2013, I concluded my doctoral studies with the defense of the thesis entitled Time-dependent mean-field games, under the direction of Prof. Diogo Gomes at Instituto Superior Técnico, in Lisbon.

How did you start working in this area? What was the motivation? Could you tell us about your mathematical beginnings, and subsequent career development?

João Almeida: When I was MSc student I met Alberto Pinto. He gave a course on Dynamical Systems and I was impressed by his mathematical insight, particularly into the field of Dynamical Systems. So it was natural for me to work with Alberto and I became his PhD student.

Carlos Braumann: Probability and Statistics was my favorite subject since high school. It is only fitting that, as a PhD student, I have encounter my main area of research by chance, when I met a book about stochastic differential equations (SDE), a subject matter I had never heard about before. I immediately recognized it was just the right tool to model several issues in Biology. Those issues also raised new theoretical interesting problems and that interplay has always been quite fascinating to me.

Diana Mendes: When I was a kid, my purpose was to be a math teacher at my home town high school. At that time, we knew few thinks about research (no TV and Internet J), but we used to solve problems, prove results and participate at Olympiads, frequently and seriously, at the adequate level. During the last year at the University, my final project supervisor was working on his Dynamical Systems book and asked for my help in some minor questions. This was my first serious contact with dynamical models and applications and it was really precious. Later I leave my country and I became a mathematician and a researcher in a Business School. It was natural what I have to do, to join models with applications in order to try to give some answers to real problems.

Flávio Ferreira: I was motivated by my PhD supervisor Alberto Pinto.

Onesimo Hernandez-Lerma: I used to work on stochastic control problems and two friends (Andrezj S. Nowak from Poland and Mrinal K. Ghosh from India), almost simultaneously, brought to my attention that the techniques that I used in control theory were also applicable to Markov games. That was my motivation to write my first paper on games. Concerning my professional beginnings and subsequent development, my doctoral dissertation, at Brown University, in USA, was on some stability problems for a class of stochastic differential equations. Then I spent a sabbatical year at the University of Texas at Austin where I began working on optimal control problems. A few years later, I did substantial work on infinite–dimensional linear programming. Finally, beginning in about the year 2000 I started working on Markov games, which I do in parallel with control problems. Related to my research work, I have published about 130 papers in peer–reviewed international journals, about 10 or 11 books (at least half of them published by Springer–Verlag), and supervised 19 Ph.D. theses. At present I supervise four Ph.D. students, two of which will complete their dissertations in the following months.

How would you describe the essence of your own research to a young student?

Carlos Braumann: Individuals and biological populations live in randomly fluctuating environments that affect birth, death and growth. The deterministic models commonly used to describe and predict their dynamical behavior are a good basis but are unable to take into account such fluctuations. So, we need stochastic models to quantify, predict and minimize the risks that such fluctuations may cause on life or on the economy in areas like epidemiology, fishing, forestry, pest control, wildlife management, animal farming, agricultural, life insurance and social security.

Marta Faias: To understand the economic behavior of the economic agents and markets, we need to develop models and mechanisms. Mathematics allows us to design these models and mechanisms in a universal language, while also providing the solutions and paving the way to study the properties of these. One main aim of my research is to explain the equilibrium prices and how they arise in several competitive economic settings, for example, in pure exchange economies with an incomplete asset structures and differential information. To undertake such goal we apply game theory. This mathematical tool permits drawing models, finding their solutions and moreover, characterizing such solutions. This research can then be used by the decision makers to help their choices.

Penelope Hernandez: By means of examples and counterexamples to illustrate the bounds of the knowledge of a specific issue.

Diogo Pinheiro: The focus of my research is on dynamical systems and differential equations, its optimal control and applications. I have a very strong interest in Hamiltonian dynamics, renormalization, and perturbation theory. I am also interested in the analysis of stochastic optimal control problems with certain forms of model uncertainty. Finally, I am pursuing applications of stochastic dynamical systems and optimal control techniques to address problems arising from Economics and Finance.

Which would you say are the most interesting/challenging open (or recently solved) problems in your area, and what do you think the future reserves in your area and in your line of research?

Onesimo Hernandez-Lerma: To answer this question requires a lot of thought . . . Nevertheless, the topic

I'm currently working on, namely, dynamic potential games (as opposed to static potential games), is full of interesting, nontrivial, open problems.

José Martins: In Mathematics everything is challenging. A simple problem in real life can be a difficult challenge in Mathematics. The beauty of Mathematics comes from solving problems that appear everywhere and every day. My research is closely related with applications in Biology, more specifically, in epidemiological modeling. The connection between Mathematics and Biology is extremely important and the contributions that Mathematics can give to the well-being of people will never finish. I hope that someday my work can give an important and decisive contribution to the well-being of people.

Jérôme Renault: I believe that exploring the mathematical aspects of strategic interactions is a fascinating and important challenge of our epoch. Games appear everywhere, in particular in social sciences, and it is very challenging (but difficult!) to find general theoretical results with practical and important applications. Regarding dynamic games, I believe that mixed models where time is continuous but agents take decisions at discrete, possibly endogenous, times, have not been considered enough and will play a role in the future.

How do you see your area in terms of its importance in mathematics and in other fields of knowledge, the impact on and from other areas and how do you expect this interplay to develop further?

Carlos Braumann: It is a fascinating area, not only because of the enormous range of current and future applications (with its feedback on new theoretical problems), but also because of the bridges and corresponding cross-fertilization with other areas of Mathematics.

Diana Mendes: I understood that interdisciplinary connections are very important, and that my research area (Nonlinear Dynamics and Nonlinear Time Series Models) has a huge reservoir of applications, involving economics, finance, geography and geomorphology, urbanism, and many others. The meetings allow me to know people, to create connections and to apply to new research projects, sometimes in unexpected problems and topics, which are really provocative and appellative. These challenges are already part of our life, and usually I divulgate them in a friendly way to my students.

Onesimo Hernandez-Lerma: In the area of potential games, the number of papers–per–year has been increasing exponentially because of their nice properties and its applications in engineering, economics, and financial mathematics, among many other fields.

Diogo Pinheiro: Since the development of calculus, differential equations have played a central role in mathematics and other fields of knowledge, with a particular emphasis on physics. Despite the fact that our treatment of differential equations has been changing in nature and expanding in scope with the course of time, mainly through the development of

alternative analytical and geometrical techniques, I believe that, together with other classes of dynamical systems, this topic will play an even deeper role in the development of mathematics and science for the foreseeable future. Let me provide some support for this claim. Start by noticing that, eventually due to the continued rise of computational power observed during the last few decades, most fields of knowledge are becoming increasingly data-driven, placing a stronger emphasis in the development of mathematical models, which very often are introduced to describe some form of evolution. On the other hand, it seems to me that our increasingly technological society may be relying more and more on complex quantitative models, to help with complicated decision-making processes. With these observations I am not claiming that dynamical systems and differential equations will be the main tool to address such needs. Instead, I believe it will be one of multiple tools to address what are, essentially, multidisciplinary problems. This means that not only will the field be of continuous importance to real-world applications, but also that such applications will keep generating problems of theoretical relevance, promoting further technical developments which will ultimately enrich mathematics as a field of knowledge.

Do you have a favorite result, yours and/or from others?

Carlos Braumann: I particular like Girsanov's theorem, which is the key to the martingale theory approach to SDE. Mine, I have two. The first concerns the clarification of the use of Itô or Stratonovich calculus (solving a controversy in the literature). The second obtains qualitative properties for general models of population growth (including populations subjected to fishing), thus generalizing similar results for specific models.

Is it difficult to get funding for doing research in your area?

Carlos Braumann: It is as difficult as in other areas.

On research, more generally: What would you say are the most important things to keep a research group going?

João Almeida: That's a difficult question. I think there isn't a special formula, but it is important to keep everyone in the group motivated by doing what he or she likes. If someone isn't motivated it is very important to be able to tell it to the group. Also foster the team spirit is a crucial point. Regular meetings and seminars in the presence of the whole group contribute positively.

Carlos Braumann: Leadership of the principal investigator and a friendly atmosphere.

Marta Faias: I believe that the most important things to keep a research group going are, first, that the members of the group research ought to be equally attracted to the research topics that are being undertaken , and second, they should also be able to talk the same scientific language. A last point that I underline are the complementarities among the researchers, a mix between inventive researchers, researchers that always have an idea to solve the emerging questions and researchers that carefully validate that solutions. These qualities are essential to the maintenance of the group.

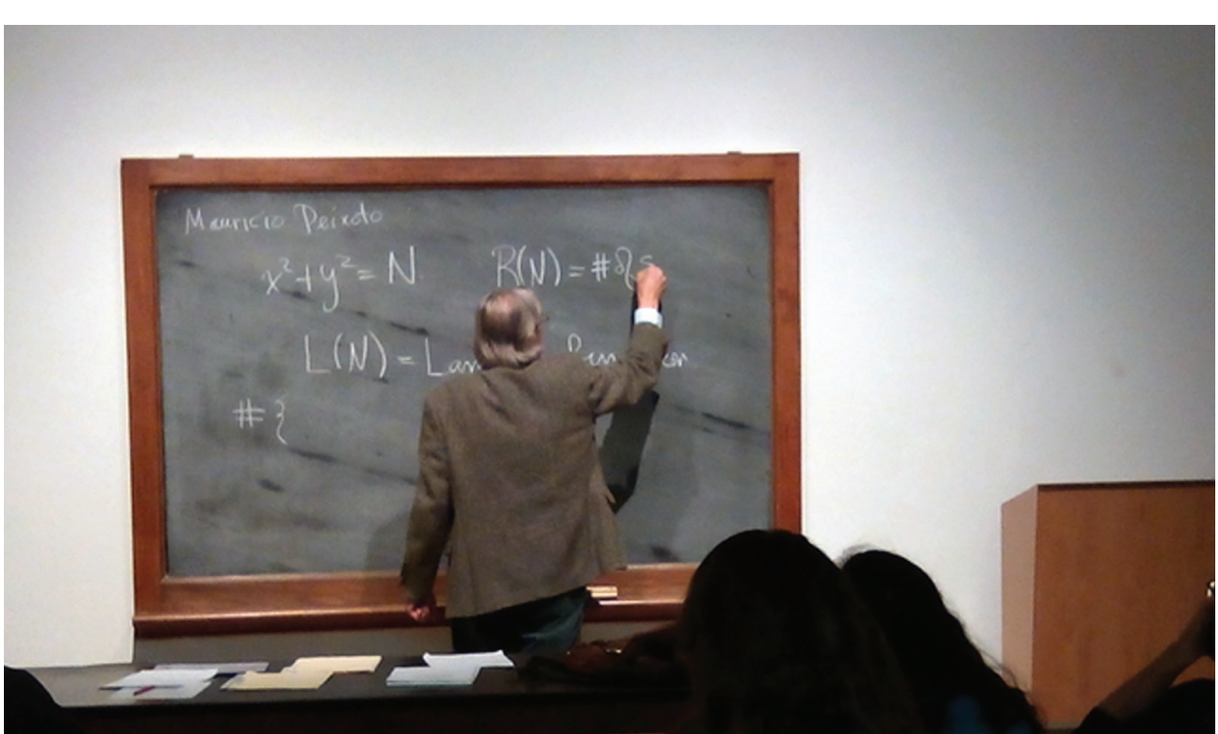
Onesimo Hernandez-Lerma: To keep the group updated on all new research developments, and constant seminars.

Edgard Pimentel: In order to keep a research group going there must be a continuous interaction between its members, in several levels. First, every integrant of the group must interact with its leaders on a regular basis. Then, smaller cells within the group may conduct more independent research activities. It ensures some sort of energy conservation within the group. Also, there must be strategies aiming at the internationalization of the group members and its activities. Mathematics has no nationality, so it is important to take advantage of this fact. Above all, a research group cannot be motivated by the number of papers or contributions it produces. On the other hand, it should be concerned with the quantum of difficult, genuinely original, problems it has been attacking in an effective manner. It is unnecessary to say that prospecting and obtaining funding and research grants are critical.

How do you see the relation between traveling and research?

João Almeida: Traveling is very important when doing research because you get to know other realities. Also, when traveling one has some extra time available to think about his work and to discuss his research with other experts on his field.

Marta Faias: I think that it is quite difficult to do very good research without travelling. Firstly, a research group should integrate a mix of different



skilled researchers, which is in general only possible if the group is composed by people from different countries. Secondly, the new results should be discussed with experts, those discussions are fundamental to improve and validate the results. Since almost certainly the experts are spread throughout the world, travelling is compulsory.

Onesimo Hernandez-Lerma: I think traveling is neither necessary nor sufficient for doing good research. However, participating each year in a few selected meetings can be quite positive from the viewpoint of professional development.

Penelope Hernandez: The exchange of questions, ideas and techniques used to be easier when a scientific is moving around the world. This is so because when you travel it is easy to disconnect with the normality and to open up your mind and your time for new experiences. The possibility to visit new and good research environment helps to share in a cool ambient the ideas just in front of a black board or just with a coffee. I have travelled a lot in my career and my experience has been positive. Sometimes it was difficult to talk with people but others I got a lot of insight about my work and the others' results.

Edgard Pimentel: Travel is critical for the advancement of research. Scientists must see their peers and interact with them on a regular basis. Trips to conferences, meetings and schools provide opportunities for us to do so.

On teaching:
What do you think about the relation between teaching and researching?

João Almeida: Researchers should also teach and teachers should do research.

Flávio Ferreira: Teachers should do research.

Onesimo Hernandez-Lerma: Teaching (a reasonable number of hours per week) can be quite positive for research, and the converse is also true.

Penelope Hernandez: A person who knows the last hot topics on research could connect them to the simple and less sophisticated fields that it used to

be taught. This way allows to the students to connect with important features and getting as a challenge the way to study and to understand the world. It is an experience when you realize your students understand why to study the boring matrices. Then they became even useful.

Diana Mendes: Personally I think that it is a quite strong relation between teaching and researching.

Any thoughts on what's crucial for a university teacher and or student?

Onesimo Hernandez-Lerma: Read a lot and work a lot!

Diana Mendes: Researching gives us a different vision about concepts, facilitates the updating of the methods and tools and offers challenging problems and answers for the students. The students are curios and captivated by thinks that they can understand, visualise (or at least imagine) and apply, instead of simple (or complicated) definitions and theorems. Researching allow us to give all these to our students.

What are your thoughts on the relation between high school and university in terms of education?

João Almeida: I think that, at least in Portugal, university and high school are still far distant from each other, nevertheless some progress have been made to approximate the two levels.

Do you have an advice for students starting their research?

João Almeida: Be persistent because there aren't easy paths along the way.

Onesimo Hernandez-Lerma: Get a good advisor.

Diana Mendes: My advice, for the students starting their research it is the following: be patient but curios, disciplined but audacious, and only do it if you really enjoy it.

Edgard Pimentel: A student starting research in mathematics must be, above of all, brave. Brave in attacking the problem, in checking her solutions, in talk about her progresses or roadblocks. A perhaps more practical advice is to allocate as much time as possible to your research. Then, as soon as something comes up, write things down and talk about them with people (a thesis director is the most suitable person in this case). Avoid focusing on things that — although potentially interesting — are not related to your thesis work: you have a problem to solve and a thesis to write; everything else falls into the distraction category.

And for the ones who are hesitating between taking a PhD and looking for a different job?

João Almeida: They should try to get a PhD degree without losing a good job opportunity.

Carlos Braumann: I will not advise a student to give away a good job offer in order to take a PhD as a full time student. I would try to convince the employer to keep the job offer and combine it with a PhD thesis of its interest.

Onesimo Hernandez-Lerma: Get a PhD; it never hurts.

Did all your research students become academics?

Carlos Braumann: The answer is yes for all that have a job. Industry and business are not yet hiring PhDs as they should. We need to convince them of the advantages of hiring PhDs and of PhD theses in entrepreneurial context and, in this phase, provide adequate incentives.

Onesimo Hernandez-Lerma: No, a couple of them work at banks or computer companies.

On other issues: Do you have hobbies?

Flávio Ferreira: Walk and cycling by the sea; watching football; gastronomy.

Onesimo Hernandez-Lerma: Yes, walking and reading.

Diana Mendes: I have some hobbies, painting and cooking, between others.

Do you have a connection to Portugal? How do you see its development?

Onesimo Hernandez-Lerma: My only connection with Portugal is Alberto Pinto!

Penelope Hernandez: I have few connection with Portugal and I think that as in Spain there are a lot of variance in the academic researchers. Fortunatelly, some of them have the energy to make new and productive issues. This generates the good ambience to continue working and collaborating.

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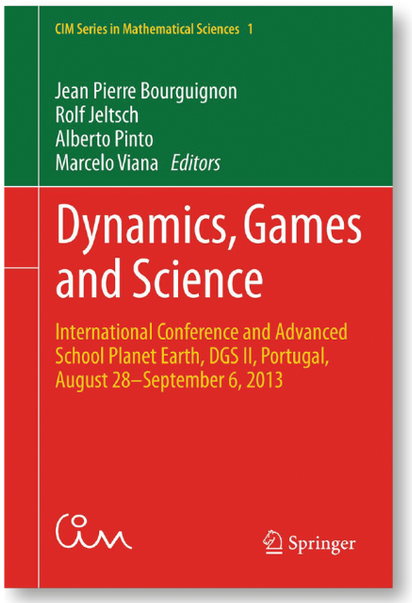

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Dynamics, Games and Science

International Conference and Advanced School Planet Earth, DGS II, Portugal, August 28–September 6, 2013

Series: CIM Series in Mathematical Sciences

►

The focus of this volume is research carried out as part of the program *Mathematics of Planet Earth*, which provides a platform to showcase the essential role of mathematics in addressing problems of an economic and social nature and creating a context for mathematicians and applied scientists to foster mathematical and interdisciplinary developments that will be necessary to tackle a myriad of issues and meet future global economic and social challenges.

Earth is a planet with dynamic processes in its mantle, oceans and atmosphere creating climate, causing natural disasters, and influencing fundamental aspects of life and life-supporting systems. In addition to these natural processes, human activity has developed highly complex systems, including economic and financial systems; the World Wide Web; frameworks for resource management, transportation, energy production and utilization; health care delivery, and social organizations. This development has increased to the point where it impacts the stability and equilibrium in human societies. Issues such as financial and economic crisis, sustainability, management of resources, risk analysis, and global integration have come to the fore.

Written by some of the world's leading specialists, this book presents the proceedings of the International Conference and Advanced School Planet Earth, Dynamics, Games and Science II, held in Lisbon, Portugal, 28 August -6 September 2013, which was organized by the International Center of Mathematics (CIM) as a partner institution of the international program *Mathematics of Planet Earth 2013*. The book describes the state of the art in advanced research and ultimate techniques in modeling natural, economic and social phenomena. It constitutes a tool and a framework for researchers and graduate students, both in mathematics and applied sciences, focusing mainly on dynamical systems, game theory, and applied sciences.

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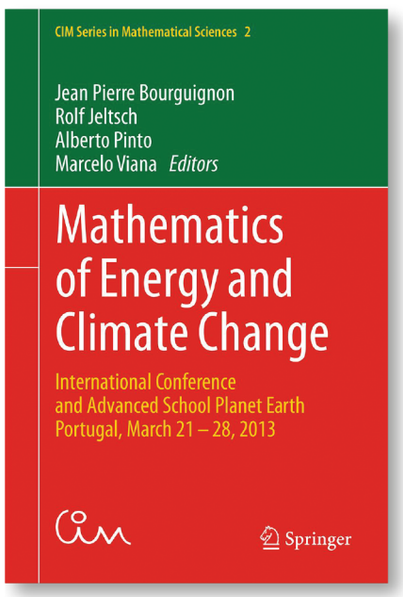

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J.-P. **Bourguignon**, R. **Jeltsch**, A. **Pinto**, M. **Viana** (Eds.)

Mathematics of Energy and Climate Change

International Conference and Advanced School Planet Earth, Portugal, March 21-28, 2013

Series: CIM Series in Mathematical Sciences, Vol. 2

►

The focus of this volume is research carried out as part of the program *Mathematics of Planet Earth*, which provides a platform to showcase the essential role of mathematics in addressing planetary problems and creating a context for mathematicians and applied scientists to foster mathematical and interdisciplinary developments that will be necessary to tackle a myriad of issues and meet future global challenges.

Earth is a planet with dynamic processes in its mantle, oceans and atmosphere creating climate, causing natural disasters, and influencing fundamental aspects of life and life-supporting systems. In addition to these natural processes, human activity has increased to the point where it influences the global climate, impacts the ability of the planet to feed itself and threatens the stability of these systems. Issues such as climate change, sustainability, man-made disasters, control of diseases and epidemics, management of resources, risk analysis, and global integration have come to the fore.

Written by specialists in several fields of mathematics and applied sciences, this book presents the proceedings of the International Conference and Advanced School Planet Earth, Mathematics of Energy and Climate Change held in Lisbon, Portugal, in March 2013, which was organized by the International Center of Mathematics (CIM) as a partner institution of the international program *Mathematics of Planet Earth 2013*. The book presents the state of the art in advanced research and ultimate techniques in modeling natural, economical and social phenomena. It constitutes a tool and a framework for researchers and graduate students, both in mathematics and applied sciences.

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