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.