Chilean Journal of Statistics
Vol. 6, No. 2, September 2015, 81–94

INTERVIEW

A conversation with Oscar Bustos

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(Received and accepted: 4 November 2014)

Abstract

Oscar Bustos was born on March 20, 1947, in San Nicolás de los Arroyos, Argentina. He completed a B.A. degree in Mathematics in 1970 at the Universidad Nacional de Córdoba (UNC), Argentina. In the period 1970-1976 he worked as a part-time instructor in the same department. In 1976 he went to the Universidad Nacional de San Luis, Argentina, where he completed a Ph.D. degree in Mathematics in 1978 under the supervision of Dr. Ricardo Maronna. Because the situation in Argentina at that moment was difficult he decided to move to Brazil (Instituo Nacional de Matemática Pura e Aplicada, IMPA) where his academic career was highly enriched by the interaction with other colleagues and students. In 1992 he returned to Argentina and the same year he joined the UNC as a full professor in the department of Mathematics, Astronomy, and Physics. Dr. Bustos since then has been a very active investigator in robustness, time series, image processing, satellite acquisition systems, among other fields. He has been the chair of the Probability and Statistics group in the same university since 1992 supervising eleven Ph.D. students, more than thirty master students and leading a number of activities such as participating in the evaluation of programs, editorial service for many journals, the creation of master's and doctoral programs in statistics and establishing a constant interaction with the National Commission on Space Activities (CONAE in Spanish). For these and other reasons he is a distinguished professor in the department of Mathematics, Astronomy, and Physics (FAMAF) at UNC, Córdoba, Argentina. Since 1990 he has been in touch with chilean investigators interacting and developing statistical methods with applications in image processing and time series.

The following conversation took place at FAMAF, UNC, Córdoba, Argentina, May 4, 2014.

Keywords: Statistics · Robustness · Time series · Image processing

Vallejos and Ojeda: First of all we want to thank you for agreeing to talk to us and we want to convey our admiration, first for the person you are and then for your path as a scientist.

Bustos: I feel honored, that such an important journal has noticed my professional development and I hope to answer your questions satisfactorily.

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ISSN: 0718-7912 (print)/ISSN: 0718-7920 (online)

http://www.soche.cl/chjs

1. Early years and family background

Vallejos: Can you tell us something about your family and childhood?
Bustos: I remember my childhood very fondly. My parents took very good care of me and gave me all they could. I do believe that most of what I have is fully due to them. My childhood began in a little town on the Córdoba Foothills called Unquillo, very popular nowadays. I had a very good time during my childhood.

Ojeda: You were born in Junquillo?

Bustos: No, I was born in San Nicolás de los Arroyos, in Buenos Aires. My father was a police officer and was reassigned very often, so much so that when I was one year old we had to move to Malargüe a town south of Mendoza just in front of your beautiful Talca.

Ojeda: Where did you attend High School and what experiences can you recall of that time of your life?

Bustos: My high school studies took place in two schools, both of the Salesian Fathers, as the first did not have the full six years cycle. The schools belonged to a system linked to the university and the plan was to graduate as bachelor and public accountant, two parallel specialties at that time; this must have changed by now. The first four years at a school in the San Vicente neighborhood and the last two in a school next to the Maria Auxiliadora Church in front of Plaza Colón both in Córdoba.

Both myself and my schoolmates of that wonderful period (our graduation took place fifty years ago and 11 survive from 14) have asserted the formation received from the Salesians. They taught us to be critical about what we read or heard and emphasized independent thought.

Figure 1. Oscar Bustos in his first communion in 1955 in Nuestra Señora de Lourdes parish, Unquillo, Córdoba, Argentina.

Vallejos: At what time of your life did you show interest in mathematics?

Bustos: My interest in mathematics started during the last year of high school, motivated by a fatherly priest (who is surely not around any more, Father Yoryeta), who was my Trigonometry and Introduction to Analysis teacher. He awoke my enthusiasm, telling me that I had aptitudes for mathematics. However, I first leaned to Physics, but when I entered the IMAF (Mathematics, Astronomy and Physics Institute), not a year had passed before I chose mathematics.

Figure 2. Oscar Bustos (near to the flag) in a closing ceremony of the academic year of the San Antonio de Padua school, Córdoba, Argentina, 1958.

Ojeda: Was there a special reason for you to decide studying at FAMAF in Córdoba?

Bustos: I started my University studies in 1965. The FAMAF did not exist then, it was the IMAF because there were not enough students for a Faculty. It answered directly to the Board of the Universidad Nacional de Córdoba. The "fatherly priest" I mentioned before had advised me to study at the IMAF.

Vallejos: How did your interest for statistics arise, when you already were a Mathematics student?

Bustos: My interest arose after graduating in Mathematics in 1970. There was great social effervescence in Argentina at that time and the university was a sounding board of that effervescence. Many of us wanted to contribute our academic preparation to applications, to be useful to the community. So I began to think what field would be fitting and

Figure 3. Oscar Bustos receiving his high school diploma in 1962 from the San Antonio de Padua high school. Oscar Bustos received an award for being the best overall student. He received the award from the parents representative. Fathers Oscar and Frank are accompanied.

in my opinion statistics is obviously the field of mathematics whose application is most immediate. My interests then led me, starting from probability and ending in statistics.

Ojeda: We know that while you were a student the country was going through a difficult situation. Can you tell us if that affected your course of action as a scientist?

Bustos: Of course it did affect it, a great deal, it affected all of us. The situation before the coup d'état became very complicated all over the country but especially in the big cities and therefore in the institutions located in them. I did try, with great effort, that those events should not affect my professional life. University students at that time participated actively in social questioning of the whole system. I had already left FAMAF in 1976 before the coup d'état, due to a situation that exceeded the limits of the people at FAMAF themselves. It was rather a problem that arose at a political level within the university. After leaving FAMAF I began work at the Universidad Nacional de San Luis and I was there when the coup d'état exploded. That situation and also my father's advice, made me think about leaving the country as soon as possible. I also knew that more possibilities would be open with a Doctor's degree. So I tried to graduate as soon as possible and was lucky enough to do so in 1978. Then, a colleague asked me: "You are a Doctor now, when are you leaving?" Because that was what we all did at that time. After deciding to leave, my professional life became much richer, thanks to the very valuable and unforgettable support I found in my Brazilian colleagues and of course in Brazilian institutions. Maybe, as a popular saying goes: "there is a silver lining to every cloud".

2. Doctorate student

Ojeda: Can you tell us why did you decide to follow your doctorate in Mathematics at the Universidad Nacional de San Luis?

Bustos: Before going to San Luis, I was already interested in following postgraduate studies somewhere, I even thought about going abroad, but whose were very difficult years to obtain scholarships or to go away. I decided to follow the doctorate studies in Mathematics at the Universidad Nacional de San Luis, because I was in the teaching staff of that University and I thought that the professors who ran that program were of a very good level.

Figure 4. Oscar Bustos and his parents, Charles and Teresa in 1965 in the Sierra de Tandil (Moving Stone Park), province of Buenos Aires, Argentina.

Ojeda: Was there a doctorate in Mathematics at FAMAF at that time?

Bustos: No, there was not. For that reason, at that time many colleagues followed doctorates in other places. The Mathematics doctorate started in the 80' decade.

Vallejos: Who was your thesis adviser and how did you establish your first contacts with that scientist?

Bustos: I contacted Doctor Victor Yohai, thanks to the professors here, he is an outstanding probabilistic and statistics practitioner (a short while ago I had the honor to give a lecture in a Workshop held to honor of his 75 years; he still has the same spirit and enthusiasm that he had when we met during the 70's). I contacted him while I was in Córdoba and he in Buenos Aires where I traveled quite often, thanks to my father's help, since there were no funds at the University, not even for telephone calls. Dr. Yohai told me that in Time Series there was a lack on research about the Robustness of that model and that I could work with Doctor Ricardo Maronna, who had also been his student. Then I told my colleagues at the Universidad de San Luis, as I had signed a contract with them and the Head of the school had mentioned before that they had a doctorate program and he

hoped that I could follow it. So there was a sort of engagement on my part, although the contract did not state it. The Universidad de San Luis was also very helpful as it engaged Dr. Ricardo Maronna as visiting professor, this allowed us to see each other frequently and advance more quickly in the thesis work.

Vallejos: Did you ask Dr. Ricardo Maronna to be your thesis adviser?

Bustos: Yes, I did ask him to be my tutor, but it was truly Víctor who put us in contact. All three of us are friends and I have always found goodwill on their part for my professional growth.

Ojeda: Was there some special spur that made you decide to develop your thesis on Time Series and Robustness?

Bustos: Really, Time Series and Robustness was recommended by Ricardo and Victor. Very little had been done at that time, about Robustness in Time Series (I am talking about the 70's). There was some work by Douglas Martin, for autoregressive moving average models of the first order only. So they suggested that I should work on it and see if some results could be obtained about extending the idea of robustness estimators to the case of mobile median autoregressive moving average models. I had some luck in my research and could obtain a few interesting results, always guided and oriented by Ricardo and Victor. Some of the results on Asymptotic Theory were published by the German Probability Journal.

Vallejos: Once you finished your doctorate, were there any possibilities to work here in the Argentine?

Bustos: No. It seemed extremely difficult. When I finished my doctorate in 1978, I intended to obtain work abroad. All my colleagues who had any possibility to leave went abroad. It was a difficult situation not only from the political aspect but also social and economic, which was worsened by a political régime that did not fulfill one's expectations, so it was very difficult to stay.

Ojeda: The results of your theses were very relevant, as they were published as a paper in the JASA. How did the experience of publishing the results of your thesis go?

Bustos: The work published in JASA was together with Víctor Johai. Although there are results from my thesis, I consider that the Victor was the main author, I just collaborated with him. It was a very nice work, fundamentally based on simulation. At that time there were no PCs (I was at the IMPA, also thanks to the letters of reference from Ricardo and Víctor) and there Víctor and I had at our disposal the possibility to link with a very potent system, the CNPq of Brazil. This institution is similar to the CONICET of Argentina or CONICYT of Chile.

It was an unforgettably good experience for my professional formation. It left a lasting mark upon me and we still are going on with the results that can be deduced from that work, because I believe that the field for Robustness is still very wide.

3. Professor at the FAMAF

Vallejos: We know of your strong links with the Faculty of Mathematics, Astronomy and Physics of the UNC. How was your teaching experience in that institution before you obtained pour postgraduate degree?

Bustos: There was a shortage of teachers that time; so we were set to teach some subject as soon as we graduated, and I started to gain experience from the first year after graduation. It was a good experience for me, I am not so sure if it was so for my students.

Ojeda: Was that a full time contract?

Bustos: Yes, at that time we still enjoyed a good situation, I am talking about the 70's, before things fell apart. It went without saying, you graduated and you had work at once. So much so that I passed my last subject on December 28, 1970 and finished my exam at noon. Then about three in the afternoon the Head of the Mathematics Department told me: "Oscar, we have already asked for a position of first assistant, full time contract for next year". That was not because it was me, that was truly done with everyone who graduated during those years.

Ojeda: How long did that connection last?

Bustos: I began in 1971 and left in 1976 due to the worsening of the situation at the Universidad Nacional de Córdoba. In that year I thought about going somewhere else and unfortunately leave FAMAF so I went over to the Universidad Nacional de San Luis.

Ojeda: Can you tell us what factors made it possible your incorporation as tenure professor of the FAMAF in 1992?

Bustos: As it happens in our countries that live pendulum situations, sometimes we are alright, other times we are badly off. At the end of the 80's Brazil was going through a very difficult economic situation, an inflation well beyond what I have lived in other places even worse than the present one in the Argentine, of the order of 40% monthly. This broke up anyone's salary, especially the salaries of research people, who have never been strong on unions; what we do does not interests politicians - at least not immediately. On the other hand, I traveled frequently to the Argentine to visit my family and FAMAF. Each time I showed up they made me give a lecture until some FAMAF colleagues told me: "Look Oscar, we would like you to come back". This I took to heart and the small stability period that took place at the start of the 90's in the Argentine made me decide to come back. Besides, my parents were much older and my family was all here. I have always remembered the IMPA specially and Brazil in general as a very hospitable country that gave me all it could during those years.

Vallejos: How was your start and experience as Head of the FAMAF Probability and Statistics group?

Bustos: The Probability and Statistics Group was already functioning with young people, recently graduated and others who were finishing their studies. It was thought that the more people would join the group, it would grow stronger. I do not know if, carried away by that enthusiasm, they chose me to be responsible for the Probability and Statistics Group, a work that I took much to heart. I felt very comfortable due to the strong support I found and still find among those that formed it and continue in it. Twenty-two years have gone by and they chose me again at the last election, so it seems that something has been useful and can be appreciated in the development of statistics here at FAMAF.

4. Robustness and time series

Ojeda: At the present time, what scope and implications do you envision for time series studies?

Bustos: Time Series in general and Robustness and Time Series in particular have a growing timeliness due to the ever wider horizon of the disciplines that feed on their methods. For example, I have received from the Zentralblatt Mathematik a request to write an introduction or commentary on two books, both edited in 2013. One of them states the new concerns about Time Series, especially non linear time series, and the other book deals with Robustness in Time Series, but delves deeper in the part about prediction, so it shows that relevance is strong. Those books are mostly oriented to research; this makes me think that it is a current issue. In my very specific case, I believe that the methods or

techniques that one uses for time series can somewhat be extended to stochastic processes, when space is the index, that is to say, they are bi-dimensional, but transcription is not direct in those processes, as in space we do not have the facility or the order given by time. I think this is a nice challenge for a mathematician as the extension is not so direct.

Vallejos: Within Statistics, can you give us your vision as regards the role of Robustness in the field of the applications?

Bustos: I see Robustness as the technique that is used to face a more realistic methodology, more founded on what one can know about a physical, economic or social process. This, without assumptions that are difficult to adopt, especially Gaussianity, of which from the classic point of view many techniques are known that work well when we have that hypothesis; that is to say the variables are normal. But when the processes appear in practice in spatial series, stochastic, Markovian processes are studied, etc., it is not quite so evident that hypothesis can be supposed. So I believe that Robustness appears as a tool necessary for a correct analysis and I see that the awareness of such a need is growing all the time, not only among people who use statistics. This is good, because some times it is difficult to convince someone about a technique when that person does not have any problem; and one of the things we have to be careful about is not to solve a problem for someone who does not have it.

5. Image analysis

Ojeda: You have been a forerunner in the area of statistic processing of images in your country and in a large part of South America; can you tell us how you leaned to that field of study?

Bustos: My first steps in the processing and statistical analysis of images began in 1988, due to the influence (still present) of Dr. Alejandro Frery of who was a student for the Master in Statistics at IMPA and whose thesis referred to a method important in that field. Alejandro went on to his doctoral thesis at the INPE (Instituto Nacional de Pesquisas Espaciais) the powerful Space Agency of Brazil. I had the great advantage of being his thesis co-director together with his tutor Dr. Nelson Mascarenhas an international figure in this field. I could not let go of the issue, as it had stimulated me. The more so as I see the need to try to fit Robustness in Statistics to all image processing techniques, especially remote sensing.

As I said, I began to be interested in this issue around 1988 due to the influence of a very good friend and colleague, Dr. Alejandro Frery, who was at the time with me in the IMPA; he was following the Master in Statistics. I do not know how, he had been in contact with people from a Danish university that was interested in Markovian processes that could be applied to the statistical analysis of satellite images. Alejandro had in turn contacted the people at the Institutio Nacional de Pesquisas Espaciais (INPE); the Brazilian Space Agency. Alejandro (who is an engineer) asked me to give him a hand in his master's thesis for the IMPA, to analyze its formal aspects. I became enthusiastic about the subject and could not thrust it aside. When Alejandro finished his Master's, he started his doctorate at the INPE which is an exemplary institution as regards research and application of spatial research. It was then difficult to let go of the subject and here we are, still at it.

Vallejos: Can you tell us how your link with the CONAE has developed?

Bustos: When I returned to the country in 1992, I had the idea that it was important to get in contact with someone who would be doing what the INPE does. Before my arrival, I knew about the existence of the National Commission of Space Activities (CONAE). In the 90's CONAE had started its space program. I contacted people at Falda del Carmen,

where the images downloads station of CONAE is located, and I had the pleasant surprise to find that many of my colleagues from FAMAF, especially from the physics area, were working at CONAE, which make me become even more interested in the subject. CONAE received me very well, I even had an offer to join the staff but I preferred to stay in the university, because I like that environment and especially that of FAMAF. I keep up my links with CONAE but rather carrying out work as consultant, professor or advisor especially at this time, when CONAE is thinking of offering three new masters as soon as possible. They would be added to those of AEARTE (Master in Space Applications of Alerts and Early Response to Emergencies) and we are all involved in that. At present, I am one of the two representatives of the UNC in the Gulich Institute, Managed together by CONAE-UNC.

Ojeda: As expert in the area what future can you foretell regarding the incursion of mathematical statistics in image processing?

Bustos: I see it as a field with a very wide application, there will always be a greater number for people to join the research in mathematics in the field of application to image processing. Especially taking into account that when one says "images" nowadays, with the technological advances we have had, it is possible to think about all fields of endeavor. But fundamentally satellite images are requiring greater attention from several disciplines, which opens a wide panorama for the development of formal methods of image processing.

6. Doctorate students

Vallejos: As adviser of Doctors, what are the main challenges that, according to your opinion are faced in this difficult work?

Bustos: In my opinion, one of the most important challenges that someone who is orienting a doctor's candidate in his thesis must face, is to remain up to date in more than one subject. Since nowadays, with the amount of information we receive, it is difficult to select and keep up to date, which implies continuous commitment to that aspect of our profession. It is clear that the challenge is much greater the more "closed" is the research field about a certain subject. In this sense, Mathematics and Statistics in the Processing and Analysis of Images have wide fields not yet fully explored.

Ojeda: Do you keep track of how many doctorate students you have formed up to now? And Masters?

Bustos: Up to now I have guided 11 doctorate students. There were many Masters because at the IMPA, where I worked for 11 years, there were postgraduate students only and at that time we had the Master in Statistics, so I have had many Master's students. I have very good memories of all of them. One of them is the president of the Brazilian institute of Economic Geography, an outstanding student, very good friend and I remember even now the subject of his thesis "Statistical processing with Computing". Dani Gamerman was another of my students, who I see as one of the front line researchers in the Time Series field. So I feel very satisfied about my students - possibly forced to be my students as they had no other choice - but for me it was a very happy period of my life; I shall always have fond recollections of IMPA and its people.

Vallejos: What advice would you give to a professor that has in charge the formation of a doctorate student for the first time?

Bustos: Well, besides the advice of keeping up to date, I would say that it is very important when setting up a problem, study a little bit and analyze very carefully the degree of difficulty, the complexity and the possibilities of the problem, so as not to fall into the pit of setting a very difficult problem, which no matter how interesting is very complicated.

Figure 5. Oscar Bustos, her daughter Alejandra and grandchildren Thomas, Martin and Paul (left to right) on the occasion of receiving the diploma Plenary Lecturer at the National University of Córdoba in 2006.

Mathematics is full of them and especially the applications, so one must be very careful. A short while ago I set up a problem to someone, fortunately after a short time we realized that matters would become very complicated, but that we could set up something as interesting as well without the need of spending two years not being able to do anything due to the difficulty of the theme. That's the most important. Keeping up to date an analyzing the difficulty of the problem that one sets up.

Ojeda: How was you relationship with the doctorate students after they graduated?

Bustos: Most of the time I keep up the relationship, in others geographical distances have prevented me from keeping them up. But in general, I have been able to establish not only an excellent professional relationship (which continues in most cases) but that of a solid friendship, which is what I value the most. One builds a link and in some cases there is a difficulty in the relationship established between the doctorate student and his tutor; more than a professional relationship a human relationship, and sometimes humans do not understand each other so well, which makes the relationship to fail, even professionally, so one must be careful. I have been lucky to find very good people along the way.

7. The development of statistics in the Argentine

Vallejos: Do you consider that the development of statistics in the Argentine is in step with the needs of the country?

Bustos: Well, much has been done in the development of statistics in the Argentine, But I believe that it is still far from the needs of the country, we have not reached the level that it would be nice to have. There are many factors that incident in the development of statistics, first the lack of use of statistics in the country on the part of the companies; second, on the academic front, only now is there an awareness of the importance of the development of statistics, and some more value is given to what is being done in that area, for example, the number of post degrees is scarce and we really would need quite many more. Of course, it must be taken into account that it is not practical to create post degree programs if there is not infrastructure to support them, and fall into the temptation of creating real something that is not useful for development.

Ojeda: What is you opinion about the quantity and quality of statistics post degrees in your country?

Bustos: The quality is very good but the numbers insufficient, we should create conditions for the development of those post degrees in a more sustainable manner; not only in the economic aspect, but also in the aspect of support for publications, research, etc. We must possibly be patient; no post degrees should be created to be merely "bureaucratic solutions". Before their creation somewhere, it is necessary to be sure that there shall be a sufficient number of professionals able to guide post degree theses staying at that place.

Vallejos: Besides the academic links, do you have good friends among mathematicians/statisticians?

Bustos: Yes of course, I consider all those who have worked with me as my friends, they have helped me (and still do) a great deal in my professional growth. Especially when I returned to the country, people who did not belong to the statistics field gave us the possibility to install this subject at FAMAF. So I have several acquaintances with whom I do not work professionally, but we are fast friends.

Ojeda: During your long academic career you must surely have attended many congresses and scientific meetings. Could you let us know some anecdote or happenings that you have encountered in them?

Bustos: I have attended several congresses and scientific meetings, mostly in Argentina, Brazil and Chile. One of the anecdotes I remember is that of the Coloquios Brasileiros en Matemática; those took place during one or more weeks at Poços de Caldas: we were secluded in a beautiful hotel to talk about mathematics. All fields were present, probability, statistics, unfortunately that ended due to the cost. Nowadays I attend congresses strictly related to image processing only, so I abandoned that wider participation. But I believe that congresses which attract young people and where courses are offered, are very important as they are very positive for the building of personal contacts.

8. Relationship with Chile

Vallejos: When was the first time that you visited Chile and who were your contacts?

Bustos: The first time I visited that beautiful country, our sister republic of Chile was in December 1990, invited by my great friend Dr. Héctor Allende Olivares, who contacted me. When he was in Germany, with somewhat confused geography they told him: "Bustos is Argentinean, he is in the Argentinean Rio de Janeiro". So Héctor contacted me, we met in Brazil in 1988 and he told me: "I would like it very much if you could accept". Then,

the first time I visited Chile I dictated a course on Robustness at the Universidad Federico Santa María, and I continued with frequent visits of which I am very proud.

Vallejos: Manuel Galea was your student?

Bustos: Not my direct student, but I participated in his thesis dissertation and he is a great friend of Chile.

Ojeda: We understand that you have visited Valparaíso many times. Is there some place in Chile that you particularly like?

Bustos: Valparaíso is a very picturesque city. Viña del Mar adds to its beautiful landscapes all the comforts of modern life and I think it is the most favorable sector to live due to its organization. Concepción is another nice place I have visited. The whole Biobio region is beautiful, I have unfortunately not been able to travel further south; I shall do some time, maybe when I retire.

Vallejos: The Argentine and Brazil have had space policies since some time already. In Brazil there is the INPE and CONAE in the Argentine are centers of great usefulness for the country. In Chile, only in 2013 was there a project started for space development up to 2020. In your opinion and as we understand that you have developed projects at CONAE, what advantages are associated to the creation of this type of agency?

Bustos: Doubtless, to have scale images obtained by satellite sensors, is of great usefulness for many activities. The costs of implementing a space policy, however small, are enormous. It is necessary to rely on a huge international cooperation from of space agencies of other countries for a sustainable development. Among the advantages that I see about the existence of a space agency in the country, there is doubtless the preparation of professionals in various disciplines for a better use of the natural resources and, no less important and ever more urgent, the care of the environment. I believe that our sister country Chile does not have a space agency yet and that the possibility should be studied. What I know about image processing in Chile is very specific, very restricted; some universities in Valparaíso have groups who download spot images to help the fisheries. In the south, at Concepción, there is a laboratory that works on frontier patrol, but those are very sporadic efforts. Hyper-spectral images are also being used for forestry research.

Ojeda: What is your opinion about the development of statistics in Chile?

Bustos: In proportion to the number of inhabitants and territory, I believe that Chile is far ahead of the Argentine in the development of statistics. The most important Chilean universities have very strong statistics groups (not only in Santiago, but also in cities in the north and south); this does not happen in the Argentine (Only in Buenos Aires, Córdoba, Río Cuarto, Rosario and that is all). I do not know the reason for this historic phenomenon but that is what one can see at present.

9. Some last questions

Vallejos: Could you address some words to young researchers who are starting their careers?

Bustos: For those who are starting in the research field, specifically in our country, there are advantages on the one hand, which is the fact of being able to benefit from scholarships, we did not have that in the past. But the research field has opened very wide, the number of researchers has grown and competition is harder. Mi advice is that they should go as quickly as possible to those places where the subject they have chosen is better developed, this should allow for greater growth. To be physically present in that place would be ideal. But not living where there is a research group is not a very serious difficulty anymore, with the Internet and the communication media.

Ojeda: It is said that young people do not choose hard science careers so often now, due to their difficulty. What can you say to motivate the new generations?

Bustos: I have thought about this phenomenon for a long time now, and it has specially drawn my attention. For example, last year here in Córdoba the provincial government granted economic help scholarships, nor very important but help nevertheless: they were not distributed as there were no interested parties. This makes me think about the attitude of our society regarding mathematics or the hard sciences subjects, this results in people looking with admiration when someone studies mathematics, as a being from another planet. It is true that the study of hard sciences is difficult, but one should not feel to be incapable of studying, everything is possible with effort, dedication and patience. But maybe the difficulty of finding work in those disciplines contributes to the lack of enthusiasm of our young people. This is due to the entrepreneurial attitude in the Argentine, there is little interest of the enterprises to get in contact with the university. I believe that this is changing lately, but during many years the companies preferred to buy everything ready made (software, research) and act solely as distributors of products from their head offices. This attitude is far from the development in leader countries, the United States, Europe or other places in the Southern Cone. Chile and Brazil are examples of successful link between enterprises and the university something that has not been fully achieved here. Maybe that is what has led to the lack of interest in hard science of our students.

Vallejos: We know that your grandson Martín is following his Mathematics career at the FAMAF. What does this mean for you?

Bustos: It is a two-edged sword. On the one hand, I feel very happy that Martín is following in my profession, because I believe that one of the ways one can help one's skin, is precisely to help them to follow the ever harder route in society and in the economic aspects. On the other hand, I am conscious of a danger stalking me, of yielding to the temptation of transmitting my frustrations and professional expectations to Martín. One must be very respectful and careful not to fall into that, although it is difficult, because one has always seen him as a child, as if he belonged to oneself. Sometimes it is not easy to leave this natural aspect aside, which is human, because one expects that ones descendants may help in future. But on the balance, I believe that I feel very happy to be able to contribute to his professional growth, in a career that he chose without any family pressure to do so.

Ojeda: What are your future projects? Would you be interested in keeping up a close relationship with FAMAF after you retire? As Consultant Professor, for example?

Bustos: I have many projects, but I am not giving much time to them, due to the commitments one has as a teacher, there are many and I like them all. But as the saying goes "do not bite more than you can chew", so it is difficult to be involved in all the projects; I must limit myself.

On the other hand, I do not wish to retire soon; I know that I must retire within three years, because in our régime one cannot have a constant or permanent relationship after turning 70, so that is an aspect that I must take into account. Besides I especially like the working atmosphere at FAMAF. However, at the time that I shall retire, I would like to continue as I do now, although I know that everything is not possible, due to regulations, but in some way keep up my links with the people at FAMAF. Above all in the formation of students; this is something interesting for me.

Vallejos: Mathematics departments have several areas and a political problem arises when it is decided how they shall develop, because one always thinks that one's field is the most important for the university. We would like to know how it is possible to handle this, as decisions may not always be favorable.

Bustos: You have to understand this clearly, you must think about others, sometimes relationships go wrong because one believes that what one does is what has to be done. But

one should be prudent and think that harmonious development is what must be sustained. In this sense here at FAMAF and especially in our group, this develops reasonably, within the limitations in the management of an institution, there is the lack of financing, the lack of positions, etc. This makes us fight sometimes to get the few resources available, but there our spirit must take over of taking care for the harmonious development of the whole before our own field, as the most important thing is that the working place must be pleasant and it is important to keep that in mind before going ahead with what one believes must be done.

Acknowledgements

We would like to thank Andree Goreux for assisting with the preparation of the manuscript and the editor of the Chilean Journal of Statistics for the constant support.

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Comments on: A conversation with Oscar Bustos

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Abstract

This is a personal tribute to Oscar H. Bustos to acknowledge his contribution to the development of the Image Processing and Remote Sensing in the Argentinian science. His invaluable knowledgeability has impacted in the academic life and the effect of his example will perdure through many academic descendants.

It is a great privilege to pay tribute to Oscar H. Bustos scientific achievements and to his invaluable contribution to the development of Statistics in Argentina. I have known Oscar since a few months after he returned in 1993 to Cordoba, Argentina, to join the Department of Mathematics at Faculty of Mathematics, Astronomy and Physics (FaMAF). Oscar had returned to Cordoba after a long stay at the Institute of Pure and Applied Mathematics (IMPA), Brazil. Coincidentally, I had also returned to Cordoba to join the Department of Mathematics at FaMAF a few months after Oscar and shortly before defending my doctoral thesis at the University of Buenos Aires under the supervision of Víctor J. Yohai. We have landed up at Famaf, the institution in which we had started our endless relationship with Math; we were "academic descendants" of Victor Yohai (Oscar did his doctoral thesis under Ricardo Maronna, himself a student of Yohai) and we have both worked on Robust Statistics (Oscar's doctoral thesis was on robust time series analysis). Perhaps because of our common background and interest in Robustness, Oscar and I have shared many points of view about Statistics. The scientific conversations with Oscar have always been illuminating and stimulating.

After the political turmoil of the early seventies in Argentina, Oscar set off to Brazil, where he stayed for 14 years. He initially spent one year at the Dept. of Statistics of the Federal University of Pernambuco and afterwards, he was hired as researcher at the prestigious IMPA where he spent 12 years. He came back in 1992 thanks to the effort of some of his colleagues at Famaf who were convinced that Oscar's return was going to be instrumental in invigorating Statistics at the institution. These visionary colleagues were not mistaken: indeed Oscar established and leaded research in the fields of remote sensing, image processing and pattern recognition at FaMAF. These areas, which had been vacant in Argentina until Oscar's return to the country, flourished under his influence. Oscar has leaded a strong multidisciplinary scientific network of researchers from Mathematics, Engineering, Physics and Computer Science. In most of his research work, he blended

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ISSN: 0718-7912 (print)/ISSN: 0718-7920 (online)

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robustness (his early interest) and image processing. This resulted in ground breaking and highly influential scientific contributions since outlying observations are ubiquitous and a perverse problem in image processing data.

Oscar directed many doctoral thesis not only at FaMAF but also at several other Argentinean institutions. He had four doctoral students at FaMAF, three at the Faculty of Exact, Physical and Natural Sciences of the National University of Córdoba; one at the Department of Computer Science of the University of Buenos Aires and two at the Department of Mathematics of the National University of San Luis. He also directed many Master's thesis in several academic institutions of Argentina.

Oscar has regularly taught at the Masters in Applied Statistics and the Masters in Image Processing, both graduate degrees held at the National University of Cordoba. In addition to his teaching activities at FAMAF, he has lectured at many other academic institutions of Argentina. For many years now, he has regularly taught many courses at the Department of Mathematics at the National University of Rio Cuarto, where got several students interested in image processing. He has also taught at the National University of San Juan, where two of his former students are now full professors. He also lectures at a Masters program in Space Applications for Emergency Response and Disaster Management, run jointly by the National Council for Space Activities (CONAE) at Falda del Carmen, Córdoba, and Famaf. In fact, Oscar has regularly collaborated in research projects at CONAE . The analysis of images supplied by these collaborations have been a source of inspiration for the development of many of Oscar's statistical new methods in image processing.

Oscar never runs out of energy, he is always eager to learn new areas and teach them, even if this means teaching more courses than he is bound to. He is never intimidated by any content, no matter how hard or new this may be, so long as he finds the topic interesting or useful to somebody's work. For many years now, he has been involved in, and deeply committed with, the instruction of remote sensing and image processing for Computer Science students. In addition to teaching countless courses in this area, he has supervised many bachelor's dissertations in Computer Science.

Oscar is curious and eager to learn just about everything. He is blessed with a formidable mathematical talent and wisdom to distinguish the essential from the secondary. Many problems captivate Oscar's attention: from the abstruse questions arising from the world of philosophy or theology to new fields in Statistics or Image Processing. He enjoys dropping by his colleagues' offices to enthusiastically share with them his new findings, learnings and doubts.

Twenty two years went by since Oscar returned from Brazil to join FaMAF. Perhaps he did not dreamed of the exceptional endeavor he was going to attempt, laying the foundations of Statistical Image Processing in our country. Even now, he must not be fully aware of the extraordinary contribution he made to the academia. Like a laborious farmer, he set the seeds which would sprout nourished with his kindness, his knowledgeability and the strength of his beliefs. Undoubtedly, the harvest will be abundant.

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Comments on: A conversation with Oscar Bustos

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The task of addressing the academic merits for a mathematician of the importance of Oscar Bustos, is without any doubts, as difficult as pleasurable. The amount of his human values and academic merits are so huge, that any attempt of resuming them is really tough. I will try to center my comments to the most relevant points, and I apologize in advance, for all those points that I will have to omit.

For many years, unfavorable winds have blown for the research in mathematical statistics in this region of the world. "Let others create" was a slogan for many. In recent decades, this situation has changed, and if Latin American science is recognized today, it is thanks to the work of important researchers, such as Professor Bustos. Scientists, that apart from conducting exceptional research, have been able to invest efforts and sacrifices for the development of science and, in particular, of mathematical statistics in this part of the world .

My colleague and friend Oscar, was formed in the school of Argentine Mathematicians of the Universidad Nacional de San Luis, in the 70s, and then moved to Rio de Janeiro, Brazil, where he was responsible for leading the group of Probability and Statistics Institute of Pure and Applied Mathematics (IMPA), where more than fifty young Latin Americans were formed.

He started his research in the area of robust estimation in time series, where together with Víctor Yohai and Ricardo Maronna, among others, became one of the most important groups in Robust Statistics in Latin America and the world. It was thanks to an article by Professor Oscar Bustos, published in 1982 in the German journal "Zeitschrift Für Wahrscheinlichkeitstheorie und Verwandte Gebiete" (Bustos, 1982), that I could take contact with him and enter the field of robust estimation in time series, adding a result to the new class of robust estimators proposed by Bustos and Yohai in their article in the Journal American Statistical Association (JASA) 1986 (Bustos and Yohai, 1986). This result was published in the Journal of Time Series Analysis in 1992 (Allende and Heilerand, 1992).

That publication started my researching activities and changed my academic life, a life in which the thought of this Group of argentinean statisticians played a crucial role. The work of professor Bustos, inspired me to take interest in Robust Statistics, thus changing my view of statistics altogether.

The kindness displayed by my colleague and friend Oscar, patiently answering my letters and, at the same time giving me "clues" to find something new, helped me to find the topic for my doctoral thesis. The correspondence transformed soon from an academic to a personal level, and not only allowing me to contact a reputable scientific tradition, but also seing very early that the field of science can not be local, but necessarily global.

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ISSN: 0718-7912 (print)/ISSN: 0718-7920 (online)

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Moreover, the organization of the Summer Schools of IMPA in Rio de Janeiro in January 1990, allowed me to personally meet my colleague Oscar Bustos.

Thereafter, the relationship between Oscar and Chilean researchers has been permanent and very friendly, allowing frequent stays at the National University of Cordoba and visits to the Technical University Federico Santa Maria (UTFSM), Valparaíso, Chile.

Discussions with Professor Bustos, in Valparaíso, eventually convinced me that the theory of statistical inference is insufficient to deal with some common types of uncertainty in the data, since we are never sure of the distributional assumption. This happens in various real situations, because in the worlds of imprecision and uncertainty, there is easily a gain or loss of information. In these situations, it is not typical that Boolean decisions occur between statements that are inconsistent and contradictory, as in the quantum world.

Not only the long friendship with Professor Bustos, since 1990, is a great honor for me; but also that as a result of this relation, the adventure of robustness started in this country, exporting these concepts to other domains such as robust learning computer algorithms in Soft-Computing.

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Chilean Journal of Statistics
Vol. 6, No. 2, September 2015, 99–100

Comments on: A conversation with Oscar Bustos

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I met Prof. Oscar Bustos in January 1985 when I made my first contact with IMPA, in Rio de Janeiro. I was accepted for a summer course, and I enrolled Computational Statistics, which was taught by Oscar at the time. I distinctly remember a few passages which I believe are worth sharing.

First of all, Oscar's mastery of both mathematical and computational aspects of every single word he speaks. I have never met someone with such ability to produce fascinating ideas while, say, deriving the expected precision of algorithms for computing tail probabilities of an obscure distribution, how such distribution may be important for modeling a problem of interest, and how to implement a variety of such algorithms with elegance and efficiency. All these facets are natural to him, which does not mean that does not prepare his lectures with painstaking detail; I can attest to the quality and depth of the handwritten material he scribbles before going to class: our first article (Bustos & Frery, 1992a, incidentally, in this very Journal) and our book (Bustos & Frery, 1992b) are a direct result.

Second, his love and care for precise notation which leaves room for no doubts. As an example, he may say and write in the blackboard that every scalar will be denoted by lowercase letters $\{a, b, \ldots, z\}$, that vectors will show in lowercase with a tilde beneath $\{\underset{\sim}{a}, \underset{\sim}{b}, \ldots, \underset{\sim}{z}\}$, and matrices in uppercase letters $\{A, B, \ldots, Z\}$. If such objects are not deterministic, its stochastic nature will be made explicit by using uppercase letters, so we end up with real random variables $\{A, B, \ldots, Z\}$, random vectors $\{\underset{\sim}{A}, \underset{\sim}{B}, \ldots, \underset{\sim}{Z}\}$, and random matrices... but, wait, how will we denote them? Sure! Using blackboard bold uppercase letters $\{\mathbb{A}, \mathbb{B}, \ldots, \mathbb{Z}\}$! But remember to reserve $\mathbb{C}$, $\mathbb{N}$, $\mathbb{Q}$, $\mathbb{R}$ and $\mathbb{Z}$ for, respectively, the complex, natural, rational, real and integer sets. And what will we do if we need those letters for random matrices? Easy! Just cross them to differentiate, leading to $\not{\mathbb{C}}, \not{\mathbb{N}}, \not{\mathbb{Q}}, \not{\mathbb{R}}$ and $\not{\mathbb{Z}}$. Well done!

But the fun comes when one has to denote estimators. We usually put hats on top of these random things, so they should look like $\{\widehat{A}, \widehat{B}, \ldots, \widehat{Z}\}$ if scalars, $\{\widehat{\underset{\sim}{A}}, \widehat{\underset{\sim}{B}}, \ldots, \widehat{\underset{\sim}{Z}}\}$ if vectors, and, oh oh, $\widehat{\mathbb{A}}, \widehat{\mathbb{B}}, \widehat{\not{\mathbb{C}}}, \widehat{\mathbb{D}}, \ldots, \widehat{\mathbb{M}}, \widehat{\not{\mathbb{N}}}, \widehat{\mathbb{O}}, \widehat{\mathbb{P}}, \widehat{\not{\mathbb{Q}}}, \widehat{\not{\mathbb{R}}}, \widehat{\mathbb{S}}, \ldots, \widehat{\mathbb{W}}, \widehat{\not{\mathbb{Z}}}$.

And expected values? Remember that E and $\mathbb{E}$ are taken, and $\not{\mathbb{E}}$ is not a terrific idea. Calligraphic! Calligraphic! Let's denote $\mathcal{E}[\widehat{\not{\mathbb{Z}}}]$ the expected value of the estimator $\widehat{\not{\mathbb{Z}}}$ and, following this venue and since it is a random matrix, we will denote $\mathcal{COV}[\widehat{\not{\mathbb{Z}}}]$ its covariance matrix. Oscar has a deserved reputation of mastering Monte Carlo techniques, so his next step may be talking how to build such a numerical experiment for estimating these two last quantities using Brute Force, i.e., at the end of the day we will end up with $\widehat{\mathcal{E}[\widehat{\not{\mathbb{Z}}}]}(r)$

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ISSN: 0718-7912 (print)/ISSN: 0718-7920 (online)

http://www.soche.cl/chjs

based on r replications and $\widehat{\mathcal{COV}[\widehat{\mathbb{Z}}]}(R)$.

Mistake! Mistake! Mistake will cry those that do not know him. He used R instead of r! A spark will glow in his eyes, and he will promptly explain that r is the (fixed) number of replications, and that $R \leq r$ is a random variable which will control the second Monte Carlo experiment based on the Monte Carlo variance of $\widehat{\mathcal{E}[\widehat{\mathbb{Z}}]}(r)$, in other words, in $\widehat{\mathcal{VAR}[\mathcal{E}[\widehat{\mathbb{Z}}]}(r)]$ (which is, itself, an estimator).

The curious reader may imagine the notational marvels Oscar devices for teaching the Jackknife and Bootstrap methods. Oscar is not the most loved author among typographers, I have heard.

The serious reader may wonder why I wrote so many lines in such a tone. The answer is simple. I have no words to thank Oscar Bustos for what he taught me and still teaches me, and I am sure many people join me in this feeling. Beyond the talent, skills and abilities there is a man, a true *Renaissance man*, somebody who learned much, is eager to learn even more and, luckily for us, is even more eager to communicate what he has learned.

As an example, one should delve into his contributions to the area of Image Processing. Besides bringing new dimension to the importance of the mathematical rigor, he knew how to knit tightly very important connections between Robust Statistics, Statistical Modeling, and Numerical Analysis which are becoming the quality standard for those who are interested in that broad research area. He has also very nice introductory texts, and has taught a number of enlightening lectures that ultimately attracted new professionals who, otherwise, would not even dream of working with Image Processing.

And speaking about generosity, I cannot conclude this note without mentioning how eager Oscar is always towards sharing connections, a quality which is at the top of the list of endangered species of academic virtues. Thanks to him I met some of the people whose friendship and academic guidance I cherish.

I had the opportunity to learn a few things with him in these almost thirty years of friendship, and if I did not learn more was just because of my limitations. It is my belief that many colleagues join me in such feeling, and in a heartfelt *thank you* to Oscar Bustos.

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