INTERNATIONAL INDIAN STATISTICAL ASSOCIATION NEWSLETTER, SPRING 2006

Dear IISA members,

Greetings! It is my pleasure to present the Spring newsletter of the year 2005-2006. We are very happy to profile Professor Rabi N. Bhattacharya of University of Arizona in our "Chancy Life" series. It is indeed very inspiring to read about his illustrious career and equally illustrious contacts including the great Professor Mahalanobis! I hope you will find this very interesting too.

We are very excited to start a new series of articles in the newsletter called "Modern and Emerging Areas in Statistics". This is meant to be a non-technical write up of different areas of current interest which would be of interest to graduate students and researchers wanting to embark in a new direction! We would like to thank Prof. Bani N. Mallick to be willing to start off the series (on a very short notice) with an excellent write up on Bioinformatics. Please do let us know if you want certain topics to be discussed.

Please mark your calendars to attend **the Cochin meeting**. It is shaping up to be a very interesting conference. Please check out the tentative schedule of plenary speakers and invited sessions included in the newsletter. The newsletter also includes a call for papers for student competition (Chair: Professor Somnath Datta) and young researchers competition (Chair: Professor Dipak Dey).

JSM-2006 dinner at Seattle is being planned for Sunday, August 6. Details appear in this newsletter below. Please send your reservation to Professor Paramjit Gill as soon as possible.

The Nomination Committee for the IISA-President for the year 2007-2008 has now been formed. It consists of Professors Kirti Shah (Chair), Somnath Datta, and Bikas Sinha. The committee will make a call for nominations in due course.

If you have any news or announcements that you would like to share with other IISA members, please send them to me directly at rsundara@uncc.edu or to Professor Paramjit Gill at paramjit.gill@ubc.ca. I would like to thank Professors Paramjit Gill and Hira Koul for their help with this newsletter. Hope you enjoy this issue!

Best Wishes
Rajeshwari Sundaram (rsundara@uncc.edu)
Newsletter Editor
University of North Carolina at Charlotte

Table of Contents:

Report from Prof. Jogesh Babu, Editor in Chief of Statistical Methodology:

Statistical Methodology is now in its 3rd year. A special issue on Bioinformatics is brought out as Volume 3, Issue 1, in January 2006. The special editors for this issue are David Banks and Grace Shieh. They did an excellent job. We have enough accepted papers to cover all the four issues of Volume 3 (2006). To maintain the standards, only papers with good quality are accepted.

The journal is receiving a large number of submissions regularly to maintain the steady flow. Slow, but sustained, growth is key in getting well and truly established. It shows that the journal is meeting demand, and is in a growth area. This in turn, results in more submissions and citations, establishing a positive spiral. Main aim is not to sacrifice quality for quantity.

The publisher is in the process of getting an impact factor rating for the journal. To ensure ISI covers this journal, it is vital that we maintain our advertised publication schedule rigorously. Having a little stock of articles allows us to meet publication schedules regardless, and acts as a safety buffer.

IMPORTANT ANNOUNCEMENTS:

♣ **Student Paper Competition: From the Student Paper Competition Committee (Somnath Datta (chair), Sujit Ghosh, Ashis Sengupta)**

IISA will host a student paper competition in Cochin. Two awards will be given, one in the Theory & Methods category and the other in the Application category. All papers of substantial statistical content are welcome. Papers should be written in English with twelve point fonts and at least 1.5 interline spacing. The length of the paper should not exceed fifteen pages excluding table and figures. The primary author of an entry paper must be a graduate student at the time of the meeting. An entry should be accompanied by a cover letter and an endorsement by the applicant's major professor. Submission

should be made by E-mail as PDF files to somnath.datta@louisville.edu by September 15, 2006. The applicant needs to attend the conference for an oral presentation of his/her paper.

♣ **Young Researcher's Award: From the Young Researcher's Award Committee (Dipak Dey (chair), Sreenivasa Rao Jammalamadaka, Ravi Khattree)**

IISA is seeking nominations for the two Young Researcher Awards for 2007. The awards will honor two outstanding researchers, one in theory and one in applications, who will be under the age of 45 years by December 31, 2006. The recipients will have significant contribution in high quality research (theory, methodology or applied), and education. In order to be eligible for the award, the candidates must be a member of IISA.

Nominations should contain a cover letter explaining the significance of the research contributions of the candidates, along with a latest CV and other supporting materials, as appropriate. They should be sent to Professor Dipak K. Dey (dipak.dey@uconn.edu) by October 15, 2006 . Electronic submissions are strongly recommended. The awards will be distributed at the forthcoming meeting of the IISA in Cochin, India , between January 2-5, 2007.

♣ **IISA Biannual Conference January 2-6, 2007 at Cochin, India:**

The next IISA biannual conference to be held in Cochin on January 2 – 6, 2007 is shaping up to be an exciting one! The confirmed plenary speakers include Professor R. N. Bhattacharya (University of Arizona, USA), Professor Vivek Borkar (TIFR, India), and Professor S. R. S. Varadhan (Courant Institute, USA). So far, 28 special invited sessions in Statistics with a total of 84 talks and 8 special invited sessions with 24 talks in probability/operations research have been scheduled. In addition, there are 9 invited sessions with a total of 33 talks in Statistics and 3 invited sessions in Probability/ Operations Research. There will be also a workshop given on Financial Mathematics organized by Prof. S. T. Rachev (University of Karlsruhe, Germany) in collaboration with Dr. Sebastian Kring (University of Karlsruhe, Germany) and Dr. Christian Menn (Cornell University) on January 6 which will be open to all the conference participants as well as to others who might register just for the workshop. A list of confirmed sessions with the session titles is included in the last page of this newsletter. There will be a few sessions of contributed papers and those wishing to present such papers should contact the Program Chair S. R. Jammalamadaka (rao@pstat.ucsb.edu) or Co-Chair P. G. Sankaran (pgsankaran@cusat.ac.in).For further information, please go to http://www.stat.osu.edu/~hnn/IISA.html.

♣ **Multivariate Methods in the 21st Century: The legacy of S. N. Roy**

This international conference will be held during December 28-29, 2006, at Kolkata, India, in celebration of the birth centenary of Prof. S.N. Roy. The International

organizing committee consists of Professors J. K. Ghosh, K.V. Mardia, S. P. Mukherjee, P. K. Sen, K. Shimizu, and the principal organizers, Professors Barry C. Arnold and Ashis SenGupta. It will be preceded by a Workshop on Multivariate Methods during Dec 23-27 at Indian Statistical Institute, Kolkata. The conference is being held under the auspices of Indian Statistical Institute and in collaboration with several academic bodies. A limited number of contributed papers may be presented, the deadline for receiving abstracts of which is September 30, 2006. Further details are available from: Barry C. Arnold, barry.arnold@ucr.edu and Ashis SenGupta (ashis@isical.ac.in; ashis@stat.ucr.edu).

♣ A note from Prof. Bovas Abraham, President of International Society for Business and Industrial Statistics (ISBIS):

This is a new section of ISI (International Statistical Institute). An ISI member can join ISBIS free of charge if he/she is not member of another section of ISI. You can just e-mail MMLY@cbs.nl. If one is not an ISI member then one can still join ISBIS by filling an application form available at the website mentioned below. More information about ISBIS can be obtained from www.stats.wits.ac.za/isbis or by contacting Professor Bovas Abraham, University of Waterloo (babraham@uwaterloo.ca).

♣ Indian dinner on Sunday, August 6, 2006 at JSM Seattle:

As you all know, the Joint Statistical Meetings this summer will be held in Seattle WA, at the Seattle Convention Center during August 6-10, 2006. The annual IISA dinner during these meetings will be held this year on Sunday, August 6, 2006 at 'Pabla-Cuisine of India,' a fine dining restaurant located within 10-minutes walking distance from the Seattle Convention Center.

A carefully planned sumptuous menu (listed below) has been prepared for the Buffet type dinner. The restaurant has a seating capacity of 70 seats only. Dinner will start at 6:30 pm and will go on until all choose to disperse. The restaurant has been fully reserved for the night, exclusively for IISA dinner participants. Thus, there will be plenty of opportunity for everyone to mingle freely as long as they please.

The cost of the dinner is US $25, per person regardless of age. No charge for children of age below 5 years.

At this time, we would like to request everyone to reserve the required number of seats for the dinner by sending e-mail to: paramjit.gill@ubc.ca by June 15, 2006. Tentative menu includes Samosa, Pakora, Tanduri chicken for appetizers and unlimited Coke, Mango Lassi, Coffee and Tea. The main entrées include five vegetarian dishes (Dal Makhani, Navratan Kurma, Eggplant Bhartha, Kofta Dilbahar, Kabuli Chana) and a non vegetarian entrée (Pabla Special Lamb Kurma). Rice (Plain as well as Pilaf), Naan (Wheat, Garlic), and Bhatora are also included. For dessert, Rasmalai, Mango Ice cream and Fruit Bowl (mixed fruit). In addition, the following items will be available on the buffet table: Green Salad (Red Onion, Lettuce, Tomato), Raita, Mint Chutney, Sweet

Chutney, Mixed pickle, Hot Sauce. Alcoholic drinks may be ordered by your own.

Contact information for Pabla-Cuisine of India (http://pablaindiacuisine.com/), Tel: (206) 623 2868, Email: pablajas@yahoo.com. It is located in the heart of Downtown Seattle at 1516 2nd Ave, # 101, Seattle, WA. 98101. It is near Pike Market on 2nd Ave. between Pine St and Pike St. Parking is readily available on street parking within the same block. Also, several paid car-parks are available

♣ **International Conference on Statistics and Informatics in Agricultural Research (27-30 December, 2006):**

To celebrate the Diamond Jubilee of the foundation of Indian Society of Agricultural Statistics, the Indian Agricultural Statistics Research Institute (IASRI), New Delhi is organizing an International Conference on "***Statistics and Informatics in Agricultural Research"*** during 27-30 December 2006 at New Delhi, India. Professor C.R. Rao would be the Sessions President and would also deliver the keynote address. The main session themes include Statistical Applications in Agricultural Research, Emerging Issues in Areas of Basic Statistical Research, Agricultural Informatics, Statistical and Computational Biology in Agriculture, Statistical and Economic Issues for Prosperity of Rural Community, Human Resource Development for Agricultural Statistics and Informatics. The deadline for paper submission is 31st August, 2006 and the notification of acceptance will be sent out by 30th September, 2006. Submissions can be made via email to the Chair: Dr S. D. Sharma (**sdsharma@iasri.res.in)** or to the co-Chair Dr V. K. Gupta (vkgupta@iasri.res.in). For further details, visit the conference's website: http://www.iasri.res.in/icsi2006

♣ **A note from Subhashis Ghoshal, an editor of Electronic Journal Statistical Survey:**

A new fully electronic journal ``Statistics Surveys'' is being introduced. A proposal to sponsor the journal has been submitted to the IMS, and is expected to be approved soon. Other major statistical societies like Bernoulli Society and ASA are also expected to co-sponsor this journal. Please see announcement page
http://bibserver.berkeley.edu/proposals/statsurv.html

There are some remarkable features of the new journal
i) extremely broad scope - all areas of statistics are covered
ii) papers could be theoretical, methodology, computational, applied or case studies
iii) papers could be original, review type, classical, teaching related etc.
iv) no constraint on size
v) papers are peer reviewed to ensure accuracy and scholarly quality, but instead of receiving an accept/reject type decision, most papers (which genuinely contribute something) are expected to be finally accepted after revision.
vi) fast reviews and no backlog once accepted
vii) has the backing of most major statistical societies.

viii) large editorial board means that your paper will find a suitable editor who knows the topic.
ix) free and open access to the journal means widest possible circulation.

As one of the editors, I solicit papers from you. The articles could be original or some review article on your area of expertise. If you have further questions, please do not hesitate to contact me at ghosal@stat.ncsu.edu.

My Chancy Life as a Statistician: Professor Rabindra N. Bhattacharya

How It Began. When I was growing up I never thought I would be a statistician, or a mathematician for that matter. I graduated from high school in 1952. In West Bengal this meant passing a state wide examination following the completion of the tenth grade. It was my ambition at the time to become a Sanskrit scholar, although I was not of a religious bent of mind. I had a wonderful Sanskrit teacher in high school, Krishna Chandra Gangopadhyay, who would not only teach us the rigors of the Sanskrit language and grammar, but would also recite freely from Kalidasa's dramas. Some lines from his sonorous recitation from Raghuvangsha still ring in my ears. However, my father and my eldest brother were strongly against my getting into the arts and studying Sanskrit. As a family of refugees following the partition of India, we were still struggling for economic survival, and I provided some prospect of getting a job in the near future with good pay. It was argued, quite correctly it seems in retrospect, that if I studied Sanskrit, at best I would get a poorly paying job as a school teacher, and at worst I would be unemployed. I therefore applied for, and got admitted to, the Intermediate Science (I.Sc.) program in Presidency College, Calcutta, one of the most venerable academic institutions in India in those days. After I completed the two-year I.Sc. program, the question of choosing the proper stream of studies came up again. I indicated my preference for mathematics. But it was suggested that I appear at the admission tests at the Shibpore College of Engineering and at the Calcutta Medical College. The first Indian Institute of Technology, or IIT, was established in Kharagpore near Calcutta a couple of years earlier, but did not yet acquire the reputation that Shibpore had in engineering. The Calcutta Medical College was then probably considered to be the premier medical institute in India. But my heart was not in these fields, as important as they were. Half way on my way to Shibpore to take the test, I got off the bus, spent the rest of the day at a friend's house playing carom and bridge (the cards game), and returned home in the evening. My parents felt hurt. I tried to explain that although I was good in math, I would not excel in engineering. I never had a practical bent of mind and had always been extremely absent minded, an argument which was particularly appealing to my mother, since she had to suffer through my father's absent mindedness, as well as mine. I did not have the heart to forego the admission test for

medical school, and passed it. But, as much as I enjoyed biology, the idea of studying to become a physician did not appeal to me. So I delayed paying the admission fees until the deadline passed, and then returned the money to my mother. There was no other option left except to continue to study for a B.Sc. degree. Once again it was pointed out that the job prospects for a mathematician were rather poor in India. Then some one mentioned that there was this new subject called statistics, which was close to mathematics, but also carried good job prospects. I got admitted to the two-year B.Sc. program in statistics in Presidency College. Thus began my journey into the world of statistics and probability.

My Early Statistics Education. The teacher who had perhaps the greatest influence on my early education in statistics in the Presidency College, Calcutta, was Professor B. N. Ghosh, or "Biren Babu", who was originally a physicist, later joining the Indian Statistical Institute (ISI), and was, I believe, one of the major figures in the design and analysis of an important state wide survey of jute production undertaken under the leadership of P.C. Mahalanobis--the founder of the ISI. In our two-year B.Sc. program, "descriptive statistics" was taught out of a rather voluminous book by Yule and Kendall (M.G.). What might have been a rather dry subject was made fascinating by Biren Babu's rare gift of exposition, combining precision and intuition. He also taught us beautifully the basics of statistical inference. Another teacher who taught us probability (out of Uspensky's book and parts of Feller's volume 1) was Professor Anil Bhattacharyya (of the "Bhattacharyya inequality" fame). Among my class mates were Jayanta K. Ghosh (known to hundreds of ISI graduates as JKG), Asit P. Basu, and Sati Chatterjee (Majumdar). There were several others in the class of about eleven, who later received their Ph.D's from U.S. institutions: Late Chandan K. Mustafi, Ph.D. (Columbia), Pankaj Ghosh, Ph.D. (U. Nebraska). One can imagine how remarkable a pool of talent this was. After our Bachelor's degree (which, in years, would be equivalent to the first two years of a Bachelor's degree in the U.S), we began a two-year Master's degree program in statistics in Calcutta University. Biren Babu taught us "sample surveys", again a subject which only some one like him could bring alive. There were two other great teachers in our M.Sc. class—Professor Mani N. Ghosh, who taught us probability (out of the first part of Cramer's book Mathematical Statistics) and introductory complex variables, and Professor Hari Kinkar Nandi who taught statistical inference (out of the two-volume treatise by Kendall (M.G.)) and a bit of multivariate analysis.

During the first year of M.Sc. I fell very ill and had to discontinue my studies for a year. Next year, in 1959, I passed my M.Sc. exam, which in number of years studied would be equivalent to a B.S. degree in the U.S. Since I came second in the exam trailing the top score by a few marks, I could not get a scholarship to do research in statistics in Calcutta University.

My Year as a Research Scholar at the Indian Statistical Institute. While studying statistics in Calcutta University I had learnt about famous scholars such as R.C. Bose, S. N. Roy and C. R. Rao who were attracted to statistics under the dynamic leadership of P.C. Mahalanobis. Unable to secure a research scholarship at Calcutta University, I thought of appearing at the all India exam for the selection of research scholars at the ISI in Calcutta. Since the M.Sc. results in Calcutta University came in almost at the end of

the year, I had to wait six months or so to take this exam. For about three months I worked as a statistician for analyzing data in a center near Calcutta for studies in population growth funded by the Ford Foundation. Early 1960, a friend of my father's suggested to him that, instead of sitting idle for three months, I seek an interview with Professor Mahalanobis for a temporary job at the ISI. One fine morning I was granted an interview with Professor, as Mahalanobis was generally referred to within the ISI community. In this interview I was asked some questions about my academic missions, etc., and it was impressed upon me that many of those who were successful at the ISI had to start "at the bottom of the ladder". At the end Professor wrote up a note and asked me to take it to Professor C. R. Rao-the Director of the Research and Training School (RTS) of the ISI. I felt grateful to Professor Mahalanobis for his kindness--granting some one like me a half an hour interview and providing me valuable advice. I took the note to Dr. Rao (as Professor Rao was referred to by every one at the ISI). Dr. Rao read the note and, after what seemed like a long spell of silence, assigned me my duties. I was to earn a small hourly rate (I think it was one rupee an hour), in teaching the statistical lab component of Dr. Rao's statistics class for the newly started four-year B.Stat. program. I was also to obtain exams from faculty teaching various courses and get them typed and copied sufficiently ahead of the exam times, and to arrange for monitoring the exams. While these and other errands took up quite a bit of my time, I was inspired by the research environment at the ISI. Among the research scholars at the institute at the time were the brilliant quartet of R. Ranga Rao, K.R. Parthasarathy, J. Sethuraman, and Raghu Varadhan. Another outstanding ISI scholar V.S. Varadarajan had just left for the U.S. after finishing his Ph.D. Regular seminars were held on various topics in mathematics, probability and statistics. I realized very soon that my mathematics education had been quite inadequate and started reading books on pure mathematics, beginning with Hardy's Pure Mathematics. When the time arrived for the all India test for the selection of research scholars, Dr. Rao seemed to think that I should not take it since I was already a research scholar. But I never thought that I was a regular research scholar. For one thing I was earning too little to help my parents and younger siblings. Equally importantly, I wanted to compete for a scholarship like every one else. A week or so before the exam, Dr. Rao left for a visit to Japan. The acting head of the ISI, in Dr. Rao's absence, was R.R. Bahadur of the University of Chicago who had been visiting the ISI that year. I asked his permission to take the test. Professor Bahadur looked surprised and said I did not need his permission to take the test, as it was open to every one. I took the test, and was ranked one. Finally I had secured a proper research scholarship, and it was in one of the world's best institutes for research in mathematics and statistics. I was full of joy and hope.

Among the cast of research scholars at the ISI named above, only Sethuraman was doing research in statistics, and that too involving high mathematics. The rest were writing theses on probability and were mainly interested in pure mathematics. As the Director of the RTS, Dr. Rao seemed to feel an urgent need for having more research scholars engage in statistics, especially applied statistics. As I recall, K.R.Shah, the research scholar selected in the preceding year, was the only one perhaps fitting that description, leaving aside a few others who were selected from among the M.Stat ranks. It was Dr. Rao's desire that I engage in applied statistical research. But my desire was to study

probability and mathematics and perhaps do research in an area of mathematical statistics such as decision theory, or asymptotic statistics.

It was not an easy task to go against Dr. Rao's wishes. Therefore, after spending a year at the ISI, I decided to leave.

During my brief stay at the ISI, many famous scholars visited the institute from all across the world. R.A. Fisher, the father of modern statistics, was an occasional visitor. I had the privilege to listen to at least one of his lectures. The famous scientist J.B.S. Haldane and his wife were long-term visiting professors. Mrs. Haldane was a noted geneticist. Mr. Haldane had an important influence in the development of the academic curricula for programs such as the B.Stat. I have already mentioned the visit by the noted mathematical statistician R.R.Bahadur from Chicago. Of course, Dr. Rao himself was by then already regarded as one of the top statisticians in the world. Among the regular statistics faculty at the ISI were Professors D. Basu, J. Roy and S.K.Mitra.

ISI was then an inspiring place for research in mathematics and statistics, and it was my misfortune that I had to leave.

Graduate Studies in Chicago. After teaching undergraduate students for three years in the newly founded Kalyani University near Calcutta, I came to the University of Chicago in 1964. I have no doubt that Professor Bahadur was instrumental in my getting a fellowship in the department of statistics at Chicago.. At the time the regular faculty members were Professors Bahadur, Billingsley, Brownlee, Goodman, Kruskal, Meier, and Wallace.

By the end of the first year I passed the written qualifying exam and started working under the supervision of Professor Billingsley, who gave me a choice between two research problems: the famous isomorphism problem in ergodic theory, and the problem of finding precise Berry-Essen bounds for probabilities of convex sets in R^k in the context of the classical multivariate CLT. Since I did not have any prior background in ergodic theory, I decided to work on the second problem. As it turned out, the isomorphism problem was settled by Ornstein the following year. On Berry-Esseen bounds and related expansions for probabilities of convex sets, Ranga Rao's thesis contained the best results at the time. Curiously, Ranga Rao's thesis advisor was Bahadur. I was fortunate to be able to improve upon Ranga Rao's results and derive precise bounds and asymptotic expansions, not just for the class of all (measurable) convex sets, but also for general "uniformity" classes originally considered by Ranga Rao in the context of weak convergence, and later completely generalized by Billingsley and Topsoe. Billingsley was very pleased and, with his recommendation, I got offers of tenure track positions at UC, Berkeley, and Carnegie-Mellon. Bell Lab also offered me a position with exactly twice the salary offered by Berkeley. I accepted the job at Berkeley, and went home for a visit after defending my thesis in June, 1967.

It turned out to be a colossal mistake on my part not to have written up my thesis for publication before leaving Chicago, and going around giving talks on it. This had an adverse effect on my career.

During my stay in Calcutta that summer I got married to Gouri, a cousin of my best friend Narayan Mukherjee.

The Berkeley Years. Arriving in Berkeley in September of 1967, my wife and I felt completely at home. This was a very cosmopolitan place, yet not a big city. The campus was beautiful. Growing up in Calcutta, we were very used to loud expressions of political dissent. During the Vietnam war era Berkeley had all of that. I would some times go to the Sproul Plaza during lunch time and listen to Joan Baez singing, or some one giving a fiery speech against the establishment. In a corner near by, a number of Hare Krishna devotees would be reciting in Sanskrit (!) passages from Bhavabhuti.

The department of statistics that Jerzey Neyman had built was full of stars. There was Blackwell, the first University Professor of the UC system. Leaving aside his deep impact on statistics, game theory and dynamic programming, I have never known a mathematician who could make very abstract and seemingly complex matters so transparent even to novices like me. I have had great teachers like Billingsley and Bahadur before, but none quite as magnificent as David Blackwell. At the other extreme was LeCam, whose lectures very few could comprehend. Yet his brilliance shines all over the asymptotic theory of statistics. There were other stalwarts like Lehmann and Sche'ffe- household names in statistics. Then there were younger stars such as Freedman and Bickel. .

I decided to leave Berkeley at the end of my fourth year there. There were several reasons behind this decision. Although the tenure decision making process was still not under way, I did not think my chances were more than 50%. Secondly, during a visit to Berkeley in 1971, Dr. S. Chakravarty, an erudite economist and a member of India's Planning Commission, had suggested that I join the Delhi School of Economics and fill a much needed position in statistics/probability there. I did want to go back to India, and so I told the department that I did not want to be considered for tenure. As it turned out no offer came from India. I did have an offer for a postdoctoral research position at the Tata Institute of Fundamental Research in Bombay; but I thought, mistakenly, that it was a junior position for some one at my stage. As it got desperately late, I started looking for a job in the U.S. I applied to Indiana University in Bloomington, and was offered an associate professorship there. At the same time, I was contacted by the University of Arizona in Tucson, and was offered an associate professorship. My wife and I decided in favor of the warm climate of Tucson.

Arizona and Indiana. The job market for mathematics (and physics) had nearly collapsed during the early and mid-70's. I recall official statements coming out of the AMS apparently suggesting that professors should discourage students from pursuing graduate studies in mathematics, unless the student felt that his or her life would not be fulfilled without engagement in mathematics. The math department at Arizona, however,

had a few positions, and was able to attract a number of outstanding young mathematicians. On arriving at Arizona I felt as if a burden had been lifted off my shoulders. I did not feel the stress to prove myself to the people around me. Here I was free to follow my own inclinations, undeterred by others' value judgments as to what was worth pursuing and what was not.

I started learning systematically Markov process theory and stochastic differential equations, subjects I had not learnt in graduate school. I also took time to write my book Normal Approximations and Asymptotic Expansions with Ranga Rao. Ranga had once visited me at Berkeley on a sabbatical leave from Illinois. But after a couple of months at Berkeley, continuing problems with retina detachment forced him to return to Urbana. For collaborating on the book, I would, therefore, visit him in Urbana for weeks at a stretch with my wife and young daughter. We would always stay at Ranga's house and enjoy his hospitality and that of his wife Shantha. Ranga and Shantha have been among the most generous and gentle souls I know. Although Ranga was no longer seriously interested in probability, I learnt from him some important mathematics related to the subject matter of the book. It is a pity that such a brilliant mathematician as Ranga Rao could not fulfill his exceptional potential because of his extremely poor eye sight! The book that we wrote was well received.

Looking back, it seems to me that the ten years (1972-82) that I spent in Arizona were among the most productive years of my academic life. Aside from the book with Ranga Rao, I wrote a paper with my friend and old classmate Jayanta K.Ghosh on the validity of the formal Edgeworth expansion. Together we solved a longstanding problem in asymptotic statistics. I was invited by the Annals editor Ron Pyke to write a Special Invited Paper, which I did (Ann. Probab. (1977)). I also wrote several papers on Markov processes and diffusions (e.g., Annals of Probab. (1978), Zeit. Wahrschinlichkeitstheorie (1982)) which are reasonably standard now.

Unfortunately, things took a dramatically bad turn when the U of A administration created a new graduate department of statistics and put some one at its helm with no research credentials in statistics, or in any thing else for that matter. As a result, two senior statisticians left U of A. The situation seemed grim to me., and I decided to leave. As luck would have it, the senior statistician at Indiana University, Madan Puri, was kindly interested in getting me to Indiana, and I was offered a professorship of mathematics there. However, the expectations were that I would help shore up the inadequately staffed statistics program there. I have been teaching graduate level statistics as well as probability ever since. Half of my Ph.D. students did their theses in statistics.

During my years at Indiana (1982-2002) some of my work focused on probabilistic methods for (1) homogenization problems in PDE, including multi-scale problems, and (2) nonlinear PDE's such as the Navier-Stokes equations. Another line of work I pursued with some energy was on (3) the derivation of stability conditions for classes of non-irreducible Markov processes, which arise in many contexts, especially in economics. I have had a long and fruitful collaboration with a brilliant economist at Cornell, Mukul Majumdar. In statistics, my work has been on (4) the analysis of the precision of the

bootstrap approximation via my earlier work on asymptotic expansions, and (5) statistics on manifolds such as arise in the analysis of shapes and images.

I have now returned to Arizona as a professor of mathematics, and I am helping develop a graduate interdisciplinary program in statistics here. Several of my old colleagues who came to Arizona in the 70's are still here. A number of them have become rather famous for their work in their respective fields, but have stayed on. I am made to feel here a little like an old son of the soil coming back.

I have generally followed my own inclinations in my academic pursuits, and have no regrets about the important decisions I had to make. But I think I have been rather lucky at Tyche's throws of the dice.

Modern and Emerging Areas in Statistics by Prof. Bani Mallick, Texas A&M University:

The field of statistics is constantly challenged by innovative problems introduced from Science, engineering and other fields. With the advent of computational power, statistics is now much more well equipped to handle these complex problems and to work with the cutting edge of technology. The applications of statistics at different fields are enormous but today we discuss statistical analysis of microarrays, which are perhaps the most common high throughput assay in use today.

Methods for DNA Microarray Analysis

Genomics study the complex interplay between a large number of genes and their products (i.e., RNA and proteins) and furthers our understanding of the biological processes in a living organism. Traditional methods in molecular biology work under "one gene per experiment" all setups with a paucity of information, that fails to provide a larger picture of gene functions. The past few years have seen the development of the technology of DNA microarrays that increases the throughput of gene expression analysis to the level of the entire genome. A microarray is a convenient tool for analyzing gene expression that consists of a small membrane or glass slide containing samples of many genes (usually between 500--20,000) arranged in a regular pattern. DNA Microarrays allow simultaneous study of expressions for a large bunch of genes (Duggan *et al*, 1999; Schena *et al*, 1995). The mere prospect of analyzing the whole genome on a single chip is tempting for a researcher who is looking for gene interactions with possible biological implications and as a result the technology has emerged popularly into a diagnostic tool.

Microarrays may be used to assay gene expression within a single sample or to compare genes. This technology is still being developed and many studies as of now, using microarrays, have represented simple surveys of gene expression profiles in a variety of cell types. Nonetheless, these studies represent an important and necessary 'first step' in our understanding and cataloging of the human genome. With new advances, researchers will be able to infer probable functions of new genes based on similarities in expression patterns with those of known genes. Ultimately, these studies promise to expand the size

of existing gene families, reveal new patterns of coordinated gene expression across gene families, and uncover entirely new categories of genes. Furthermore, because the product of any one gene usually interacts with those of many others, our understanding of how these genes coordinate will become clearer through such analyses, and precise knowledge of these inter-relationships will emerge. The use of microarrays allows faster differentiation of the genes responsible for certain biological traits or diseases by enabling scientists to examine a much larger number of genes. This technology will also aid the examination of the integration of gene expression and function at the cellular level, revealing how multiple gene products work together to produce physical and chemical responses to both static and changing cellular needs.

Biological Principles: As mentioned before microarrays measure gene expression that is, a gene is expressed if its DNA has been transcribed to RNA and gene expression is the level of transcription of the DNA of the gene. The primary biological processes can be viewed as information transfer process (Nguyen *et al*, 2002). All the necessary information for functioning of the cells are encoded in molecular units called genes. The information transfer processes are crucial processes mediating the characteristic features or phenotypes of the cells (e.g. normal and diseased cells). A schematic representation of the information transfer process is:

$$\text{DNA} \Rightarrow \text{mRNA} \Rightarrow \text{amino acid} \rightarrow \text{cell phenotype} \rightarrow \text{organism phenotype}$$

This model shows how the genes (DNAs) are linked to the organism phenotype and the reason for measuring mRNA (transcript abundance), the direct product of DNA transcription. There are different levels of gene expression, one at transcription level where mRNA is made from DNA and another at protein level where protein is made from mRNA. Microarrays measure gene expression at the transcription level, although protein arrays have also been developed.

In the experimentation procedure, the nucleotide sequence for a few thousand genes are printed on a glass slide. A target and a reference sample are labeled with red and green dyes and each are hybridized with the DNA on the slide. Through fluoroscopy, the log(red/green) intensities of RNA hybridizing at each site is measured. This way the expression level of each gene in the target relative to the reference sample has been obtained. Positive values indicate higher expression in the target versus the reference, and vice versa for negative values.

In a typical gene expression data set, we have thousands of rows representing individual genes and the columns containing the gene expression values for a few samples. The main difficulty with microarray data analysis is that the sample size n is very small when compared to the dimension of the problem (the number of genes) p. The number of genes for a single individual is usually in the thousands and there are few individuals in the data set. This is known as the problem “large p, small n”. Developing models for such data structures can be complicated, and computational methods are generally quite intensive.

There are several major data analysis problems statisticians are involved with like:

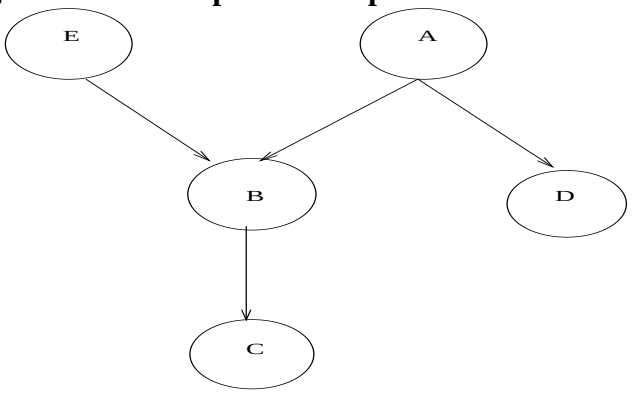
Gene selection: The broad aim here is to identify "marker" genes for disease classes, that is selection of significant genes via expression patterns. That way we narrow down the analysis of the enormous number of genes (from a microarray data of a diseased tissue) to a few that have significantly distinct expression profiles and are indicative of a causal relationship with certain biological phenomenon (Lee et al., 2002; Lee and Mallick, 2004; Bae and Mallick, 2005). *We are drowning in information with micrarray data but our starvation of knowledge can be satisfied by only a few genes.*

Tumor Classification: Precise classification of tumors is critical for cancer diagnosis and treatment. Diagnostic pathology has traditionally relied on macro and microscopic histology and tumor morphology as the basis for tumor classification. Current classification frameworks, however, are unable to discriminate among tumors with similar histopathologic features, which vary in clinical course and in response to treatment. In recent years, there has been a move towards the use of cDNA microarrays for tumor classification. These high-throughput assays provide relative mRNA expression measurements simultaneously for thousands of genes. A key goal statistical task is to perform classification via different expression patterns. *Gene expression profiles may offer more information than classical morphology and may potentially provide an alternative to classical tumor diagnosis schemes.* (Alon et al., 1999; Golub et al.,1999 and Hedenfalk et al., 2001, Mallick et al., 2005).

Gene clustering: When there is no well-defined target (phenotypical) and it is of interest to break down the genes into separate classes with significantly different expression profiles. This is helpful in categorizing a variety of simultaneous (and possibly previously unknown) biological activities as they occur over time (D'Haeseleer et al., 2000). When we have time course data (gene expressions over time) then the problem becomes more complex functional clustering problem (Ray and Mallick, 2006).

Network Models: A central goal of this analysis is to construct a model for genetic networks such that the model class incorporates dependencies between genes. To understand the nature of cellular function, it is necessary to study the behavior of genes in a holistic rather than in an individual manner because the expressions and activities of genes are not isolated or independent of each other.

Figure 1: An example of a simple network structure.



Consider the Figure 1. Here there are 5 genes A, B, C, D, E. Suppose that gene B is a transcription factor of gene C. Gene A does not directly affect C, and once we fix the expression level of B we will observe that A and C are independent. In other words, the effect of A on gene C is mediated through gene B. In this case A and C are conditionally independent given B. Similarly, genes B and D are regulated by A.
Thus genes B and D are conditionally independent once we know the expression level of A. Gene E inhibits the transcription of gene A and in our graphical model we represent it by placing an arc form E to B. The expression of B is regulated by two genes A and E which are known as B's parent, denoted as *Pa*(B). Hence the network model can presented through the parent-child relationship, and local models can be composed through conditional dependence assumptions. The main challenge is, how to identify the network and estimate the dependence structure.

Several sources of variation and systematic bias are introduced at each stage of a microarray experiment. To ensure the reliability of the conclusion drawn from the statistical method, careful experimentation is essential. There are several other high throughput Bioinformatics data which also need careful statistical analysis. For example serial analysis of gene expression (SAGE) data, which makes measurements at the mRNA level, and thus provides a picture of the expression profile of a set of cells, but the mechanics are different and the data may give us a different way of looking at the biology. Mass spectrometry data is another important one for profiling the proteomic complement of a set of cells. These are some of the important challenges for the future.

REFERENCES:

1. Alon, U., Barkai, N., Notterman, D. A., Gish, K., Ybarra, S., Mack, D. and Levine, A. J. (1999). Broad Patterns of Gene Expression revealed by Clustering Analysis of Tumor and Normal Colon Tissues probed by Oligonucleotide Arrays. *Proc. Natl. Acad. Science*, **96**, 6745-6750.

2. Bae, K. and Mallick, B. (2004). Gene selection using a two-level hierarchical Bayesian model, *Bioinformatics*, **20**, 3423-3430.

3. Duggan, D. J., Bittner, M. L., Chen, Y., Meltzer, P. S. and Trent, J. M. (1999). Expression Profiling using cDNA Microarrays. *Nature Genet.*, **21**, 10-14.

4. D'haeseleer, P., Liang, S. and Somogyi, R. (2000). Genetic network inference: from co-expression clustering to reverse engineering. *Bioinformatics*, **16**, 707-726.

5. Golub T. R., Slonim, D., Tamayo, P., Huard, C., Gaasenbeek., M., Mesirov, J., Coller, H., Loh, M., Downing, J., Caliguiri, M., Bloomfield, C. and Lender, E. (1999). Molecular classification of Cancer: Class Discovery and Class Prediction by Gene Expression Monitoring. *Science*, **286**, 531-537.

6. Hedenfalk, I., Duggan, D., Chen, Y., Radmacher, M., Bittner, M., Simon, R., Meltzer, P., Gusterson, B., Esteller, M., Kallioniemi, O. P., Wilfond, B., Borg, A. and Trent J. (2001). Gene Expression Profiles in Hereditary Breast Cancer. *New England Journal of Medicine*, **344**, 539-548.

7. Lee, K. Y., Sha N., Doughetry, E. R., Vanucci, M. and Mallick, B. K. (2003). Gene selection: a Bayesian variable selection approach. *Bioinformatics*, **19**, 90-97.

8. Lee, K.E and Mallick, B. (2004). Bayesian methods for gene selection in the survival model with application to DNA microarray data, *Sankhya*, **66**, 756-778.

9. Mallick, B.K., Ghosh, D. and Ghosh, M. (2005). Bayesian classification of tumors using gene expression data, *Journal of the Royal Statistical Society, B*, **67**, 219-234.

10. Nguyen, D.V., Arpat, A.B., Wang, N. and Carroll, R.J. (2002). DNA microarray experiments: biological and technological aspects. *Biometrics*, **58**, 701-717.

11. Ray, S. and Mallick, B.K. (2006). Functional clustering by Bayesian wavelet methods, *Journal of the Royal Statistical Society, B*, **68**, 305-332.

12. Schena, M., Shalon, D., Davis, R. and Brown, P. (1995). Quantitative Monitoring of Gene Expression Patterns with a Complementary DNA Microarray. Science, **270**, 467-470.

Professor Narayan Chandra Giri: In Memorium

Professor Narayan Chandra Giri was born on May 1, 1928 at a remote Sagar Island in the Bay of Bengal, about 80 miles from the city of Kolkata, West Bengal, India. He passed away peacefully in his sleep on Sunday, January 29, 2006, at his residence in Montreal, Canada.

After finishing his early and secondary education in the village, Professor Giri joined Midnapore Collge under the University of Calcutta and received his B.Sc. with major in statistics in 1951, followed by his M.Sc. in statistics in 1953 under the same university.

Professor Giri's first appointment was as a statistical assistant in the Jute Agricultural Research Institute in West Bengal, followed by a statistical research investigator position at the famous Institute of Agricultural Research Statistics in New Delhi. His keen interest in design of experiments on which he worked and published books later in his life grew out of these assignments.

Professor Giri went to USA in 1958 as a graduate student first at the University of Oregon and then moved to Stanford University in 1959. Here at Stanford, he came in close contact with Professor Charles Stein and Professor Samuel Karlin, and developed his deep interest and excellent skills in multivariate analysis.

After finishing his Ph.D. in statistics in 1961, Professor Giri joined the University of Arizona and then visited Cornell University for two years where he came in close contact with late Professor Jack Kiefer. After a brief stay at the University of Montreal, Professor Giri joined the Indian Institute of Technology (I.I.T.) at Kanpur, India, in 1966 as an Associate Professor and was promoted to a Full Professor after one year, which is extremely rare in academia. Professor Giri left Kanpur I.I.T. in 1968 and returned to Canada permanently with a professorship position at the University of Montreal, a position he held until his retirement in 2003.

Although Professor Giri worked generously on many areas of statistics, his first love which lasted life long with him was in the area of multivariate analysis. His several papers published in the Annals of Mathematical Statistics in the 60's joint with Professor Stein and late Professor Kiefer provide fundamental contributions in classical multivariate analysis. Minimaxity of Hotelling's T-square test as well as the test for multiple correlation exploiting underlying group structures were established. A new concept of local and asymptotic minimaxity was defined and such properties were proved for some general multivariate tests. During my academic visit to the University of Montreal in 1974, under a postdoctoral fellowship from Professor Giri for which I am eternally grateful to him, I read with great interest his papers with Professors Stein and Kiefer and appreciated very much their novel skills in handling of very complex multivariate testing problems using the powerful tool of invariance!

Professor Giri always had a very soft corner for his country men and whenever there was an opportunity to invite them, he was eager to do so even without expecting any return. He enjoyed his collaboration with late Professor Anadi Roy (Lucknow University), late Prof. M.N. Das (IARS, New Delhi), late Prof Ajit Bhattacharya (I.I.T., Kharagpur), Prof. S.R. Chakravorti (I.S.I., Calcutta), Professor Pradeep Banerjee (Univ. of New Brunswick, Canada), Prof. Sujit Basu (Vice-Chancellor, Biswabharati), and Prof. Kalyan Das (Calcutta). I myself will cherish forever my fond memories of fruitful interaction with him during well over twenty years.

Professor Giri published more than 75 research articles mainly on analysis of designed experiments and multivariate analysis, and also 12 books on Design of Experiments, Multivariate Analysis, and basic statistics and probability. His book on Multivariate Analysis published by Academic Press is an excellent addition to the statistics literature. His more than a dozen of doctoral students are well placed in academia and outside academia all over Canada.

Professor Giri was a Fellow of the Royal Statistical Society (1970), American Statistical Association (1971), Institute of Mathematical Statistics (1973), and also an elected member of the International Statistical Institute. He was the founding editor of the Canadian Journal of Statistics.

Professor Giri is survived by his wife Nilima, daughter Nabanita, son Nandan and grand daughter Ava Rose.

This obituary was written by Bimal K. Sinha, University of Maryland, Baltimore County.

Tentative Schedule of Special Invited and Invited Sessions for Cochin Meeting (partial list only):

Plenary Speakers

Professors R. N. Bhattacharya (University of Arizona, USA), Vivek Borkar (TIFR, India) and S. R. S. Varadhan (Courant Institute, USA)

Special Invited Sessions in Statistics

1. N. Balakrishna (CUST, India): Financial Time Series
2. N. Balakrishnan (McMaster, Canada)-I. Distributions and Applications
3. N. Balakrishnan (McMaster, Canada)-II. Ordered Data Analysis
4. Smarajit Bose (ISIK, India), Recent developments in Pattern Recognition
5. Anirban Dasgupta (Purdue Univ, USA), Contemporary asymptotics
6. Susmita Datta (Univ. of Louisville, USA): Statistics for Genomics and Proteomics
7. Jayant Deshpande (Univ. of Pune, India), Reliability
8. Paramjit Gill (UBC, Canada):
9. Subhash Kochar (Portland State Univ. and ISID), Stochastic Orderings
10. Gopal Kadekodi (Instt. for Social and Econ. Change, India),
11. Rajeeva Karandikar (ISID, India): Financial Mathematics
12. Hira Koul (Michigan State Univ., USA): Econometrics and Finance
13. Soumen Lahiri (Iowa State Univ., USA), Computer Intensive Statistical Methods
14. Bani Mallick (Texas A&M, USA): Bayesian Bioinformatics
15. Sunil Mathur (Mississippi State Univ., USA)), Bio-informatics
16. Kanchan Mukherjee (Univ of Liverpool, UK) Time Series
17. H. Nagaraja (Ohio State Univ., USA)), Biostatistics
18. Uttara Naik-Nimbalkar (Univ of Pune, India): Inference for Dependent data
19. R. V. Ramamoorthi+ (Michigan State Univ., USA), Bayesian Nonparametrics
20. Ashis Sengupta (Indian Statistical Instt., Kolkata) Directional Statistics
21. Debasis Sengupta (ISIK, India): Environmental Statistics
22. T. N. Sriram (Univ of Georgia, USA), Interdisciplinary applications of Multivariate methods
23. Winfried Stute (Univ. of Giessen, Germany), Model Diagnosis
24. Tata SubbaRao (Univ of Manchester, UK): Time Series

Invited Sessions in Statistics

1. Mousumi Bannerjee (Univ of Michigan, USA):
2. Sanjib Basu (NIU, USA)
3. Varghese George (Medical College of Georgia), "Statistical Genetics: Recent Advances in Gene Mapping"
4. Bani Mallick and R V Ramamoorthy: Bayesian Biostatistics
5. Vasudevan Mangalam (Univ of Brunei), Survival analysis and Censoring
6. Thomas Mathew (UMBC, USA): Applied Multivariate Analysis

The International Indian Statistical Association is a non-profit organization. Its...Â Significance levels in statistics are a crucial component of hypothesis testing. However, unlike other values in your statistical output, the significance level is not something that statistical software calculates. Instead, you choose the significance level. Have you ever wondered why?