



International Indian Statistical Association Newsletter



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Cover Image

Main Campus of the Cochin University of Science and Technology, venue for the IISA 2024 Conference to be hosted in Kochi, Kerala, India.

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From the Editor's desk May Newsletter is here

Dear IISA members,

As we embrace the vibrant month of May, we take a moment to reflect on the illustrious past, the promising future, and the remarkable present of the International Indian Statistical Association (IISA). This edition is particularly special as we dedicate it to celebrating the memories of the legend, Prof. C.R. Rao, whose pioneering work has left an indelible mark on the world of statistics. His profound contributions continue to inspire statisticians globally, and we are proud to celebrate his enduring influence in this newsletter.

In the same breath, we mourn the loss of Prof. P.K. Sen, a stalwart whose dedication and brilliance shaped the lives of many in our community. His passing is a significant loss, and we extend our heartfelt condolences to his family, friends, and colleagues. Prof. Sen's work and spirit will forever remain a cornerstone of our association's history and ethos.

Despite these somber moments, we find joy in recognizing the achievements of the early career awardees. These bright minds represent the future of statistics and are a testament to the thriving and growing community that the IISA fosters. Their innovative research and contributions are setting new benchmarks, and we are excited to see their careers unfold.

Looking ahead, we eagerly anticipate the upcoming IISA conference in December. This event promises to be a cornerstone for collaboration, learning, and networking, bringing together statisticians from around the globe to share their knowledge and advancements. It is an opportunity to strengthen our bonds and push the boundaries of our collective expertise.

As we reflect on our past achievements and look forward to future milestones, it is evident that the IISA community is not just growing but thriving. Our association is a beacon of excellence, nurturing talent and fostering a collaborative environment where ideas flourish.

We thank each member of our community for their contributions and dedication. It is through your unwavering support that we continue to achieve greatness and uphold the standards set by our revered predecessors.

Last but not the least, I would like to announce that this is the last newsletter that I have edited for IISA. It's time for me to pass the baton to our next Editor (to be revealed soon)! I would like to extend my heartfelt gratitude to everyone at IISA for believing in me, and giving me the opportunity to serve as the Newsletter Editor. It has been a wonderful experience working with everyone.

Adieu!

Warm regards,
Sayantan Banerjee
Editor-in-Chief

Remembering the Legend Professor Calyampudi Radhakrishna Rao

by ANIL K. BERA, PROFESSOR, DEPARTMENT OF ECONOMICS, UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN (UIUC), USA. IN COLLABORATION WITH RONG YUWEN, YICE ZHANG, AND WENQI ZENG.



The Legend—Prof. C.R. Rao

Tuesday, August 22, 2023. It was just another early fall evening in Amherst, New York, U.S.A. In India, the time was early morning of August 23, and the whole country was gripped with nervous excitement for the oncoming touchdown of Chandrayaan (moon craft in Sanskrit) near the little explored lunar South pole, the first for any space program. Chandrayaan did successfully land on the moon as planned. However, before that, a star from the world of Statistics completed its journey and became a part of the stellar remnants. This star was born on September 10, 1920. Of course, here we are talking about Dr. Calyampudi Radhakrishna Rao, or in short Dr. C. R. Rao¹, one of the brightest stars for more than four-score (80) years in the celestial sphere of Statistics. As we know dead stars cast long shadows, and lights from the Rao star will be reaching to us for many years to come.

I encountered Dr. Rao for the first time during my third year (1973) B.Sc. Statistics classes through the Cramér-Rao inequality (CRI) and the Rao-Blackwell theorem (RBT). I studied at the Ramakrishna Mission Residential College (RKMRC), Narendrapur, West Bengal, India. We had wonderful teachers who explained the concepts of CRI and RBT to us very well. In addition to that, we memorized these thoroughly for examination purposes, and all of us secured good scores.

After the B.Sc. Final examinations were over, in 1975, Professor Prasanta K. Giri (dearly known to all of us as Prasantada), Head of the Statistics Department, RKMRC suggested I try for admission at the famed Indian Statistical Institute (ISI) for M. Stat (Master of Statistics). It was not the eminence of ISI that attracted me most, but the full fellowship that they offered to each student admitted there; possibly the only institute in the world to do so, even to this day. Around that time, one day, Economics Professor Satyananda Ghosh (known as Satyada to all) at RKMRC, now Swami Suparnanandaji Maharaj, Secretary of the Ramakrishna Mission Institute of Culture in Kolkata, called me and offered the college hostel accommodation, so that I could comfortably prepare for ISI admission and take the entrance examination. He also added something that my young ignorant mind placed little importance. Even today I can roughly recall his words, “I heard that there is a Rao at ISI who is doing wonderful work. The whole world is talking about him.” I already knew a bit about ISI and its founder, the towering figure, Professor Prasanta Chandra Mahalanobis (PCM), the father of Indian Statistics. My impression was that there could possibly be nothing that Satyada, an economics teacher knew about ISI that I did not or that Prasantada had not told me already. The naïve of me just could not make a connection of “Satyada’s Rao” to CRI and RBT!

Anyway, I managed to jump through the ISI written test hoops. However, for me, the real fear was the Oral (viva-voce) Exam which would be conducted in English. First, my spoken English was no good, and I had heard that the questions asked were frequently not from statistics but from pure mathematics. Yes indeed, the viva started with pure math but luckily not that difficult. Then slowly they crept into statistics. One (rather two) question was, "What do you know about CRI and RBT?" We memorized almost the entire syllabus by heart for B.Sc. final exams just a few months before. I was able to recite the "complete" answer as if I were reading it out from my well-prepared Exam Notes. Then there came a bombshell, "Mr. Bera, can you tell us about the connection between the two?" Now what kind of question was that? We studied CRI and RBT completely separately, though one after the other. We had almost exhaustively gone through all the past B.Sc. exam questions but never encountered this one. At that moment, with no immediate answer to the question asked, I started getting worried about the scholarship money of Rs.150/- per month more than losing the opportunity of getting into ISI. Then suddenly, a past overheard conversation between two of the Statistics teachers in the first-floor corridor of RKMRC flashed back in my memory, one excitedly telling the other, "Do you know, C. R. Rao published both CRI and RBT in a single paper before he reached age 25?", with a lot of emphasis on single. At that time, I thought, who cares, not very useful for exam purposes!

Now back to the interview, scholarship, or no scholarship? I cleared my throat, and in a seemingly confident tone answered, "To start with, these two results of Rao were published in a single paper...". Of course, I didn't know what to say next. No sooner than I let out the above response, there was a soft but enthusiastic voice from a senior member of the interview panel, "Absolutely!". Then there was complete silence. However, that was followed by loud clapping and laughter. I felt so happy and relaxed, thinking, "Now they really cannot fail me and deny the scholarship." Of course, I was grilled with a few more questions but I was relaxed as if I had the scholarship money in my pocket.

Fortunately, or unfortunately, I did not last long in ISI Calcutta. After a year, in July 1976, I found myself at ISI, Delhi Campus for the 2nd year of my M. Stat. degree. The new ISI Delhi Center was inaugurated by Mrs. Indira Gandhi, Prime Minister of India on 31 December 1974. Dr. Rao himself was instrumental in establishing that campus. When I arrived there everything appeared brand new, at least in comparison with that of the main ISI campus in Calcutta.

There I saw Dr. Rao for the very first time with my own eyes. During tea-times, I would keenly observe him walking from his office to the institute cafeteria, engaged in deep discussion with a sizeable crowd that followed him. Sometimes I would hear the crowd breaking into a loud laughter. That used to puzzle me. At that precocious age I used to think that a person of Dr. Rao's stature would never engage in informal chitchats. However, I was totally wrong on that. I did not have to wait too long to discover what a great storyteller he was. What impressed me most was his office on the first floor of the newly built ISI Academic Building. It was huge, with two entrances. One day, I saw the office open, but there was no one. I gathered the courage to have a close look from the outside. The wall on one side was completely occupied by sliding-glass-door-shelves full of books. Then there was an enormous sized table. To my disappointment, the table was empty except for a writing pad and a few pens/pencils. That was all the capital he needed to produce masterpieces.

The following year I and some of my classmates were lucky to have a face-to-face, encounter with Dr. Rao. International Statistical Institute (another ISI) held its 41st World Statistics Congresses (WSC) in New Delhi in 1977. Dr. Rao was the president of ISI from 1977 to 1979 and the WSC was held at his invitation. Organizing such a huge undertaking was an enormous task as I observed firsthand. Dr. Rao himself went through every minute detail of the conference. The first job was sending hundreds of invitation letters which back on those days was quite an uphill task. Almost everything was done by hand. Dr. Rao instructed us to thoroughly check every typed invitation letter and the envelope. He even taught us how to fold the letters in a proper fashion, and then inserting into the envelopes and sealing in the right manner. Finally, the address-stickers were crossed checked and pasted at the right positions.

Dr. Rao being the Director of ISI, could have easily delegated such tedious tasks to us and we would have gladly done them. However, Dr. Rao stayed back with us every night for the envelope-stuffing sessions which on some nights went on until around 2:00AM. Dr. Rao would fill up those hours with wits and stories from his life. He had an amazing storytelling skill. His stories were so captivating that we would often forget, at least temporarily, that he was the Director of the Institute. Given our tender young age, Rao knew exactly how to narrate the stories to prevent us from the slightest boredom. Some of his stories even had Bollywood flavor. I distinctly remember one related to a legendary Bollywood heroine. Dr. Rao received the third-highest civilian award in India, Padma Bhushan in 1968. The same year Smt. Vyjayanthimala, a noted Indian actress and dancer was Padma Shri (fourth-highest civilian award) awardee. However, she met a statistician as if a different species, for the first time in her life. Disregarding severe objections coming from Mrs. Rao, the film star insisted on taking many photographs with Dr. Rao. He did not mind that at all, as we were told. All the photos were later mailed to Dr. Rao's ISI Calcutta faculty residence

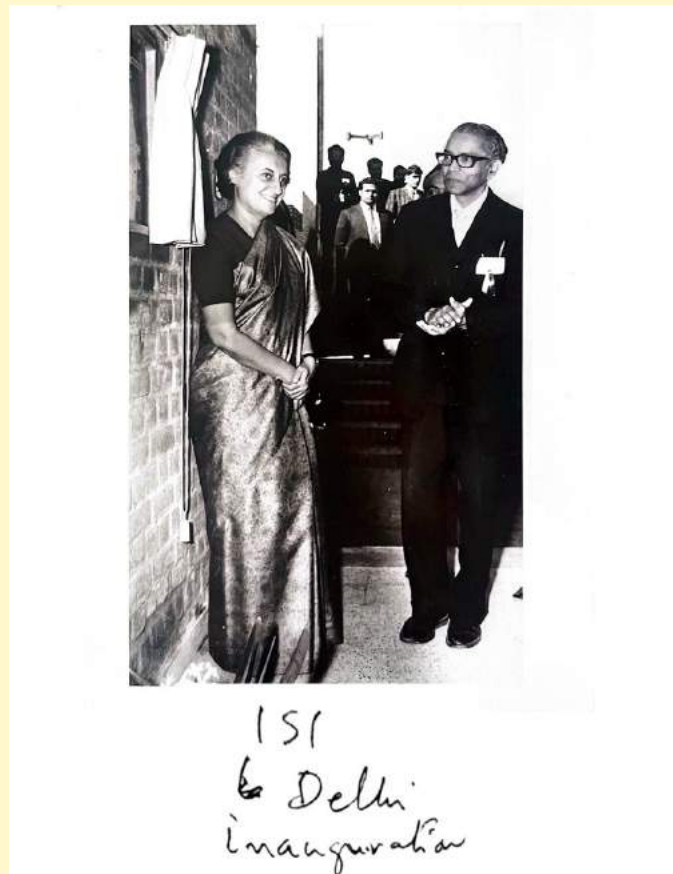


Fig.2: Inauguration of the ISI Delhi Campus by Prime Minister Mrs. Indira Gandhi on December 31, 1974.



Mrs. and Dr. Rao, planting tree saplings on the under-construction Delhi Campus of ISI, 1973.

address. To the utter disappointment of Dr. Rao, all the photos with the star Smt. Vyjayanthimala disappeared! Dr. Rao jokingly challenged us to “estimate” the person responsible for that disappearance!

For the 41st WSC, Dr. Rao assembled the best scientists from all over the world. He had a definitive purpose in mind in involving students in the organization of the conference. Students had the rare opportunity to meet and mingle with the most prominent statisticians. Our job was to take care of all the local needs of the visiting scientists. We were also provided cars, the ubiquitous Hindustan Ambassador, a big luxury at that time, to transport the scientists from the ISI Delhi Campus and Hotels to the Conference Venue, the Bigyan Bhavan (the Science Building) at the Central Secretariat Rajpath Area. Dr. Rao allotted tasks to each one of us to the finest details. One evening there was a huge pre-conference reception for all the conference delegates in the brand new vast green lawn bordered with newly planted exotic trees and shrubs. I later came to know that many of those plants and shrubs were selected and planted by Dr. and Mrs. Rao (Figure 3).

Last time I visited ISI Delhi Center in 2016, I noticed that the tiny plants of 1977 had grown into enormous sizes, some towering over the main administrative building over the last two-score years.

Some scientists had been staying at the ISI Guest House for several months prior to the conference and giving courses to the M. Stat students. One such visitor was Professor Juran Kleffe, from the Academy of Science of the German Democratic Republic (East Germany, that time), Berlin. Professor Kleffe was a postdoc to Dr. Rao and taught us the minimum norm quadratic unbiased estimation (MINQUE) theory. None of us understood any of it. Looking back, I see that Dr. Rao wanted to introduce this novel topic to us. However, not everything was lost in the long run. The beautiful term MINQUE was stuck in my mind. Almost after quarter a century later I used MINQUE in addressing a pressing issue in statistics [1]. That paper opened further avenues of research.

The pre-conference evening gathering was a night to behold - as if thousands of bright stars and planets had descended on the ISI lawn. I remember an amusing episode. All the delegates had beautifully prepared name tags with affiliation and country names. Since at that time he was already affiliated with ISI as a postdoc, Dr. Kleffe had an ISI, INDIA, printed tag. I think Dr. Rao had a hand on that tag since I saw him taking care of almost everything to the finest details. While a former Ph.D. student from ISI, Professor Jayram Sethuraman’s affiliation was Florida State University (FSU), U.S.A. That did not go unnoticed by Professor Nikhilesh Bhattacharya, Head, of the Economic Research Unit (ERU), ISI, Calcutta. Bhattacharya jokingly remarked that only Dr. Rao can make an Indian out of a German, and an American out of an Indian. There were many instances of changed nationalities like this.

I also remember a funny incident at the inauguration of the conference. Prime Minister (PM) Morarji Desai who won against Mrs. Gandhi in the March 1977 elections, then an 81-year-old man was to inaugurate the conference. That election was held at the conclusion of the emergency period 1975-1977. When the time came for PM Desai to light the lamp, there were hordes of photographers clicking with their cameras directly focusing on him. PM Desai became very furious and shouted at the paparazzo, “Do you want to make me blind?” He almost turned back to his seat. With my privilege of being Dr. Rao’s ground soldier, I was right there. To my utter astonishment, I noticed



This was during Neyman and Bose visits to ISI, Calcutta in 1974, during which both received honorary Doctoral Degree.

Dr. Rao quietly stepping in and dispensed the lensmen with a gentle tilt of his index finger. And thus Dr. Rao saved the day.

The 41st World Statistics Congress (WSC) in New Delhi was a great success. I think that was due to the meticulous planning and its efficient implementation by Dr. Rao. To celebrate the occasion, the Postal Department of India issued a Block of 4 Commemorative stamps on December 13, 1977, as in Figure 5.

After completing my M. Stat in 1977, I continued at ISI Delhi as a Junior Research Fellow (JRF) to earn a Ph.D. in Mathematical Economics. I thought I could formulate a “law” (something of the nature of $E = mc^2$) combining three economic agents – producer, trader, and consumer. I was utterly unsuccessful on that. Also, after doing rigorous Statistics for so long, Economics appeared to me somewhat unappealing. One night in March 1979 I made a secret journey all the way to down under Australia. I was lucky to obtain a full fellowship from the Australian National University (ANU) to do a Ph.D. There was no way of going back to my first love – Statistics. Thus, as a compromise, I settled for econometrics, something in between economics and statistics, absolutely, not knowing anything about the field. I left ISI, Delhi, and Dr. Rao behind me. However, Dr. Rao did not leave me.

Since I had no formal training in econometrics, at ANU, I was advised to attend some courses. There I learned something called the Lagrange multiplier (LM) test. Several Ph.D. students were also working on that topic. Occasionally, they would also refer to it as Rao’s score (RS) test. There was so much excitement and so much discussion and debate on Dr. Rao too. It came to my mind that none of these people had seen Rao; he was almost a mythical figure to them, while I had seen him from close quarters for almost two years. In a way that was my mere capital. I got an idea - a simple one indeed. To develop a test for normality using the RS principle under the framework of Pearson System of curves - a topic learned by heart during the first year of my B. Sc. at RKMRC. I discussed my idea with a senior Ph.D. student Carlos M. Jarque who appreciated it and even anticipated its far-reaching implications. For me, it was just about combining two entirely different elements to obtain something new and useful. Our effort resulted in the Jarque-Bera (JB) test for normality [2]. Given that it was derived from the RS principle, the JB test statistic has a simple, elegant, and beautiful expression. And that may be the secret behind its wide applications in several disciplines. In my last count, JB and its various incarnations have close to 12,000 citations, as per Google Scholar. At one stage I started getting inquiries wanting to know the history behind the JB test. That is now available on a You Tube video, “Jarque-Bera Test for Normality: A Brief History,” <https://www.youtube.com/watch?v=wLD8-59qSFE>.

Our papers on RS tests became very popular, and our suggested tests found their way into most of the econometrics textbooks and software packages. Very soon, we noticed a profound impact of RS tests on the theory and practice of econometrics. Within a few years there was a need for writing a survey paper, “Rao’s Score Test in



Fig.5: Commemorative Stamps issued by the Postal Department of India to celebrate 41st World Statistics Congress in New Delhi, December 1977.

Econometrics," [3], which was very well received. While writing this paper I discovered that Ray Byron of A.N.U. was the first to introduce the RS test to the econometrics literature, for testing restrictions in demand equations [4]. Quite coincidentally Professor Byron was my thesis advisor; however, ironically, he discouraged me from working on RS tests. I think that was because Rao's test principle was quite ahead of its time, and its potential was not fully realized by researchers for many years.

In 1997, I was invited to organize a Special Session on "Rao's Score Test" at the joint meeting of the American Statistical Association (ASA), Anaheim, California, August 9-13. That session was very well attended and the response from the audience was immense. Possibly due to the success at the ASA Meeting, the following year (1998), the Editor-in-Chief of the Journal of Statistical Planning and Inference (JSPI), Professor J.N. Srivastava invited Rahul Mukerjee of IIM-Calcutta and me to bring out a JSPI Special Issue on Rao's Score Test. In fact, 1998 marked the 50th anniversary of Rao's 1948 seminal paper [5]. The special issue was to commemorate that occasion along with celebrating the profound impact of Rao's work on the theory and practice of statistics and in many other fields. In our preface to that JSPI issue, Rahul and I even boldly conjectured that, "Possibly it can be said that the eventual impact of this (RS) Statistics will be comparable to that of Karl Pearson's goodness-of-fit test suggested in 1900." Now after a quarter century, we are glad to note that our conjecture is on its way to be fully vindicated. Dr. Rao himself contributed an article [6], "Two score and 10 years of Score Test," that provided historical highlights and a very personal account of the development of his RS test. We rarely have documented records of the major developments in science, and therefore, Dr. Rao's article will remain as an invaluable historical document.

During that period, Dr. Rao himself contacted me on several occasions, addressing me as, "Dear Professor Bera," and signing off as "C.R. Rao"; I think, he noticed not only my work but also the contributions of several of my Ph.D. students. Whenever he would get any questions on RS test, he would just pass that to me. I am not sure whether I was able to do full justice to his utmost faith in me. However, he never failed to acknowledge even my slightest contribution.

In October 2001, I traveled to State College, PA to conduct the Econometric Theory (ET) interview [7]. During that trip, I enjoyed the warm hospitality of Mrs. Rao. And Dr. Rao was most generous with his time, and very patiently responded to my questions. With his profound help, I think, that interview provided a well-thought-out social, historical, and academic document of the past world to which we are now connected only through Dr. Rao. In connection to the ET interview let me mention one incident. I was in their living room trying to remember some references. Noticing my helplessness, Dr. Rao took me upstairs to his study room, and switched on his desktop. Then he instructed me to Google the keywords. I had heard about Google but had never used it. Google was just out possibly a couple years earlier. Dr Rao was already well versed in that. With his instructions, I was able to unearth all the references in no time. In fact, Dr. Rao never had been shy of technology. Long before the era of digital revolution, he wrote the book, Computer and Future Human Society, published in 1969. Being a visionary, he anticipated the massive usage of computers and pretty accurately forecasted the importance of digital technology in our daily lives.

Let me now fast forward to September 10, 2020, which marked the 100 years of Dr. Rao. This was truly a historical



The Trinity: Tagore, Mahalanobis, and Rao (in that order) in my office, UIUC.

occasion. To celebrate that, I organized an online webinar during the height of the COVID-19 pandemic with the help of my Ph.D. student Malabika Koley. At one stage, the number of webinar participants went way beyond 250. We had three most prominent statisticians from India to discuss the life and works of Dr. Rao. They were B.L.S. Prakasa Rao (former Director of ISI), Professor Rahul Mukerjee from IIM-Kolkata and Bimal Roy (former Director of ISI). We even managed to include some Rabindra Sangeet [music composed by Rabindranath Tagore (RNT)] since Tagore's music was also one of the favorites of Dr. Rao. That music was beautifully rendered by a mathematician cum professional singer Dr. Sudeshna Basu (Ph.D. from ISI-Calcutta). This was possibly the very first occasion of inclusion of music in any statistical gathering.

In this context, let me share an anecdote about Dr. Rao's musical and literary interests. During one of my meetings, Dr. Rao told me he became a great fan of Tagore's songs through his mentor Professor Prasanta Chandra Mahalanobis (PCM). PCM and Dr. Rao had a unique relationship. The professor took Dr. Rao into his confidence and freely discussed all sorts of issues. Dr. Rao told me that one of the favorite quotes of PCM was from Tagore,

"সাত কোটি সন্তানে, হে মুগ্ধ জননী, রেখেছ বাঙালি ক'রে, মানুষ
করনি।"

"O enchanted mother, you have kept your seven crores of children simply as Bengalis, please let them grow up." Here Tagore expressed his deep displeasure with the Bengali mentality. And that PCM shared this with Dr. Rao was a testament to their deep relationship. Dr. Rao also confided with me that through PCM, he also got the opportunity to appreciate some literary work on RNT. In all his endeavors related to Statistics, PCM received great moral support from the poet RNT, who even wrote a poem for one of the early issues of Sankhyā, the Indian Journal of Statistics, in 1935 (Volume 2, p.1). Here I should mention that my generation did not get the opportunity to meet RNT and PCM firsthand. However, many of us are lucky to meet and interact with Dr. Rao from a close quarter. And we all know what a humble and kind person he was. All three RNT, PCM and Dr. Rao, a trinity indeed, had a major role in establishing ISI as a premier institute in the whole world. In my own humble life too, all three played a dominating role, so much so that they are a permanent fixture in my UIUC office, Figure 6.

Now coming back to the Rao 100 years celebration-webinar in September 2020, at the end of the day, we had a three and a half hours long video. Thus, one can imagine how long the participants stayed on. We had a unique and historical video where generations of statisticians from all over the world directly paid their tributes to Dr. Rao on his 100th birthday. One of my then research assistants Vivienne Wang, a senior year undergrad, performed a very painstaking job of editing the long video and skillfully cut it down to a watchable length of one and a half hour. This video is now available on YouTube: <https://www.youtube.com/watch?v=bFvCGVRe904>

To conclude, this is just my story, and I am not even a direct Ph.D. student of Dr. Rao. Given that over his full academic life, he directed the research work of more than 50 Ph.D. students who in turn produced more than 350 Ph.D.'s. Just imagine the cumulative impact of Dr. Rao through all of them, besides his monumental and path-breaking contributions to statistics. It is needless to mention that Dr. Rao will be fondly remembered by the entire statistical community not only for his scholarly contribution, but also as a humble and gentle soul. To conclude my story, I borrow a couple of lines from RNT to offer my final tribute to Dr. Rao:

"তোমার কীর্তির চেয়ে তুমি যে মহৎ, তাই তব জীবনের রথ
পশ্চাতে ফেলিয়া যায় কীর্তির তোমার বারম্বার।"

"You are greater than your achievements. The chariot of your life leaves your achievements behind, time after time."

Acknowledgement: I am most grateful to my Ph.D. student and coauthor of several papers, Malabika Koley who provided immense help throughout this Rao-story-project and gave many thoughtful comments and pertinent suggestions. Of course, I retain the responsibility of any remaining errors and omissions.

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Anil K. Bera is a professor in the Department of Economics, University of Illinois at Urbana-Champaign (UIUC), USA and Rong Yuwen, Yice Zhang and Wenqi Zeng are his research assistants at UIUC.

About the photos: In this essay, I am using original photographs sent to me by Dr. Rao for the 2003 Econometric Theory (ET) Interview. Some of the photos I could not use there. After the Interview was published, I wanted to return all the photos. However, Dr. Rao generously told to keep all with me. That time I never thought after a score-of-years the photos will become so useful. Now Dr. Rao's generosity augurs so well for all of us.

As per Dr. Rao's legendary attention to every single detail, he added hand-written captions to the photos. Those photos are reproduced here along with his captions and the typed versions. I believe, through these handwritings, we will remain connected to a vanishing world through the living memory of Dr. Rao.

Remembering the Legend Professor Calyampudi Radhakrishna Rao

by RAVI KHATTREE, DISTINGUISHED PROFESSOR OF APPLIED STATISTICS, DEPARTMENT OF MATHEMATICS AND STATISTICS, CO-DIRECTOR, CENTER FOR DATA SCIENCE AND BIG DATA ANALYTICS, OAKLAND UNIVERSITY ROCHESTER, MICHIGAN

Prof. C R. Rao was my PhD advisor at the University of Pittsburgh and I had taken several courses from him there. There is absolutely no doubt that as students we were at awe with him and when his name itself can be so overwhelming, learning from him can indeed be nerve-wracking. But Prof. Rao was perhaps aware of that and was able to empathize with us. Thus during the lectures, he certainly made us comfortable and at ease by his humor, his jokes and his teaching style.



At Oakland University in 2002, where Prof. Rao was given an honorary doctorate. Pictured with him is the-then University President Gary Russi.

His classes were like a beautifully directed play, where he was the director as well as lead actor and we were unwittingly playing the other characters when we were called on the black board to prove the theorems and sometimes, famous results named after him. Like a central character in a play who actually moves the story, he was the one to control the discussions and theme of the topic being discussed while at the same time allowing others – we, the students – to be an important part of it. Thus the classes were never the routine boring lectures and by the very mechanism of the classes, we had to be fully involved with all our intellectual faculties on full alert. We weren't just expected to take lecture notes; Instead, after taking notes, one of us, randomly selected by Prof Rao every week or every two weeks, would be asked to improve upon the notes by filling in all the assertions left unproven and adding missing steps of the proofs and then distribute those complete notes to the entire class. This was perhaps the best way to learn and to learn from master himself. In fact, it was from him where not only did I learn real statistics but also learned how to teach it.

Post-PhD, we met often in conferences, at the university of Pittsburgh and at the Penn State University. He visited me at the North Dakota State University once and Oakland University three times. In those years, I got to know him better and much more appreciated the wide impact of his work in the sciences in general. And I cannot deny that during those early years the immense pressure I had due to the high expectations from my other colleagues of mine, because "I was C R Rao's student". This certainly made me do better in what I did and possibly also for what I could have done otherwise. His research work has undoubtedly influenced my own research and his time to time encouragements gave me a confidence to explore new research areas and problems. On his human



At Oakland University. From left to right: Prof. Ravi Khattree, Prof. CR Rao, Mrs. Rao, Prof. Subbaiah Perla

side, he was very fond of my daughter Gauree and loved to play with her. Whenever we met, he would inquire about her and the child-like smile on his face clearly showed the genuineness of his inquiry. He led a very simple and what one would call a low-maintenance life. Whenever he stayed with us, his only requirement was the coffee in the morning. In 2002, when Oakland University honored him with an honorary doctorate, he was almost 82 years old. Out of consideration for his age, our then-university president Gary Russi suggested that Prof. Rao may want to join the faculty procession only for the last few steps or even just arrive directly at the very high stage from the backdoor instead of walking and climbing the several steps at all. Prof. Rao with his typical smile, politely yet firmly denied the suggestion and said that he would rather walk along with other faculty members and he gracefully did so for the entire quarter mile long distance without any difficulty in that cold and windy weather of Michigan in the early May. His passing is a personal loss for me. I and my family will always miss you, Prof. Rao.



Prof. Rao with my daughter, Vaidehee Gauree

Remembering the Legend Professor Calyampudi Radhakrishna Rao

by SHALABH, DEPARTMENT OF MATHEMATICS & STATISTICS, INDIAN INSTITUTE OF TECHNOLOGY, KANPUR

Memories with Prof. CR Rao

My first memories of Professor CR Rao date back to 1985 when he visited our house to meet my father, Professor VK Srivastava, a Professor of Statistics at Lucknow University, during the Indian Science Congress that was held at Lucknow University. My next interaction occurred after a gap of sixteen years when I got the chance to meet him in 2001 at the 53rd conference of the International Statistical Institute, held in Seoul, Korea.



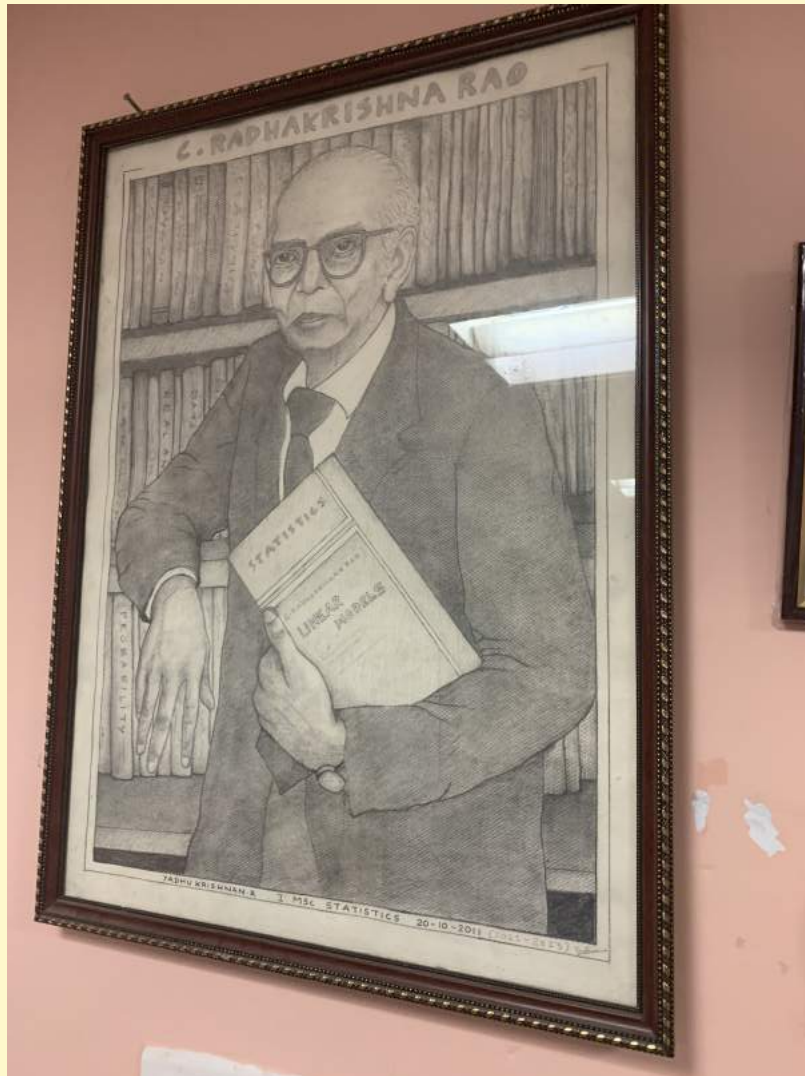
With Professor CR Rao at the 53rd session of the International Statistical Institute held in Seoul, Korea, in 2001.



A group photograph with the faculty and students in the Department of Statistics, University of Lucknow, in 1986 during the Indian Science Congress. Professor CR Rao is in 2nd row, 5th from right and Professor VK Srivastava is in 2nd row, 4th from left. He invited Upma Srivastava (1st row, 2nd from left) for PhD.

Afterward, my prolonged association took off in 2006 when I was awarded the Humboldt fellowship and went to the University of Munich. During the stay, one fine day, I was chatting with Professor H. Toutenburg, my Postdoc mentor, over a cup of coffee about some problems with linear models, regression, and econometrics. After carefully hearing what I said, he picked up the phone, called Professor Rao, described those concepts, and then floated the notion of incorporating them into the book. In less than two minutes, Prof. Rao graciously consented. As a result, Springer published the book "Linear Models and Generalizations - Least Squares and Alternatives" in 2008. Working

with him and meeting his expectations was a challenge but a memorable experience for me. At the age of 86 years, his promptness in resolving queries and thoughts for the book reflected his in-depth and updated knowledge. I frequently told him in our personal conversations that you are a special creation of God and not like other people. He often urged me to get our book's low-price edition published to benefit many people in India and other nations, which eventually came true when Beijing World Publishing Corporation released a low-price edition in China. Besides he also encouraged me to apply for the Young Researcher Award from the International Indian Statistical Association, for which he wrote my recommendation letter, and I received it in 2014.



A sketch by the MSc (Statistics) 2011 students at the Department of Statistics, Pondicherry University, India

Moreover, it is an honour for me to have received the Professor C.R. Rao National Award for Young Statisticians in 2011 from the Ministry of Statistics and Programme Implementation, Government of India. "Who else could be a better recipient than my co-author!" - he said when I told him about the award. Such remarks are my valuable memories, and his succinct, clear, and comprehensive emails are my treasure. Every year on his birthday, I gave him a thank-you note to express my gratitude to him for all his support, encouragement, and assistance in helping me shape my career. Words fall short of expressing my gratitude for illuminating the lives of so many students, my appreciation for guiding the development of statistics, and an acknowledgment on my own behalf as well as that of the statistical community. With his eternal presence, the future of Statistics will be revealed in due time. His soul may rest in peace, we all pray.

Prof. Bhramar Mukherjee, University of Michigan



It is our pleasure and honor to announce that Prof. Bhramar Mukherjee, John D. Kalbfleisch Collegiate Professor of Biostatistics, Chair, Biostatistics, and Professor, Epidemiology at University of Michigan, has been awarded the 2024 Marvin Zelen Leadership Award. She is also the first recipient of the Indian Origin of this award. A detailed announcement can be found at <https://www.hsph.harvard.edu/biostatistics/zelenaward/>.

Bhramar has been recently appointed as the Yale School of Public Health's inaugural Senior Associate Dean of Public Health Data Science and Data Equity, an important new leadership position that reflects the school's focus on data science as a critical pillar for the future of public health. She joins YSPH on Aug. 1, 2024. Read more here: <https://ysph.yale.edu/news-article/award-winning-statistician-joins-yale-school-of-public-health-leadership/>

On behalf of the entire IISA Community, a big Congratulations to Bhramar!

Dr. Abhirup Datta receives COPSS Emerging Leader Award



Congratulations to Dr. Abhirup Datta, for receiving the COPSS Emerging Leader Award! More information can be found here: <https://community.amstat.org/copss/awards/leadership-academy>

IISA mourns the passing away of Prof. Pranab Kumar Sen



With a heavy heart, we share the news of the passing of the respected Professor Pranab Kumar Sen on 31st December 2023. a professor of statistics and the Cary C. Boshamer professor of Biostatistics at the University of North Carolina at Chapel Hill, USA. He was 86.

Prof. Sen was one of the leading statisticians in the past few decades, making significant contributions to non-parametric statistics and biostatistics. Through his research and mentorship, he had a large impact on the field of statistical research. Prof. Sen has authored multiple books on non-parametric statistics, advised over 80 Ph.D. students, and published over 600 research papers. Despite his innumerable accomplishments, he has always been humble. Please join us in paying respect to Prof. Sen and condolences to his family.

Check out the paper <https://arxiv.org/abs/0805.2229> to learn more about his life and works.

IISA mourns the passing away of Prof. T. Thrivikraman



We say goodbye to Professor Dr. T. Thrivikraman, known as TT Sir, a gentle, wise figure who inspired many. He was a respected leader in Mathematics, serving as Professor and Head at Cochin University of Science and Technology, and President of the Kerala Mathematical Association. TT Sir's legacy lives on as he leaves behind a profound impact on the field and those he taught.

The Early Career Award in Statistics and Data Sciences in Theory



Dr. Rahul Mazumder

It is our pleasure to announce that Dr. Rahul Mazumder, NTU Associate Professor of Operations Research and Statistics at the MIT Sloan School of Management, has been awarded the IISA Early Career Award in Statistics and Data Sciences (ECASDS) 2023 awards in the category of Theory for his outstanding research. Dr. Mazumder is affiliated with MIT Operations Research Center, MIT Center for Statistics and Data Science, and the College of Computing. Prior to MIT he spent two years as an assistant professor of statistics at Columbia University. He did his PhD in Statistics from Stanford University under the supervision of Trevor Hastie. He did his BStat and MStat from ISI, Kolkata. His research interests are at the intersection of statistics, machine learning and mathematical programming (large-scale convex and mixed integer optimization), and their applications to industry, the government, and the sciences. He is a recipient of the INFORMS Donald P. Gaver, Jr. Early Career Award for Excellence in Operations Research, INFORMS Optimization Society Young Researchers Prize, Office of Naval Research Young Investigator Award, INFORMS ICS Prize (Honorable Mention). He is currently serving as an Associate Editor of the Annals of Statistics, Bernoulli, and Operations Research.

The Early Career Award in Statistics and Data Sciences in Applications



Dr. Kiranmoy Das

It is our pleasure to announce that Dr. Kiranmoy Das, professor at Beijing Institute of Mathematical Sciences and Applications, China and associate professor at ISI Kolkata, has been awarded the IISA Early Career Award in Statistics and Data Sciences (ECASDS) 2023 awards in the category of Applications for his outstanding research. Dr. Das did his PhD from Penn State University in 2011, and taught in Temple University, USA; and Presidency University, Kolkata, before joining ISI in 2014. His research interests include Bayesian modeling, Biostatistics, Computational Statistics and Wireless Communications. Dr. Das has supervised two PhD and nearly 30 MS students, and received C.R. Rao National Award from the Government of India in 2021.

The Early Career Award in Statistics and Data Sciences in Applications



Dr. Rajarshi Guhaniyogi

It is our pleasure to announce that Dr. Rajarshi Guhaniyogi, associate professor in the department of statistics at Texas A&M University, has been awarded the IISA Early Career Award in Statistics and Data Sciences (ECASDS) 2023 awards in the category of Applications for his outstanding research. Dr. Guhaniyogi specializes in developing Bayesian methodologies tailored for learning from diverse non-Euclidean objects, Bayesian data sketching using random compression matrices, distributed Bayesian inference for large structured datasets, Bayesian high-dimensional regression, deep learning, manifold regression, online Bayesian learning with streaming data, and spatial and spatio-temporal modeling for vast datasets. His noteworthy contributions have been featured in prestigious statistical and machine learning journals, including the Journal of the American Statistical Association, Journal of Machine Learning Research, Annals of Applied Statistics, Journal of Computational and Graphical Statistics, Technometrics, Bayesian Analysis, Psychometrika, Biostatistics, and Environmetrics. Dr. Guhaniyogi's methodologies have a broader impact beyond his academic publications, extending into numerous collaborative initiatives. His methods are employed in collaborative projects in the fields of neuroimaging, forestry, and environmental health, showcasing their applicability and significance in real-world scenarios.

The Early Career Award in Statistics and Data Sciences in Interdisciplinary Studies and Practice



Dr. Ambuj Tiwari

It is our pleasure to announce that Dr. Ambuj Tiwari, professor in the Department of Statistics and the Department of EECS (by courtesy) at the University of Michigan, Ann Arbor, has been awarded the IISA Early Career Award in Statistics and Data Sciences (ECASDS) 2023 awards in category of Interdisciplinary Studies and Practice for his outstanding research in Machine Learning. Dr. Tiwari's research interests lie in machine learning including statistical learning theory, online learning, reinforcement learning and control theory, network analysis, and optimization for machine learning. He collaborates with scientists to seek novel applications of machine learning in behavioral sciences, psychiatry, and molecular sciences. His research has been recognized with paper awards at COLT 2005, COLT 2011, and AISTATS 2015. He received an NSF CAREER award in 2015, a Sloan Research Fellowship in 2017, and was named IMS Fellow in 2022. He serves on the editorial boards of two major journals: Journal of Machine Learning Research and Statistical Science. Besides his role as a professor, he serves as the Director of the Master's program in Data Science and is also affiliated with the Michigan Institute for Data Science (MIDAS).

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Dr. Probal Chaudhuri
Professor, Theoretical Statistics and
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Indian Statistical Institute, Kolkata

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IISA inaugurates Career Advice Center

IISA is starting a career advice forum, primarily to help students and young professionals with career advice. Anybody needing help or advice can reach out to this forum, and we will identify experienced IISA members to respond to the queries within a short span of time. Topics of interest may be about choices of courses to enroll in for particular career choices (for example, government statistics jobs in India or biopharmaceutical jobs in the USA), options for higher studies in different countries, internship opportunities, collaborators for grant proposals or particular research projects, and so on. These examples are for illustration purposes only, and this forum will go into whatever topics IISA members want to delve into, where some IISA members can help out others.

While this is primarily directed towards students and young professionals and researchers, there is no restriction on who may pose a query.

The most efficient way of posting a question, or responding to one is to use the Slack workspace for IISA, accessible here: https://join.slack.com/t/international-ale1861/shared_invite/zt-mlu6xyfb-nek4crzVZFhxQj3B9K6muQ. Once you have installed Slack (in case you are not using it already), please join in the #career-advice channel, and post your questions there. You may also take the opportunity to join other IISA-related slack channels you'll find under the same workspace. An alternative to using Slack is to post your questions using this google form: <https://forms.gle/MY5HNMZgC2XaNbFn9>. We will periodically collect the queries coming to the google form, and post them to the Slack channel.

Responses to the queries will be posted on the Slack channel first. Then selected queries and their responses will also be posted on the IISA newsletter.

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Datta's Data Dives

by JYOTISHKA DATTA, DEPT. OF STATISTICS, VIRGINIA TECH



"In general, a law which has not been voted unanimously involves subjecting men to an opinion which is not their own, or to a decision they believe contrary to their interest. It follows that a very great probability of the truth of this decision is the only reasonable and just grounds according to which one can demand such submission."

"The truth belongs to those who seek it, not to those who claim to own it."

- Marie-Jean-Antoine-Nicolas de Caritat, Marquis de Condorcet (September 17, 1743–March 28, 1794)

Chances are that if you are reading this in early 2024, there is an election looming in the horizon and news about it are occupying a significant portion of your daily news feed, whether you like it or not. Predictions about the results will slowly start emerging as we draw closer, and will be fiercely debated over the next few days. Elections are perhaps one of those situations where prediction accuracy trumps interpretability—and the stakes are pushed to the extremes — when forecasters get it right, they are bestowed with too much credit, and when they are off the target, the credibility of their entire trade is under mass scrutiny.

I am not a psephologist or a political analyst by any stretch of imagination, although I must admit that I have enjoyed the vicarious glory when Nate Silver rose to stardom and on rare occasions, I might have even used his oft-quoted remark on the difference between data science and statistics ¹. For this article, I will stick to a more fundamental, epistemic question that has perplexed thinkers for a really long time: is the *vox populi* always correct? To make things simpler, assuming there is an objective truth, can a group of individuals arrive at the correct decision by majority voting? If yes, under which conditions, and if not, will it be a complete disaster?

The history or philosophy of science is rife with attempts to formalize the notion of 'wisdom of the crowd' from the ancient ages, and Aristotle is often credited by historians as one of the first people to recognize the power of information aggregation. The reader, a student of statistics, is probably more familiar with the 'wisdom of crowd' estimation by Sir Francis Galton, published as an article entitled 'Vox Populi' in the March edition of Nature [Galton, 1949]. If not, here is a shortened version: Galton [1949] describes a weight-judging competition in Plymouth where a fattened ox is selected, and competitors, each paying six pennies, guess the weight after the ox has been slaughtered and dressed, where the most successful guesses would receive a prize. Galton commented that the six penny entry-fee would prevent people from practical joking, and the prize money would encourage putting the best bet, and the competitors included butchers and farmers, experts in the matter. After discarding 13 of the 800 guesses, Galton observed that the median guess (his preferred measure), 1208 pounds, was within 1% of the true weight, 1197 pounds, and the mean would coincide with the actual weight, producing a perfect estimate [Wallis, 2014]. Galton, at the end of the article, remarked that, "This result is, I think, more creditable to the trustworthiness of a democratic judgment than might have been expected." Indeed, 'wisdom of crowds' is pervasive in almost all human endeavors wherever decision-making and uncertainty work together: when the truth is singular, and the errors are 'random' (and not systematic), averaging must improve accuracy. I would defer interested readers to the popular book, "The Wisdom of the Crowds" [Surowiecki, 2005] for a broader perspective.

¹When asked about the difference between statistics and data science during JSM 2013, Silver famously replied, "I think data-scientist is a sexed up term for a statistician".

But, the first *rigorous* mathematical foundation for ‘wisdom of the crowd’ dates back to the Age of Enlightenment, just before the French Revolution had swept France, to a French philosopher and mathematician, *Marie Jean Antoine Nicolas de Caritat, Marquis de Condorcet*, or simply Condorcet. Often called the last of *philosophes*, or the last witness of the Age of Enlightenment, Condorcet was a fascinating and tragic hero of his times, and a proponent of human rights and equality for all, making him exceptional even amongst enlightened thinkers. Among other things, he advocated for educational reforms, representative government, abolition of colonial slavery and equal rights for women, especially women suffrage and argued for equality of all races, and formulated human progress via indefinite perfectibility of humankind and society. Condorcet also pioneered statistical and probabilistic thinking into social sciences, via ‘social arithmetic’, and apply mathematical calculations to financial planning, jury decision-making, public health and other fields.

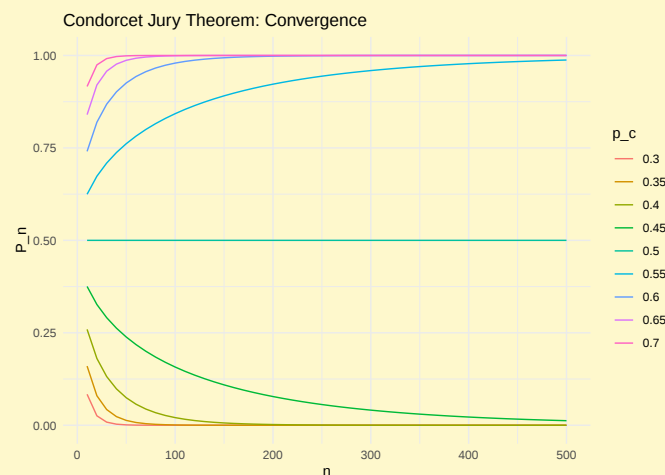


Condorcet

Coming back to our main story, it was this Nicolas de Condorcet who, 164 years before Galton, laid out the first precise mathematical calculations for the majority voting rule, or the ‘wisdom of the crowd’, via the famous Condorcet Jury Theorem, or CJT [Condorcet, 1785]. I will state the simplest version here and point interested readers to Goodin and Spiekermann [2018] for a book-length treatment. Assume there exists an objective truth or a true state of the world and an odd n number of voters, each with probability p_c of voting for the correct alternative, arrive at the collective decision by a majority rule. Then, the classical version of CJT asserts two things. First, in a group of ‘independent’, ‘competent’, and ‘sincere’ voters, where each voter is more likely to be right than wrong ($p_c > 1/2$), the majority vote is more likely to be accurate than any individual vote. Second, as the number of such voters approaches infinity, the probability that the majority is correct approaches 1. In familiar notations, if P_n denotes the probability that the majority rule arrives at the correct outcome, it’s easy to derive that,

$$P_n = \sum_{k=\frac{n+1}{2}}^n \binom{n}{k} p_c^k (1-p_c)^{n-k} \approx 1 - \Phi\left(\frac{n/2 - np_c}{\sqrt{np_c(1-p_c)}}\right).$$

Thus, the CJT asserts that for every n and every $p_c > 1/2$ (a) $P_{n+2} > P_n$ and (b) $P_n \rightarrow 1$, as $n \rightarrow \infty$, as the upper half of the figure below shows.



Convergence of P_n as n grows for different levels of individual competence p_c

This remarkable result from the very early days of probability was largely lost to history [Black et al., 1958], along with Condorcet’s other famous paradox, where he showed that majority voting could lead to cyclic preferences, even when the individual preferences are not cyclic, *i.e.*, A is preferred to B and B is preferred to C, and yet C is preferred to A, by the majority.

Of course, the idea of information aggregation or majority voting has applications in our own field, for example, ensemble learners like random forest are based on the idea that aggregating predictions from multiple models can improve prediction accuracy or classification performance, when they are better than random and sufficiently decorrelated. I will present here a simple result for such a situation, based on an exercise from Vershynin [2018]²:

Consider a randomized algorithm for decision-making (e.g., determining if a number is prime) that gives correct answers with probability $\frac{1}{2} + \delta$, where $\delta > 0$ (i.e., assuming ‘competence’). By running the algorithm n times and taking the majority vote, the probability of obtaining the correct answer would be at least $1 - \epsilon$ for any $\epsilon > 0$, as long as, $n \geq \frac{1}{2\delta^2} \ln(\frac{1}{\epsilon})$.

But, is the majority always correct, or, is CJT always applicable in the real world? Recall that CJT only requires each voter to be barely better than random, that they arrive at their judgment independently of each other, and they ‘all express their opinion in good faith’. These assumptions can fail. Indeed, experts have raised objections to all three of them: competence, independence and sincerity, and examined how they can be violated and also to what extent those objections can be forestalled [see Goodin and Spiekermann, 2018]. As the lower half of Figure 24 suggests, if each voter is more likely to be wrong than right, i.e., their ‘individual competence’ p_c is less than $1/2$, more voters will in fact make things worse and the optimal jury shall consist of a single expert.

Perhaps more skepticism is warranted for the assumption of ‘independence’ which can fail if voters have ‘systematic’ biases or uncritically follow the same propaganda or are subjected to the same misinformation or have the same prejudices. An interesting paper along these lines is Hill and Garner [2021] who question applicability of CJT to the case of virtue signalling, as our strong conformist tendencies make us less independent. Condorcet himself expressed concerns that the masses suffer from ‘great ignorance with many prejudices’, and unfortunately it still rings true after almost 250 years.

Condorcet, a perfect embodiment of the era of Enlightenment, spent his last days in hiding, while writing his greatest work, the *Esquisse*. *Esquisse* presents the idea of continuous human progress towards ultimate perfection, envisioning stages of enlightenment and equality culminating in a future epoch marked by the destruction of inequality between nations and classes. On the morning of March 29, 1794, which is exactly 230 years back to this date, Nicolas de Condorcet was found dead in his prison cell, cause of death unknown.

This article has now grown lengthier than it was supposed to, and I must end it here. As we look towards an uncertain future with equal parts hope and trepidation, I will leave the readers with one of my favorite quotes by Condorcet, translated by Landes [2009]:

“I believe humankind is infinitely perfectible, and that it should thus devote itself to achieving peace, liberty and equality, whose term is impossible to fix. I also believe that this progress must be the work of reason, fortified by meditation, supported by experience.” — Condorcet, under the pseudonym “Un Vieux Bramine”.

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²As Vershynin remarks, the proof is immediate by applying Hoeffding’s inequality.

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