Conference Report

Report of Celebration of National Mathematics Day with the theme, "From Statistics to Machine Learning" held on 22nd December 2021

On the occasion of National Mathematics Day, Institute of Science Education and Culture (ISEC), Kolkata organized a National Webinar on 22nd December 2021 to celebrate it through Google Meet platform. In the inaugural session, Prof. Santanu Das, the Secretary of ISEC wished all and talked about the theme of webinar of that very day. Then he invited Prof. Anil Kumar Ghosh, the President of ISEC to inaugurate the national webinar. Prof. Ghosh addressed Dr. Kaushik Bharati, the honorable Chairman of Seminar Committee of ISEC, distinguished speakers, members of ISEC family, invitees and guests of the Seminar and welcomed everyone. He spoke about the significance of celebrating National Mathematics Day as it is the birthday of an inborn, genius mathematician, Srinivasa Ramanujan. Prof. A. K. Ghosh said that the topic of the first lecture is based on artificial intelligence, robotics with capable physics and in-depth study of surroundings. He considered that there is some boundary between humans and technology. Human beings can design and produce software with very powerful computer which can produce a robot. Then he spoke that the second lecture was on about that era when Prof. Calyampudi Radhakrishna Rao (C. R. Rao) was attached with the Indian Statistical Institute, Kolkata. That was very nostalgic time. Prof. Ghosh recalled that this year is the 134th birth anniversary of Srinivasa Ramanujan. He concluded his inaugural speech by saying that the webinar is organised to pay respectful tribute to Srinivasa Ramanujan. He wished the success of the national webinar of that day and also wished a very happy, prosperous and colourful New Year 2022. After that Dr. Kaushik Bharati, Convener and Chairman, Seminar Committee and Executive Council member, ISEC, Kolkata delivered the welcome address. He mentioned that celebrating the National Mathematics Day is not only a celebration of immense impotence of mathematics but it is also paying homage to the legendary great mathematician, Srinivasa Ramanujan on his auspicious birthday. He spoke about the number 1729, famously known as Ramanujan number. Not only the Indians but also the whole world was sad that this great mathematician passed away at a very young age of 39. He hoped that the renowned speakers of that important day would surely enlighten all by delivering their lectures. After that Dr. Bharati handed over the responsibility of conducting the webinar to Prof. Santanu Das, the Secretary, ISEC, Kolkata.

Prof. Santanu Das introduced the first speaker, Dr. Koushik Ghosh, Assistant Professor of Mathematics at the University Institute of Technology, University of Burdwan. Dr. Ghosh has been awarded with S. N. Bose Birth Centenary Award. After the illustrious biosketch mentioned by the Secretary, ISEC, Dr. Ghosh started his lecture on "A Mathematical Journey to Machine Learning".

Objective of the lecture was to give basic concept of machine learning which is based on statistics, linear algebra, calculus and metric space, and to demonstrate simple and multiple regression process. Machine intelligence is the concept of artificial intelligence that is programmed on a

machine to solve the problems related to human intelligence. The techniques which help to design those problem solvers are called machine learning. Three types of machine learnings are Unsupervised (learning with unlabeled dataset); supervised (with known input output pairs of classifiers) and reinforcement learning (learning based on reward or punishment). The regression analysis is a vastly used machine learning algorithm that is based on supervised learning. In Simple regression, one independent and another dependent variable are involved. When one variable is dependent but all other variables more than two are independent, it is called multiple regression. Linear regression deals with an equation of straight line but nonlinear regression deals with parabolic equation. Partial regression analysis inspects the effect of an added variable in a simple / multiple / linear / nonlinear regression. Dr. Ghosh made the audiences understand the mathematics behind the simple linear regression using least squares method by graphical explanation of an example related to it, so that the audience can also get the idea of the pattern of some data. To explain the multiple regression analysis, he showed equations related to that followed by describing examples of that. After that Dr. Ghosh explained nonlinear or quadratic regression using least square method. Then he gave the concept of data science and classification of data science. He then explained k-nearest neighbour (kNN) algorithm. He spoke that this algorithm is simple and easy to implement. For this, Dr. Ghosh showed an example of benign and malignant features of sample data found in literature. From that example, he explained and gave the concept of kNN classifier. He stated the idea of perceptron model, artificial intelligence with artificial neural network. He explained, support vector machine can work as the classifier and deep learning which is an artificial intelligence function based on human brain processing and data generating patterns. After that Dr. Ghosh gave the introduction of Naïve Bayes Algorithm which is based on conditional probability. Then he spoke about normal distribution with simple realistic examples. After his lecture there was an interactive session with the audience and to explain queries related to parabolic regression, he gave the concept of correlation coefficient used in machine learning.

The Speaker of the second lecture of the webinar of that memorable day was Dr. Purabi Mukherji, retired Professor of Mathematics, Gokhale Memorial Girl's College, Kolkata. Dr. Mukherji has enormous research activities in mathematical modelling of geophysics and geochemistry and history of science. She successfully completed three major projects on history of mathematics sponsored by Indian National Science Academy (INSA), New Delhi and has authored two books written in English titled "History of the Calcutta School of Physical Science" and "Research Schools on Number Theory in India"— published by Springer in 2018 and 2020 respectively. She has important contributions in the volume entitled "Introduction to History of Science in India" published by National Academy of Sciences in India, Allahabad and Ramakrishna Mission Institute of Culture, Kolkata. For her contributions in History of Science, Dr. Mukherji has been awarded with "Bharat Ratna Rajiv Gandhi Gold Medal Award" by the Global Economic Progress and Research Association (GEPRA), New Delhi. After introducing her biosketch, Prof. Santanu Das invited Dr. Mukherji to deliver her lecture. The topic of her lecture was "Prof. C. R. Rao and the Golden Era of ISI". In her lecture she told that on 10th September, 1920, Calyampudi Radhakrishna Rao (C. R. Rao) was born in the then small town in integrated Madras Presidency of British India [presently in Karnataka]. The proud parents of C. R. Rao were Sri C. D. Naidu and Smt. Laxmikanthamma. C. R. Rao had dedicated a book to his mother as he had great respect and gratitude towards his mother. As suggested by his father, C. R. Rao studied Mathematics. In 1940, Rao was awarded with M.A. in Mathematics standing first class first from the Andhra University, Waltair (Visakhapatnam). That was the time of World War and C. R. Rao took decision to go to Calcutta seeking for a job in military in the Department of Survey. But he met a young man in train who was also going to Calcutta to get enrolled in a training programme in Statistics at the Indian Statistical Institute (ISI). That meeting took a

turning point in the life of C. R. Rao and he went to ISI. After getting impressed by the research staff and ongoing projects, Rao decided to make his career in research. So, he took admission to ISI for getting trained in Statistics with the permission of his mother. On 1st January, 1941, he joined there. Six months later, Rao joined in Post-Graduate programme in Statistics at Calcutta University as suggested by Prof. P. C. Mahalanobis. Mahalanobis had recognized Rao's incredible talent and encouraged him. In 1943, Rao received M.A. degree in Statistics standing first class first with 87% marks which is still an unbroken record at Calcutta University. Rao's Masters thesis was an extraordinary piece of work at that time when he was 23-year old. But, in the year of 2003, he said in an interview that in 1941 – 1943 he should have been worked harder! Later, the reviewers remarked that Rao's masters work was 'almost equivalent to a PhD degree'. Rao was recruited as Technical Apprentice at ISI after passing his M.A. and started research work along with a part-time faculty at Calcutta University. There, he got two great mathematician mentors R. C. Bose and S. N. Roy and the period 1944–1946 was the most eventful in his research career. During 1941 census in U.P, Mahalanobis assigned Rao a project for analyzing multivariate anthropometric data collected. It was an interplay between applications and theory, and this approach became the central theme of Rao's seven decades long statistical journey. As selected by Prof. Mahalanobis in August 1946, C. R. Rao went to Cambridge to help J. C. Trevor, an anthropologist at the Duckworth Laboratory of Cambridge University. Then Rao enrolled in King's College, Cambridge University and registered for PhD under the supervision of the founder of modern-day Statistics, Prof. R. A. Fisher, FRS, and C. R. Rao received his Ph.D. degree from the University of Cambridge in 1948 for the thesis entitled "Statistical Problems of Biological Classification". In 1948, at the age of 28 years, Prof. Mahalanobis appointed him as a Professor at ISI and Head of the 'Research and Training School' and under Rao's leadership, the 'Research and Training' became a centre of excellent research, training and consultation centre in Statistics. D. Basu was the first PhD scholar of Prof. Rao and he earned his degree in 1953. The period from 1930 to 1960 is referred to as 'Golden Age of Statistics'. After the independency in 1947, Pandit Jawaharlal Nehru admitted that. By the initiatives taken by Nehru, in 1959, the Indian Parliament adopted a bill and declared ISI as an 'Institute of National Importance' and empowered it to award its own degrees. Prof. Rao initiated several training programmes at the International Statistical Educational Centre (ISEC) with the support of UNESCO and the Government of India. Prof. Rao was a founder member of the Indian Econometric Society established in 1960. Prof. Rao introduced Rao's score statistic, Neyman-Rao statistic, and Rao's distance function. C. R. Rao was fortunate to interact with R. C. Bose, S. N. Roy, K. R. Nair and A. Bhattacharya. Dr. Mukherji said that most of Prof. Rao's research papers written during the forties had been published in Bulletin of the Calcutta Mathematical Society and Sankhya (of ISI). In 1945, Rao published the paper titled "Information and accuracy attainable in the estimation of statistical parameters" [Bulletin of the Calcutta Mathematical Society, Vol. 37, No. 3, 1945, pp.81-91] and established his legacy as one of the legends of modern Statistics. There were so many eminent and renowned works stated by Prof. Mukherji in her lecture and the audience got spell bound. There was an interactive session after her lecture.

After the deliberations, Prof. Santanu Das delivered the vote of thanks to all as the Secretary, ISEC. After that, Dr. Manas Kumar Saha, the Executive Council Member of ISEC, Kolkata sang a Bengali song, "*maromia tumi chole gele*". Dr. Anuradha De, another Council Member of ISEC, played her recorded song. Finally, programme of that day ended there.

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