

## C R Rao



**C**alyampudi Radhakrishna Rao was born on 10 September 1920 in Huvvina Hadagalli of the then Madras province of India. His father C. D. Naidu was an inspector of police and mother Laxmikanthamma, a house wife. He did his high school education in Visakhapatnam, Andhra Pradesh and subsequently received his Master's degree in Mathematics from Andhra University in 1940. He joined the Indian Statistical Institute in January 1941 as a statistical trainee. He enrolled in the newly started master's program of the Calcutta University, receiving a Master's degree in Statistics in 1943 securing the highest rank and gold medal of the university. His master's thesis was on a Characterization of random variables based on regression properties, a problem posed by Ragner Frisch.

Rao joined as a regular employee of the Institute in 1943 and embarked on a research career making fundamental contributions to statistics and at the same time assisting Mahalanobis in his projects. In 1946 he was deputed by Mahalanobis to work on an anthropology project of J.C.Trevor, at Cambridge in England. While at Cambridge, during 1946–48, he worked on classification problems based on which he received his doctorate in 1948 (later in 1965 he received Sc.D from the same Cambridge University). He returned to India and rejoined the Institute in 1948. He married Bhargavi in the same year. He was a professor from 1949 and subsequently became Director of the then Research and Training School of the Institute. After the death of Mahalanobis, Rao became the Director and Secretary of the Institute. In 1976 after he expressed a desire not to continue as Director, he was honoured with Jawaharlal Nehru Professorship at the Institute. Though he made short visits to the U.S.A earlier, it was only in 1978 that he took up a temporary appointment at the University of Pittsburgh, U.S.A and subsequently

remained there on a permanent basis as University Professor. In 1988 he moved to Pennsylvania State University as Eberly Professor of Statistics.

Rao made contributions to nearly all fields of statistics. He has extensively contributed to estimation theory, testing of hypotheses introducing several new tests, linear models developing  $g$ -inverses, multivariate analysis including cluster analysis and factor analysis, characterizations of probability distributions, entropy measures, signal processing, sequential boot-strap, shape analysis, design of experiments and sample surveys. He made significant contributions to econometrics as well. Cramér-Rao inequality, Rao-Blackwellization, Rao's score test, Rao's U-test, Fisher-Rao metric, Rao distance, Rao's orthogonal arrays, and Kagan-Linnik-Rao theorem are now classical.

Cramér-Rao bound is one of the breakthroughs in Statistics. It is interesting to note that a version of this bound is used in the derivation of Weyl-Heisenberg uncertainty principle in Physics. Score test, one of the breakthroughs in Statistics, has found applications in econometrics and survival analysis. He was the first to introduce differential geometric methods in statistical estimation. He was also one of the first to discuss problems in cluster analysis and graphical representation of multi-dimensional data in reduced dimensions.

Most of Rao's theoretical work was not just motivated by applications, but actually grew out of applied problems. According to Rao, he would not have thought of Score test if he had not worked on a particular practical problem in genetics which Fisher asked him to investigate. Rao arrived at the  $g$ -inverse, while studying the long term effects of radiation on the survivors of the atom bomb attack. His work on shape analysis has origins in a problem posed by a cardiologist on constructing the shape of the human left ventricle from a pair of X-ray projection images taken from two perpendicular camera sets.

Rao is author of 14 books, more than 350 research publications and nearly 30 edited volumes. Watching Rao lecture is like watching a skilled artist at work with every statistical function and procedure at his command.

He is recipient of several awards and honours. He received the S.S.Bhatnagar award in 1963, elected Fellow of the Royal Society in 1967. He received Padma Bhushan in 1968 and the second highest honour, Padma Vibhushan in 2001 from the Government of India. He received the Wilks Medal of the American Statistical Association in 1979 and U.S. National Medal of Science in 2002. He is a member of several scientific academies, including the National Academy of Sciences of U.S.A. He has received honorary doctorates from several universities and institutes from all the continents, including the Indian Statistical Institute.

Professor Rao delivered the 21<sup>st</sup> Convocation Address of Indian Statistical Institute held on March 5, 1987 entitled as “ Uncertainty Randomness and Creativity” and the 24<sup>th</sup> Convocation Address held on December 29, 1989 entitled as “Taming of Uncertainty”.

*Article by: Bhamidi V. Rao, Professor, Statistics and Mathematics Unit, Indian Statistical Institute, Kolkata, India.*