

## REVIEWS

### **Professor Malay Ghosh's outstanding contribution to statistics**

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Professor Malay Ghosh's contribution to theoretical statistics covers a wide range of area, such as survey statistics, order and nonparametric statistics, sequential analysis, decision theory, Bayesian statistics, and small-area estimation. Malay also contributed to applied research projects on prostate cancer studies, case-control studies, quality assurance, county-level estimation and on detection of exoplanets.

Professor Malay Ghosh obtained a BA in Statistics in 1962 from the University of Calcutta, and a MA in 1964 from the same university. Afterwards, he moved to the United States and obtained his PhD degree in 1969 from the University of North Carolina at Chapel Hill, under the supervision of Pranab K. Sen. His PhD dissertation title is "Asymptotically optimal nonparametric tests for miscellaneous problems of linear regression". After his PhD, Malay took several research assistant positions at the University of North Carolina. He was an associate professor at the Indian Statistical Institute from 1971 to 1978, then became a professor at the Iowa State University in 1978. In 1982, Malay joined the University of Florida, Gainesville, where he became the Distinguished Professor of the Department of Statistics in 1998.

Professor Malay Ghosh has co-authored two books, published about 315 research manuscripts and supervised sixty PhD students, including Partha Lahiri, Gauri S. Datta, Kannan Natarajan and Nitis Mukhopadhyay. His contribution to small area estimation spans over two decades. With his PhD students, Partha Lahiri, Gauri Datta and Kannan Natarajan, Malay was the first to develop a unified Bayesian approach for solving small area estimation problems. He served from 1996 to 2001 in the United States Census Advisory Committee as a representative of the American Statistical Association.

Malay's other methodological contributions to Survey Statistics include development of new empirical Bayes confidence intervals based on Edgeworth expansion, outlier adjustment, and use of measurement error models. Malay has applied Bayesian and empirical Bayesian methods for the adjustment of census counts, estimation of median income of four-person families, estimation of the proportion of

people without health insurance for small domains cross-classified by age, sex, ethnicity and other characteristics.

Malay was the editor of "Sequential Analysis" for eight years, and "Sankhya, B" for four years. He is currently a member of the Editorial Board of "Statistics in Transition". Previously, he was part of the Editorial Board of the "Journal of Statistical Research" and the "Brazilian Journal of Statistics". He acted as Associate Editor for many journals: "Journal of the American Statistical Association", "Sequential Analysis", "Statistics and Decisions", "Communications in Statistics – Theory and Methods", "Journal of Nonparametric Statistics", "Journal of Statistical Planning and Inference", "Annals of Statistics", "Statistics", "American Statistician" and "Metron". Malay published about 315 papers, some in the most prestigious journals. In January 2020, he has 5,638 citations on researchgate.net and a ResearchGate score of 39.28, with an h-index of 36. Malay's score is higher than 95% of all ResearchGate members' scores. His most h-cited papers are Small area estimation: An appraisal (601 citations), Small area estimation: An approach (321 citations), both co-authored with J. N. K. Rao. Other highly cited papers are Penalized regression, standard errors, and Bayesian lassos (271 citations), Multivariate negative dependence (175 citations), Generalized linear models for small area estimation (156 citations), Sequential estimation (132 citations), Some remarks on non-informative priors (100 citations), Bayesian multivariate spatial models for roadway traffic crash mapping (99 Citations), On the invariance of noninformative priors (95 citations), Constrained Bayes estimation with applications (92 citations), Simultaneous estimation of parameters under entropy loss (91 citations), Statistical decision theory and Bayesian analysis (90 citations), Bayesian prediction in linear models: Applications to small area estimation (83 citations), Miscellanea. Second-order probability matching priors (81 citations), Bayesian methods for finite population sampling (78 citations). Five of these papers are published in the "Journal of the American Statistical Association", two papers are published in the "The Annals of Statistics". The other journals are "Bayesian Analysis", "Biometrika", "Statistical Science" and "Technometrics". Malay is also the co-author of two famous books: Sequential estimation (Wiley and Sons) with N. Mukhopadhyay and P.K. Sen, and Bayesian methods for finite population sampling (Chapman and Hall) with G. Meeden. Malay was principal investigator on several projects awarded by the National Science Foundation: "Simultaneous estimation of parameters in exponential families", "Admissibility in multiparameter estimation and in finite population sampling", "Multiparameter estimation and estimation in finite population sampling", "Empirical and hierarchical Bayes estimation in finite population sampling, quality assurance and random effects models", "Hierarchical and empirical Bayes estimation in survey sampling, linear models and quality assurance", "Bayesian methods and inference", "Bayesian Methods for small area estimation and latent structure models", "Parametric

and semiparametric Bayesian methods for small area estimation”, “Bayesian and likelihood based multilevel models for small area estimation”, “Some topics in small area estimation”, “Empirical and hierarchical Bayesian methods with applications to small area estimation”, “Case-control studies, new directions and applications”, “Some contributions to sampling theory with applications” and “Bayesian empirical likelihood and penalized splines for small area estimation”. Other projects are: “Nonparametric estimation and estimation in finite population sampling” (Research Development Award), “Conference on topics in generalized linear models” (US National Security Agency), “Bayesian neural networks for prostate cancer studies” (National Institute of Health), “Validation study of subdomain estimation method” (Centre of Diseases Control and Prevention), “Topics in Bayesian analysis, empirical likelihood and decision theory” (US National Security Agency), “Multivariate empirical and hierarchical Bayes methods for small area estimation”, “Developing small area models for improved county-level estimation of agricultural cash rent” (U.S. Department of Agriculture), and “Small area estimation” (ASA Senior Research Fellowship). Malay collaborated in other research projects: “Order statistics and nonparametric statistics”, “Conference on topics in generalized linear models” and “Search for Earth-mass planets: Bayesian Algorithms to analyse transit timing observations”. Malay is an elected fellow of the American Statistical Association, the Institute of Mathematical Statistics, the International Statistical Institute and the International Society for Bayesian Analysis. In 1993, he received the Eugene Lukacs Distinguished Visiting Professorship of Statistics at the Bowling Green State University. Malay was awarded the Jerzy Sława-Neyman Medal at the 100th Anniversary of the Polish Statistical Society in 2012, the Lifetime Achievement Award from the International Indian Statistical Association in 2017 and the Small Area Estimation Award in 2019.

In May 2014, an international conference in honour of Professor Malay Ghosh, entitled “Frontiers of Hierarchical Modelling in Observational Studies, Complex Surveys, and Big Data”, was hosted by the Joint Program in Survey Methodology, University of Maryland at College Park. Several areas to which Ghosh made substantial contributions were represented, including small-area estimation, objective Bayesian inference, hierarchical Bayesian modelling, and statistical inference for case-control studies. More than 200 people (including 16 of his doctoral students) celebrated Ghosh’s outstanding contributions to statistics and his dedicated role as researcher, teacher and mentor. At last but not least, Malay taught a wide ranges of course: Intermediate probability and inference, Advanced inference, Sequential analysis, Nonparametric inference, Decision theory, Large sample theory, General theory of linear estimation and hypothesis testing, Multivariate analysis, Descriptive statistics, Statistical models, Statistical methods, Multivariate nonparametric inference,

Reliability theory, Introductory probability theory, Introductory inference, Advanced probability theory, Introductory statistical methods, Applied Bayesian statistics, Bayesian theory and likelihood.

The outstanding academic and research curriculum mentioned above are the reasons to propose Professor Malay Ghosh as a candidate for a Degree of Doctor Honoris Causa. I have no doubt that he is an ideal candidate, given the quality of his research curriculum during his impressive academic career. I strongly request that Professor Malay Ghosh be awarded the Degree of Doctor Honoris Causa by the University of Economics in Katowice.

## Scientific achievements of Professor Malay Ghosh

**Professor Dr. Ralf T. Münnich,**  
*TrierUniversity, Trier, 28<sup>th</sup> January 2020*

It was in January 2004 when Professor Ghosh entered the conference room at the IMS/ASA-SRMS Joint Mini Meeting, Raichak, West Bengal, India. Of course, I knew who had just entered the room when I was preparing my talk. But it was the incredible aura that surrounded him and made me pause. Quite unpretentiously he greeted me with a “Hi, I’m Malay” – this incredibly impressive researcher immediately showed his very friendly, warm and human manner with which he was no less impressive. This special professional though kind manner was evident in all meetings, conversations and invitations, and I’ll mention some of them in a moment. Therefore, it is a special pleasure and honour for me to formulate a laudation for this outstanding researcher, Professor Malay Ghosh, on the occasion of his honorary doctorate from the University of Economics in Katowice.

Professor Ghosh is without any doubt a world-leading researcher in statistics. His contributions to statistics cover a wide range of topics from theoretical findings to very important applications in many different areas. His main areas of interest are Bayesian and empirical Bayesian methodology, resampling methods, and hierarchical modelling, as well as sampling and small area estimation. His amazing 59 page curriculum vitae speaks for itself and you can easily find many other topics that have stimulated major interest.

After completing his studies in Calcutta, Professor Ghosh subsequently took the next steps of his career at UNC in Chapel Hill, the Indian Statistical Institute in Calcutta, and Iowa State University in Ames, until he became full professor in Calcutta. After another period at Iowa State, he finally arrived at the department of statistics at the University of Florida at Gainesville in 1982. Though he completed several prominent visiting professorships far off, he never left Florida. Since 1998, he has been Distinguished Professor of Statistics at the University of Florida, Gainesville, and currently the only one at this institution.

Professor Ghosh has served in almost 20 different roles as an editor and an associate editor for international journals. Amongst these journals are highly prestigious publications as the “Journal of the American Statistical Association” and the “Annals of Statistics”.

Relating to his own research, Professor Ghosh can be proud of over 300 peer-reviewed papers with nine more in press, and by the time of writing this laudatory speech surely even more. His research work is published in the most prestigious

statistics journals including the “Annals of Statistics”, the “Journal of the American Statistical Association”, “Biometrika”, the “Journal of the Royal Statistical Society B”, as well as many other well-known journals.

Since 1976, Professor Ghosh has supervised and co-supervised more than 60 PhD students. The variety of topics of the theses is as impressive as the range of his own research, covering theoretical and practical findings in so many directions. Amongst his students are so famous researchers who have also become professors, such as Nitis Mukhopadhyay, Partha Lahiri, and Gauri Datta. It is not solely his own list of PhD students who have benefitted from his rich set of ideas but also a long list of guests. And whenever I speak to one of his students, I hear only very warm words about his research and mental support. Possibly sometimes so impressive that students face a challenge of making his ideas into reality as quickly as Professor Ghosh develops them. This unbelievable intensity in research ideas and promotion of students may sometimes provide a special challenge for students. However, he has always associated this with particularly positive support to foster a best possible development of his students and guests.

As you might expect that this outstanding re-searcher would likely be less committed to committee services, you will be surprised to see his very long list of contributions to all faculties where he was and is present. He has been active in many directions in the university system, with special emphasis on postgraduate education. In addition to these university committees, he showed major support on many different occasions outside the university. It is unbelievable, how he could manage all these duties besides his amazing research record. These activities encompass various roles in societies such as the Institute for Mathematical Statistics and the American Statistical Association, for which he served in many different positions. Additionally, he was well respected and often invited to participate in programme committees for international conferences. It is self-explanatory that having him on a board was already a major point of attraction for any conference. Especially for the series of Small Area Statistics Conferences, he was always appointed as member of the advisory committee.

As Professor Ghosh was certainly often asked to organise invited sessions, he himself has provided an impressively long list of over 120 invited papers covering so many regions all over the world. Additionally, he has provided 130 invited and special invited lectures in such different areas of his interest. This incredible reputation is almost certainly the reason why he shows comparatively few contributed papers in his curriculum vitae.

Besides his amazing list of research contributions, he was the principal investigator in many highly recognised research projects and grants, of which many stemmed from the National Research Foundation. This amazing list was enriched by further collaborations with important organisations such the U.S. Census Bureau, the Bureau

of Labor Statistics, and the National Agriculture Statistics Services. This again proves how the many theoretical findings of Professor Ghosh serve as an important contribution to applications in many fields of statistics.

Let me focus on some of Professor Ghosh's outstanding contributions, though this is more a personal view. His contributions to small area statistics are surely pioneering.

In 1987, he published, together with Professor Lahiri, a paper on Robust empirical Bayes estimation of variances from stratified samples in the "Journal of the American Statistical Association". The focus of the paper is a simultaneous estimation of means in multiple finite populations. This is essentially useful and applicable for estimating annual incomes or unemployment rates, which are to be estimated in many areas simultaneously. The research has influenced a wide spectrum of research from empirical Bayes prediction to frequentist methodology of small area estimation, which can be drawn from far more than 100 citations in these research areas.

His article on Small area estimation: An appraisal, together with J. N. K. Rao, has been published in "Statistical Science" in 1994 and received major attention being cited over 1,000 times.

Professor Ghosh's research covers so many different areas: he has also provided important contributions to economics. Several papers and presentations focused on specific aspects of income and its parameters. The methods in use cover Bayesian cross-sectional and intertemporal approaches as well as regional aspects using small area techniques. Especially research on regional incomes provides an important topical theme, which plays an important role in applications and even in policy support. Reliable figures more and more play an utmost important role for a modern democracy and Professor Ghosh's research on benchmarking in small area statistics enables the provision of the necessary basis. In light of this economics related research, Professor Ghosh visited Katowice several times.

Another important area of his research focuses on the American census which surely serves as an important source of economic data for the society. I don't need to remind you that his many contributions on a variety of regression methods surely serve as an outstanding basis for modern quantitative research. Finally, Professor Ghosh's research on finite population sampling and Bayesian inference for statistics, in general, and for econometrics provides excellent findings which are necessary input for modern economic research.

Professor Ghosh's eminence as a statistician has already been well recognised internationally. He is a fellow of the American Statistical Association, the Institute of Mathematical Statistics, and the International Society for Bayesian Statisticians. He is an elected member of the International Statistical Institute. He is a holder of the Jerzy Sława-Neyman Medal (2012), the Lifetime Achievement Award from the Indian Statistical Association (2017), and the Small Area Estimation Award (2019).

Without a shadow of doubt, Professor Ghosh is a distinguished authority in statistics. His contributions to statistics have not only been an example for junior researchers but for everyone working in this field. They have shown important methods providing paths for future research. In all ways, Professor Ghosh's a remarkably positive kind manner combined with his incredible productivity and creativity deserves to be awarded the doctorate honoris causa.

Finally, I recommend with strong emphasis this outstanding researcher, Professor Malay Ghosh, for the doctorate honoris causa from the University of Economics in Katowice.