Research Interests:

I have varied research interests in Theoretical/Mathematical Statistics. Although I primarily work in the areas of Theoretical/Mathematical Statistics, some of the research methodologies proposed by me and my co-workers have found interesting applications in molecular sciences and engineering. My current research interests can be classified into following four broad areas:

(i). Entropy Estimation

In molecular sciences, estimation of entropies of molecules is important for the understanding of many chemical and biological processes, such as the spontaneity of a chemical reaction, protein folding, intermolecular protein-protein interactions and protein-ligand interactions. It is also a key in the design of drugs that can stabilize the normally folded molecular structure or correct a misfolded structure since protein misfolding is a cause of several diseases such as Alzheimer disease, mad cow disease, cystic fibrosis and some types of cancer. Estimation of the internal entropy of macromolecules, such as proteins, is a challenging problem because of the large number of correlated internal molecular coordinates. For estimating the internal entropy of a molecule, molecular scientists have been using quasi-harmonic approach based on the assumption of a multivariate normal distribution for the internal molecular coordinates. For the multivariate normal distribution, we have proposed several estimators of entropy and have established their optimum properties. In the multivariate normal set up, the estimators proposed by us provide significant improvements over the traditional maximum likelihood estimators used by molecular scientists. The quasi-harmonic approach used by molecular scientists is adequate when the temperature at which the molecule is studied is low, and thus the fluctuations in internal coordinates are small. At higher temperatures, the multivariate normal distribution is inadequate as the dihedral angles at higher temperatures exhibit multimodes and skewness in their distributions. Moreover the internal coordinates of molecules are circular variables and thus the assumption of multivariate normality seems to be inappropriate. Therefore a nonparametric and circular statistic approach to the problem of estimation of entropy is desirable. To take care of limitations of quasi harmonic approach, we have proposed a nonparametric approach for estimating entropy of a molecule. This approach is getting a lot of attention among molecular scientists and is being well cited in various core journals in the area of molecular sciences (such as The Journal of Chemical Physics, Journal of Computational Chemistry, Journal of Molecular Biology, BMC Neuroscience, Information Processing in Medical Imaging, and Journal of Proteome). Our work in this area has also received attention among engineers and has been referred in electrical engineering and computer science journals (such as Entropy, Information Theory, and Information Hiding-LNCS).

(ii) Theory of Stochastic Orders and its Applications

To enhance the performance of a system a common practice employed by reliability engineers is to use redundant components in the system. The problem of where and how to allocate redundant components in a system, in order to optimize its lifetime or some other performance characteristic, is interesting and important in reliability theory and its applications. It has posed many interesting theoretical problems in probability, which have attracted attention of many researchers. Performances of various allocations can be compared through stochastic comparisons (with respect to one of various stochastic orders) between the corresponding system lifetimes. We have extensively used the theory of stochastic orders to deal with the problems of optimal allocation of redundant components in coherent systems. We have also used the theory of stochastic orders to study properties of some other important models in Reliability Theory and Survival Analysis. Our work in this area has been extensively cited in the literature (see, for example, books by Shaked and Shanthikumar (2007, pages 58, 63, 74, 77, 107, 231, 263), and Lai and Xie (2006, page 404)).

REFERENCES

1. Shaked, M. and Shanthikumar, J. G. (2007). *Stochastic Orders*. Springer, New York.
2. Lai, Chin-Diew and Xie, Min (2006). *Stochastic Ageing and Dependence for Reliability*. Springer, New York.

(iii) Estimation in Restricted Parameteric Space

Problems concerning estimation of parameters when it is known a priori that some of these parameters are subject to certain order restrictions are of considerable interest in many practical situations. We have extensively studied problems involving estimation of parameters of k (≥ 2) populations when it is known a priori that some or all of these parameters satisfy certain types of restrictions. For various probability models, we have proposed estimators that improve upon the standard (natural) estimators and have established their various optimal properties. Work carried out by us in this area has been extensively cited in the literature (see, for example, the recent book by Constance van Eeden (2006, see pages 74-77, 80, 82-87, 89-93, 100, 124, 125, 127, 128).

REFERENCE

van Eeden, C (2006). Restricted-parameter-space Estimation Problems - Admissibility and Minimaxity Properties. Springer, Lecture Notes in Statistics.

(iv) Ranking and Selection Problems and Related Estimation Problems

In many practical situations it may be of interest to select the best (or worst, or simultaneously the best and the worst) of k (≥ 2) available alternatives (or populations), where the worth (to measure bestness or worstness) of a population is defined in terms of numerical value of an unknown parameter associated with it. These problems fall under the umbrella of Ranking and Selection Problems. We have studied these problems using decision theoretic approach. Specifically, we have proposed various statistical selection procedures for the goal of simultaneous selection of the best and/or the worst populations from k (≥ 2) available populations. The optimum properties of the proposed selection procedures are studied using decision theoretic approach. We have also made some contributions in the theory of Multiple Comparisons. We have proposed procedures for simultaneous multiple comparisons with the best and worst populations, thereby generalizing the existing procedures for simultaneous multiple comparisons with the best. One of our research papers in this area (Misra, N, Sharma, S K & Gill, A N, 2002: ***Simultaneous multiple comparisons with the worst and best***. American Journal of Mathematical and Management Sciences, 22, 115-139) was awarded the ***Jacob Wolfowitz Award,*** for the outstanding theoretical advances paper of the year 2003, by American Journal of Mathematical and Management Sciences, New York, USA. We have also done some work on estimation of the ranked parameters of k (≥ 2) populations when the ranking between the parameters is not known a priori and also on estimation of the parameters of the selected populations. Work carried out by us in these areas has been extensively cited in the literature.