TRIMMED JACKKNIFE KERNEL DENSITY ESTIMATORS FOR THE PROBABILITY DENSITY FUNCTION*

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Abstract

In this paper, we use the trimmed Jackknife estimate for the kernel density. Using Von Mises derivatives of statistical functionals, it is shown that trimmed jackknife estimate preserves the usual asymptotic properties of the kernel density estimates. Furthermore, it is shown that there exists an optimal trimming proportion α which will minimize the bias of the trimmed estimate.

Keywords and phrases: influence curve, kernel density estimates, statistical functional, influence curve.

1. Introduction

An estimate of the probability density function f(x) of a distribution F is an important input in most data analysis procedures. In applications, the kernel method of density estimation is extensively used. The estimates obtained, using non negative kernels, however, turn out to be biased. The method of jackknifing can be used to reduce the bias. Robust methods are preferable, in as much as in practice, data may contain outliers and also, the pseudo values in jackknifing procedures are fat tailed in distribution and are not independent. A simple alternative to the usual jackknife to make it robust, by using the trimmed average of pseudo values was developed by Hinkley and Wang (1980).

In this paper, it is shown that the trimmed jackknife estimate preserves the usual asymptotic properties of the kernel density estimates. Furthermore, through the use of the influence curve of the estimates, it is shown that the estimates are robust, and that the bias reducing performance of the jackknife procedure for the kernel density estimate can be improved by using an optimal trimming proportion α^* for the trimmed mean.

2. Kernel Density Estimates

Given an iid sample $X_1, X_2, \ldots, X_n$, in practice it is often necessary to estimate the density f(x) at a point x, of the distribution F which generated the random sample. Kernel density estimators $\hat{f}_n(x)$ is a class of estimators that are used for this task; it is defined by

$$f_n(x) \equiv \frac{1}{nh_n} \sum_{i=1}^{n} K\left(\frac{x-Y_i}{nh_n}\right) \quad (2.1)$$

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where

n is the sample size;

k is an specified kernel function which satisfies

(i) $\sup_x |k(x)| < \infty$

(ii) $\int k(x)dx = 1$ (2.2.)

(iii) $\lim_{x \to \infty} |xk(x)| = 0$

(iv) there is a positive integer r which satisfies

$$\int x^i k(x)dx=0 \text{ for } i=1,2,\ldots,r-1,$$

$$\int x^r\, k(x)\, dx \neq 0,$$

and $\int |x^r k(x)| dx < \infty$

The usual choices for K are probability density functions like the normal distribution;

h_n is the window or band width and is chosen in an optimal manner in the sense of integrated mean square error, and is a function of the distribution F; hence we write $h_n = h(F)$.

3. Kernel Density Estimators as Statistical Functionals

Let F_n denote the empirical distributions function determined by the sample $X_1,\ldots, X_n$; thus

$$F_n(x) = \frac{1}{n} \sum_{i=1}^{n} \delta(x-X_i)$$

where $\delta(t) = \begin{cases} 0 & \text{if } t < 0 \\ 1 & \text{if } t \geq 0 \end{cases}$

We can rewrite (2.1) as

$$\hat{f}_n(x) = \int \frac{1}{h_n} K\left(\frac{x-y}{h_n}\right) dF_n(y) \qquad (3.1)$$

thus $f_n(x)$ depends on the data $X_1,\ldots,X_n$ only through the distribution F_n and is therefore a functional of the form $T(F_n)$. $T(F_n)$ estimates a parameter $T(F)$ of the underlying distribution F; in kernel density estimation, $T(F) = f(x)$ the density of x. Rustagi, Javier and Victoria (1989) derived its influence curve as

$$t_1(F_n;x,y) = \frac{1}{h_n} K\left(\frac{x-y}{h_n}\right) + \frac{1}{b} K\left(\frac{x-y}{b}\right) \qquad (3.2)$$

where $b = \sup \{h_n\}$. At the underlying distribution F, the influence curve is

$$t_1(F;x,y) = \frac{1}{b} K\left(\frac{x-y}{b}\right). \qquad (3.3)$$

4. Characterization of a Trimmed Jackknife Estimates In a Statistical Functional

Following Hinkley and Wang (1980), let the statistical functional $T(F)$ be estimated by $T(F_n)$, where F_n is the empirical distribution function determined by observations $X_1,X_2,\ldots,X_n$ from F. Denote by $F_{n,-j}$ the empirical distribution or function based on the same observations $X_1,X_2,\ldots,X_n$ with the jth observation X_j removed. Then the jth pseudo value is defined by

$$P_{n,-j} = n\,T(F_n)-(n-1)\,T(F_{n,-j}) = T(F_n) + (n-1)\,[T(F_n) - T(F_{n,-j})] \qquad (4.1)$$

for $j = 1,2,\ldots, n$.

Let these pseudo values be arranged as an ordered statistic $P_{(n-1)} \le P_{(n-2)} \le \ldots \le P_{(n,-n)}$.

For a given trimming proportion α (say $\alpha = .05$), we remove the first α smallest and the largest α largest pseudo values and average the remaining $n(1-2\alpha)$ pseudo values. This average is the α-trimmed jackknife estimate for $T(F)$, given by

$$T_{n,\alpha} = \frac{1}{n(1-2\alpha)} \sum_{j=r_\alpha+1}^{n-r_\alpha} P_{(n,-j)},$$

$$r_\alpha = [n\alpha]. \qquad (4.2)$$

Using a Taylor's expansion for $T(F_n)$, Hinkley & Wang (1980) evaluated the expression inside the square bracket in (4.1), which when substituted in (4.2) yields a characterization for $T_{n,\alpha}$ in terms of its first order Von Mises derivative:

$$T_{n,\alpha} = t^{\alpha}(F) + n^{-1} \sum_{j=1}^{n} t_1^{\alpha}(F;X_j) + O_p(n^{-1}). \qquad (4.3)$$

where

$$t^{\alpha}(f) = \frac{1}{1-2\alpha} \int_{\alpha}^{1-\alpha} L^{-1}(u)\,du\ ; \qquad (4.4)$$

$$L(y) = P_r[T(F) + t_1(F;X) \le y]; \qquad (4.5)$$

$$t_1(F;x) = \frac{d}{dt}\,[T(F+ t(\delta_x-F)) - T(F)]\Big|_{t=0} \qquad (4.6)$$

the first order Von Mises derivative (Von Mises 1948), also called the influence curve of the statistical functional $T(F)$ (Hampel, 1974);

$$t_1^{\alpha}(F;x) = [t_1(F;x)]_{\alpha}^{1-\alpha} + E[t_2(F\cdot x,Y|$$

where

$$t_2(F;x,Y)=\frac{d}{dt}[t_1(F+t(\delta_y-F);\ x) - t_1(F;x)]\Big|_{t=0}$$

- the Von Mises second order derivative; (4.8)

δz is the degenerate distribution at Z;

and $[t_1(F;x)]_{\alpha}^{1-\alpha}$ is defined by

$$(1-2\alpha)[t_1(F;x)]_{\alpha}^{1-\alpha} = \begin{cases} L^{-1}(1-\alpha), & L^{-1}(1-\alpha) \le t_1(F;x) \\ t_1(F;x), & L^{-1}(1-\alpha) \le t_1(F;x) \le L^{-1}(1-\alpha) \\ L^{-1}(\alpha), & t_1(F;x) \le {}^{-1}(\alpha) \end{cases} \qquad (4.8)$$

5. Trimmed Jackknife Kernel Density Estimators

Denote by $f_{n,\alpha}(x)$ the α-trimmed Jackknife kernel density estimator. The representation for this estimator is obtained by specializing equations (4.3), (4.4), (4.5), and (4.6) to

$T(F) = f(x)$ the density of x, and $t_1(F;x)$ the influence curve to

$$t_1(F;X,Z) = \frac{1}{b} K\left(\frac{X-Z}{b}\right),$$

the influence curve of $T(F)=f(x)$ at the point Z given by (3.3). Define $t^{\alpha}(f(x)$ as the resulting expression for $T^{\alpha}(F)$ given by (4.3) when specialized to $T(F) = f(x)$.

6. Asymptotic Distribution for Jackknife Kernel Density Estimators.

Theorem 6.1 $\sqrt{n}\,[f_{n,\alpha}(x) -$

$$t^{\alpha}(f(x)] \sim AN(0, \sigma_2^2)$$

Proof: This follows from (4.3) by putting $T(F) = f(x)$ and

$t_1(F;x)$ to $t_1(F;X,Z) =$

$\frac{1}{b} K\left(\frac{X-Z}{b}\right)$, and by

invoking the Central Limit Theorem.

Remarks: (i) $\sigma_2^2 = Var\,(t_1^{\alpha}(F;x)|T=f(x|.)$.

(ii) It follows from (3.3) that the second order Von Mises derivative $t_2(F;X,Y)$ in (4.7) is zero; hence (4.7) reduces to

$$t_1^{\alpha}(f(x);\, x) = \int_{\alpha}^{1-\alpha} t_1(f(x);x,y]\, dy$$

$$= \begin{cases} L^{-1}(1-\alpha) & \text{if } L^{-1}(1-\alpha) \le \frac{1}{b} K\left(\frac{x-y}{b}\right) \\ \frac{1}{b} K\left(\frac{x-y}{b}\right) & \text{if } L^{-1}(\alpha) \le \frac{1}{b} k\left(\frac{x-y}{b}\right) \le L^{-1}(1-\alpha) \\ L^{-1}(\alpha) & \text{if } \frac{1}{b} K\left(\frac{x-y}{b}\right) \ge L^{-1}(1-\alpha) \end{cases} \qquad (5.1)$$

This is the influence curve of the estimators under study.

7. Influence Curve and Robustness of Trimmed Jacknnife Kernel Density Estiamtors

It has been observed (Javier, 1989 [2]) that an ordinary kernel density estimator, given by equation (2.1), is robust to outliers, since its influence curve (3.3) is continuous and bounded for most of the choices for the kernel function K(.). For the α-trimmed mean jackknife kernel density estimators, the influence curve is given by (5.1): it is bounded and continuous for most of the choices for K(.). Hence, following Hampel (1974), the trimmed jackknife kernel density estimators are robust to outliers, since its influence curve (5.1) is bounded. They are also insensitive to wiggling or grouping of data points, since (5.1) is continuous and has bounded derivatives for most K(.).

8. Improving the Bias Reducing Performance of the Jacknnife Kernel Density Estimators.

The ordinary kernel density estimators (2.1) is biased. To reduce bias, jackknifing technique is resorted as was done by Rustagi & Dynin (1980) on the OHIO breast cancer data. They have shown that under certain regularity conditions the bias can be improved from $O(h^r)$ down to $O(h^{r+\alpha})$, $\alpha > 0$, h is the bandwith which goes to zero with increasing sample size n, and r is a positive integer defined in (2.2). For α-Trimmed jackknife density estimators with trimming proportion α, Javier (1989 [1]), gave an expression for the bias $B(\alpha)$ as a function of α, $0 < \alpha < 1/2$:

$$B(\alpha) = \frac{1}{1-2\alpha}\left\{\int_{X_\alpha}^{X_{1-\alpha}} \{\frac{1}{b} K(\frac{x-y}{b})-m] dF(y) + \int_{L^{-1}(\alpha)}^{L^{-1}(1-\alpha)} [\frac{1}{b}K(\frac{x-y}{b})-m]dF(y) + L^{-1}(1-\alpha)L(L^{-1}(1-\alpha)+f(x)) + L^{-1}(\alpha)\ L\ (L^{-1}\alpha) + f(x)\right\} + Op(n-1),\quad (0<\alpha<\frac{1}{2});$$

$$m = E[\frac{1}{b}\ K\ (\frac{x-Y}{b})]$$

Observing that bias $B(\alpha)$ is positive, becomes unbounded as $\alpha \longrightarrow 12^-$, and that its derivative $B'(\alpha)$ is negative for α close to zero, Javier (1989) concluded that there is an optimal trimming proportion α* which minimizes the bias. This means that the bias reducing performance of the jackknife kernel density estimators can be improved by using an appropriate trimming proportiion α*. A computer search for α* is now being initiated and will be reported in a future paper.

9. Application

The technique presented in this paper was used on the OHIO breast cancer data and was reported in a paper by Rustagi, Javier, and Victoria (1989).

10. Acknowledgement

Support in the preparation of this paper from the Philippine National Science Society (NRCP) is hereby gratefully acknowledged.

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Philippine Statistical Association (PSA)
(Affiliated with the International Statistical Institute)

The PSA was organized in 1953 to promote the development of the statistical profession in the country and the improvement of statistics in all relevant fields of scientific applications. Membership in the Association therefore, while selective, is not limited only to professional statisticians but is also open to all kinds of professionals in various disciplines and institutions with serious interest in the sound application and use of statistical methods or theories in these fields.

The **Philippine Statistician** is the official journal of the PSA. It aims to publish a wide range of papers of technical, theoretical or applied statistical nature and considered of general or special interest to varied groups of statisticians.

Manuscripts submitted to the **Philippine Statistician** must neither have been published or are being elsewhere considered for publication. They will be referred. Two well-typed and complete copies should be sent to the Editor, **Philippine Statistician**, Philippine Social Science Council, Commonwealth Avenue, Diliman, Quezon City.

Notes for authors

1. Two copies (original and duplicate) of the manuscript should be submitted. They should be typed double-spaced and on one side of the paper only with ample margins (at least 30 mm) on all four sides.

2. The institutional affiliate of each author including the postal address should be indicated.

3. The manuscript should include in the beginning a single paragraph of the summary which should not contain a formula followed by keywords in alphabetical order.

4. The corrections are: *italics* are underlined by a straight line, **bold-faced** by a wavy line, Greek by a red line, and script letters are encircled in blue, graphs, figures and diagrams should be drawn expertly in Indian ink on separate plain white paper roughly twice the size they are to appear in print.

5. All long formulas are to be displayed in separate line and numbered consecutively. However, short formulas which are included in the text should be written in linear form such as (a+b)/(c+d) instead of

$$\frac{a+b}{c+d}$$

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Dissertation Abstracts

BERSALES, LISA GRACE S. (1990). Optimal Combination of Forecasts. Ph.D. dissertation, University of the Philippines.

The combination of two competing forecasts is recommended as an alternative to choosing one and discarding the other. Optimality of the combined forecast in terms of unbiasedness and minimum mean square error of prediction is discussed. Estimation of the optimal combined forecast is done for the case when the competing forecasts are generated by regression models and for the case when the models generating the competing forecasts are unknown. The combination of quarterly and monthly forecasts is considered as a special case. Data analyses involving forecasting Consumer Price Index in the Philippines are used to numerically illustrate the advantage of using combined forecasts.

TEEHANKEE, BENITO L. (1989). A Comparison of the Effectiveness of the Unrelated Question Randomized Response Technique with a Standard Questionnaire Technique Using Stigmatized Behavior in De La Salle University as a Model. Master of Statistics Thesis, University of the Philippines.

This study gives a historical overview of the development of the randomized response technique (RRT) and validates the unrelated question variation of the technique using cheating and drug use among De La Salle University students as a focus.

The validation was done using two classroom-administered surveys: one using the randomized response technique (n = 538) and the other using a standard technique (n = 244). Obtained data were transformed logarithmically and z tests performed to compare mean estimates from the two methods.

Results showed that compared to the standard direct questionnaire, the RRT method gave significantly higher estimates of both types of sensitive behaviors - signifying less evasive response bias when the method is used. There was, however, no difference in non-response rates between the randomized response technique and the standard technique.

The impressive performance of RRT compared to direct questioning suggests that the method can be used when dealing with sensitive topics similar to those covered by the study and for comparable target subjects. The method can be feasibly applied through a mass-administered questionnaire without using complicated randomizing devices as long as instructions are clearly given.

SORIANO, MINA L. (1987) A Graphical Method for Separation of a Mixture Distribution into its Gaussian Components Applied to Fish Length-frequency Distribution. Master of Statistics Thesis, University of the Philippines.

A modified method of Gregor's algorithm for decomposition of a mixture distribution into Gaussian components is presented here as applied to discrete mixture distributions of constant class interval. This new method called Modified Gregor method (MG) uses the local modes to estimate the mean of components and the area around the mean for estimating the variance and subgroup population components. The Kolmogorov-Smirnov statistic is used for goodness of fit test of the composite distribution.

This method has proven to be comparable and efficient as the commonly used graphical technique called Battacharya method. It is applied here to length-frequency distributions of fish data as a tool for the preliminary analysis in the study of fish population dynamics.

. Furthermore, a graphical computer program has been developed for the MG method. It is written in BASICA language for IBM PC or compatible with graphics card.

The Philippine Statistical Association (PSA) held its Annual Conference on 14 July 1989 at the Central Bank Cafetorium. The theme of the conference was "Statistics for the 1990s".

The Chairman of this year's Annual Conference was Ms. Chulia J. Azarcon of the Tariff Commission who acted as emcee. Welcome remarks were delivered by the Vice President of the PSA, Ms. Nelia Marquez of the National Statistics Office (NSO). The presence of representatives from the various regional chapters of the PSA was acknowledged. A total of 340 delegates attended the conference, composed of government officials and employees, and representatives from the private sector. The Polytechnic University of the Philippines, the National Statistics Office and other government agencies, and the University of the Philippines Los Banos sent a good number of delegates to the Conference.

Two papers were presented during the conference. The first paper, entitled "Trends in Information Technology: Implications on the Philippine Statistical System" was submitted by Dr. Emmanuel Velasco of the SGV and Co., and was presented by Mr. Jaime del Rosario of SGV. Dr. Velasco's paper dealt with dramatic trends in information technology and the manner in which these developments would impact on the statistical system in its effort to provide accurate and efficient information. The discussants were Dr. Hector Morada, Chief Statistical Research Coordinator of the Statistical Research and Training Center and Dean Emma Teodoro of the De La Salle University.

The second paper, entitled "Strategies for Improving the Quality and Utilization of Statistical Information" was presented by its authors, Professor Ceferino Sinsioco, Director of the Statistical Research and Training Center and Dr. Rudy Tan, Manager of the Statistics Department of United Laboratories. The paper advocated the use of Strategic Quality Management for Statistical Information as an approach to upgrade the quality of statistical information and to optimize the utilization of such information. Dr. Isidoro David, Head of the Statistics Unit of the Asian Development Bank and Dr. William Torres, Managing Director of the National Computer Center were the discussants.

After the presentation of the papers, an open forum was held with Director Heidi Arboleda of the National Economic and Development Authority as moderator.

Guest speaker for the occasion was Secretary Rainerio O. Reyes of the Department of Transportation and Communications. In his address, Secretary Reyes underscored the need for reliable statistical information in solving the many pressing problems of the country's transportation and communications system. As a gesture of appreciation and thanks, the PSA awarded a certificate of life membership in the PSA to Secretary Reyes.

The President of the PSA, National Statistics Office Administrator Tomas P. Africa delivered the closing remarks.

A brief report of the papers read at the Conference and the ensuing discussions are hereby presented.

"TRENDS IN INFORMATION TECHNOLOGY"

Mr. Jaime del Rosario of the Sycip, Gorres and Velayo, Inc. presented the paper written by Dr. Emmanuel T. Velasco on the latest trends in information technology. Dr. Velasco traced the evolution of information technology from its beginnings in the 1940s to its present role of providing people the opportunity to collect, store and retrieve voluminous information at the shortest possible time and at the least cost. He discussed the following recent advances in computer technology:

1) the 386-chip-based work stations which allow for greater storage capacity and higher processing speeds;

2) high volume transaction processing with the aid of personal computers;

3) relational database management systems which provide users with a much simpler and more comprehensible view of data than the traditional systems;

4) enhanced graphic software capabilities which provide end-users with the capability to develop presentation graphics in color;

5) development of electronic maps;

6) development of scanning technologies/pattern recognition.

7) artificial intelligence and expert systems;

8) smart card/laser card;

9) use of optimal storage media with the use of laser technology; and

10) fiber optics advances in telecommunications technology which reduce installation space, increase transmission capacity and free transmissions from electrical interference.

In practical terms, these advances allow for increased data storage capacity; increased information processing speed; increased use in transaction systems; powerful analysis and modelling functions; increased storage space for documents and images; ultra-high transmission of large quantities of information in the form of data, images and text; image management systems; networking of workstations; and the ability to make the best choices from a large number of options. These developments in information technology provide various opportunities to meet the growing needs of the Philippine statistical system. Specific application possibilities were discussed in the paper.

Dr. Hector Morada's Discussion:

Dr. Morada defined information technology and compared this with statistical methods. In this comparison, parallelism was drawn between the two fields of interest and important components were identified for purposes of analysis. These are 1) data; 2) sources of data; 3) organization manning and supervising system; 4) the technology or methodology; and 5) users of the systems output. Dr. Morada emphasized that while the technology or methodology is important, the process of gathering data is more important since the most expensive technology is nothing if the data quality is poor. Hence, the challenge posed to practitioners is how to use information technology in the orderly and accurate collection of data from a multitude of sources. Although information technology is an indispensable element of the Philippine statistical system, it cannot solve many of its problems such as organization, coordination, standardization and data quality. More than information technology and improved statistical methods, strong resolve and political will are also important in improving the Philippine statistical system.

Dean Emma Teodoro's Discussion:

Dean Teodoro looked at the implications of global trends in information technology on the Philippine statistical system. For one, she pointed out that although the cost of hardware has been going down, that of software has been on the rise. Hence, the total cost can still be very high, which is the reason why developing countries like ours still lag far behind developed countries when it comes to information technology. Another reason why information technology is expensive is the tax structure which is higher for both computers and parts thereof. Dean Teodoro also mentioned certain areas in computer technology which statistician may utilize, such as queueing, compression, algorithm, etc.

"ON A STRATEGY FOR IMPROVING THE QUALITY AND UTILIZATION OF STATISTICAL INFORMATION

This paper, presented by Professor Ceferino Sinsioco and Dr. Rudy Tan, was primarily concerned with the quality of statistical information and its optimal utilization. Quality is defined in terms of "fitness for use" and "freedom from deficiencies". The problems that result in the sub-optimal utilization of statistical information are discussed. The paper's centerpiece is a recommendation for a strategy for improving quality, called the strategic Quality Management for Statistical Information (SQMSI). SQMSI is based on the Juran Trilogy, a structured approach for managing quality developed by Dr. Joseph M. Duran. The use of SQMSI is expected to produce quality statistical information by "designing quality even during the pre-planning stage rather than just inspecting quality during the editing process". In addition to specific recommendations regarding the implementation of the SQMSI, the paper submits other recommendations regarding the institution of a statistical data management program, i.e., updating of the statistical information technology, development of statistical database systems and the strengthening of the statistical consulting program.

Dr. Isidoro David's Discussion:

Although Dr. David agreed with the paper's objective of improving the quality and utilization of statistical data, he regarded the authors' definition of quality statistical information as unworkable for an operational definition. Dr. David believed it is time a working definition of quality of data is made. The definitions should be operational and estimable, i.e., with measurement values attached to the concepts. Dr. David also disagreed with the idea that all duplications are bad. According to him, some duplications in the collection of statistical data may be healthy and desirable. On improving data utilization, Dr. David suggested the establishment of public use of files as another step. With regard to the paper's specific recommendations, Dr. David viewed the proposal to create councils and committees as additional red tape which do not really solve the problem. Dr. David particularly objected to the recommendation regarding accreditation of statistical consultants and the accreditation of such in all research projects involving statistical applications.

Dr. William Torres' Discussion:

On his part, Dr. Torres gave his own simple definition of quality, which is "in accordance with specifications". This definition, however, requires an answer to the question of who will make the specifications. Another point he emphasized was the necessity to study the size of the project specification before talking about strategies. According to him, the business statistics-oriented strategy of Juran may not be appropriate for national statistics. In addition, quality statistical data can be achieved by improving the process of producing statistics and the first strategy, he says, should be to shorten the process. The second strategy would be to improve the information exchange among participants in the process. Accessibility of public files is also an area which should be looked into. Dr. Torres concluded by saying everybody, and not only statisticians, should be concerned with producing quality statistical information.

Speech of Secretary Rainerio O. Reyes

After a brief address to the participants in the Annual Conference, Secretary Reyes proceeded with background information about his Office, the Department of Transportation and Communications -- its five sectoral offices and 13 attached agencies and corporations. In his talk, the Secretary provided various statistical data such as the average waiting time before a commuter can get a ride during rush hours, occupancy rates of buses, average number of LRT passengers per day, the number of buses that have to be fielded to alleviate the transport crisis, etc. In addition, Secretary Reyes underscored the important role played by statistics in the development of transportation and communications reports and studies. In particular, statistical systems and formulas were used for studies involving the national telephone program such as a study on the update on the telecommunications network and development plan, telephone demand and verification study. Based on studies such as these; the Department of Transportation and Communications sets targets and formulates policies. The Secretary focused on two of the Department's most current targets - on land transportation and on telecommunications. For his parting words, the Secretary enjoined the Philippine Statistical Association to assist the Department of Transportation and Communications through the provision of more statistical inputs relevant to the Department's functions.

C.J. Azarcon

The First Summer Workshop in Theoretical and Applied Statistics
11 April to 11 May 1989

1. The Workshop

A summer workshop on modern methods of improved estimation of fundamental statistical quantities was held in the Statistical Center from 11 April to 11 May 1989. Fifteen participants from both academe and government attended in addition to about ten resource persons who came for discussions on special topics. The workshop consisted of a lecture/discussion on modern techniques of estimation for one and a half hours and another one-half hour of discussion on the needs of government and industry. The workshop was partially funded by a grant from the Statistical Research and Training Center.

2. Why the Workshop

The workshop was conceived for two purposes. Statistics plays a fundamental role in national economies. Governments depend on accurate and valid estimates of various quantities for policy and decision-making. The workshop aimed at the fundamental problem in unbiased estimation of such quantities such as probability density, hazard function and information. The major aim of the workshop was to provide an up-to-date development of theoretical and practical techniques to Statisticians in the Philippines. The workshop was also a venue for dialogue among academe, government and industry.

3. Workshop Output

In addition to the lecture and discussion on modern estimation techniques, dimension reduction and software development, the workshop identified some problems that need attention. Among these are:

(a) underutilization of academic expertise by government and industry;

(b) academe is not fully aware of the statistical needs of government and industry;

(c) government and industry have inadequate knowledge of modern and up-to-date statistical techniques;

(d) data gathered by both government and industry are underutilized;

(e) the role of the Statistician in government and industry is not fully recognized.

4. What must be done

The workshop recommends the following among others to meet the needs issuing from the problems cited above:

(a) Organization of an annual workshop where academe, government and industry can meet and discuss issues that need attention. Such a workshop should consider a specific theme around which lectures, talks and discussion should devolve;

(b) Formalizing the linkage between academe and government so that government data will be made accessible to academe.

A well-organized and adequately funded annual workshop should stimulate not only dialogue but also vigorous research in theoretical as well as applied statistics. Mathematicians may also find research topics motivated by actual statistical problems.

M. Morada

B. Roscom

I. de Mesa

A.M. de Guzman

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1989 Individual Members

Malumay, Vilma M.
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Mangaran, Armele J.
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Manguba, Virginia B.
Manguni, Seraline L.
Margallo, Virginio T.
Marquez, Lauro T.
Martin, Minerva D.
Martinez, Josephine G.
Martinez, Narcisa C.
Masilungan, Pacito H.
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Mercado, Aster I
Mercado, Danilo J.
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Monta, Florentina D.
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Monteclaro, Flordeliza
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Morada, Marietta A.
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Ocaya Joy Doris A.
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Osorio, Bing
Osorio, Nieves L.
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Palos, Leonisa E.
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Papa, Linda S.
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Parcon, Gaye A.
Pardo, Aludia Z.
Parial, Marilou L.
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Pascual, Marle Joy B.
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Paterno, Margarita Carmen
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Pena, Sophie P.
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Peralta, Ma. Teresa D.
Perez, Errol B.
Perez, Josie B.
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Ajero, Lorna May
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Alaban, Roberto, Jr.
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Alatiit, Annie C.
Albacea, Eliezer A.
Alday, Herminio N.
Aldecoa, Lourdes T.
Alejandrea, Eliseo
Almario, Analyn P.
Almario, Myra C.
Aloba, Teresa D.
Alvarez, Manuel O.
Alvaro, Flerida C.
Amandy, Winifredo G.
Amar, Marissa C.
Amora, Vicente C.
Angeles, Regina A.
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Aperocho, Estelito V.
Aquino, Carmelita P.
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Asuncion, Ninah S.
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Baluca, Patricio L.
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Callos, Remeses G.
Calvelo, Gerardo O.
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Castro, Lina V.
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Chua, Rosario C.
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Cordial, Jenette H.
Coronel, Ma. Theresa S.
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Cruz, Raul C.
Cruz, Remedios A.
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Cubinar, Gloria A.
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Dagdagan, Felicidad
Dahandal, Udasa N.
Dalag, Roberto M.
Daplas, Rosalie L.
Dayrit, Francisca N.
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De Castro, Modesta M.
De Castro, Severa B.

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Duka, Joey A.
Dulay, Resurreccion
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Dumayag, Tessie C.
Duran, Heidi F.
Durante, Ma. Ofelia
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Engracia. Luisa T.
Ericta, Carmelita N.
Esclamad, Katrina
Escobillo, Evangeline M.
Escuadro, Rico Hipolito R.
Esleta, Azucena P.
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Espinoza, Marites
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Francisco, Marissa Q.
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Gabilla, Gloria E.
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Homocillo, Lourdes V.
Hufana, Lourdes J.
Hwang, Peggy May T.
Ignacio, Veronica
Ilustre, Mary Grace G.
Israel, Zenaida S.
Itaas, Estela C.
Jacob, Zenaida
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Jamero, Baltazar L.
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Javier, Virgilio E.
Javier, Walfredo R.
Jawili, Cristina E.
Jimenea, Nora M.
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Jimenez, Anne F.
Jimenez, Dionisia C.
Joaquin, Anton Von S.
Juan, Mabini L.
Juinio, Regina
Kho, Kathleen U.
Labina, Charlie S.
Lafiguera, Lagrimas L.
Lagunilla, Wilhelmina O.
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Lamela, Llorena G.
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Lao, Wilfredo C.
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Legaspi, Stella Marie I.
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Arboleda, Heidi R.
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De Guzman, Generoso G.
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Ono, Mitsuo
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Parel, Cristina P.
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