ABSTRACTS OF PAPERS

(Abstracts of papers presented at the New York meeting of the Institute, December 27–30, 1949)

1. The Asymptotic Distribution of the Extremal Quotient. E. J. Gumbel, New York, and R. D. Keeney, Metropolitan Life Insurance Company, New York.

The extremal quotient is the ratio of the largest to the absolute value of the smallest observation. Its analytical properties for symmetrical, continuous and unlimited distributions are obtained from a study of the auto-quotient defined as the ratio of two non-negative variates with identical distributions. The relation of the two statistics is established by proving that, for sufficiently large samples from an initial distribution with median zero, the largest (or smallest) value may be assumed to be positive (or negative) and that the extremes are independent. The logarithm of the extremal quotient has asymptotically a symmetrical distribution. Its median is unity. As many moments exist for the extremal quotient as moments and reciprocal moments exist simultaneously for the initial variate. For the exponential type of initial distributions, the asymptotic distribution of the extremal quotient can only be expressed by a complicated integral which may be approximated in the interval $\frac{1}{2} < q < 2$ by the logarithmically transformed normal probability function. In this case, no moments exist. For the Cauchy type, the asymptotic distribution of the extremal quotient is very simple. The logarithm of the extremal quotient has the same (logistic) distribution as the midrange for initial distributions of exponential type. For both initial types, the asymptotic distributions of the extremal quotients possess one parameter which may be estimated from the observations.

2. A Second Formula for Partial Sums of Hypergeometric Series having the Unit as Fourth Argument. Hermann von Schelling, Naval Medical Research Laboratory, U. S. Submarine Base, New London, Conn.

If the arguments α and β are changed after the summation, published *Ann. Math. Stat.* Vol. *20*, (1949) p. 120, and this method is applied a second time, a new formula results for partial sums of $F(\alpha,\beta,\gamma;1)$. A simple recurrence formula is developed for these partial sums. The new equation is a numerical short cut as it is demonstrated with an example.

3. A Coverage Distribution. Herbert Solomon, Office of Naval Research, Washington, D. C.

Consider a fixed target circle of radius T_R and center at a distance R from an aiming point. Let N circles each of radius W_R be dropped at the aiming point with their centers subject to a bivariate normal distribution with circular symmetry, the common standard deviation denoted by σ. Define γ as the set theoretical sum of the N random circles with the fixed circle and let c be the ratio of γ to the total area of the fixed circle. Then it is desired to find P_{c_0} where

$$P_{c_0} = P\{c \geq c_0 \mid T_R, W_R, R, N\}$$

where T_R, W_R, and R are in σ units. Define $R^* = W_R + aT_R$ where $a = a(c, W_R, T_R)$; $|a| \leq 1$. It is shown that for $N = 1$, the family of curves in the RR^* plane defined by P_{c_0} = constant have a slope, m, given by

$$m = \frac{I_1(RR^*)}{I_0(RR^*)}$$

where I_k is the modified Bessel Function of k^{th} order. In fact as the product

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RR^* approaches infinity, m approaches unity. From these results, the contours of equal probability are easily determined. When $N > 1$, overlap considerations make the computation of explicit values for P_{c_0} intractable. However, in this case, upper and lower bounds for P_{c_0} can be obtained.

4. The Problem of the Greater Mean. R. R. BAHADUR AND HERBERT ROBBINS, University of North Carolina, Chapel Hill.

"Optimum" solutions (in the sense of Wald's theory of statistical decision functions) are obtained for the "problem of the greater mean". Let π_i $(i = 1,2)$ be normal populations with means m_i and common variance σ^2, all unknown, and denote the arbitrary but given set of possible parameter points $\omega = (m_1, m_2 : \sigma)$ by Ω. Suppose that a set of $n_1 + n_2$ independent observations is drawn, n_i from π_i, and let $v = (x_{11}, \cdots, x_{1n_1}; x_{21}, \cdots, x_{2n_2})$ denote the sample point. Any measurable function $f(v)$ such that $0 \leq f(v) \leq 1$ is called a decision function. Given a "risk function" $r(f \mid \omega)$ defined for all f and all $\omega \epsilon \Omega$, a decision function $f^*(v)$ is "optimal" if (*i*) $\sup[r(f^* \mid \omega)] = \inf \sup [r(f \mid \omega)]$, and (*ii*) no decision function is "uniformly better" than $f^*(v)$. If $f^*(v)$ is the unique (up to sets of measure 0) decision function with property (*i*), it is "optimum". *Case* 1. Given any decision function $f(v)$ and any $\omega \epsilon \Omega$, let

$$r(f \mid \omega) = \max [m_1, m_2] - m_1E [f \mid \omega] - m_2E[1 - f \mid \omega].$$

Let

$$f^\circ(v) = \begin{matrix} 1 \text{ if } \bar{x}_1 > \bar{x}_2 \\ 0 \text{ otherwise} \end{matrix} \qquad \left(\bar{x}_i = n_i^{-1} \sum_{j=1}^{n_i} x_{ij}\right)$$

It is shown that under certain conditions on Ω, $f^\circ(v)$ is optimum. *Case* 2. Given any decision function which takes on only the values 0 and 1, corresponding to the two decisions "$m_1 \leq m_2$" and "$m_2 \leq m_1$" respectively, and any $\omega \epsilon \Omega$, let

$$r(f \mid \omega) = P(\text{incorrect decision} \mid \omega, f).$$

It is shown that under certain conditions on Ω, $f^\circ(v)$ is optimal. The conditions on Ω are very similar in the two cases, and are likely to be satisfied in most applications. However, it is shown by examples that there exist non-degenerate types of Ω with respect to which decision functions other than $f^\circ(v)$ are *uniformly better* than $f^\circ(v)$. The methods of the paper can be applied to a number of similar problems.

5. Some Extensions of Bayes' Theorem. F. C. Leone, Case Institute of Technology, Cleveland 6, Ohio.

There is some past or *a priori* knowledge about the quality of a population of lots and a sample is taken from a random lot. What can be said about the lot from which this sample is taken? We are incorporating the results of our experiment or sample with the previous knowledge to form a judgment. From the *a priori* distribution and a sample of n with c defectives, say two in twenty-five, we form an *a posteriori* distribution of all two in twenty-five cases. From this distribution we can answer questions such as: "What is the *a posteriori* probability that a lot producing a two in twenty-five result should have a proportion of defectives ten per cent or below?" We consider as our *a priori* situation such distributions as the rectangular, triangular, normal, Pearson's Type III and Type I. These extensions are applied to some industrial data. In considering lot quality on one hundred per cent inspection, the *a priori* distributions of these data are mostly U-shaped with some bell-shaped and J-shaped. In some cases a Pearson Type I proves to be a good fit for the *a priori* distribution.

6. **On Optimum Selections from Multinormal Populations.** Z. W. BIRNBAUM AND D. G. CHAPMAN, University of Washington, Seattle.

Let $(X, Y_1, \cdots, Y_n)$ have an $(n + 1)$-dimensional non-singular normal probability density $f(X, Y_1, \cdots, Y_n)$. By "selection" in $(Y_1, \cdots, Y_n)$ we shall understand a measurable function $\varphi(Y_1, \cdots, Y_n)$ such that $0 \leq \varphi \leq 1$ for all $Y_1, \cdots, Y_n$. By a "truncation in $(Y_1, \cdots, Y_n)$ to the set Ω" we understand a selection $\varphi(Y_1, \cdots, Y_n)$ such that $\varphi = 1$ for $(Y_1, \cdots, Y_n)$ in Ω, and $\varphi = 0$ in Ω. A "linear truncation" will be a truncation to a set defined by a condition of the form $\sum_{c=1}^{n} c_i Y_i \geq k$. Using a slight generalization of Neyman-Pearson's fundamental lemma, the following theorems are proven: among selections for which the expectation of X, after selection, assumes a fixed value, the one which maximizes the "retained" portion of the universe $\int \cdots \int \varphi(Y_1, \cdots, Y_n) f(X, Y_1, \cdots Y_n) dX dY_1 \cdots dY_n$ is a linear truncation. Among all the selections for which a given quantile of X, after selection, assumes a fixed value, the one which maximizes the retained portion of the universe is a linear truncation. (Research under the sponsorship of the Office of Naval Research).

7. **Simple Regression Analysis with Autocorrelated Disturbances.** HOWARD L. JONES, Illinois Bell Telephone Company, Chicago.

When the disturbances in a regression equation are connected by a linear difference equation, the parameters of both equations can be estimated simultaneously by maximizing a function that describes the joint probability of the disturbances or a linear function thereof. This note discusses a simple example.

8. **A Test of Klein's Model III for Changes of Structure.** A. W. MARSHALL, The Rand Corporation, Santa Monica, Calif.

This paper suggests a test of equations from linear stochastic equation systems on the basis of observations not included in the original computation period. Rejection regions of approximately the right size (asymptotically correct) are constructed and the use of naive economic models as an auxillary test are suggested. The procedure is applied to Klein's Model III, the results are tabulated and discussed.

9. **An Application of the Theory of Extreme Values to Economic Problems.** S. B. LITTAUER, Columbia University, AND E. J. GUMBEL, New York.

Most studies of economic time series have been concerned with establishing regularities of behavior, often by analogy with mechanical systems. Much as regularity in economic phenomena is desirable, such evidence as has been available leaves the reality of this sought for regularity considerably in doubt. It seems more fruitful rather to ask the question, "What is the pattern of the non-regularity" and if reasonably answered, to offer some verifiable form of explanation therefor. It seems further desirable that any attempt at "scientific" explanation of economic phenomena be fortified by evidence of statistical stability supported by criteria such as were established by Shewhart for the control of quality of manufactured product. In the present instance certain concepts of experimental inference, which seem natural therefor, are employed in order to give some general and plausible unity to the behavior of economic time series.

Following upon the postulates of the theory presented here, the appropriate formal development employs concepts of statistical quality control and of the statistical theory of extreme values. Within this theory the importance of the absence of statistical stability is emphasized, and the relevance of the use of concepts in extreme values is made evident. By introducing a superuniverse, peaks and troughs are random expressions of a super chance-"cause" system. The use of these statistical concepts is not motivated by mere analogy but rather as the natural means for explanation of the phenomena studied.

A number of examples of the application of these statistical methods to selected series are offered as evidence of the workability of the theory here presented. The extremes of the Dow-Jones index of selected industrials show that the 1928 value was completely outside the previous levels and should not have been considered as a "stable high plateau basic for perpetual prosperity". Instead this should have suggested the imminent breakdown. The validity of the application of the theory of extreme values to these phenomena is not so strongly substantiated as are the many applications that have been made of them to flood frequencies, wind velocities, extreme temperatures, breaking strengths and other natural phenomena. Nevertheless the results here obtained are highly suggestive of a tenable economic hypothesis.

10. Bias Due to the Omission of Independent Variables in Ordinary Multiple Regression Analysis. (Preliminary Report). T. A. Bancroft, Iowa State College, Ames.

Given n observations of the dependent variate y and the independent variates x_1, $x_2, \cdots, x_k, \cdots, x_r$, $k < r$, all variates measured from their respective sample means, and we have calculated the ordinary regression of y on the first k variates and y on all r variates. We define ordinary multiple regression as the single-equation approach, error only in y which is assumed normally and independently distributed with zero mean and variance σ^2, the x_i being fixed from sample to sample.

In order to determine whether to omit or retain the last $(r - k)$ independent variates we formulate a rule of procedure: calculate Snedecor's $F =$

$$\frac{\text{Reduction in } Sy^2 \text{ due to } (r-k) \text{ variates}/(r-k)}{\text{Error mean square after fitting all } r \text{ variates}}$$

If F is non-significant at some assigned significance level α, we pool the sums of squares and degrees of freedom, involved in the numerator and denominator of F, to obtain an estimate of the error σ^2, and fit y on the first k variates only. If F is significant at the assigned significance level we use the denominator only in F for our estimate of σ^2 and hence fit y on all r variates.

The object of this investigation is to determine the bias in our estimate e^* of σ^2, if we follow such a rule of procedure. The bias turns out to be

$$\frac{2\sigma^2\lambda}{n_1+n_2} + \sigma^2 e^{-\lambda} \sum_{i=0}^{\infty} \left[I_{x_0}\left(\frac{n_2}{2}+1, \frac{n_1}{2}+i\right) - I_{x_0}\left(\frac{n_2}{2}, \frac{n_1}{2}+i\right) \frac{-2i}{n_1+n_2} I_{x_0}\left(\frac{n_2}{2}, \frac{n_1}{2}+i\right)\right] \frac{\lambda^i}{i!},$$

where
$$x_0 = \frac{n_2}{n_2+n_1\alpha}, \qquad \lambda = \frac{\sum_{i=k+1}^{r} (\beta_i')^2}{2\sigma^2},$$

n_1 and n_2 are the respective degrees of freedom for the numerator and denominator of F, and $\sum_{i=k+1}^{r} (\beta_i')^2$ is a function of the population regression coefficients $\beta_{k+1}, \cdots, \beta_r$. The bias is discussed for selected values of the parameters involved.

11. Estimating Parameters of Pearson Type III Populations From Truncated Samples. A. C. Cohen, Jr., The University of Georgia, Athens.

The method of moments is employed with 'single' truncated random samples (1) to estimate the mean, μ, and the standard deviation, σ, of a Pearson Type III population when α_3 is known and (2) to estimate μ, σ, and α_3 when only the form of the distribution is known in advance. No information is assumed to be available about the number of variates in the omitted portion of the sample. The results obtained can be readily applied to practical problems with the aid of "Salvosa's Tables of Pearson's Type III Function." An illustrative example is included in the paper.

12. The Cyclical Normal Distribution. E. J. Gumbel, New York.

The usual normal distribution becomes invalid for variates, like an angle, lying on the circumference of a circle. The distribution of such variates was established by R. von Mises by the same methods as used for the classical derivation. The cyclical normal distribution is symmetrical about a mode and antimode. The probability function is proportional to an incomplete Bessel function of the first kind and of order zero for an imaginary argument, and contains two parameters, the direction of the resultant vector and a parameter k linked to the absolute amount of the vector. The parameters may be estimated by the method of maximum likelihood. For $k = 0$, the distribution degenerates into a uniform cyclical distribution. If k is of the order 3, the distribution approaches the linear normal one, k being the reciprocal of the variance. With increasing values of k, the distribution looses its cyclical character and becomes concentrated in a narrow strip. This distribution holds for symmetrical unimodal values varying according to pure chance about a unique mode in a closed space (as the angles of the wind directions) or a closed time, and gives a theoretical model for the variations of temperatures, pressures, rainfalls, storms, discharges, floods, death- and birth rates over the year, and earth quakes over the day. The comparison between theory and observations in plotting the square roots of the frequency on polar coordinate paper provides a statistical criterion for the regularity of cyclical phenomena. (Work done in part under contract W 44/109/QM/2202 with the Research and Development Branch, Office of the Quartermaster General).

13. Treatment of Attenuation Problems by Random Sampling. H. Kahn and T. Harris, The Rand Corporation, Santa Monica, Calif.

Exact analytical calculations of the transmission of energy by particles through shields are difficult; to avoid them random sampling methods may be resorted to. The straightforward procedure of simulating life histories of particles, using random number tables, may be used for thin shields, but in the case of thick shields with tremendous attenuations, tremendous numbers of particles would be required. In order to obtain reasonably small standard errors, using reasonable numbers of simulated life histories, it is necessary to modify the original problem to one having a lower attenuation factor, the solution bearing a known relation to the solution of the original problem. Alternatively, this may often be regarded as an application of well known statistical sampling procedures, such as representative sampling or importance sampling. Various special procedures can be devised. One of the first was the splitting technique due to J. v. Neumann. Among others may be mentioned the exponential transformation, a simple analytic transformation of the original problem into one having a much lower attenuation factor.

14. On the Existence of Nearly Locally Best Unbiased Estimates. Herman Rubin, Stanford University, Stanford, Calif.

For any family $\mathcal{F}$ of distributions, and any distribution F_0 of $\mathcal{F}$, there exists a bilinear function K whose arguments are all parameters defined for all distributions of $\mathcal{F}$ and for which there exist unbiased estimates which have finite variance if F_0 is the true distribution, and which has the following properties: (1) If θ is any parameter in the domain of K, and t is any unbiased estimate of θ, then $var(t \mid F_0) \geq K(\theta, \theta)$. (2) This result is best possible, i. e., for any θ there is an unbiased estimate t of θ whose variance differs from $K(\theta, \theta)$ by less than any preassigned amount.

15. The Experimental Evaluation of Multiple Definite Integrals. GEORGE W. TAYLOR, U. S. Army Electronics Laboratory, San Diego, Calif.

When one is forming an estimate of the total, or mean value, of some quantity, sampling at carefully selected points will frequently be preferable to employing a method which involves randomization. The estimation of the total volume of water in a given lake or the amount of energy being released in a given time and space, are examples of problems where specified points for sampling should result in a reduction in the error of estimate. These and similar problems lead naturally to numerical integration methods. In the case of single integrals, Gauss' and Tchebychef's formulae yield maximum efficiency with respect to controlling the polynomial error and statistical error respectively, but often the Newton-Cotes formulae can be applied more conveniently.

For the evaluation of double integrals, an eight point and a thirteen point formula for fifth degree accuracy and a twelve point and a twenty-one point formula for seventh degree accuracy have been developed for integrating over a rectangle and similar formulae have been developed for integrating over areas bounded by a parabola and a straight line or by two parabolas. The following system of equations is employed in developing these formulae:

$$\sum_{\alpha=1}^{m} R_\alpha x_\alpha^i y_\alpha^j = C_{ij}, \quad \text{for all } i, j \text{ for which } i + j \leq 2n,$$

$$\text{and where } C_{ij} = \frac{a^{i}b^{j}}{(i+1)(j+1)} \text{ for both } i \text{ and } j \text{ even,}$$

$$= 0 \text{ otherwise.}$$

Formulae for the numerical evaluation of triple integrals taken over a rectangular parallelopiped are developed, including a twenty-one point formula with fifth degree accuracy. It is shown that comparable formulae can be developed for integrating functions of more than three variables and a $2n + 1$ point formula with third degree accuracy for integrating a function of n variables over a rectangular n-space is obtained.

16. Tests of Fit of a Cumulative Distribution Function over Partial Range of Sample Data. BRADFORD F. KIMBALL, New York State Dept. of Public Service, New York.

Case 1. Sample data are completely ordered over range tested.

Let the $n + 1$ true frequency differences associated with an ordered random sample of n values of x be denoted by u_i. The *cdf* of a theoretical test function based on m of the above frequency differences is identified and methods of approximating it are discussed.

Case 2. Sample data in k ordered groups over range tested.

Let $\Delta_i F$ denote the true frequency differences over the k sample intervals to be covered by the test. Let m_i denote the number of unit frequency differences u_i covered by the *ith* interval. Define M and W by

$$M + 1 = \sum_k m_i, \qquad M \leqq n;$$

$$W = \sum_k \Delta_i F, \qquad W \leqq 1.$$

A theoretical function Z is defined by

$$Z = \frac{(M + 1)(M + 2)}{k - 1} \sum_k \frac{[\Delta_i F - m_i W/(M + 1)]^2}{m_i}.$$

Set

$$Y = Z/W^2.$$

The *cdf* of Y is identified and methods of approximation to it are discussed.

Applications to testing agreement of sample with hypothetical *cdf* of universe are considered for both cases in some detail.

17. Large Sample Tests for Comparing Percentage Points of Two Arbitrary Continuous Populations. A. W. Marshall and J. E. Walsh, The Rand Corporation Santa Monica, Calif.

Let us consider two continuous populations, the first with density function $f(x)$ and $100\alpha\%$ point θ_α, the second with density function $g(x)$ and $100\beta\%$ point ϕ_β. These two populations are arbitrary except that $f(\theta_\alpha) \neq 0$, $g(\phi_\beta) \neq 0$ and both $f'(\theta_\alpha)$, $g'(\phi_\beta)$ exist and are continuous in the vicinity of the specified points. This paper presents significance tests for $\theta_\alpha - \phi_\beta$ which are based on large samples from these populations. The exact significance level of a test is not known but its value is bounded within reasonably close limits (asymptotically). Efficiency properties of these tests (compared to the corresponding noncentral t-tests) are investigated for the case in which both populations are normal and the ratio of variances is known. Results are also derived for simultaneously testing $\theta_\alpha - \phi_\beta$ and $f(\theta_\alpha)/g(\phi_\beta)$. These tests have known significance levels (asymptotically). A particular application of tests of this type occurs when it is desired to test whether two samples came from the same population and agreement of the two populations in a specified region is to be emphasized. For this special case, the significance levels of the resulting tests are reasonably accurate for moderate as well as large sized samples.

18. On the Distribution of Wald's Classification Statistic. H. L. Harter, Michigan State College, East Lansing.

A study is made of the distribution of the classification statistic introduced by Wald. The exact distribution of V in the univariate case, as obtained by the use of characteristic functions and contour integration, is given for both degenerate and non-degenerate cases. The problem of classifying an individual into one or the other of two populations, using the statistic V, is discussed. In the multivariate case, examples are given of the distribution of an approximation to V suggested by Wald. The procedure here consists integrating out two variables from the joint distribution of three variables to find the distribution of the third. Four cases arise, depending upon whether the sample size and the number of variates are even or odd. Since this approximation is valid only for large samples, an attempt is made to find an approximation which is asymptotically equivalent to it as the sample size increases, but which is valid also for small samples. Results are given for a sampling experiment performed to determine an empirical distribution of V for a specific small sampling case, using a population of 10,000 pieces modeled after Shewhart's normal bowl. Obstacles in the path of practical applications are discussed.

19. Analysis of Extreme Values. W. J. Dixon, University of Oregon, Eugene.

Consider a population $N(\mu, \sigma^2)$ contaminated by introducing a certain proportion of values from a population $N(\mu + \lambda\sigma, \sigma^2)$ or $N(\mu, \lambda^2\sigma^2)$. The performance of various statistics for discovering these contaminators is assessed by sampling methods for samples of size 5 and 15. (This research was sponsored by the Office of Naval Research).

20. A Note On The Variance Of Truncated Normal Distributions. A. C. Cohen, Jr., The University of Georgia, Athens.

Formulas are derived whereby the variance of truncated normal distributions can readily be computed with the aid of an ordinary table of areas and ordinates of the normal frequency function. These results are applicable to certain tolerance problems involved in Statistical Quality Control. Their use will enable one to make computations required in solving such problems without resorting to Karl Pearson's relatively inaccessible tables of "Values of the Incomplete Normal Moment Functions".

21. Some Estimates and Tests Based on the r Smallest Values in a Sample (By Title). J. E. Walsh, The Rand Corporation, Santa Monica, Calif.

Let us consider a situation where only the r smallest values of sample of size n are available. This paper investigates the case where n is large and r is of the form $pn + 0(\sqrt{n})$. Properties of some well known estimates and tests of the $100p\%$ population point (based on statistics of the type used for the sign test) are investigated. If the sample is from a normal population, these nonparametric results have high efficiencies for small values of p (at least 95% if $p \leq 1/10$). The other investigations are restricted to the case of a normal population. Asymptotically "best" estimates and tests of the population percentage points are derived for the case where the population variance is known. If the population variance is unknown, asymptotically most efficient estimates and tests can be obtained for the smaller population percentage points by suitable choices of p and $0(\sqrt{n})$. The results of the paper have application in the field of life testing. There the r smallest sample values can be obtained without the necessity of obtaining the remaining sample values. By starting with a larger number of units but stopping the experiment when only a small percentage have "died", it is often possible to obtain the same amount of "information" with a substantial saving in cost and time over that required by starting with a smaller number of units but continuing until all have "died".

22. Some Comments on the Efficiency of Significance Tests (By Title) J. E. Walsh, The Rand Corporation, Santa Monica, Calif.

A method sometimes used to measure the efficiency of a significance test consists in associating a statistic with the test and defining the efficiency of the test to be the efficiency of this statistic considered as an estimate. This paper investigates the power function implications of this method of defining the efficiency of a test. Examples are presented which show that an estimate efficiency of $100E\%$ does not necessarily imply that the corresponding most powerful test based on $100E\%$ as many sample values has approximately the same power function as the given test (for the admissible set of alternative hypotheses). In several of the examples it was found that estimate efficiency makes no allowance for the effect of significance level while the relationship between the power functions of the given test and the corresponding most powerful test changes noticeably with respect to significance level. Some of these examples are non-asymptotic while others are asymptotic. However, results are obtained for the asymptotic case which indicate that this equality of power functions does hold for a rather broad class of significance tests if the pertinent statistics have distributions which are asymptotically normal.

23. Application of Sequential Sampling Method to Check the Accuracy of a Perpetual Inventory Record. Joseph B. Jeming, New York.

The problem of checking the continuing property records of a large utility company is handled by an application of the sequential sampling method as developed by the Statistical Research Group, Columbia University. Without the application of a sampling procedure the problem can only be solved either by a complete physical inventory which is very costly, or by a cycle check which takes many years to complete. By use of the sequential sampling method, results of desired accuracy are obtained quickly and at very low cost since an extremely small percentage of field inspection for the mass property accounts of any large utility produces satisfactory conclusions.

NEWS AND NOTICES

Readers are invited to submit to the Secretary of the Institute news items of interest.

Personal Items

Dr. Ralph A. Bradley accepted an appointment as Assistant Professor in the Mathematics Department of McGill University, Montreal, Canada after receiving his Ph.D. in mathematical statistics at the University of North Carolina in June, 1949.

Mr. Fred J. Clark, Jr. received his master of science degree in mathematics from the University of Illinois in August, 1949 and is now employed by the University of California at the Sandia Laboratory in Albuquerque, New Mexico.

Professor J. L. Doob is on leave from the University of Illinois to teach at Cornell University for the academic year 1949–1950.

Mark W. Eudey obtained his Ph.D. degree in statistics at the University of California, Berkeley, and is now Vice President of California Municipal Statistics, Inc.

Dr. Joseph L. Hodges, Jr. has been promoted to Assistant Professor and Research Associate at the Statistical Laboratory, University of California, Berkeley.

Professor Paul Horst, formerly of the Department of Psychology, University of Washington, is now Director of Research at the Educational Testing Service, Princeton, New Jersey.

Dr. Fred C. Leone, formerly an Instructor and a Research Fellow at Purdue University, has been appointed Instructor in the Mathematics Department and Director of the Statistical Laboratory at the Case Institute of Technology.

Mr. Fred W. Lott, who has been studying at the University of Michigan for his Ph.D., has accepted an assistant professorship at Iowa State Teachers College, Cedar Falls, Iowa.

Dr. Francis McIntyre has resigned as Director of Export Control, Office of International Trade, U. S. Department of Commerce, Washington, D. C. to accept a post as Director of Economic Research, California Texas Oil Co., 551 Fifth Avenue, New York, New York.

Mr. R. B. Murphy, who has been a graduate student at Princeton University has accepted an instructorship in the Mathematics Department of Carnegie Institute of Technology.

Professor Jerzy Neyman, Director of the Statistical Laboratory, University of California at Berkeley, will be on sabbatical leave for the Spring Semester, 1950.

Mr. Monroe L. Norden, formerly of the Glenn L. Martin Co., is now a Mathematical Statistician with the Operations Research Office, Johns Hopkins University, Ft. Lesley, J. McNair, Washington 25, D. C.