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A Monte Carlo Study of Pearson and Log-Linear Chi-Square One Sample Tests with Small N

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A MONTE CARLO STUDY OF PEARSON AND LOG-LINEAR CHI-SQUARE ONE SAMPLE TESTS WITH SMALL N

by

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VITA

The author, Adam James Miller II, is the son of Adam James Miller, Sr. and Mabel (Hansen) Miller. He was born June 23, 1920, in Chicago, Illinois.

His elementary education was obtained in the public schools of Chicago, Illinois. His secondary education was obtained at St. John's Military Academy, Delafield, Wisconsin, where he graduated in 1937.

In September, 1937, he entered M. I. T., and in June, 1941, he received the degree of Bachelor of Science with a major in Business and Engineering Administration. While attending M. I. T., he also was a special student at the Harvard Graduate School of Education during 1939.

From April, 1941, to February, 1944, he was Assistant Plant Engineer and Assistant to the Superintendent of Hull and Machinery Outfitting at North Carolina Shipbuilding Company, a subsidiary of Newport News Shipbuilding and Drydock Company. From February, 1944, to May, 1946, he served as an Engineering Officer in the United States Navy Reserve. During this period, as a civilian, he supervised the construction of the least expensive Liberty Ship ever built. He also received a commendation for delivering the least expensive pair of LSM ships at any navy yard and converted this same type of ship to missile launchers in minimum time. The last year of his naval service was spent as Personnel and Engineering Officer for a division of 990 people, having a budget of $900,000,000.per annum.

In 1941, he purchased a partnership in a Texaco distributorship, devoting part-time to that enterprise as well as devoting himself to other interests, including employment as a Production Engineer at Chicago Screw Company (1946 to 1948). After that, he devoted full-time effort to the gasoline distributorship, becoming senior partner and, therefore, president of the succeeding corporation. From a nadir in 1948, sales were increased to over $2,000,000 in 1954.

Desiring to return to academia and a teaching career, the author enrolled as a student in Loyola University of Chicago's Graduate School of Business in April, 1970. He received the M.B.A. degree with a major in Quantitative Methods in June, 1971. From June, 1971, to date, he has been a student in Loyola University's Graduate School of Education. In addition, he served as a Lecturer, Educational Foundations, Loyola University, in the fall and spring semesters of 1977-1978.

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CHAPTER I

INTRODUCTION

Until recently most of the literature of the social, behavioral, educational, and philosophical sciences was expository, descriptive, or historical in nature, as described in part by Stephen Issac and William B. Michael.[1] As these authors imply, such approaches lack sophistication and complexity of experimental design, statistical manipulation, and analysis, which was not due to a paucity of excellent books or courses of instruction available in the early 1900's, but rather to a defection from experimentation to essay writing. Campbell and Stanley believed that disillusioned rejection of the scientific method was based upon over-optimistic expectations regarding the experimental approach, difficulty of securing adequate data, and the rejection of favored hypotheses.[2] Most techniques could handle only a few variables at a time. This lack of ability

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[1] Stephen Issac and William B. Michael, Handbook in Research and Evaluation (San Diego: Robert R. Knapp, 1971), pp. 17-23.

[2] Donald T. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research (Chicago: Rand McNally and Company, 1963), pp. 1-6.

to account for extraneous and concomitant variables was the greatest fault of the then available statistical procedures. Obviously much of this disenchantment was also due to the lack of the general reader's competency in the allied disciplines of tests and measurements, which was later verified by S. T. Mayo.[1] However, of equal importance were the negative attitudes of educators toward quantitative thinking.

As more and more behavioral scientists became familiar with the scientific method and the differences between descriptive and inferential statistics, the level of research writing improved in quality. This rejuvenation occurred in the 1930's with the influx of governmental funding due to renewed Army and Navy interest in psychological and educational testing for decision making and personnel selection and classification.[2, 3]

Needless to say, so far as the physical sciences were concerned, experimental designs and analyses were more advanced in stature than those of the socio-behavioral sciences. This disparity was evidenced by the test statistics that were used to verify or reject the null hypotheses that

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[1]Samuel T. Mayo, Pre-Service Preparation of Teachers in Educational Measurement (United States Department of Health, Education, and Welfare, 1967), pp. 61-62.

[2]Robert L. Ebel, Essentials of Educational Measurement (Englewood Cliffs, N. J.: Prentice-Hall, 1972), pp. 3-27.

[3]W. Allen Wallis and Harry V. Roberts, Statistics: A New Approach (Glencoe, Ill.: The Free Press, 1965), pp. 19-20.

were proposed and investigated. An examination of the publications of this period would demonstrate that the work in the physical sciences involved analysis of variance and covariance, factorial designs of various types, factor or discriminant analysis, and various multivariate analyses. Unfortunately, educational and psychological audiences were not yet ready to understand and interpret this kind of advanced research. Most research reports in such a vein were concerned with differences between the means of the groups or the measures of relationships of the groups studied. Of course, present readers recognize these approaches as reports utilizing the t-test statistic[1] and the chi-square test statistic[2] for contingency or cross-break tabulation, almost entirely with two categories.

As the review of related literature will demonstrate, reader and researcher competency has advanced to the point where the physical and the behavioral scientists are no longer so divergent in knowledge of the components of research design and analysis as they formerly were. In 1938-1939, when Philip J. Rulon was first involved in promulgat-

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[1]The "t" variable and test statistic are discussed in many basic statistic texts, such as T. H. Wonnacott and R. J. Wonnacott, Introductory Statistics (New York: John Wiley and Sons, 1969). These authors give an historical perspective to the statistic introduced by Gossett, writing under the pseudonym, "Student", later validated by R. A. Fisher.

[2]Karl Pearson, "Experimental Discussion of the Chi-square Test for Goodness of Fit," Biometrika, 1932, 24, pp. 351-381.

ing his formula for calculating split-half test reliability[1], a grant was received from the World Book Company and the Committee on Scientific Aids to Learning to research the effectiveness of a series of phonographic recordings in terms of knowledge, comprehension, motivation, and attitude changes. Despite the fact that Rulon and his assistants were all well versed in behavioral research techniques and statistics, it was decided to report the results utilizing multiple t-tests. The rationale was that the number of consumers of the monographs would be greater than if analysis of variance or factorial designs had been used.[2]

The revival of interest in the scientific and statistical approach and the concurrent increased recognition of socio-behavioral science as a science was based upon the evolution of the digital computer - the parent of "the knowledge and information explosion". The first hint that the logic and apparatus of the physical sciences could be applied to the third force - behavioral sciences - was the realization that electro-mechanical devices could be applied to problems other than those of science and engi-

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[1]Philip J. Rulon, "A Simplified Procedure for Determining the Reliability of a Test by Split-halves," <u>Harvard Educational Review</u>, 1939, 9, pp. 99-103.

[2]Philip J. Rulon and others, "A Comparison of Phonographic Recordings with Printed Materials," <u>Harvard Educational Review</u>, 1943, 13, a series of 4.

neering. In 1937 Vannevar Bush designed a differential analyzer at M. I. T. capable of negating the criticism that educational and psychological research was based only upon a small number of variables. The differential analyzer could handle 27 variables. This fact opened a broad vista to the speedy solution of technological and engineering problems. It was only a matter of time that digital computers would become refined and generally available to all disciplines. This revitalized the socio-behavioral studies whose potency had been previously restricted by the number of variables that could be considered in that ultimate mechanism - man.

Eventually, software packages for statistical inference and hypothesis testing were developed to the degree that the average student could conduct meaningful research analyses of both simple and complex designs. Most of these packages are concerned with parametric statistics that are well understood and conceptualized. However, the assumptions used in these techniques are often forgotten or ignored. Fortunately, much research has been conducted that demonstrates the degree to which these assumptions, such as independence of the variables and the parametric form of the distribution, can be violated and still result in a robust procedure, especially when the sample size is large and the central limit theorem applies.

Lindgren, for example, states:

> Statistical problems involving normal distributions arise in many applications in which a population is adequately (if sometimes only approximately) represented by a normal distribution. The mathematics involved in treating normal populations is especially tractable and therefore highly developed and procedures derived on the assumption of normality frequently turn out to be 'robust' - Their applicability is somewhat insensitive to moderate departures from normality.[1]

Many studies of various experimental designs have been made by Raymond O. Collier and Frank B. Baker to compare the power of the F-test under permutation (randomization) versus the normal theory power evaluation.[2] Although the designs considered were mainly randomized block and repeated measures designs, the findings are applicable to the simple one sample tests used in this study since the F-test statistic is a ratio of two chi-squares. The essential findings were that the normal theory power evaluations only slightly overestimated those arrived at by permutation.

Conversely, nonparametric statistics do not usually make any assumptions except that the random variables be independent, and with the recent revisions such as those made

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[1]Bernard W. Lindgren, Statistical Theory, 1st ed. (New York: The MacMillan Co., 1960), p. 315.

[2]Raymond O. Collier, Jr. and Frank B. Baker, "Some Monte Carlo Results on the Power of the F-test Under Permutation in the Simple Randomized Block Design," Biometrika, 1966, 53, pp. 199-203; "Analysis of Experimental Designs by Means of Randomization, a Univac 1103 Program," Behavioral Science, 1961, 6, p. 369; and others referenced later in this study.

to the SPSS, SPS, BIOMED, and other packages, behavioral scientists can now compute a variety of nonparametric statistics from One-sample Chi-square tests to Kruskal-Wallis One-way Analysis of Variance.[1]

Although nonparametric statistics are often conceived as being "quick and dirty" second cousins to the parametric analogues, they should be considered as very useful tools of the practicing educator and the behaviorist, particularly when the investigator cannot make his measurements on an interval or ratio scale. It was previously noted that parametric statistics also require certain basic assumptions. The conditions which must be satisfied to make a parametric test most powerful are at least these:

1. The observations must be independent.

2. The observations must be drawn from normally distributed populations.

3. The populations have have the same variance (or a known ratio of variances).

4. The variables must have been measured in at least an interval scale.

5. For the F-test of analysis of variance, the means of these normal and homoscedastic populations must have effects that are additive.

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[1]Norman H. Nie and C. Hadlai Hull, et al, Statistical Package for the Social Sciences (New York: McGraw-Hill, Revision 7, 1977).

When the assumptions are fewer and weaker for a particular model, the conclusions that result can be generalized more, but the test of the null hypothesis is weaker. Siegel resolves this question of test selection by introducing the concept of power efficiency when the sample size available is such that a test with the larger sample is as powerful as another having a smaller sample size.[1] For example, if N = 30 in both cases, test A may be more powerful than test B. However, test B may be more powerful with N = 30 than is test A with N = 20. In this case, the experimenter does not have to choose between broad generality and power if the sample size can be enlarged for test A. This relationship is stated as follows: The power efficiency of test B = $(100)N_a/N_b$ percent. Thus the assumptions and scaling problems of parametric statistics can be avoided if there is a sufficiently large sample. This argument leads to a vital point in this study: What is the minimal sample size that can be used for selected tests involving the chi-square goodness of fit statistic?

Other vital points covered in this study are the chi-square statistic itself and the chi-square probability

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[1]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill, 1956), pp. 1-34.

distribution. The following chapter on a review of the literature will give some indication of the abundant use of the chi-square test for contingency tables. However, the primary concern is to compare the Pearsonian chi-square test and the log-linear maximum likelihood chi-square test. The use of the chi-square test is the least complex of the nonparametric tests. The one sample case will be the basis of the general discussion.

In order to obtain sufficient precision, a large number of one sample cases must be used to establish any of the premises made in this study. The Monte Carlo Method of simulation of an empirical experiment will be used to procure random sampling, as explained by J. M. Hammersley and D. C. Handscomb,[1] Jack P . C. Kleijnen,[2] Y. A. Schreider,[3] and I. M. Sobol.[4] In simulations of this type, researchers most often generate their random variables from a uniform or normal distribution. Donald E. Knuth states that random numbers should not be generated with a method chosen at

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[1]J. M. Hammersley and D. C. Handscomb, Monte Carlo Methods (Methuen and Company, 1964), pp. 1-42.

[2]Jack P. C. Kleijnen, Statistical Techniques in Simulation, Part I (New York: Marcel Dekker, Inc., 1974), pp. 1-48.

[3]Yu. A. Schreider, The Monte Carlo Method, trans. by G. J. Tee (Oxford: Pergamon Press, 1966), pp. 1-91.

[4]I. M. Sobol, The Monte Carlo Method (Chicago: University of Chicago Press, 1974), pp. 7-30.

random; some theory should be used as a basis for the generator.[1] This research purports the use of the gamma distribution of order $\nu/2$, which is Pearson's chi-square distribution with ν degrees of freedom. The rationale for this selection is the concern with one case samples of small size and where there is a great likelihood that such samples would be skewed rather than normal or uniform in distribution. Furthermore, use of random variables generated according to chi-square distributions of varying degrees of freedom and expected frequencies should substantiate Siegel's claim that nonparametric techniques are distribution free.[2]

Since the one sample case assumes nothing except that the random variables are independent, the concept of robustness - that is, the insensitivity of the violation of assumptions for a statistical procedure - does not enter into this study. As Siegel states:

> The literature does not contain much information about the power function of the χ^2 test. Inasmuch as this test is most commonly used when we do not have a clear alternative available, we are usually not in a position to compute the exact power of the test.

When nominal measurement is used or when the data con-

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[1]Donald E. Knuth, The Art of Computer Programming, vol. 1: Fundamental Algorithms; vol. 2: Seminumerical Algorithms; 7 vols. (Reading: Addison-Wesley Company, 1968 - 1973), 2:5.

[2]Siegel, p. 3.

> sist of frequencies in inherently discrete categories, then the notion of power-efficiency of the χ^2 test is meaningless, for in such cases there is no parametric test that is suitable. If the data are such that a parametric test is available, then the χ^2 test may be wasteful of information.
>
> It should be noted that when df >1, χ^2 tests are insensitive to the effects of order, and thus when a hypothesis takes order into account, χ^2 may not be the best test.[1]

The alternative to investigating the power function or the robustness of this test statistic is to analyze the "goodness of fit" for the samples that are generated. This rationale establishes the problem that will be researched.

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[1] Siegel, p. 47.

STATEMENT OF THE PROBLEM

As the review of related literature will demonstrate, prior research has made several comparisons of nonparametric tests and parametric tests based on the uniform, normal, exponential, and Poisson distributions. Therefore, the first problem is to devise an algorithm for a distribution whose use has been neglected, such as the chi-square distribution. The program should be capable of being easily understood, efficient in terms of micro-seconds necessary to generate the random numbers, and capable of producing these numbers with a high quantitative measure of randomness. The output should be of such form that the two types of chi-square statistics can be easily identified and sorted. The probabilities of each type of statistic should also be printed out concurrently with the cell frequencies that are generated for each iteration. Furthermore, the program should be comprehensive in nature, so that random numbers of good quality can be generated for distributions other than the chi-square if it is later found to be desirable to make comparisons between distributions.

An article by Fienberg about model fitting and goodness of fit tests was the impetus for this research which compares Pearson's chi-square test statistic, henceforth indicated as $X^2(P)$, and the log-linear likelihood test, henceforth indicated as $X^2(L)$.[1] Fienberg's article points out that for small samples it is not clear whether $X^2(P)$ or $X^2(L)$ is superior. The observations resulting from research by other writers will be covered in the section entitled REVIEW OF RELATED LITERATURE.

For the purpose of this study, two variables will be manipulated: (1) the number of categories from 4 to 8; (2) the expected cell frequencies 3, 5, and 10. Such action will result in one sample cases of sizes 12 to 80. Upon the basis of these one sample cases that are generated, a comparison will be made first to decide the superiority of $X^2(P)$ or $X^2(L)$ for small sample sizes and, in addition, secondarily will permit the following equal area model hypotheses to be evaluated:

$$H_0 = P_1 = P_{01} \qquad\qquad H_1 = \text{not } H_0$$
$$P_2 = P_{02}$$
$$\vdots \quad \vdots$$
$$P_k = P_{0k}$$

Furthermore, an ancillary third investigation will be to express $X^2(P)$ and $X^2(L)$ as a function of the expected cell frequencies, E(x), the degrees of freedom and α regions.

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[1]Stephen E. Fienberg, "The Analysis of Multidimensional Contingency Tables," Ecology, 1970, 51, pp. 419-433.

Since tests for goodness of fit are concerned with the probabilities in the upper tail of the distribution, this is the main criterion under which $X^2(P)$ and $X^2(L)$ will be compared. Where cumulative multinomial probabilities have been published for some of the small samples that will be generated, this information will also be given in order to make a more comprehensive decision about the errors involved in the approximations that are most commonly used.

Although the basic premise of this dissertation is that the parent populations are skewed, comparisons resulting from Gaussian random number generations will be made since great disparity is apparent for the same sample sizes, degrees of freedom, and expected values used in the chi-square distributions.

CHAPTER II

REVIEW OF RELATED LITERATURE

INTRODUCTION

In an important paper, Tukey posed many unsolved problems in experimental statistics, particularly in the area of client and consumer relationships with respect to complexity, inference, and assumptions.[1] While advising that the complexity of experimental statistics will clearly increase, he stated that the methodology should be tailored to the needs of the user. He writes:

> 'What should be done' is almost always more important than 'what can be done exactly'. Hence new developments in experimental statistics are more likely to come in the form of approximate methods than in the form of exact ones.

This is of interest, since in this study various one sample problems will be manipulated using Pearson's approximation to the chi-square distribution, the maximum likelihood ratio, and the exact multinomial probabilities.

Tukey goes on to state:

> In every statistical area, we almost certainly need methods admitting one more nuisance parameter, methods of one higher level of robustness and de-parametrization, methods with both of these desiderata. Here we may turn

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[1]John W. Tukey, "Unsolved Problems of Experimental Statistics," Journal of the American Statistical Association, 1954, 49, pp. 707-731.

> the carpet back to see the dirt - it is a large carpet trying to cover much dirt. We have a reasonably wide variety of procedures for analyzing counted data which assume pure binomial variation - contingency tables, chi-square, and ω^2 goodness of fit tests, Kolmogorov-Smirnov bounds on the population distribution and so on.

The crux of this study emphasizes some of Tukey's problems and questions, such as: "Statistics must continually study the behavior of its techniques when their conventional assumptions are not true." For example, many techniques assume homogeneity of variance, utilize a normality assumption almost exclusively as a means of predicting the stability of estimated variance, and discuss the efficiency of estimation assuming an underlying normal distribution. What about those experiments that do not meet these assumptions?

Tukey also presents some provocative questions that are related to this current study:

> What are we trying to do with goodness of fit tests? (Surely not to test whether the model fits exactly, since we know that no model fits exactly!)
>
> Why isn't someone writing a book on one and two sample techniques?[1]

Tukey's questions are now easier to answer. At the same time that Tukey was presenting his position, Cochran was espousing on the X^2 test of goodness of fit.[2] As a search of the literature would demonstrate, this problem

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[1]Tukey, p. 721.

[2]William G. Cochran, "The X^2 Test of Goodness of Fit," Annals of Mathematical Statistics, 1952, 23, pp. 315-345.

has been investigated in almost all aspects from 1900 when Pearson invented the test until the present. Formerly, the users tended to be more restrictive in their selection of α levels, subject to selecting rigid cut-off points for hypothesis testing, overly conservative, and selective in the choice of application or model fitting.

Since the 1950's, many standard texts have included chapters on nonparametric statistics and one and two sample techniques. Siegel's text is often utilized in this area, as referenced in the first chapter of this paper. For the student and user of statistical theory, there is Hays[1], as well as Walsh.[2] For the more advanced, Lindgren[3], Mood, Graybill and Boes[4], and also Johnson and Kotz[5] are suggested.

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[1]William L. Hays, Statistics for the Social Sciences, 2d ed. (New York: Holt, Rinehart and Winston, Inc., 1973).

[2]John E. Walsh, Handbook of Nonparametric Statistics (Princeton, N. J.: D. Van Nostrand Co., Inc., 1962).

[3]Bernard W. Lindgren, Statistical Theory, 1st ed. (New York: The MacMillan Co., 1960).

[4]Alexander M. Mood, Franklin A. Graybill, and Duane C. Boes, Introduction to the Theory of Statistics, 3rd ed. (New York: McGraw-Hill, 1974).

[5]Norman L. Johnson and Samuel Kotz, Distributions in Statistics, 4 vols. (New York: John Wiley and Sons, 1970).

Many journal articles and dissertations have concerned themselves with the X^2 test, particularly with respect to contingency tables, categorization, expected cell and sample size, substitutes for the Pearsonian X^2 statistic, model fitting, and the like. Therefore, because there is an abundance of publications in this area and because they pertain to and influence the use of the X^2 statistic in the one sample case, these articles will be reviewed in succeeding sections. Also, sections will be presented on the chi-square and the multinomial distributions, recent work on one sample cases, and the Monte Carlo experimental methodology.

LITERATURE ON DISTRIBUTION THEORY

The four-volume series by Johnson and Kotz on Distributions in Statistics, referred to in the previous section, seems destined to be an authoritative and definitive work in the statistical field and can be expected to become a standard reference, just as the articles of Cochran[1] and those of Lewis and Burke[2] on the chi-square test have become. Needless to say, the replies to the Lewis and Burke criticisms by Edwards[3], Pastore[4], and Peters[5], and the recapitulation of these replies by Lewis and Burke[6] form a part of this body of knowledge on the chi-square test methodology.

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[1] William G. Cochran, "The X^2 Test of Goodness of Fit," pp. 315-345.

[2] Don Lewis and C. J. Burke, "The Use and Misuse of the Chi-square Test," Psychological Bulletin, 1949, 46, pp. 433-489.

[3] A. L. Edwards, "On the Use and Misuse of the Chi-square Test - The Case of the 2 x 2 Contingency Table," Psychological Bulletin, 1950, 47, pp. 341-346.

[4] N. Pastore, "Some Comments on 'The Use and Misuse of the Chi-square Test'," Psychological Bulletin, 1950, 47, pp. 338-340.

[5] Charles C. Peters, "The Misuse of Chi-square - A Reply to Lewis and Burke," Psychological Bulletin, 1950, 47, pp. 331-337.

[6] Don Lewis and C. J. Burke, "Further Discussion of the Use and Misuse of the Chi-square Test," Psychological Bulletin, 1950, 47, pp. 347-355.

Before proceeding to discuss current literature about the one sample case, it would seem advantageous to review statistical distributions and the chi-square applications that are discussed historically and to consider the trends of current investigations. After publication, Kotz and Johnson made a subjective historical appraisal of over 2500 papers in the literature when they prepared their series on "Distributions in Statistics".[1]

They pointed out that originally distributions arose in connection with real-life situations and that in the latter part of the 19th century and early part of the 20th century, the studies were divided into two categories. One subdivision was the determination of sampling distributions based on variables having established distributions. The other was the study of systems of distributions with reference to use in model fitting. While the first of these has displayed prolonged interest that still continues in more and more complexity, model fitting is presently attracting revived interest. The works of Fienberg, Goodman, and Haberman, which are reviewed later, evoked this present investigation, the algorithm, and the Monte Carlo experiment.

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[1]Samuel Kotz and Norman L. Johnson, "Statistical Distributions: A Survey of the Literature, Trends, and Prospects," American Statistician, 1973, 27, pp. 15-17.

Kotz and Johnson state that during the period from 1925 to 1939 a number of new distributions were derived as variants of classical distributions and that this period was followed by a decade of interest in establishment of tables, approximations, and frequency moment estimators. From 1950 to 1959 there was a considerable interest in "robustness". This area is still under investigation as statisticians are displaying increased concern with multivariate analysis and maximum likelihood estimation. The value of this study of the chi-square statistic is supported by the number of articles that Kotz and Johnson have tabulated in the 1960-1969 period. In that period, references to the gamma, exponential, and non-central X^2 distributions even exceed those of the normal distribution. A multidimensional study by McNamee that is of particular pertinency to this study is reviewed later with respect to sample size and to expected and observed cell size.[1]

Quoting from an early journal article by Lancaster,[2] Johnson and Kotz place Pearson's X^2 approximation in a historical perspective that is often overlooked by all but

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[1]Raymond Joseph McNamee, "Robustness of Homogeneity Tests in Parallelepiped Contingency Tables" (Ph.D. Dissertation, Loyola University of Chicago, 1973), pp. 1-134.

[2]H. O. Lancaster, "Forerunners of the Pearson X^2," Australian Journal of Statistics, 1966, 8, pp. 117-126.

applied mathematical statisticians. Briefly, Lancaster states:

> Manipulations leading to a chi-square distribution or something much like it, have a history going back well before Karl Pearson's classic 1900 paper, in which the chi-square distribution was used to approximate the null distribution of the chi-square statistic for goodness of fit.
>
> Descriptions are given of a Bayesian derivation by Laplace of a gamma distribution for a precision parameter in a very special case; of a somewhat similar manipulation by Bienayme (1838) in a trinomial context; of Bienayme's asymptotic development (1852) of the gamma distribution for the sum of squared errors (not residuals) in the linear hypothesis context; of related work by Ellis (1844); and of Helmert's well known derivations (1875-1876) of the chi-square distributions for the (normed) sums of squared errors and residuals in the normal linear hypothesis case.

The gamma distribution derived by Laplace was the posterior distribution of the precision constant ($h=\frac{1}{2}\sigma^{-2}$) that causes the area of the Gaussian probability function to equal one, given the values of n independent normal variables with zero mean and standard deviation σ (assuming a uniform prior distribution for h). The origin of the Bayesian approach by Laplace was undoubtedly encouraged by Thomas Bayes' essay, published posthumously in 1763.[1] Where Bayes excelled in logical penetration, using the

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[1]Sir Ronald A. Fisher, Statistical Methods for Research Workers (New York: Hafner Publishing Co., 1958), 13th ed., pp. 20-21 citing Thomas Bayes, "An Essay Toward Solving a Problem in the Doctrine of Chances," Philosophical Transactions, 1763, liii, pp. 370-418.

theory of probability as an instrument of inductive reasoning, Laplace was a master of the analytical technique. He introduced the principle of inverse probability where the deduction of inferences respecting populations resulted from observations respecting samples. Fisher was adverse to this technique.

Similar work by Bienayme obtained the continuous χ^2 distribution as the limiting distribution of the discrete random variable $\sum_{i=1}^{k}(N_i - np_i)^2 (np_i)^{-1}$ when $(N_1 \ . \ . \ . \ N_k)$ have a joint multinomial distribution with parameters n, p_1, $p_2 \ . \ . \ . \ , p_k$. This will be discussed later in a following section as applied to this paper.

Laplace's work on the normal distribution was extended by Poisson, Bienayme, and Todhunter. Later, Sheppard studied the theme advanced by Bienayme of the distribution of a linear form in the class frequencies of a multinomial distribution and considered possible tests of goodness of fit for the multinomial distribution. As a test of goodness of fit, Sheppard proposed to work out the value of the difference of the observed frequency from the expected frequency for each cell of a contingency table and to see how often it exceeded its probable error. The similarity of this approach to that of Pearson is obvious, and he obtained his solution based upon the variance-covariance matrix rather than the matrix of a generalized contingency table proposed by Sheppard. Many others, such as Bravais, Schols, and Edgeworth, developed the study along the lines of the joint multivariate normal distribution.[1] However, this study is restricted to the approximations to the multinomial distribution, and succeeding sections will be essentially concerned with these relationships and problems.

[1] H. O. Lancaster, The Chi-squared Distribution (New York: John Wiley & Sons, 1969), pp. 2-3.

CHI-SQUARE DISTRIBUTIONS AND STATISTICS

A simplified explanation of the chi-square distribution may make later discussions of the distribution easier for the uninitiated reader to understand. Such explanations are presented in many basic textbooks, and a comprehensive presentation has been made by Glass and Stanley.[1] In order to construct the distribution whose mathematical curve was derived by Pearson in 1900, it is necessary to assume a huge population of scores that are essentially normally distributed with mean 0 and standard deviation 1. One then selects n scores X_n at random and calculates the standard score for each of them. The next step is to square each z score and sum them as follows: $z_1^2 + z_2^2 + \ldots z_n^2 = \chi^2$. Having selected many thousands of sets of X_n, one can then calculate the corresponding χ_n^2 and construct a frequency polygon of the values so obtained. If this frequency polygon is smoothed after many thousand values of χ_n^2 have been recorded and if the scale of the ordinate is adjusted so that the area under the curve is 1, the graph of the chi-square distribution with

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[1]Gene V. Glass and Julian C. Stanley, Statistical Methods in Education and Philosophy (Englewood Cliffs, N. J.: Prentice-Hall, 1970), pp. 228-232.

n degrees of freedom will be obtained. The area under the curve is set equal to 1 so that the distribution is a probability distribution, approximately the exact continuous multinomial distribution.

The X^2 distribution is the basis of a test statistic which is used for many purposes but is essentially used for the chi-square test of goodness of fit. As Cochran states:[1]

> In the standard applications of the test, the n observations in a random sample from a population are classified into k mutually exclusive classes. There is some theory or null hypothesis which gives the probability p_i that an observation falls into the ith class (i = 1, 2, . . . k). Sometimes the p_i are completely specified by the theory as known numbers, and sometimes they are less completely specified as known functions of one or more parameters $a_1, a_2 \ldots$ whose actual values are unknown. The quantities $m_i = np_i$ are called the expected numbers, where $\sum_{i=1}^{k} p_i = 1 \qquad \sum_{i=1}^{k} m_i = 1$
> The starting point in the theory is the joint frequency distribution of the observed numbers x falling in the respective classes. If the theory is correct, these observed numbers follow a multinomial distribution with p as probabilities.

The test criterion for the null hypothesis that the theory is correct, proposed by Pearson, is:

$$X^2 = \sum_{i=1}^{k} \frac{(x_i - m_i)^2}{m_i} = \sum_{i=1}^{k} \frac{x_i^2}{m_i} - n$$

A more common notation is:

$$X^2 = \sum_{i=1}^{k} \frac{(n_i - Np_i)^2}{Np_i} \text{ or } \sum_{i} \frac{(O_i - E_i)^2}{E_i} = X^2(P) = \sum_{\text{All cells}} \frac{(\text{observed} - \text{expected})^2}{\text{expected}}.$$

where $p_i = \phi_i$; $\sum n = N$ (the total sample size); and $E(x) = m$.

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[1]William G. Cochran, "The Chi-square Test of Goodness of Fit," p. 315.

Similarly, the multinomial probability is expressed as:

$$P(n_1, n_2, \ldots, n_k) = \frac{N!}{n_1!\, n_2! \ldots n_k!}\, p_1^{n_1}\, p_2^{n_2} \cdots\cdots p_k^{n_k}$$ [1]

There is a different chi-square distribution for each integer value of n (1, 2, 3, . . .). The properties of the curve depend upon the value of n, usually indicated as ν , the degrees of freedom. Glass and Stanley provide a partial description of the family of chi-square distributions:

1. The mean of a chi-square distribution with ν degrees of freedom is equal to ν .

2. The mode of χ^2 is at the point ν -2 for ν =2 or greater.

3. The standard deviation of χ_ν^2 is $\sqrt{2\nu}$.

4. The skewness of χ_ν^2 is $\sqrt{8/\nu}$. Hence every chi-square distribution is positively skewed, but the asymmetry becomes very slight for large degrees of freedom.

5. As the degrees of freedom become large, χ_ν^2 approaches more nearly a normal distribution with mean and standard deviation of $\sqrt{2\nu}$.

An important theorem that will be emphasized in the review of several journal articles that follows is:

If $\chi_{\nu_1}^2$ has a chi-square distribution with ν df. and if $\chi_{\nu_2}^2$ has a chi-square distribution with ν_2 df. and is independent of $\chi_{\nu_1}^2$, then $\chi_{\nu_1}^2 + \chi_{\nu_2}^2$ has a chi-square

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[1] In later sections $X^2(P)$ will represent the Pearsonian chi-square, $X^2(L)$ the likelihood ratio chi-square and (M) the multinomial probability.

[2] Glass and Stanley, pp. 231-232.

distribution with $\nu_1 + \nu_2$ df. This theorem is used in model fitting, partitioning, analysis of association, and other methodologies.

The importance of the chi-square variate is particularly evident when one considers that the t, X^2, and F distributions are all based on the normal distribution and are interrelated as:

$$t_\nu^2 = \frac{z^2}{\chi_\nu^2/\nu} = \frac{\chi_1^2/1}{\chi_\nu^2/\nu} = F_{1,\nu} \quad \text{and} \quad F_{\nu,\infty} = \frac{\chi_\nu^2}{\nu} .$$

APPLICATIONS AND CRITICISMS OF THE X^2 STATISTIC

Most of the early relevant literature has to do with the chi-square test and degrees of freedom, sample size, the misuse of the test, and possible substitutes for the statistic. As Cochran points out, the most common of all uses of the X^2 test is for the 2 x 2 contingency table, and a review of this r x c table is indicative of the errors and conflicts that have prevailed for many years. For example, in the 2 x 2 tables, Pearson attributed 3 degrees of freedom to X^2, whereas it should receive only 1, (r-1)(c-1).[1] Pearson made this correction at about the same time that Fisher was trying to verify Pearson's work using the multinomial as an exact test.[2] Dissonance of this type pervades the literature on chi-square and depends upon the kind of tables being considered, that is, whether one is considering a random sample from only one population, or if two populations are being compared, or if the two populations have fixed marginal totals in repeated sampling. This complexity increases as the dimensions of the contingency tables in-

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[1]Cochran, "X^2 Test," p. 319, and Lancaster, "The X^2 Distribution," pp. 170-178.

[2]Fisher, p. 96.

crease, as demonstrated in the dissertation of R. J. McNamee that has been previously mentioned.

The X^2 test and distribution is used in many experimental situations; however, the major applications are in testing the goodness of fit, independence, and homogeneity. Although this paper is concerned with a basic example of goodness of fit, the one sample case, many of the problems and concepts of the other applications are pertinent to this research. The theoretical frequencies and the corresponding sample size is a major consideration of most of the writers already cited. Other concepts are the normal approximation to the binomial, hypergeometric, and Poisson distribution, maximum likelihood, minimum X^2, moments, and cumulants.

Lewis and Burke discuss at great length the rule of thumb of having 5 or 10 as the expected cell frequencies. They state:[1]

> Many users and would-be users of the chi-square test gain erroneous impressions from what they read about limitations on the size of theoretical frequencies. A textbook says that frequencies of less than 10 are to be avoided. This statement is often interpreted to mean not that 10 is a limiting value to be exceeded whenever possible, but that 10 is a value around which the various theoretical frequencies may fall; and if an occasional frequency happens to be as low as 4 or 5, that is all right because other frequencies will be larger than 10 and everything will average out in the end. A textbook that gives 5 as the suggested minimum tends to encourage the retention of impossibly small theoretical frequencies. And so does a text

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[1]Lewis and Burke, "Use and Misuse of the X^2 Test," pp. 486-487.

which states, in effect, that Yates' correction for continuity should be applied if the cell frequencies are 5 or less and precision is desired. This implies not only that frequencies of less than 5 are quite acceptable, but also that Yates' correction is an antidote for small frequencies. Both implications are fallacious.

Yule and Kendall state:[1]

> In the first place, N must be reasonably large. . . It is difficult to say exactly what constitutes largeness, but as an arbitrary figure we may say that N should be at least 50, however few the number of cells.
>
> No theoretical cell frequency should be small. Here again it is hard to say what constitutes smallness, but 5 should be regarded as the very minimum, and 10 is better.

Hoel gives 5 as the recommended minimal value of the theoretical or expected frequency, but he emphasizes the importance of having a fairly large value of the total N by stating that, if the number of categories or cells is less than 5, the individual expected values should be larger than 5.[2] On the other hand, Cramer recommends a minimal value of 10 and states that, if the expected values, even after grouping, are less than 10, the chi-square should not be applied.[3]

Cochran recognizes these differences in opinion,

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[1]G. U. Yule and M. G. Kendell, <u>An Introduction to the Theory of Statistics</u>, 12th ed. (London: Griffin, 1940), p. 422.

[2]P. G. Hoel, <u>Introduction to Mathematical Statistics</u> (New York: Wiley & Sons, 1947), p.191.

[3]H. Cramer, <u>Mathematical Methods of Statistics</u> (Princeton: Princeton University Press, 1946), p. 420.

but he states that the value of the minimal expectation also depends upon the application of the test and the level of significance that has been selected as the criterion. For example, in the goodness of fit tests of bell-shaped curves such as the normal distribution, the expectations in the tails are small, and there is little disturbance to the 5% level when a single expectation is as low as 1/2. Cochran suggests using Fisher's exact multinomial test for 2 x 2 contingency tables in samples up to size 30. In tests in which all expectations are small, Cochran refers to the results of Neyman and Pearson, which support the contention that the tabular X^2 is tolerably accurate, provided that all expectations are at least 2. He also imposes the constraint that the degrees of freedom are less than 15. If the degrees of freedom exceed 60, Cochran suggests using the normal approximation to the exact distribution using Haldane's expressions for the mean and variance.

Most educational research does not have an excessive number of degrees of freedom or a large sample size and, since this paper is concerned with the nonparametric one sample case, Siegel's position on small expected frequencies should be considered. When there are only 2 categories, k, each expected frequency should be at least 5. When k categories are greater than 2, the chi-square test for the one sample case should not be used when more than 20 percent of the expected frequencies are smaller than 5 or when any expected frequency is smaller than 1. Expected frequencies sometimes can be increased by combining adjacent categories, but only if these resulting categories are meaningful. If one starts with but two categories or has but two categories after combining and has an expected frequency of less than 5, then the binomial test should be used rather than the chi-square test.

The modification of the rule of 5 is made in this study since McNamee found that the chi-square test for first order interaction is quite robust as far as sample size is concerned, when the expected frequency for each cell is as small as 3. He also found that if the cells have a minimum value of 1, the chi-square for second order interaction is within the limits of error for the 400 iterations used in his study.[1] This lower value is not used in this study since it is designed around the one sample case.

It should be obvious that the goodness of fit test is the primary emphasis of this monograph and a simple definition is in order. Goodness of fit tests are used to test the hypothesis that nature is in a certain specified state when the alternative hypothesis is the general one that nature is not in that state. As previously mentioned,

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[1]McNamee, pp. 104-105.

the X^2 test is most generally used. As cited by Lancaster:

> In the series, Mathematical Contributions to the Theory of Evolution, Karl Pearson introduced a number of theoretical statistical distributions, which were new to statistics, and among which the Type III is, after an appropriate choice of scale and origin, the distribution of χ^2 or alternatively the gamma-distribution. Given any particular set of empirical data, it became necessary to distinguish those distributions which fitted it closely from those which did not. Pearson realised that the normal curve had too often been accepted uncritically as fitting empirical data.
>
> Pearson had been much concerned with generalizing the univariate normal distribution to the general normal correlation; so that, it appeared natural for him to provide a normal approximation to the multinomial distribution. . . The symbol, χ^2 , was first introduced by Pearson (1896), where it was written in place of $\mathbf{x}^T\mathbf{R}^{-1}\mathbf{x}$ for brevity.
>
> Pearson's contributions to statistical theory were numerous but, perhaps, the greatest of them was the χ^2 test of goodness of fit, which has remained one of the most useful of all statistical tests. Pearson (1900a) states 'the object of this paper is to investigate a criterion of the probability on any theory of an observed system of errors, and to apply it to the determination of goodness of fit in the case of frequency curves'.[1]

It is self evident that the statistic can be applied to studies of parent populations other than that of the normal distribution. Various texts, such as those of Fisher, Lancaster, Lindgren and others, demonstrate the use of the chi-square test for the Poisson, exponential, hypergeometric and other distributions particularly in contrast to the estimates derived from maximum likelihood, likelihood ratio,

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[1]Lancaster, "The Chi-Square Distribution," p. 3.

moment and cumulant generation, and other tests.

The statistics that are derived from the sum of the powers are based upon the concepts of moments and cumulants. The first moment, m', is the arithmetic mean and is usually written $\bar{x}$, and it follows that the moments of the higher powers of a random variable or of a distribution are the expectations of the powers of the random variable which has the given distribution. If X is a random variable, the r^{th} moment of X, usually denoted by μ_r', is defined as $\mu_r' = E[X^r]$.[1] It follows that the second moment about the mean is the variance, the third moment is a measure of the skewness, and the fourth moment is the kurtosis.

The moments are properties resulting from a moment generating function which is defined by letting X be a random variable with density $f_X(\cdot)$. The expected value of e^{tx} is defined as the generating function if the expected value exists for every value of t in some interval $-h < t < h$; $h > o$. The logarithm of the moment generating function is defined as the cumulant function of X. The r^{th} cumulant, denoted by k_r, is the coefficient of $t^r/r!$ in the Taylor

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[1] Mood, p. 73.

series expansion of the cumulant generating function.[1] This discussion of moments and cumulants is not absolutely necessary to this current study except insofar as it may be required in the explanation of the results and because of its reference importance in the literature about the chi-square distribution.

A formal presentation of the maximum likelihood principle is beyond the scope of this paper, and is mentioned here briefly since it is involved in one of the statistics that is used in the calculations resulting from the various sets of data that are generated according to selected Type III gamma distributions. Furthermore, the maximum likelihood estimator method is the basis of rigorous proofs used by mathematical statisticians since these estimators meet the requirement that they are unbiased, consistent, efficient, and sufficient. Fisher makes a point of distinguishing between probability and the mathematical quantity that is appropriate for making statistical inferences among different populations. Lindgren explains maximum likelihood as follows:

> Suppose first that the population of interest is discrete, so that it is meaningful to speak of the probability that $\mathbf{X}=x$, where $\mathbf{X}$ denotes a sample $(X_1, \ldots, X_n)$

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[1]Mood, p. 80.

and x a possible realization $(x_1, \ldots, x_n)$. This probability that $\mathbf{X}=x$ depends on x, of course, but it also depends on the state of nature θ which governs. As a function of θ for given x, it is called the likelihood function:

$$L(\theta)=P_{\theta}(\mathbf{X}=x).$$

The principle of maximum likelihood requires first that a value $\theta=\hat{\theta}$ be found which furnishes the 'best explanation' of a given result that is observed. That is, holding x fixed, we allow θ to wander over the various possible states of nature and select one, $\hat{\theta}$, which maximizes the probability L(θ) of obtaining the result actually observed. Then, having found a state $\hat{\theta}$ that best explains the observed result x, we take the action that would be best if $\hat{\theta}$ really were the true state. This best action for a given state of nature is naturally determined by the loss function (or, equivalently, by the regret function) as that action which minimizes the loss (or regret).

Because the best explanation of a given x depends on that x, held fixed during the maximization of L(θ), the minimizing θ depends on x. It defines a function of the observations - a statistic. The rule of taking the action that minimizes $\ell(\theta,a)$ is then a decision function, an assignment of an action to each possible outcome of the sampling experiment.[1]

A goodness of fit test that evolves from the above principle is that of the likelihood ratio test. For a one sample case when the hypothesis is that nature is in a certain specified state and the alternative hypothesis is that nature is not in that state, the null hypothesis is:

$$H_0: p_1 = \pi_1, \ldots \quad \text{and} \quad p_k = \pi_k$$

where $\pi_1, \ldots \pi_k$ are specified numbers on the interval $[0,1]$ whose sum is 1 and k parameters $p_1, \ldots p_k$ are restricted by the condition that their sum equals 1.

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[1]Lindgren, pp. 188-189.

The basis for testing H_0 is a random sample of n observations on X with the joint probability function

$$f(x;p) = p_1^{f_1}, p_2^{f_2} \ldots p_k^{f_k}$$

which depends on the observations $(X_1, \ldots, X_n)$ only through the corresponding frequencies. The likelihood ratio test for $p = \pi$ against $p \neq \pi$ is the ratio of $L(\pi)$, the maximum on the simple hypothesis that $p = \pi$, and $L(\hat{p})$, the maximum on $H_0 + H_1$, where $p = \hat{p}$ and $\hat{p}_i = f_i/n$. It is expressed as

$$\lambda = \frac{L(\pi)}{L(\hat{p})} = \frac{\pi_1^{f_1} \cdots\cdots \pi_k^{f_k}}{(f_1/n)^{f_1} \cdots\cdots (f_k/n)^{f_k}} = n^n \prod_{i=1}^{k} \left(\frac{\pi_i}{f_i} \right)^{f_i} \qquad 1$$

The null hypothesis is rejected for $\lambda <$ constant, the value of which is determined by the α selected. Since the calculation of the distribution is prolonged and is based upon a multiplication product, the logarithm is used for the large sample distribution $-2 \log \lambda$. This distribution is asymptotically chi-square with $k - 1$ degrees of freedom and the rejection limit is the $100(1 - \alpha)$th percentile of that distribution. The similarity of the above statistic and the log-linear likelihood test, $X^2(L) = 2 \sum$ (observed) log (observed/expected), which is investigated in this Monte Carlo study should be easily and readily recognized.[2]

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[1]Lindgren, p. 295.

[2]Journal articles by Feinberg, Goodman, and Haberman that utilize X2(L) as a test statistic are referenced in the Bibliography.

A brief presentation of tests that are competitive alternatives to X^2 is made because of their recurrence in the literature. The method of maximum likelihood consists in multiplying the log of the number expected in each category by the number observed, summing for all categories and finding the value of θ for which the sum is the positive maximum solution of the differention of the resulting quadratic equation. The method of minimum X^2 is arrived at by differentiating for the smallest positive solution resulting from the comparison of observed with expected frequencies and calculating the discrepancy, X^2, between them.[1]

The ω^2 test has been constructed and developed by Cramer', von Mies, and Smirnov in order to avoid the grouping of continuous data that is necessary with X^2 and still resembles the X^2 test in that the tests are not directed against any specific alternative hypothesis. Neyman's smooth test also postulates that the cumulative frequency (assumed continuous) is known from the null hypothesis. If the frequency functions which are continuous and depart in a gradual and regular manner from the null hypothesis, the variates will not follow a rectangular distribution in the interval (0,1) whereas these variates would follow a rectangular distribution when the deviations from the null

[1]Fisher, pp. 304-305, and Lancaster, pp. 136-139.

hypothesis are erratic or discontinuous. The X^2 test is not directed specifically at either class.[1] As it can be noted, tests other than X^2 often have certain restrictions as to their application or information necessary to their use. This factor coupled with the overwhelming familiarity of users of statistical methods and the consuming audience with the X^2 results in application of this test statistic for all but very specific problems.

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[1] Cochran, pp. 335-339.

LITERATURE BASIC TO THE PROBLEM

ERIC and Psychological Abstract searches reveal that there has been a paucity of research regarding the chi-square test for the one sample case, particularly for samples randomly drawn from distributions that are not normal in form. However, it is obvious that many other chi-square investigations are applicable to the problem that is herein proposed.

Guenther has been actively involved in chi-square tests for hypotheses concerning multinomial probabilities, the power and sample size for such tests.[1] Three cases are presented: (1) the hypothesis which specifies all the multinomial probabilities, (2) the hypothesis of independence, and (3) the hypothesis of homogeneity. He points out that if these hypotheses are false, the statistic has approximately a noncentral chi-square distribution with the same degrees of freedom but also a noncentrality parameter λ. Haynam, Govindarajulu, and Leone have prepared tables of the noncentral chi-square distribution designed for easy solution

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[1]William C. Guenther, "Power and Sample Size for Approximate Chi-Square Tests," American Statistician, 1977, 31, pp. 83-85.

to these power problems.[1]

The results of these works emphasize the large sample size necessary for the tests to have appreciable power. An article by Meng and Chapman further reports on the noncentrality parameter for r x c contingency tables.[2] Again, the power of these tests was approximated on a large sample basis. The concept of noncentrality is introduced here only insofar as it may be necessary to explain some of the results of this study should the null hypothesis be rejected for the small sample sizes that are used.

Categorization for this experiment has been explained in the chapter on the statement of the problem and the means by which the results from the random numbers generated by the Monte Carlo study which is used and is explained in the next chapter concerning the design. However, since questions arise as to the effectiveness of using equal area or linear score models, Kerlinger's rules of categorization are of interest at this point. Categorization is another word for partitioning, which is referred to in many articles that use

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[1]G. E. Haynam, Z. Govindarajulu, and F. C. Leone, "Tables of the Cumulative Non-Central Chi-Square Distribution," Selected Tables in Mathematical Statistics, Vol. 1, eds. H. L. Harter and D. B. Owens, (Chicago: Markham Publishing Co., 1970).

[2]Rosa C. Meng and Douglas G. Chapman, "The Power of Chi Square Tests for Contingency Tables," Journal of the American Statistical Association, 1966, 61, pp. 965-975.

analysis of variance or multiple contingency tables as a means of methodology. Emphasizing that the first step in any analysis is categorization, Kerlinger lists five rules of categorization:

> 1. Categories are set up according to the research problem and purpose.
> 2. The categories are exhaustive.
> 3. The categories are mutually exclusive and independent.
> 4. Each category (variable) is derived from one classification principle.
> 5. Any categorization scheme must be on one level of discourse.[1]

Kittelson and Roscoe studied the power and robustness of the chi-square and Kolmogorov statistics with both the linear score scale and equal area models.[2] They found that the traditional procedure for testing goodness of fit to normal used a linear score scale model in which the chi-square approximation of the multinomial cell limits were defined by dividing a standard score scale into equal parts. The criticism of this method is that the expected frequencies in the tails of the distribution tend to be very small with samples of reasonable size, such as n = 100 or less.

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[1]Fred N. Kerlinger, Foundations of Behavioral Research, 2d ed. (New York: Holt, Rinehart & Winston, 1973), pp. 137-143.

[2]Howard M. Kittelson and John T. Roscoe, "An Empirical Comparison of Four Chi-Square and Kolmogorov Models for Testing Goodness of Fit to Normal" (paper presented to AERA, Chicago, 1972), pp. 1-8.

When the sample sizes are small, as in this experiment, an alternative chi-square model has been suggested by many authors. In these cases, the cell limits are defined by dividing the area under the curve into equal parts - an equal area model. Not only does this model overcome the problem of small expected frequencies in the tails, it also increases the power of the chi-square approximation by having uniform expected frequencies in each division. Mann and Wald investigated the power of the chi-square test with regard to the distance of the observed and expected distribution and found that the optimum power for the goodness of fit test for continuous distribution is achieved when the expected frequencies are equal.[1] Williams elaborated on their results together with useful numerical tabulations.[2]

Watson suggested the equal area model for the chi-square test of goodness of fit but also suggested that the number of cells should be at least ten.[3] Kempthorne also

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[1]H. B. Mann and A. Wald, "On the Choice of the Number of Class Intervals in the Application of the Chi Square Test," Annals of Mathematical Statistics, 1942, 13, pp. 306-317.

[2]C. A. Williams, Jr., "On the Choice of the Number and Width of Classes for the Chi Square Test of Goodness of Fit," Journal of the American Statistical Association, 1950, 45, pp. 77-86.

[3]G. S. Watson, "The Chi-Square Goodness of Fit Test for Normal Distributions," Biometrika, 1957, 44, pp. 336-348.

favored the equal area model, but his findings were based in part upon a Monte Carlo study when the number of cells (k) was set equal to the sample size (n).[1] An extensive empirical study by Roscoe and Byars demonstrated an acceptable approximation with expectancies as small as one when testing goodness of fit to uniform.[2] They found that the approximation is not quite so good with uniform hypotheses, but did not examine goodness of fit to normal. The main contribution was that the average expected frequencies had to be increased for lower α levels for uniform distributions and also for those distributions that varied from the uniform; otherwise, the approximations tended to be liberal.

Kittelson and Roscoe randomly generated ten thousand uniformly distributed sets of samples for each combination of sample size and number of cells under study. Sample sizes were 10, 20, 30, and 50. The cell sizes were set equal to 6, 10, and 20 with the number of cells also being set equal to 50 for samples of size 50. The null

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[1] Kempthorne, "The Classical Problem of Inference - Goodness of Fit," Fifth Berkeley Symposium on Mathematical Statistics and Probability, 1967, 1, pp. 235-249.

[2] J. T. Roscoe and J. A. Byars, "An Investigation of the Restraints with Respect to Sample Size Commonly Imposed on the Use of the Chi-Square Statistic," Journal of the American Statistical Association, 1971, 66, pp. 755-759.

hypothesis was sampling from normal distribution and testing against the normal distribution. The false hypothesis was sampling from uniform distribution and testing from normality. The chi-square equal area models proved to be superior to the chi-square linear score model and to both of the Kolmogorov tests. The chi-square equal area model was erratic with samples of size 10; however, an acceptable approximation was achieved with all other sample sizes (n = 20, 30, and 50).

Whitney made several comparisons of various non-parametric tests and parametric tests based on the normal distribution and non-normal alternatives, rectangular, double rectangular, triple rectangular, and Cauchy distributions.[1] With sample sizes of 5, 10, and 50, and an underlying normal distribution, the normal approximation to the binomial showed greater power than the "t" test, and the "t" test was more powerful than the sign test. Under the assumption of a rectangular distribution, the normal test was considerably better than the sign test. With a double rectangular distribution, the normal test has high power while the sign test is of little value when there are

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[1]D. R. Whitney, "A Comparison of the Power of Non-Parametric Tests and Tests Based on the Normal Distribution Under Non-Normal Alternatives" (Ph.D. dissertation, Ohio State University, 1948).

only small increases in the mean but has greater power when the increases are large.

When Whitney selected a triple rectangular distribution with a density function that was highly peaked and had a fair amount in the tails, the sign test had more power than the normal or "t" tests. However, if the distribution was flattened, the normal or "t" tests were more powerful. With a Cauchy distribution, Whitney found the sign test consistent, and the normal or "t" tests were inconsistent. In his summary, Whitney states:

> Alternatives in which the probability is heavily concentrated about the mean or median favor the sign test over the normal test and the "t" test.[1]

This research is of a similar nature in that the chi-square distribution is a violation of the normal assumption that is often made. The chi-square test is a popular nonparametric test statistic, and the methodology of considering the hypothesis for each quantile of the distribution is analogous to the Kolmogorov-Smirnov test statistic with its step function and the consideration of violating the upper and lower bounds of the selected function. Details of the design of the experiment and additional review of related literature are contained in the following chapters.

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[1]Whitney, p. 4.

CHAPTER III

DESIGN OF THE STUDY

THE ALGORITHM

The choice of an algorithm with which to generate random variables from chi-square distributions using methods to generate these variables that utilize proven techniques and that are already known is pivotal to the study. After review of two of the renowned volumes of Pearson and Hartley[1] and tables by Harter,[2] it was found and confirmed by the IBM Research Division[3] that the algorithm established by Knuth, cited below, had all the necessary attributes.

Except for differences in notation, Knuth's formula for the chi-square distribution is the same as that found in the preceding works by other authors. His algorithm is as follows:

> The chi-square distribution with ν degrees of freedom, also called the gamma distribution of order $\nu/2$. We have

$$F(x) = \frac{1}{2^{\nu/2}\,\Gamma(\nu/2)} \int_0^x t^{\nu/2-1}\, e^{-t/2}\, dt, \qquad x \geq 0$$

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[1] E. S. Pearson and H. O. Hartley, Biometrika Tables for Statisticians, 2 vols. (Cambridge: Cambridge University Press, 1956-1972).

[2] H. Leon Harter, "A New Table of Percentage Points of the Chi-Square Distribution," Biometrika, 1964, 51, pp. 231-234.

[3] IBM Research Division, Yorktown Heights, New York, 10598.

> If $\nu = 2k$ where k is an integer, set $X = 2(Y_1 + Y_2 + \dots + Y_k)$, where the Y's are independent random variables with the exponential distribution, each with mean 1. If $\nu = 2k + 1$, set $X = 2(Y_1 + \dots + Y_k) + Z^2$, where the Y's are as before, and Z is an independent random variable with the normal distribution (mean zero, variance one).[1]

As can be noted, the chi-square distributed random variables are dependent upon exponential distributed random variables when the degrees of freedom are even and upon both normal and exponential distributed random variables when the degrees of freedom are odd. This permits the selection of various subroutines to generate the variables.

As Quenouille has noted, the increased popularity of Monte Carlo methods has increased the supply of random observations.[2] Until recently, these observations were available only in the form of random numbers,[3] random normal deviates,[4] correlated random normal deviates,[5] and serially

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[1]Knuth, vol. 2, p. 115.

[2]M. H. Quenouille, "Tables of Random Observations from Standard Distributions," Biometrika, 1959, 46, pp. 178-181.

[3]M. G. Kendall and B. Babington Smith, Tables of Random Sampling Numbers (Cambridge: Cambridge University Press, 1939; L. H. C. Tippett, Random Sampling Numbers (Cambridge: Cambridge University Press, 1927); and Rand Corporation, A Million Random Digits with 100,000 Normal Deviates (Glencoe, Illinois: Free Press, 1955).

[4]H. Wold, Random Normal Deviates (Cambridge: Cambridge University Press, 1954).

[5]E. C. Fieller, T. Lewis, and E. S. Pearson, Random Correlated Normal Deviates (Cambridge: Cambridge University Press, 1955).

correlated random number and normal deviates.[1] In order to draw random observations from any distribution, it was necessary to calculate the distribution function and the transformation of rectangularly distributed observations using this function. Since these two steps could require considerable calculations, Quenouille constructed tables that relate estimated values of non-normal observations to the corresponding values obtained with the same observations transformed to normality. One thousand random observations are provided from each distribution. Obviously, one thousand random variables is an insufficient quantity for anything but a pilot study, but Quenouille's work has been referenced here for the researcher that might wish to write his own program and to provide a mathematical background source. The contents of the tables are:

x_1 - random normal deviates.

x_2 - random rectangular deviates.

x_3 - random deviates from a distribution whose logarithm was normally distributed.

x_4 - random deviates from the exponential distribution.

x_5, x_6, x_7 - random deviates from an Edgeworth

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[1] M. G. Kendall, "Tables of Autoregressive Series," Biometrika, 1949, 36, pp. 267-289.

Type A expansion with various k values.

x_8 - random observations from the two-sided exponential distribution.

A set of subroutines that are readily available and undoubtedly come to mind first for use in the algorithm and study are those of IBM - the "Scientific Subroutine Packages".[1] The subroutine RANDU could be used for uniformly distributed random numbers and transformed to exponentially distributed numbers. The subroutine GAUSS computes normally distributed random numbers with a given mean and standard deviation. Together these operations would allow the use of the Knuth algorithm for chi-square distributed random variables. However, the necessity of performing the transformations would result in longer computer time and more lines of printout or storage. Other subroutines from SSP that are of interest but that can be circumvented are:

NDTR which computes $y = P(x) = \text{PROB.}(X \leq x)$ where X is a random variable distributed normally with mean zero and variance one.

NDTRI computes $x = P^{-1}(y)$ such that $y = P(x) = \text{PROB.}(X \leq x)$ where X is again a random variable distributed

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[1]IBM, SSP ("Scientific Subroutine Packages"), Form H20-0205-3, rev. 2/14/69, pp. 68, 77, 78, 81, and 83.

normally with mean zero and variance one.

CDTR computes P = P(x) = PROB.($X \leq x$) where X is a random variable following the chi-square distribution with continuous parameter m.

CHISQ calculates degrees of freedom for a given contingency table A of observed frequencies with n rows (conditions) and m columns (groups).

Knuth examined several techniques for generating normal deviates and favors Marsaglia's rectangle-wedge-tail method as being an extremely efficient program with small average running time.[1] Since this study will necessitate the generation of 540,000 random numbers from chi-square distributions and entail the generation of at least 1,602,000 exponentially distributed and 216,000 to 756,000 normally distributed random variables, speed and accuracy are paramount. Knuth describes three methods of generating normal deviates and states:

> The polar method is rather slow, but it has essentially perfect accuracy, and it is very easy to write a program for the polar method if we assume square root and logarithm subroutines are available. Teichroew's method is also easy to program, and it requires no other subroutines; therefore it takes considerably less total memory space. Teichroew's method is only approximate, although in most applications its accuracy (an error bounded by 2×10^{-4} when $|R| \leq 1$) is quite satisfactory. Marsaglia's method is considerably faster than either

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[1]Knuth, vol. 2, pp. 105-108.

of the others, and like the polar method it gives essentially perfect accuracy. It requires square root, logarithm, and exponential subroutines, and an auxiliary table of 100-400 constants, so its memory space requirement is rather high; yet its speed more than compensates for this on a large computer. A program for Marsaglia's method is considerably more difficult to prepare, but a general-purpose subroutine based on Algorithm M will be a valuable part of any subroutine library.[1]

Just as in the case of the normal distribution, there is an extremely fast rectangle-wedge-tail method available for the exponential distribution based on a decomposition of the frequency function.

Inasmuch as The McGill Random Number Package "Super-Duper" facilitated the design of this experiment to such great extent, directions about how to use the package, as well as an off-line print-out of the source package, are included in Appendix A.[2]

The uniform number generator (which is either called directly or else is built into the normal and exponential generators) combines a multiplicative congruential generator and a shift register generator. The congruential generator uses the multiplier 69069, found after a search of millions of multipliers to have nearly optimal lattice structure in 2, 3, 4, and 5 dimensions - much better than any of the

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[1]Knuth, vol. 2, pp. 113-115.

[2]G. Marsaglia, K. Ananthanarayanan, and N. Paul, School of Computer Science, McGill University, Montreal, Quebec, Canada, National Research Council of Canada (NRC-A7901).

highly touted but poorly justified multipliers used for the past 20 years. But, even though the congruential generator is as good as a congruential generator can be, it is still not good enough, and it has been combined with a shift register generator on 32 bits (right shift 15, left shift 17). The bit patterns produced by the two separate generators are added as binary vectors - that is, exclusive or addition. Combining the two generators produces a sequence with period about 5×10^{18}.

Having established the accuracy and speed of the methods of Marsaglia, et al, and having confirmed Knuth's evaluation of the randomness of the algorithm that will be used in the generation of chi-square distributed random variables, it is now fitting to discuss the Monte Carlo methodology, the number of iterations, the calculations of the category cut-off values, the computer program, and the test statistics and their evaluation.

MONTE CARLO METHODOLOGY

The Monte Carlo method, often called the method of statistical trials, is a method of solving problems of computational mathematics by simulation of random quantities. The methodology comprises that branch of mathematics which is considered essentially experimental rather than analytical. The problems are of two types - probabilistic or deterministic, depending upon whether or not they are concerned with the behavior and outcome of random processes or variables.[1] Kleijnen makes an interesting observation about the use of analytical and numerical solutions:

> An analytical solution uses properties known from that part of mathematics called 'analysis' which comprises differential and integral calculus. It gives a solution in the form of a formula that holds for various possible values of the independent variables and parameters. . .
>
> A numerical solution substitutes numbers for the independent variables and parameters of the model and manipulates these numbers. Many numerical techniques are iterative, i.e., each step in the solution gives a better solution using the results from previous steps. . . Two special numerical techniques are the Monte Carlo method and simulation.[2]

In the same vein, Hammersley states:

> It should almost go without saying, if it were not so important to stress, that whenever in the Monte Carlo estimation of a multiple integral we are able to per-

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[1]Sobol, p. 1.

[2]Kleijnen, p. 5.

form part of the integration by analytical means, that part should be so performed. As in some kinds of gambling, it pays to make use of one's knowledge of form.[1]

Electronic computers are to be credited with modern day Monte Carlo methods, and, as Sobol points out, the accepted birth date of the methodology is 1949, and the American mathematicians, Neyman and Ulam, are considered its originators.[2] However, Schreider points out that historically the first example of a computation by a Monte Carlo method is Buffon's celebrated problem of needle tossing, which he described in 1777 in his treatise Essai d'Arithmetique Morale.[3] This resulted in a method for computing the quantity $1/\pi$. Where K is the number of times that the dropped needles cross parallel lines on a ruled plane and N is the number of times the needles are tossed, then according to the Law of Large Numbers, $K/N \approx 1/\pi$.

The generation of random variables of various distribution can be obtained by transformation of independent uniformly distributed variables as described in the preceding section about the algorithm. Where L is the number of pairs of coordinates out of a possible N pairs, an estimate of the computation of the probability p is based upon the integral of the area which can be represented by $L/N \approx p = \int_0^1 f(x)\, dx$. The estimate of the error obviously depends on

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[1] Hammersley and Handscomb, p. 74.

[2] Sobol, p. 1.

[3] Schreider, p. 4.

the number N of tests. Note that no conditions need be imposed on the smoothness of the function f(x), in order for this method of computing the integral to be applicable. It is sufficient that f(x) be measurable and bounded. Errors will be "smoothed out" by the use of large N. This indicates that the use of an electronic computer is of utmost importance in order to calculate the desired statistics with forecastable precision.

Since this study is based upon small sample sizes N ranging from 12 to 80, precision must be obtained by utilizing a large number of iterations where the error δ of the Monte Carlo method for the computation of the probability of an event A is of the order $\delta \sim 1/\sqrt{N}$. It is evident that a reduction of the error is associated with a significant increase in the number of tests. The discussion of the selection of the number of iterations follows in a succeeding section based upon Chebyshev's Theorem.

The random variables that are generated are discrete and can assume the values defined by the table

$$X = \begin{pmatrix} x_1 & x_2 & \cdots & x_n \\ p_1 & p_2 & & p_n \end{pmatrix}$$ where $x_1, x_2, \ldots x_n$ are the possible values of the variable X, and $p_1, p_2, \ldots p_n$ are the probabilities corresponding to them. The Monte Carlo method assumes that the variables are continuous and

the probability that X lies in the arbitrary interval (a', b') contained in $[a, b]$ is equal to the integral $P(a' < x < b') = \int_a^b p(x)\, dx$.

The conditions that prevail for both discrete and continuous random variables are that the density p(x) is non-negative and that the integral, or sum, of the density over the whole interval is equal to 1. It should be noted that, as the size of the intermediate intervals is reduced, the discrete distribution approaches the continuous distribution as the limit. On the basis of a single trial one cannot precisely predict the values that X and the corresponding probability will assume. The more the trials there are, that is, the larger the sample, the more precise the prediction will be.

Kleijnen and Knuth discuss the generation of random variables for Monte Carlo studies at some great length. Kleijnen concludes that there are no foolproof generators, and at the present the best one seems to be the multiplicative generator. Since the major part of this experiment is based upon numerical solutions and the corresponding Monte Carlo method, Knuth's recommendation is followed, and Marsaglia's multiplicative congruential generator with a shift register generator has been adopted.

THE NUMBER OF ITERATIONS

The Monte Carlo methodology in this experiment is used to approximate the probability distribution obtained from calculating the Pearsonian and log-linear chi-square statistics at the various quantiles represented by the cut-off points of the various categories used in each sample set, i.e., k = 4 to 8, and the theoretical distribution above the ten percent level of significance. As previously stated, the number of iterations t determines the precision of the estimates.

The determination of the number of iterations N is based upon a procedure used by Kavanagh[1] and more recently by McNamee.[2] Let $X^2(P)$ be the Pearsonian statistic and $X^2(L)$ be the log-linear statistic calculated by the following formulae:

$$X^2(P) = \sum_{\text{all cells}} (\text{observed} - \text{expected})^2/(\text{expected})$$

$$X^2(L) = 2\sum_{\text{all cells}} (\text{observed})\log(\text{observed}/\text{expected})$$

McNamee's approach was that he was interested in the 90th percentile or less of the theoretical distribution and

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[1] J. A. Kavanagh, "A Monte Carlo Study of the Polynomial Discriminant Method for Pattern Recognition" (Ph.D. Dissertation, University of Minnesota, 1972), p. 26.

[2] McNamee, pp. 40-42.

the comparison with the statistic which was calculated as $X^2(P)$ above. Considering the following notation used in this discussion where p is an estimate of y:

$$y = p = \begin{cases} 1 \text{ for } \{X^2(P) \mid X^2(P) \geq \chi^2_{.90}\} \\ 0 \text{ for } \{X^2(P) \mid X^2(P) < \chi^2_{.90}\} \end{cases}$$

Where t (or n) independent iterations or observations of y (or p) and where p is the probability that $X^2(P) \geq \chi^2_{.90}$, then $\sum_{i=1}^{t} y_i$ is binomially distributed with the parameter p. Mathematical proofs since Pearson[1] up to Tate and Hyer's[2] report on the comparison of the multinomial and chi-square tests, apply The Central Limit Theorem to approximate the distribution of $\bar{y}$ (P) as the number of observations (n) gets larger. All the proofs assume at some point that the observed frequencies are distributed normally about the expected frequencies with a mean of P and variance of P(1 - P)/n. From this the following probability statement can be made where Z_α is found in standard normal tables.

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[1]Karl Pearson, "On the Criterion That a Given System of Deviations from the Probable in the Case of a Correlated System of Variables Is Such That It Can Be Reasonably Supposed to Have Arisen from Random Coupling," Philosophical Magazine Series, 1900, 50, pp. 157-175.

[2]Merle W. Tate and Leon A. Hyer, "Significance Values for an Exact Multinomial Test and Accuracy of the Chi-Square Approximation, Final Report" (Bureau of Research, Office of Education, Washington D. C., 1969), BR-8-B-023, pp. 1-75.

$$\Pr\left(\frac{|P - P_o|}{\sqrt{P_o (1 - P_o/n}} \leq Z_{1-\alpha/2}\right) = \alpha$$

$$Z \overset{d}{\sim} N(0,1)$$

The worst situation considered in McNamee's study was when $P_o = .9$ and the variance was $(.9)(.1)/n$. Obviously, the worst condition that could exist would be when $P_o = .5$ and the variance $(.5)(.5)/n$. In this above-mentioned study, the experimenter was satisfied when $|P - P_o| = d = .03$ ninety-five percent of the time and $P - P_o \pm .03$, the estimate of the true P_o ninety-five percent of the time for the true value $P_o = .90$. The number of iterations was calculated to be 385 and subsequently 400 iterations were used in the study. This resulted in precision values (d) of .02 for $P_o = .95$ and .009 for $P = .99$.

Pilot computer runs were made for this study of the one sample test using 400 iterations. However, after the program was rewritten for efficiency and speed, it was decided to use 1000 iterations, even though this would only increase the precision minimally, namely to .02 for $P_o = .90$, .01 for $P_o = .95$, and .006 for $P_o = .99$ using the same 95% criteria of the previously described experiment.

Based upon the work of Slakter,[1] 10,000 random samples should be generated for each empirical distribution.

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[1]M. J. Slakter, "Comparative Validity of the Chi-Square and Two Modified Chi-Square Goodness-of-Fit Tests for Small but Equal Expected Frequencies," Biometrika, 1966, 53, pp. 619-622.

Similar calculations for this experiment would have meant ten times as many computations as were used and the generation of over 23,580,000 random variables. Tate and Hyer[1] used 65,536 sets of outcomes for the relatively simple multinomial distribution, N = 8, k = 4 and the ϕ equal. Their total grant required in excess of 8,000,000 sets of outcomes. It is self evident that there is insufficient time or money to extend this study to a like scope.

[1]Tate and Hyer, p. 5.

CATEGORIZATION AND PROGRAMMING

The arguments for the use of the equal area model for the chi-square test of goodness of fit were discussed extensively in the previous chapter, pages 42-46. The samples of random variables that are generated in this study are categorized accordingly. The only difficulty that arises in such categorization is the establishment of the chi-square category cut-off points for many of the various percentiles that are not generally tabulated. Although interpolation of values of χ^2 is explained in BTS 1,[1] the procedures suggested in BTS 2[2] are used since this volume includes many tabulations calculated by Harter,[3] which are more comprehensive than previous tabulations in that the tables are entered with ν and P, rather than Q; include additional entries for P; and have eight significant figures for low values of ν and P rather than the usual six significant figures.

Where 3-decimal accuracy is adequate, linear interpolation is usually sufficient and particularly where $\nu < 30$. However, for greater accuracy, and in line with established

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[1]Pearson and Hartley, BTS 1, pp. 13-16.

[2]Pearson and Hartley, BTS 2, pp. 140-142 and pp. 382-385.

[3]Harter, p. 234.

practice, the study uses percentage points accurate to four decimal points, particularly since the study is for samples of small size and no more than seven degrees of freedom. In order to interpolate the untabulated percentage points, Pearson's five-point Lagrangian interpolation formulae are used. BTS 2 table 69 contains the coefficients which are used to break down the gaps between the standard quantiles x(P) and are presented in eight different grids, which are based upon the standard P-values for which x is tabled and the P-value for which x is required.[1]

The interpolated value: $x_p = \sum_{i=1}^{5} L_i x_{p_i}$ or $x(P) = L_1x(P_1) + L_2x(P_2) + L_3x(P_3) + L_4x(P_4) + L_5x(P_5)$.

For example, in order to interpolate the value for the first category cut-off point, when the sample has six categories and five degrees of freedom, one should use grid 4 since x(P) = 1/6 of the area = .1667, and this value is near the center of the tabled values in grid 4. The calculations are as follows:

P_i	0.05	0.10	0.20	0.30	0.40
L_i	-.024019	.242443	1.054338	-.350307	.077545
$\chi^2(P_i)$	1.14548	1.61031	2.34253	2.99991	3.65550

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[1]Pearson and Hartley, BTS 2, pp. 382-385.

Summing the products $L_i \chi^2(P_i)$, it is found that $\chi^2(.16 \mid 5) = 2.0651897$. Subtracting this from $\chi^2(.20|5) = 2.34253$, dividing the difference by 400, multiplying this quotient by 67, and adding the product to $\chi^2(.16|5)$ result in the linear interpolation for $\chi^2(.1667|5) = 2.112$. This was checked by calculated $\chi^2(.17|5)$ and interpolating downward to .1667 with comparable results.

With the algorithm selected and with the categorization process established, the succeeding steps in the design are to write an assembler-fortran program to generate the random variables, calculate $X^2(P)$ and $X^2(L)$ for the various sample sets, and then refine the program for speed and ease of evaluation. First, the fortran subroutine for calculating the Pearsonian chi-square probabilities, $X^2(P)$, was adapted from the SPSS package, and fortran statements for the calculation of the log-linear chi-square probabilities, $X^2(L)$, were appended to the random number generator that has been previously discussed. Part of a sample run of 40 iterations is given in Appendix B and demonstrates how lengthy and time consuming the basic design could be, while also showing how the algorithm is used for a chi-square distribution with four degrees of freedom and expected frequencies of three. Column one consists of the Y_1 random numbers that are generated from an exponential distribution, column two consists of the Y_2 variables, and column three is the desired chi-square random variable which is twice the sum of

Y_1 and Y_2. The cell frequencies are displayed along with the Pearsonian and the log-linear chi-square values and the apropos probabilities. It should be noted that this sample of 40 iterations required 986 lines, evidence that the program had to be condensed for 1000 iterations of the fifteen sample sets that are studied.

Appendix C shows the output of an intermediate stage in the evolution of the final program. This sample run is for a chi-square distribution having seven degrees of freedom and expected cell frequencies of three. For the sake of brevity, only the fortran statements and some of the output is reproduced in this appendix, which displays how the program branches to $X = 2(Y_1 + . . . Y_k)$ for distributions having an even number of degrees of freedom or branches to $X = 2(Y_1 + Y_k) + Z^2$ for odd numbered degrees of freedom. As before, the Pearsonian and log-linear chi-square values and probabilities are printed. When the log-linear statistic is indeterminate because of a zero cell frequency, this fact is flagged by the printing of a series of asterisks.

Appendix D is an example of the final condensed version of the program that was evolved and part of the output when 1000 iterations were used for each sample set. It should be noted that the intermediate calculations are not printed and that the output is sorted according to the probabilities of the Pearson test statistic. This procedure facilitates the tabulation and comparison of $X^2(P)$ and $X^2(L)$.

Calculations by the use of an electronic hand calculator were madė of randomly selected sample sets at each stage of the programming evolution to verify the accuracy of the computer work. In addition, the nonparametric subroutine of SPSS VII for one case samples was used for further proof of the program. A single example of this is shown in Appendix E and demonstrates the value of the program that was designed when many cases must be studied and speed and efficiency are of utmost concern.

EVALUATION

The primary hypothesis:

$$H_0 : P_1 = P_{01} \qquad\qquad H_1 = \text{not } H_0$$
$$P_2 = P_{02}$$
$$\vdots \quad \vdots$$
$$P_k = P_{0k}$$

will be evaluated for $X^2(P)$ and $X^2(L)$ by tabulating the frequencies that appear within the equal area proportions for both test statistics when the number of categories were selected a priori from 4 to 8 and the expected cell frequencies were 3, 5, and 10.

For example, when K = 4, the hypothesized proportions falling within each category are 25 percent. Using 1000 iterations, 250 sample sets should fall within each category. However, when zero cell frequencies occur, $X^2(L)$ is indeterminate, as can be recognized from the test statistic: $X^2(L) = 2 \sum (\text{observed})\log(\text{observed}/\text{expected})$. When this occurs, the number of indeterminate iterations will be noted on the tabulation and the percentages adjusted accordingly. The percentage of error that occurs will also be displayed for both test statistics. Since 10 percent is usually the criteria of goodness of fit when a researcher is "model fitting", as in ANOVA, ANOCOVA, etc., the null hypothesis will be accepted if the experimental frequencies are within this 10 percent limit. In order to identify the effect of small sample size, the tabulations will be presented separately for each K category and the three expected frequencies, E(x) = 3, 5, and 10.

For each N and K, where $\phi = 1/K$, the chi-square probabilities for $X^2(P)$ and $X^2(L)$ will be tabled in the .005-.009, .010-.050, and .051-.100 regions since these regions are the ones most often used in making statistical inferences in the one sample case. These tabulations will also show the exact multinomial probabilities that are available from the Tate and Hyer study previously noted. Except for the special case of the binomial distribution, there had previously been no tables of the multinomial. The reason for this is that there are too many parameters in the general case to permit construction of manageable tables, and the expansion of the multinomial is long and laborious for all but small N. However, in the case of the equal area model being studied, the ϕ are equal, just as in the Tate and Hyer [1] study, and the size of the tables and the labor is greatly reduced. This is particularly true if the calculations are made using logarithms and log factorials when

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[1]Tate and Hyer, pp. 1-8 and pp. 25-75.

computing the multinomial probability of an outcome. Tate and Hyer used a digital computer program that was written by David L. March[1] for a CDC 6400 computer to further reduce the complexity of the procedures.

Since the Tate study of the multinomial distribution was limited to N of 30 or less and ϕ of 1/7 or more, a complete comparison of the multinomial probability of P(M) and X^2(P) and X^2(L) is possible for only part of this study.

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[1]David L. March, Multin Program, 1968, Lehigh University Computing Center, Bethlehem, Pa.

CHAPTER IV

RESULTS OF THE STUDY

INTRODUCTION

This chapter presents the results of the study which were derived using Monte Carlo methodology to generate random numbers from gamma distributions of order $\nu/2$, which are Pearson's chi-square distributions with ν degrees of freedom. This decision was based on the desire to verify Siegel's claim that nonparametric techniques are distribution free, whereas researchers most often generate their random variables from uniform or normal distributions. By varying the degrees of freedom from 3 to 7, distributions of varying measures of skewness were generated. Sample size was manipulated by using expected cell frequencies of 10, 5, and 3.

As originally programmed, see Appendix B, this research required 1,080,000 random numbers constructed from 1,602,000 exponentially and 756,000 normally distributed random variables and necessitated 745,500 lines of computer output and 3 hours 55 minutes 52.5 seconds of CPU time, even though the efficient McGill Random Number Package "Super-Duper" was used. The intermediate program, shown as Appendix C, cut the CPU time but increased the lines of output to over 4,000,000. The program that was finally evolved required only 42,345 lines of output and 41 minutes 38.9 seconds of CPU time, a drastic reduction. A sample of this program is displayed as Appendix D.

The efficiency of the Monte Carlo program made it possible to examine various one sample cases with expected values of 10, 5, and 3 in each cell. These numbers were proposed in many articles reviewed in CHAPTER II and will be discussed further in the following sections, particularly those on the use of Fienberg's $X^2(L)$ and the equal area models with categories of 4, 5, 6, 7 and 8, wherein the total sample size is restricted, as noted in the STATEMENT OF THE PROBLEM.

The rationale for the use of α regions rather than point estimates is explained in the section on the goodness of fit. The results obtained from the use of Pearson's chi-square, $X^2(P)$, the log-linear likelihood ratio, $X^2(L)$, and the multinomial, (M), for these regions are reported as a function of the expected cell frequencies, E(x), and the number of categories, k. Generally, $X^2(P)$ is as desirable a test statistic as the multinomial (M). However, the deviations that do exist have interesting implications which will be discussed in the pertinent sections.

$X^2(P)$ OR $X^2(L)$ FOR SMALL SAMPLES

Since so little research has been reported regarding the chi-square test for the one sample case, examples of the one sample case and the constraints imposed in this study are reiterated to differentiate this experiment from many other chi-square investigations. Siegel explains the function of the chi-square one sample test as follows:

> Frequently research is undertaken in which the researcher is interested in the number of subjects, objects, or responses which fall in various categories. For example, a group of patients may be classified according to their preponderant type of Rorschach response, and the investigator may predict that certain types will be more frequent than others. Or children may be categorized according to their most frequent modes of play, to test the hypothesis that these modes will differ in frequency. Or persons may be categorized according to whether they are 'in favor of', 'indifferent to', or 'opposed to' some statement of opinion, to enable the researcher to test the hypothesis that these responses will differ in frequency.
>
> The X^2 test is suitable for analyzing data like these. The number of categories may be two or more. The technique is of the goodness-of-fit type in that it may be used to test whether a significant difference exists between an <u>observed</u> number of objects or responses falling in each category and an <u>expected</u> number based on the null hypothesis.
>
> In order to be able to compare an observed with an expected group of frequencies, we must of course be able to state what frequencies would be expected. The null hypothesis states the proportion of objects falling in each of the categories in the presumed population. That is, from the null hypothesis we may deduce what are the expected frequencies.[1]

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[1]Siegel, pp. 42-43

A key phrase is 'the presumed population'. Much of the literature that has been reviewed is based upon sampling from uniform or normal populations although the seed for this research was Fienberg's statement that, for small samples, it is not clear whether $X^2(P)$ or $X^2(L)$ is the superior statistic, and that study was based upon sampling from Poisson distributions.[1]

As Fienberg explained, the same maximum likelihood estimates for the expected cell counts for log-linear models can be obtained under a variety of different sampling procedures. The most simple such sampling procedure which can be assumed is that one where the observed cell counts have independent Poisson distributions with the expected counts as their means. However, since this experiment is concerned with small sample sizes and small expected cell frequencies, the basic assumption was made to sample from skewed chi-square distributions of various degrees of freedom.

In support of Cochran,[2] Siegel states that "The chi-square test for the one sample case should not be used when more than 20 percent of the expected frequencies are smaller than 5 or when any expected frequency is smaller than 1."[3] McNamee showed that the chi-square test for

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[1]Fienberg, pp. 421-425.

[2]Cochran, "X^2 Test," p. 319.

[3]Siegel, p. 46.

first order interaction is quite robust with expected values as small as 3.[1] This conclusion and the well-known rules of 5 or 10 decided what expected values would be covered in this study.

The results of 1000 iterations for the 15 different combinations of 5 categories and 3 expected frequencies are displayed in Table 1 on the following pages, listed in ascending order of k categories with $\phi = 1/k$ and $E(x) = 10, 5,$ and 3. The theoretically expected frequency for each category is 1000/k. The observed frequency for each equal proportion is listed along with the percentage deviation from the theoretical frequency, % e, for $X^2(P)$ and $X^2(L)$. The frequencies of $X^2(L)$ that are indeterminate, Indet, are listed for the corresponding proportions. The frequencies of chi-square probabilities generated from a normal distribution and the deviation from the theoretical frequencies are listed as f Gauss and % e. This latter sampling procedure will be discussed in the following section, EVALUATION OF THE HYPOTHESIS OF EQUAL PROPORTIONS.

Since the .10 level is the usual α level for goodness of fit tests, it has been selected as the criterion for the comparison of the two test statistics, $X^2(P)$ and $X^2(L)$. For example, when $K = 4$, $\phi = 1/4$, $E(x) = 10$, and $N = 40$, the deviations for the 4 categories are less than

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[1]McNamee, p. 104.

10 percent, as shown in Table 1, and $X^2(P)$ or $X^2(L)$ result in similar decisions of inference or hypothesis testing for the one sample case. Both statistics support the null hypothesis that the samples came from chi-square populations. Likewise, when K = 5, ϕ = 1/5, E(x) = 10, and N = 50, an experimenter would be likely to use $X^2(P)$ or $X^2(L)$. Only when K = 4 and E(x) = 5 and when K = 6 and E(x) = 10, does $X^2(L)$ display a better fit to the sampled chi-square distributions than $X^2(P)$, and this could be due to experimentwise error since 45 sample sets were generated.

The most obvious disadvantage to the use of $X^2(L)$ for small samples is the increasing number of the statistic that are more and more indeterminate as the number of categories are increased, and the expected frequencies are decreased. The pattern of the number of these indeterminate test statistics also reflects the skewness and kurtosis of the populations since the categories with the higher proportions, i.e., the right-hand tail, have increasing frequencies of indeterminate results.

The number of zero observations that are encountered in the higher probabilities of the chi-square and the arithmetic of the test statistic, $X^2(L) = 2 \sum$ (observed)log(observed/expected), portends that many calculations would be indeterminate since the logarithm of zero divided by a number is indeterminate. In the case of contingency tables, this effect can be negated to a large degree by transposing rows or columns, as in the study by McNamee.[1] A point not emphasized is that such transposition changes the identification of the corresponding interactions. Fienberg, Goodman, Haberman and others utilizing transposition modify the models to reflect the alteration or deletion of some interactions.[2] The rejection of $X^2(L)$ for use in one sample cases does not detract from Fienberg's use in the analysis of multidimensional contingency tables, since $X^2(L)$ can be used in the selection of suitable models, via an iterative technique of partitioning.

Further reference to the use of $X^2(P)$ and $X^2(L)$ is made in a succeeding section in which the statistics are compared to the exact multinomial in three α regions from .005 to .100 with the implications for goodness of fit.

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[1] McNamee, p. 66

[2] Fienberg, pp. 426-431.

TABLE 1

EVALUATION OF HYPOTHESES OF EQUAL AREA MODELS

$K = 4, \phi = 1/4, N = 40, 20, \text{ and } 12$

Expected Frequency 250 per Category

N = 40

P_o	f X^2(P)	% e	f X^2(L)	% e	Indet	f Gauss	% e
$P_{.25}$	257	+2.8	248	-0.8		242	3.2
$P_{.50}$	234	-6.4	246	-1.6		210	16.0
$P_{.75}$	265	+6.0	248	-0.8		276	10.4
$P_{1.00}$	244	-2.4	258	+3.2		272	8.8

TABLE 1 - Continued

N = 20

P_o	f X^2(P)	% e	f X^2(L)	% e	Indet	f Gauss	% e
$P_{.25}$	332	+32.8	265	+6.0		305	+22.0
$P_{.50}$	141	-43.6	224	-10.4		159	-36.4
$P_{.75}$	300	+20.0	271	+8.4		294	+17.6
$P_{1.00}$	227	-9.2	225	-10.0	15	242	-3.2

TABLE 1 - Continued

N = 12

P_o	f X^2(P)	% e	f X^2(L)	% e	Indet	f Gauss	% e
$P_{.25}$	223	-10.8	223	-10.8		197	-21.2
$P_{.50}$	302	+20.8	195	-22.0		322	+28.8
$P_{.75}$	207	-17.2	314	+25.6		228	-8.8
$P_{1.00}$	268	+7.2	150	-40.0	118	253	+1.2

TABLE 1 - Continued

$K = 5, \phi = 1/5, N = 50, 25,$ and 15

Expected Frequency 200 per Category

N = 50

P_o	f $X^2(P)$	% e	f $X^2(L)$	% e	Indet	f Gauss	% e
$P_{.20}$	215	+7.5	199	-0.5		208	+4.0
$P_{.40}$	178	-11.0	181	-9.5		180	-10.0
$P_{.60}$	207	+3.5	193	-3.5		199	-.5
$P_{.80}$	197	-1.5	216	+8.0		216	+8.0
$P_{1.00}$	203	+1.5	211	+5.5		197	-1.5

TABLE 1 - Continued

N = 25

P_o	f $X^2(P)$	% e	f $X^2(L)$	% e	Indet	f Gauss	% e
$P_{.20}$	207	+3.5	184	-8.0		232	+16.0
$P_{.40}$	116	-42.0	160	-20.0		127	-36.5
$P_{.60}$	262	+31.0	215	+7.5		244	+22.0
$P_{.80}$	196	-2.0	204	+2.0		190	-5.0
$P_{1.00}$	219	+9.5	218	+9.0	19	207	+3.5

TABLE 1 - Continued

N = 15

P_o	f $X^2(P)$	% e	f $X^2(L)$	% e	Indet	f Gauss	% e
$P_{.20}$	189	-5.5	189	-5.5		186	-7.0
$P_{.40}$	232	+16.0	170	-17.5		206	+3.0
$P_{.60}$	167	-16.5	223	+11.5	6	179	-10.5
$P_{.80}$	176	-12.0	139	-30.5	39	204	+2.0
$P_{1.00}$	236	+18.0	112	-44.0	167	225	+12.5

TABLE 1 - Continued

$K = 6, \Phi = 1/6, N = 60, 30,$ and 18

Expected Frequency 166-2/3 per Category

N = 60

P_o	f X^2(P)	% e	f X^2(L)	% e	Indet	f Gauss	% e
$P_{.167}$	144	-13.6	150	-10.0		149	-10.6
$P_{.333}$	205	+23.0	174	+4.4		185	+11.0
$P_{.500}$	151	-9.4	171	+2.6		138	-17.2
$P_{.667}$	186	+11.6	178	+6.8		184	+10.4
$P_{.833}$	157	-5.8	165	-1.0		168	+0.8
$P_{1.00}$	157	-5.8	162	-2.8		176	+5.6

TABLE 1 - Continued

N = 30

P_o	f $X^2(P)$	% e	f $X^2(L)$	% e	Indet	f Gauss	% e
$P_{.167}$	182	+9.2	182	+9.2		183	+9.8
$P_{.333}$	187	+12.2	129	-22.6		162	-2.8
$P_{.500}$	109	-34.6	176	+5.6		117	-29.8
$P_{.667}$	196	+17.6	155	-7.0		210	+26.0
$P_{.833}$	171	+2.6	185	+11.0	2	159	-4.6
$P_{1.00}$	155	-7.0	156	-6.4	15	169	+1.4

TABLE 1 - Continued

N = 18

P_o	f $X^2(P)$	% e	f $X^2(L)$	% e	Indet	f Gauss	% e
$P_{.167}$	157	-5.8	145	-13.0		177	+6.2
$P_{.333}$	112	-32.8	124	-25.6		102	-38.8
$P_{.500}$	171	+2.6	168	+0.8	9	181	+8.6
$P_{.667}$	227	+36.2	170	+2.0	47	206	+23.6
$P_{.833}$	174	+4.4	119	-28.6	70	161	-3.4
$P_{1.00}$	159	-4.6	43	-74.2	105	173	+3.8

TABLE 1 - Continued

$K = 7$, $\phi = 1/7$, $N = 70$, 35, and 21

Expected Frequency 142-6/7 per Category

$N = 70$

P_o	f $X^2(P)$	% e	f $X^2(L)$	% e	Indet	f Gauss	% e
$P_{.143}$	119	-16.7	112	-21.6		154	+7.8
$P_{.286}$	118	-17.4	122	-14.6		122	-14.6
$P_{.429}$	131	-8.3	141	-1.3		118	-17.4
$P_{.571}$	150	+5.0	144	+0.8		134	-6.2
$P_{.714}$	143	-0.1	136	-4.8		158	+10.6
$P_{.857}$	177	+23.9	171	+19.7		178	+24.6
$P_{1.00}$	162	+13.4	174	+21.8		136	-4.8

TABLE 1 - Continued

N = 35

P_o	f $X^2(P)$	% e	f $X^2(L)$	% e	Indet	f Gauss	% e
$P_{.143}$	112	-21.6	114	-20.2		133	-6.9
$P_{.286}$	126	-11.8	117	-18.1		149	+4.3
$P_{.429}$	111	-22.3	126	-11.8		116	-18.8
$P_{.571}$	184	+28.8	166	+16.2		176	+23.2
$P_{.714}$	170	+19.0	139	-2.7	2	161	+12.7
$P_{.857}$	137	-4.1	158	+10.6	11	113	-20.9
$P_{1.00}$	160	+12.0	138	-3.4	29	152	+6.4

TABLE 1 - Continued

N = 21

P_o	f $X^2(P)$	% e	f $X^2(L)$	% e	Indet	f Gauss	% e
$P_{.143}$	93	-34.9	130	-9.0		100	-30.0
$P_{.286}$	159	+11.3	127	-11.1		172	+20.4
$P_{.429}$	181	+26.7	134	-6.2	18	167	+16.9
$P_{.571}$	102	-28.6	109	-23.7	24	95	-33.5
$P_{.714}$	186	+30.2	103	-27.9	62	198	+38.6
$P_{.857}$	138	-3.4	90	-37.0	77	145	+1.5
$P_{1.00}$	141	-1.3	42	-70.6	84	123	-13.9

TABLE 1 - Continued

$K = 8, \phi = 1/8$, N = 80, 40, and 24

Expected Frequency 125 per Category

N = 80

P_o	f X^2(P)	% e	f X^2(L)	% e	Indet	f Gauss	% e
$P_{.125}$	32	-74.4	29	-76.8		120	-4.0
$P_{.250}$	49	-60.8	46	-63.2		114	-8.8
$P_{.375}$	68	-45.6	73	-41.6		130	+4.0
$P_{.500}$	71	-43.2	77	-38.4		118	-5.6
$P_{.625}$	103	-17.6	90	-28.0		137	+9.6
$P_{.750}$	150	+20.0	133	+6.4		142	+13.6
$P_{.875}$	159	+27.2	176	+40.8		106	-15.2
$P_{1.00}$	368	+194.4	374	+199.2	2	133	+6.4

TABLE 1 - Continued

N = 40

P_o	f $X^2(P)$	% e	f $X^2(L)$	% e	Indet	f Gauss	% e
$P_{.125}$	53	-57.6	54	-56.8		93	-25.6
$P_{.250}$	79	-36.8	76	-39.2		150	+20.0
$P_{.375}$	93	-25.6	84	-32.8		130	+4.0
$P_{.500}$	89	-28.8	92	-26.4		86	-31.2
$P_{.625}$	109	-12.8	106	-15.2		135	+8.0
$P_{.750}$	150	+20.0	137	+9.6	3	143	+14.4
$P_{.875}$	202	+61.6	182	+45.6	20	131	+4.8
$P_{1.00}$	225	+80.0	201	+60.8	68	132	+5.6

TABLE 1 - Continued

N = 24

P_o	f X^2(P)	% e	f X^2(L)	% e	Indet	f Gauss	% e
$P_{.125}$	77	-38.4	79	-36.8		103	-17.6
$P_{.250}$	113	-9.6	114	-8.8		157	+25.6
$P_{.375}$	54	-56.8	31	-75.2	8	60	-52.0
$P_{.500}$	142	+13.6	132	+5.6	28	178	+42.4
$P_{.625}$	148	+18.4	89	-28.8	58	150	+20.0
$P_{.750}$	136	+8.8	83	-33.6	58	118	-5.6
$P_{.875}$	128	+2.4	66	-47.2	89	121	-3.2
$P_{1.00}$	202	+61.6	34	-72.8	131	113	-9.6

EVALUATION OF THE HYPOTHESES OF EQUAL PROPORTIONS

Table 1, which is included in the previous section, not only provides the tabulation necessary to answer the question posed by Fienberg as to whether $X^2(P)$ or $X^2(L)$ is superior for one sample tests with small N, but also evaluates the hypotheses:

$$H_0 : P_1 = P_{01} \qquad H_1 = \text{not } H_0$$
$$P_2 = P_{02}$$
$$\vdots \qquad \vdots$$
$$P_k = P_{0k}$$

The proportions under the null hypotheses are of equal area and therefore are associated with equal probabilities and uniform expected frequencies for each of the 5 different categories enumerated with k varying from 4 to 8. The criterion for each sample set is that the percentage of error should not exceed 10% if H_0 is to be accepted.

The table displays that H_0 would be rejected for the great majority of one sample cases generated from chi-square distributions whether $X^2(P)$ or $X^2(L)$ was used as the test statistic. This preponderant rejection was not anticipated although the section, LITERATURE BASIC TO THE

PROBLEM, was concerned with the use of equal area models resulting from sampling from uniform distributions. Roscoe and Byars stated that the chi-square tests of goodness of fit are not so good with non-uniform hypotheses.[1] Watson tested for goodness of fit to normal but suggested that the number of cells should be at least 10.[2] Kempthorne tested for goodness of fit to normal but set the number of cells equal to the sample size.[3] Dahiya found that the chi-square approximation tends to be liberal if the value of K is set too high and is larger than n.[4]

Because of the results obtained when sampling from chi-square distributions, Gaussian random numbers were also generated and are tabulated in Table 1 for the same sample sizes, degrees of freedom, and expected values used for $X^2(P)$. The frequencies tabled as f Gauss and corresponding deviations from the expected frequency in each category, % e, were calculated utilizing $X^2(P)$. The test statistic $X^2(L)$ was omitted from the study of the Gaussian since examination of the computer print-out disclosed that many of the samples

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[1]Roscoe and Byars, pp. 755-759.

[2]Watson, pp. 336-348.

[3]Kempthorne, "The Classical Problem of Inference," pp. 235-249.

[4]R. C. Dahiya, "On the Pearson Chi-squared Goodness of Fit Test Statistic," Biometrika, 1971, 58, pp. 685-686.

were indeterminate, although fewer in number than those from the chi-square sampling.

The null hypotheses of equal proportions were rejected for the goodness of fit except for K = 5, ϕ = 1/5, $\bar{E}(x)$ = 10, and N = 50. It should be noted that this same sample set had similar results for $X^2(P)$ and $X^2(L)$. In general, the sampling from normal resulted in lower percentage error than did sampling from chi-square distributions. A major point to be considered is that of the small sample size studied. The most important implication found in this part of the design is the increase of error found in the larger number categories. This will be discussed in a later chapter in conjunction with the results of the tests for goodness of fit when $X^2(P)$ and $X^2(L)$ are compared with the exact multinomial probability (M) for the α regions in the upper tail of the distributions.

COMPARISONS OF $X^2(P)$, $X^2(L)$ AND (M) AT VARIOUS LEVELS OF SIGNIFICANCE

Tests in which a comparison of an observed probability distribution is made with a theoretical distribution like the Poisson, binomial, normal or others, are called goodness of fit tests. As previously stated, one of the most commonly used test statistics is the chi-square test. As Snedecor explains, "The chi-square test is a large sample approximation, based on the assumption that the distribution of the observed members in the classes are not far from normal. This assumption fails where some or all of the observed numbers are very small."[1]

Small sample sizes and small expected frequencies have already been reviewed, and the problem is raised here only because, in the more extreme cases, it is possible to work out the exact distribution of chi-square. The probability that f_i observations fall in the i^{th} class is given by the multinomial distribution. Tate and Hyer have tabulated the exact cumulative probabilities for a multinomial such that expected frequencies vary from 1 to not less than 5 in the case where the expected frequencies are equal, which is equivalent to the equal area model; they have also

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[1]George W. Snedecor and William G. Cochran, Statistical Methods, 6th ed. (Ames, Iowa: Iowa State University Press, 1967), pp. 235-242.

studied the accuracy of the conventional chi-square goodness of fit tests in the often used levels of significance.[1]

In designs of greater complexity than the one sample case, such as contingency tables, analysis of variance and the like, the chi-square statistic is usually involved. However, the question of sample size and expected frequencies still continues to be a matter of discussion in these cases. Cochran suggests using Fisher's exact multinomial for 2 x 2 contingency tables in samples up to size 30. In tests in which all expectations are small, the contention is that the tabular X^2 is tolerably accurate, provided that all expectations are at least 2. A constraint is also imposed that the degrees of freedom are less than 15. If the degrees of freedom exceed 60, it is suggested that the normal approximation to the exact distribution be used.[2]

The above usage of the chi-square statistic is referred to at this point in order to introduce the concept of "Lack of Fit". "Lack of Fit" occurs when the sum of squares contains at least two sources of variation. According to Cochran and Cox, the first contribution is due to experimental errors, which make the values deviate from the true response surface. The second is that there be inflation of

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[1]Tate and Hyer, pp. 25-72.

[2]Cochran, "X^2 Test," pp. 329-334.

the values due to the failure of the linear equation to represent the correct shape of the response surface. Likewise, a chi-square proportion evaluation can show a lack of fit if the parent population is not uniform or normal.[1]

Since the usual test for goodness of fit is concerned with the probabilities of the various test statistics in the upper tail of the studied distributions rather than the evaluation of equal proportions, the frequencies that were observed for $X^2(P)$ and $X^2(L)$ for 3 α regions and 1000 iterations of the 15 different sample sets generated are presented for comparison in Table 2. The frequencies that are probable for 1000 multinomial outcomes are also listed for comparison in the same α regions.

The rationale for using probability regions rather than point estimates is multiple. As Kempthorne points out, "A point estimate alone is of little value because we are in the position of having a sample of one from a population of which we do not know the spread. We do not know, therefore, how close we are likely to be to the true value."[2] A reader is more frequently concerned with making an interval estimate in order to know the probability of this confidence in-

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[1]William G. Cochran and Gertrude M. Cox, Experimental Designs, 2d ed. (New York: John Wiley & Sons, 1957), p. 340.

[2]Oscar Kempthorne, The Design and Analysis of Experiments (Huntington, N. Y.: Robert E. Krieger, 1973), p. 28.

terval containing the true value. Cochran's criterion is:

> . . . compare the exact P and the P from the X^2 table, when the null hypothesis is true, in the region in which the tabular P lies between 0.05 and 0.01. This criterion is not ideal, but it does appraise the performance of the tabular approximation in the borderline region between statistical significance and nonsignificance. A disturbance is regarded as unimportant if when the P is 0.05 in the X^2 table, the exact P lies between 0.04 and 0.06, and if when the tabular P is 0.01, the exact P lies between 0.007 and 0.015. These limits are, of course, arbitrary; some would be content with less conservative limits.[1]

As Skipper, Guenther, and Nass contend, .05 is not sacred. They say:

> . . . there is a need for social scientists to choose levels of significance with full awareness of the implications of Type I and Type II error for the problem under investigation . . . the tendency to dichotomy resulting from judging some results significant and others 'non-significant can be misleading both to professionals and lay audiences . . . a more rational approach might be to report the actual level of significance, placing the burden of interpretative skill upon the reader. Such a policy would also encourage scientists to give higher priority to selecting appropriate levels of significance for a given problem.[2]

This approach to hypothesis testing is similar to that used in commerce and industry where the use of the prob-value, short for probability value, is prevalent. The prob-value is defined as the probability that the sample value

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[1]Cochran, "X^2 Test," pp. 328-329.

[2]James K. Skipper, Jr., Anthony L. Guenther, and Gilbert Nass, "The Sacredness of .05: A Note Concerning the Uses of Statistical Levels of Significance in the Social Sciences," American Sociologist, 1967, 2, pp. 16-18.

would be as extreme as the value actually observed/H_0, and the reader would reject H_0 iff prob-value $< \alpha$.[1]

Furthermore, Tate and Hyer ignore the more extreme outcomes that have probabilities less than .005 since they felt that such extreme values seldom occur and, if they do, are most often a result of experimental or sampling errors. The regions that were selected not only encompass α levels that are often used for tests of significance but are also of mathematical necessity. The calculation of the cumulative multinomial probability of an outcome results in an exact probability. Only by grouping these probabilities can there be any meaningful comparison with the corresponding Pearson chi-square statistic for a set of outcomes. For example, the cumulative multinomial probability is .043 for an outcome of a random sample of 15 in 5 categories of 1, 0, 6, 5, 3 (order is immaterial) and the null hypothesis of all ϕ = 1/5 would be rejected at the 4.3 percent level. $X^2(P)$ for the same outcome is 8.66667 with the tabular probability approximately .0745 so that the null hypothesis would still be rejected for the .100 goodness of fit criterion. However, it should be noted that the probability is in a different region. As Tate and Hyer found, the median percentage agreement between the exact (M) and the approxi-

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[1]T. H. Wonnacott and R. J. Wonnacott, Introductory Statistics (New York: John Wiley & Sons, 1969), pp. 179-181.

mation $X^2(P)$ probabilities in the regions $< .010$, .010-.050, .051-.100 and $> .100$ was 68. On average, the probabilities fell in the same region about 2/3 of the time. However, as in the point example above, the most apparent source of error was the number of outcomes yielding the same X^2, but having varying multinomial probabilities and, on the other hand, the number of outcomes having the same multinomial probabilities, but yielding varying X^2.[1]

Table 2, which follows, is easily read. The α region .005-.009 has an expected frequency, $f_e = 5$; the .010-.050 region has $f_e = 41$, while the .051-.100 region has $f_e = 50$. These are the same no matter how many categories, K, are involved. The number of observations of $X^2(P)$, $X^2(L)$, and (M) for 1000 iterations are enumerated according to the sample sizes. The source of $X^2(P)$ and $X^2(L)$ is the random number generator print-out. Since (M) is an exact probability, f_e for the 7 sample sets, each containing the 3 α regions of interest, is easily calculated from Tate and Hyer's tables.[2] For each sample set, the lowest and highest probability within the 3 regions is ascertained. By subtracting the lowest from the highest, the probability range within each region is determined. When this result is multi-

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[1]Tate and Hyer, pp. 2, 13.

[2]Tate and Hyer, pp. 28-72.

plied by 1000, the frequency within each region is obtained for this study.

There is very little difference in the observed frequencies of $X^2(P)$ and $X^2(L)$ except when there are large numbers of indeterminate $X^2(L)$. This occurs in all five categories when $E(x) = 3$ and when $E(x) = 5$ and $K = 8$. This bias favors the selection of the Pearson chi-square statistic over the log-linear likelihood ratio statistic unless it is known a priori that zero or small cell frequencies are unlikely to be observed. Specifically, $X^2(P)$ has a tendency to have fewer values in the .005-.050 region than $X^2(L)$ but more in the .051-.100 region. If the statistic is being used for goodness of fit tests, either one could be used with the preceding constraints. $X^2(P)$ is generally less than the theoretical frequencies expected in the three regions, when K is less than 7. This would cause a researcher sometimes to make a Type II error and fail to reject the null hypothesis when the null hypothesis was false.

The results tabulated for $K = 8$, $\phi = 1/8$, $N = 80$, 40, and 24, are worthy of special consideration since the observed results are so divergent from the theoretical and since they also support many of Tate and Hyer's conclusions. They also found that:

1. When f_e were five or fewer, the mean errors increased as the number of categories increased.

2. The percentage error of $X^2(P)$ decreased as the (M) probabilities increased over the .005-.100 region.

3. If close approximations to the exact probabilities are needed, the $X^2(P)$ test is not satisfactory when E(x) are fewer than about 10, and, even when they are more than 10, the approximation may at times be poor. On the other hand, if one is interested only in whether the cumulative probability associated with an outcome in a multinomial distribution is less or greater than .05, the chi-square test performs reasonably well with expectations as small as 1.

4. The use of the chi-square in place of the multinomial involves at least 2 types of error, one arising from the approximations that are made in deriving the chi-square function from the multinomial, the other from the fact that the former is a continuous function, while the latter is discrete.

5. All of the proofs of the chi-square distribution assume at some point that the observed frequencies in a category, O_i, are distributed normally about E_i in the i^{th} category. This means that E_i must be greater than zero to preclude positive skewness and large enough to temper discreteness. The question in the application of chi-square to frequency data is that of how large E_i must be to make the assumption of normality in categories tenable.

CHAPTER V contains more specifics as to why some of the preceding divergent results were observed, differences with established authorities, and implications for future research.

TABLE 2

COMPARISONS OF FREQUENCIES OF $X^2(P)$, $X^2(L)$, AND (M)

FOR 1000 ITERATIONS

IN VARIOUS PROBABILITY REGIONS

K = 4, ϕ = 1/4, N = 40, 20, and 12

	.005-.009	.010-.050	.051-.100
Expected Freq.	5	41	50
N = 40			
$X^2(P)$	4	45	49
$X^2(L)$	5	51	41
(M)	Not Available		
N = 20			
$X^2(P)$	4	35	48
$X^2(L)$	3	37	57
(M)	5	40	43
N = 12			
$X^2(P)$	0	35	37
$X^2(L)$	1	4	48
(M)	3	25	37

TABLE 2 - Continued

K = 5, ϕ = 1/5, N = 50, 25, and 15

	.005-.009	.010-.050	.051-.100
Expected Freq.	5	41	50
N = 50			
X^2(P)	3	54	56
X^2(L)	3	57	46
(M)	Not Available		
N = 25			
X^2(P)	3	36	57
X^2(L)	0	43	50
(M)	5	41	45
N = 15			
X^2(P)	0	34	64
X^2(L)	0	12	17
(M)	3	33	42

K = 6, ϕ = 1/6, N = 60, 30, and 18

	.005-.009	.010.-.050	.051-.100
Expected Freq.	5	41	50
N = 60			
X^2(P)	2	40	47
X^2(L)	6	46	44
(M)	Not Available		
N = 30			
X^2(P)	3	43	29
X^2(L)	7	33	38
(M)	5	40	49
N = 18			
X^2(P)	3	25	50
X^2(L)	0	3	13
(M)	5	41	46

TABLE 2 - Continued

K = 7, Φ = 1/7, N = 70, 35, and 21

	.005-.009	.010-.050	.051-.100
Expected Freq.	5	41	50
N = 70			
X^2(P)	6	44	51
X^2(L)	7	41	55
(M)	Not Available		
N = 35			
X^2(P)	3	43	53
X^2(L)	2	42	49
(M)	Not Available		
N = 21			
X^2(P)	5	46	72
X^2(L)	0	2	23
(M)	5	40	45

K = 8, Φ = 1/8, N = 80, 40, and 24

	.005-.009	.010-.050	.051-.100
Expected Freq.	5	41	50
N = 80			
X^2(P)	22	137	111
X^2(L)	34	123	136
(M)	Not Available		
N = 40			
X^2(P)	13	73	79
X^2(L)	7	67	79
(M)	Not Available		
N = 24			
X^2(P)	6	56	64
X^2(L)	1	5	16
(M)	Not Available		

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

CONCLUSIONS

This study supports the continuing controversy, highlighted in 1949, that began with the publications by Lewis and Burke relative to the use and misuse of the chi-square test. The bibliography reflects the many well-known statisticians who have concerned themselves with the resolution of the required sample size, expected frequencies, sampling techniques, categorization and application of the chi-square statistic to tests of goodness of fit; contingency tables, both simple and multi-dimensional; analysis of variance, univariate and multivariate; analysis of co-variance; and many other experimental designs of the block and lattice types.

From the results shown in CHAPTER IV, it is evident that $X^2(P)$ is to be preferred to $X^2(L)$ for small sample sizes and small expected cell frequencies because $X^2(L)$ becomes indeterminate when observed zero cells occur. This occurs more and more frequently as the number of categories are increased and the expected frequencies are decreased for the one sample case. This does not detract from the use of $X^2(L)$ when used in model fitting for multi-dimensional contingency tables.

It is interesting to note that Tate and Hyer had originally intended to include only the probabilities for the multinomials, k = 3, 4, 5 and total sample sizes N which would yield expected frequencies not more than 5. As they proceeded, it became evident that the often read statement that the chi-square test is satisfactory when the expected frequencies are not less than 5 and the degrees of freedom 2 or more was not supported by their research. The study was extended to larger samples with k = 3, 4, 5, 6, 7 and N's. Unfortunately, only for k = 3 did they tabulate results when the expected frequencies were as large as 10 and N = 30.

As shown in Table 2, this study supports the Tate and Hyer findings that the chi-square approximation improved as the multinomial probabilities increased over the .005-.100 region, but the errors were greatest in the .005-.009 region. Another important point of agreement is that when the expected frequencies were 5 or fewer, the errors increased as the number of categories increased, and likewise if the expected frequencies decreased. However, the errors did decrease when the expected frequencies were 10 or more. As the expected frequencies increase, the range of the multinomial probabilities of outcomes having identical chi-square probabilities decreases.

At first glance, the above seems to disagree with McNamee's findings that the chi-square test for first order interaction is quite robust as far as sample size is concerned, when the expected frequency for each cell is as small as 3. He also found that if the cells have a minimum value of 1, the chi-square for second order interaction was within the .03 limit of error allowed. However, this disagreement is only valid if close approximation to exact probabilities is needed, such as reported in a preceding section, EVALUATION OF THE HYPOTHESES OF EQUAL PROPORTIONS. Table 1 discloses that the chi-square test is not satisfactory when expected frequencies are fewer than about 10, and, even when they are more than 10, the approximation may be poor. However, the chi-square test performs reasonably well with small expectations, even as small as 1, if the researcher is interested only in the probability values of the multinomial or chi-square distribution in the upper right hand tail and wishes to know if the probability of an outcome is less than or greater than .05. The rule of 5 is no better than the rule of 1 when chi-square is used to test the hypothesis that the parameters of a multinomial distribution have specified values against the alternative that at least one parameter is not as specified.

In another study comparing multinomial and chi-square probabilities for samples with unequal ϕ, El Shanawany found that most chi-square probabilities would lead to the same conclusion as the multinomial probabilities if one accepted the null hypothesis when P was greater than .05, remained in doubt when P was between .05 and .01, and rejected the hypothesis when P was less than .01.[1]

Snedecor[2] and Cochran[3] explain the reason for some of the divergent results tabulated in Tables 1 and 2, particularly in chi-square distributions with the larger number of categories and smaller expected frequencies. Obviously, the chi-square distributions that were generated for the Monte Carlo methodology had different degrees of skewness and kurtosis. A measure of the amount of skewness in a population is given by the average value of $(X - \mu)^3$, taken over the population. This quantity is called the third moment about the mean and, when divided by σ^3, to render the measure independent of scale, the result is the coefficient of skewness. Since the mean of the population is seldom known, the sample estimate $\sqrt{b_1}$ or g_1 is usually calculated as follows:

$$\sqrt{b_1} = g_1 = m_3/(m_2 \sqrt{m_2})$$

where the second moment $m_2 = \sum (X - \bar{X})^2/n$ and the third moment $m_3 = \sum (X - \bar{X})^3/n$. If the sample comes from a nor-

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[1] M. R. Shanawany, "An Illustration of the Accuracy of the Chi-square Approximation," Biometrika, 1936, 28, pp. 315-345.

[2] Snedecor and Cochran, pp. 86-89.

[3] William G. Cochran, Sampling Techniques, 2d ed. (New York: John Wiley & Sons, 1963), p. 43.

mal distribution, g_1 is approximately normally distributed with mean zero and S.D. $\sqrt{(6/n)}$.

Kurtosis is a further type of departure from normality. In a population, a measure of kurtosis is the value of the fourth moment $(X - \mu)^4$ divided by σ^4. For the normal distribution, this ratio has the value of 3. If the ratio exceeds 3, there is usually an excess of values near the mean with a corresponding depletion of the tails of the distribution curve. Ratios less than 3 result from curves that have a flatter top than the normal. A sample estimate of the fourth moment is given by:

$$g_2 = b_2 - 3 = (m_4/m_2^2) - 3$$

$$\text{where } m_4 = \sum (X - \bar{X})^4/n$$

In large samples, over 1000, from the normal distribution, g_2 is normally distributed with mean zero and S.D. $\sqrt{24/n}$.

In samples from non-normal populations, the quantities g_1 and g_2 are used as estimates of the population values. The measures of skewness and kurtosis both go to zero when the sample size increases as expected from The Central Limit Theorem. It should be noted that kurtosis is damped much faster than the skewness. The purpose of this rather lengthy discussion is to emphasize the effects that this study's sampling from non-normal distributions had on the variance in those samples.

As Cochran points out, "One effect of non-normality is that the estimated variance may be more highly variable from sample to sample than we expect . . . " The variance of s^2 in random samples can be expressed as:

$$V(s^2) = \frac{2\sigma^4}{n-1} \left\{ 1 + \frac{n-1}{n} \cdot \frac{g_2}{2} \right\}$$

"The factor outside the brackets is the variance of s^2 in samples from a normal population. The term inside the brackets is the factor by which normal variance is multiplied when the population is non-normal." Readers may well recognize that the above formula states that the variance of s^2 is the sum of variance when the parent population is normal and $\frac{K_4}{n}$, the fourth cumulant divided by the sample size. It should be noted that the skewness does not affect the stability of s^2: the important factor is the fourth moment in the parent population. Further reference to the effects of skewness and kurtosis is made in the next section recommending future extension of some Collier and Baker studies.

RECOMMENDATIONS FOR FUTURE RESEARCH

Since chi-square tests for hypotheses concerning multinomial probabilities are among the most frequently used statistical procedures, the current study suggests many lines that should be investigated further. This research should be duplicated, using sampling from other distributions, particularly the uniform and the Poisson, and the results compared to ascertain if the error patterns would be similar. The Tate and Hyer study should be extended to include more categories and larger expected frequencies, at least 10 for these additional categories and those already tabled for $k = 4, 5, 6$ and 7. These studies should shed some light upon that area where Cochran suggests using the chi-square for samples with small expected frequencies but fewer than 15 degrees of freedom.

Mayo states that there is difficulty in finding a comprehensive treatment of contingency analysis in the literature and that "Especially conspicuous by its absence is an explanation of how to interpret interaction when the null hypothesis of independence is rejected."[1] McNamee's research was undoubtedly inspired by this. It is suggested

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[1]Samuel T. Mayo, "Interactions Among Categorical Variables," Educational and Psychological Measurement, 1961, 21, p. 840.

that McNamee's research on the "Robustness of Homogeneity Tests in Parallelepiped Contingency Tables" be extended to include sampling from other than the uniform distribution, preferably sampling from normal, chi-square, and Poisson distributions, in order to get more generalized results.

More complex designs, such as the completely randomized or randomized block, should be broken down into smaller contingency tables and tested by use of the chi-square statistic as suggested by both Snedecor and Cochran.[1] When the initial chi-square test shows a significant value, subsequent tests should be made that may help to explain the high values of chi-square. These subsequent tests should take into account the various studies by Baker and Collier listed in the bibliography which cover the effect of skewness and kurtosis in randomized block designs. Baker and Collier compared results under normal theory and under permutation theory. It is suggested that these studies be extended to include sampling from the chi-square distributions and the Poisson.

This study and its methodology could be adapted to the study of the fit to response surfaces as described by Cochran and Cox.[2] However, much of the research suggested

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[1] Snedecor and Cochran, pp. 127 and 242.

[2] Cochran and Cox, pp. 335-368.

above could be facilitated if the multinomial tables were enlarged.

Research methodologists must not be unmindful of the fact that social, behavioral, and educational scientists currently constitute a growing majority of intermediate consumers of statistical literature.

While it is known that analytical and computer studies are oriented toward the mathematical statisticians, it must also be realized that this group comprises a minority. Scientific recognition of pre-eminent authorities is necessary for mathematical approaches to analytical investigation. Therefore, the present study was intended to encourage renewed analytical concentration upon the questions raised by this empirical research.

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APPENDIX A

HOW TO USE THE McGILL RANDOM NUMBER PACKAGE "SUPER-DUPER"

To get uniform, normal or exponential random variables, call as ordinary FORTRAN functions. For example,

U=UNI(0)

will produce a uniform random variable U in the half-open interval (0,1), while

V=VNI(0)

will produce a uniform variate V in the open interval (-1,1). Similarly

X=RNOR(0)

will produce a standard normal random variable X and

Y=REXP(0)

will produce a standard exponential variate Y.

In each case the arguments of UNI, VNI, RNOR and REXP are dummy integers that are ignored by the subroutine. Thus either X=RNOR(3) or X=RNOR(362436) will cause a normal random variable to be stored in the memory location of X.

The package also includes a provision for random integers:

K=IUNI(0)

will produce a random integer in the range $0 \leq K < 2^{31}$, while

L=IVNI(0)

will produce a random signed integer in the full possible range of the 360 machine: $-2^{31} \leq L < 2^{31}$.

The uniform number generator (which is either called directly or else is built into the normal and exponential generators) combines a multiplicative congruential generator and a shift register generator. The congruential generator uses the multiplier 69069, found after a search of millions of multipliers to have nearly optimal lattice structure in 2, 3, 4 and 5 dimensions - much better than any of the highly touted but poorly justified multipliers used for the past 20 years. But even though the congruential generator is as good as a congruential generator can be, it is still not good enough, and we have combined it with a shift register generator on 32 bits (right shift 15, left shift 17). The bit patterns produced by the two separate generators are added as binary vectors - that is, <u>exclusive</u> <u>or</u> addition. Combining the two generators produces a sequence with period about 5×10^{18}.

The program has built-in starting values for those who forget, or don't care, to assign their own starting values. To assign starting values IS and JS to the congruential and shift register sequences, one uses

CALL RSTART(IS,JS),

where IS and JS are any two integers within the allowable range of 360 FORTRAN.

Those wanting to use a pure congruential generator with multiplier 69069 may do so by

CALL RSTART(IS,0)

while those wanting a pure shift register generator would

CALL RSTART(0,JS).

Do not:

CALL RSTART(0,0)

unless you want a sequence of 5×10^{18} zeros.

The package comes as a source deck, containing one program written in IBM/360 Assembler Language (which may be assembled using the BPS Basic Assembler or any higher level assembler, e.g., E, F or G) and two small FORTRAN Function Subprograms (which require a compiler at the FORTRAN G or higher level).

If you plan to use the package very often, you should have an object deck produced when the source deck is compiled, to simplify and speed up subsequent use. Better yet, if you find the program as useful as we have designed it to be, you may take steps to have it included in your subroutine library so that RSTART, UNI, VNI, RNOR, REXP, IUNI and IVNI may be called as standard functions in the same way as ALOG, COS, SIN, etc.

Timing for the Super-Duper Random Number Package, with some comparisons:

UNIFORM RANDOM VARIABLES	360/75 O/S	370/155 RAX
	All times in micro-seconds	
X=UNI(0) (Super-duper)	28	38
X=VNI(0) (Super-duper)	30	40
NORMAL RANDOM VARIABLES		
1. X=SQRT(-*ALOG(UNI(0)))*COS(3.141593*UNI(0))	234	420
2. Polar method	153	230
3. X=RNOR(0) (Super-duper)	45	65
EXPONENTIAL RANDOM VARIABLES		
1. X=-ALOG(UNI(0))	99	163
2. X=REXP(0) (Super-duper)	49	71

McGILL RANDOM NUMBER PACKAGE "SUPER-DUPER"

SUMMARY OF CALLING PROCEDURES

FORTRAN STATEMENT	RESULT
U=UNI(0)	U is assigned a normalized floating value in $0 \leq u < 1$, uniform distribution.
U=UNI(1) U=UNI(2) U=UNI(71)	Same result as above. The integer argument of UNI is ignored by the subroutine, as are the integer arguments of VNI, RNOR, REXP, IUNI, IVNI below.
V=VNI(0)	V is assigned a normalized floating point value in the interval $-1 < v < 1$, uniform distribution
X=RNOR(0)	X is assigned a normalized floating point value with the normal (Gaussian) density, mean zero, variance 1.
Y=REXP(0)	Y is assigned a normalized floating point value with the exponential density e^{-y}, $y > 0$.
K=IUNI(0)	K is assigned a random integer value in the range $0 \leq K < 2^{31}$, uniform distribution.
L=IVNI(0)	L is assigned a random integer value, uniform in the range $-2^{31} \leq L < 2^{31}$.
CALL RSTART(I,J) Here I and J are any two integers you care to choose, e.g.,your social insurance number and your birth date written backwards.	This call statement should be used before the above functions are called; it starts the congruential generator (multiplier 69069) with I or I + 1, depending on whether I is odd or even, and the shift register generator with J mod 2048. If CALL RSTART(I,J) is not used, the subroutine will use the built-in starting values for I and J. One can make the uniform generator a pure congruential generator by CALL RSTART(I,0) where I is any integer $\neq 0$, and a pure shift register generator with CALL RSTART(0,J) and $J \neq 0$. Avoid CALL RSTART(0,0) - it will produce a sequence of zeros. If CALL RSTART(I,J) is used with both I and J not zero, the generator combines a congruential generator and a shift register generator and has period 5×10^{18}.

```
*
*         MCGILL UNIVERSITY    SCHOOL OF COMPUTER SCIENCE
*
*         RANDOM NUMBER GENERATOR PACKAGE - 'SUPER-DUPER'
*         ------ ------ --------- -------   -----------
*
*         UNIFORM,NORMAL AND EXPONENTIAL RANDOM NUMBER GENERATOR
*
*         G. MARSAGLIA, K.ANANTHANARAYANAN, N.PAUL.
*
*       REGISTER USAGE
*       -------- -----
*       GPR 0 - STORES RESULT OF IUNI,IVNI
*       GPR 1 - (REGB) CALCULATION OF RESULTS
*       GPR 2 - (REGC) CALCULATION OF RESULTS
*       GPR 3 - (REGD) CALCULATION OF RESULTS
*       GPR13 - ADDRESS OF SAVE AREA OF CALLING PROGRAM,OR OF THIS
*               PROGRAMS'S SAVE AREA ON CALL TO RNORTH OR REXPTH
*       GPR14 - CONTAINS RETURN ADDRESS.
*       GPR15 - USED AS BASE REGISTER.
*       FPR 0 - RESULT OF UNI,VNI,REXP,RNOR.
*
RANDOM START 0                 DEFINE ENTRY POINTS
       ENTRY RSTART            CALL RSTART(I1,I2)
       ENTRY UNI               U=UNI(0)
       ENTRY VNI               V=VNI(0)
       ENTRY RNOR              X=RNOR(0)
       ENTRY REXP              Y=REXP(0)
       ENTRY IUNI              K=IUNI(0)
       ENTRY IVNI              J=IVNI(0)
       EXTRN RNORTH            FORTRAN FUNCTIONS REQUIRED-RNORTH(I)
       EXTRN REXPTH                                      REXPTH(I)
REGB   EQU   1
REGC   EQU   2                 REGISTER EQUATES
REGD   EQU   3
*
*    CALL RSTART(I1,I2)        I1,I2 ARE USED FOR STARTING THE TWO
*                              SEQUENCES 'MCGN' AND 'SRGN'.
       USING RSTART,15
RSTART STM   REGB,REGD,24(13)  SAVE REGISTERS 1,2,3
       LM    REGC,REGD,0(1)    LOAD ADDRESSES OF I1,I2 INTO REGC,REGD
       L     REGC,0(REGC)      LOAD VALUE OF I1 INTO REGC
       LTR   REGC,REGC
       BC    8,ST1             IF ZERO,STORE AT 'MCGN',ELSE
       O     REGC,X1           ENSURE ODD,TO KEEP PERIOD OF 'MCGN' LARGE
ST1    ST    REGC,MCGN         STORE AT 'MCGN'
       L     REGD,0(REGD)      LOAD I2 INTO REGD
       LTR   REGD,REGD
       BC    8,ST2             IF ZERO, STORE AT 'SRGN',ELSE
       N     REGD,X7FF         TAKE RESIDUE MODULO 2048
       O     REGD,X1           AND ENSURE NON-ZERO
ST2    ST    REGD,SRGN         AND STORE AT 'SRGN'.
RETRNO LM    REGB,REGD,24(13)  RESTORE REGISTERS 1,2,3
       BCR   15,14             AND RETURN
*
*     U=UNI(0)                 RESULT IS NORMALIZED FLOATING POINT VALUE
*                              UNIFORMLY DISTRIBUTED ON (0.0,1.0).
       USING UNI,15
```

```
UNI      STM   REGB,REGD,24(13) SAVE REGISTERS 1,2,3
RDIGT1   L     REGB,SRGN        LOAD SRGN INTO REGB
         LR    REGC,REGB        AND INTO REGC
         SRL   REGC,15          SHIFT REGC RIGHT 15 BITS
         XR    REGB,REGC        AND XOR INTO REGB
         LR    REGC,REGB        COPY REGB INTO REGC
         SLL   REGC,17          SHIFT IT LEFT 17 BITS.
         XR    REGB,REGC        AND XOR INTO REGB
         ST    REGB,SRGN        SAVE THE NEW 'SRGN'
         L     REGD,MCGN        LOAD MCGN INTO REGD
         M     REGC,MULT        AND MULTIPLY BY 69069
         ST    REGD,MCGN        STORE RESULT,MODULO 2**32, AS NEW 'MCGN'
         XR    REGD,REGB        XOR NEW 'MCGN' AND 'SRGN' IN REGD
         SRL   REGD,8           SHIFT REGD RIGHT 8 BITS FOR F.P. FRACTION
         AL    REGD,CHAR        ADD CHARACTERISTIC X'40' INTO FIRST BYTE
         ST    REGD,FWD         STORE AT FWD, LOAD INTO FPR 0,
         LE    0,FWD            AND ADD NORMALIZED TO ZERO
         AE    0,Z              LEAVING RESULT 'UNI' IN FPR 0.
RETRN1   LM    REGB,REGD,24(13)
         BCR   15,14            RETURN
*
*        V=VNI(0)               RESULT IS NORMALIZED FLOATING POINT VALUE
*                               UNIFORM ON (-1.0,1.0)
         USING VNI,15
VNI      STM   REGB,REGD,24(13) SAVE REGISTERS 1,2,3
RDIGT2   L     REGB,SRGN        LOAD SRGN INTO REGB
         LR    REGC,REGB        AND INTO REGC
         SRL   REGC,15          SHIFT REGC RIGHT 15 BITS
         XR    REGB,REGC        AND XOR INTO REGB
         LR    REGC,REGB        COPY REGB INTO REGC
         SLL   REGC,17          SHIFT IT LEFT 17 BITS.
         XR    REGB,REGC        AND XOR INTO REGB
         ST    REGB,SRGN        SAVE THE NEW 'SRGN'
         L     REGD,MCGN        LOAD MCGN INTO REGD
         M     REGC,MULT        AND MULTIPLY BY 69069
         ST    REGD,MCGN        STORE RESULT,MODULO 2**32, AS NEW 'MCGN'
         XR    REGD,REGB        XOR NEW 'MCGN' AND 'SRGN' IN REGD
         SRA   REGD,7           SHIFT RIGHT 7 BITS PRESERVING SIGN BIT
         N     REGD,SIGN        ZERO OUT LAST 7 BITS  OF FIRST BYTE
         AL    REGD,CHAR        ADD CHARACTERISTIC X'40' TO FIRST BYTE
         ST    REGD,FWD         STORE AT FWD, LOAD INTO FPR 0
         LE    0,FWD            AND ADD NORMALIZED TO ZERO
         AE    0,Z              LEAVING RESULT 'VNI' IN FPR 0.
RETRN2   LM    REGB,REGD,24(13)
         BCR   15,14            RETURN
*
*        X=RNOR(0)              RESULT IS STANDARD NORMAL VARIATE.
*
*        METHOD
*        ------
*     1.  GENERATE H1H2H3H4H5H6H7H8,8 RANDOM HEXADECIMAL DIGITS.
*
*     2.   IF H1H2 .LT. 68, SET 'RNOR' TO
*                          (NTBL(H1H2)+.H3H4H5H6H7H8)/16, AND QUIT.
*     3.   IF H1H2 .LT. D0, SET 'RNOR' TO
*                          (-NTBL(H1H2-68)-.H3H4H5H6H7H8)/16, AND QUIT.
*     4.   IF H1H2H3 .LT. E2F, SET 'RNOR' TO
*                          (NTBL(H1H2H3-CE8)+.H4H5H6H7H8)/16, AND QUIT.
```

```
*     5.  IF H1H2H3 .LT. F5E, SET 'RNOR' TO
*                      (-NTBL(H1H2H3-E17)-.H4H5H6H7H8)/16, AND QUIT.
*     6.  ELSE,GENERATE 'RNOR' FROM THE NORMAL TOOTH-TAIL SUBPROGRAM.
*
*
          USING RNOR,15
RNOR      STM   REGB,REGD,24(13) SAVE REGISTERS 1,2,3
RDIGT3    L     REGB,SRGN        LOAD SRGN INTO REGB
          LR    REGC,REGB        AND INTO REGC
          SRL   REGC,15          SHIFT REGC RIGHT 15 BITS
          XR    REGB,REGC        AND XOR INTO REGB
          LR    REGC,REGB        COPY REGB INTO REGC
          SLL   REGC,17          SHIFT IT LEFT 17 BITS,
          XR    REGB,REGC        AND XOR INTO REGB
          ST    REGB,SRGN        SAVE THE NEW 'SRGN'
          L     REGD,MCGN        LOAD MCGN INTO REGD
          M     REGC,MULT        AND MULTIPLY BY 69069
          ST    REGD,MCGN        STORE RESULT,MODULO 2**32, AS NEW 'MCGN'
          XR    REGD,REGB        XOR NEW 'MCGN' AND 'SRGN' IN REGD
NRCT      SLR   REGC,REGC        ZERO OUT REGC
          CL    REGD,X68         IF REGD GE 68000000,BRANCH TO 'ND2'
          BC    11,ND2
ND1       SLDL  REGC,8           SHIFT FIRST 2 HEX DIGITS INTO REGC
          IC    REGC,NTBL(REGC)  FETCH CORRESPONDING BYTE FROM NTBL
          STC   REGC,PSTWRD+1    STORE AS 2ND BYTE OF PSTWRD
          SRL   REGD,8           TAKE REMAINING 24 BITS OF REGD
          AL    REGD,PCHAR       FORM FLOATING POINT FRACTION,CHAR X'3F'
          ST    REGD,FRAC        AND STORE AT 'FRAC'
          LE    0,PSTWRD         ADD 'PSTWRD' AND 'FRAC'
          AE    0,FRAC           LEAVING RESULT IN FPR 0
          LM    REGB,REGD,24(13)
          BCR   15,14            RETURN
ND2       CL    REGD,XD0         IF REGD GE D0000000,BRANCH TO 'ND3'
          BC    11,ND3
          SLDL  REGC,8           SHIFT FIRST 2 HEX DIGITS INTO REGC
          SL    REGC,X68R        AND SUBTRACT 00000068
          IC    REGC,NTBL(REGC)  FETCH CORRESPONDING BYTE FROM NTBL
          STC   REGC,NSTWRD+1    STORE AS 2ND BYTE OF NSTWRD
          SRL   REGD,8           TAKE REMAINING 24 BITS OF REGD
          AL    REGD,PCHAR       FORM FLOATING POINT FRACTION,CHAR X'3F'
          ST    REGD,FRAC        AND STORE AT 'FRAC'
          LE    0,NSTWRD         SUBTRACT 'FRAC' FROM 'NSTWRD'
          SE    0,FRAC           LEAVING RESULT IN FPR 0
          LM    REGB,REGD,24(13)
          BCR   15,14            RETURN
ND3       CL    REGD,XE2F        IF REGD GE F2F00000,BRANCH TO 'ND4'
          BC    11,ND4
          SLDL  REGC,12          SHIFT FIRST 3 HEX DIGITS INTO REGC
          SL    REGC,XCE8        AND SUBTRACT 00000CE8
          IC    REGC,NTBL(REGC)  FETCH CORRESPONDING BYTE FROM NTBL
          STC   REGC,PSTWRD+1    STORE AS 2ND BYTE OF PSTWRD
          SRL   REGD,8           TAKE REMAINING 20 BITS OF REGD
          AL    REGD,PCHAR       FORM FLOATING POINT FRACTION,CHAR X'3F'
          ST    REGD,FRAC        AND STORE AT 'FRAC'
          LE    0,PSTWRD         ADD 'PSTWRD' AND 'FRAC'
          AE    0,FRAC           LEAVING RESULT IN FPR 0
          LM    REGB,REGD,24(13)
          BCR   15,14            RETURN
```

```
ND4      CL    REGD,XF5E          IF REGD GE XF5E00000,BRANCH TO 'NTTHTL'
         BC    11,NTTHTL
         SLDL  REGC,12            SHIFT FIRST 3 HEX DIGITS INTO REGC
         SL    REGC,XE17          AND SUBTRACT 00000E17
         IC    REGC,NTBL(REGC)    FETCH CORRESPONDING BYTE FROM NTBL
         STC   REGC,NSTWRD+1      STORE AS 2ND BYTE OF NSTWRD
         SRL   REGD,8             TAKE REMAINING 20 BITS OF REGD
         AL    REGD,PCHAR         FORM FLOATING POINT FRACTION,CHAR X'3F'
         ST    REGD,FRAC          AND STORE AT 'FRAC'
         LE    0,NSTWRD           SUBTRACT 'FRAC' FROM 'NSTWRD'
         SE    0,FRAC             LEAVING RESULT IN FPR 0
         LM    REGB,REGD,24(13)
         BCR   15,14              RETURN
NTTHTL   ST    REGD,ARG           STORE REGD AS ARGUMENT FOR RNORTH ROUTINE
         STM   14,0,12(13)        SAVE ALL REGISTERS FROM 14 TO 3.
         LR    3,13               COPY PREVIOUS SAVE AREA ADDRESS TO GPR3
         LA    13,SVAREA          LOAD ADDRESS OF SVAREA INTO GPR13
         ST    13,8(0,3)          STORE ADDRESS OF SVAREA IN SAVE AREA
         ST    3,4(0,13)          STORE ADDRESS OF PREVIOUS SAVE AREA
         LA    1,ARGLST           PLACE ADDRESS OF ARGUMENT LIST IN GPR 1
         L     15,ADNTH
         BALR  14,15              BRANCH TO SUBPROGRAM
         LR    13,3               RESTORE ADDRESS OF SAVE AREA IN GPR13
         MVI   12(13),X'FF'       SET RETURN INDICATOR
RETRN3   LM    14,REGD,12(13)     RESTORE ALL REGISTERS
         BCR   15,14              RETURN
*
*        Y=REXP(0)                RESULT IS STANDARD EXPONENTIAL VARIATE.
*
*        METHOD
*        ------
*    1.  GENERATE H1H2H3H4H5H6H7H8, 8 RANDOM HEXADECIMAL DIGITS
*
*    2.  IF H1H2 .LT. D5, SET 'REXP' TO
*                            (ETBL(H1H2)+.H3H4H5H6H7H8)/16, AND QUIT.
*    3.  IF H1H2H3 .LT. F17, SET 'REXP' TO
*                            (ETBL(H1H2H3-CFF)+.H4H5H6H7H8)/16, AND QUIT
*    4.  ELSE,GENERATE 'REXP' FROM THE EXPONENTIAL TOOTH-TAIL SUBPROGRAM
*
         USING REXP,15
REXP     STM   REGB,REGD,24(13)   SAVE REGISTERS 1,2,3
RDIGT4   L     REGB,SRGN          LOAD SRGN INTO REGB
         LR    REGC,REGB          AND INTO REGC
         SRL   REGC,15            SHIFT REGC RIGHT 15 BITS
         XR    REGB,REGC          AND XOR INTO REGB
         LR    REGC,REGB          COPY REGB INTO REGC
         SLL   REGC,17            SHIFT IT LEFT 17 BITS.
         XR    REGB,REGC          AND XOR INTO REGB
         ST    REGB,SRGN          SAVE THE NEW 'SRGN'
         L     REGD,MCGN          LOAD MCGN INTO REGD
         M     REGC,MULT          AND MULTIPLY BY 69069
         ST    REGD,MCGN          STORE RESULT,MODULO 2**32, AS NEW 'MCGN'
         XR    REGD,REGB          XOR NEW 'MCGN' AND 'SRGN' IN REGD
ERCT     SLR   REGC,REGC          ZERO OUT REGC
         CL    REGD,XD5           IF REGD GE D5000000,BRANCH TO 'ED2'
         BC    11,ED2
ED1      SLDL  REGC,8             SHIFT FIRST 2 HEX DIGITS INTO REGC
         IC    REGC,ETBL(REGC)    FETCH CORRESPONDING BYTE FROM ETBL
```

```
         STC   REGC,PSTWRD+1      STORE AS 2ND BYTE OF PSTWRD
         SRL   REGD,8             TAKE REMAINING 24 BITS OF REGD
         AL    REGD,PCHAR         FORM FLOATING POINT FRACTION,CHAR X'3F'
         ST    REGD,FRAC          AND STORE AT 'FRAC'
         LE    0,PSTWRD           ADD 'PSTWRD' AND 'FRAC'
         AE    0,FRAC             LEAVING RESULT IN FPR 0
         LM    REGB,REGD,24(13)
         BCR   15,14              RETURN
ED2      CL    REGD,XF17          IF REGD GE F1700000,BRANCH TO 'ETTHTL'
         BC    11,ETTHTL
         SLDL  REGC,12            SHIFT FIRST 3 HEX DIGITS INTO REGC
         SL    REGC,XCFF          AND SUBTRACT 00000CFF
         IC    REGC,ETBL(REGC)    FETCH CORRESPONDING BYTE FROM ETBL
         STC   REGC,PSTWRD+1      STORE AS 2ND BYTE OF PSTWRD
         SRL   REGD,8             TAKE REMAINING 20 BITS OF REGD
         AL    REGD,PCHAR         FORM FLOATING POINT FRACTION,CHAR X'3F'
         ST    REGD,FRAC          AND STORE AT 'FRAC'
         LE    0,PSTWRD           ADD 'PSTWRD' AND 'FRAC'
         AE    0,FRAC             LEAVING RESULT IN FPR 0
         LM    REGB,REGD,24(13)
         BCR   15,14              RETURN
ETTHTL   ST    REGD,ARG           STORE REGD AS ARGUMENT FOR REXPTH ROUTINE
         STM   14,0,12(13)        SAVE ALL REGISTERS FROM 14 TO 3.
         LR    3,13               COPY PREVIOUS SAVE AREA ADDRESS TO GPR 3
         LA    13,SVAREA          LOAD ADDRESS OF SVAREA INTO GPR13
         ST    13,8(0,3)          STORE ADDRESS OF SVAREA IN SAVE AREA
         ST    3,4(0,13)          STORE ADDRESS OF PREVIOUS SAVE AREA
         LA    1,ARGLST           PLACE ADDRESS OF ARGUMENT LIST IN GPR 1
         L     15,ADETH
         BALR  14,15              BRANCH TO SUBPROGRAM
         LR    13,3               RESTORE ADDRESS OF SAVE AREA IN GPR13
         MVI   12(13),X'FF'       SET RETURN INDICATOR
RETRN4   LM    14,REGD,12(13)     RESTORE ALL REGISTERS
         BCR   15,14              RETURN
*
*      K=IUNI(0)                  UNIFORMLY DISTRIBUTED POSITIVE INTEGER.
*
         USING IUNI,15
IUNI     STM   REGB,REGD,24(13)   SAVE REGISTERS 1,2,3
RDIGTS   L     REGB,SRGN          LOAD SRGN INTO REGB
         LR    REGC,REGB          AND INTO REGC
         SRL   REGC,15            SHIFT REGC RIGHT 15 BITS
         XR    REGB,REGC          AND XOR INTO REGB
         LR    REGC,REGB          COPY REGB INTO REGC
         SLL   REGC,17            SHIFT IT LEFT 17 BITS.
         XR    REGB,REGC          AND XOR INTO REGB
         ST    REGB,SRGN          SAVE THE NEW 'SRGN'
         L     REGD,MCGN          LOAD MCGN INTO REGD
         M     REGC,MULT          AND MULTIPLY BY 69069
         ST    REGD,MCGN          STORE RESULT,MODULO 2**32, AS NEW 'MCGN'
         XR    REGD,REGB          XOR NEW 'MCGN' AND 'SRGN' IN REGD
         SRL   REGD,1             SHIFT LEFT 1 BIT,LEAVING SIGN BIT ZERO
         LR    0,REGD             AND MOVE RESULT 'IUNI' TO GPR 0.
RETRN5   LM    REGB,REGD,24(13)
         BCR   15,14              RETURN
*
*      J=IVNI(0)                  UNIFORMLY DISTRIBUTED INTEGER.
*
```

```
*        METHOD                        THE BASIC RANDOM NUMBER IS  A COMBINATION
*        ------                        OF TWO SEPARATELY GENERATED NUMBERS,
*                                      'SRGN' & 'MCGN' AS FOLLOWS.
*        1.   TEMP=XOR(SRGN,SRGN SHIFTED RIGHT 15 BITS)
*        2.   SRGN=XOR(TEMP,TEMP SHIFTED LEFT 17 BITS)
*        3.   MCGN=MCGN*69069,MODULO 2**32
*        4.   RESULT=XOR(MCGN,SRGN)
*
                USING IVNI,15
IVNI     STM    REGB,REGD,24(13) SAVE REGISTERS 1,2,3
RDIGT6   L      REGB,SRGN        LOAD SRGN INTO REGB
         LR     REGC,REGB        AND INTO REGC
         SRL    REGC,15          SHIFT REGC RIGHT 15 BITS
         XR     REGB,REGC        AND XOR INTO REGB
         LR     REGC,REGB        COPY REGB INTO REGC
         SLL    REGC,17          SHIFT IT LEFT 17 BITS,
         XR     REGB,REGC        AND XOR INTO REGB
         ST     REGB,SRGN        SAVE THE NEW 'SRGN'
         L      REGD,MCGN        LOAD MCGN INTO REGD
         M      REGC,MULT        AND MULTIPLY BY 69069
         ST     REGD,MCGN        STORE RESULT,MODULO 2**32, AS NEW 'MCGN'
         XR     REGD,REGB        XOR NEW 'MCGN' AND 'SRGN' IN REGD
         LR     0,REGD           LEAVE RESULT 'IVNI' IN GPRO
RETRN6   LM     REGB,REGD,24(13)
         BCR    15,14            RETURN
*       CONSTANTS SECTION
MULT     DC          F'69069'
SRGN     DC          F'01073'
X7FF     DC          X'000007FF'
MCGN     DC          F'12345'
X1       DC          X'00000001'
FWD      DC          F'0'
Z        DC          E'0.0'
CHAR     DC          X'40000000'
SIGN     DC          X'80FFFFFF'
XD5      DC          X'D5000000'
XF17     DC          X'F1700000'
XCFF     DC          X'00000CFF'
X68      DC          X'68000000'
XD0      DC          X'DC000000'
X68R     DC          X'00000068'
XE2F     DC          X'E2F00000'
XCE8     DC          X'00000CE8'
XF5E     DC          X'F5E00000'
XE17     DC          X'00000E17'
PSTWRD   DC          X'41AA0000'
NSTWRD   DC          X'C1AA0000'
RCHAR    DC          X'3F000000'
FRAC     DC          F'0'
ARG      DS          F
ADNTH    DC          A(RNORTH)
ADETH    DC          A(REXPTH)
ARGLST   DC          X'80'
         DC          AL3(ARG)
SVAREA   DS          18F
NTBL     DC     1X'00'           TABLE USED FOR NORMAL LOOK-UP
         DC     1X'01'           FIRST PART HAS 104 ELEMENTS
         DC     2X'02'
```

```
         DC    4X'03'
         DC    5X'04'
         DC    1X'09'
         DC    5X'0A'
         DC    3X'0E'
         DC    1X'12'
         DC    1X'17'
         DC    5X'00'              START OF SECOND PART OF NORMAL TABLE
         DC    5X'01'              223 ELEMENTS
         DC    4X'02'
         DC    2X'03'
         DC    1X'04'
         DC    5X'05'
         DC    5X'06'
         DC    5X'07'
         DC    5X'08'
         DC    4X'09'
         DC    4X'0B'
         DC    4X'0C'
         DC    4X'0D'
         DC    1X'0E'
         DC    3X'0F'
         DC    3X'10'
         DC    3X'11'
         DC    2X'12'
         DC    2X'13'
         DC    2X'14'
         DC    2X'15'
         DC    2X'16'
         DC    1X'17'
         DC    1X'18'
         DC    1X'19'
         DC    1X'1A'
         DC    1X'1B'
         DC    1X'1C'
         DC    1X'1D'
         DC    10X'05'
         DC    7X'06'
         DC    5X'07'
         DC    2X'08'
         DC    9X'0B'
         DC    5X'0C'
         DC    1X'0D'
         DC    10X'0F'
         DC    7X'10'
         DC    3X'11'
         DC    12X'13'
         DC    9X'14'
         DC    5X'15'
         DC    2X'16'
         DC    13X'18'
         DC    10X'19'
         DC    7X'1A'
         DC    5X'1B'
         DC    2X'1C'
         DC    15X'1E'
         DC    13X'1F'
         DC    12X'20'
```

```
         DC    10X'21'
         DC    9X'22'
         DC    8X'23'
         DC    7X'24'
         DC    6X'25'
         DC    5X'26'
         DC    4X'27'
         DC    3X'28'
         DC    3X'29'
         DC    2X'2A'
         DC    2X'2B'
ETBL     DC    15X'00'          START OF TABLE FOR EXPONENTIALS
         DC    13X'01'          FIRST PART HAS 213 ELEMENTS
         DC    9X'02'
         DC    5X'03'
         DC    5X'06'
         DC    8X'08'
         DC    8X'0A'
         DC    6X'0C'
         DC    2X'0E'
         DC    2X'11'
         DC    4X'15'
         DC    1X'19'
         DC    2X'20'
         DC    1X'2B'
         DC    1X'01'           SECOND PART OF EXPONENTIAL TABLE
         DC    4X'02'           455 ELEMENTS
         DC    7X'03'
         DC    11X'04'
         DC    10X'05'
         DC    5X'06'
         DC    9X'07'
         DC    1X'08'
         DC    8X'09'
         DC    7X'0B'
         DC    1X'0C'
         DC    6X'0D'
         DC    4X'0E'
         DC    5X'0F'
         DC    5X'10'
         DC    3X'11'
         DC    4X'12'
         DC    4X'13'
         DC    4X'14'
         DC    3X'16'
         DC    3X'17'
         DC    3X'18'
         DC    2X'19'
         DC    2X'1A'
         DC    2X'1B'
         DC    2X'1C'
         DC    2X'1D'
         DC    2X'1E'
         DC    2X'1F'
         DC    1X'21'
         DC    1X'22'
         DC    1X'23'
         DC    1X'24'
```

```
         DC      1X'25'
         DC      1X'26'
         DC      1X'27'
         DC      1X'28'
         DC      1X'29'
         DC      1X'2A'
         DC      5X'05'
         DC      2X'07'
         DC      1X'09'
         DC      1X'0B'
         DC      4X'0D'
         DC      9X'0F'
         DC      3X'10'
         DC     10X'12'
         DC      5X'13'
         DC      9X'16'
         DC      6X'17'
         DC      2X'18'
         DC     13X'1A'
         DC     10X'1B'
         DC      7X'1C'
         DC      5X'1D'
         DC      2X'1E'
         DC     13X'21'
         DC     11X'22'
         DC      9X'23'
         DC      8X'24'
         DC      6X'25'
         DC      5X'26'
         DC      4X'27'
         DC      2X'28'
         DC      1X'29'
         DC     15X'2C'
         DC     14X'2D'
         DC     13X'2E'
         DC     12X'2F'
         DC     11X'30'
         DC     11X'31'
         DC     10X'32'
         DC      9X'33'
         DC      9X'34'
         DC      8X'35'
         DC      8X'36'
         DC      7X'37'
         DC      7X'38'
         DC      6X'39'
         DC      6X'3A'
         DC      6X'3B'
         DC      5X'3C'
         DC      5X'3D'
         DC      4X'3E'
         DC      4X'3F'
         END
C ENGR TOOTH FUNCTION
      FUNCTION RNORTH(K)
      DIMENSION C(45)
      DATA C/Z40FD285F,Z40FD285F,Z40FAA9AD,Z40F5A648,Z40F32496,
     $ Z40EE2131,Z40E69C1A,Z40E19885,Z40DA139E,Z40D28E87,Z40C887BE,
```

```
      $ Z40C102A6,Z40B6FBDD,Z40ACF513,Z40A2FE4A,Z4098E78C,Z40916269,
      $ Z4C875BAC,Z407D54D6,Z40734E0D,Z406BC8F6,Z4061C22C,Z405A3D15,
      $ Z4052B7FE,Z404B32E7,Z4043ADD0,Z403C28B9,Z40372554,Z402FA03D,
      $ Z402A9CDE,Z40259973,Z4020960E,Z401E145C,Z401910F7,Z40168F45,
      $ Z40140D93,Z40118BEC,Z3FF0A2E4,Z3FC887BE,Z3FA06C98,Z3F785172,
      $ Z3F785172,Z3F50364C,Z3F50364C,Z3F50364C/
       DATA I1/ZFBC3540C/,I2/ZFE79702E/
       IF(K.GT.I1)GO TO 3
       S=UNI(0)
       T=UNI(C)
       B=AINT(7.*(S+T)+37.*ABS(S-T))
       X=UNI(0)-UNI(0)
       RNORTH=.0625*(X+SIGN(B,X))
       RETURN
    3  IF(K.GT.I2)GO TO 5
    4  RNORTH=2.75*VNI(0)
       J=16.*ABS(RNORTH)+1.
       IF(J-14) 6,6,7
     6 P=(J+J-1)*.1497466E-2
       GO TO 8
     7 P=(89-J-J)*.698817E-3
     8 IF(UNI(0).GT.79.78846*(EXP(-.5*RNORTH*RNORTH)
      $     -C(J)-P*(J-16.*ABS(RNORTH)))) GOTO4.
       RETURN
     5 V=VNI(0)
       IF(V.EQ.0) GO TO 5
       X=SQRT(7.5625-2.*ALOG(ABS(V)))
       IF(UNI(0)*X.GT.2.75)GO TO 5
       RNORTH=SIGN(X,V)
       RETURN
       END
C      REXP TOOTH FUNCTION
       FUNCTION REXPTH(K)
       DIMENSION C(65)
       DATA C/Z40F00000,Z40E10000,Z40D40000,Z40C70000,Z40BB0000,
      $ Z40AF0000,Z40A50000,Z409B0000,Z40910000,Z40890000,Z40800000,
      $ Z40780000,Z40710000,Z406A0000,Z40640000,Z405E0000,Z40580000,
      $ Z40530000,Z404E0000,Z40490000,Z40440000,Z40400000,Z403C0000,
      $ Z40390000,Z40350000,Z40320000,Z402F0000,Z402C0000,Z40290000,
      $ Z40270000,Z40240000,Z40220000,Z40200000,Z401E0000,Z401C0000,
      $ Z401A0000,Z40190000,Z40170000,Z40160000,Z40150000,Z40130000,
      $ Z40120000,Z40110000,Z40100000,Z3FF00000,Z3FE00000,Z3FD00000,
      $ Z3FC00000,Z3FB00000,Z3FB00000,Z3FA00000,Z3F900000,Z3F900000,
      $ Z3F800000,Z3F800000,Z3F700000,Z3F700000,Z3F600000,Z3F600000,
      $ Z3F600000,Z3F500000,Z3F500000,Z3F400000,Z3F400000,Z3F400000/
       DATA I1/ZFB4FAA91/
       IF(K.GT.I1)GO TO 5
    1  U1=UNI(C)
       IF(U1.GT..7917049) GO TO 3
       T=1.-1.239962*U1
       REXPTH=-ALOG(T)
       J=16.*REXPTH+1.
       IF(UNI(C)*(.0604*T+.0039).GT.T-C(J))GOTO1
       RETURN
    3  REXPTH=19.20352*U1-15.20352
       J=16.*REXPTH+1.
       EX=EXP(-REXPTH)
       IF(UNI(0)*(.0604*EX+.0039).GT.EX-C(J))GOTO1
```

```
      RETURN
    5 U1=UNI(0)
      IF(U1.EQ.0)GO TO 5
      REXPTF=4.-ALOG(U1)
      RETURN
      END
```

APPENDIX B

HASP SYSTEM LOG

```
$ 15.49.19 JOB 771 -- RAI8FAC2 -- BEGINNING EXEC - PART 9 - CLASS 1
 *15.50.21 JOB 771 ILU0011 RAI8FAC2 ASM       150K REQ,  150K USED, 00:00:55 ET, 00:00:06 CPU,  11.59%,  0000  (COMP)
 *15.50.43 JOB 771 ILU0011 RAI8FAC2 FORT      150K REQ,   80K USED, 00:00:21 ET, 00:00:06 CPU,  31.96%,  0000  (COMP)
 *15.51.30 JOB 771 ILU0011 RAI8FAC2 LKED      150K REQ,   96K USED, 00:00:46 ET, 00:00:01 CPU,   3.55%,  0000  (COMP)
 *15.51.45 JOB 771 ILU0011 RAI8FAC2 GO        150K REQ,   38K USED, 00:00:15 ET, 00:00:03 CPU,  26.09%,  0000  (COMP)
$*15.51.49 JOB 771 -- RAI8FAC2 -- END EXECUTION;     973 LINES
```

```
HASP3.1.14 JOB STATISTICS --   650 CARDS READ --    986 LINES PRINTED --    0 CARDS PUNCHED --   2.50 MINUTES (ELAPSED TIME)
```

```
//RAI8FAC2 JOB (3101,1,,2),'MILLER',                                            JOB 771
//     MSGLEVEL=(1,1),CLASS=1,TIME=1
// EXEC ASMGFORT,PARM.LKED=
            XXASMGFORT PROC DECK=''                                                      00000100
            XXASM    EXEC  PGM=ASMGASM,PARM='B,LO,ES,RL,UM,FX,CO=3,&DECK'                00000200
IEF653I SUBSTITUTION JCL - PGM=ASMGASM,PARM='B,LO,ES,RL,UM,FX,CO=3,'
            XXSYSLIB   DD  DSN=MATH210.MACLIB,DISP=SHR                                   00000300
            XX         DD  DSN=SYS1.MACLIB,DISP=SHR                                      00000400
            XXSYSUT1   DD UNIT=SYSDA,SPACE=(3500,(400,50))                               00000500
            XXSYSUT2   DD UNIT=SYSDA,SPACE=(3500,(400,50))                               00000600
            XXSYSUT3   DD UNIT=SYSDA,SPACE=(3500,(400,50))                               00000700
//SYSPRINT DD DUMMY
            X/SYSPRINT  DD SYSOUT=A                                                      00000800
            XXSYSPUNCH  DD SYSOUT=B                                                      00000900
            XXSYSLIN DD DSN=&LOADSET,UNIT=SYSDA,SPACE=(80,(200,50)),                    X00001000
            XX     DISP=(MOD,PASS),DCB=(RECFM=F,LRECL=80,BLKSIZE=80)                     00001100
//ASM.SYSIN DD *
                      IEF236I ALLOC. FOR RAI8FAC2 ASM
                      IEF237I 251    ALLOCATED TO SYSLIB
                      IEF237I 150    ALLOCATED TO
                      IEF237I 157    ALLOCATED TO SYSUT1
                      IEF237I 155    ALLOCATED TO SYSUT2
                      IEF237I 157    ALLOCATED TO SYSUT3
                      IEF237I 301    ALLOCATED TO SYSPUNCH
                      IEF237I 155    ALLOCATED TO SYSLIN
                      IEF237I 351    ALLOCATED TO SYSIN
IEF142I - STEP WAS EXECUTED - COND CODE 0000
                      IEF285I   MATH210.MACLIB                                  KEPT
                      IEF285I   VOL SER NOS= LD3001.
                      IEF285I   SYS1.MACLIB                                     KEPT
                      IEF285I   VOL SER NOS= SYSVOL.
                      IEF285I   SYS77227.T003350.RF000.RAI8FAC2.R0003070        DELETED
                      IEF285I   VOL SER NOS= LD3031.
                      IEF285I   SYS77227.T003350.RF000.RAI8FAC2.R0003071        DELETED
                      IEF285I   VOL SER NOS= LD3029.
                      IEF285I   SYS77227.T003350.RF000.RAI8FAC2.R0003072        DELETED
                      IEF285I   VOL SER NOS= LD3031.
                      IEF285I   SYS77227.T003350.RF000.RAI8FAC2.LOADSET         PASSED
                      IEF285I   VOL SER NOS= LD3029.
        IEF373I STEP /ASM      / START 77227.1549
        IEF374I STEP /ASM      / STOP  77227.1550 CPU    0MIN 06.39SEC MAIN 150K LCS    0K
IL0002I STEP /ASM      /   UNIT 251            4 EXCPS
IL0002I STEP /ASM      /   UNIT 150           26 EXCPS
IL0002I STEP /ASM      /   UNIT 157            0 EXCPS
IL0002I STEP /ASM      /   UNIT 155           10 EXCPS
IL0002I STEP /ASM      /   UNIT 157            2 EXCPS
IL0002I STEP /ASM      /   UNIT 301            0 EXCPS
IL0002I STEP /ASM      /   UNIT 155           39 EXCPS
IL0002I STEP /ASM      /   UNIT 351          519 EXCPS
IL0003I STEP /ASM      /   EXCPS:  DISK        81;  TAPE          0;  UR        519;  TP          0;  TOTAL        600;
            XXFORT  EXEC  PGM=IEYFORT,PARM='LINECNT=60'                                  00001200
            XXSYSPRINT DD SYSOUT=A                                                       00001300
            XXSYSPUNCH  DD SYSOUT=B                                                      00001400
            XXSYSLIN DD DSN=&LOADSET,DISP=(MOD,PASS),                                   X00001500
            XX      DCB=(RECFM=F,LRECL=80,BLKSIZE=80)                                    00001600
//FORT.SYSIN DD *
                      IEF236I ALLOC. FOR RAI8FAC2 FORT
                      IEF237I 304    ALLOCATED TO SYSPRINT
                      IEF237I 301    ALLOCATED TO SYSPUNCH
                      IEF237I 155    ALLOCATED TO SYSLIN
                      IEF237I 354    ALLOCATED TO SYSIN
IEF142I - STEP WAS EXECUTED - COND CODE 0000
```

```
                    IEF285I   SYS77227.T003350.RF000.RAI8FAC2.LOADSET           PASSED
                    IEF285I   VOL SER NOS= LD3029.
          IEF373I STEP /FORT     / START 77227.1550
          IEF374I STEP /FORT     / STOP  77227.1550 CPU    0MIN 06.92SEC MAIN  80K LCS    0K
IL0002I STEP /FORT     /  UNIT 384          197 EXCPS
IL0002I STEP /FORT     /  UNIT 3C1            0 EXCPS
IL0002I STEP /FORT     /  UNIT 155          111 EXCPS
IL0002I STEP /FORT     /  UNIT 354          124 EXCPS
IL0003I STEP /FORT     /  EXCPS:  DISK          111;  TAPE          0;  UR          321;  TP          0;  TOTAL          432;
             XXLKED  EXEC  PGM=IEWL,PARM='XREF,LET,LIST',COND=(4,LT,FORT)              00001700
             XXSYSLIB DD DSN='SYS1.FORTLIB',DISP=SHR                                   00001800
             XX          DD DSN=SSPLIB,DISP=SHR                                        00001900
             XXSYSLMOD  DD  DSN=&GOSET(MAIN),DISP=(NEW,PASS),UNIT=SYSDA,              X00002000
             XX SPACE=(TRK,(20,5,1))                                                   00002100
             XXSYSPRINT DD SYSOUT=A                                                    00002200
             XXSYSUT1 DD UNIT=SYSDA,DISP=(,,DELETE),SPACE=(CYL,(1,1))                  00002300
             XXSYSLIN DD DSN=&LOADSET,DISP=(OLD,DELETE),                              X00002400
             XX          DCB=(RECFM=F,LRECL=80,BLKSIZE=80)                             00002500
             XX        DD DDNAME=SYSIN                                                 00002600
                    IEF236I ALLOC. FOR RAI8FAC2 LKED
                    IEF237I 150    ALLOCATED TO SYSLIB
                    IEF237I 251    ALLOCATED TO
                    IEF237I 157    ALLOCATED TO SYSLMOD
                    IEF237I 384    ALLOCATED TO SYSPRINT
                    IEF237I 155    ALLOCATED TO SYSUT1
                    IEF237I 155    ALLOCATED TO SYSLIN
IEF142I - STEP WAS EXECUTED - COND CODE 0000
                    IEF285I   SYS1.FORTLIB                                      KEPT
                    IEF285I   VOL SER NOS= SYSVOL.
                    IEF285I   SSPLIB                                            KEPT
                    IEF285I   VOL SER NOS= LD3001.
                    IEF285I   SYS77227.T003350.RF000.RAI8FAC2.GOSET             PASSED
                    IEF285I   VOL SER NOS= LD3031.
                    IEF285I   SYS77227.T003350.RF000.RAI8FAC2.R0003079          DELETED
                    IEF285I   VOL SER NOS= LD3029.
                    IEF285I   SYS77227.T003350.RF000.RAI8FAC2.LOADSET           DELETED
                    IEF285I   VOL SER NOS= LD3029.
          IEF373I STEP /LKED     / START 77227.1550
          IEF374I STEP /LKED     / STOP  77227.1551 CPU    0MIN 01.64SEC MAIN  96K LCS    0K
IL0002I STEP /LKED     /  UNIT 150           84 EXCPS
IL0002I STEP /LKED     /  UNIT 251           14 EXCPS
IL0002I STEP /LKED     /  UNIT 157           27 EXCPS
IL0002I STEP /LKED     /  UNIT 384            5 EXCPS
IL0002I STEP /LKED     /  UNIT 155           18 EXCPS
IL0002I STEP /LKED     /  UNIT 155          151 EXCPS
IL0003I STEP /LKED     /  EXCPS:  DISK          294;  TAPE          0;  UR            5;  TP          0;  TOTAL          299;
             XXGO      EXEC PGM=*.LKED.SYSLMOD,COND=((4,LT,FORT),(4,LT,LKED))        00002700
             XXSYSIN DD DDNAME=ASMINPT                                                 00002800
             XXSYSPRINT  DD SYSOUT=A                                                   00002900
             XXFT05F001 DD DDNAME=FORTINPT                                             00003000
             XXFT06F001  DD SYSOUT=A                                                   00003100
             XXFT07F001  DD SYSOUT=B                                                   00003200
  //GO.FORTINPT DD *
  //
                    IEF236I ALLOC. FOR RAI8FAC2 GO
                    IEF237I 157    ALLOCATED TO PGM=*.DD
                    IEF237I 384    ALLOCATED TO SYSPRINT
                    IEF237I 355    ALLOCATED TO FT05F001
                    IEF237I 385    ALLOCATED TO FT06F001
                    IEF237I 3C1    ALLOCATED TO FT07F001
IEF142I - STEP WAS EXECUTED - COND CODE 0000
                    IEF285I   SYS77227.T003350.RF000.RAI8FAC2.GOSET             PASSED
```

```
                     IEF285I   VOL SER NOS= LD3031.
        IEF373I STEP /GO      / START 77227.1551
        IEF374I STEP /GO      / STOP  77227.1551 CPU    0MIN 03.92SEC MAIN  38K LCS   0K
IEU002I STEP /GO       /  UNIT 157          0 EXCPS
IEU002I STEP /GO       /  UNIT 364          0 EXCPS
IEU002I STEP /GO       /  UNIT 355          2 EXCPS
IEU002I STEP /GO       /  UNIT 385        642 EXCPS
IEU002I STEP /GO       /  UNIT 3C1          0 EXCPS
IEU003I STEP /GO       /  EXCPS:  DISK         0;  TAPE         0;  UR        644;  TP         0;  TOTAL        644;
                     IEF285I   SYS77227.T003350.PF000.RAIBFAC2.GOSET          DELETED
                     IEF285I   VOL SER NOS= LD3031.
        IEF375I  JOB /RAIBFAC2/ START 77227.1549
        IEF376I  JOB /RAIBFAC2/ STOP  77227.1551 CPU    0MIN 18.87SEC
```

```
      DIMENSION INT(5)
      READ(5,101,END=50) DF,E
      WRITE(6,102) DF,E
  101 FORMAT(2F3.0)
  102 FORMAT(' DEGREES OF FREEDOM=',F3.0,/,' EXPECTED FREQ=',F3.0)
      ZF=0
      DO 20 J=1,40
      DO 10 I=1,5
   10 INT(I)=0
      DO 5 I=1,15
      Y1=REXP(0)
      Y2=REXP(0)
      X=(Y1+Y2)*2
      WRITE (6,103) Y1,Y2,X
  103 FORMAT(3F10.5)
      IF(X.GT.1.649) GO TO 4
      INT(1)=INT(1)+1
      GO TO 5
    4 IF(X.GT.2.753) GO TO 3
      INT(2)=INT(2)+1
      GO TO 5
    3 IF(X.GT.4.045) GO TO 2
      INT(3)=INT(3)+1
      GO TO 5
    2 IF(X.GT.5.989) GO TO 1
      INT(4)=INT(4)+1
      GO TO 5
    1 INT(5)=INT(5)+1
    5 CONTINUE
      CHISQP=0
      CHISQL=0
      DO 15 I=1,5
      IF(INT(I).NE.0) GO TO 14
      ZF=1
      GO TO 15
   14 CHISQL=CHISQL+INT(I)*ALOG(INT(I)/E)
   15 CHISQP=CHISQP+((INT(I)-E)**2)/E
      IF(ZF) 18,18,17
   17 CHISQL=999
      PL=99
      DL=999
      IERRL=999
      ZF=0
      GO TO 19
   16 CHISQL=CHISQL+CHISQL
      CALL CDTR(CHISQL,DF,PL,DL,IERRL)
   19 CALL CDTR(CHISQP,DF,PP,DP,IERR)
   20 WRITE(6,100) INT,CHISQP,PP,DP,IERR,CHISQL,PL,DL,IERRL
  100 FORMAT(' CELL FREQ',5I3,             '     CHISQP=',F7.4,'  P=',F7.5, '
     A   DEN=',F7.4,'    IERR=',I2,3X,'CHISQL=',F7.4,'    P=',F7.5, '    DE
     BN=',F7.4,'    IERR=',I2)
   50 STOP
      END
```

```
                              SUBPROGRAMS CALLED
SYMBOL      LOCATION      SYMBOL    LOCATION      SYMBOL      LOCATION      SYMBOL      LOCATION      SYMBOL      LOCATION
IHCOM#        10C         REXP        110         CDTR          114         ALOG          118

                              SCALAR MAP
SYMBOL      LOCATION      SYMBOL    LOCATION      SYMBOL      LOCATION      SYMBOL      LOCATION      SYMBOL      LOCATION
DF            150         E           154         ZF            158         J             15C         I             160
Y1            164         Y2          168         X             16C         CHISQP        170         CHISQL        174
PI            178         DL          17C         IERRL         180         IEERL         184         PP            188
DP            18C         IERR        190

                              ARRAY MAP
SYMBOL      LOCATION      SYMBOL    LOCATION      SYMBOL      LOCATION      SYMBOL      LOCATION      SYMBOL      LOCATION
INT           194

                              FORMAT STATEMENT MAP
SYMBOL      LOCATION      SYMBOL    LOCATION      SYMBOL      LOCATION      SYMBOL      LOCATION      SYMBOL      LOCATION
   101        1A8            102      1AF            103      1DF            100      1E6

   *OPTIONS IN EFFECT*  ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,MAP
   *OPTIONS IN EFFECT*  NAME = MAIN     , LINECNT =        60
   *STATISTICS*    SOURCE STATEMENTS =        51,PROGRAM SIZE =     1586
   *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
              C RNOR TOOTH FUNCTION
0001                FUNCTION RNORTH(K)
0002                DIMENSION C(45)
0003                DATA C/Z40FD2B5F,Z40FD2B5F,Z40FAA9AD,Z40F5A648,Z40F32496,
                   $ Z40EE2131,Z40E69C1A,Z40E19885,Z40DA139E,Z40D28E87,Z40C887BE,
                   $ Z40C1C2A6,Z40B6FBDD,Z40ACF513,Z40A2EE4A,Z4098E780,Z40916269,
                   $ Z408756A0,Z407D54D6,Z40734E0D,Z406BC0F6,Z4061C22C,Z405A3D15,
                   $ Z4052B7FE,Z404B32E7,Z4043ADD0,Z403C2889,Z4037255 4,Z402FA03D,
                   $ Z402A9CD8,Z40259973,Z4020960E,Z401E145C,Z401910F7,Z40168F45,
                   $ Z4014 0D93,Z40118BE0,Z3FF0A2E4,Z3FC887BE,Z3FA06C98,Z3F785172,
                   $ Z3F785172,Z3F50364C,Z3F50364C,Z3F50364C/
0004                DATA I1/ZF8C35400/,I2/ZFE79702E/
0005                IF(K.GT.I1)GO TO 3
0006                S=UNI(0)
0007                T=UNI(0)
0008                B=AINT(7.*(S+T)+37.*ABS(S-T))
0009                X=UNI(0)-UNI(0)
0010                RNORTH=.0625*(X+SIGN(B,X))
0011                RETURN
0012          3     IF(K.GT.I2)GO TO 5
0013          4     RNORTH=2.75*VNI(0)
0014                J=16.*ABS(RNORTH)+1.
0015                IF(J-14) 6,6,7
0016            6   P=(J+J-1)*.1497466E-2
0017                GO TO 8
0018            7   P=(89-J-J)*.698817E-3
0019          8     IF(UNI(0).GT.79.78846*(EXP(-.5*RNORTH*RNORTH)
                   $     -C(J)-P*(J-16.*ABS(RNORTH)))) GOTO4
0020                RETURN
0021          5     V=VNI(0)
0022                IF(V.EQ.0) GO TO 5
0023                X=SQRT(7.5625-2.*ALOG(ABS(V)))
0024                IF(UNI(0)*X.GT.2.75)GO TO 5
0025                RNORTH=SIGN(X,V)
0026                RETURN
0027                END
```

SUBPROGRAMS CALLED

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
UNI	D4	VNI	D8	EXP	DC	SQRT	E0	ALOG	E4

EQUIVALENCE DATA MAP

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
RNORTH	138								

SCALAR MAP

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
I1	13C	I2	140	K	144	S	148	T	14C
B	150	X	154	J	158	P	15C	V	160

ARRAY MAP

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
C	164								

```
*OPTIONS IN EFFECT*  ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,MAP
*OPTIONS IN EFFECT*  NAME = RNORTH  , LINECNT =       60
*STATISTICS*    SOURCE STATEMENTS =       27,PROGRAM SIZE =      1368
*STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
          C      REXP TOOTH FUNCTION
 0001            FUNCTION REXPTH(K)
 0002            DIMENSION C(65)
 0003            DATA C/Z40F00000,Z40E10000,Z40D40000,Z40C70000,Z40B80000,
                $ Z40AF0000,Z40A50000,Z409B0000,Z40910000,Z40890000,Z40800000,
                $ Z40780000,Z40710000,Z406A0000,Z40640000,Z405E0000,Z40580000,
                $ Z40530000,Z404F0000,Z40490000,Z40440000,Z40400000,Z403C0000,
                $ Z40390000,Z40350000,Z40320000,Z402F0000,Z402C0000,Z40290000,
                $ Z40270000,Z40240000,Z40220000,Z40200000,Z401E0000,Z401C0000,
                $ Z401A0000,Z40190000,Z40170000,Z40160000,Z40150000,Z40130000,
                $ Z40120000,Z40110000,Z40100000,Z3FF00000,Z3FE00000,Z3FD00000,
                $ Z3FC00000,Z3FB00000,Z3FB00000,Z3FA00000,Z3F900000,Z3F900000,
                $ Z3F800000,Z3F800000,Z3F700000,Z3F700000,Z3F600000,Z3F600000,
                $ Z3F600000,Z3F500000,Z3F500000,Z3F400000,Z3F400000,Z3F400000/
 0004            DATA I1/ZFB4FAA91/
 0005            IF(K.GT.I1)GO TO 5
 0006     1      U1=UNI(0)
 0007            IF(U1.GT..7917049) GO TO 3
 0008            T=1.-1.239962*U1
 0009            REXPTH=-ALOG(T)
 0010            J=16.*REXPTH+1.
 0011            IF(UNI(0)*(.0604*T+.0039).GT.T-C(J))GOTO1
 0012            RETURN
 0013     3      REXPTH=19.20352*U1-15.20352
 0014            J=16.*REXPTH+1.
 0015            EX=EXP(-REXPTH)
 0016            IF(UNI(0)*(.0604*EX+.0039).GT.EX-C(J))GOTO1
 0017            RETURN
 0018     5      U1=UNI(0)
 0019            IF(U1.EQ.0)GO TO 5
 0020            REXPTH=4.-ALOG(U1)
 0021            RETURN
 0022            END
```

```
                                   SUBPROGRAMS CALLED
SYMBOL      LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION
UNI               BC      ALOG            C0      EXP             C4

                                   EQUIVALENCE DATA MAP
SYMBOL      LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION
REXPTH            E8

                                   SCALAR MAP
SYMBOL      LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION
I1                EC      K               F0      U1              F4      T               F8      J               FC
EX               100

                                   ARRAY MAP
SYMBOL      LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION      SYMBOL    LOCATION
C                104

  *OPTIONS IN EFFECT*  ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,MAP
  *OPTIONS IN EFFECT*  NAME = REXPTH  , LINECNT =       60
  *STATISTICS*    SOURCE STATEMENTS =        22,PROGRAM SIZE =      1076
  *STATISTICS*  NO DIAGNOSTICS GENERATED

  *STATISTICS*  NO DIAGNOSTICS THIS STEP
```

```
F88-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED    NONE
         DEFAULT OPTION(S) USED -  SIZE=(92160,28672)
****MAIN        DOES NOT EXIST BUT HAS BEEN ADDED TO DATA SET
```

```
DEGREES OF FREEDOM= 4.
EXPECTED FREQ= 3.
   0.66810     1.77000     4.87619
   1.24333     0.58456     3.65577
   1.38725     1.06426     4.90302
   0.76441     0.22591     1.98065
   0.25727     0.37661     1.26655
   0.65595     0.13091     4.57372
   0.40684     0.67893     2.17153
   1.16184     0.75339     3.83046
   0.94565     0.76194     3.41518
   0.57768     3.81208     8.77952
   0.98445     0.32061     2.61012
   3.75223     1.07559     9.65565
   0.44498     0.06307     6.89610
   0.56729     0.28673     1.70605
   0.18550     0.97028     2.31158
CELL FREQ   3  5  3  2  2   CHISQP= 2.0000  P=0.26424  DEN= 0.1839  IERR= 0  CHISQL= 1.8645  P=0.23934  DEN= 0.1835  IERR= 0
   1.28661     1.09853     6.37027
   0.17793     0.66038     1.07663
   0.38536     5.00220    10.77512
   0.46480     0.75317     2.43594
   2.13972     0.14259     4.50462
   0.17079     0.53111     1.40380
   1.90876     4.23764    12.29280
   0.28431     0.44305     1.45473
   2.61212     0.07795     5.38014
   1.88682     1.49012     6.75388
   0.19054     0.31506     1.01120
   0.27894     0.90460     2.36709
   0.56734     1.75136     4.63740
   1.39611     0.19325     3.17871
   0.43467     0.44338     1.63011
CELL FREQ   3  4  1  3  4   CHISQP= 2.0000  P=0.26424  DEN= 0.1839  IERR= 0  CHISQL= 2.4057  P=0.33840  DEN= 0.1806  IERR= 0
   1.65823     1.09293     5.50231
   0.31252     0.37461     1.37427
   1.82810     1.01276     5.68176
   0.57234     0.11060     1.36627
   4.18684     0.52116     9.41600
   1.35309     0.29181     3.28961
   0.48561     0.12460     1.22042
   0.63391     2.19721     5.66224
   0.03622     4.10029     8.27302
   0.06336     0.68091     1.48853
   0.80376     0.14822     1.90595
   1.51466     2.96354     6.95599
   0.39554     0.34094     2.47297
   0.52883     1.05546     3.36938
   1.44758     1.78968     6.47451
CELL FREQ   4  2  2  3  4   CHISQP= 1.3333  P=0.14430  DEN= 0.1711  IERR= 0  CHISQL= 1.3592  P=0.14874  DEN= 0.1722  IERR= 0
   0.54365     1.06152     3.21035
   0.22485     0.89362     2.23654
   0.21676     0.21274     0.65960
   0.00940     0.31853     0.65584
   0.73876     0.48746     2.45244
   3.00509     0.98182     7.97380
   1.01286     0.04639     2.11849
   0.85715     0.38605     2.47440
   2.38948     1.08157     6.54210
   0.85323     0.34028     2.35701
   0.18516     1.57997     4.15025
```

```
  0.09664    0.79928    1.61564
  0.11967    1.98170    4.20274
  0.36365    0.97833    3.86395
  0.35642    3.26439    7.24162
CELL FREQ   3  5  2  2  3  CHISQP= 2.0000  P=0.26424  DEN= 0.1839  IERR= 0  CHISQL= 1.8645  P=0.23934  DEN= 0.1835  IERR= 0
  1.50667    0.09820    3.20974
  0.24646    1.58437    3.66164
  0.21741    1.21762    2.87005
  1.00448    0.66516    3.33927
  3.20461    0.77880    7.96681
  3.15670    0.12330    6.55999
  0.30997    0.57407    1.76608
  0.22472    0.13712    0.72366
  0.79714    0.56261    2.71949
  0.92196    1.64636    5.13665
  1.38500    0.95554    4.68167
  0.82643    0.86531    3.38347
  0.87126    0.81140    3.36532
  5.15009    1.87364   14.04746
  0.39210    1.53791    3.86001
CELL FREQ   1  2  7  2  3  CHISQP= 7.3333  P=0.68071  DEN= 0.0469  IERR= 0  CHISQL= 6.4212  P=0.83018  DEN= 0.0647  IERR= 0
  0.46635    0.83164    2.59596
  0.37067    0.91086    2.56306
  1.67092    0.40862    4.15908
  6.62541    1.44771   10.14622
  1.32218    0.39203    3.42842
  0.56119    1.50244    4.12727
  0.05777    1.42762    2.97116
  0.13856    0.47668    1.23048
  3.23039    1.82855   10.11767
  3.24560    2.78537   12.06193
  0.31428    0.22317    1.07489
  0.69086    0.24580    1.87336
  1.69409    0.06808    3.52435
  0.59073    1.93876    5.05898
  0.31196    0.44574    1.51540
CELL FREQ   3  3  3  3  3  CHISQP= 0.0     P=0.0      DEN= 0.0     IERR= 0  CHISQL= 0.0     P=0.0      DEN= 0.0     IERR= 0
  0.89159    0.43732    2.65783
  0.54045    1.01827    3.11744
  0.07006    0.30243    0.74498
  1.58232    0.40480    3.97423
  1.26954    0.07056    2.68019
  1.84620    1.60886    6.91613
  0.89282    2.30958    6.40481
  1.47076    1.59238    6.12630
  2.56462    0.14426    5.41817
  0.04756    1.14746    2.39005
  0.05074    0.90927    1.92001
  0.35527    1.45097    3.61248
  0.75503    0.73006    2.98218
  0.21742    1.24294    2.92071
  0.78323    0.35298    2.35241
CELL FREQ   1  5  5  1  3  CHISQP= 5.3333  P=0.74523  DEN= 0.0926  IERR= 0  CHISQL= 5.8221  P=0.78716  DEN= 0.0792  IERR= 0
  1.51202    0.63774    4.29952
  1.03901    0.47008    3.01816
  1.86029    0.44031    4.60122
  3.13262    2.63271   11.53066
  0.29668    0.45807    1.56550
  1.08073    1.05078    4.26302
  0.20617    0.26738    0.94811
  0.25101    0.67938    1.86070
  3.38882    1.06551    8.90866
```

Zero = Uniform Distrib.

```
  1.95970     0.13469     4.18877
  2.24333     0.01712     4.52090
  3.24031     3.86028    14.24116
  2.00819     0.77358     5.56354
  1.27493     0.10398     2.75761
  0.47204     4.14167     9.22743
CELL FREQ   2   1   2   6   4   CHISQP= 5.3333  P=0.74523   DEN= 0.0926   IERR= 0   CHISQL= 5.1783  P=0.73051   DEN= 0.0972   IERR= 0
  0.25325     0.13623     0.77897
  2.40520     1.08703     6.98445
  2.63971     0.70192     6.66326
  0.42796     0.53554     1.92701
  0.49680     1.21908     3.43175
  0.86432     0.16641     1.94146
  1.35730     0.12146     2.95753
  2.63293     0.09525     5.45636
  2.54722     0.01113     5.11671
  1.29152     0.40650     3.39604
  0.01364     1.00136     2.03000
  3.13386     0.26386     6.79543
  2.77686     0.31561     6.18494
  0.07524     1.05991     2.27030
  0.42562     2.84605     6.54333
CELL FREQ   1   4   3   2   5   CHISQP= 3.3333  P=0.49633   DEN= 0.1574   IERR= 0   CHISQL= 3.5906  P=0.53577   DEN= 0.1491   IERR= 0
  0.92401     0.39522     2.63847
  1.92368     0.39507     4.63910
  1.78810     1.37602     6.32824
  1.35160     0.39765     3.49850
  2.04945     0.59857     5.29604
  0.96767     0.02792     3.59120
  2.19671     1.55036     7.49415
  0.64042     1.52383     4.32849
  2.41098     0.68876     6.19948
  1.38984     0.77977     4.33921
  0.08343     0.19698     0.50063
  0.69880     1.59261     4.58282
  0.16880     0.00733     0.35226
  0.07817     0.15675     0.46984
  0.31751     2.36057     5.35615
CELL FREQ   3   1   2   6   3   CHISQP= 4.6667  P=0.67676   DEN= 0.1131   IERR= 0   CHISQL= 4.4987  P=0.65730   DEN= 0.1186   IERR= 0
  0.72527     0.40113     2.25280
  0.21081     1.48456     3.39075
  0.04426     0.35858     0.80568
  2.21050     0.84942     6.11983
  0.46125     1.42171     3.76591
  0.73232     0.68272     2.83008
  0.01266     1.72448     3.47426
  3.32209     1.14195     8.92609
  0.19154     1.05013     2.48333
  0.03104     1.17230     2.52768
  0.12835     0.33835     0.53340
  0.14689     0.24148     0.77674
  3.43052     0.76527     6.43159
  1.58315     0.63362     4.43354
  2.23045     0.21267     4.88624
CELL FREQ   3   3   4   2   3   CHISQP= 0.6667  P=0.04462   DEN= 0.1194   IERR= 0   CHISQL= 0.6796  P=0.04618   DEN= 0.1210   IERR= 0
  0.23294     1.29010     3.04607
  0.02984     2.74853     5.55674
  0.36227     0.27847     1.28149
  0.09299     1.60248     3.39095
  3.34680     0.66935     8.43031
  3.81849     0.20302     6.04434
  0.93108     0.15553     2.17322
```

```
  0.34474    1.20775    3.10498
  0.22328    0.99231    2.43117
  1.26339    2.59747    7.72172
  0.22931    2.63164    5.72190
  2.15945    1.96307    8.24503
  0.21378    0.73309    1.89374
  0.00901    0.22327    0.46456
  2.18238    0.45617    5.27710
CELL FREQ   2  3  3  3  4   CHISQP= 0.6667  P=0.04462  DEN= 0.1194  IERR= 0  CHISQL= 0.6796  P=0.04618  DEN= 0.1210  IERR= 0
  0.36961    0.53495    1.80912
  0.44083    2.06836    5.01639
  0.09654    0.00143    0.19594
  0.45551    0.80730    2.52563
  0.50793    0.54210    2.10004
  0.29626    0.69554    1.96359
  0.74481    0.33346    2.15655
  0.13163    1.12919    2.52166
  1.06643    0.49966    3.13657
  0.99442    2.34835    6.68554
  0.23075    0.90924    2.27997
  0.05587    1.71629    3.54432
  2.53548    0.60134    6.27365
  1.07852    1.59485    5.34674
  0.01211    0.07445    0.17312
CELL FREQ   2  7  2  2  2   CHISQP= 6.6667  P=0.84541  DEN= 0.0595  IERR= 0  CHISQL= 5.3747  P=0.74904  DEN= 0.0915  IERR= 0
  0.43325    0.65897    2.18444
  0.06009    0.44187    1.00392
  1.35490    0.93617    2.78212
  0.08403    1.30940    2.90665
  0.49553    0.33148    1.65401
  2.39527    1.85459    8.49973
  0.26406    0.25558    1.03929
  0.66985    0.38410    2.10789
  0.05445    0.82129    1.75149
  1.48562    2.50466    7.98056
  0.42791    0.19730    1.25042
  2.12160    1.42262    7.06724
  0.01971    0.11414    0.26769
  0.86021    0.27489    2.27018
  1.52986    1.03837    5.13647
CELL FREQ   4  5  2  1  3   CHISQP= 3.3333  P=0.49633  DEN= 0.1574  IERR= 0  CHISQL= 3.5906  P=0.53577  DEN= 0.1491  IERR= 0
  0.78921    0.13355    1.84552
  0.09629    5.60679   11.40616
  0.05262    1.33575    2.77673
  0.67306    4.28650    9.91914
  1.02449    1.76780    5.58457
  0.61328    1.31729    3.86114
  0.72922    0.22294    1.90432
  1.43352    0.59343    4.05390
  2.81777    1.35550    8.34653
  1.07787    2.87810    7.91195
  0.61570    0.11010    1.45160
  0.33665    0.13596    0.94525
  1.00382    2.28748    6.58260
  1.28032    4.37098   11.30261
  0.19308    0.26439    0.95494
CELL FREQ   3  2  2  2  6   CHISQP= 4.0000  P=0.59399  DEN= 0.1353  IERR= 0  CHISQL= 3.4522  P=0.51481  DEN= 0.1536  IERR= 0
  1.56822    0.04296    3.22236
  0.21760    0.47500    1.38518
  2.59837    0.88000    6.95575
  1.28411    1.26355    5.09339
  1.43953    3.48956    9.85817
```

```
   0.22225    0.85126    2.14702
   0.13198    4.14143    6.54683
   1.67200    0.80872    4.96142
   0.67990    0.71774    2.79530
   0.60863    0.32504    1.86735
   1.25516    0.07392    2.65815
   0.44703    3.87687    8.64780
   0.54132    2.39848    5.87960
   0.06346    1.08612    2.29915
   1.27404    0.27438    3.09682
 CELL FREQ   1  4  3   3  4   CHISQP= 2.0000  P=0.26424   DEN= 0.1839   IERR= 0   CHISQL= 2.4057   P=0.33840   DEN= 0.1806   IERR= 0
   0.25212    0.56301    1.63025
   0.16089    0.69121    2.10420
   4.12922    0.99435   10.24715
   1.44361    0.17028    3.22778
   1.49228    0.90232    5.78921
   0.24591    0.19732    0.88046
   0.59359    0.04664    1.28045
   0.06829    0.17218    0.46095
   1.90081    0.15921    4.12004
   0.06789    0.59117    1.31812
   0.11310    1.31765    2.86149
   0.17256    0.29522    0.93556
   0.34282    1.68372    4.45308
   2.66154    0.40275    6.12857
   0.10296    0.29993    0.80579
 CELL FREQ   7  1  2   3  2   CHISQP= 7.3333  P=0.88071   DEN= 0.0469   IERR= 0   CHISQL= 6.4212   P=0.83018   DEN= 0.0647   IERR= 0
   0.32121    0.21205    1.06652
   1.85771    0.99659    5.70860
   0.54512    1.29861    3.68747
   1.03157    0.31836    2.69987
   0.12710    1.32331    2.90081
   3.33816    0.62237    7.92105
   0.29952    6.19424   12.96751
   1.42937    3.16032    9.17939
   0.80972    0.17417    1.96778
   0.76167    3.30445    8.13224
   0.27012    0.70768    1.95561
   0.45433    0.36143    1.63153
   2.27442    0.04411    4.63707
   1.67564    1.15592    5.66313
   0.57668    2.77667    6.70710
 CELL FREQ   2  3  2   3  5   CHISQP= 2.0000  P=0.26424   DEN= 0.1839   IERR= 0   CHISQL= 1.8645   P=0.23934   DEN= 0.1835   IERR= 0
   0.06065    0.10671    0.33470
   0.35363    0.06106    0.82939
   1.61723    0.72134    4.67715
   0.54005    1.61192    4.32373
   0.14549    0.15561    0.60860
   1.54298    0.40850    4.10296
   3.61916    0.15073    7.53978
   0.81289    1.76748    5.16073
   2.28653    1.17632    6.72569
   0.67417    0.22740    1.80313
   2.73866    0.27404    6.03541
   0.63706    2.57488    6.42366
   0.52090    1.07579    3.19338
   1.09609    2.50343    7.20305
   1.96049    0.05345    3.98267
 CELL FREQ   3  1  2   4  5   CHISQP= 3.3333  P=0.49633   DEN= 0.1574   IERR= 0   CHISQL= 3.5906   P=0.53577   DEN= 0.1491   IERR= 0
   1.62276    0.83907    4.92366
   1.27722    0.06710    2.08863
   0.55919    1.06822    3.25461
```

```
   0.33417     2.75011     6.16857
   1.75281     0.78815     5.08192
   0.17716     0.13315     0.62061
   0.11124     0.40770     1.19788
   0.43664     2.56647     6.00622
   1.37204     5.95346    14.65101
   0.27949     0.46332     1.46563
   0.02808     2.54217     5.14049
   0.34503     0.98068     2.65182
   0.41058     1.55354     3.92826
   0.35460     0.67364     2.05689
   2.17624     0.59101     5.53450
CELL FREQ   3   3   2   4   3   CHISQP= 0.6667  P=0.04462   DEN= 0.1194   IERR= 0   CHISQL= 0.6796   P=0.04618   DEN= 0.1210   IERR= 0
   1.90142     0.88728     5.57739
   0.12391     0.61746     1.48275
   0.11458     3.73193     7.69301
   0.34986     0.65323     2.40619
   0.61942     0.26622     1.81127
   1.35870     0.35787     3.43314
   0.50522     0.14036     1.29115
   3.22863     2.81395    12.08516
   0.68109     1.31675     3.99568
   0.18577     0.72878     1.82910
   0.76260     0.12427     1.77374
   5.49416     0.30683    11.60198
   0.34525     0.08097     0.85243
   0.79898     0.97365     3.44526
   1.36067     0.72917     4.17968
CELL FREQ   3   4   3   2   3   CHISQP= 0.6667  P=0.04462   DEN= 0.1194   IERR= 0   CHISQL= 0.6796   P=0.04618   DEN= 0.1210   IERR= 0
   2.67737     2.16513     9.68500
   0.19130     0.10455     0.59170
   4.23611     0.11407     8.70036
   0.74854     0.46104     2.41917
   1.06512     0.27603     2.68230
   0.44866     1.70169     4.30070
   1.36885     0.25483     3.26737
   1.51744     1.09318     5.22123
   0.73453     0.14327     1.75560
   2.85709     0.27117     6.25652
   1.40693     0.35179     3.51742
   0.39094     0.54892     1.87573
   1.28773     0.42291     3.42127
   2.51271     0.95588     6.93718
   0.33010     0.04095     0.74210
CELL FREQ   2   4   3   2   4   CHISQP= 1.3333  P=0.14430   DEN= 0.1711   IERR= 0   CHISQL= 1.3592   P=0.14874   DEN= 0.1722   IERR= 0
   0.17952     0.02846     0.41596
   1.10487     3.74681     9.70336
   1.09288     0.04968     4.08512
   3.32117     0.42490     7.50013
   1.02292     0.98247     4.01077
   0.10557     0.53556     1.28220
   0.35745     1.58131     3.87752
   0.49574     1.25199     3.49547
   0.78260     2.52520     6.61599
   0.43120     0.33250     1.52740
   0.13008     0.32244     0.90504
   0.77978     0.47690     2.51337
   0.18004     0.60037     1.56082
   1.21374     1.21441     4.85629
   0.15380     0.97175     2.25110
CELL FREQ   5   2   3   2   3   CHISQP= 2.0000  P=0.25424   DEN= 0.1839   IERR= 0   CHISQL= 1.8645   P=0.23934   DEN= 0.1835   IERR= 0
   1.65671     1.59739     6.50821
```

```
  0.16718    0.15968    0.65372
  0.79673    0.62357    2.84059
  1.95035    1.08235    6.06540
  0.17280    0.34053    1.02660
  0.14961    0.08504    0.46929
  0.62272    1.12854    3.90251
  5.24331    0.28044   11.04750
  1.11167    0.32380    2.87094
  0.80128    0.41926    2.44109
  0.56406    2.61899    6.36610
  0.06049    0.34647    0.81392
  1.23067    0.83591    4.13316
  0.68836    0.46706    2.35069
  0.41043    1.70178    4.22442
CELL FREQ   4  2  3  2  4   CHISQP= 1.3333   P=0.14430   DEN= 0.1711   IERR= 0   CHISQL= 1.3592   P=0.14874   DEN= 0.1722   IERR= 0
  0.18480    0.15767    0.66493
  0.13528    1.56771    3.40598
  0.60348    0.27369    1.75433
  0.27633    0.42538    1.40341
  1.92905    0.68316    5.22442
  0.64660    1.30175    3.90069
  0.51640    1.79560    4.62401
  2.33168    1.43571    7.53478
  0.51650    0.29937    1.63174
  0.34746    0.83025    2.35541
  0.21337    0.95783    2.34240
  0.15567    0.86748    2.04629
  0.71075    2.59042    6.60234
  2.53586    0.06830    5.14831
  0.19733    0.06660    0.52827
CELL FREQ   4  4  2  3  2   CHISQP= 1.3333   P=0.14430   DEN= 0.1711   IERR= 0   CHISQL= 1.3592   P=0.14874   DEN= 0.1722   IERR= 0
  0.26766    2.03662    4.60657
  3.56302    1.72209   10.57026
  1.12534    1.01642    4.28353
  0.16506    0.97061    2.27135
  2.62085    0.69077    6.62326
  0.62130    0.24368    1.72996
  2.11106    0.01209    4.24628
  2.15646    0.47615    5.26524
  0.52523    4.14091    9.33228
  3.22372    0.10209    6.65162
  0.00051    0.48999    0.96100
  1.20939    2.52460    7.46838
  1.38280    1.26753    5.30066
  0.13711    0.72092    1.71606
  1.96529    1.14902    6.22863
CELL FREQ   1  3  0  5  6   CHISQP= 8.6667   P=0.93001   DEN= 0.0284   IERR= 0   CHISQL=*******   P=*******   DEN=*******   IERR= 0
  0.26937    0.10280    0.74433
  0.64414    3.14823    7.56474
  0.11204    0.27353    0.77112
  0.10424    0.20286    0.73421
  0.87783    2.53711    6.62988
  1.47891    0.39583    3.74948
  0.92256    0.36070    2.56651
  0.34320    3.15700    7.00041
  0.83302    1.28876    4.24356
  0.95853    0.91712    3.75130
  0.21584    2.79157    6.01481
  1.15955    1.22159    4.70228
  1.30782    0.17122    2.95808
  0.87431    0.78254    3.31369
  0.01490    0.61184    1.25348
```

```
CELL FREQ    4  1  4  2  4    CHISQP= 2.6667  P=0.38494   DEN= 0.1757   IERR= 0   CHISQL= 3.0853   P=0.45634   DEN= 0.1649   IERR= 0
   1.90494    1.46463    6.73914
   1.39415    0.54466    3.87761
   0.61767    0.03896    1.31326
   0.30679    0.87380    2.36118
   0.41557    0.89288    2.61688
   0.37123    0.46196    1.66038
   0.25729    1.38813    3.29083
   1.23792    1.36743    5.21071
   0.91823    0.00455    1.84556
   2.19667    1.21204    6.81742
   0.38978    0.37326    1.52008
   0.29150    0.36092    1.34486
   0.32174    1.20464    3.05315
   0.72388    1.08494    3.61765
   2.91444    0.41299    6.65484
CELL FREQ    3  4  4  1  3    CHISQP= 2.0000  P=0.26424   DEN= 0.1839   IERR= 0   CHISQL= 2.4057   P=0.33840   DEN= 0.1806   IERR= 0
   0.93026    0.62314    3.10679
   1.96497    0.46905    4.86804
   1.60509    1.04230    5.29478
   1.68243    1.20599    5.77685
   2.84691    1.08431    7.86243
   1.68829    0.36178    4.10012
   0.56314    2.60385    6.33398
   0.06029    1.02941    2.17940
   0.16532    1.45224    3.23512
   0.99033    0.01440    2.00946
   0.74283    2.17167    5.82899
   0.48956    0.57004    2.11921
   0.20080    0.03169    0.46498
   0.16237    0.45354    1.23160
   1.72502    0.24852    3.94709
CELL FREQ    2  3  3  5  2    CHISQP= 2.0000  P=0.26424   DEN= 0.1839   IERR= 0   CHISQL= 1.8645   P=0.23934   DEN= 0.1835   IERR= 0
   0.80137    0.61360    3.22995
   3.76383    0.43457    8.39679
   1.83149    0.45040    4.56377
   0.19904    0.21415    0.82638
   0.06407    0.66693    1.46201
   2.06042    0.13605    4.35293
   0.79556    0.55219    2.70149
   0.01293    1.52848    3.08281
   0.31511    0.59222    1.81466
   1.43814    0.06378    3.00383
   0.12750    0.50030    1.25560
   0.80745    1.32846    4.27183
   0.01049    2.34517    4.71132
   0.65997    0.02004    1.36062
   0.30851    0.79239    3.20180
CELL FREQ    4  2  4  4  1    CHISQP= 2.6667  P=0.38494   DEN= 0.1757   IERR= 0   CHISQL= 3.0853   P=0.45634   DEN= 0.1649   IERR= 0
   0.00140    0.71968    1.44217
   0.33828    1.93410    4.54477
   0.73049    1.18114    3.82325
   0.47663    0.72160    2.39685
   0.51015    0.00839    2.23708
   1.82216    2.50351    8.65133
   3.36760    1.42134    9.57788
   0.56793    2.42562    5.96706
   0.83837    0.45833    2.59340
   0.89487    1.66133    5.11239
   0.49995    0.17495    1.32980
   0.08276    0.27319    0.71190
   0.48243    0.54282    2.95049
```

```
  2.84424    0.48646    6.66140
  0.70074    0.65716    2.71580
CELL FREQ   3  5  1  3  3   CHISQP= 2.6667  P=0.38494   DEN= 0.1757   IERR= 0   CHISQL= 2.9110   P=0.42718   DEN= 0.1698   IERR= 0
  0.75895    2.79417    7.10624
  0.00583    1.10529    2.22225
  1.96533    1.10761    6.14588
  4.26477    0.00717    8.54388
  7.06419    0.18909   14.50656
  0.74084    1.36813    4.21795
  1.75947    0.57734    4.67361
  0.71838    0.74850    2.93376
  0.68743    0.26869    1.91224
  0.45672    2.25243    5.41629
  2.06891    0.60121    5.34024
  0.49841    1.49188    3.98059
  0.78129    0.70812    2.97681
  0.59349    0.85022    2.86742
  0.23220    0.59007    1.64454
CELL FREQ   1  2  4  4  4   CHISQP= 2.6667  P=0.38494   DEN= 0.1757   IERR= 0   CHISQL= 3.0853   P=0.45634   DEN= 0.1649   IERR= 0
  0.07804    2.59801    5.35211
  0.94621    0.35620    2.60483
  1.23920    0.54547    3.56935
  1.99925    0.71448    5.42746
  0.25829    3.66166    7.83990
  1.25086    2.38840    7.27851
  0.08618    0.33652    0.84540
  1.76002    0.39047    4.30097
  1.61618    1.52076    6.27386
  1.26135    0.28150    3.08569
  1.03320    1.39937    4.86515
  2.29610    0.54957    5.69134
  1.34176    0.69603    4.07557
  0.23070    0.00170    0.46480
  0.00468    1.75594    3.52123
CELL FREQ   2  1  3  6  3   CHISQP= 4.6667  P=0.67676   DEN= 0.1131   IERR= 0   CHISQL= 4.4987   P=0.65730   DEN= 0.1186   IERR= 0
  0.55197    0.56227    2.26840
  0.80485    0.53736    2.68443
  1.03745    0.59044    3.25576
  0.59933    2.01762    5.23430
  0.45178    0.13697    1.17752
  1.00340    0.50696    3.02071
  2.36059    0.55138    5.82394
  0.01729    1.02559    2.06575
  0.51970    0.44599    1.93138
  3.36040    2.04976   12.02032
  0.67107    0.07158    1.48529
  0.20274    0.38814    1.18175
  0.41076    0.44114    1.70380
  1.21444    0.65626    3.74140
  0.25125    1.36154    3.22557
CELL FREQ   3  5  4  2  1   CHISQP= 3.3333  P=0.49633   DEN= 0.1574   IERR= 0   CHISQL= 3.5906   P=0.53577   DEN= 0.1491   IERR= 0
  1.17576    0.03240    2.41632
  0.80497    0.98935    3.56863
  3.44529    0.57929    8.04916
  1.12189    0.09207    2.42793
  0.26543    1.04368    2.61622
  0.97137    1.27654    4.49581
  0.38750    0.82248    2.41997
  1.62820    0.25951    3.77541
  0.82912    0.49618    2.65059
  0.62264    1.37877    4.00282
  1.13836    2.66251    7.60174
```

```
  0.05220    0.85448    1.81335
  1.23376    0.04643    2.56039
  0.23162    0.42389    1.31103
  0.36598    1.09016    2.91227
CELL FREQ   1  7  4   1  2   CHISQP= 8.6667  P=0.93001  DEN= 0.0284  IERR= 0  CHISQL= 8.1473  P=0.91367  DEN= 0.0347  IERR= 0
  1.73292    0.39203    4.24990
  0.46156    0.30122    1.52555
  0.12046    0.49902    1.23896
  2.00194    0.23232    4.40850
  0.62503    0.03537    1.32080
  0.39214    0.22449    1.23326
  0.22082    0.24754    0.93672
  0.81950    1.49808    4.63516
  2.38067    1.92445    8.61023
  0.64791    1.18707    3.66995
  1.66322    0.57401    4.47447
  2.53974    0.03460    5.14067
  0.57434    1.61197    4.37261
  2.19955    0.14608    4.69126
  1.07549    0.08319    2.31736
CELL FREQ   5  1  1   7  1   CHISQP=10.6667  P=0.96942  DEN= 0.0129  IERR= 0  CHISQL=10.3787  P=0.96549  DEN= 0.0145  IERR= 0
  2.51157    1.55017    8.12348
  0.04636    0.17066    0.43403
  2.32194    0.79492    6.23371
  1.20614    0.25946    2.93119
  3.36869    0.31057    7.35851
  0.13165    2.47023    5.20375
  1.24719    0.12385    2.74209
  0.23116    1.43382    3.32997
  0.56840    3.42074    7.97627
  0.10609    4.22075    8.65367
  1.59598    0.00794    4.40784
  2.62630    0.08819    5.42898
  1.20875    0.02918    3.67566
  0.29472    2.86720    6.32385
  0.84350    0.24433    2.17567
CELL FREQ   1  2  3   3  6   CHISQP= 4.6667  P=0.67676  DEN= 0.1131  IERR= 0  CHISQL= 4.4987  P=0.65730  DEN= 0.1186  IERR= 0
  0.36033    1.94145    4.60356
  3.98852    0.06832    9.31367
  0.28360    3.95625    8.47970
  4.08769    1.55942   11.49422
  1.28706    2.21810    7.01031
  0.25374    3.26736    7.04221
  1.98956    0.57333    5.12577
  2.15689    0.26153    4.83083
  3.76064    0.38538    8.29202
  0.22980    0.35626    1.17211
  0.14658    0.91596    2.12508
  0.07385    2.62108    5.39105
  0.16648    0.43383    1.20063
  0.83924    3.26494    8.20836
  2.61766    0.30576    5.84083
CELL FREQ   2  1  0   5  7   CHISQP=11.3333  P=0.97694  DEN= 0.0096  IERR= 0  CHISQL=*******  P=*******  DEN=*******  IERR= 0
  0.87461    1.78532    5.31986
  0.54362    0.29279    1.67282
  0.20911    1.34623    3.10867
  0.39110    0.15612    1.09443
  0.33470    0.91552    2.50044
  0.05630    2.70976    5.53224
  0.78057    0.28060    2.12253
  0.38663    0.34442    1.46211
  0.21257    0.39397    1.21308
```

```
   1.46113    0.65013    4.22252
   0.28552    1.52331    3.61767
   0.42187    0.40944    1.66263
   1.52723    0.03975    3.13396
   2.79249    0.05915    5.70328
   0.24214    0.79025    2.06479
CELL FREQ   3   5   3   4   0    CHISQP= 4.6667   P=0.67676   DEN= 0.1131   IERR= 0   CHISQL=*******   P=*******   DEN=*******   IERR= 0
   1.95099    0.42067    4.74333
   0.09396    1.71567    3.61925
   0.63436    0.26019    1.78911
   4.43964    2.41000   13.69928
   0.17612    0.92373    2.19969
   0.04196    1.26597    2.65585
   0.73320    1.15063    3.76766
   0.60028    0.09574    1.39204
   2.00540    0.42730    4.86540
   0.03535    0.48635    1.04340
   1.18847    2.68956    7.75566
   0.86943    1.19445    4.12776
   0.01088    0.42018    0.86212
   0.00940    0.67174    1.36227
   3.50539    0.69162    8.39403
CELL FREQ   4   3   2   3   3    CHISQP= 0.6667   P=0.04462   DEN= 0.1194   IERR= 0   CHISQL= 0.6796   P=0.04618   DEN= 0.1210   IERR= 0
```

APPENDIX C

```
      DIMENSION INT(10),BND(10)
      INTEGER BR
   60 READ(5,101,END=50) DF,E,BND
      IDF=DF+.1
      WRITE(6,102) DF,E,(BND(I),I=1,IDF)
      II=IDF+1
      KK=DF/2.+.1
      ZF=0
      ITEMS=(DF+1)*E+.1
      ASSIGN 6 TO BR
      IF(MOD(IDF,2).EQ.1) ASSIGN 7 TO BR
      DO 20 J=1,40
      DO 10 I=1,II
   10 INT(I)=0
      DO 9 I=1,ITEMS
      Y=0
      DO 8 K=1,KK
      YTEMP=REXP(0)
      WRITE(6,104)YTEMP
    8 Y=Y+YTEMP
  104 FORMAT(' YTEMP=',F8.4)
      GO TO BR,(6,7)
    6 Y=Y+Y
      GO TO 5
    7 Z=RNGR(0)
      WRITE(6,105)Z
  105 FORMAT(' Z=',F8.4)
      Y=Y+Y+Z*Z
    5 WRITE(6,103) Y
  103 FORMAT(' Y=',F8.4)
      DO 4 K=1,IDF
      IF(Y.GT.BND(K)) GO TO 4
      INT(K)=INT(K)+1
      GO TO 9
    4 CONTINUE
      INT(II)=INT(II)+1
    9 CONTINUE
      CHISQP=0
      CHISQL=0
      DO 15 I=1,II
      IF(INT(I).NE.0) GO TO 14
      ZF=1
      GO TO 15
   14 CHISQL=CHISQL+INT(I)*ALOG(INT(I)/E)
   15 CHISQP=CHISQP+((INT(I)-E)**2)/E
      IF(ZF) 16,16,17
   17 CHISQL=999
      PL=99
      DL=999
      IERRL=999
      ZF=0
      GO TO 19
   16 CHISQL=CHISQL+CHISQL
      CALL CDTR(CHISQL,DF,PL,DL,IERRL)
   19 CALL CDTR(CHISQP,DF,PP,DP,IERR)
      WRITE(6,100)CHISQP,PP,DP,IERR,CHISQL,PL,DL,IERRL,(INT(I),I=1,II)
      WRITE(6,100)CHISQP,PP,DP,IERR,CHISQL,PL,DL,IERRL,(INT(I),I=1,II)
   20 CONTINUE
```

```
0059             GO TO 60
0060          50 END FILE 6
0061             STOP
0062         100  FORMAT(                                    ' CHISQP=',F7.4,'  P=',F7.5, '
                A  DEN=',F6.4,'  IERR=',I1,'  CHISQL=',F7.4,'  P=',F7.5,'  DEN=',F6
                B.4,'  IERR=',I1,'  CELL FREQ',10I3)
0063          101 FORMAT(2F3.0,10F7.4)
0064          102 FORMAT(' DEGREES OF FREEDOM=',F3.0,/,' EXPECTED FREQ=',F3.0,/,
                1' BOUNDARY VALUES=',10F8.4)
0065             END
```

```
DEGREES OF FREEDOM= 7.
EXPECTED FREQ= 3.
BOUNDARY VALUES=  3.1040  4.2550  5.2870  6.3460  8.0920  9.0370 11.3390  .
YTEMP=  0.6681
YTEMP=  1.7700
YTEMP=  1.2433
Z= -0.0221
Y=  7.3633
YTEMP=  1.3873
YTEMP=  1.0643
YTEMP=  0.7644
Z=  1.2259
Y=  7.9347
YTEMP=  0.2573
YTEMP=  0.3760
YTEMP=  0.6559
Z=  0.1309
Y=  2.5956
YTEMP=  0.4068
YTEMP=  0.3789
YTEMP=  1.1618
Z=  0.5659
Y=  4.6154
YTEMP=  0.9456
YTEMP=  0.7519
YTEMP=  0.5777
Z= -1.9371
Y=  8.3228
YTEMP=  0.9845
YTEMP=  0.3206
YTEMP=  3.7522
Z=  0.7631
Y= 10.6969
YTEMP=  0.4450
YTEMP=  0.0031
YTEMP=  0.5673
Z=  1.7242
Y=  5.8036
YTEMP=  0.1855
YTEMP=  0.9703
YTEMP=  1.2866
Z= -0.0235
Y=  4.8853
YTEMP=  0.1779
YTEMP=  0.7604
YTEMP=  0.3854
Z= -1.8003
Y=  5.6883
YTEMP=  1.8866
YTEMP=  1.4901
YTEMP=  0.1905
Z= -0.0651
Y=  7.1392
YTEMP=  0.2789
YTEMP=  0.9056
YTEMP=  0.5673
Z= -1.2514
Y=  5.0677
YTEMP=  1.1961
YTEMP=  0.1932
YTEMP=  0.4347
```

```
Z= -0.6709
Y=  4.4981
YTEMP=  1.6562
YTEMP=  1.0929
YTEMP=  0.3125
Z= -0.3121
Y=  6.2248
YTEMP=  1.8281
YTEMP=  1.0126
YTEMP=  0.5723
Z=  1.4858
Y=  9.0340
YTEMP=  4.1868
YTEMP=  0.5212
YTEMP=  1.3531
Z=  1.5416
Y= 14.4994
YTEMP=  0.4856
YTEMP=  0.1246
YTEMP=  0.6339
Z= -1.6972
Y=  5.3688
YTEMP=  0.0362
YTEMP=  4.1003
YTEMP=  0.0634
Z=  0.5559
Y=  8.7068
YTEMP=  0.8038
YTEMP=  0.1482
YTEMP=  1.5147
Z= -0.7133
Y=  5.4421
YTEMP=  0.8955
YTEMP=  0.3409
YTEMP=  0.6288
Z= -0.5559
Y=  4.0396
YTEMP=  1.4476
YTEMP=  1.7897
YTEMP=  0.5437
Z= -0.5615
Y=  7.8771
YTEMP=  0.2248
YTEMP=  0.8936
YTEMP=  0.2166
Z=  1.2127
Y=  4.1417
YTEMP=  0.0094
YTEMP=  0.3165
YTEMP=  0.7388
Z= -1.4875
Y=  4.3459
YTEMP=  3.0051
YTEMP=  0.9816
YTEMP=  1.0129
Z=  0.2964
Y= 10.0874
YTEMP=  0.8571
YTEMP=  0.3801
YTEMP=  2.3895
Z= -1.3816
Y=  9.1621
```

```
CHISQP= 6.6667  P=0.53561  DEN=0.1089  IERR=0  CHISQL= 6.9044  P=0.56110  DEN=0.1055  IERR=0  CELL FREQ  1  2  6  4  4  3  3  1
YTEMP=  0.8532
YTEMP=  0.3403
YTEMP=  0.1852
Z= -1.3800
Y=  4.6616
YTEMP=  0.0086
YTEMP=  0.7993
YTEMP=  0.1197
Z= -1.4817
Y=  4.0506
YTEMP=  0.9636
YTEMP=  0.9783
YTEMP=  0.3564
Z= -1.3269
Y=  6.3574
YTEMP=  1.5067
YTEMP=  0.0982
YTEMP=  0.2465
Z=  0.8969
Y=  4.5070
YTEMP=  0.2174
YTEMP=  1.2176
YTEMP=  1.0045
Z=  1.6683
Y=  7.7294
YTEMP=  1.1287
YTEMP=  0.7788
YTEMP=  3.1567
Z=  0.6858
Y= 10.5987
YTEMP=  0.3106
YTEMP=  0.5741
YTEMP=  0.2247
Z=  1.0121
Y=  3.2419
YTEMP=  0.7971
YTEMP=  0.5626
YTEMP=  0.9226
Z=  2.3339
Y= 10.0103
YTEMP=  1.3850
YTEMP=  0.9555
YTEMP=  0.8264
Z= -0.3653
Y=  6.4674
YTEMP=  0.6713
YTEMP=  0.8114
YTEMP=  5.1501
Z= -1.3735
Y= 15.5524
YTEMP=  0.3921
YTEMP=  1.5379
YTEMP=  0.4664
Z= -0.3316
Y=  4.9027
YTEMP=  0.3707
YTEMP=  0.9109
YTEMP=  1.6709
Z= -0.6586
Y=  6.3387
YTEMP=  6.6254
```

```
YTEMP=  1.4477
YTEMP=  1.3222
Z=   0.7670
Y= 19.3789
YTEMP=  0.5612
YTEMP=  1.5024
YTEMP=  0.0578
Z= -0.8653
Y=   4.9916
YTEMP=  0.1386
YTEMP=  0.4767
YTEMP=  3.2304
Z= -1.3286
Y=   9.4563
YTEMP=  3.2456
YTEMP=  2.7854
YTEMP=  0.3143
Z=   1.2232
Y= 14.1866
YTEMP=  0.6909
YTEMP=  0.2458
YTEMP=  1.6941
Z=   0.8806
Y=   6.0370
YTEMP=  0.5907
YTEMP=  1.9388
YTEMP=  0.3120
Z= -2.0092
Y= 13.0476
YTEMP=  1.3263
YTEMP=  0.1164
YTEMP=  0.8916
Z= -0.6246
Y=   5.0630
YTEMP=  0.5405
YTEMP=  1.6163
YTEMP=  0.0701
Z=   1.4899
Y=   5.4774
YTEMP=  1.5623
YTEMP=  0.4048
YTEMP=  1.2695
Z=   0.8831
Y=   7.2931
YTEMP=  1.8462
YTEMP=  1.6089
YTEMP=  0.8926
Z= -0.7471
Y=   9.2539
YTEMP=  1.4708
YTEMP=  1.5924
YTEMP=  2.5648
Z=   0.1443
Y= 11.2766
YTEMP=  0.0476
YTEMP=  1.1475
YTEMP=  0.0507
Z= -0.4093
Y=   2.6590
CHISQP= 9.3333   P=0.77040   DEN=0.0666   IERR=0   CHISQL=*******   P=*******   DEN=******   IERR=*   CELL FREQ  1  2  5  3  4  0  6  3
YTEMP=  0.3553
YTEMP=  1.4510
```

```
YTEMP=   0.7550
Z= -0.1736
Y=   5.1527
YTEMP=   0.2174
YTEMP=   1.2429
YTEMP=   0.7832
Z= -0.6430
Y=   4.9006
YTEMP=   1.5120
YTEMP=   0.6377
YTEMP=   1.0390
Z= -0.6576
Y=   6.8100
YTEMP=   1.8603
YTEMP=   0.4403
YTEMP=   3.1326
Z=   1.2484
Y=  12.4250
YTEMP=   0.2967
YTEMP=   0.4881
YTEMP=   1.0807
Z= -0.5508
Y=   4.0343
YTEMP=   0.2062
YTEMP=   0.2679
YTEMP=   0.2510
Z=   0.5544
Y=   1.7575
YTEMP=   3.3888
YTEMP=   1.0655
YTEMP=   1.9597
Z=   0.1347
Y=  12.8462
YTEMP=   2.2433
YTEMP=   0.0171
YTEMP=   3.2403
Z= -1.9428
Y=  14.7759
YTEMP=   2.0082
YTEMP=   0.7736
YTEMP=   1.2749
Z=   0.0415
Y=   8.1151
YTEMP=   0.4720
YTEMP=   4.1417
YTEMP=   0.2533
Z=   0.0737
Y=   9.7394
YTEMP=   2.4052
YTEMP=   1.0870
YTEMP=   2.0597
Z= -0.1394
Y=  12.2833
YTEMP=   0.4280
YTEMP=   0.5355
YTEMP=   0.4960
Z= -0.7191
Y=   3.4377
YTEMP=   0.8643
YTEMP=   0.1064
YTEMP=   1.3573
Z=   0.0593
```

```
Y=   4.6595
YTEMP=   2.6329
YTEMP=   0.0953
YTEMP=   2.5472
Z=   0.1986
Y=  10.5903
YTEMP=   1.2315
YTEMP=   0.4065
YTEMP=   0.0136
Z=  -0.5014
Y=   3.6747
YTEMP=   3.1339
YTEMP=   0.2639
YTEMP=   2.7769
Z=  -0.1906
Y=  12.3855
YTEMP=   0.0752
YTEMP=   1.0599
YTEMP=   0.4256
Z=  -0.3461
Y=   3.2413
YTEMP=   0.9240
YTEMP=   0.3952
YTEMP=   1.9239
Z=  -0.2707
Y=   6.5595
YTEMP=   1.7881
YTEMP=   1.3760
YTEMP=   1.3516
Z=  -0.2726
Y=   9.1058
YTEMP=   2.0495
YTEMP=   0.5986
YTEMP=   0.9677
Z=  -0.3279
Y=   7.3389
YTEMP=   2.1967
YTEMP=   1.5504
YTEMP=   0.6404
Z=  -1.0236
Y=   9.8232
YTEMP=   2.4110
YTEMP=   0.0866
YTEMP=   1.3896
Z=  -1.0668
Y=  10.1173
YTEMP=   0.6988
YTEMP=   1.5926
YTEMP=   0.1688
Z=   0.1948
Y=   4.9584
YTEMP=   0.0782
YTEMP=   0.1567
YTEMP=   0.3175
Z=  -1.8606
Y=   4.5666
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=*******   P=*******   DEN=******   IERR=*   CELL FREQ  1  4  5  0  3  1  5  5
YTEMP=   0.7253
YTEMP=   0.4011
YTEMP=   0.2106
Z=  -0.9846
Y=   3.6436
```

```
YTEMP=  0.0443
YTEMP=  0.3586
YTEMP=  2.2105
Z= -0.3494
Y=   5.3488
YTEMP=  0.4612
YTEMP=  1.4217
YTEMP=  0.7323
Z=   0.6202
Y=   5.6152
YTEMP=  0.0127
YTEMP=  1.7245
YTEMP=  3.3221
Z= -0.5795
Y=  10.4542
YTEMP=  0.1915
YTEMP=  1.0501
YTEMP=  0.0910
Z= -0.6103
Y=   3.0379
YTEMP=  0.1284
YTEMP=  0.3383
YTEMP=  0.1469
Z=   1.3040
Y=   2.9275
YTEMP=  3.4305
YTEMP=  0.7853
YTEMP=  1.5831
Z=   0.5711
Y=  11.9241
YTEMP=  2.2305
YTEMP=  0.2127
YTEMP=  0.2329
Z= -0.8526
Y=   6.0790
YTEMP=  0.0298
YTEMP=  2.7485
YTEMP=  0.3623
Z=   1.7785
Y=   9.4442
YTEMP=  0.0930
YTEMP=  1.6025
YTEMP=  3.3466
Z= -0.3684
Y=  10.2202
YTEMP=  3.8165
YTEMP=  0.2037
YTEMP=  0.9311
Z=   0.0305
Y=   9.9074
YTEMP=  0.3447
YTEMP=  1.2076
YTEMP=  0.2233
Z= -0.4923
Y=   3.7919
YTEMP=  1.2634
YTEMP=  2.5975
YTEMP=  0.2293
Z=   1.2313
Y=   9.6964
YTEMP=  2.1595
YTEMP=  1.9631
```

```
YTEMP=  0.2136
Z= -0.1706
Y=  8.7017
YTEMP=  0.0090
YTEMP=  0.2233
YTEMP=  2.1824
Z= -0.8937
Y=  5.6280
YTEMP=  0.3696
YTEMP=  0.5349
YTEMP=  0.4408
Z=  1.7672
Y=  5.8139
YTEMP=  0.0965
YTEMP=  0.0014
YTEMP=  0.4555
Z=  0.7446
Y=  1.6617
YTEMP=  0.5679
YTEMP=  0.5421
YTEMP=  0.2963
Z= -0.0705
Y=  2.6975
YTEMP=  0.7448
YTEMP=  0.3335
YTEMP=  0.1316
Z= -0.5667
Y=  2.7410
YTEMP=  1.0684
YTEMP=  0.4999
YTEMP=  0.9944
Z= -1.8484
Y=  8.5416
YTEMP=  0.2307
YTEMP=  0.9092
YTEMP=  0.0555
Z=  1.6538
Y=  5.1267
YTEMP=  2.5355
YTEMP=  0.6013
YTEMP=  1.0785
Z=  0.9074
Y=  9.2540
YTEMP=  0.0121
YTEMP=  0.0745
YTEMP=  0.4333
Z=  0.5340
Y=  1.3246
YTEMP=  0.0601
YTEMP=  0.4417
YTEMP=  1.5545
Z=  0.2237
Y=  3.7637
CHISQP=13.3333  P=0.93561  DIF=0.0220  IERR=0  CHISQL=*******  P=*******  DEN=******  IERR=*  CELL FREQ  6  3  1  5  0  2  6  1
YTEMP=  0.0640
YTEMP=  1.3654
YTEMP=  0.4955
Z= -0.2565
Y=  3.9405
YTEMP=  2.3953
YTEMP=  1.0546
YTEMP=  0.2691
```

```
Z=  1.7556
Y= 12.1099
YTEMP=  0.6698
YTEMP=  0.3841
YTEMP=  0.0545
Z= -0.3838
Y=  2.3641
YTEMP=  1.4656
YTEMP=  2.5047
YTEMP=  0.4279
Z=  0.2598
Y=  8.9039
YTEMP=  2.1216
YTEMP=  1.4220
YTEMP=  0.0197
Z=  0.0516
Y=  7.1293
YTEMP=  0.8602
YTEMP=  0.2749
YTEMP=  1.5299
Z= -0.5384
Y=  5.6198
YTEMP=  0.7692
YTEMP=  0.1335
YTEMP=  0.0963
Z=  3.0643
Y= 11.4279
YTEMP=  1.3357
YTEMP=  0.6731
YTEMP=  4.2665
Z= -0.5245
Y= 12.8657
YTEMP=  1.7678
YTEMP=  0.6133
YTEMP=  1.3173
Z= -0.1667
Y=  7.4245
YTEMP=  0.2229
YTEMP=  1.4335
YTEMP=  0.5934
Z= -0.3803
Y=  4.6444
YTEMP=  1.3555
YTEMP=  1.0779
YTEMP=  2.8781
Z=  0.9907
Y= 11.6044
YTEMP=  0.1101
YTEMP=  0.3367
YTEMP=  0.1360
Z=  1.4504
Y=  3.2691
YTEMP=  4.3710
YTEMP=  0.1931
YTEMP=  0.2844
Z= -0.7898
Y= 10.3207
YTEMP=  1.0268
YTEMP=  0.0035
YTEMP=  0.0430
Z=  0.2176
Y=  2.2058
```

```
YTEMP=  0.4750
YTEMP=  2.5984
YTEMP=  0.8800
Z= -0.7841
Y=  8.5216
YTEMP=  1.2636
YTEMP=  1.4395
YTEMP=  3.4696
Z=  1.1598
Y= 13.7304
YTEMP=  0.8513
YTEMP=  0.1320
YTEMP=  4.1414
Z=  2.2970
Y= 15.5255
YTEMP=  0.8087
YTEMP=  0.6799
YTEMP=  0.7177
Z= -0.0461
Y=  4.4149
YTEMP=  0.3250
YTEMP=  1.2552
YTEMP=  0.0739
Z= -0.8845
Y=  4.0906
YTEMP=  3.8769
YTEMP=  0.5413
YTEMP=  2.3965
Z=  0.8760
Y= 14.4006
YTEMP=  1.0861
YTEMP=  1.2740
YTEMP=  0.2744
Z=  1.6896
Y=  8.1239
YTEMP=  0.5630
YTEMP=  0.1609
YTEMP=  0.6912
Z= -2.8492
Y= 11.3480
YTEMP=  1.4436
YTEMP=  0.1703
YTEMP=  1.9923
Z= -0.4023
Y=  7.3742
YTEMP=  0.2459
YTEMP=  0.1973
YTEMP=  0.5936
Z=  0.1091
Y=  2.0855
CHISQP=11.3333  P=0.87527  DEN=0.0398  IERR=0  CHISOL= 9.6770  P=0.79237  DEN=0.0614  IERR=0  CELL FREQ  3  3  2  1  3  3  1  8
YTEMP=  0.0583
YTEMP=  0.1722
YTEMP=  1.9008
Z=  1.0967
Y=  5.4854
YTEMP=  0.0679
YTEMP=  0.5912
YTEMP=  0.1131
Z=  0.8176
Y=  2.2129
YTEMP=  0.1726
```

APPENDIX D

```
$ 20.37.52 JOB 711 -- RAI9ADA9 -- BEGINNING EXEC - PART 10- CLASS 4
 *20.39.12 JOB 711 ILU001I RAI9ADA9 ASM        230K REQ,  230K USED, 00:01:02 ET, 00:00:06 CPU,  9.94%,  0000  (COMP)
 *20.39.55 JOB 711 ILU001I RAI9ADA9 FORT       230K REQ,   80K USED, 00:00:42 ET, 00:00:07 CPU, 18.23%,  0000  (COMP)
 *20.40.20 JOB 711 ILU001I RAI9ADA9 LKED       230K REQ,   96K USED, 00:00:25 ET, 00:00:01 CPU,  6.29%,  0000  (COMP)
 *20.53.16 JOB 711 ILU001I RAI9ADA9 GO         230K REQ,   48K USED, 00:12:55 ET, 00:02:33 CPU, 19.73%,  0000  (COMP)
 *20.54.23 JOB 711 ILU001I RAI9ADA9 SORT       230K REQ,  230K USED, 00:01:06 ET, 00:00:03 CPU,  5.19%,  0000  (COMP)
$*20.54.25 JOB 711 -- RAI9ADA9 -- END EXECUTION:    1407 LINES


HASP3.1.14 JOB STATISTICS --   671 CARDS READ --   1,416 LINES PRINTED --    0 CARDS PUNCHED --  16.54 MINUTES (ELAPSED TIME)
```

```
     //RAI9ADA9 JOB (3203,1,,2),'MILLER',                                                    JOB 711
     //     MSGLEVEL=(1,1),CLASS=4,TIME=4
     // EXEC ASMGFORT,PARM.LKED=
               XXASMGFORT PROC DECK=''                                                                  00000100
               XXASM    EXEC  PGM=ASMGASM,PARM='B,LO,ES,RL,UM,FX,CO=3,&DECK'                            00000200
 IEF653I SUBSTITUTION JCL - PGM=ASMGASM,PARM='B,LO,ES,RL,UM,FX,CO=3,'
               XXSYSLIB    DD  DSN=MATH210.MACLIB,DISP=SHR                                              00000300
               XX        DD  DSN=SYS1.MACLIB,DISP=SHR                                                   00000400
               XXSYSUT1    DD UNIT=SYSDA,SPACE=(3500,(400,50))                                          00000500
               XXSYSUT2    DD UNIT=SYSDA,SPACE=(3500,(400,50))                                          00000600
               XXSYSUT3    DD UNIT=SYSDA,SPACE=(3500,(400,50))                                          00000700
     //SYSPRINT DD DUMMY
               X/SYSPRINT   DD SYSOUT=A                                                                 00000800
               XXSYSPUNCH   DD SYSOUT=B                                                                 00000900
               XXSYSLIN DD DSN=&LOADSET,UNIT=SYSDA,SPACE=(80,(200,50)),                                X00001000
               XX      DISP=(MOD,PASS),DCB=(RECFM=F,LRECL=80,BLKSIZE=80)                                00001100
     //ASM.SYSIN DD *
                           IEF236I ALLOC. FOR RAI9ADA9 ASM
                           IEF237I 251    ALLOCATED TO SYSLIB
                           IEF237I 150    ALLOCATED TO
                           IEF237I 156    ALLOCATED TO SYSUT1
                           IEF237I 157    ALLOCATED TO SYSUT2
                           IEF237I 155    ALLOCATED TO SYSUT3
                           IEF237I 3C0    ALLOCATED TO SYSPUNCH
                           IEF237I 156    ALLOCATED TO SYSLIN
                           IEF237I 351    ALLOCATED TO SYSIN
 IEF142I - STEP WAS EXECUTED - COND CODE 0000
                           IEF285I   MATH210.MACLIB                                   KEPT
                           IEF285I   VOL SER NOS= LD3001.
                           IEF285I   SYS1.MACLIB                                      KEPT
                           IEF285I   VOL SER NOS= SYSVOL.
                           IEF285I   SYS77241.T013450.RF000.RAI9ADA9.R0009175         DELETED
                           IEF285I   VOL SER NOS= WORK07.
                           IEF285I   SYS77241.T013450.RF000.RAI9ADA9.R0009176         DELETED
                           IEF285I   VOL SER NOS= LD3030.
                           IEF285I   SYS77241.T013450.RF000.RAI9ADA9.R0009177         DELETED
                           IEF285I   VOL SER NOS= LD3029.
                           IEF285I   SYS77241.T013450.RF000.RAI9ADA9.LOADSET          PASSED
                           IEF285I   VOL SER NOS= WORK07.
          IEF373I STEP /ASM      / START 77242.2038
          IEF374I STEP /ASM      / STOP  77242.2039 CPU    0MIN 06.22SEC MAIN 230K LCS   0K
 ILU002I STEP /ASM      /  UNIT 251          4 EXCPS
 ILU002I STEP /ASM      /. UNIT 150         26 EXCPS
 ILU002I STEP /ASM      /  UNIT 156          0 EXCPS
 ILU002I STEP /ASM      /  UNIT 157          0 EXCPS
 ILU002I STEP /ASM      /  UNIT 155          0 EXCPS
 ILU002I STEP /ASM      /  UNIT 3C0          0 EXCPS
 ILU002I STEP /ASM      /  UNIT 156         39 EXCPS
 ILU002I STEP /ASM      /  UNIT 351        519 EXCPS
 ILU003I STEP /ASM      /  EXCPS|  DISK       69|  TAPE          0|  UR        519|  TP          0|  TOTAL       588|
               XXFORT   EXEC   PGM=IEYFORT,PARM='LINECNT=60'                                            00001200
               XXSYSPRINT DD SYSOUT=A                                                                   00001300
               XXSYSPUNCH  DD SYSOUT=B                                                                  00001400
               XXSYSLIN DD DSN=&LOADSET,DISP=(MOD,PASS),                                               X00001500
               XX       DCB=(RECFM=F,LRECL=80,BLKSIZE=80)                                               00001600
     //FORT.SYSIN DD *
                           IEF236I ALLOC. FOR RAI9ADA9 FORT
                           IEF237I 388    ALLOCATED TO SYSPRINT
                           IEF237I 3C0    ALLOCATED TO SYSPUNCH
                           IEF237I 156    ALLOCATED TO SYSLIN
                           IEF237I 355    ALLOCATED TO SYSIN
 IEF142I - STEP WAS EXECUTED - COND CODE 0000
```

```
                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.LOADSET          PASSED
                    IEF285I   VOL SER NOS= WORK07.
        IEF373I STEP /FORT    / START 77242.2039
        IEF374I STEP /FORT    / STOP  77242.2039 CPU    0MIN 07.72SEC MAIN  80K LCS   0K
ILU002I STEP /FORT     /  UNIT 388        204 EXCPS
ILU002I STEP /FORT     /  UNIT 3C0          0 EXCPS
ILU002I STEP /FORT     /  UNIT 156        117 EXCPS
ILU002I STEP /FORT     /  UNIT 355        130 EXCPS
ILU003I STEP /FORT     /  EXCPS:  DISK        117;  TAPE          0;  UR        334;  TP          0;  TOTAL        451;
            XXLKED  EXEC  PGM=IEWL,PARM='XREF,LET,LIST',COND=(4,LT,FORT)              00001700
            XXSYSLIB DD DSN='SYS1.FORTLIB',DISP=SHR                                  00001800
            XX          DD DSN=SSPLIB,DISP=SHR                                       00001900
            XXSYSLMOD  DD  DSN=&GOSET(MAIN),DISP=(NEW,PASS),UNIT=SYSDA,             X00002000
            XX SPACE=(TRK,(20,5,1))                                                  00002100
            XXSYSPRINT DD SYSOUT=A                                                   00002200
            XXSYSUT1 DD UNIT=SYSDA,DISP=(,,DELETE),SPACE=(CYL,(1,1))                 00002300
            XXSYSLIN DD DSN=&LOADSET,DISP=(OLD,DELETE),                             X00002400
            XX          DCB=(RECFM=F,LRECL=80,BLKSIZE=80)                            00002500
            XX          DD DDNAME=SYSIN                                              00002600
                    IEF236I ALLOC. FOR RAI9ADA9 LKED
                    IEF237I 150    ALLOCATED TO SYSLIB
                    IEF237I 251    ALLOCATED TO
                    IEF237I 156    ALLOCATED TO SYSLMOD
                    IEF237I 388    ALLOCATED TO SYSPRINT
                    IEF237I 157    ALLOCATED TO SYSUT1
                    IEF237I 156    ALLOCATED TO SYSLIN
IEF142I - STEP WAS EXECUTED - COND CODE 0000
                    IEF285I   SYS1.FORTLIB                                     KEPT
                    IEF285I   VOL SER NOS= SYSVOL.
                    IEF285I   SSPLIB                                           KEPT
                    IEF285I   VOL SER NOS= LD3001.
                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.GOSET            PASSED
                    IEF285I   VOL SER NOS= WORK07.
                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.R0009184         DELETED
                    IEF285I   VOL SER NOS= LD3030.
                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.LOADSET          DELETED
                    IEF285I   VOL SER NOS= WORK07.
        IEF373I STEP /LKED    / START 77242.2039
        IEF374I STEP /LKED    / STOP  77242.2040 CPU    0MIN 01.59SEC MAIN  96K LCS   0K
ILU002I STEP /LKED     /  UNIT 150         84 EXCPS
ILU002I STEP /LKED     /  UNIT 251         14 EXCPS
ILU002I STEP /LKED     /  UNIT 156         27 EXCPS
ILU002I STEP /LKED     /  UNIT 388          5 EXCPS
ILU002I STEP /LKED     /  UNIT 157         18 EXCPS
ILU002I STEP /LKED     /  UNIT 156        157 EXCPS
ILU003I STEP /LKED     /  EXCPS:  DISK        300;  TAPE          0;  UR          5;  TP          0;  TOTAL        305;
            XXGO     EXEC PGM=*.LKED.SYSLMOD,COND=((4,LT,FORT),(4,LT,LKED))          00002700
            XXSYSIN DD DDNAME=ASMINPT                                                00002800
            XXSYSPRINT  DD SYSOUT=A                                                  00002900
            XXFT05F001 DD DDNAME=FORTINPT                                            00003000
            XXFT06F001  DD SYSOUT=A                                                  00003100
            XXFT07F001  DD SYSOUT=B                                                  00003200
    //GO.FT08F001 DD DSN=&&T1,UNIT=SYSDA,VOL=SER=WORK05,
    // DISP=(NEW,PASS),DCB=(LRECL=133,RECFM=FB,BLKSIZE=3990),
    // SPACE=(3990,(40,1))
    //GO.FORTINPT DD *
                    IEF236I ALLOC. FOR RAI9ADA9 GO
                    IEF237I 156    ALLOCATED TO PGM=*.DD
                    IEF237I 388    ALLOCATED TO SYSPRINT
                    IEF237I 356    ALLOCATED TO FT05F001
                    IEF237I 38C    ALLOCATED TO FT06F001
                    IEF237I 3C0    ALLOCATED TO FT07F001
```

```
                                    IEF237I 250    ALLOCATED TO FT08F001
IEF142I - STEP WAS EXECUTED - COND CODE 0000
                                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.GOSET          PASSED
                                    IEF285I   VOL SER NOS= WORK07.
                                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.T1             PASSED
                                    IEF285I   VOL SER NOS= WORK05.
          IEF373I STEP /GO        / START 77242.2040
          IEF374I STEP /GO        / STOP  77242.2053 CPU    2MIN 33.10SEC MAIN  48K LCS    0K
ILU002I STEP /GO       /  UNIT 156           0 EXCPS
ILU002I STEP /GO       /  UNIT 388           0 EXCPS
ILU002I STEP /GO       /  UNIT 356           3 EXCPS
ILU002I STEP /GO       /  UNIT 38C           3 EXCPS
ILU002I STEP /GO       /  UNIT 3C0           0 EXCPS
ILU002I STEP /GO       /  UNIT 250          34 EXCPS
ILU003I STEP /GO       /  EXCPS:  DISK        34:  TAPE          0:  UR          6:  TP          0:  TOTAL         40:
    //S2 EXEC SORTD
              XXSORT     EXEC PGM=SORT,REGION=80K                                                 00000010
              XXSYSOUT  DD    SYSOUT=A                                                            00000020
              XXSORTLIB DD    DSNAME=SYS1.SORTLIB,DISP=SHR                                        00000030
    //SORTWK01 DD DSN=&&TEMP1,UNIT=SYSDA,VOL=SER=WORK05,
    // DISP=(NEW,DELETE),SPACE=(CYL,(1))
    //SORTWK02 DD DSN=&&TEMP2,UNIT=SYSDA,VOL=SER=WORK05,
    // DISP=(NEW,DELETE),SPACE=(CYL,(1))
    //SORTWK03 DD DSN=&&TEMP3,UNIT=SYSDA,VOL=SER=WORK05,
    // DISP=(NEW,DELETE),SPACE=(CYL,(1))
    //SORTIN DD DSN=&&T1,DISP=(OLD,DELETE)
    //SORTOUT DD SYSOUT=A,DCB=BLKSIZE=133
    //SYSIN DD *
    //
                                    IEF236I ALLOC. FOR RAI9ADA9 SORT      S2
                                    IEF237I 381    ALLOCATED TO SYSOUT
                                    IEF237I 150    ALLOCATED TO SORTLIB
                                    IEF237I 250    ALLOCATED TO SORTWK01
                                    IEF237I 250    ALLOCATED TO SORTWK02
                                    IEF237I 250    ALLOCATED TO SORTWK03
                                    IEF237I 250    ALLOCATED TO SORTIN
                                    IEF237I 382    ALLOCATED TO SORTOUT
                                    IEF237I 359    ALLOCATED TO SYSIN
IEF142I - STEP WAS EXECUTED - COND CODE 0000
                                    IEF285I   SYS1.SORTLIB                                   KEPT
                                    IEF285I   VOL SER NOS= SYSVOL.
                                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.TEMP1          DELETED
                                    IEF285I   VOL SER NOS= WORK05.
                                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.TEMP2          DELETED
                                    IEF285I   VOL SER NOS= WORK05.
                                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.TEMP3          DELETED
                                    IEF285I   VOL SER NOS= WORK05.
                                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.T1             DELETED
                                    IEF285I   VOL SER NOS= WORK05.
          IEF373I STEP /SORT      / START 77242.2053
          IEF374I STEP /SORT      / STOP  77242.2054 CPU    0MIN 03.45SEC MAIN 230K LCS    0K
ILU002I STEP /SORT     /  UNIT 381          10 EXCPS
ILU002I STEP /SORT     /  UNIT 150           0 EXCPS
ILU002I STEP /SORT     /  UNIT 250          24 EXCPS
ILU002I STEP /SORT     /  UNIT 250           0 EXCPS
ILU002I STEP /SORT     /  UNIT 250           0 EXCPS
ILU002I STEP /SORT     /  UNIT 250          36 EXCPS
ILU002I STEP /SORT     /  UNIT 382       1,000 EXCPS
ILU002I STEP /SORT     /  UNIT 359           2 EXCPS
ILU003I STEP /SORT     /  EXCPS:  DISK        60:  TAPE          0:  UR      1,012:  TP          0:  TOTAL      1,072:
                                    IEF285I   SYS77241.T013450.RF000.RAI9ADA9.GOSET          DELETED
                                    IEF285I   VOL SER NOS= WORK07.
```

```
IEF375I   JOB /RAI9ADA9/ START 77242.2038
IEF376I   JOB /RAI9ADA9/ STOP  77242.2054 CPU    2MIN 52.08SEC
```

```
      DIMENSION INT(10),BND(10)
      INTEGER BR
   60 READ(5,101,END=50) DF,E,BND
      IDF=DF+.1
      WRITE(6,102) DF,E,(BND(I),I=1,IDF)
      II=IDF+1
      KK=DF/2.+.1
      ZF=0
      ITEMS=(DF+1)*E+.1
      ASSIGN 6 TO BR
      IF(MOD(IDF,2).EQ.1) ASSIGN 7 TO BR
      DO 20 J=1,1000
      DO 10 I=1,II
   10 INT(I)=0
      DO 9 I=1,ITEMS
      Y=0
      DO 8 K=1,KK
    8 Y=Y+REXP(0)
      GO TO BR,(6,7)
    6 Y=Y+Y
      GO TO 5
    7 Y=Y+Y+RNOR(0)**2
    5 DO 4 K=1,IDF
      IF(Y.GT.BND(K)) GO TO 4
      INT(K)=INT(K)+1
      GO TO 9
    4 CONTINUE
      INT(II)=INT(II)+1
    9 CONTINUE
      CHISQP=0
      CHISQL=0
      DO 15 I=1,II
      IF(INT(I).NE.0) GO TO 14
      ZF=1
      GO TO 15
   14 CHISQL=CHISQL+INT(I)*ALOG(INT(I)/E)
   15 CHISQP=CHISQP+((INT(I)-E)**2)/E
      IF(ZF) 18,18,17
   17 CHISQL=999
      PL=99
      DL=999
      IERRL=999
      ZF=0
      GO TO 19
   18 CHISQL=CHISQL+CHISQL
      CALL CDTR(CHISQL,DF,PL,DL,IERRL)
   19 CALL CDTR(CHISQP,DF,PP,DP,IERR)
      WRITE(8,100)CHISQP,PP,DP,IERR,CHISQL,PL,DL,IERRL,(INT(I),I=1,II)
   20 CONTINUE
      GO TO 60
   50 END FILE 8
      STOP
  100 FORMAT(                                    ' CHISQP=',F7.4,'  P=',F7.5, '
     A DEN=',F6.4,'  IERR=',I1,'  CHISQL=',F7.4,'  P=',F7.5,'  DEN=',F6
     B.4,'  IERR=',I1,'  CELL FREQ',10I3)
  101 FORMAT(2F3.0,10F7.4)
  102 FORMAT(' DEGRFES OF FREEDOM=',F3.0,/,' EXPECTED FREQ=',F3.0,/,
     1' BOUNDARY VALUES=',10F8.4)
```

```
0056            END
```

```
                                 SUBPROGRAMS CALLED
SYMBOL     LOCATION     SYMBOL   LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION
IBCOM#       11C        REXP       120        RNOR         124        CDTR         128        ALOG         12C

                                 SCALAR MAP
SYMBOL     LOCATION     SYMBOL   LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION
DF           16C        E          170        IDF          174        I            178        II           17C
KK           180        ZF         184        ITEMS        188        BR           18C        J            190
Y            194        K          198        CHISQP       19C        CHISQL       1A0        PL           1A4
DL           1A8        IERRL      1AC        PP           1B0        DP           1B4        IERR         1B8

                                 ARRAY MAP
SYMBOL     LOCATION     SYMBOL   LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION
INT          1BC        BND        1E4

                                 FORMAT STATEMENT MAP
SYMBOL     LOCATION     SYMBOL   LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION     SYMBOL     LOCATION
   100       20C           101     278           102       284

   *OPTIONS IN EFFECT*  ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,MAP
   *OPTIONS IN EFFECT*  NAME = MAIN     , LINECNT =       60
   *STATISTICS*    SOURCE STATEMENTS =         56,PROGRAM SIZE =       1976
   *STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
          C RNOR TOOTH FUNCTION
0001            FUNCTION RNORTH(K)
0002            DIMENSION C(45)
0003            DATA C/Z40FD2B5F,Z40FD2B5F,Z40FAA9AD,Z40F5A648,Z40F32496,
               $ Z40EE2131,Z40E69C1A,Z40E19885,Z40DA139E,Z40D28E87,Z40C887BE,
               $ Z40C102A6,Z40B6FBDD,Z40ACF513,Z40A2EE4A,Z4098E780,Z40916269,
               $ Z40675BA0,Z407D54D6,Z40734E0D,Z406BC8F6,Z4061C22C,Z405A3D15,
               $ Z4052B7FE,Z404B32E7,Z4043ADD0,Z403C28B9,Z40372554,Z402FA03D,
               $ Z402A9CD8,Z40259973,Z4020960E,Z401E145C,Z401910F7,Z40168F45,
               $ Z40140D93,Z40118BE0,Z3FF0A2E4,Z3FC887BE,Z3FA06C98,Z3F785172,
               $ Z3F785172,Z3F50364C,Z3F50364C,Z3F50364C/
0004            DATA I1/ZFBC35400/,I2/ZFE79702F/
0005            IF(K.GT.I1)GO TO 3
0006            S=UNI(0)
0007            T=UNI(0)
0008            B=AINT(7.*(S+T)+37.*ABS(S-T))
0009            X=UNI(0)-UNI(0)
0010            RNORTH=.0625*(X+SIGN(B,X))
0011            RETURN
0012       3    IF(K.GT.I2)GO TO 5
0013       4    RNORTH=2.75*VNI(0)
0014            J=16.*ABS(RNORTH)+1.
0015            IF(J-14) 6,6,7
0016         6  P=(J+J-1)*.1497466E-2
0017            GO TO 8
0018         7  P=(89-J-J)*.698817E-3
0019       8    IF(UNI(0).GT.79.78846*(EXP(-.5*RNORTH*RNORTH)
               $     -C(J)-P*(J-16.*ABS(RNORTH)))) GOTO4
0020            RETURN
0021       5    V=VNI(0)
0022            IF(V.EQ.0) GO TO 5
0023            X=SQRT(7.5625-2.*ALOG(ABS(V)))
0024            IF(UNI(0)*X.GT.2.75)GO TO 5
0025            RNORTH=SIGN(X,V)
0026            RETURN
0027            END
```

SUBPROGRAMS CALLED

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
UNI	D4	VNI	D8	EXP	DC	SQRT	E0	ALOG	E4

EQUIVALENCE DATA MAP

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
RNORTH	138								

SCALAR MAP

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
I1	13C	I2	140	K	144	S	148	T	14C
B	150	X	154	J	158	P	15C	V	160

ARRAY MAP

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
C	164								

```
*OPTIONS IN EFFECT*  ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,MAP
*OPTIONS IN EFFECT*  NAME = RNORTH  , LINECNT =       60
*STATISTICS*    SOURCE STATEMENTS =        27,PROGRAM SIZE =      1368
*STATISTICS*  NO DIAGNOSTICS GENERATED
```

```
      C      REXP TOOTH FUNCTION
             FUNCTION REXPTH(K)
             DIMENSION C(65)
             DATA C/Z40F00000,Z40E10000,Z40D40000,Z40C70000,Z40BB0000,
            $ Z40AF0000,Z40A50000,Z409B0000,Z40910000,Z40890000,Z40800000,
            $ Z40780000,Z40710000,Z406A0000,Z40640000,Z405E0000,Z40580000,
            $ Z40530000,Z404E0000,Z40490000,Z40440000,Z40400000,Z403C0000,
            $ Z40390000,Z40350000,Z40320000,Z402F0000,Z402C0000,Z40290000,
            $ Z40270000,Z40240000,Z40220000,Z40200000,Z401E0000,Z401C0000,
            $ Z401A0000,Z40190000,Z40170000,Z40160000,Z40150000,Z40130000,
            $ Z40120000,Z40110000,Z40100000,Z3FF00000,Z3FE00000,Z3FD00000,
            $ Z3FC00000,Z3FB00000,Z3FB00000,Z3FA00000,Z3F900000,Z3F900000,
            $ Z3F800000,Z3F800000,Z3F700000,Z3F700000,Z3F600000,Z3F600000,
            $ Z3F600000,Z3F500000,Z3F500000,Z3F400000,Z3F400000,Z3F400000/
             DATA I1/ZFB4FAA91/
             IF(K.GT.I1)GO TO 5
      1      U1=UNI(0)
             IF(U1.GT..7917049) GO TO 3
             T=1.-1.239962*U1
             REXPTH=-ALOG(T)
             J=16.*REXPTH+1.
             IF(UNI(0)*(.0604*T+.0039).GT.T-C(J))GOTO1
             RETURN
      3      REXPTH=19.20352*U1-15.20352
             J=16.*REXPTH+1.
             EX=EXP(-REXPTH)
             IF(UNI(0)*(.0604*EX+.0039).GT.EX-C(J))GOTO1
             RETURN
      5      U1=UNI(0)
             IF(U1.EQ.0)GO TO 5
             REXPTH=4.-ALOG(U1)
             RETURN
             END
```

SUBPROGRAMS CALLED

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
UNI	BC	ALOG	C0	EXP	C4				

EQUIVALENCE DATA MAP

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
REXPTH	E8								

SCALAR MAP

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
I1	EC	K	F0	U1	F4	T	F8	J	FC
EX	100								

ARRAY MAP

SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION	SYMBOL	LOCATION
C	104								

```
*OPTIONS IN EFFECT*  ID,EBCDIC,SOURCE,NOLIST,NODECK,LOAD,MAP
*OPTIONS IN EFFECT*  NAME = REXPTH  , LINECNT =       60
*STATISTICS*    SOURCE STATEMENTS =        22,PROGRAM SIZE =      1076
*STATISTICS*  NO DIAGNOSTICS GENERATED

*STATISTICS*  NO DIAGNOSTICS THIS STEP
```

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```
F88-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED   NONE
         DEFAULT OPTION(S) USED -  SIZE=(92160,28672)
****MAIN       DOES NOT EXIST BUT HAS BEEN ADDED TO DATA SET
```

DEGREES OF FREEDOM= 7.
EXPECTED FREQ=10.
BOUNDARY VALUES= 3.1040 4.2550 5.2870 6.3460 8.0920 9.0370 11.3390

```
*** SORT/MERGE  5734-SM1,VER 1,MOD 4, CONTROL STATEMENTS   DATE=   77.242   ***
 SORT FIELDS=(20,7,FI,A,67,7,FI,A)
IGH036I - B =    97
IGH037I - G =  1116
IGH038I - NMAX  APROX EQUAL      3000
IGH070I - FILE SIZE   IS NOT  SPECIFIED
IGH045I - END SORT PH
IGH049I - SKIP MERGE PH
IGH054I - RCD IN     1000,OUT      1000
IGH052I - END OF SORT/MERGE
```

CHISQP= 1.2000	P=0.00907	DEN=0.0230	IERR=0	CHISQL= 1.2061	P=0.00921	DEN=0.0232	IERR=0	CELL FREQ 12 9 11 10 8 10 11 9
CHISQP= 1.8000	P=0.02992	DEN=0.0470	IERR=0	CHISQL= 1.8112	P=0.03045	DEN=0.0475	IERR=0	CELL FREQ 10 9 12 11 12 8 10 8
CHISQP= 2.0000	P=0.04016	DEN=0.0553	IERR=0	CHISQL= 1.9780	P=0.03895	DEN=0.0544	IERR=0	CELL FREQ 9 11 8 10 13 8 10 11
CHISQP= 2.0000	P=0.04016	DEN=0.0553	IERR=0	CHISQL= 1.9780	P=0.03895	DEN=0.0544	IERR=0	CELL FREQ 11 8 9 13 10 8 11 10
CHISQP= 2.0000	P=0.04016	DEN=0.0553	IERR=0	CHISQL= 2.0115	P=0.04080	DEN=0.0558	IERR=0	CELL FREQ 8 9 11 8 11 9 12 12
CHISQP= 2.0000	P=0.04016	DEN=0.0553	IERR=0	CHISQL= 2.0283	P=0.04174	DEN=0.0565	IERR=0	CELL FREQ 10 9 10 10 13 10 7 11
CHISQP= 2.0000	P=0.04016	DEN=0.0553	IERR=0	CHISQL= 2.0618	P=0.04366	DEN=0.0579	IERR=0	CELL FREQ 11 10 7 9 12 9 12 10
CHISQP= 2.0000	P=0.04016	DEN=0.0553	IERR=0	CHISQL= 2.0618	P=0.04366	DEN=0.0579	IERR=0	CELL FREQ 12 9 9 10 12 7 11 10
CHISQP= 2.0000	P=0.04016	DEN=0.0553	IERR=0	CHISQL= 2.1024	P=0.04604	DEN=0.0596	IERR=0	CELL FREQ 10 8 11 11 11 7 10 12
CHISQP= 2.2000	P=0.05205	DEN=0.0636	IERR=0	CHISQL= 2.1601	P=0.04955	DEN=0.0619	IERR=0	CELL FREQ 8 10 8 10 12 9 13 10
CHISQP= 2.2000	P=0.05205	DEN=0.0636	IERR=0	CHISQL= 2.1783	P=0.05068	DEN=0.0627	IERR=0	CELL FREQ 11 13 11 9 8 9 8 11
CHISQP= 2.2000	P=0.05205	DEN=0.0636	IERR=0	CHISQL= 2.2342	P=0.05425	DEN=0.0649	IERR=0	CELL FREQ 8 11 12 10 11 8 8 12
CHISQP= 2.6000	P=0.08062	DEN=0.0790	IERR=0	CHISQL= 2.6166	P=0.08193	DEN=0.0796	IERR=0	CELL FREQ 9 12 11 8 12 8 12 8
CHISQP= 2.6000	P=0.08062	DEN=0.0790	IERR=0	CHISQL= 2.6334	P=0.08328	DEN=0.0802	IERR=0	CELL FREQ 10 12 10 10 13 7 8 10
CHISQP= 2.6000	P=0.08062	DEN=0.0790	IERR=0	CHISQL= 2.6334	P=0.08328	DEN=0.0802	IERR=0	CELL FREQ 10 7 10 13 10 10 12 8
CHISQP= 2.6000	P=0.08062	DEN=0.0790	IERR=0	CHISQL= 2.6517	P=0.08475	DEN=0.0809	IERR=0	CELL FREQ 9 11 10 8 13 7 11 11
CHISQP= 2.6000	P=0.08062	DEN=0.0790	IERR=0	CHISQL= 2.6517	P=0.08475	DEN=0.0809	IERR=0	CELL FREQ 10 13 11 9 11 8 7 11
CHISQP= 2.6000	P=0.08062	DEN=0.0790	IERR=0	CHISQL= 2.6517	P=0.08475	DEN=0.0809	IERR=0	CELL FREQ 11 8 9 10 11 7 13 11
CHISQP= 2.6000	P=0.08062	DEN=0.0790	IERR=0	CHISQL= 2.6517	P=0.08475	DEN=0.0809	IERR=0	CELL FREQ 9 7 13 11 10 8 11 11
CHISQP= 2.6000	P=0.08062	DEN=0.0790	IERR=0	CHISQL= 2.7884	P=0.09613	DEN=0.0856	IERR=0	CELL FREQ 10 10 10 10 11 6 10 13
CHISQP= 2.8000	P=0.09713	DEN=0.0860	IERR=0	CHISQL= 2.6813	P=0.08716	DEN=0.0819	IERR=0	CELL FREQ 10 11 8 9 11 8 14 9
CHISQP= 2.8000	P=0.09713	DEN=0.0860	IERR=0	CHISQL= 2.6813	P=0.08716	DEN=0.0819	IERR=0	CELL FREQ 10 11 8 8 14 11 9 9
CHISQP= 2.8000	P=0.09713	DEN=0.0860	IERR=0	CHISQL= 2.8337	P=0.10006	DEN=0.0872	IERR=0	CELL FREQ 12 13 10 11 9 10 7 8
CHISQP= 2.8000	P=0.09713	DEN=0.0860	IERR=0	CHISQL= 2.8337	P=0.10006	DEN=0.0872	IERR=0	CELL FREQ 8 13 12 10 10 7 11 9
CHISQP= 2.8000	P=0.09713	DEN=0.0860	IERR=0	CHISQL= 2.9887	P=0.11395	DEN=0.0922	IERR=0	CELL FREQ 6 11 10 9 13 10 11 10
CHISQP= 2.8000	P=0.09713	DEN=0.0860	IERR=0	CHISQL= 3.0222	P=0.11706	DEN=0.0932	IERR=0	CELL FREQ 12 9 11 11 12 6 10 9
CHISQP= 2.8000	P=0.09713	DEN=0.0860	IERR=0	CHISQL= 3.0222	P=0.11706	DEN=0.0932	IERR=0	CELL FREQ 11 9 12 12 11 6 10 9
CHISQP= 3.0000	P=0.11500	DEN=0.0925	IERR=0	CHISQL= 2.9039	P=0.10626	DEN=0.0895	IERR=0	CELL FREQ 10 11 11 8 14 10 8 8
CHISQP= 3.0000	P=0.11500	DEN=0.0925	IERR=0	CHISQL= 2.9600	P=0.11132	DEN=0.0913	IERR=0	CELL FREQ 13 9 9 7 13 10 9 10
CHISQP= 3.0000	P=0.11500	DEN=0.0925	IERR=0	CHISQL= 3.1708	P=0.13123	DEN=0.0975	IERR=0	CELL FREQ 13 9 10 10 12 6 10 10
CHISQP= 3.0000	P=0.11500	DEN=0.0925	IERR=0	CHISQL= 3.1708	P=0.13123	DEN=0.0975	IERR=0	CELL FREQ 10 6 12 10 10 9 10 13
CHISQP= 3.0000	P=0.11500	DEN=0.0925	IERR=0	CHISQL= 3.2448	P=0.13853	DEN=0.0996	IERR=0	CELL FREQ 10 10 12 11 12 11 6 8
CHISQP= 3.2000	P=0.13410	DEN=0.0984	IERR=0	CHISQL= 3.2162	P=0.13569	DEN=0.0988	IERR=0	CELL FREQ 12 10 8 12 13 9 9 7
CHISQP= 3.2000	P=0.13410	DEN=0.0984	IERR=0	CHISQL= 3.2162	P=0.13569	DEN=0.0988	IERR=0	CELL FREQ 12 12 9 13 10 8 9 7
CHISQP= 3.2000	P=0.13410	DEN=0.0984	IERR=0	CHISQL= 3.2162	P=0.13569	DEN=0.0988	IERR=0	CELL FREQ 9 12 8 10 13 7 9 12
CHISQP= 3.2000	P=0.13410	DEN=0.0984	IERR=0	CHISQL= 3.3071	P=0.14478	DEN=0.1012	IERR=0	CELL FREQ 13 7 10 10 11 7 10 12
CHISQP= 3.2000	P=0.13410	DEN=0.0984	IERR=0	CHISQL= 3.3711	P=0.15131	DEN=0.1029	IERR=0	CELL FREQ 9 13 11 12 9 6 10 10
CHISQP= 3.2000	P=0.13410	DEN=0.0984	IERR=0	CHISQL= 3.3711	P=0.15131	DEN=0.1029	IERR=0	CELL FREQ 11 12 9 10 10 9 6 13
CHISQP= 3.2000	P=0.13410	DEN=0.0984	IERR=0	CHISQL= 3.3711	P=0.15132	DEN=0.1029	IERR=0	CELL FREQ 9 10 9 11 13 6 12 10
CHISQP= 3.2000	P=0.13410	DEN=0.0984	IERR=0	CHISQL= 3.4117	P=0.15551	DEN=0.1038	IERR=0	CELL FREQ 11 11 13 11 8 6 10 10
CHISQP= 3.4000	P=0.15430	DEN=0.1036	IERR=0	CHISQL= 3.3549	P=0.14965	DEN=0.1025	IERR=0	CELL FREQ 11 11 11 7 14 9 9 8
CHISQP= 3.4000	P=0.15430	DEN=0.1036	IERR=0	CHISQL= 3.3549	P=0.14966	DEN=0.1025	IERR=0	CELL FREQ 8 9 11 14 11 7 9 11
CHISQP= 3.4000	P=0.15430	DEN=0.1036	IERR=0	CHISQL= 3.3830	P=0.15254	DEN=0.1031	IERR=0	CELL FREQ 10 8 13 9 9 7 11 13
CHISQP= 3.4000	P=0.15430	DEN=0.1036	IERR=0	CHISQL= 3.5074	P=0.16556	DEN=0.1061	IERR=0	CELL FREQ 11 7 9 13 10 7 12 11
CHISQP= 3.6000	P=0.17548	DEN=0.1081	IERR=0	CHISQL= 3.5370	P=0.16871	DEN=0.1067	IERR=0	CELL FREQ 12 9 14 11 9 7 10 8
CHISQP= 3.6000	P=0.17548	DEN=0.1081	IERR=0	CHISQL= 3.7535	P=0.19231	DEN=0.1111	IERR=0	CELL FREQ 9 13 12 10 12 6 9 9
CHISQP= 3.6000	P=0.17548	DEN=0.1081	IERR=0	CHISQL= 3.7941	P=0.19684	DEN=0.1119	IERR=0	CELL FREQ 8 6 13 11 12 11 9 10
CHISQP= 3.6000	P=0.17548	DEN=0.1081	IERR=0	CHISQL= 3.7941	P=0.19684	DEN=0.1119	IERR=0	CELL FREQ 10 9 12 13 11 8 6 11
CHISQP= 3.6000	P=0.17548	DEN=0.1081	IERR=0	CHISQL= 3.7941	P=0.19684	DEN=0.1119	IERR=0	CELL FREQ 13 9 11 11 12 6 10 8
CHISQP= 3.6000	P=0.17548	DEN=0.1081	IERR=0	CHISQL= 3.9185	P=0.21089	DEN=0.1140	IERR=0	CELL FREQ 11 10 11 11 12 6 12 7
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.4869	P=0.16339	DEN=0.1056	IERR=0	CELL FREQ 9 12 9 9 15 8 9 9
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.5499	P=0.17008	DEN=0.1070	IERR=0	CELL FREQ 10 11 15 10 10 8 8 8
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.5778	P=0.17309	DEN=0.1076	IERR=0	CELL FREQ 9 9 15 7 9 10 10 11
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.7094	P=0.18742	DEN=0.1103	IERR=0	CELL FREQ 11 11 12 8 14 8 8 8
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.7597	P=0.19300	DEN=0.1112	IERR=0	CELL FREQ 10 14 11 8 12 8 7 10
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.8060	P=0.19817	DEN=0.1121	IERR=0	CELL FREQ 13 7 8 11 11 9 8 13
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.8060	P=0.19817	DEN=0.1121	IERR=0	CELL FREQ 11 9 7 8 13 8 11 13
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.8283	P=0.20067	DEN=0.1125	IERR=0	CELL FREQ 11 9 14 11 11 7 7 10
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.8740	P=0.20583	DEN=0.1132	IERR=0	CELL FREQ 9 10 10 10 14 6 9 12
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.9203	P=0.21109	DEN=0.1140	IERR=0	CELL FREQ 6 13 9 9 10 9 11 13
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 3.9762	P=0.21748	DEN=0.1148	IERR=0	CELL FREQ 10 9 10 13 12 6 8 12
CHISQP= 3.8000	P=0.19750	DEN=0.1120	IERR=0	CHISQL= 4.1006	P=0.23188	DEN=0.1165	IERR=0	CELL FREQ 7 12 12 10 11 6 10 12

CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 3.8859	P=0.20718	DEN=0.1134	IERR=0	CELL FREQ	13	14	10	8	9	7	10	9
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 3.9881	P=0.21885	DEN=0.1150	IERR=0	CELL FREQ	13	12	10	8	13	7	8	9
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 3.9881	P=0.21885	DEN=0.1150	IERR=0	CELL FREQ	13	10	9	12	13	7	8	8
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.0103	P=0.22142	DEN=0.1153	IERR=0	CELL FREQ	10	7	12	14	11	10	9	7
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.0744	P=0.22883	DEN=0.1162	IERR=0	CELL FREQ	11	9	12	9	14	6	9	10
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.1125	P=0.23327	DEN=0.1167	IERR=0	CELL FREQ	8	13	7	11	7	10	12	12
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.1150	P=0.23355	DEN=0.1167	IERR=0	CELL FREQ	14	11	6	11	11	10	8	9
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.1150	P=0.23355	DEN=0.1167	IERR=0	CELL FREQ	11	10	6	8	14	11	11	9
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.1430	P=0.23684	DEN=0.1171	IERR=0	CELL FREQ	8	13	10	11	13	6	10	9
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.1430	P=0.23684	DEN=0.1171	IERR=0	CELL FREQ	6	13	9	10	13	8	11	10
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.1765	P=0.24076	DEN=0.1175	IERR=0	CELL FREQ	9	11	9	12	13	6	8	12
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.4660	P=0.27519	DEN=0.1202	IERR=0	CELL FREQ	13	10	9	11	10	10	12	5
CHISQP= 4.0000	P=0.22022	DEN=0.1152	IERR=0	CHISQL= 4.4842	P=0.27739	DEN=0.1203	IERR=0	CELL FREQ	11	11	11	13	9	5	11	9
CHISQP= 4.2000	P=0.24352	DEN=0.1177	IERR=0	CHISQL= 4.2107	P=0.24478	DEN=0.1179	IERR=0	CELL FREQ	7	11	9	11	14	7	12	9
CHISQP= 4.2000	P=0.24352	DEN=0.1177	IERR=0	CHISQL= 4.2970	P=0.25500	DEN=0.1188	IERR=0	CELL FREQ	11	14	8	6	10	9	10	12
CHISQP= 4.2000	P=0.24352	DEN=0.1177	IERR=0	CHISQL= 4.2970	P=0.25500	DEN=0.1188	IERR=0	CELL FREQ	10	14	9	8	11	6	10	12
CHISQP= 4.2000	P=0.24352	DEN=0.1177	IERR=0	CHISQL= 4.3433	P=0.26051	DEN=0.1192	IERR=0	CELL FREQ	8	13	11	6	9	9	13	11
CHISQP= 4.2000	P=0.24352	DEN=0.1177	IERR=0	CHISQL= 4.3992	P=0.26718	DEN=0.1197	IERR=0	CELL FREQ	8	13	10	6	12	8	12	11
CHISQP= 4.2000	P=0.24353	DEN=0.1177	IERR=0	CHISQL= 4.3992	P=0.26718	DEN=0.1197	IERR=0	CELL FREQ	8	10	12	8	11	6	12	13
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.2235	P=0.24630	DEN=0.1180	IERR=0	CELL FREQ	7	10	11	11	15	8	8	10
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.3593	P=0.26241	DEN=0.1193	IERR=0	CELL FREQ	13	10	9	14	7	7	10	10
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.3928	P=0.26641	DEN=0.1196	IERR=0	CELL FREQ	10	9	12	9	14	7	7	12
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.4334	P=0.27127	DEN=0.1199	IERR=0	CELL FREQ	12	11	14	11	10	8	7	7
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.4334	P=0.27127	DEN=0.1199	IERR=0	CELL FREQ	14	10	12	8	11	11	7	7
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.4949	P=0.27867	DEN=0.1204	IERR=0	CELL FREQ	12	12	7	9	13	7	12	8
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.5254	P=0.28235	DEN=0.1206	IERR=0	CELL FREQ	10	8	12	9	13	6	13	9
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.5660	P=0.28725	DEN=0.1208	IERR=0	CELL FREQ	13	8	8	11	13	6	10	11
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.5660	P=0.28725	DEN=0.1208	IERR=0	CELL FREQ	10	11	6	8	13	8	11	13
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.5660	P=0.28725	DEN=0.1208	IEPR=0	CELL FREQ	11	8	13	8	13	6	10	11
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.6498	P=0.29739	DEN=0.1213	IERR=0	CELL FREQ	12	9	12	7	13	10	11	6
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.6498	P=0.29739	DEN=0.1213	IERR=0	CELL FREQ	13	6	12	11	7	10	12	9
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.6498	P=0.29739	DEN=0.1213	IERR=0	CELL FREQ	13	10	7	12	11	6	12	9
CHISQP= 4.4000	P=0.26728	DEN=0.1197	IERR=0	CHISQL= 4.8789	P=0.32526	DEN=0.1220	IERR=0	CELL FREQ	12	11	6	11	12	6	11	11
CHISQP= 4.6000	P=0.29136	DEN=0.1210	IERR=0	CHISQL= 4.3833	P=0.26527	DEN=0.1195	IERR=0	CELL FREQ	9	9	8	11	7	9	12	15
CHISQP= 4.6000	P=0.29136	DEN=0.1210	IERR=0	CHISQL= 4.5596	P=0.28647	DEN=0.1208	IERR=0	CELL FREQ	10	7	9	9	13	7	11	14
CHISQP= 4.6000	P=0.29136	DEN=0.1210	IERR=0	CHISQL= 4.6236	P=0.29421	DEN=0.1211	IERR=0	CELL FREQ	14	9	11	9	13	6	9	9
CHISQP= 4.6000	P=0.29136	DEN=0.1210	IERR=0	CHISQL= 4.7704	P=0.31204	DEN=0.1217	IERR=0	CELL FREQ	14	12	10	6	11	7	10	10
CHISQP= 4.6000	P=0.29136	DEN=0.1210	IERR=0	CHISQL= 4.7662	P=0.31396	DEN=0.1218	IERR=0	CELL FREQ	11	12	7	7	11	12	13	7
CHISQP= 4.6000	P=0.29136	DEN=0.1210	IERR=0	CHISQL= 5.0609	P=0.34747	DEN=0.1220	IERR=0	CELL FREQ	6	11	6	11	10	12	12	12
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.3572	P=0.26216	DEN=0.1193	IERR=0	CELL FREQ	10	10	9	9	7	9	16	10
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.6059	P=0.29207	DEN=0.1210	IERR=0	CELL FREQ	15	10	7	8	11	9	12	8
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.6914	P=0.30243	DEN=0.1214	IERR=0	CELL FREQ	7	9	8	12	14	8	9	13
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.6914	P=0.30243	DEN=0.1214	IERR=0	CELL FREQ	9	14	8	12	13	8	9	7
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.7320	P=0.30736	DEN=0.1216	IERR=0	CELL FREQ	11	8	7	8	14	8	13	11
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.7823	P=0.31349	DEN=0.1217	IERR=0	CELL FREQ	10	10	14	11	7	7	8	13
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.8463	P=0.32129	DEN=0.1219	IERR=0	CELL FREQ	11	8	9	9	14	6	13	10
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.8463	P=0.32129	DEN=0.1219	IERR=0	CELL FREQ	6	9	14	11	9	8	13	10
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.8463	P=0.32129	DEN=0.1219	IERR=0	CELL FREQ	8	11	9	9	10	6	14	13
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.8463	P=0.32129	DEN=0.1219	IERR=0	CELL FREQ	8	11	10	13	14	6	9	9
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.8463	P=0.32129	DEN=0.1219	IERR=0	CELL FREQ	9	8	13	11	9	6	14	10
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.9021	P=0.32810	DEN=0.1220	IERR=0	CELL FREQ	14	10	10	8	12	6	8	12
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.9484	P=0.33374	DEN=0.1220	IERR=0	CELL FREQ	8	9	13	12	13	11	8	6
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.9484	P=0.33374	DEN=0.1220	IERR=0	CELL FREQ	8	13	8	13	11	6	9	12
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.9707	P=0.33646	DEN=0.1220	IERR=0	CELL FREQ	12	10	11	11	14	6	7	9
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 4.9707	P=0.33646	DEN=0.1220	IERR=0	CELL FREQ	6	11	12	14	11	10	7	9
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 5.1693	P=0.36069	DEN=0.1219	IERR=0	CELL FREQ	12	9	10	10	14	5	9	11
CHISQP= 4.8000	P=0.31564	DEN=0.1218	IERR=0	CHISQL= 5.2278	P=0.36781	DEN=0.1217	IERR=0	CELL FREQ	6	10	12	13	11	11	11	6
CHISQP= 4.8000	P=0.31565	DEN=0.1218	IERR=0	CHISQL= 4.7609	P=0.31088	DEN=0.1217	IERR=0	CELL FREQ	8	11	10	9	11	6	15	10
CHISQP= 4.8000	P=0.31565	DEN=0.1218	IERR=0	CHISQL= 5.2714	P=0.37312	DEN=0.1216	IERR=0	CELL FREQ	11	9	8	12	13	5	10	12
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 4.5295	P=0.28284	DEN=0.1206	IERR=0	CELL FREQ	10	8	10	8	16	8	11	9
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 4.8566	P=0.32254	DEN=0.1219	IERR=0	CELL FREQ	11	9	12	9	10	7	7	15
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 4.9430	P=0.33308	DEN=0.1220	IERR=0	CELL FREQ	12	10	9	8	15	6	10	10

CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 4.9612	P=0.33530	DEN=0.1220	IERR=0	CELL FREQ	11	9	11	6	15	9	8	11
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.1025	P=0.35254	DEN=0.1220	IERR=0	CELL FREQ	12	14	9	8	12	8	6	11
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.1528	P=0.35868	DEN=0.1219	IERR=0	CELL FREQ	10	12	12	10	14	9	7	6
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.1528	P=0.35868	DEN=0.1219	IERR=0	CELL FREQ	12	7	10	14	12	9	10	6
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.1528	P=0.35868	DEN=0.1219	IERR=0	CELL FREQ	9	10	12	6	14	7	12	10
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.1991	P=0.36432	DEN=0.1218	IERR=0	CELL FREQ	9	12	13	6	13	7	11	9
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.3920	P=0.38776	DEN=0.1212	IERR=0	CELL FREQ	10	5	8	12	14	10	10	11
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.3920	P=0.38776	DEN=0.1212	IERR=0	CELL FREQ	5	10	10	14	12	10	11	8
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.4099	P=0.38992	DEN=0.1211	IERR=0	CELL FREQ	12	12	10	6	13	11	6	10
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.4383	P=0.39336	DEN=0.1209	IERR=0	CELL FREQ	11	13	10	9	11	5	13	8
CHISQP= 5.0000	P=0.34004	DEN=0.1220	IERR=0	CHISQL= 5.5627	P=0.40837	DEN=0.1203	IERR=0	CELL FREQ	10	13	11	11	12	5	7	11
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.1266	P=0.35548	DEN=0.1219	IERR=0	CELL FREQ	9	9	14	10	14	9	6	9
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.1433	P=0.35752	DEN=0.1219	IERR=0	CELL FREQ	10	11	9	15	9	6	12	8
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.1433	P=0.35752	DEN=0.1219	IERR=0	CELL FREQ	15	10	6	11	12	9	9	8
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.2891	P=0.37527	DEN=0.1216	IERR=0	CELL FREQ	7	14	12	7	12	7	11	10
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.2891	P=0.37527	DEN=0.1216	IERR=0	CELL FREQ	7	7	7	12	14	11	10	12
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.3196	P=0.37898	DEN=0.1214	IERR=0	CELL FREQ	7	10	9	10	13	6	11	14
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.3937	P=0.38797	DEN=0.1211	IERR=0	CELL FREQ	8	12	11	14	11	6	7	11
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.4218	P=0.39137	DEN=0.1210	IERR=0	CELL FREQ	7	13	10	11	12	6	13	8
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.4218	P=0.39137	DEN=0.1210	IERR=0	CELL FREQ	13	8	10	13	12	6	7	11
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.5923	P=0.41192	DEN=0.1201	IERR=0	CELL FREQ	9	11	10	8	11	5	14	12
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.6102	P=0.41407	DEN=0.1200	IERR=0	CELL FREQ	12	11	11	12	13	6	9	6
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.6944	P=0.42415	DEN=0.1194	IERR=0	CELL FREQ	8	8	12	11	12	5	11	13
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 5.7448	P=0.43015	DEN=0.1190	IERR=0	CELL FREQ	13	12	10	11	12	5	10	7
CHISQP= 5.2000	P=0.36443	DEN=0.1218	IERR=0	CHISQL= 6.1640	P=0.47926	DEN=0.1151	IERR=0	CELL FREQ	11	4	11	10	12	9	10	13
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.0029	P=0.34039	DEN=0.1220	IERR=0	CELL FREQ	10	10	10	11	8	7	8	16
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.1552	P=0.35897	DEN=0.1219	IERR=0	CELL FREQ	8	11	9	8	13	7	9	15
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.3660	P=0.38460	DEN=0.1213	IERR=0	CELL FREQ	15	8	6	12	11	8	10	10
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.4559	P=0.39550	DEN=0.1209	IERR=0	CELL FREQ	13	10	11	11	14	7	7	7
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.4840	P=0.39889	DEN=0.1207	IERR=0	CELL FREQ	7	10	13	13	13	7	10	7
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.5175	P=0.40293	DEN=0.1205	IERR=0	CELL FREQ	13	9	7	7	12	7	13	12
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.5200	P=0.40322	DEN=0.1205	IERR=0	CELL FREQ	9	13	11	9	11	7	14	6
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.5535	P=0.40727	DEN=0.1203	IERR=0	CELL FREQ	6	8	12	12	13	8	8	13
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.5758	P=0.40994	DEN=0.1202	IERR=0	CELL FREQ	10	12	12	7	11	6	14	8
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.7185	P=0.42703	DEN=0.1192	IERR=0	CELL FREQ	9	13	11	9	14	5	10	9
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.7185	P=0.42703	DEN=0.1192	IERR=0	CELL FREQ	10	11	9	9	14	5	9	13
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.8207	P=0.43916	DEN=0.1184	IERR=0	CELL FREQ	5	11	12	9	13	9	8	13
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 5.8835	P=0.44659	DEN=0.1178	IERR=0	CELL FREQ	11	14	7	11	11	5	11	10
CHISQP= 5.4000	P=0.38873	DEN=0.1211	IERR=0	CHISQL= 6.3461	P=0.50003	DEN=0.1130	IERR=0	CELL FREQ	12	10	13	12	10	4	9	10
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.2032	P=0.36482	DEN=0.1218	IERR=0	CELL FREQ	8	8	11	7	16	9	10	11
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.5663	P=0.40880	DEN=0.1202	IERR=0	CELL FREQ	11	9	6	15	11	8	8	12
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.5719	P=0.40948	DEN=0.1202	IERR=0	CELL FREQ	8	10	14	10	14	8	6	10
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.5877	P=0.41137	DEN=0.1201	IERR=0	CELL FREQ	7	13	12	8	14	7	8	11
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.5877	P=0.41137	DEN=0.1201	IERR=0	CELL FREQ	8	11	8	7	14	7	13	12
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.6166	P=0.41484	DEN=0.1199	IERR=0	CELL FREQ	11	12	10	10	15	6	7	9
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.6380	P=0.41741	DEN=0.1198	IERR=0	CELL FREQ	12	10	14	7	10	7	7	13
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.7020	P=0.42506	DEN=0.1193	IERR=0	CELL FREQ	6	7	10	12	14	9	9	13
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.7020	P=0.42506	DEN=0.1193	IERR=0	CELL FREQ	6	9	12	10	14	7	9	13
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.7020	P=0.42506	DEN=0.1193	IERR=0	CELL FREQ	9	7	14	9	12	10	6	13
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.7707	P=0.43324	DEN=0.1188	IERR=0	CELL FREQ	10	6	13	10	13	8	13	7
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 5.9747	P=0.45729	DEN=0.1170	IERR=0	CELL FREQ	11	12	9	12	14	8	5	9
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 6.0434	P=0.46531	DEN=0.1163	IERR=0	CELL FREQ	8	8	12	11	13	5	13	10
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 6.0434	P=0.46531	DEN=0.1163	IERR=0	CELL FREQ	11	13	12	5	8	10	8	13
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 6.1272	P=0.47502	DEN=0.1155	IERR=0	CELL FREQ	13	7	10	12	12	5	9	12
CHISQP= 5.6000	P=0.41285	DEN=0.1200	IERR=0	CHISQL= 6.6022	P=0.52856	DEN=0.1097	IERR=0	CELL FREQ	12	12	10	12	8	4	10	12
CHISQP= 5.8000	P=0.43671	DEN=0.1186	IERR=0	CHISQL= 5.3853	P=0.38695	DEN=0.1212	IERR=0	CELL FREQ	9	8	7	10	16	8	12	10
CHISQP= 5.8000	P=0.43671	DEN=0.1186	IERR=0	CHISQL= 5.3853	P=0.38695	DEN=0.1212	IERR=0	CELL FREQ	8	10	10	8	16	7	9	12
CHISQP= 5.8000	P=0.43671	DEN=0.1186	IERR=0	CHISQL= 5.4355	P=0.39302	DEN=0.1210	IERR=0	CELL FREQ	9	9	9	9	14	8	7	15
CHISQP= 5.8000	P=0.43671	DEN=0.1186	IERR=0	CHISQL= 5.6285	P=0.41627	DEN=0.1198	IERR=0	CELL FREQ	9	7	10	15	13	7	11	8
CHISQP= 5.8000	P=0.43671	DEN=0.1186	IERR=0	CHISQL= 5.7484	P=0.43058	DEN=0.1190	IERR=0	CELL FREQ	8	9	12	10	12	8	6	15
CHISQP= 5.8000	P=0.43671	DEN=0.1186	IERR=0	CHISQL= 5.7722	P=0.43342	DEN=0.1188	IERR=0	CELL FREQ	14	6	8	8	9	10	14	11
CHISQP= 5.8000	P=0.43671	DEN=0.1186	IERR=0	CHISQL= 5.8170	P=0.43872	DEN=0.1184	IERR=0	CELL FREQ	9	11	6	12	11	9	7	15

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CHISQP= 5.8000  P=0.43671  DEN=0.1186  IERR=0  CHISQL= 5.9710  P=0.45686  DEN=0.1170  IERR=0  CELL FREQ 13 11  6  7 13  8  9 13
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CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 5.6581  P=0.41982  DEN=0.1196  IERR=0  CELL FREQ 10  9 15  7 14  8  8  9
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CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 5.9366  P=0.45283  DEN=0.1174  IERR=0  CELL FREQ  7  8 13 14 13  8  7 10
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 5.9366  P=0.45283  DEN=0.1174  IERR=0  CELL FREQ  8  8 13  7 10  7 13 14
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 5.9656  P=0.45622  DEN=0.1171  IERR=0  CELL FREQ  6 15 10 10  9  7 10 13
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 5.9656  P=0.45622  DEN=0.1171  IERR=0  CELL FREQ 10 13  7 10 15  6  9 10
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 6.1250  P=0.47477  DEN=0.1155  IERR=0  CELL FREQ 14 13  7 11 12  6  8  9
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 6.2215  P=0.48586  DEN=0.1144  IERR=0  CELL FREQ  9  9 14 10 14  9 10  5
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 6.2382  P=0.48777  DEN=0.1143  IERR=0  CELL FREQ 11 10  5 10 12  9  8 15
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 6.2382  P=0.48777  DEN=0.1143  IERR=0  CELL FREQ 11  9 10  8 10  5 15 12
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 6.2495  P=0.48906  DEN=0.1141  IERR=0  CELL FREQ  7 12  7 12 14  6 11 11
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 6.3821  P=0.50410  DEN=0.1126  IERR=0  CELL FREQ  6 11 11 13 13  8 12  6
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 6.4146  P=0.50774  DEN=0.1122  IERR=0  CELL FREQ 10  7 10 13 14  5 10 11
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 6.4480  P=0.51149  DEN=0.1117  IERR=0  CELL FREQ 14  7 11 10 12  5  9 12
CHISQP= 6.0000  P=0.46025  DEN=0.1168  IERR=0  CHISQL= 6.5502  P=0.52284  DEN=0.1104  IERR=0  CELL FREQ 12 12  7  8 12  5 13 11
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CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 5.8083  P=0.43770  DEN=0.1185  IERR=0  CELL FREQ  8  7  8 12 11  8 10 16
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.0109  P=0.46153  DEN=0.1167  IERR=0  CELL FREQ  9  8 12  7 15  7  9 13
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.0109  P=0.46153  DEN=0.1167  IERR=0  CELL FREQ  7 13 15  9 12  7  9  8
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.1354  P=0.47596  DEN=0.1154  IERR=0  CELL FREQ 12  7 15 11 12  7  9  7
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.1714  P=0.48011  DEN=0.1150  IERR=0  CELL FREQ  8 12 15 12 11  8  6  8
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.2217  P=0.48589  DEN=0.1144  IERR=0  CELL FREQ 10 12  8 10  6  7 15 12
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.4315  P=0.50964  DEN=0.1119  IERR=0  CELL FREQ  6 12  7 14 12 10  7 12
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.4385  P=0.51043  DEN=0.1119  IERR=0  CELL FREQ  9  9 11 12  8  5 15 11
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.5463  P=0.52241  DEN=0.1105  IERR=0  CELL FREQ  5 10 13 10 12  8  8 14
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.5926  P=0.52751  DEN=0.1099  IERR=0  CELL FREQ 13  9 13 11 13  5  8  8
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 6.7170  P=0.54107  DEN=0.1082  IERR=0  CELL FREQ 11  8 13  7 13  5 12 11
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 7.0899  P=0.58042  DEN=0.1028  IERR=0  CELL FREQ 10 14 11  8 12  4 10 11
CHISQP= 6.2000  P=0.48340  DEN=0.1147  IERR=0  CHISQL= 7.1515  P=0.58672  DEN=0.1018  IERR=0  CELL FREQ  9 10 12  4 12  8 13 12
CHISQP= 6.4000  P=0.50610  DEN=0.1123  IERR=0  CHISQL= 6.1635  P=0.47921  DEN=0.1151  IERR=0  CELL FREQ  6  8 11  9 11  8 16 11
CHISQP= 6.4000  P=0.50610  DEN=0.1123  IERR=0  CHISQL= 6.4459  P=0.51125  DEN=0.1118  IERR=0  CELL FREQ 11  6  8  7 14  9 14 11
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 5.9345  P=0.45259  DEN=0.1174  IERR=0  CELL FREQ  9 10  8  9  8  7 16 13
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 6.2139  P=0.48499  DEN=0.1145  IERR=0  CELL FREQ  7 16 11 10 10  6  9 11
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 6.3773  P=0.50356  DEN=0.1126  IERR=0  CELL FREQ  8  8 10  8 14  6 12 14
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 6.4220  P=0.50858  DEN=0.1121  IERR=0  CELL FREQ  6  9 11  8 15  7 12 12
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 6.4740  P=0.51438  DEN=0.1114  IERR=0  CELL FREQ 10  6  9 13 14  8  7 13
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 6.5984  P=0.52814  DEN=0.1098  IERR=0  CELL FREQ 14 12 13 11 10  6  7  7
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 6.6206  P=0.53058  DEN=0.1095  IERR=0  CELL FREQ  8 15 12 10 12  5  9  9
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 6.6612  P=0.53502  DEN=0.1090  IERR=0  CELL FREQ 11  5 11 10 15  8  8 12
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 6.7182  P=0.54121  DEN=0.1082  IERR=0  CELL FREQ  8 12  6 12 10  6 14 12
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 6.7970  P=0.54968  DEN=0.1071  IERR=0  CELL FREQ 10 14  5 10  9  7 13 12
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 7.0260  P=0.57382  DEN=0.1037  IERR=0  CELL FREQ  6 10 11 12 11  5 14 11
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 7.3183  P=0.60349  DEN=0.0992  IERR=0  CELL FREQ 11 13 10 13 12  4  9  8
CHISQP= 6.4000  P=0.50611  DEN=0.1123  IERR=0  CHISQL= 7.4427  P=0.61572  DEN=0.0973  IERR=0  CELL FREQ  7 11 11 12 13  4 10 12
CHISQP= 6.6000  P=0.52832  DEN=0.1098  IERR=0  CHISQL= 5.8849  P=0.44675  DEN=0.1178  IERR=0  CELL FREQ 11  8 17 10  9  9  7  9
CHISQP= 6.6000  P=0.52832  DEN=0.1098  IERR=0  CHISQL= 6.1572  P=0.47848  DEN=0.1151  IERR=0  CELL FREQ  7  8 10  8 16  8 13 10
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CHISQP= 6.6000  P=0.52832  DEN=0.1098  IERR=0  CHISQL= 6.3318  P=0.49842  DEN=0.1132  IERR=0  CELL FREQ 14 11  7  9 15  7  8  9
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CHISQP= 6.6000  P=0.52832  DEN=0.1098  IERR=0  CHISQL= 6.7829  P=0.54817  DEN=0.1073  IERR=0  CELL FREQ 10 14  9 10  6  6 14 11
CHISQP= 6.6000  P=0.52832  DEN=0.1098  IERR=0  CHISQL= 6.7829  P=0.54817  DEN=0.1073  IERR=0  CELL FREQ 11 10 10  9 14  6  6 14
CHISQP= 6.6000  P=0.52832  DEN=0.1098  IERR=0  CHISQL= 6.7875  P=0.54866  DEN=0.1072  IERR=0  CELL FREQ  5  9 13 10 15  8  9 11
CHISQP= 6.6000  P=0.52832  DEN=0.1098  IERR=0  CHISQL= 6.8729  P=0.55777  DEN=0.1060  IERR=0  CELL FREQ  9 14 13  8  5  9 13  9
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CHISQP= 6.6000	P=0.52832	DEN=0.1098	IERR=0	CHISQL= 6.8851	P=0.55906	DEN=0.1058	IERR=0	CELL	FREQ	6	12	14	10	13	11	6	8
CHISQP= 6.6000	P=0.52832	DEN=0.1098	IERR=0	CHISQL= 6.9973	P=0.57084	DEN=0.1042	IERR=0	CELL	FREQ	13	7	11	12	14	5	9	9
CHISQP= 6.6000	P=0.52832	DEN=0.1098	IERR=0	CHISQL= 7.4389	P=0.61534	DEN=0.0973	IERR=0	CELL	FREQ	14	11	8	10	10	4	13	10
CHISQP= 6.6000	P=0.52832	DEN=0.1098	IERR=0	CHISQL= 7.4723	P=0.61859	DEN=0.0968	IERR=0	CELL	FREQ	11	9	12	10	14	4	8	12
CHISQP= 6.6000	P=0.52832	DEN=0.1098	IERR=0	CHISQL= 7.6248	P=0.63316	DEN=0.0943	IERR=0	CELL	FREQ	12	12	7	10	12	4	13	10
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 6.1076	P=0.47276	DEN=0.1157	IERR=0	CELL	FREQ	9	10	10	8	17	7	11	8
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 6.5963	P=0.52791	DEN=0.1098	IERR=0	CELL	FREQ	7	9	12	6	10	9	11	16
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 6.5963	P=0.52791	DEN=0.1098	IERR=0	CELL	FREQ	12	9	10	16	9	6	11	7
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 6.6369	P=0.53236	DEN=0.1093	IERR=0	CELL	FREQ	8	11	11	6	16	7	10	11
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 6.7710	P=0.54689	DEN=0.1074	IERR=0	CELL	FREQ	8	15	10	7	9	6	13	12
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 6.7710	P=0.54689	DEN=0.1074	IERR=0	CELL	FREQ	6	9	12	8	15	7	13	10
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 6.7710	P=0.54689	DEN=0.1074	IERR=0	CELL	FREQ	12	15	7	9	13	6	10	8
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 6.8355	P=0.55379	DEN=0.1065	IERR=0	CELL	FREQ	9	11	10	10	16	8	5	11
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 6.9192	P=0.56266	DEN=0.1053	IERR=0	CELL	FREQ	6	7	11	14	11	7	10	14
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 7.0102	P=0.57218	DEN=0.1040	IERR=0	CELL	FREQ	11	10	13	8	8	5	15	10
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 7.4365	P=0.61511	DEN=0.0974	IERR=0	CELL	FREQ	6	13	12	13	12	5	10	9
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 7.5538	P=0.62642	DEN=0.0955	IERR=0	CELL	FREQ	11	8	10	10	11	4	11	15
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 7.5538	P=0.62642	DEN=0.0955	IERR=0	CELL	FREQ	10	10	15	8	11	4	11	11
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 7.7007	P=0.64028	DEN=0.0931	IERR=0	CELL	FREQ	9	13	9	12	13	4	12	8
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 7.7007	P=0.64028	DEN=0.0931	IERR=0	CELL	FREQ	12	8	9	13	13	4	12	9
CHISQP= 6.8000	P=0.55000	DEN=0.1070	IERR=0	CHISQL= 7.7007	P=0.64028	DEN=0.0931	IERR=0	CELL	FREQ	13	8	9	12	12	4	9	13
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 6.6946	P=0.53864	DEN=0.1085	IERR=0	CELL	FREQ	8	13	10	8	16	9	10	6
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 6.8412	P=0.55440	DEN=0.1064	IERR=0	CELL	FREQ	8	8	8	15	11	10	6	14
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.0510	P=0.57641	DEN=0.1034	IERR=0	CELL	FREQ	12	11	8	7	14	6	8	14
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.0677	P=0.57814	DEN=0.1031	IERR=0	CELL	FREQ	15	14	9	9	9	9	5	10
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.1013	P=0.58159	DEN=0.1026	IERR=0	CELL	FREQ	10	14	14	10	12	7	6	7
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.1013	P=0.58159	DEN=0.1026	IERR=0	CELL	FREQ	12	10	14	10	14	6	7	7
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.1653	P=0.58813	DEN=0.1016	IERR=0	CELL	FREQ	9	9	14	10	14	6	12	6
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.1699	P=0.58859	DEN=0.1015	IERR=0	CELL	FREQ	9	9	8	9	15	5	13	12
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.2105	P=0.59270	DEN=0.1009	IERR=0	CELL	FREQ	8	11	13	9	15	5	11	8
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.2608	P=0.59776	DEN=0.1001	IERR=0	CELL	FREQ	13	10	7	9	15	5	10	11
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.2675	P=0.59843	DEN=0.1000	IERR=0	CELL	FREQ	12	6	8	6	14	13	12	9
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.7191	P=0.64199	DEN=0.0928	IERR=0	CELL	FREQ	10	9	10	9	14	4	10	14
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.7359	P=0.64354	DEN=0.0925	IERR=0	CELL	FREQ	12	15	10	11	8	4	10	10
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.8213	P=0.65138	DEN=0.0911	IERR=0	CELL	FREQ	10	13	10	9	14	12	8	4
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.8213	P=0.65138	DEN=0.0911	IERR=0	CELL	FREQ	12	14	8	10	13	4	9	10
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.8953	P=0.65809	DEN=0.0899	IERR=0	CELL	FREQ	12	8	11	12	11	4	8	14
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 7.9920	P=0.66670	DEN=0.0883	IERR=0	CELL	FREQ	11	11	13	9	13	4	12	7
CHISQP= 7.0000	P=0.57112	DEN=0.1041	IERR=0	CHISQL= 8.7162	P=0.72632	DEN=0.0764	IERR=0	CELL	FREQ	11	9	13	10	13	3	11	10
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 6.5306	P=0.52067	DEN=0.1107	IERR=0	CELL	FREQ	10	11	8	7	17	8	8	11
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 6.5306	P=0.52067	DEN=0.1107	IERR=0	CELL	FREQ	8	8	11	10	17	7	8	11
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 6.5586	P=0.52376	DEN=0.1103	IERR=0	CELL	FREQ	9	11	7	11	17	7	9	9
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 6.8949	P=0.56009	DEN=0.1057	IERR=0	CELL	FREQ	11	9	9	8	16	6	8	13
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 6.8949	P=0.56009	DEN=0.1057	IERR=0	CELL	FREQ	8	6	9	13	16	8	9	11
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 6.8949	P=0.56009	DEN=0.1057	IERR=0	CELL	FREQ	8	8	11	9	16	6	9	13
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.0193	P=0.57313	DEN=0.1038	IERR=0	CELL	FREQ	12	11	8	9	16	7	6	11
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.0335	P=0.57460	DEN=0.1036	IERR=0	CELL	FREQ	7	7	13	9	15	9	7	13
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.0918	P=0.58062	DEN=0.1027	IERR=0	CELL	FREQ	10	11	6	8	15	9	14	7
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.0918	P=0.58062	DEN=0.1027	IERR=0	CELL	FREQ	8	14	11	9	15	7	10	6
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.0918	P=0.58062	DEN=0.1027	IERR=0	CELL	FREQ	8	9	10	7	15	6	11	14
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.1940	P=0.59103	DEN=0.1012	IERR=0	CELL	FREQ	12	6	8	7	15	8	13	11
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.2179	P=0.59345	DEN=0.1008	IERR=0	CELL	FREQ	9	10	12	9	16	5	8	11
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.2443	P=0.59611	DEN=0.1004	IERR=0	CELL	FREQ	13	7	10	12	7	6	10	15
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.3880	P=0.61037	DEN=0.0981	IERR=0	CELL	FREQ	10	10	12	6	14	8	6	14
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.4343	P=0.61490	DEN=0.0974	IERR=0	CELL	FREQ	13	13	6	8	14	6	9	11
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.5002	P=0.62129	DEN=0.0963	IERR=0	CELL	FREQ	14	14	7	9	12	9	5	10
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.6024	P=0.63104	DEN=0.0947	IERR=0	CELL	FREQ	7	14	9	13	12	5	12	8
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 7.8621	P=0.65509	DEN=0.0905	IERR=0	CELL	FREQ	10	9	13	10	15	4	9	10
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 8.0216	P=0.66931	DEN=0.0878	IERR=0	CELL	FREQ	8	9	11	12	14	4	13	9
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 8.0216	P=0.66931	DEN=0.0878	IERR=0	CELL	FREQ	9	14	13	8	11	4	12	9
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 8.1460	P=0.68010	DEN=0.0858	IERR=0	CELL	FREQ	7	14	11	12	12	4	11	9
CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 8.1460	P=0.68010	DEN=0.0858	IERR=0	CELL	FREQ	11	11	7	12	14	4	9	12

CHISQP= 7.2000	P=0.59164	DEN=0.1011	IERR=0	CHISQL= 8.1460	P=0.68010	DEN=0.0858	IERR=0	CELL FREQ	7	9	12	14	11	4	11	12
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 7.3999	P=0.61154	DEN=0.0980	IERR=0	CELL FREQ	13	7	10	6	14	8	14	8
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 7.4446	P=0.61590	DEN=0.0972	IERR=0	CELL FREQ	13	7	11	6	15	7	12	9
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 7.4446	P=0.61590	DEN=0.0972	IERR=0	CELL FREQ	6	12	11	7	15	7	9	13
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 7.6432	P=0.63490	DEN=0.0940	IERR=0	CELL FREQ	13	7	12	9	15	10	9	5
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 7.7692	P=0.64662	DEN=0.0920	IERR=0	CELL FREQ	13	8	9	7	14	5	13	11
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 7.8779	P=0.65651	DEN=0.0902	IERR=0	CELL FREQ	6	5	10	10	14	14	10	11
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 8.0263	P=0.66972	DEN=0.0877	IERR=0	CELL FREQ	13	11	13	8	11	6	5	13
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 6.1183	P=0.67772	DEN=0.0862	IERR=0	CELL FREQ	15	8	9	10	12	4	10	12
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 8.1421	P=0.67977	DEN=0.0858	IERR=0	CELL FREQ	8	11	14	9	10	4	14	10
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 8.3409	P=0.69651	DEN=0.0825	IERR=0	CELL FREQ	13	11	7	10	13	4	13	9
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 9.0986	P=0.75435	DEN=0.0702	IERR=0	CELL FREQ	11	9	13	10	12	3	9	13
CHISQP= 7.4000	P=0.61155	DEN=0.0980	IERR=0	CHISQL= 9.1545	P=0.75824	DEN=0.0693	IERR=0	CELL FREQ	8	12	10	12	10	3	13	12
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 6.9130	P=0.56201	DEN=0.1054	IERR=0	CELL FREQ	17	11	8	8	8	7	12	9
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.0680	P=0.57816	DEN=0.1031	IERR=0	CELL FREQ	10	8	17	11	8	6	11	9
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.4742	P=0.61878	DEN=0.0968	IERR=0	CELL FREQ	8	15	9	7	14	6	12	9
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.4926	P=0.62055	DEN=0.0965	IERR=0	CELL FREQ	12	16	10	11	11	6	7	7
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.4926	P=0.62055	DEN=0.0965	IERR=0	CELL FREQ	6	7	7	11	16	10	11	12
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.6201	P=0.63272	DEN=0.0944	IERR=0	CELL FREQ	12	7	7	14	14	7	7	12
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.6409	P=0.63468	DEN=0.0941	IERR=0	CELL FREQ	11	9	11	8	16	5	8	12
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.6409	P=0.63468	DEN=0.0941	IERR=0	CELL FREQ	11	12	8	11	16	5	9	8
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.6506	P=0.63559	DEN=0.0939	IERR=0	CELL FREQ	7	13	7	10	14	6	9	14
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.7527	P=0.64510	DEN=0.0923	IERR=0	CELL FREQ	13	7	7	8	12	6	13	14
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.8659	P=0.65543	DEN=0.0904	IERR=0	CELL FREQ	8	15	10	5	13	7	12	10
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.9077	P=0.65919	DEN=0.0897	IERR=0	CELL FREQ	7	14	13	6	10	6	13	11
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 7.9232	P=0.66059	DEN=0.0894	IERR=0	CELL FREQ	9	5	8	11	12	7	14	14
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 8.0757	P=0.67404	DEN=0.0869	IERR=0	CELL FREQ	12	7	10	7	14	5	13	12
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 8.3592	P=0.69801	DEN=0.0822	IERR=0	CELL FREQ	8	12	8	11	11	4	11	15
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 8.4095	P=0.70213	DEN=0.0814	IERR=0	CELL FREQ	10	10	11	7	15	4	12	11
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 8.4949	P=0.70902	DEN=0.0800	IERR=0	CELL FREQ	13	9	14	11	7	4	12	10
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 8.5649	P=0.71458	DEN=0.0788	IERR=0	CELL FREQ	12	12	12	5	13	5	12	9
CHISQP= 7.6000	P=0.63082	DEN=0.0947	IERR=0	CHISQL= 9.2526	P=0.76498	DEN=0.0678	IERR=0	CELL FREQ	9	12	9	14	12	3	11	10
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 7.2546	P=0.59714	DEN=0.1002	IERR=0	CELL FREQ	17	10	7	11	11	7	7	10
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 7.4007	P=0.61162	DEN=0.0979	IEPR=0	CELL FREQ	11	8	8	7	15	9	15	7
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 7.6244	P=0.63312	DEN=0.0943	IERR=0	CELL FREQ	7	6	11	12	16	8	8	12
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 7.6969	P=0.63992	DEN=0.0932	IERR=0	CELL FREQ	8	14	6	12	15	10	8	7
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 7.6969	P=0.63992	DEN=0.0932	IERR=0	CELL FREQ	8	14	15	12	10	7	6	8
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 7.7053	P=0.64070	DEN=0.0930	IERR=0	CELL FREQ	9	10	10	13	16	6	6	10
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 7.9068	P=0.65911	DEN=0.0897	IERR=0	CELL FREQ	12	8	6	14	12	7	14	7
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 7.9641	P=0.66423	DEN=0.0888	IERR=0	CELL FREQ	5	14	7	15	11	10	9	9
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 8.3066	P=0.69366	DEN=0.0831	IERR=0	CELL FREQ	9	5	13	9	13	11	14	6
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 8.3331	P=0.69586	DEN=0.0827	IERR=0	CELL FREQ	16	10	10	11	10	4	8	11
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 8.3624	P=0.69828	DEN=0.0822	IERR=0	CELL FREQ	10	6	12	8	14	5	12	13
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 8.5413	P=0.71271	DEN=0.0792	IERR=0	CELL FREQ	8	12	11	8	15	4	12	10
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 8.6098	P=0.71811	DEN=0.0781	IERR=0	CELL FREQ	7	11	11	11	15	4	9	12
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 8.9060	P=0.74053	DEN=0.0733	IERR=0	CELL FREQ	11	14	12	10	4	6	11	12
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 8.9676	P=0.74501	DEN=0.0723	IERR=0	CELL FREQ	9	12	12	13	12	6	12	4
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 9.4753	P=0.77969	DEN=0.0644	IERR=0	CELL FREQ	10	8	11	12	12	3	10	14
CHISQP= 7.8000	P=0.64944	DEN=0.0915	IERR=0	CHISQL= 9.4753	P=0.77969	DEN=0.0644	IERR=0	CELL FREQ	10	12	10	12	14	3	8	11
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.4504	P=0.61646	DEN=0.0971	IERR=0	CELL FREQ	12	11	8	17	9	6	9	8
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.4910	P=0.62039	DEN=0.0965	IERR=0	CELL FREQ	8	11	11	17	8	6	8	11
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.5007	P=0.62133	DEN=0.0963	IERR=0	CELL FREQ	17	10	10	9	9	6	12	7
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.5341	P=0.62454	DEN=0.0958	IERR=0	CELL FREQ	8	7	14	7	11	8	16	9
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.6866	P=0.63896	DEN=0.0933	IERR=0	CELL FREQ	7	7	13	16	12	8	7	10
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.6874	P=0.63904	DEN=0.0933	IERR=0	CELL FREQ	11	15	9	6	15	8	8	8
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.7088	P=0.64103	DEN=0.0930	IERR=0	CELL FREQ	7	13	8	8	15	7	8	14
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.7088	P=0.64103	DEN=0.0930	IERR=0	CELL FREQ	14	13	8	8	15	7	7	8
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.7378	P=0.64371	DEN=0.0925	IERR=0	CELL FREQ	15	9	10	8	15	7	10	6
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 7.7399	P=0.64391	DEN=0.0925	IERR=0	CELL FREQ	10	8	11	10	17	9	10	5
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.0522	P=0.67199	DEN=0.0873	IERR=0	CELL FREQ	6	11	6	8	14	9	15	11
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.0958	P=0.67578	DEN=0.0866	IERR=0	CELL FREQ	14	15	9	12	8	8	9	5
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.1142	P=0.67737	DEN=0.0863	IERR=0	CELL FREQ	11	10	7	11	16	8	12	5

CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.2047	P=0.68511	DEN=0.0848	IERR=0	CELL FREQ	7	11	10	13	12	6	6	15
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.2047	P=0.68511	DEN=0.0848	IERR=0	CELL FREQ	12	11	6	13	15	6	7	10
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.3575	P=0.69787	DEN=0.0823	IERR=0	CELL FREQ	11	7	11	11	15	7	5	13
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.3743	P=0.69925	DEN=0.0820	IERR=0	CELL FREQ	14	7	8	13	12	5	8	13
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.4032	P=0.70162	DEN=0.0815	IERR=0	CELL FREQ	9	15	13	10	12	5	10	6
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.5293	P=0.71176	DEN=0.0794	IERR=0	CELL FREQ	10	13	8	11	14	6	13	5
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.5654	P=0.71462	DEN=0.0788	IERR=0	CELL FREQ	9	10	15	10	14	4	9	9
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.5654	P=0.71462	DEN=0.0788	IERR=0	CELL FREQ	10	9	9	15	14	4	10	9
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 8.9179	P=0.74140	DEN=0.0731	IERR=0	CELL FREQ	12	14	7	8	13	4	11	11
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 9.1344	P=0.75685	DEN=0.0697	IERR=0	CELL FREQ	12	9	6	13	11	4	12	13
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 9.6016	P=0.78770	DEN=0.0625	IERR=0	CELL FREQ	10	14	9	13	10	3	9	12
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 9.6422	P=0.79022	DEN=0.0619	IERR=0	CELL FREQ	14	8	11	10	11	3	13	10
CHISQP= 8.0000	P=0.66741	DEN=0.0882	IERR=0	CHISQL= 9.6702	P=0.79196	DEN=0.0615	IERR=0	CELL FREQ	10	10	10	8	13	3	13	13
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 7.6370	P=0.63432	DEN=0.0941	IERR=0	CELL FREQ	7	7	11	10	17	7	12	9
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 7.7234	P=0.64239	DEN=0.0927	IERR=0	CELL FREQ	8	7	10	12	10	6	10	17
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 7.7416	P=0.64407	DEN=0.0924	IERR=0	CELL FREQ	11	7	17	9	11	8	11	6
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 7.9402	P=0.66211	DEN=0.0892	IERR=0	CELL FREQ	17	11	10	9	11	9	8	5
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 8.4152	P=0.70259	DEN=0.0813	IERR=0	CELL FREQ	9	13	10	5	15	7	8	13
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 8.4152	P=0.70259	DEN=0.0813	IERR=0	CELL FREQ	8	9	13	15	13	7	10	5
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 8.6833	P=0.72380	DEN=0.0769	IERR=0	CELL FREQ	12	10	6	5	14	11	14	8
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 8.7155	P=0.72627	DEN=0.0764	IERR=0	CELL FREQ	12	8	11	10	16	4	10	9
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 8.7155	P=0.72627	DEN=0.0764	IERR=0	CELL FREQ	12	16	9	11	10	4	8	10
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 8.7577	P=0.72947	DEN=0.0757	IERR=0	CELL FREQ	13	13	13	9	13	5	8	6
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 8.9588	P=0.74437	DEN=0.0725	IERR=0	CELL FREQ	4	15	11	13	7	11	9	10
CHISQP= 8.2000	P=0.68471	DEN=0.0849	IERR=0	CHISQL= 9.0442	P=0.75050	DEN=0.0711	IERR=0	CELL FREQ	4	14	9	13	11	7	9	13
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 7.7993	P=0.64938	DEN=0.0915	IERR=0	CELL FREQ	13	6	8	9	17	9	10	8
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 7.7993	P=0.64938	DEN=0.0915	IERR=0	CELL FREQ	8	8	10	13	17	6	9	9
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 7.9237	P=0.66063	DEN=0.0894	IERR=0	CELL FREQ	12	8	10	11	17	6	7	9
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 8.0787	P=0.67429	DEN=0.0869	IERR=0	CELL FREQ	11	10	10	6	17	6	11	9
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 8.2240	P=0.68674	DEN=0.0845	IERR=0	CELL FREQ	10	13	16	9	12	7	7	6
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 8.4966	P=0.70916	DEN=0.0800	IERR=0	CELL FREQ	5	7	12	11	16	9	12	8
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 8.5692	P=0.71492	DEN=0.0788	IERR=0	CELL FREQ	7	10	15	9	12	5	14	8
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 8.6109	P=0.71819	DEN=0.0781	IERR=0	CELL FREQ	13	9	11	7	14	6	6	14
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 8.6516	P=0.72135	DEN=0.0774	IERR=0	CELL FREQ	11	10	12	9	16	11	5	6
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 8.8263	P=0.73463	DEN=0.0746	IERR=0	CELL FREQ	8	15	11	6	12	5	13	10
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 8.8263	P=0.73463	DEN=0.0746	IERR=0	CELL FREQ	6	15	8	12	11	5	13	10
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 9.0361	P=0.74992	DEN=0.0712	IERR=0	CELL FREQ	12	12	7	6	14	5	11	13
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 9.0905	P=0.75378	DEN=0.0704	IERR=0	CELL FREQ	13	12	9	11	15	4	8	8
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 9.0905	P=0.75378	DEN=0.0704	IERR=0	CELL FREQ	8	9	8	4	12	11	13	15
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 9.0905	P=0.75378	DEN=0.0704	IERR=0	CELL FREQ	8	9	13	8	15	4	12	11
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 9.1982	P=0.76126	DEN=0.0687	IERR=0	CELL FREQ	9	9	14	11	12	4	7	14
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 9.2347	P=0.76376	DEN=0.0681	IERR=0	CELL FREQ	14	12	5	13	12	5	9	10
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 9.2669	P=0.76594	DEN=0.0676	IERR=0	CELL FREQ	8	11	13	10	7	4	14	13
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 9.3368	P=0.77063	DEN=0.0665	IERR=0	CELL FREQ	5	13	5	12	12	8	13	12
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL= 9.9392	P=0.80795	DEN=0.0575	IERR=0	CELL FREQ	11	12	10	11	15	3	10	8
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL=10.2105	P=0.82305	DEN=0.0537	IERR=0	CELL FREQ	12	12	12	13	12	3	9	7
CHISQP= 8.4000	P=0.70135	DEN=0.0816	IERR=0	CHISQL=11.3707	P=0.87675	DEN=0.0394	IERR=0	CELL FREQ	14	11	11	11	11	2	10	10
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 7.5528	P=0.62633	DEN=0.0955	IERR=0	CELL FREQ	11	7	8	10	18	8	10	8
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 7.9356	P=0.66170	DEN=0.0892	IERR=0	CELL FREQ	8	13	8	7	17	11	7	9
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.4114	P=0.70228	DEN=0.0814	IERR=0	CELL FREQ	7	9	11	6	15	10	7	15
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.4801	P=0.70784	DEN=0.0802	IERR=0	CELL FREQ	7	12	12	7	12	6	8	16
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.4928	P=0.70885	DEN=0.0800	IERR=0	CELL FREQ	10	8	9	14	16	5	10	8
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.4928	P=0.70885	DEN=0.0800	IERR=0	CELL FREQ	8	9	16	10	14	5	8	10
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.4968	P=0.70917	DEN=0.0800	IERR=0	CELL FREQ	9	7	14	15	13	6	7	9
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.5107	P=0.71028	DEN=0.0797	IERR=0	CELL FREQ	16	9	10	12	13	6	6	8
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.5949	P=0.71694	DEN=0.0784	IERR=0	CELL FREQ	8	13	10	8	16	5	8	12
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.6573	P=0.72179	DEN=0.0773	IERR=0	CELL FREQ	8	8	15	11	12	6	14	6
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.6635	P=0.72227	DEN=0.0772	IERR=0	CELL FREQ	9	5	13	11	16	8	11	7
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 8.8337	P=0.73518	DEN=0.0745	IERR=0	CELL FREQ	10	12	5	12	16	6	9	10
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 9.0979	P=0.75430	DEN=0.0702	IERR=0	CELL FREQ	9	9	16	10	12	4	8	12
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 9.0979	P=0.75430	DEN=0.0702	IERR=0	CELL FREQ	12	10	16	12	9	8	4	9
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 9.3412	P=0.77092	DEN=0.0664	IERR=0	CELL FREQ	9	9	15	12	13	4	7	11

CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 9.3412	P=0.77092	DEN=0.0664	IERR=0	CELL FREQ	12	9	11	7	15	4	9	13
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL= 9.4209	P=0.77617	DEN=0.0652	IERR=0	CELL FREQ	11	14	12	10	8	4	7	14
CHISQP= 8.6000	P=0.71734	DEN=0.0783	IERR=0	CHISQL=10.1227	P=0.81828	DEN=0.0549	IERR=0	CELL FREQ	9	11	11	14	14	3	9	9
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 7.8674	P=0.65557	DEN=0.0904	IERR=0	CELL FREQ	8	11	18	10	9	6	9	9
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 8.2421	P=0.68827	DEN=0.0842	IERR=0	CELL FREQ	10	12	8	7	12	7	7	17
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 8.2727	P=0.69083	DEN=0.0837	IERR=0	CELL FREQ	7	8	17	10	13	9	10	6
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 8.5453	P=0.71303	DEN=0.0792	IERR=0	CELL FREQ	5	9	8	12	17	8	10	11
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 8.9922	P=0.74678	DEN=0.0719	IERR=0	CELL FREQ	7	8	15	11	14	8	12	5
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 8.9922	P=0.74678	DEN=0.0719	IERR=0	CELL FREQ	8	15	7	12	8	5	14	11
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 9.0620	P=0.75177	DEN=0.0708	IERR=0	CELL FREQ	13	14	6	13	13	8	7	6
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 9.1471	P=0.75773	DEN=0.0695	IERR=0	CELL FREQ	5	6	8	14	15	10	11	11
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 9.2087	P=0.76198	DEN=0.0685	IERR=0	CELL FREQ	13	8	6	5	15	12	12	9
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 9.2087	P=0.76198	DEN=0.0685	IERR=0	CELL FREQ	8	5	12	6	15	9	12	13
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 9.2087	P=0.76198	DEN=0.0685	IERR=0	CELL FREQ	8	13	6	15	9	5	12	12
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 9.4395	P=0.77737	DEN=0.0649	IERR=0	CELL FREQ	13	4	9	13	15	10	8	8
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 9.5639	P=0.78533	DEN=0.0630	IERR=0	CELL FREQ	13	11	15	7	12	4	10	8
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 9.5639	P=0.78533	DEN=0.0630	IERR=0	CELL FREQ	13	8	10	11	15	4	12	7
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL= 9.5639	P=0.78533	DEN=0.0630	IERR=0	CELL FREQ	11	10	13	12	15	7	8	4
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL=10.2294	P=0.82406	DEN=0.0535	IERR=0	CELL FREQ	13	11	10	4	13	5	12	12
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL=10.4070	P=0.83334	DEN=0.0511	IERR=0	CELL FREQ	8	9	9	13	14	3	12	12
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL=11.8147	P=0.89318	DEN=0.0347	IERR=0	CELL FREQ	9	12	11	12	9	2	12	13
CHISQP= 8.8000	P=0.73266	DEN=0.0750	IERR=0	CHISQL=11.8553	P=0.89458	DEN=0.0343	IERR=0	CELL FREQ	11	12	11	12	13	2	11	8
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 8.0037	P=0.66774	DEN=0.0881	IERR=0	CELL FREQ	7	18	9	11	11	9	8	7
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 8.4307	P=0.70385	DEN=0.0811	IERR=0	CELL FREQ	7	10	9	7	16	7	15	9
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 8.4730	P=0.70726	DEN=0.0804	IERR=0	CELL FREQ	9	13	6	8	11	9	7	17
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 8.4730	P=0.70726	DEN=0.0804	IERR=0	CELL FREQ	9	6	11	13	17	7	8	9
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 8.4730	P=0.70726	DEN=0.0804	IERR=0	CELL FREQ	7	9	9	6	17	8	13	11
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 8.5288	P=0.71172	DEN=0.0794	IERR=0	CELL FREQ	7	8	6	12	17	8	10	12
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 8.8315	P=0.73502	DEN=0.0745	IERR=0	CELL FREQ	6	14	8	6	11	9	16	10
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 9.1184	P=0.75573	DEN=0.0699	IERR=0	CELL FREQ	13	7	8	14	15	9	9	5
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 9.2160	P=0.76248	DEN=0.0684	IERR=0	CELL FREQ	14	6	14	13	12	8	6	7
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 9.2160	P=0.76248	DEN=0.0684	IERR=0	CELL FREQ	13	6	14	12	7	6	14	8
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 9.3755	P=0.77319	DEN=0.0659	IERR=0	CELL FREQ	13	6	9	11	15	5	8	13
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 9.4999	P=0.78127	DEN=0.0640	IERR=0	CELL FREQ	11	6	7	12	15	5	11	13
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 9.5713	P=0.78580	DEN=0.0629	IERR=0	CELL FREQ	16	10	7	12	12	4	10	9
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL= 9.8245	P=0.80126	DEN=0.0592	IERR=0	CELL FREQ	13	13	11	5	14	5	11	8
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL=10.0604	P=0.81482	DEN=0.0558	IERR=0	CELL FREQ	6	11	8	12	13	4	14	12
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL=11.9352	P=0.89729	DEN=0.0335	IERR=0	CELL FREQ	12	14	9	12	11	2	10	10
CHISQP= 9.0000	P=0.74734	DEN=0.0718	IERR=0	CHISQL=11.9352	P=0.89729	DEN=0.0335	IERR=0	CELL FREQ	10	10	14	12	12	2	9	11
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 8.1858	P=0.68351	DEN=0.0851	IERR=0	CELL FREQ	9	7	9	12	18	7	10	8
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 8.7174	P=0.72641	DEN=0.0764	IERR=0	CELL FREQ	10	7	15	9	9	8	6	16
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.0599	P=0.75162	DEN=0.0708	IERR=0	CELL FREQ	9	9	6	16	13	8	13	6
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.1664	P=0.75907	DEN=0.0692	IERR=0	CELL FREQ	9	14	8	5	16	10	11	7
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.3411	P=0.77092	DEN=0.0664	IERR=0	CELL FREQ	7	10	15	13	14	5	8	8
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.3524	P=0.77166	DEN=0.0663	IERR=0	CELL FREQ	9	5	7	12	16	7	12	12
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.3590	P=0.77210	DEN=0.0662	IERR=0	CELL FREQ	6	8	15	6	13	7	12	13
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.6472	P=0.79054	DEN=0.0618	IERR=0	CELL FREQ	9	9	12	9	16	4	13	8
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.7059	P=0.79414	DEN=0.0609	IERR=0	CELL FREQ	13	14	10	7	11	5	14	6
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.7381	P=0.79609	DEN=0.0605	IERR=0	CELL FREQ	9	16	7	10	13	4	10	11
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.7716	P=0.79811	DEN=0.0600	IERR=0	CELL FREQ	7	9	9	4	16	11	12	12
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.8441	P=0.80242	DEN=0.0589	IERR=0	CELL FREQ	4	10	12	14	15	9	7	9
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL= 9.9463	P=0.80836	DEN=0.0574	IERR=0	CELL FREQ	13	7	12	8	15	4	12	9
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL=10.1226	P=0.81827	DEN=0.0549	IERR=0	CELL FREQ	12	4	14	13	13	7	10	7
CHISQP= 9.2000	P=0.76139	DEN=0.0686	IERR=0	CHISQL=10.5502	P=0.84052	DEN=0.0492	IERR=0	CELL FREQ	11	13	11	14	12	4	10	5
CHISQP= 9.4000	P=0.77480	DEN=0.0655	IERR=0	CHISQL= 8.4725	P=0.70723	DEN=0.0804	IERR=0	CELL FREQ	10	9	8	6	12	8	9	18
CHISQP= 9.4000	P=0.77480	DEN=0.0655	IERR=0	CHISQL= 9.1449	P=0.75758	DEN=0.0695	IERR=0	CELL FREQ	17	10	13	9	10	5	9	7
CHISQP= 9.4000	P=0.77480	DEN=0.0655	IERR=0	CHISQL= 9.1449	P=0.75758	DEN=0.0695	IERR=0	CELL FREQ	17	9	13	7	10	5	10	9
CHISQP= 9.4000	P=0.77480	DEN=0.0655	IERR=0	CHISQL= 9.1721	P=0.75947	DEN=0.0691	IERR=0	CELL FREQ	14	8	8	14	15	6	7	8
CHISQP= 9.4000	P=0.77480	DEN=0.0655	IERR=0	CHISQL= 9.2190	P=0.76269	DEN=0.0683	IERR=0	CELL FREQ	8	12	11	7	17	5	9	11
CHISQP= 9.4000	P=0.77480	DEN=0.0655	IERR=0	CHISQL= 9.5034	P=0.78150	DEN=0.0640	IERR=0	CELL FREQ	10	5	10	9	14	6	16	10
CHISQP= 9.4000	P=0.77480	DEN=0.0655	IERR=0	CHISQL= 9.5130	P=0.78211	DEN=0.0638	IERR=0	CELL FREQ	8	12	6	7	14	6	12	15
CHISQP= 9.4000	P=0.77480	DEN=0.0655	IERR=0	CHISQL= 9.5192	P=0.78251	DEN=0.0637	IERR=0	CELL FREQ	11	5	9	7	16	7	12	13

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CHISQP= 9.4000   P=0.77480   DEN=0.0655   IERR=0   CHISQL= 9.8376   P=0.80204   DEN=0.0590   IERR=0   CELL FREQ  8 13 14 12 14   5  6  8
CHISQP= 9.4000   P=0.77480   DEN=0.0655   IERR=0   CHISQL= 9.8699   P=0.80393   DEN=0.0585   IERR=0   CELL FREQ 10  9  8 13 12   4 16  8
CHISQP= 9.4000   P=0.77480   DEN=0.0655   IERR=0   CHISQL=10.3072   P=0.82817   DEN=0.0524   IERR=0   CELL FREQ 10 10 13  9 14   6  4 14
CHISQP= 9.4000   P=0.77480   DEN=0.0655   IERR=0   CHISQL=10.3072   P=0.82817   DEN=0.0524   IERR=0   CELL FREQ 13 14 14  4  9   6 10 10
CHISQP= 9.4000   P=0.77480   DEN=0.0655   IERR=0   CHISQL=10.7323   P=0.84927   DEN=0.0469   IERR=0   CELL FREQ 14  5 10 13 12   4 12 10
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL= 9.1404   P=0.75727   DEN=0.0696   IERR=0   CELL FREQ  9 11  7  8 15   6 16  8
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL= 9.4011   P=0.77487   DEN=0.0655   IERR=0   CELL FREQ  9  8 12  7 17   5 10 12
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL= 9.4011   P=0.77487   DEN=0.0655   IERR=0   CELL FREQ  9  8  5 12 17   7 12 10
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL= 9.4228   P=0.77629   DEN=0.0652   IERR=0   CELL FREQ  9  6 14 14 15   7  7  8
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL= 9.5894   P=0.78694   DEN=0.0627   IERR=0   CELL FREQ 11  5 14  8 11   7  8 16
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL= 9.8059   P=0.80016   DEN=0.0595   IERR=0   CELL FREQ 12  8 16 11 13   5  6  9
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL= 9.8609   P=0.80340   DEN=0.0587   IERR=0   CELL FREQ 11 11 10  8 17   4  8 11
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL= 9.8964   P=0.80548   DEN=0.0581   IERR=0   CELL FREQ 12  6  9 13 15   6  6 13
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL=10.0573   P=0.81465   DEN=0.0559   IERR=0   CELL FREQ  8 11 10  8 15   4  9 15
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL=10.1205   P=0.81815   DEN=0.0550   IERR=0   CELL FREQ 12  9 13  9 16   4 10  7
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL=10.1427   P=0.81937   DEN=0.0547   IERR=0   CELL FREQ  8 14  9  8 15   4  9 13
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL=10.1611   P=0.82037   DEN=0.0544   IERR=0   CELL FREQ  4 16 11 10 13   8  7 11
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL=10.1611   P=0.82037   DEN=0.0544   IERR=0   CELL FREQ 13 11 10  7 16   4  8 11
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL=11.1773   P=0.86893   DEN=0.0415   IERR=0   CELL FREQ  7 12 10 12 12   3  9 15
CHISQP= 9.6000   P=0.78760   DEN=0.0625   IERR=0   CHISQL=11.4583   P=0.88016   DEN=0.0384   IERR=0   CELL FREQ 14 11 12  6 11   3 10 13
CHISQP= 9.8000   P=0.79981   DEN=0.0595   IERR=0   CHISQL= 8.7351   P=0.72776   DEN=0.0761   IERR=0   CELL FREQ  8 13  9  9 18   9  7  7
CHISQP= 9.8000   P=0.79981   DEN=0.0595   IERR=0   CHISQL= 9.2354   P=0.76380   DEN=0.0681   IERR=0   CELL FREQ 10 10 10 10 18   5 10  7
CHISQP= 9.8000   P=0.79981   DEN=0.0595   IERR=0   CHISQL= 9.3748   P=0.77315   DEN=0.0659   IERR=0   CELL FREQ  9  9  9 14 17   8  9  5
CHISQP= 9.8000   P=0.79981   DEN=0.0595   IERR=0   CHISQL= 9.5679   P=0.78559   DEN=0.0630   IERR=0   CELL FREQ 13 11 17  7  9   5  8 10
CHISQP= 9.8000   P=0.79981   DEN=0.0595   IERR=0   CHISQL=10.2957   P=0.82758   DEN=0.0526   IERR=0   CELL FREQ 11 13 10 16 11   5  5  9
CHISQP= 9.8000   P=0.79981   DEN=0.0595   IERR=0   CHISQL=10.2957   P=0.82758   DEN=0.0526   IERR=0   CELL FREQ 11 16  5 13 10   5  9 11
CHISQP= 9.8000   P=0.79981   DEN=0.0595   IERR=0   CHISQL=11.1275   P=0.86685   DEN=0.0421   IERR=0   CELL FREQ  4 10 13  9 13   5 13 13
CHISQP= 9.8000   P=0.79981   DEN=0.0595   IERR=0   CHISQL=11.6404   P=0.88698   DEN=0.0365   IERR=0   CELL FREQ 12 13  6 10 14   3 12 10
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL= 9.6138   P=0.78846   DEN=0.0623   IERR=0   CELL FREQ 15  7 11  7  8   6 10 16
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL= 9.6154   P=0.78857   DEN=0.0623   IERR=0   CELL FREQ  6 13 12  9 17   8  9  6
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL= 9.6778   P=0.79242   DEN=0.0613   IERR=0   CELL FREQ 15  9 11  6 16   8  9  6
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=10.2793   P=0.82671   DEN=0.0528   IERR=0   CELL FREQ  6 12 13 11 16   7  5 10
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=10.2793   P=0.82671   DEN=0.0528   IERR=0   CELL FREQ  7 11 12 16 13   6 10  5
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=10.2936   P=0.82746   DEN=0.0526   IERR=0   CELL FREQ  9 10  7  4 17  10 12 11
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=10.2936   P=0.82746   DEN=0.0526   IERR=0   CELL FREQ 10  9 10 12 11   4 17  7
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=10.3853   P=0.83223   DEN=0.0514   IERR=0   CELL FREQ  7 14 12  9 15   5  6 12
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=10.6424   P=0.84500   DEN=0.0480   IERR=0   CELL FREQ 12 13  5  6 15   6 11 12
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=10.6943   P=0.84748   DEN=0.0474   IERR=0   CELL FREQ 13  5  6 13 13   6 10 14
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=10.7182   P=0.84861   DEN=0.0471   IERR=0   CELL FREQ  8 13  7 15 13   8 12  4
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=10.9586   P=0.85956   DEN=0.0441   IERR=0   CELL FREQ  9  4 14 13 13   6  8 13
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=11.2815   P=0.87320   DEN=0.0404   IERR=0   CELL FREQ 13  9 12 10 14   5  4 13
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=11.4998   P=0.88174   DEN=0.0380   IERR=0   CELL FREQ  9  8  8 13 14   3 11 14
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=12.9075   P=0.92560   DEN=0.0251   IERR=0   CELL FREQ 14  9 13  8 12   2 11 11
CHISQP=10.0000   P=0.81143   DEN=0.0567   IERR=0   CHISQL=12.9075   P=0.92560   DEN=0.0251   IERR=0   CELL FREQ 13 11  9 12 14   2 11  8
CHISQP=10.2000   P=0.82248   DEN=0.0539   IERR=0   CHISQL= 9.6360   P=0.78985   DEN=0.0620   IERR=0   CELL FREQ  5 11  9  9 10   7 11 18
CHISQP=10.2000   P=0.82248   DEN=0.0539   IERR=0   CHISQL= 9.6496   P=0.79068   DEN=0.0618   IERR=0   CELL FREQ 14  7  9 11 17   6  9  7
CHISQP=10.2000   P=0.82248   DEN=0.0539   IERR=0   CHISQL= 9.9005   P=0.80572   DEN=0.0581   IERR=0   CELL FREQ  6  8 10 15 16   6 11  8
CHISQP=10.2000   P=0.82248   DEN=0.0539   IERR=0   CHISQL=10.0747   P=0.81562   DEN=0.0556   IERR=0   CELL FREQ 12  7 11  7 17   5 12  9
CHISQP=10.2000   P=0.82248   DEN=0.0539   IERR=0   CHISQL=10.1103   P=0.81759   DEN=0.0551   IERR=0   CELL FREQ 16  7  8  6 14   6 11 12
CHISQP=10.2000   P=0.82248   DEN=0.0539   IERR=0   CHISQL=10.5731   P=0.84165   DEN=0.0489   IERR=0   CELL FREQ  8  9  9  4 14   8 12 16
CHISQP=10.2000   P=0.82248   DEN=0.0539   IERR=0   CHISQL=10.6641   P=0.84604   DEN=0.0477   IERR=0   CELL FREQ 14  4 10 10 11   7 16  8
CHISQP=10.2000   P=0.82248   DEN=0.0539   IERR=0   CHISQL=10.8528   P=0.85483   DEN=0.0454   IERR=0   CELL FREQ  5 15  9 12 13   5  8 13
CHISQP=10.2000   P=0.82248   DEN=0.0539   IERR=0   CHISQL=11.3965   P=0.87776   DEN=0.0391   IERR=0   CELL FREQ 13  4 12 11  9   5 11 15
CHISQP=10.4000   P=0.83298   DEN=0.0512   IERR=0   CHISQL= 9.6195   P=0.78882   DEN=0.0622   IERR=0   CELL FREQ  7  6 11 10 18   9 12  7
CHISQP=10.4000   P=0.83298   DEN=0.0512   IERR=0   CHISQL= 9.6195   P=0.78882   DEN=0.0622   IERR=0   CELL FREQ 11 18 10  7 12   7  9  6
CHISQP=10.4000   P=0.83298   DEN=0.0512   IERR=0   CHISQL=10.0709   P=0.81541   DEN=0.0557   IERR=0   CELL FREQ 14 10 17  9  7   5  8 10
CHISQP=10.4000   P=0.83298   DEN=0.0512   IERR=0   CHISQL=10.1730   P=0.82102   DEN=0.0543   IERR=0   CELL FREQ  5 10 13  7 17   8 12  8
CHISQP=10.4000   P=0.83298   DEN=0.0512   IERR=0   CHISQL=10.3208   P=0.82889   DEN=0.0522   IERR=0   CELL FREQ  8 13  9 16 14   5  8  7
CHISQP=10.4000   P=0.83298   DEN=0.0512   IERR=0   CHISQL=10.3614   P=0.83100   DEN=0.0517   IERR=0   CELL FREQ  5  6 12 11 17   9  8 12
CHISQP=10.4000   P=0.83298   DEN=0.0512   IERR=0   CHISQL=10.7166   P=0.84853   DEN=0.0471   IERR=0   CELL FREQ 12 11 10 11 17   4  7  8
CHISQP=10.4000   P=0.83298   DEN=0.0512   IERR=0   CHISQL=10.8644   P=0.85535   DEN=0.0453   IERR=0   CELL FREQ  9  8  4 11 16   7 14 11
CHISQP=10.4000   P=0.83298   DEN=0.0512   IERR=0   CHISQL=10.9008   P=0.85700   DEN=0.0448   IERR=0   CELL FREQ  8 13 12 16 10   5 11  5
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CHISQP=10.4000	P=0.83298	DEN=0.0512	IERR=0	CHISQL=10.9008	P=0.85700	DEN=0.0448	IERR=0	CELL FREQ	5	12	13	10	16	5	8	11
CHISQP=10.4000	P=0.83298	DEN=0.0512	IERR=0	CHISQL=10.9131	P=0.85754	DEN=0.0447	IERR=0	CELL FREQ	9	7	12	4	15	8	15	10
CHISQP=10.4000	P=0.83298	DEN=0.0512	IERR=0	CHISQL=10.9913	P=0.86100	DEN=0.0437	IERR=0	CELL FREQ	10	5	13	12	13	6	15	6
CHISQP=10.4000	P=0.83298	DEN=0.0512	IERR=0	CHISQL=11.0169	P=0.86211	DEN=0.0434	IERR=0	CELL FREQ	16	11	13	10	12	7	7	4
CHISQP=10.4000	P=0.83298	DEN=0.0512	IERR=0	CHISQL=11.0391	P=0.86308	DEN=0.0432	IERR=0	CELL FREQ	8	15	7	14	13	4	8	11
CHISQP=10.4000	P=0.83298	DEN=0.0512	IERR=0	CHISQL=11.4408	P=0.87949	DEN=0.0386	IERR=0	CELL FREQ	8	11	11	10	17	3	10	10
CHISQP=10.4000	P=0.83298	DEN=0.0512	IERR=0	CHISQL=11.7968	P=0.89256	DEN=0.0349	IERR=0	CELL FREQ	12	14	8	9	11	3	8	15
CHISQP=10.4000	P=0.83298	DEN=0.0512	IERR=0	CHISQL=11.9731	P=0.89855	DEN=0.0331	IERR=0	CELL FREQ	7	14	10	3	13	8	11	14
CHISQP=10.4000	P=0.83298	DEN=0.0512	IERR=0	CHISQL=12.1615	P=0.90463	DEN=0.0314	IERR=0	CELL FREQ	12	9	11	11	14	3	6	14
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL= 9.1371	P=0.75704	DEN=0.0696	IERR=0	CELL FREQ	7	7	9	19	11	9	8	10
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL= 9.1371	P=0.75704	DEN=0.0696	IERR=0	CELL FREQ	7	10	9	7	19	8	9	11
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL= 9.2011	P=0.76146	DEN=0.0686	IERR=0	CELL FREQ	9	9	11	9	19	6	9	8
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL= 9.9062	P=0.80605	DEN=0.0580	IERR=0	CELL FREQ	8	12	6	18	9	6	11	10
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL= 9.9905	P=0.81089	DEN=0.0568	IERR=0	CELL FREQ	10	5	8	18	11	8	8	12
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL=10.4600	P=0.83603	DEN=0.0504	IERR=0	CELL FREQ	11	10	9	10	18	4	10	8
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL=10.5714	P=0.84156	DEN=0.0489	IERR=0	CELL FREQ	5	7	9	14	16	7	13	9
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL=10.7202	P=0.84870	DEN=0.0470	IERR=0	CELL FREQ	9	6	14	14	10	6	6	15
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL=11.0465	P=0.86340	DEN=0.0431	IERR=0	CELL FREQ	7	14	8	10	16	4	9	12
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL=11.6006	P=0.88552	DEN=0.0369	IERR=0	CELL FREQ	9	17	12	11	10	3	9	9
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL=12.0474	P=0.90099	DEN=0.0324	IERR=0	CELL FREQ	15	11	12	9	14	3	7	9
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL=12.0474	P=0.90099	DEN=0.0324	IERR=0	CELL FREQ	11	7	14	9	12	3	9	15
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL=12.3045	P=0.90902	DEN=0.0301	IERR=0	CELL FREQ	11	11	6	9	13	3	15	12
CHISQP=10.6000	P=0.84296	DEN=0.0486	IERR=0	CHISQL=13.4104	P=0.93728	DEN=0.0214	IERR=0	CELL FREQ	14	9	14	12	10	2	8	11
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL= 9.9181	P=0.80674	DEN=0.0578	IERR=0	CELL FREQ	13	11	7	8	18	6	8	9
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=10.2411	P=0.82468	DEN=0.0533	IERR=0	CELL FREQ	11	5	10	12	18	7	9	8
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=10.2411	P=0.82468	DEN=0.0533	IERR=0	CELL FREQ	8	7	10	18	11	5	12	9
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=10.4096	P=0.83348	DEN=0.0510	IERR=0	CELL FREQ	11	10	17	14	9	7	6	6
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=10.4917	P=0.83762	DEN=0.0500	IERR=0	CELL FREQ	7	8	14	15	15	6	7	8
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=10.6603	P=0.84586	DEN=0.0478	IERR=0	CELL FREQ	11	10	8	9	18	4	9	11
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=10.7727	P=0.85115	DEN=0.0464	IERR=0	CELL FREQ	6	9	8	10	11	5	16	15
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=10.8581	P=0.85507	DEN=0.0453	IERR=0	CELL FREQ	8	6	9	9	14	5	16	13
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=10.8631	P=0.85530	DEN=0.0453	IERR=0	CELL FREQ	6	13	15	9	15	6	6	10
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=10.9474	P=0.85907	DEN=0.0442	IERR=0	CELL FREQ	13	5	8	15	15	10	6	8
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=11.0655	P=0.86421	DEN=0.0428	IERR=0	CELL FREQ	10	8	11	10	17	4	13	7
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=11.1572	P=0.86809	DEN=0.0418	IERR=0	CELL FREQ	14	5	12	6	13	7	8	15
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=11.2217	P=0.87076	DEN=0.0410	IERR=0	CELL FREQ	16	10	5	11	14	5	8	11
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=11.2704	P=0.87275	DEN=0.0405	IERR=0	CELL FREQ	15	8	5	5	15	10	12	10
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=11.3121	P=0.87443	DEN=0.0400	IERR=0	CELL FREQ	14	11	15	10	5	6	13	6
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=11.3121	P=0.87443	DEN=0.0400	IERR=0	CELL FREQ	6	10	14	5	15	6	13	11
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=11.4298	P=0.87906	DEN=0.0387	IERR=0	CELL FREQ	16	6	13	9	13	10	4	9
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=11.8233	P=0.89348	DEN=0.0346	IERR=0	CELL FREQ	10	12	10	17	8	3	11	9
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=11.9848	P=0.89894	DEN=0.0330	IERR=0	CELL FREQ	14	12	9	4	9	5	13	14
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=12.0535	P=0.90119	DEN=0.0324	IERR=0	CELL FREQ	8	13	13	10	14	4	5	13
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=12.1457	P=0.90413	DEN=0.0315	IERR=0	CELL FREQ	14	3	8	10	15	9	13	8
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=12.2701	P=0.90798	DEN=0.0304	IERR=0	CELL FREQ	7	15	14	8	12	3	11	10
CHISQP=10.8000	P=0.85242	DEN=0.0460	IERR=0	CHISQL=12.3525	P=0.91045	DEN=0.0296	IERR=0	CELL FREQ	16	11	6	10	11	3	11	12
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL= 9.6744	P=0.79221	DEN=0.0614	IERR=0	CELL FREQ	7	11	9	19	9	6	10	9
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=10.1812	P=0.82146	DEN=0.0541	IERR=0	CELL FREQ	11	8	8	17	15	7	7	7
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=10.3674	P=0.83131	DEN=0.0516	IERR=0	CELL FREQ	7	18	10	9	9	5	9	13
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=10.3931	P=0.83263	DEN=0.0513	IERR=0	CELL FREQ	16	7	6	10	16	8	7	10
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=10.7223	P=0.84880	DEN=0.0470	IERR=0	CELL FREQ	13	5	13	9	17	8	7	8
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=10.7223	P=0.84880	DEN=0.0470	IERR=0	CELL FREQ	13	9	13	5	8	8	17	7
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=11.1980	P=0.86979	DEN=0.0413	IERR=0	CELL FREQ	15	5	10	9	13	7	15	6
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=11.2253	P=0.87091	DEN=0.0410	IERR=0	CELL FREQ	13	4	17	9	12	7	9	9
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=11.2659	P=0.87256	DEN=0.0405	IERR=0	CELL FREQ	8	9	7	11	17	11	4	13
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=11.5405	P=0.88328	DEN=0.0375	IERR=0	CELL FREQ	5	13	13	13	15	6	6	9
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=11.6470	P=0.88722	DEN=0.0364	IERR=0	CELL FREQ	7	13	11	5	15	5	14	10
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=11.6470	P=0.88722	DEN=0.0364	IERR=0	CELL FREQ	15	7	11	5	14	10	13	5
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=11.6860	P=0.88863	DEN=0.0360	IERR=0	CELL FREQ	12	4	13	9	16	6	12	8
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=12.0236	P=0.90021	DEN=0.0327	IERR=0	CELL FREQ	9	9	12	8	17	3	11	11
CHISQP=11.0000	P=0.86138	DEN=0.0436	IERR=0	CHISQL=12.4761	P=0.91405	DEN=0.0286	IERR=0	CELL FREQ	10	10	14	7	14	3	14	8
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=10.1984	P=0.82239	DEN=0.0539	IERR=0	CELL FREQ	9	6	8	9	9	7	14	18

CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=10.4679	P=0.83643	DEN=0.0503	IERR=0	CELL FREQ	8	8	15	11	8	7	17	6
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=10.5182	P=0.83894	DEN=0.0496	IERR=0	CELL FREQ	7	10	7	17	15	6	8	10
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=10.5901	P=0.84247	DEN=0.0487	IERR=0	CELL FREQ	10	5	9	8	18	7	10	13
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=10.6665	P=0.84616	DEN=0.0477	IERR=0	CELL FREQ	10	15	9	8	17	5	8	8
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=11.0312	P=0.86274	DEN=0.0432	IERR=0	CELL FREQ	8	10	11	14	17	5	9	6
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=11.8065	P=0.89290	DEN=0.0348	IERR=0	CELL FREQ	10	14	8	10	12	4	6	16
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=12.2057	P=0.90600	DEN=0.0310	IERR=0	CELL FREQ	17	9	9	8	12	3	10	12
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=12.2483	P=0.90732	DEN=0.0306	IERR=0	CELL FREQ	10	9	5	14	13	10	15	4
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=12.5465	P=0.91604	DEN=0.0280	IERR=0	CELL FREQ	7	13	8	10	11	3	16	12
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=12.6190	P=0.91805	DEN=0.0274	IERR=0	CELL FREQ	14	8	10	10	15	7	3	13
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=12.9335	P=0.92625	DEN=0.0249	IERR=0	CELL FREQ	11	11	8	6	13	3	14	14
CHISQP=11.2000	P=0.86987	DEN=0.0413	IERR=0	CHISQL=12.9795	P=0.92739	DEN=0.0245	IERR=0	CELL FREQ	9	11	13	13	12	4	14	4
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=10.7620	P=0.85066	DEN=0.0465	IERR=0	CELL FREQ	12	10	6	6	18	9	7	12
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=10.9305	P=0.85832	DEN=0.0445	IERR=0	CELL FREQ	9	7	10	6	16	6	10	16
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=11.5461	P=0.88349	DEN=0.0375	IERR=0	CELL FREQ	11	9	17	7	9	4	14	9
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=11.5876	P=0.88504	DEN=0.0370	IERR=0	CELL FREQ	12	12	8	16	14	5	6	7
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=11.6210	P=0.88627	DEN=0.0367	IERR=0	CELL FREQ	7	8	11	15	15	5	6	13
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=11.7426	P=0.89065	DEN=0.0354	IERR=0	CELL FREQ	11	12	6	10	14	6	16	5
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=12.0068	P=0.89967	DEN=0.0328	IERR=0	CELL FREQ	9	11	14	16	8	4	12	6
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=12.0295	P=0.90041	DEN=0.0326	IERR=0	CELL FREQ	9	5	13	14	12	5	7	15
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=12.2892	P=0.90856	DEN=0.0302	IERR=0	CELL FREQ	6	14	12	7	14	9	4	14
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=12.3725	P=0.91104	DEN=0.0295	IERR=0	CELL FREQ	10	13	8	11	17	3	9	9
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=12.5284	P=0.91553	DEN=0.0281	IERR=0	CELL FREQ	10	14	5	14	11	4	14	8
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=13.1156	P=0.93066	DEN=0.0235	IERR=0	CELL FREQ	10	12	14	13	8	6	3	14
CHISQP=11.4000	P=0.87790	DEN=0.0390	IERR=0	CHISQL=13.9503	P=0.94793	DEN=0.0181	IERR=0	CELL FREQ	13	10	10	11	16	8	10	2
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=10.2795	P=0.82672	DEN=0.0528	IERR=0	CELL FREQ	9	9	7	8	19	6	10	12
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=10.2795	P=0.82672	DEN=0.0528	IERR=0	CELL FREQ	12	9	9	8	10	6	7	19
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=J	CHISQL=10.5187	P=0.83897	DEN=0.0496	IERR=0	CELL FREQ	9	10	8	10	19	5	11	8
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=11.0131	P=0.86195	DEN=0.0435	IERR=0	CELL FREQ	11	10	8	13	18	5	8	7
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=11.2150	P=0.87049	DEN=0.0411	IERR=0	CELL FREQ	11	16	9	7	16	5	8	8
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=11.3675	P=0.87663	DEN=0.0394	IERR=0	CELL FREQ	6	12	13	7	17	6	12	7
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=11.7688	P=0.89158	DEN=0.0352	IERR=0	CELL FREQ	10	14	9	11	17	4	7	8
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=11.8053	P=0.89285	DEN=0.0348	IERR=0	CELL FREQ	8	12	10	5	10	5	13	17
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=11.8710	P=0.89512	DEN=0.0341	IERR=0	CELL FREQ	8	13	7	8	12	4	17	11
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=12.3261	P=0.90967	DEN=0.0299	IERR=0	CELL FREQ	13	7	13	11	16	4	6	10
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=12.8268	P=0.92356	DEN=0.0257	IERR=0	CELL FREQ	14	7	10	9	16	3	9	12
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=12.9160	P=0.92582	DEN=0.0250	IERR=0	CELL FREQ	12	7	8	15	15	3	10	10
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=13.1564	P=0.93161	DEN=0.0232	IERR=0	CELL FREQ	13	9	10	14	10	3	6	15
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=14.3253	P=0.95431	DEN=0.0160	IERR=0	CELL FREQ	8	13	13	15	10	2	8	11
CHISQP=11.6000	P=0.88550	DEN=0.0369	IERR=0	CHISQL=14.4330	P=0.95601	DEN=0.0155	IERR=0	CELL FREQ	14	9	7	11	14	2	10	13
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=10.8080	P=0.85279	DEN=0.0459	IERR=0	CELL FREQ	7	7	9	11	18	7	14	7
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=10.8944	P=0.85671	DEN=0.0449	IERR=0	CELL FREQ	10	8	18	10	7	6	14	7
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=11.1919	P=0.86953	DEN=0.0414	IERR=0	CELL FREQ	7	10	11	7	17	7	6	15
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=11.3401	P=0.87554	DEN=0.0397	IERR=0	CELL FREQ	5	11	9	8	17	7	15	8
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=11.6363	P=0.88683	DEN=0.0365	IERR=0	CELL FREQ	6	10	8	12	17	5	14	8
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=11.7049	P=0.88931	DEN=0.0358	IERR=0	CELL FREQ	6	11	9	14	17	5	7	11
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=11.7388	P=0.89052	DEN=0.0355	IERR=0	CELL FREQ	7	18	12	10	10	4	8	11
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=11.7648	P=0.89144	DEN=0.0352	IERR=0	CELL FREQ	12	15	5	7	16	7	7	11
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=12.1216	P=0.90337	DEN=0.0317	IERR=0	CELL FREQ	7	7	13	9	11	4	17	12
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=12.4802	P=0.91417	DEN=0.0285	IERR=0	CELL FREQ	12	11	16	10	14	6	4	7
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=12.5024	P=0.91480	DEN=0.0283	IERR=0	CELL FREQ	14	11	14	8	15	4	6	8
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=12.8458	P=0.92405	DEN=0.0255	IERR=0	CELL FREQ	7	10	17	13	11	3	10	9
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=12.8997	P=0.92541	DEN=0.0251	IERR=0	CELL FREQ	15	13	13	4	13	8	5	9
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=13.3567	P=0.93612	DEN=0.0218	IERR=0	CELL FREQ	13	6	9	11	14	3	9	15
CHISQP=11.8000	P=0.89267	DEN=0.0348	IERR=0	CHISQL=14.3327	P=0.95443	DEN=0.0160	IERR=0	CELL FREQ	12	10	8	9	16	2	13	10
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=10.7025	P=0.84787	DEN=0.0473	IERR=0	CELL FREQ	11	6	8	7	19	9	8	12
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=11.0947	P=0.86546	DEN=0.0425	IERR=0	CELL FREQ	14	11	6	8	18	7	7	9
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=11.1811	P=0.86909	DEN=0.0415	IERR=0	CELL FREQ	8	10	6	14	18	6	10	8
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=11.3236	P=0.87489	DEN=0.0399	IERR=0	CELL FREQ	8	12	15	7	17	7	8	6
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=11.4492	P=0.87981	DEN=0.0385	IERR=0	CELL FREQ	7	6	9	12	16	7	7	16
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=11.9391	P=0.89742	DEN=0.0335	IERR=0	CELL FREQ	7	11	12	8	18	4	9	11
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=12.1240	P=0.90345	DEN=0.0317	IERR=0	CELL FREQ	8	10	6	14	15	5	7	15

CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=12.1440	P=0.90408	DEN=0.0315	IERR=0	CELL FREQ	12	10	11	6	17	6	13	5
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=12.1440	P=0.90408	DEN=0.0315	IERR=0	CELL FREQ	6	17	5	12	10	6	13	11
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=12.2918	P=0.90864	DEN=0.0302	IERR=0	CELL FREQ	6	9	14	13	16	5	6	11
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=12.3062	P=0.90907	DEN=0.0301	IERR=0	CELL FREQ	11	9	14	10	17	4	9	6
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=12.4083	P=0.91209	DEN=0.0292	IERR=0	CELL FREQ	12	13	11	8	17	4	9	6
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=12.4921	P=0.91451	DEN=0.0284	IERR=0	CELL FREQ	14	4	11	16	13	8	7	7
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=12.6453	P=0.91876	DEN=0.0271	IERR=0	CELL FREQ	15	6	8	13	15	4	11	8
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=12.7313	P=0.92107	DEN=0.0265	IERR=0	CELL FREQ	11	5	9	12	17	4	10	12
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=13.4245	P=0.93758	DEN=0.0214	IERR=0	CELL FREQ	15	12	13	7	14	3	8	8
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=14.0899	P=0.95040	DEN=0.0173	IERR=0	CELL FREQ	8	13	3	12	13	5	14	12
CHISQP=12.0000	P=0.89944	DEN=0.0329	IERR=0	CHISQL=16.9168	P=0.98206	DEN=0.0066	IERR=0	CELL FREQ	9	9	10	11	14	1	14	12
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=11.1924	P=0.86955	DEN=0.0414	IERR=0	CELL FREQ	11	7	9	8	19	5	10	11
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=11.1924	P=0.86955	DEN=0.0414	IERR=0	CELL FREQ	7	5	9	11	10	8	19	11
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=11.2472	P=0.87181	DEN=0.0408	IERR=0	CELL FREQ	17	8	10	8	16	8	7	6
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=11.8201	P=0.89337	DEN=0.0346	IERR=0	CELL FREQ	7	16	12	8	8	5	8	16
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=11.8775	P=0.89534	DEN=0.0341	IERR=0	CELL FREQ	11	8	6	17	9	5	15	9
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=12.0233	P=0.90020	DEN=0.0327	IERR=0	CELL FREQ	7	7	17	7	12	5	14	11
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=12.1137	P=0.90312	DEN=0.0318	IERR=0	CELL FREQ	13	7	7	10	15	5	7	16
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=13.6889	P=0.94300	DEN=0.0196	IERR=0	CELL FREQ	3	12	12	16	8	6	13	10
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=13.7069	P=0.94335	DEN=0.0195	IERR=0	CELL FREQ	12	11	9	4	16	4	12	12
CHISQP=12.2000	P=0.90583	DEN=0.0310	IERR=0	CHISQL=14.8396	P=0.96189	DEN=0.0135	IERR=0	CELL FREQ	9	12	7	12	12	2	10	16
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=11.3744	P=0.87690	DEN=0.0393	IERR=0	CELL FREQ	10	9	7	19	12	5	8	10
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=11.5294	P=0.88286	DEN=0.0376	IERR=0	CELL FREQ	10	11	19	6	10	5	10	9
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=11.5619	P=0.88408	DEN=0.0373	IERR=0	CELL FREQ	8	9	6	9	16	6	9	17
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=12.0708	P=0.90174	DEN=0.0322	IERR=0	CELL FREQ	5	9	12	16	7	8	16	7
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=12.2880	P=0.90852	DEN=0.0302	IERR=0	CELL FREQ	7	13	10	8	18	4	11	9
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=12.2880	P=0.90852	DEN=0.0302	IERR=0	CELL FREQ	18	13	10	8	11	4	9	7
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=12.3100	P=0.90918	DEN=0.0300	IERR=0	CELL FREQ	11	6	14	8	7	5	17	12
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=12.5086	P=0.91497	DEN=0.0283	IERR=0	CELL FREQ	9	8	14	17	12	5	5	10
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=12.6246	P=0.91820	DEN=0.0273	IERR=0	CELL FREQ	9	17	14	7	10	4	7	12
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=12.7267	P=0.92095	DEN=0.0265	IERR=0	CELL FREQ	7	13	17	8	12	4	12	7
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=13.0294	P=0.92860	DEN=0.0241	IERR=0	CELL FREQ	14	4	13	9	16	6	7	11
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=13.1426	P=0.93129	DEN=0.0233	IERR=0	CELL FREQ	5	9	16	10	11	4	15	10
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=13.5271	P=0.93974	DEN=0.0207	IERR=0	CELL FREQ	10	12	14	7	13	5	4	15
CHISQP=12.4000	P=0.91185	DEN=0.0292	IERR=0	CHISQL=13.8764	P=0.94658	DEN=0.0185	IERR=0	CELL FREQ	3	11	15	8	15	6	12	10
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=10.5760	P=0.84179	DEN=0.0489	IERR=0	CELL FREQ	8	9	7	11	20	9	9	7
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=11.3021	P=0.87403	DEN=0.0401	IERR=0	CELL FREQ	13	10	9	7	19	6	7	9
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=11.8968	P=0.89599	DEN=0.0339	IERR=0	CELL FREQ	8	9	7	9	17	5	9	16
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=11.9670	P=0.89835	DEN=0.0332	IERR=0	CELL FREQ	9	7	7	11	18	5	9	14
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=12.1959	P=0.90570	DEN=0.0310	IERR=0	CELL FREQ	7	17	12	9	15	5	8	7
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=12.1959	P=0.90570	DEN=0.0310	IERR=0	CELL FREQ	7	15	8	17	12	5	9	7
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=12.8969	P=0.92534	DEN=0.0251	IERR=0	CELL FREQ	14	13	6	12	16	5	8	6
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=13.0590	P=0.92932	DEN=0.0239	IERR=0	CELL FREQ	9	16	14	8	9	6	14	4
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=13.2684	P=0.93417	DEN=0.0224	IERR=0	CELL FREQ	8	10	11	10	18	3	12	8
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=13.3581	P=0.93615	DEN=0.0218	IERR=0	CELL FREQ	14	14	8	4	12	7	15	6
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=14.0236	P=0.94924	DEN=0.0177	IERR=0	CELL FREQ	13	12	14	4	12	6	5	14
CHISQP=12.6000	P=0.91752	DEN=0.0275	IERR=0	CHISQL=14.4516	P=0.95629	DEN=0.0154	IERR=0	CELL FREQ	11	10	14	3	15	5	9	13
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=11.9209	P=0.89681	DEN=0.0337	IERR=0	CELL FREQ	8	11	7	8	17	6	16	7
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=12.4826	P=0.91423	DEN=0.0285	IERR=0	CELL FREQ	6	5	15	12	17	8	8	9
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=12.5683	P=0.91665	DEN=0.0278	IERR=0	CELL FREQ	4	9	9	10	18	7	14	9
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=12.9521	P=0.92672	DEN=0.0247	IERR=0	CELL FREQ	15	17	9	4	10	6	10	9
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=13.1380	P=0.93118	DEN=0.0233	IERR=0	CELL FREQ	16	15	8	13	10	4	7	7
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=13.2025	P=0.93267	DEN=0.0229	IERR=0	CELL FREQ	6	11	14	11	17	7	4	10
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=13.3989	P=0.93704	DEN=0.0215	IERR=0	CELL FREQ	4	9	7	10	14	6	15	15
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=13.3989	P=0.93704	DEN=0.0215	IERR=0	CELL FREQ	15	4	15	7	14	6	10	9
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=13.8479	P=0.94605	DEN=0.0187	IERR=0	CELL FREQ	5	11	10	14	15	4	14	7
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=13.9883	P=0.94861	DEN=0.0179	IERR=0	CELL FREQ	12	3	13	10	17	6	10	9
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=14.1389	P=0.95124	DEN=0.0170	IERR=0	CELL FREQ	11	13	15	7	15	3	9	7
CHISQP=12.8000	P=0.92287	DEN=0.0259	IERR=0	CHISQL=14.4351	P=0.95604	DEN=0.0154	IERR=0	CELL FREQ	3	12	15	7	14	6	13	10
CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=12.4764	P=0.91406	DEN=0.0286	IERR=0	CELL FREQ	6	14	8	11	18	5	8	10
CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=13.3343	P=0.93563	DEN=0.0220	IERR=0	CELL FREQ	14	8	11	12	17	4	8	6
CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=13.5950	P=0.94113	DEN=0.0202	IERR=0	CELL FREQ	8	9	9	11	18	3	9	13

CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=13.9315	P=0.94759	DEN=0.0182	IERR=0	CELL FREQ	9	3	14	17	9	7	9	12
CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=13.9315	P=0.94759	DEN=0.0182	IERR=0	CELL FREQ	14	9	12	9	17	3	7	9
CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=13.9575	P=0.94806	DEN=0.0180	IERR=0	CELL FREQ	5	12	4	12	16	7	14	10
CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=14.5500	P=0.95778	DEN=0.0149	IERR=0	CELL FREQ	15	6	12	11	15	3	7	11
CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=14.5514	P=0.95780	DEN=0.0149	IERR=0	CELL FREQ	10	4	15	14	13	4	8	12
CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=14.9137	P=0.96288	DEN=0.0132	IERR=0	CELL FREQ	5	10	14	3	14	8	12	14
CHISQP=13.0000	P=0.92789	DEN=0.0244	IERR=0	CHISQL=17.8317	P=0.98725	DEN=0.0048	IERR=0	CELL FREQ	13	9	11	15	8	1	10	13
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=12.3348	P=0.90993	DEN=0.0298	IERR=0	CELL FREQ	12	10	6	9	19	8	5	11
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=12.5425	P=0.91593	DEN=0.0280	IERR=0	CELL FREQ	8	8	11	8	17	7	16	5
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=12.5721	P=0.91675	DEN=0.0278	IERR=0	CELL FREQ	8	7	14	18	12	5	7	9
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=12.9559	P=0.92681	DEN=0.0247	IERR=0	CELL FREQ	10	8	7	17	12	5	6	15
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.2202	P=0.93308	DEN=0.0228	IERR=0	CELL FREQ	8	17	9	7	15	4	12	8
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.3206	P=0.93533	DEN=0.0221	IERR=0	CELL FREQ	11	7	5	16	16	5	10	10
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.5714	P=0.94065	DEN=0.0204	IERR=0	CELL FREQ	11	11	10	4	18	5	12	9
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.5849	P=0.94092	DEN=0.0203	IERR=0	CELL FREQ	12	7	11	14	17	6	4	9
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.7691	P=0.94456	DEN=0.0191	IERR=0	CELL FREQ	5	5	14	13	12	6	16	9
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.8176	P=0.94548	DEN=0.0189	IERR=0	CELL FREQ	8	9	10	18	13	3	11	8
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.8857	P=0.94675	DEN=0.0185	IERR=0	CELL FREQ	12	9	13	5	17	8	12	4
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.8857	P=0.94675	DEN=0.0185	IERR=0	CELL FREQ	12	13	12	9	17	5	8	4
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.9043	P=0.94709	DEN=0.0183	IERR=0	CELL FREQ	11	11	6	6	11	4	16	15
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=13.9480	P=0.94789	DEN=0.0181	IERR=0	CELL FREQ	15	9	11	5	12	4	16	8
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=14.1542	P=0.95149	DEN=0.0169	IERR=0	CELL FREQ	7	14	8	3	17	9	10	12
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=14.6496	P=0.95924	DEN=0.0144	IERR=0	CELL FREQ	4	14	9	15	9	4	14	11
CHISQP=13.2000	P=0.93262	DEN=0.0229	IERR=0	CHISQL=14.7560	P=0.96074	DEN=0.0139	IERR=0	CELL FREQ	14	7	15	6	14	3	11	10
CHISQP=13.4000	P=0.93706	DEN=0.0215	IERR=0	CHISQL=12.3970	P=0.91176	DEN=0.0293	IERR=0	CELL FREQ	9	7	10	13	19	5	7	10
CHISQP=13.4000	P=0.93706	DEN=0.0215	IERR=0	CHISQL=12.8497	P=0.92414	DEN=0.0255	IERR=0	CELL FREQ	4	11	12	9	19	7	9	9
CHISQP=13.4000	P=0.93706	DEN=0.0215	IERR=0	CHISQL=13.3283	P=0.93550	DEN=0.0220	IERR=0	CELL FREQ	10	14	9	6	18	4	9	10
CHISQP=13.4000	P=0.93706	DEN=0.0215	IERR=0	CHISQL=13.4524	P=0.93818	DEN=0.0212	IERR=0	CELL FREQ	14	6	12	8	17	6	5	12
CHISQP=13.4000	P=0.93706	DEN=0.0215	IERR=0	CHISQL=14.8877	P=0.96253	DEN=0.0133	IERR=0	CELL FREQ	14	15	12	14	8	3	6	8
CHISQP=13.4000	P=0.93706	DEN=0.0215	IERR=0	CHISQL=15.0821	P=0.96504	DEN=0.0125	IERR=0	CELL FREQ	14	4	12	14	14	4	7	11
CHISQP=13.4000	P=0.93706	DEN=0.0215	IERR=0	CHISQL=18.2938	P=0.98929	DEN=0.0041	IERR=0	CELL FREQ	10	12	8	14	13	1	14	8
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=12.7172	P=0.92069	DEN=0.0266	IERR=0	CELL FREQ	12	8	5	9	19	6	12	9
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=13.0454	P=0.92899	DEN=0.0240	IERR=0	CELL FREQ	5	7	10	14	18	7	7	12
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=13.1301	P=0.93100	DEN=0.0234	IERR=0	CELL FREQ	17	9	10	10	16	7	5	6
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=13.2545	P=0.93385	DEN=0.0225	IERR=0	CELL FREQ	13	8	8	15	17	8	6	5
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=13.4646	P=0.93843	DEN=0.0211	IERR=0	CELL FREQ	9	11	14	7	18	7	10	4
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=13.5668	P=0.94055	DEN=0.0204	IERR=0	CELL FREQ	13	12	7	8	18	4	11	7
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=13.7030	P=0.94328	DEN=0.0196	IERR=0	CELL FREQ	7	16	10	9	16	5	12	5
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=13.7575	P=0.94433	DEN=0.0192	IERR=0	CELL FREQ	8	9	12	17	15	6	4	9
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=14.3590	P=0.95485	DEN=0.0158	IERR=0	CELL FREQ	12	17	10	4	12	5	13	7
CHISQP=13.6000	P=0.94123	DEN=0.0202	IERR=0	CHISQL=14.8560	P=0.96211	DEN=0.0134	IERR=0	CELL FREQ	8	6	12	16	11	3	9	15
CHISQP=13.8000	P=0.94514	DEN=0.0190	IERR=0	CHISQL=13.0085	P=0.92810	DEN=0.0243	IERR=0	CELL FREQ	9	5	12	7	19	6	11	11
CHISQP=13.8000	P=0.94514	DEN=0.0190	IERR=0	CHISQL=13.6296	P=0.94182	DEN=0.0200	IERR=0	CELL FREQ	7	5	11	7	17	6	15	12
CHISQP=13.8000	P=0.94514	DEN=0.0190	IERR=0	CHISQL=13.7513	P=0.94421	DEN=0.0193	IERR=0	CELL FREQ	14	18	10	6	11	4	9	8
CHISQP=13.8000	P=0.94514	DEN=0.0190	IERR=0	CHISQL=13.7911	P=0.94498	DEN=0.0190	IERR=0	CELL FREQ	12	11	8	5	16	6	6	16
CHISQP=13.8000	P=0.94514	DEN=0.0190	IERR=0	CHISQL=13.9564	P=0.94804	DEN=0.0180	IERR=0	CELL FREQ	9	3	10	12	19	9	9	9
CHISQP=13.8000	P=0.94514	DEN=0.0190	IERR=0	CHISQL=14.3206	P=0.95424	DEN=0.0160	IERR=0	CELL FREQ	10	10	8	8	18	3	14	9
CHISQP=13.8000	P=0.94514	DEN=0.0190	IERR=0	CHISQL=14.5531	P=0.95783	DEN=0.0149	IERR=0	CELL FREQ	8	12	5	16	15	4	8	12
CHISQP=13.8000	P=0.94514	DEN=0.0190	IERR=0	CHISQL=14.9904	P=0.96388	DEN=0.0129	IERR=0	CELL FREQ	14	10	4	15	14	6	12	5
CHISQP=13.8000	P=0.94514	DEN=0.0190	IERR=0	CHISQL=15.7283	P=0.97228	DEN=0.0100	IERR=0	CELL FREQ	9	10	8	11	18	2	12	10
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=12.1918	P=0.90558	DEN=0.0311	IERR=0	CELL FREQ	9	6	10	7	20	7	9	12
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=13.1067	P=0.93045	DEN=0.0236	IERR=0	CELL FREQ	8	10	19	11	8	5	13	6
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=13.1571	P=0.93163	DEN=0.0232	IERR=0	CELL FREQ	19	13	5	10	10	6	10	7
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=13.3440	P=0.93584	DEN=0.0219	IERR=0	CELL FREQ	5	8	7	13	18	8	7	14
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=13.4548	P=0.93823	DEN=0.0212	IERR=0	CELL FREQ	12	7	9	9	19	4	8	12
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=13.8534	P=0.94615	DEN=0.0186	IERR=0	CELL FREQ	16	13	7	10	16	6	5	7
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=14.3027	P=0.95395	DEN=0.0161	IERR=0	CELL FREQ	9	18	10	4	13	5	9	12
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=14.3568	P=0.95481	DEN=0.0158	IERR=0	CELL FREQ	14	8	17	11	13	4	7	6
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=14.8283	P=0.96174	DEN=0.0136	IERR=0	CELL FREQ	10	13	6	9	18	3	10	11
CHISQP=14.0000	P=0.94882	DEN=0.0178	IERR=0	CHISQL=17.8654	P=0.98741	DEN=0.0047	IERR=0	CELL FREQ	13	12	11	13	14	2	4	11
CHISQP=14.2000	P=0.95226	DEN=0.0167	IERR=0	CHISQL=12.4145	P=0.91227	DEN=0.0291	IERR=0	CELL FREQ	10	10	8	7	20	6	7	12
CHISQP=14.2000	P=0.95226	DEN=0.0167	IERR=0	CHISQL=12.9017	P=0.92546	DEN=0.0251	IERR=0	CELL FREQ	14	7	6	7	19	11	9	7

CHISQP=14.2000	P=0.95226	DEN=0.0167	IERR=0	CHISQL=13.2025	P=0.93267	DEN=0.0229	IERR=0	CELL FREQ	8	7	13	7	19	5	9	12
CHISQP=14.2000	P=0.95226	DEN=0.0167	IERR=0	CHISQL=13.6489	P=0.94221	DEN=0.0199	IERR=0	CELL FREQ	9	7	12	17	16	5	7	7
CHISQP=14.2000	P=0.95226	DEN=0.0167	IERR=0	CHISQL=14.0425	P=0.94957	DEN=0.0175	IERR=0	CELL FREQ	15	9	5	6	17	6	13	9
CHISQP=14.2000	P=0.95226	DEN=0.0167	IERR=0	CHISQL=14.9082	P=0.96281	DEN=0.0132	IERR=0	CELL FREQ	13	12	9	13	17	4	5	7
CHISQP=14.2000	P=0.95226	DEN=0.0167	IERR=0	CHISQL=15.0410	P=0.96452	DEN=0.0126	IERR=0	CELL FREQ	11	8	15	3	17	11	8	7
CHISQP=14.2000	P=0.95226	DEN=0.0167	IERR=0	CHISQL=15.8259	P=0.97324	DEN=0.0097	IERR=0	CELL FREQ	6	14	12	12	16	3	11	6
CHISQP=14.4000	P=0.95549	DEN=0.0156	IERR=0	CHISQL=12.7012	P=0.92027	DEN=0.0267	IERR=0	CELL FREQ	12	8	6	6	20	10	8	10
CHISQP=14.4000	P=0.95549	DEN=0.0156	IERR=0	CHISQL=13.8947	P=0.94691	DEN=0.0184	IERR=0	CELL FREQ	13	10	10	7	19	4	7	10
CHISQP=14.4000	P=0.95549	DEN=0.0156	IERR=0	CHISQL=14.3548	P=0.95478	DEN=0.0159	IERR=0	CELL FREQ	8	17	11	4	9	6	16	9
CHISQP=14.4000	P=0.95549	DEN=0.0156	IERR=0	CHISQL=14.3548	P=0.95478	DEN=0.0159	IERR=0	CELL FREQ	11	6	8	9	17	4	16	9
CHISQP=14.4000	P=0.95549	DEN=0.0156	IERR=0	CHISQL=16.0235	P=0.97510	DEN=0.0091	IERR=0	CELL FREQ	14	15	10	8	15	3	5	10
CHISQP=14.4000	P=0.95549	DEN=0.0156	IERR=0	CHISQL=16.1942	P=0.97660	DEN=0.0085	IERR=0	CELL FREQ	7	5	15	13	11	3	15	11
CHISQP=14.4000	P=0.95549	DEN=0.0156	IERR=0	CHISQL=19.2645	P=0.99260	DEN=0.0028	IERR=0	CELL FREQ	12	14	11	8	7	1	12	15
CHISQP=14.6000	P=0.95852	DEN=0.0146	IERR=0	CHISQL=12.6771	P=0.91962	DEN=0.0269	IERR=0	CELL FREQ	7	7	13	7	20	7	10	9
CHISQP=14.6000	P=0.95852	DEN=0.0146	IERR=0	CHISQL=13.9019	P=0.94705	DEN=0.0184	IERR=0	CELL FREQ	9	14	19	9	9	4	9	7
CHISQP=14.6000	P=0.95852	DEN=0.0146	IERR=0	CHISQL=14.4232	P=0.95585	DEN=0.0155	IERR=0	CELL FREQ	9	15	6	15	16	5	7	7
CHISQP=14.6000	P=0.95852	DEN=0.0146	IERR=0	CHISQL=15.8786	P=0.97375	DEN=0.0095	IERR=0	CELL FREQ	7	11	9	13	16	3	15	6
CHISQP=14.6000	P=0.95852	DEN=0.0146	IERR=0	CHISQL=19.5290	P=0.99332	DEN=0.0026	IERR=0	CELL FREQ	11	6	12	12	16	1	12	10
CHISQP=14.6000	P=0.95852	DEN=0.0146	IERR=0	CHISQL=19.6478	P=0.99362	DEN=0.0025	IERR=0	CELL FREQ	13	6	9	11	15	1	12	13
CHISQP=14.8000	P=0.96135	DEN=0.0137	IERR=0	CHISQL=13.2364	P=0.93345	DEN=0.0226	IERR=0	CELL FREQ	5	8	12	7	9	8	11	20
CHISQP=14.8000	P=0.96135	DEN=0.0137	IERR=0	CHISQL=13.3913	P=0.93687	DEN=0.0216	IERR=0	CELL FREQ	8	5	11	6	11	9	10	20
CHISQP=14.8000	P=0.96135	DEN=0.0137	IERR=0	CHISQL=14.6274	P=0.95892	DEN=0.0145	IERR=0	CELL FREQ	18	8	14	7	12	5	5	11
CHISQP=14.8000	P=0.96135	DEN=0.0137	IERR=0	CHISQL=15.1589	P=0.96598	DEN=0.0122	IERR=0	CELL FREQ	11	14	5	15	16	5	8	6
CHISQP=14.8000	P=0.96135	DEN=0.0137	IERR=0	CHISQL=15.9266	P=0.97420	DEN=0.0094	IERR=0	CELL FREQ	3	7	11	16	16	6	10	11
CHISQP=14.8000	P=0.96135	DEN=0.0137	IERR=0	CHISQL=15.9368	P=0.97430	DEN=0.0093	IERR=0	CELL FREQ	7	6	10	10	13	3	17	14
CHISQP=14.8000	P=0.96135	DEN=0.0137	IERR=0	CHISQL=16.5343	P=0.97934	DEN=0.0076	IERR=0	CELL FREQ	13	6	4	14	13	4	11	15
CHISQP=15.0000	P=0.96400	DEN=0.0128	IERR=0	CHISQL=12.4241	P=0.91255	DEN=0.0290	IERR=0	CELL FREQ	8	10	9	6	21	8	8	10
CHISQP=15.0000	P=0.96400	DEN=0.0128	IERR=0	CHISQL=13.5476	P=0.94016	DEN=0.0205	IERR=0	CELL FREQ	7	7	15	9	10	6	7	19
CHISQP=15.0000	P=0.96400	DEN=0.0128	IERR=0	CHISQL=14.6378	P=0.95907	DEN=0.0145	IERR=0	CELL FREQ	19	11	8	8	12	4	12	6
CHISQP=15.0000	P=0.96400	DEN=0.0128	IERR=0	CHISQL=15.4306	P=0.96914	DEN=0.0111	IERR=0	CELL FREQ	10	6	9	11	19	3	11	11
CHISQP=15.0000	P=0.96400	DEN=0.0128	IERR=0	CHISQL=15.5261	P=0.97018	DEN=0.0107	IERR=0	CELL FREQ	17	7	11	9	12	5	15	4
CHISQP=15.0000	P=0.96400	DEN=0.0128	IERR=0	CHISQL=16.1236	P=0.97599	DEN=0.0088	IERR=0	CELL FREQ	3	5	11	10	11	9	18	13
CHISQP=15.0000	P=0.96400	DEN=0.0128	IERR=0	CHISQL=19.4578	P=0.99313	DEN=0.0026	IERR=0	CELL FREQ	17	10	7	11	11	1	13	10
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=12.6747	P=0.91956	DEN=0.0269	IERR=0	CELL FREQ	9	9	10	10	21	6	8	7
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=13.3868	P=0.93677	DEN=0.0216	IERR=0	CELL FREQ	8	7	20	13	7	8	6	11
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=13.9465	P=0.94786	DEN=0.0181	IERR=0	CELL FREQ	5	19	9	9	15	7	9	7
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=14.0442	P=0.94960	DEN=0.0175	IERR=0	CELL FREQ	7	14	12	6	19	6	7	9
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=14.2383	P=0.95290	DEN=0.0165	IERR=0	CELL FREQ	8	18	7	16	8	5	7	11
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=15.2695	P=0.96730	DEN=0.0117	IERR=0	CELL FREQ	10	9	5	15	18	4	10	9
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=15.6402	P=0.97139	DEN=0.0103	IERR=0	CELL FREQ	8	15	7	10	10	3	18	9
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=16.3057	P=0.97753	DEN=0.0082	IERR=0	CELL FREQ	10	5	9	12	18	3	13	10
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=16.6795	P=0.98042	DEN=0.0072	IERR=0	CELL FREQ	9	8	11	10	19	2	10	11
CHISQP=15.2000	P=0.96648	DEN=0.0120	IERR=0	CHISQL=******	P=*******	DEN=******	IERR=*	CELL FREQ	9	8	15	10	13	0	13	12
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=13.9122	P=0.94723	DEN=0.0183	IERR=0	CELL FREQ	6	12	6	11	20	6	10	9
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=14.8396	P=0.96189	DEN=0.0135	IERR=0	CELL FREQ	7	8	9	16	18	4	10	8
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=14.8846	P=0.96249	DEN=0.0133	IERR=0	CELL FREQ	9	10	8	10	19	4	14	6
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=15.3167	P=0.96785	DEN=0.0115	IERR=0	CELL FREQ	5	10	14	7	16	6	16	6
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=16.0710	P=0.97552	DEN=0.0089	IERR=0	CELL FREQ	9	10	17	7	16	3	7	11
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=16.1350	P=0.97609	DEN=0.0087	IERR=0	CELL FREQ	9	3	17	11	16	9	6	9
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=17.5109	P=0.98562	DEN=0.0054	IERR=0	CELL FREQ	6	10	13	10	18	2	11	10
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=17.9449	P=0.98778	DEN=0.0046	IERR=0	CELL FREQ	9	6	14	11	16	2	14	8
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=18.0974	P=0.98846	DEN=0.0044	IERR=0	CELL FREQ	13	12	10	6	16	2	7	14
CHISQP=15.4000	P=0.96880	DEN=0.0112	IERR=0	CHISQL=18.1196	P=0.98856	DEN=0.0043	IERR=0	CELL FREQ	8	14	8	14	15	2	6	13
CHISQP=15.6000	P=0.97097	DEN=0.0105	IERR=0	CHISQL=14.1227	P=0.95096	DEN=0.0171	IERR=0	CELL FREQ	10	8	6	9	20	5	13	9
CHISQP=15.6000	P=0.97097	DEN=0.0105	IERR=0	CHISQL=14.6658	P=0.95947	DEN=0.0143	IERR=0	CELL FREQ	9	14	12	7	19	6	5	8
CHISQP=15.6000	P=0.97097	DEN=0.0105	IERR=0	CHISQL=15.6542	P=0.97153	DEN=0.0103	IERR=0	CELL FREQ	9	10	9	8	19	3	14	8
CHISQP=15.6000	P=0.97097	DEN=0.0105	IERR=0	CHISQL=15.8049	P=0.97304	DEN=0.0098	IERR=0	CELL FREQ	15	6	8	5	15	5	10	16
CHISQP=15.6000	P=0.97097	DEN=0.0105	IERR=0	CHISQL=16.7422	P=0.98086	DEN=0.0071	IERR=0	CELL FREQ	3	13	8	14	12	7	17	6
CHISQP=15.8000	P=0.97299	DEN=0.0098	IERR=0	CHISQL=14.7340	P=0.96044	DEN=0.0140	IERR=0	CELL FREQ	8	12	11	10	20	8	4	7
CHISQP=15.8000	P=0.97299	DEN=0.0098	IERR=0	CHISQL=17.5859	P=0.98602	DEN=0.0052	IERR=0	CELL FREQ	8	14	12	8	9	2	18	9
CHISQP=15.8000	P=0.97299	DEN=0.0098	IERR=0	CHISQL=18.1359	P=0.98863	DEN=0.0043	IERR=0	CELL FREQ	11	16	8	11	16	6	2	10
CHISQP=16.0000	P=0.97488	DEN=0.0091	IERR=0	CHISQL=15.7089	P=0.97209	DEN=0.0101	IERR=0	CELL FREQ	10	9	3	10	20	7	10	11

CHISQP=16.0000	P=0.97488	DEN=0.0091	IERR=0	CHISQL=16.3054	P=0.97753	DEN=0.0082	IERR=0	CELL FREQ	7	4	12	9	16	5	17	10
CHISQP=16.0000	P=0.97488	DEN=0.0091	IERR=0	CHISQL=17.1715	P=0.98368	DEN=0.0061	IERR=0	CELL FREQ	11	4	14	15	16	7	9	4
CHISQP=16.0000	P=0.97488	DEN=0.0091	IERR=0	CHISQL=18.3041	P=0.98933	DEN=0.0040	IERR=0	CELL FREQ	16	2	14	10	15	7	7	9
CHISQP=16.0000	P=0.97488	DEN=0.0091	IERR=0	CHISQL=18.3464	P=0.98950	DEN=0.0040	IERR=0	CELL FREQ	9	6	13	11	17	2	8	14
CHISQP=16.0000	P=0.97488	DEN=0.0091	IERR=0	CHISQL=18.9243	P=0.99157	DEN=0.0032	IERR=0	CELL FREQ	11	12	6	13	15	2	6	15
CHISQP=16.0000	P=0.97488	DEN=0.0091	IERR=0	CHISQL=19.1162	P=0.99217	DEN=0.0030	IERR=0	CELL FREQ	12	2	14	15	11	7	14	5
CHISQP=16.2000	P=0.97665	DEN=0.0085	IERR=0	CHISQL=14.4270	P=0.95591	DEN=0.0155	IERR=0	CELL FREQ	8	10	6	6	20	7	9	14
CHISQP=16.2000	P=0.97665	DEN=0.0085	IERR=0	CHISQL=15.5356	P=0.97029	DEN=0.0107	IERR=0	CELL FREQ	16	11	5	18	10	6	8	6
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=15.3534	P=0.96827	DEN=0.0114	IERR=0	CELL FREQ	6	19	13	7	14	6	9	6
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=15.8705	P=0.97367	DEN=0.0096	IERR=0	CELL FREQ	16	5	11	10	18	5	8	7
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=16.3541	P=0.97793	DEN=0.0081	IERR=0	CELL FREQ	10	17	8	10	17	5	9	4
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=16.6040	P=0.97986	DEN=0.0074	IERR=0	CELL FREQ	17	9	8	5	16	4	13	8
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=16.7365	P=0.98082	DEN=0.0071	IERR=0	CELL FREQ	8	12	12	7	12	3	19	7
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=17.0566	P=0.98296	DEN=0.0063	IERR=0	CELL FREQ	3	13	10	5	19	10	10	10
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=17.1070	P=0.98328	DEN=0.0062	IERR=0	CELL FREQ	4	9	12	9	17	9	16	4
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=17.2357	P=0.98406	DEN=0.0059	IERR=0	CELL FREQ	15	9	8	6	17	3	8	14
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=18.3803	P=0.98963	DEN=0.0039	IERR=0	CELL FREQ	13	4	9	15	12	3	16	8
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=19.3926	P=0.99296	DEN=0.0027	IERR=0	CELL FREQ	11	12	7	16	14	2	13	5
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=20.5134	P=0.99544	DEN=0.0018	IERR=0	CELL FREQ	12	11	12	10	18	1	9	7
CHISQP=16.4000	P=0.97830	DEN=0.0080	IERR=0	CHISQL=20.6418	P=0.99566	DEN=0.0017	IERR=0	CELL FREQ	8	9	14	17	13	1	8	10
CHISQP=16.6000	P=0.97983	DEN=0.0074	IERR=0	CHISQL=15.6203	P=0.97118	DEN=0.0104	IERR=0	CELL FREQ	13	10	10	8	20	4	6	9
CHISQP=16.6000	P=0.97983	DEN=0.0074	IERR=0	CHISQL=16.6196	P=0.97998	DEN=0.0074	IERR=0	CELL FREQ	14	14	4	9	18	6	9	6
CHISQP=16.6000	P=0.97983	DEN=0.0074	IERR=0	CHISQL=18.9916	P=0.99179	DEN=0.0031	IERR=0	CELL FREQ	6	2	16	11	16	7	12	10
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=15.4014	P=0.96882	DEN=0.0112	IERR=0	CELL FREQ	5	12	7	9	20	6	8	13
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=15.5564	P=0.97051	DEN=0.0106	IERR=0	CELL FREQ	11	9	6	6	13	5	20	10
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=15.5564	P=0.97051	DEN=0.0106	IERR=0	CELL FREQ	13	10	9	11	20	6	6	5
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=15.5564	P=0.97051	DEN=0.0106	IERR=0	CELL FREQ	9	10	13	6	20	6	11	5
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=15.8206	P=0.97319	DEN=0.0097	IERR=0	CELL FREQ	6	4	11	9	20	8	9	13
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=17.1901	P=0.98379	DEN=0.0060	IERR=0	CELL FREQ	8	6	19	11	13	8	3	12
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=17.5131	P=0.98563	DEN=0.0054	IERR=0	CELL FREQ	12	3	12	8	19	5	11	10
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=17.6954	P=0.98658	DEN=0.0050	IERR=0	CELL FREQ	18	8	10	10	15	3	5	11
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=17.8351	P=0.98726	DEN=0.0048	IERR=0	CELL FREQ	12	9	8	16	17	3	10	5
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=19.1167	P=0.99217	DEN=0.0030	IERR=0	CELL FREQ	6	10	7	12	17	2	11	15
CHISQP=16.8000	P=0.98127	DEN=0.0069	IERR=0	CHISQL=19.2021	P=0.99242	DEN=0.0029	IERR=0	CELL FREQ	13	9	7	6	12	2	17	14
CHISQP=17.0000	P=0.98260	DEN=0.0064	IERR=0	CHISQL=16.2856	P=0.97737	DEN=0.0083	IERR=0	CELL FREQ	17	6	8	17	13	7	5	7
CHISQP=17.0000	P=0.98260	DEN=0.0064	IERR=0	CHISQL=17.7627	P=0.98691	DEN=0.0049	IERR=0	CELL FREQ	13	6	16	9	17	3	9	7
CHISQP=17.0000	P=0.98260	DEN=0.0064	IERR=0	CHISQL=21.4398	P=0.99683	DEN=0.0013	IERR=0	CELL FREQ	11	14	11	12	17	1	7	7
CHISQP=17.2000	P=0.98385	DEN=0.0060	IERR=0	CHISQL=15.1530	P=0.96591	DEN=0.0122	IERR=0	CELL FREQ	8	8	11	6	21	5	11	10
CHISQP=17.2000	P=0.98385	DEN=0.0060	IERR=0	CHISQL=16.7126	P=0.98065	DEN=0.0071	IERR=0	CELL FREQ	9	13	14	7	19	4	6	8
CHISQP=17.2000	P=0.98385	DEN=0.0060	IERR=0	CHISQL=18.2039	P=0.98892	DEN=0.0042	IERR=0	CELL FREQ	13	8	14	8	18	3	5	11
CHISQP=17.2000	P=0.98385	DEN=0.0060	IERR=0	CHISQL=18.5371	P=0.99023	DEN=0.0037	IERR=0	CELL FREQ	11	8	9	9	19	2	14	8
CHISQP=17.4000	P=0.98501	DEN=0.0056	IERR=0	CHISQL=14.9761	P=0.96369	DEN=0.0129	IERR=0	CELL FREQ	7	9	13	7	21	6	7	10
CHISQP=17.4000	P=0.98501	DEN=0.0056	IERR=0	CHISQL=19.0934	P=0.99210	DEN=0.0030	IERR=0	CELL FREQ	5	11	11	15	15	4	4	15
CHISQP=17.6000	P=0.98609	DEN=0.0052	IERR=0	CHISQL=15.5354	P=0.97028	DEN=0.0107	IERR=0	CELL FREQ	6	12	8	9	21	5	11	8
CHISQP=17.6000	P=0.98609	DEN=0.0052	IERR=0	CHISQL=16.1734	P=0.97642	DEN=0.0086	IERR=0	CELL FREQ	5	7	6	8	20	8	13	13
CHISQP=17.6000	P=0.98609	DEN=0.0052	IERR=0	CHISQL=16.4964	P=0.97905	DEN=0.0077	IERR=0	CELL FREQ	13	7	10	12	8	5	20	5
CHISQP=17.6000	P=0.98609	DEN=0.0052	IERR=0	CHISQL=16.7454	P=0.98089	DEN=0.0071	IERR=0	CELL FREQ	5	12	6	15	19	6	7	10
CHISQP=17.6000	P=0.98609	DEN=0.0052	IERR=0	CHISQL=17.0700	P=0.98305	DEN=0.0063	IERR=0	CELL FREQ	10	5	14	6	19	5	8	13
CHISQP=17.6000	P=0.98609	DEN=0.0052	IERR=0	CHISQL=17.4586	P=0.98533	DEN=0.0055	IERR=0	CELL FREQ	8	5	12	11	19	4	14	7
CHISQP=17.6000	P=0.98609	DEN=0.0052	IERR=0	CHISQL=17.5279	P=0.98571	DEN=0.0053	IERR=0	CELL FREQ	9	5	18	12	16	4	9	7
CHISQP=17.6000	P=0.98609	DEN=0.0052	IERR=0	CHISQL=18.4166	P=0.98977	DEN=0.0039	IERR=0	CELL FREQ	6	15	18	9	11	3	12	6
CHISQP=17.8000	P=0.98709	DEN=0.0048	IERR=0	CHISQL=18.1137	P=0.98853	DEN=0.0043	IERR=0	CELL FREQ	5	8	18	6	15	4	12	12
CHISQP=18.0000	P=0.98803	DEN=0.0045	IERR=0	CHISQL=17.9960	P=0.98801	DEN=0.0045	IERR=0	CELL FREQ	5	6	14	11	19	4	12	9
CHISQP=18.0000	P=0.98803	DEN=0.0045	IERR=0	CHISQL=19.1369	P=0.99223	DEN=0.0030	IERR=0	CELL FREQ	12	19	13	4	10	3	10	9
CHISQP=18.0000	P=0.98803	DEN=0.0045	IERR=0	CHISQL=19.4335	P=0.99307	DEN=0.0027	IERR=0	CELL FREQ	8	2	8	14	19	7	11	11
CHISQP=18.0000	P=0.98803	DEN=0.0045	IERR=0	CHISQL=19.5912	P=0.99348	DEN=0.0025	IERR=0	CELL FREQ	5	3	8	14	15	6	16	13
CHISQP=18.0000	P=0.98803	DEN=0.0045	IERR=0	CHISQL=19.6313	P=0.99358	DEN=0.0025	IERR=0	CELL FREQ	13	13	7	12	18	3	10	4
CHISQP=18.0000	P=0.98803	DEN=0.0045	IERR=0	CHISQL=19.9730	P=0.99437	DEN=0.0022	IERR=0	CELL FREQ	9	10	11	5	12	2	12	19
CHISQP=18.0000	P=0.98803	DEN=0.0045	IERR=0	CHISQL=20.5941	P=0.99558	DEN=0.0017	IERR=0	CELL FREQ	12	5	15	10	17	2	12	7
CHISQP=18.2000	P=0.98890	DEN=0.0042	IERR=0	CHISQL=16.1350	P=0.97609	DEN=0.0087	IERR=0	CELL FREQ	9	13	10	9	21	5	7	6
CHISQP=18.2000	P=0.98890	DEN=0.0042	IERR=0	CHISQL=17.4486	P=0.98528	DEN=0.0055	IERR=0	CELL FREQ	5	17	11	7	18	5	10	7
CHISQP=18.2000	P=0.98890	DEN=0.0042	IERR=0	CHISQL=19.0725	P=0.99204	DEN=0.0030	IERR=0	CELL FREQ	13	9	10	10	20	2	8	8

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CHISQP=18.2000  P=0.98890  DEN=0.0042  IERR=0  CHISQL=19.9668  P=0.99436  DEN=0.0022  IERR=0  CELL FREQ 11  5  5 12 15  3 12 17
CHISQP=18.2000  P=0.98890  DEN=0.0042  IERR=0  CHISQL=22.1691  P=0.99762  DEN=0.0009  IERR=0  CELL FREQ 17  9 12  7 16  1  9  9
CHISQP=18.4000  P=0.98971  DEN=0.0039  IERR=0  CHISQL=17.3546  P=0.98475  DEN=0.0057  IERR=0  CELL FREQ  5 10  9  6 20  5 11 14
CHISQP=18.4000  P=0.98971  DEN=0.0039  IERR=0  CHISQL=18.2970  P=0.98930  DEN=0.0041  IERR=0  CELL FREQ  6  7  3 10 13 10 11 20
CHISQP=18.4000  P=0.98971  DEN=0.0039  IERR=0  CHISQL=18.8393  P=0.99129  DEN=0.0033  IERR=0  CELL FREQ  7 13  6  5 18  4 13 14
CHISQP=18.4000  P=0.98971  DEN=0.0039  IERR=0  CHISQL=18.9907  P=0.99178  DEN=0.0031  IERR=0  CELL FREQ 11 12 19  4 13  6  4 11
CHISQP=18.4000  P=0.98971  DEN=0.0039  IERR=0  CHISQL=19.3153  P=0.99274  DEN=0.0028  IERR=0  CELL FREQ  3 15  6  6 17  8 10 15
CHISQP=18.4000  P=0.98971  DEN=0.0039  IERR=0  CHISQL=21.9453  P=0.99740  DEN=0.0010  IERR=0  CELL FREQ 12 13 10  8 19  1  9  8
CHISQP=18.6000  P=0.99046  DEN=0.0036  IERR=0  CHISQL=17.9439  P=0.98777  DEN=0.0046  IERR=0  CELL FREQ  6 16  6 10 19  4  9 10
CHISQP=18.6000  P=0.99046  DEN=0.0036  IERR=0  CHISQL=23.2425  P=0.99845  DEN=0.0006  IERR=0  CELL FREQ  6 12  7  9 15  1 15 15
CHISQP=18.6000  P=0.99046  DEN=0.0036  IERR=0  CHISQL=*******  P=*******  DEN=******  IERR=*  CELL FREQ  6 17 10 11 10  0 12 14
CHISQP=18.8000  P=0.99116  DEN=0.0034  IERR=0  CHISQL=19.2079  P=0.99244  DEN=0.0029  IERR=0  CELL FREQ  3 18  9  6  8 13  7 16
CHISQP=19.0000  P=0.99181  DEN=0.0031  IERR=0  CHISQL=19.0245  P=0.99189  DEN=0.0031  IERR=0  CELL FREQ 19 15 13  7  8  7  8  3
CHISQP=19.0000  P=0.99181  DEN=0.0031  IERR=0  CHISQL=21.0992  P=0.99637  DEN=0.0014  IERR=0  CELL FREQ 11 15 12 10 18  2  6  6
CHISQP=19.2000  P=0.99242  DEN=0.0029  IERR=0  CHISQL=18.7317  P=0.99093  DEN=0.0035  IERR=0  CELL FREQ  9 12 11  6 20  4  5 13
CHISQP=19.2000  P=0.99242  DEN=0.0029  IERR=0  CHISQL=20.2362  P=0.99492  DEN=0.0020  IERR=0  CELL FREQ 18  7 14 14 12  3  5  7
CHISQP=19.2000  P=0.99242  DEN=0.0029  IERR=0  CHISQL=24.4453  P=0.99905  DEN=0.0004  IERR=0  CELL FREQ 17 13  1 10 14  4 11 10
CHISQP=19.4000  P=0.99298  DEN=0.0027  IERR=0  CHISQL=21.4185  P=0.99680  DEN=0.0013  IERR=0  CELL FREQ 11 11 12  5 13  2 19  7
CHISQP=19.6000  P=0.99350  DEN=0.0025  IERR=0  CHISQL=18.2542  P=0.98913  DEN=0.0041  IERR=0  CELL FREQ  9 13  5 10 21  8  4 10
CHISQP=19.6000  P=0.99350  DEN=0.0025  IERR=0  CHISQL=18.4235  P=0.98980  DEN=0.0039  IERR=0  CELL FREQ  6 10 11  5 20  5 15  8
CHISQP=19.6000  P=0.99350  DEN=0.0025  IERR=0  CHISQL=20.4494  P=0.99532  DEN=0.0018  IERR=0  CELL FREQ  8  9  9 14 20  7  2 11
CHISQP=19.6000  P=0.99350  DEN=0.0025  IERR=0  CHISQL=20.6019  P=0.99559  DEN=0.0017  IERR=0  CELL FREQ  7 10 13 12 20  2  7  9
CHISQP=19.8000  P=0.99398  DEN=0.0023  IERR=0  CHISQL=18.9496  P=0.99165  DEN=0.0032  IERR=0  CELL FREQ 11  3 11 12 21  7  7  8
CHISQP=19.8000  P=0.99398  DEN=0.0023  IERR=0  CHISQL=20.4814  P=0.99538  DEN=0.0018  IERR=0  CELL FREQ  8 18 14  4 15  4  6 11
CHISQP=20.0000  P=0.99443  DEN=0.0022  IERR=0  CHISQL=21.3035  P=0.99665  DEN=0.0013  IERR=0  CELL FREQ 18  8 11  7 17  2  7 10
CHISQP=20.0000  P=0.99443  DEN=0.0022  IERR=0  CHISQL=21.6981  P=0.99714  DEN=0.0011  IERR=0  CELL FREQ  3  9 13 16 17  6  4 12
CHISQP=20.2000  P=0.99485  DEN=0.0020  IERR=0  CHISQL=19.6576  P=0.99364  DEN=0.0025  IERR=0  CELL FREQ 12  6 11  5 20  4  8 14
CHISQP=20.2000  P=0.99485  DEN=0.0020  IERR=0  CHISQL=22.1122  P=0.99757  DEN=0.0010  IERR=0  CELL FREQ  8  3 13 11 19  3 10 13
CHISQP=20.2000  P=0.99485  DEN=0.0020  IERR=0  CHISQL=22.1590  P=0.99761  DEN=0.0009  IERR=0  CELL FREQ 15 14  9 16 14  4  4  4
CHISQP=20.2000  P=0.99485  DEN=0.0020  IERR=0  CHISQL=23.8820  P=0.99880  DEN=0.0005  IERR=0  CELL FREQ  8 14 19  6 12  1 10 10
CHISQP=20.4000  P=0.99523  DEN=0.0019  IERR=0  CHISQL=19.6151  P=0.99354  DEN=0.0025  IERR=0  CELL FREQ  9  9  3  8 16  7 20  8
CHISQP=20.4000  P=0.99523  DEN=0.0019  IERR=0  CHISQL=21.0953  P=0.99637  DEN=0.0014  IERR=0  CELL FREQ  9 15  8 10 20  2  7  9
CHISQP=20.4000  P=0.99523  DEN=0.0019  IERR=0  CHISQL=21.3052  P=0.99666  DEN=0.0013  IERR=0  CELL FREQ  7 12 14  9 20  2  7  9
CHISQP=20.6000  P=0.99559  DEN=0.0017  IERR=0  CHISQL=17.9343  P=0.98773  DEN=0.0046  IERR=0  CELL FREQ  7  7 11 11 22  5 11  6
CHISQP=21.0000  P=0.99623  DEN=0.0015  IERR=0  CHISQL=22.0255  P=0.99749  DEN=0.0010  IERR=0  CELL FREQ  5  9 14 13 19  3 12  5
CHISQP=21.2000  P=0.99651  DEN=0.0014  IERR=0  CHISQL=19.0902  P=0.99209  DEN=0.0030  IERR=0  CELL FREQ  6  6 11  8 15  5 21  8
CHISQP=21.2000  P=0.99651  DEN=0.0014  IERR=0  CHISQL=21.5078  P=0.99691  DEN=0.0012  IERR=0  CELL FREQ  7 13 11  8 21 10  8  2
CHISQP=21.6000  P=0.99702  DEN=0.0012  IERR=0  CHISQL=17.5356  P=0.98575  DEN=0.0053  IERR=0  CELL FREQ  9  6  7  8 23  7  8 12
CHISQP=21.6000  P=0.99702  DEN=0.0012  IERR=0  CHISQL=17.8251  P=0.98722  DEN=0.0048  IERR=0  CELL FREQ 10 10  7  7 23  8 10  5
CHISQP=21.8000  P=0.99725  DEN=0.0011  IERR=0  CHISQL=18.9179  P=0.99155  DEN=0.0032  IERR=0  CELL FREQ  6  7  8  8 22  5 10 14
CHISQP=21.8000  P=0.99725  DEN=0.0011  IERR=0  CHISQL=22.2738  P=0.99772  DEN=0.0009  IERR=0  CELL FREQ  8 14  8  3 20  4 13 10
CHISQP=22.0000  P=0.99746  DEN=0.0010  IERR=0  CHISQL=21.8451  P=0.99730  DEN=0.0011  IERR=0  CELL FREQ  5  8  8 15 20  3  8 13
CHISQP=22.0000  P=0.99746  DEN=0.0010  IERR=0  CHISQL=21.8571  P=0.99731  DEN=0.0011  IERR=0  CELL FREQ  9 17  8  6 19  3 12  6
CHISQP=22.0000  P=0.99746  DEN=0.0010  IERR=0  CHISQL=24.1409  P=0.99892  DEN=0.0004  IERR=0  CELL FREQ 15 13 10  9 19  4  8  2
CHISQP=22.2000  P=0.99765  DEN=0.0009  IERR=0  CHISQL=21.6119  P=0.99704  DEN=0.0012  IERR=0  CELL FREQ  5  9  8 13 21  3 13  8
CHISQP=22.2000  P=0.99765  DEN=0.0009  IERR=0  CHISQL=21.8912  P=0.99735  DEN=0.0011  IERR=0  CELL FREQ 11  5 11  6 21  3 13 10
CHISQP=22.4000  P=0.99783  DEN=0.0009  IERR=0  CHISQL=20.1632  P=0.99477  DEN=0.0020  IERR=0  CELL FREQ  4 10  7 13 22  7  6 11
CHISQP=22.6000  P=0.99800  DEN=0.0008  IERR=0  CHISQL=23.0701  P=0.99834  DEN=0.0007  IERR=0  CELL FREQ 13  5  6  7 19  3 16 11
CHISQP=22.8000  P=0.99815  DEN=0.0007  IERR=0  CHISQL=19.1679  P=0.99232  DEN=0.0029  IERR=0  CELL FREQ  6  7  9 12 23  5  8 10
CHISQP=22.8000  P=0.99815  DEN=0.0007  IERR=0  CHISQL=23.2444  P=0.99845  DEN=0.0006  IERR=0  CELL FREQ  8 20 15 11  3  4 12  7
CHISQP=22.8000  P=0.99815  DEN=0.0007  IERR=0  CHISQL=23.6469  P=0.99869  DEN=0.0005  IERR=0  CELL FREQ 12  2 12 10 21  5 11  7
CHISQP=22.8000  P=0.99815  DEN=0.0007  IERR=0  CHISQL=26.5739  P=0.99960  DEN=0.0002  IERR=0  CELL FREQ  5 18 10  9 17  1 12  8
CHISQP=23.2000  P=0.99843  DEN=0.0006  IERR=0  CHISQL=21.7413  P=0.99719  DEN=0.0011  IERR=0  CELL FREQ  5 10  6 20 17  6  5 11
CHISQP=23.4000  P=0.99855  DEN=0.0006  IERR=0  CHISQL=20.6876  P=0.99574  DEN=0.0017  IERR=0  CELL FREQ  8  7  9  5 21  7 17  6
CHISQP=23.4000  P=0.99855  DEN=0.0006  IERR=0  CHISQL=24.8502  P=0.99919  DEN=0.0003  IERR=0  CELL FREQ 15  6  5 16 17  3  5 13
CHISQP=23.8000  P=0.99876  DEN=0.0005  IERR=0  CHISQL=22.5651  P=0.99797  DEN=0.0008  IERR=0  CELL FREQ 10  9  7 13 22  5 11  3
CHISQP=24.0000  P=0.99886  DEN=0.0005  IERR=0  CHISQL=22.0206  P=0.99748  DEN=0.0010  IERR=0  CELL FREQ  6  8  5  7 21  5 16 12
CHISQP=24.4000  P=0.99903  DEN=0.0004  IERR=0  CHISQL=24.2728  P=0.99898  DEN=0.0004  IERR=0  CELL FREQ 11  8  8  9 17  3  4 20
CHISQP=25.4000  P=0.99936  DEN=0.0003  IERR=0  CHISQL=23.9257  P=0.99883  DEN=0.0005  IERR=0  CELL FREQ  9 14  5  6 15  5 21  5
CHISQP=26.0000  P=0.99950  DEN=0.0002  IERR=0  CHISQL=23.0129  P=0.99830  DEN=0.0007  IERR=0  CELL FREQ  9 14  7  4 23  5  8 10
CHISQP=26.0000  P=0.99950  DEN=0.0002  IERR=0  CHISQL=29.5573  P=0.99989  DEN=0.0000  IERR=0  CELL FREQ 11 11  9 20 16  1  8  4
CHISQP=26.4000  P=0.99957  DEN=0.0002  IERR=0  CHISQL=26.2211  P=0.99954  DEN=0.0002  IERR=0  CELL FREQ 12 10 14  8 22  2  6  6
```

```
CHISQP=26.8000  P=0.99964  DEN=0.0001  IERR=0  CHISQL=22.4138  P=0.99785  DEN=0.0009  IERR=0  CELL FREQ 12  7 11  6 24  6  9  5
CHISQP=26.8000  P=0.99964  DEN=0.0001  IERR=0  CHISQL=23.7090  P=0.99872  DEN=0.0005  IERR=0  CELL FREQ  5  6 14 11 23  6 10  5
CHISQP=27.4000  P=0.99972  DEN=0.0001  IERR=0  CHISQL=25.1525  P=0.99929  DEN=0.0003  IERR=0  CELL FREQ  7  4  8 12 16  5  6 22
CHISQP=27.4000  P=0.99972  DEN=0.0001  IERR=0  CHISQL=26.4496  P=0.99958  DEN=0.0002  IERR=0  CELL FREQ 12 14 12  6 22  5  3  6
CHISQP=27.8000  P=0.99976  DEN=0.0001  IERR=0  CHISQL=21.9559  P=0.99741  DEN=0.0010  IERR=0  CELL FREQ  8  9  5  8 25  7  7 11
CHISQP=28.8000  P=0.99984  DEN=0.0001  IERR=0  CHISQL=25.1958  P=0.99930  DEN=0.0003  IERR=0  CELL FREQ  7  8  9 14 24  7  8  3
CHISQP=30.4000  P=0.99992  DEN=0.0000  IERR=0  CHISQL=28.5806  P=0.99983  DEN=0.0001  IERR=0  CELL FREQ  8  3 11  9 24  3 10 12
CHISQP=37.6000  P=1.00000  DEN=0.0000  IERR=0  CHISQL=36.6049  P=0.99999  DEN=0.0000  IERR=0  CELL FREQ 18  3  9  8 23  3 12  4
```

APPENDIX E

```
//RAI9AJM1 JOB (3023,2,1),'MILLER',MSGLEVEL=1,CLASS=5,TIME=1                JOB 648
//S1 EXEC SPSS
            XXSPSS PROC VERSION=H71,LABELS=2,SCRUNIT=SYSDA,DATA=10,                    00000100
            XX    LIBRARY='RAISYSTM.LINKLIB'                                           00000101
            XXGO    EXEC PGM=SPSS&VERSION,REGION=240K                                  00000200
IEF653I SUBSTITUTION JCL - PGM=SPSSH71,REGION=240K
            XXSTEPLIB  DD  DSN=&LIBRARY,DISP=SHR                                       00000300
IEF653I SUBSTITUTION JCL - DSN=RAISYSTM.LINKLIB,DISP=SHR
            XXFT01F001 DD UNIT=SYSDA,SPACE=(CYL,(&LABELS,1))                           00000400
IEF653I SUBSTITUTION JCL - UNIT=SYSDA,SPACE=(CYL,(2,1))
            XXFT02F001 DD DSN=&SCRNAME,UNIT=&SCRUNIT,LABEL=RETPD=0,                    00000500
IEF653I SUBSTITUTION JCL - DSN=&SCRNAME,UNIT=SYSDA,LABEL=RETPD=0,
            XX         SPACE=(CYL,(&DATA,5))                                           00000600
IEF653I SUBSTITUTION JCL - SPACE=(CYL,(10,5))
            XXFT03F001 DD  DDNAME=INSYSTM                                              00000700
            XXFT04F001 DD  DDNAME=OUTSYSTM                                             00000800
            XXFT05F001 DD DDNAME=SYSIN                                                 00000900
            XXFT06F001 DD SYSOUT=A                                                     00001000
            XXFT08F001 DD  DDNAME=INBCD                                                00001100
            XXFT09F001 DD  DDNAME=OUTBCD                                               00001200
            XXFT10F001 DD DSNAME=RAISYSTM.SPSSH.VERSION7.ACCOUNTS,DISP=SHR,            00001300
            XX DCB=BUFNO=1                                                             00001400
//GO.SYSIN DD *
//
                         IEF236I ALLOC. FOR RAI9AJM1 GO        S1
                         IEF237I 251    ALLOCATED TO STEPLIB
                         IEF237I 155    ALLOCATED TO FT01F001
                         IEF237I 156    ALLOCATED TO FT02F001
                         IEF237I 351    ALLOCATED TO FT05F001
                         IEF237I 387    ALLOCATED TO FT06F001
                         IEF237I 251    ALLOCATED TO FT10F001
IEF142I - STEP WAS EXECUTED - COND CODE 0000
                         IEF285I   RAISYSTM.LINKLIB                                KEPT
                         IEF285I   VOL SER NOS= LD3001.
                         IEF285I   SYS77232.T052533.RF000.RAI9AJM1.R0010549       DELETED
                         IEF285I   VOL SER NOS= LD3029.
                         IEF285I   SYS77232.T052533.RF000.RAI9AJM1.SCRNAME        DELETED
                         IEF285I   VOL SER NOS= LD3030.
                         IEF285I   RAISYSTM.SPSSH.VERSION7.ACCOUNTS               KEPT
                         IEF285I   VOL SER NOS= LD3001.
      IEF373I STEP /GO      / START 77235.1503
      IEF374I STEP /GO      / STOP  77235.1504 CPU    0MIN 01.52SEC MAIN 202K LCS    0K
IEL0002I STEP /GO     /  UNIT 251         137 EXCPS
IEL0002I STEP /GO     /  UNIT 155           0 EXCPS
IEL0002I STEP /GO     /  UNIT 156           2 EXCPS
IEL0002I STEP /GO     /  UNIT 351          10 EXCPS
IEL0002I STEP /GO     /  UNIT 387          39 EXCPS
IEL0002I STEP /GO     /  UNIT 251           2 EXCPS
IEL0003I STEP /GO     /  EXCPS:  DISK     141;  TAPE        0;  UR        49;  TP        0;  TOTAL      190;
      IEF375I  JOB /RAI9AJM1/ START 77235.1503
      IEF376I  JOB /RAI9AJM1/ STOP  77235.1504 CPU    0MIN 01.52SEC
```

SPSS FOR OS/360, VERSION H, RELEASE 7.1, JULY 11, 1977

```
DEFAULT SPACE ALLOCATION..      ALLOWS FOR..    100 TRANSFORMATIONS
WORKSPACE      70000 BYTES                      400 RECODE VALUES + LAG VARIABLES
TRANSPACE      10000 BYTES                     1600 IF/COMPUTE OPERATIONS

                    RUN NAME          CHI-SQUARE TEST CHECK JOB222
                    VARIABLE LIST     CATEGORY, FREQ
                    INPUT FORMAT      FREEFIELD
                    N OF CASES        5
                    WEIGHT            FREQ
                    NPAR TESTS        CHI-SQUARE = CATEGORY/

    GIVEN     1 VARIABLES, WORKSPACE ALLOWS FOR   4373 CASES

                    READ INPUT DATA
```

```
CHI-SQUARE TEST CHECK JOB222                                    08/23/77        PAGE    2

FILE    NONAME    (CREATION DATE = 08/23/77)

- - - - - CHI-SQUARE TEST

   CATEGORY

    VALUE            1.          2.          3.          4.          5.
    COUNT            4.          6.          5.          4.          6.
   EXPECTED          5.00        5.00        5.00        5.00        5.00

        CHI-SQUARE                  D.F.          SIGNIFICANCE
           0.800                     4               0.938
```

APPROVAL SHEET

The dissertation submitted by Adam J. Miller II has been read and approved by the following committee:

Dr. Jack A. Kavanagh, Director
Associate Professor, Foundations, Loyola

Dr. Samuel T. Mayo
Professor, Foundations, Loyola

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The final copies have been examined by the director of the dissertation and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the dissertation is now given final approval by the Committee with reference to content and form.

The dissertation is therefore accepted in partial fulfillment of the requirements for the degree of Doctor of Education.

April 23, 1979
Date

Jack A. Kavanagh
Director