STATISTISKA CENTRALBYRÅN 1978-11-07

PROMEMORIOR FRÅN P/STM
NR 2

LITTERATURFÖRTECKNING ÖVER ARTIKLAR OM KONTINGENSTABELLER

AV
ANDERS ANDERSSON

INLEDNING

TILL

Promemorior från P/STM / Statistiska centralbyrån. – Stockholm : Statistiska centralbyrån, 1978-1986. – Nr 1-24.

Efterföljare:

Promemorior från U/STM / Statistiska centralbyrån. – Stockholm : Statistiska centralbyrån, 1986. – Nr 25-28.

R & D report : research, methods, development, U/STM / Statistics Sweden. – Stockholm : Statistiska centralbyrån, 1987. – Nr 29-41.

R & D report : research, methods, development / Statistics Sweden. – Stockholm : Statistiska centralbyrån, 1988-2004. – Nr. 1988:1-2004:2.

Research and development : methodology reports from Statistics Sweden. – Stockholm : Statistiska centralbyrån. – 2006-. – Nr 2006:1-.

Promemorior från P/STM 1978:2. Litteraturförteckning över artiklar om kontingenstabeller / Anders Andersson.
Digitaliserad av Statistiska centralbyrån (SCB) 2016.

urn:nbn:se:scb-PM-PSTM-1978-2

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SAMMANFATTNING

Förteckningen omfattar artiklar, rapporter och andra skrifter rörande analys av kontingenstabeller, som har publicerats åren 1974-1978, i vissa fall tidigare.

Förteckningen består av följande fyra avsnitt.

1 Inledning

2 Refererenslista 1974-1978

3 Kategorisering av artiklar 1969-1978

4 Summering av innehåll i artiklar 1969-1978

Avsnitt 1 redogör för hur förteckningen är upplagd och vilka statistiska tidskrifter som har granskats.

Skrifter om kontingenstabeller, som har publicerats 1974 eller tidigare, förtecknas i R Killion & D Zahn, A Bibliography of Contingency Table Literature 1900 to 1974, International Statistical Review, 44, 71-112, 1976.

1 Inledning

Syftet med denna litteraturförteckning har varit att samla in uppgifter om publicerade artiklar som behandlar ämnet analys av data i kontingenstabeller.

Dels kan man se arbetet som en fortsättning på R Killion, D Zahn, "A Bibliography of Contingency Table Literature 1900 to 1974", International Statistical Review 44, 71-112, 1976, dels som en komplettering av ovanstående bibliografi, då i form av mer detaljerade uppgifter om en del av artiklarna.

Följande statistiska tidskrifter har granskats (med reservation för att någon artikel kan ha blivit förbigången):

THE AMERICAN STATISTICIAN	1975 - 3/78
APPLIED STATISTICS	1975 - 2/78
BIOMETRICS	1975 - 2/78
BIOMETRIKA	1975 - 2/78
JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION	1975 - 2/78
JOURNAL OF THE ROYAL STATISTICAL SOCIETY (A)	1975 - 2/78
JOURNAL OF THE ROYAL STATISTICAL SOCIETY (B)	1975 - 1/78
SCANDINAVIAN JOURNAL OF STATISTICS	1974 - 3/78

Litteraturförteckningen är uppdelad i fyra avsnitt. Avsnitt 2 är en referenslista som upptar artiklar och böcker publicerade 1974-1978 samt ett fåtal sådana före 1974 som ej ingår i Killion-Zahn.

En kort referenstitel säger ofta inte så mycket om vad en artikel innehåller. Avsnitt 3 och 4 av denna litteraturförteckning är förhoppningsvis till någon hjälp när det gäller att informera ytterligare om vad som skrivits inom området kontingenstabeller.

Avsnitt 3 består av ett försök att klassificera vissa av artiklarna från 1969-1978 i fem klasser med avseende på ämnesinriktning. Klassificeringen är gjord med hjälp av kryssmarkeringar, där varje kryss innebär att artikeln behandlar, helt eller delvis, det delområde inom ämnet som krysset representerar. Flertalet av artiklarna har följaktligen flera kryss, då ett delområde oftast inte kan särskiljas speciellt. Avsnittet avslutas med en kort lista på de artiklar som ger information om datorprogram för analys av kontingenstabeller, samt en förteckning över läroböcker som finns inom området.

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De artiklar som ingår i avsnitt 3 har inte utvalts enligt något speciellt system. Grundregeln har snarare varit att de artiklar som varit tillgängliga ingår i förteckningen. Visserligen har en viss gallring utförts, men som alltid är det svårt att avgöra vad som skall ingå och vad som bör strykas.

Avsnitt 4 består av de summeringar och introduktioner (summaries) som inleder artiklarna i föregående avsnitt, dvs från perioden 1969-1978. Då sökord (keywords) förekommer, har dessa inkluderats i förteckningen.

Det är en förhoppning att denna litteraturförteckning kan hållas "up to date" och vara så aktuell som möjligt. Huvudintresset har lagts på de statistiska frågeställningarna, men också inom sociologi och medicin förekommer en mängd tillämpningar. Åtskilliga artiklar av intresse finns säkert att hämta från tidskrifter inom dessa områden. Kompletteringar, rättelser och allmänna synpunkter på denna litteraturförteckning kan lämnas till Harry Lütjohann, P/STM.

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2 Referenslista 1974-1978

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Davis, J A (1974). The log linear analysis of survey replications. Social Indicator Models, 75-104. Edited by Kenneth C Land and Seymour Spilerman. New York: Russell Sage.

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Sundberg, R (1975). Some results about decomposable (or Markov-type) models for multidimensional contingency tables: Distribution of marginals and partitioning of tests. Scandinavian Journal of Statistics 2, 71-79.

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Tveter, J O (1972). On testing of independence in 2xR tables by stepwise test-procedure. Statistical Research Report, Institute of Mathematics, University of Oslo.

Whitehead, J (1978). Large sample sequential methods with applications to the analysis of 2x2 contingency tables. Biometrika 65, 351-356.

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3 Kategorisering av vissa artiklar 1969-1978 i fem ämnesinriktningar

1 Två-dimensionella kontingenstabeller
2 Multidimensionella kontingenstabeller
3 Kvasioberoende och ofullständiga tabeller
4 Alternativa analysansatser
5 Estimationsprinciper, andra än maximum-likelihood

	1	2	3	4	5
Altham (1975)	x		x		
Andersen (1974)		x		x	
Berkson, Nagnur (1974)		x			x
Bishop (1969)		x		x	
Bishop (1971)		x		x	
Bishop, Fienberg (1969)	x		x	x	x
Björn Jensen (1978)	x	x		x	
Bloomfield (1974)		x		x	
Brown (1976)		x		x	
Chen, Fienberg (1974)	x				x
Cohen, (1971)		x			
Collombier (1978)		x	x	x	
Fienberg (1969)	x		x	x	
Fienberg (1970)	x		x		
Fienberg (1972)		x	x	x	
Freeman (1975)	x		x		
Gillespie (1977)		x		x	
Gokhale (1971)		x		x	
Goodman (1970)		x		x	
Goodman (1971)		x			
Goodman (1973)		x		x	
Goodman (1974)		x		x	
Goodman (1975)		x			x
Grizzle, Koch, Starmer (1969)		x		x	
Grizzle, Williams (1972)		x		x	x
Haberman (1972)		x	x	x	
Haberman (1973)	x		x	x	
Haberman (1974)	x			x	
Haldorsen (1976)	x	x		x	
Haldorsen (1977)		x		x	
Imrey, Johnson, Koch (1976)		x	x		

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	1	2	3	4	5
Ku, Kullback (1974)		x		x	
Ku, Varner, Kullback (1971)	x	x			
Kvist (1975)		x		x	
Lee (1977)		x		x	
Lee (1978)		x		x	
Leonard (1975)	x			x	
Madsen (1976)		x		x	
Mantel (1970)	x		x		
Nagnur (1969)		x			x
Nelder (1974)		x		x	
Nerlove, Press (1973)		x		x	
Pokorny, Havranek (1978)		x			
Reynolds (1977)		x		x	
Simon (1974)	x			x	
Sundberg (1975)	x	x		x	

Artiklar som ger information om datorprogram för analys av kontingenstabeller

Bloomfield, P (1974). Linear transformations for multivariate binary data. Biometrics 30, 609-617.

Collombier, D (1978). On the treatment of truncated contingency tables and incomplete experimental designs. In COMPSTAT 78, Proceedings in Computational Statistics; 3rd Symposium held in Leiden 1978, ed. by L C A Corsten and I Hermans. Vienna: Physica-Verlag.

Dunér, B (1978). Analys av kvalitativa data med log-linjära modeller: metoder och program. 4-betygsuppsats vid statistiska institutionen, Uppsala universitet (handledare B Muthén och K G Jöreskog).

Haberman, S J (1972). Log-linear fit for contingency tables. Journal of the Royal Statistical Society, C (Applied Statistics) 21, 218-225.

Nerlove, M och Press, S J (1973). Univariate and multivariate log-linear and logistic models. Rand Corporation Technical Report R-1306-EDA/NIH, Santa Monica, California.

Pokorny, D och Havranek, T (1978). On some procedures for identifying sources of depence in contingency tables. In COMPSTAT 78, Proceedings in Computational Statistics; 3rd Symposium held in Leiden 1978, ed. by L C A Corsten and I Hermans. Vienna: Physica-Verlag.

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Bishop, Y M M, Fienberg, S E och Holland P W (1975). Discrete Multivariate Analysis: Theory and Practice. Cambridge, Mass.: The MIT Press.

Everitt, B S (1977). The Analysis of Contingency Tables. London: Chapman and Hall.

Fienberg, S E (1977). The Analysis of Cross-Classified Categorical Data. Cambridge, Mass.: The MIT Press.

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4 Summering av innehåll i artiklar 1969-1978

Altham, P M E (1975). Quasi-independent triangular contingency tables. Biometrics 31, 233-238.

> The model of quasi-independence in a triangular contingency table is parametrised in a way which is both easy to interpret probabilistically, and easy to analyse.

Andersen, A H (1974). Multidemensional contingency tables. Scandinavian Journal of Statistics 1, 115-127

> The aim of the paper is to give a survey of the theory of multidimensional contingency tables. For the n-dimensional contingency table, we discuss in the hierarchical models estimation of the interactions among the n criteria, and testing for these interactions. By means of general theory of exponential families, the existence and uniqueness of the maximum likelihood estimates, and asymptotic results about likelihood ratio tests and χ^2-tests, are obtained. It is shown that estimation, and the performance of asymptotic as well as exact tests, are particulary simple if only the decomposable models are considered.
>
> Key words: contingency table, log-linear model, interaction, hierarchical model, decomposable model, exact test.

Berkson, J och Nagnur, B N (1974). A note on the minimum χ^2_1 estimate and a L A M S T (Locally Asymptotically Most Stringent Test) χ^2 in the "no interaction" problem. Journal of the American Statistical Association 69, 1038-1040.

> A method is presented of obtaining the minimum χ^2_1 estimates for the problem of "no interaction" defined in the model of logit additivity, with some examples, and these are compared with the ML estimates. The χ^2_L of Nagnur is compared with the Pearson χ^2 for the two sets of estimates, and a striking difference in the comparison of the two χ^2's for the ML and minimum χ^2_1 estimates is noted.

Bishop, Y M M (1969). Full contingency tables, logits and split contingency tables. Biometrics 25, 383-399.

> Three methods of fitting log-linear models to multivariate contingency-table data with one dichotomous variable are discussed. Logit analysis is commonly used when a full contingency table of s dimensions is regarded as a table of rates of dimension s - 1. The split-table method treats the same data as two separate tables each of dimension s - 1. We show that the full contingency-table method can be regarded as a generalized approach: models which can be fitted by it include both the mutually exclusive

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subsets that can be fitted by the other two methods. Even when the logit method permits the model of choice to be fitted, the full contingency-table method of iterative proportional fitting to the set of sufficient configurations has the advantage of requiring neither matrix inversion nor substitution of an arbitrary value in empty elementary cells.

Bishop, Y M M (1971). Effects of collapsing multidimensional contingency tables. Biometrics 27, 545-562.

The conditions are defined under which collapsing multidimensional contingency tables, by adding over variables, will affect the apparent interaction between the remaining variables. This leads to a simple method of distinguishing those log-linear models for which the cell estimates may be obtained by direct multiplication, from those requiring iterative fitting. The implications of fitting over-parametrized models are discussed with particular reference to the "partial association" model used implicitly (a) when information from separate two-dimensional tables is combined to test the association between the two variables, and (b) when rates are adjusted by indirect standardization.

Bishop, Y M M och Fienberg, S E (1969). Incomplete two-dimensional contingency tables. Biometrics 25, 119-128.

This paper examines the estimation of expected cell counts in two-dimensional contingency tables when some of the cells are known a priori to be empty. A log-linear model, corresponding to the model of independence or homogeneity for "complete" tables, is fitted to the cell counts. The resulting cell estimates can always be computed by an iterative proportional fitting method, although some tables can be fitted directly. The direct method of fitting is applied to a set of medical data. It is pointed out that the iterative proportional fitting method can readily be extended to tables of higher dimensionality.

Björn Jensen, E (1978). Conditional plausibility inference in contingency tables. Scandinavian Journal of Statistics 5, 129-140.

Conditional plausibility methods are developed for the examination of a reduction from one decomposable model to another decomposable model in a contingency table. It is shown, by a slight extension of a result of Sundberg (1975), that it suffices to consider the hypothesis of homogeneity in a one-dimensional table and the hypothesis of independence in a two-dimensional table. Conditional plausibility estimates and tests are derived for these two hypotheses and a general procedure for studying the plausibility surface is suggested. A concrete three-diminsional table

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is analysed by the derived plausibility methods.

Key words: plausibility theory, conditional analysis, contingency tables, decomposable models, conditional modes.

Bloomfield, P (1974). Linear transformations for multivariate binary data. Biometrics 30, 609-617.

The interpretation of statistical data may often be simplified by a preliminiary transformation. In the context of contingency tables, one way of achieving this would be to relabel the possible outcomes, or in other words to permute the cells of the table. For a 2^d table, certain permutations have the property that a loglinear model for the cell probabilities transforms in a simple way. These are, in a sense, linear transformations of the original variables.

The aim of making such a transformation is to fit the transformed data by a simple model, such as a low-order hierarchical model or one in which certain variables are independent of others. A 2^4 table has been analyzed with this end in view. All the models were fitted to the original data, and to do this a computer program has been developed which will fit nonhierarchical models by iterative scaling.

Brown, M B (1976). Screening effects in multidimensional contingency tables. Applied Statistics 25, 37-46.

Using the parallelism between the general linear hypothesis and the log-linear models, we propose that the importance of effects in the log-linear model for multidimensional contingency tables be studied by computing two test statistics for each effect. These test statistics, called marginal and partial association, indicate the order of magnitude of the change in the tests-of-fit when the effect is either entered or deleted from a model. Hence effects may be labelled as definitely needed in the model, definitely not needed, and "uncertain". The set of models which require further analysis is then limited to those models which include the effects definitely needed and reasonable combinations of the "uncertain" effects.

Key words: Log-linear model, multidimensional contingency table, minimum discriminant information statistic, general linear hypothesis, marginal association, partial association.

Chen, T och Fienberg, S E (1974). Two-dimensional contingency tables with both completely and partially cross-classified data. Biometrics 30, 629-642.

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Models are developed for the analysis of contingency table data with supplemental marginal totals. The method of maximum likelihood is used to estimate the parameters in the models, and the expected cell values for goodness-of-fit statistics. The value of utilizing the supplemental margins is discussed in terms of asymptotic variances and the consistency of estimates. The approach developed is illustrated in a 2x2 table example. In the final section the general case of partially cross-classified observations in two-dimensional contingency tables is considered.

Cohen, J E (1971). Estimation and interaction in a censored 2x2x2 contingency table. Biometrics 27, 379-386.

An iterative procedure is presented for obtaining the maximum likelihood estimates of the probabilities of three noninteracting attributes when the available observations are the number of individuals having none of the attributes, the numbers of individuals having each one and only that one of the attributes, and the number of individuals having two or more of the attributes. The prodedure is applied to observations of the prevalence of single and mixed infections of human malaria. The results are interpreted with caution.

Collombier, D (1978). On the treatment of truncated contingency tables and incomplete experimental designs. COMPSTAT 1978, 215-220.

Some results on the treatment of truncated contingency tables and incomplete experimental designs are given, especially for the two way tables and designs. These results concern the detection of the connected components and of the non-interactive cells, the formulation of the hypotheses, the computation of the degrees of freedom and the estimation in (quasi) log-linear models.

Key words: Contingency tables, log-linear models, experimental designs, linear models.

Fienberg, S E (1969). Preliminary graphical analysis and quasi-independence for two-way contingency tables. Applied Statistics 18, 153-168.

Interactions in two-way contingency tables are described by means of a linear model in the logarithmic scale for the cell probabilities. A graphical procedure, based on the half-normal plotting technique, is described for locating cells exhibiting interaction, when the number of such cells is relatively small compared with the total number of cells in the table. A quasi-independent model is introduced which allows the cells not separated by the graphical procedure to have a multiplicative structure, similar to that for independence of row and column classifications. These ideas are then applied to the analysis of an occupational mobility table.

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Fienberg, S E (1970). Quasi-independence and maximum likelihood estimation in incomplete contingency tables. Journal of the American Statistical Association 65, 1610-1616.

Many authors have been concerned with contingency tables containing cells which are missing, a priori zero or otherwise specified. This article examines the problem of maximum likelihood estimation for such tables under the "quasi-independence" model. In particular, conditions are provided to ensure the existence of unique nonzero maximum likelihood estimates for the cells of incomplete tables obtained by deleting the missing or a priori zero cells, even when other cells contain zero counts due to sampling variation.

Fienberg, S E (1972). The analysis of incomplete multi-way contingency tables. Biometrics 28, 177-202.

Several authors have recently considered the analysis of contingency tables containing cells which are missing, a priori zero, or otherwise specified. Such tables are usually referred to as being incomplete. This paper reexamines this recent literature and shows how the methodology can be extended to the analysis of incomplete multi-way cross-classifications. Several examples are given, and the methods developed here are examined in the light of these examples. The emphasis is on the use of techniques for the actual analysis of data and on the ties with the analysis of complete multi-way tables.

Key words: Computation of expected cell values, degrees of freedom for goodness-of-fit tests, incomplete contingency tables, log-linear models, maximum likelihood estimation, multiway contingency tables, multinomial data, poisson sampling scheme, quasi-independence, quasi-loglinear models, separability, structural zeros.

Freeman, G H (1975). Analysis of interactions in incomplete two-way tables. Applied Statistics 24, 46-55.

In incomplete two-way tables, analysis of variance can be used only to find adjusted means and sums of squares. It is proposed that, even in very incomplete tables, missing plot values can sometimes be fitted and the interaction sum of squares partitioned into principal components in the same way as with complete data. An example is given in detail in which this method of analysis gives a useful guide to the combination of results from many different trials.

Key words: Incomplete two-way tables, interactions, principal component analysis.

Gillespie, M W (1977). Log-linear techniques and the regression analysis of dummy dependent variables. Sociological Methods & Research 6, 103-122.

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The main body of this paper consists of two sections. The first reviews the statistical advantages of the log-linear techniques and briefly takes issue with two less convincing arguments that have been offered as reasons for the use of these techniques. The second section presents three arguments for the use of dummy dependent-variable regression: (a) the ability of dummy dependent-variable regression to accommodate both discrete and continous independent variables, (b) the ability to manipulate algebraically the reduced-form equations of dummy dependent-variable regression in order to decompose zero-order relationship into causal and noncausal components and to calculate separate reciprocal effects in the case of simultaneous equation models, and (c) the ability of dummy dependent-variable regression to yield estimates of "fundamental parameters" - i.e., coefficients that correspond to the causal structure that generated the observed relations between the variables. Since we regard this last advantage as the most important, we spend more time examining it.

Before proceeding, two caveats are in order. First, this paper focuses on the use of log-linear techniques only as a method for evaluation path analytic or structural equation models; the other uses to which log-linear techniques can be put (Bishop et al., 1975: chs. 5-8) are not considered. Second, the importance of the advantages of dummy dependent-variable regression that we present is subject to legitimate dispute; therefore, we want to downplay any authoritative stance that this paper might convey with regard to which of the two techniques is better or more useful.

Gokhale, D V (1971). An iterative procedure for analysing log-linear models. Biometrics 27, 681-687.

For a class of log-linear models in multinomial experiments, an iterative procedure is proposed for obtaining maximum likelihood estimates of cell frequencies. A condition is given under which the above estimates also conform to restrictions on the cell frequencies imposed by the sampling scheme. The iterative procedure is applied to a three-way contingency table for obtaining estimates for cells under a hypothesis about some interaction parameters.

Goodman, L A (1970). The multivariate analysis of qualitative data: Interactions among multiple classifications. Journal of the American Statistical Association 65, 226-256.

For the m-way contingency table, we discuss both the direct estimation of the multiplicative interactions among the m variables, and the indirect testing of hypotheses pertaining to these interactions. We consider, among other things, hierarchical hypotheses pertaining to the interactions among the m variables,

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including hypotheses that can be expressed in terms of one or more of the following kinds of concepts: (a) the usual concepts of independence and equiprobability; (b) concepts describing conditional properties (e.g. conditional independence) pertaining to a subset of the m variables, given the level of some of the remaining variables; (c) concepts related to the usual logit-analysis or to a generalized form of logit-analysis; and (d) concepts related to a more general log-linear model. Methods of partitioning these hypotheses are introduced which provide, among other things, insight into the relationship between tests applied to the m-way table and tests applied to marginal tables formed from the m-way table. We also show, by example, how the combined use of direct estimation and indirect testing can lead to the discovery of hypotheses (models) that fit the data in the m-way table better than the hypotheses that have been fitted in the earlier literature.

Goodman, L A (1971). Paritioning of chi-square, analysis of marginal contingency tables, and estimation of expected frequencies in multi-dimensional contingency tables. Journal of the American Statistical Association 66, 339-344.

A step-by-step method is presented herein for partitioning a certain kind of hypothesis H about the m-way contingency table into (a) a series of hypotheses about marginal tables formed from the m-way table by ignoring one or more of table's m dimensions; and (b) a hypothesis about independence, conditional independence, or conditional equiprobability in the m-way table. This step-by-step method facilitates both the testing of H and the calculation of $\hat{F}$, the estimated expected frequencies in the m-way table under H. The method introduced herein for calculating $\hat{F}$ is easier to apply than the usual iterative-scaling method in many cases.

Goodman, L A (1973). The analysis of multidimensional contingency tables when some variables are posterior to others: A modified path analysis approach. Biometrika 60, 179-192.

Models and methods for analyzing the relations among a set of polytomous variables, when some of the variables are posterior to others, are presented. The techniques proposed here yield "path diagrams" that are somewhat analogous to those used in path analysis. Earlier path analysis models are not suited to the case where the variables are polytomous, or dichotomous, but the models proposed herein are. For each of our models, methods are presented for (a) testing whether the model fits the data, (b) partitioning the test statistic into components that can be used to test submodels within the overall model, and (c) estimating the parameters in the model. An illustrative application is also included.

Some key words: Multidimensional contingency tables,

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log-linear models, logistic models, system of simultaneous logistic models, path analysis for polytomous variables, maximum likelihood estimation, tests of fit of models.

Goodman, L A (1974). Exploratory latent structure analysis using both identifiable and unidentifiable models. Biometrika 61, 215-231.

This paper considers a wide class of latent structure models. These models can serve as possible explanations of the observed relationships among a set of m manifest polytomous variables. The class of models considered here includes both models in which the parameters are identifiable and also models in which the parameters are not. For each of the models considered here, a relatively simple method is presented for calculating the maximum likelihood estimate of the frequencies in the m-way contingency table expected under the model, and for determining whether the parameters in the estimated model are identifiable. In addition, methods are presented for testing whether the model fits the observed data, and for replacing unidentifiable models that fit by identifiable models that fit. Some illustrative applications to data are also included.

Some key words: Contingency tables, latent structure, log-linear models, maximum likelihood estimation, tests of fit.

Goodman, L A (1975). On the relationship between two statistics pertaining to tests of three-factor interaction in contingency tables. Journal of the American Statistical Association 70, 624-625.

This note solves a problem posed by Berkson and Nagnur at the end of their recent article (2). The problem pertains to the relationship between two particular statistics that can be used in the three-way contingency table to test the null hypothesis H_0 of zero three-factor interaction; viz., the usual chi-square goodness-of-fit statistic and a statistic proposed by Nagnur (9). Although the formulas for these two statistics appear to be quite different, we shall prove that the two statistics are equal when the expected frequencies under H_0 are estimated by the usual maximum-likelihood method. This equality holds true both for the 2x2xK contingency table and also the IxJxK table.

Grizzle, J E, Koch, G G och Starmer, C F (1969). Analysis of categorial data by linear models. Biometrics 25, 489-504.

Assume there are n_i, $i = 1, 2, \ldots, s$, samples from s multinomial distributions each having r categories of response. Then define any u functions of the unknown true cell probabilities $\{\pi_{ij}: i = 1, 2, \ldots, s; j = 1, 2, \ldots, r, \text{ where } \sum_{i=1}^{r} \pi_{ij} = 1\}$ that have

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derivatives up to the second order with respect to π_{ij}, and for which the matrix of first derivatives is of rank u.

A general noniterative procedure is described for fitting these functions to a linear model, for testing the goodness-of-fit of the model, and for testing hypotheses about the parameters in the linear model.

The special cases of linear functions and logarithmic functions of the π_{ij} are developed in detail, and some examples of how the general approach can be used to analyze various types of categorical data are presented.

Grizzle, J E och Williams, O D (1972). Log-linear models and tests of independence for contingency tables. Biometrics 28, 137-156.

Statistical methods for testing independence in multiway contingency tables which are based on the correspondence between the analysis of factorial experiments and tests of marginal independence are developed. This relationship simplifies the interpretation of analyses of contingency tables and leads to simplified tests for tables in which some of the probabilities are constrained to be zero. The linear models approach is used to calculate smoothed estimates of probabilities.

Key words: Multinomial distribution, independence, association, log-linear model, chi-square, interaction, weighted least squares.

Haberman, S J (1972). Log-linear fit for contingency tables. Journal of the Royal Statistical Society, C (Applied Statistics) 21, 218-225.

Language: ANSI Standard Fortran.

This algorithm performs an iterative proportional fit of the marginal totals of a contingency table. The method used has been described by Deming and Stephan (1942), Fienberg (1970) and Goodman (1970). The algorithm may be used to obtain maximum likelihood estimates which correspond to hierarchical log-linear models for both complete and incomplete contingency tables.

Haberman, S J (1973). The analysis of residuals in cross-classified tables. Biometrics 29, 205-220.

Techniques are proposed for analysis of residuals associated with log-linear models for frequency tables. Results are applied to two-way tables and logit models.

Key words: Logit analysis, contingency tables, residuals, incomplete tables.

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Haberman, S J (1974). Log-linear models for frequency tables with ordered classifications. Biometrics 30, 589-600.

Log-linear models are proposed for use with frequency tables with ordered classifications. Procedures are given for selection of models, determination of maximum likelihood (ML) equations, computation of ML estimates, and determination of asymptotic variances and tests.

Haldorsen, T (1976). Forelesninger om avhengighetsmål i kontingenstabeller av universitetslektor Harald Goldstein. Statistisk sentralbyrå, Arbeidsnotat IO 76/27.

1 Innledning
2 Faktorer av betydning for valg av betraktningsmåte
3 To responsvariable på ordinalnivå
4 To variable på nominalnivå
5 Samsvar, en spesiell form for sammenheng
6 Klasseinndelningen av materialet
7 Et spesielt syn på assosiasjon i kontingenstabeller
8 Log-lineære modeller

Haldorsen, T (1977). Om Log-lineær analyse av flerveistabeller. Statistisk sentralbyrå, Arbeidsnotat IO 77/46.

Notatet inneholder en del momenter om log-lineær analyse av flerveistabeller. Data til et gjennomgangseksempel er tatt fra helseundersøkelsen 1975 og er om tannlegekontakter.

Log-lineære modeller gir oss et system for å beskrive og finne fram til strukturen i en flerveistabell. På en forholdsvis naturlig og oversiktlig måte avbildes de kompliserte former for avhengighet/uavhengighet det kan være mellom to eller flere variable i en flerveistabell. Beregningene som kreves, kan utføres av programmet ECTA som er lagt inn på Byråets regneanlegg.

I kapittel 2 har vi en kort omtale av modellene. For tillfellet med tre variable belyser vi tolkningen av parametrene og nevner noen av de strukturer som kan beskrives ved modellene. Videre ser vi på observatoren som vi vil bruke for å teste ulike hypoteser. I kapittel 3 presenteres data og vi viser hvordan en spesiell hypotese om tabellen kan testes. Videre behandler vi situasjonen når vi vil bruke data til å lete etter en modell. Vi fortsetter letingen etter modell i kapittel 4 og drøfter da ulike trinnvise prosedyrer. I kapittel 5 tolkes den endelige modell ved hjelp av parametrene i modellen og ved alternative metoder. Hvis data består av stratifiserte utvalg og/eller en velger en spesiell betraktningsmåte for sine variable, er det aktuelt å modifisere den generelle metode. Vi behandler dette i kapittel 6. Kapittel 7 inneholder noen momenter om å sløyfe en eller flere variable i analysen.

Stoff om log-lineære modeller finnes etterhvert i flere lærebøker. Vi har brukt Bishop, Fienberg and Holland (1975) som referanse. Boken krever ikke store forkunnskaper i matematisk statistik og inneholder mange eksempler.

Imrey, P B, Johnson, W D och Koch, G G (1976). An incomplete contingency table approach to paired-comparison experiments. Journal of the American Statistical Association 71, 614-623.

A wide varety of paired-comparison experiments and surveys may be viewed within the framwork of "incomplete" contingency table analysis. Bradley-Terry models for such data can be chosen and further examined by a noniterative logit analysis. Multivariate paired comparisons with factor structure can be analyzed through reparameterization of the underlying models for each combination of factor levels. The method is subject to sample-size restrictions but allows the experimenter to design his survey without complex symmetry conditions or independence assumptions.

Ku, H H och Kullback, S (1974). Log-linear models in contingency table analysis. The American Statistician 28, nov 1974, 115-125.

In recent statistical literature dealing with the analysis of categorical data in the form of multiway cross-classifications or contingency tables, some authors have alluded to the analogy of such analyses with those used for quantitative data, in particular analysis of variance and regression analysis techniques. We propose to illustrate, through the use of two examples, the estimation and testing of parameters in the log-linear model which is for contingency tables the counterpart of the linear model in the continuous variate case.

Ku, H H, Varner, R N och Kullback, S (1971). On the analysis of multidimensional contingency tables. Journal of the American Statistical Association 66, 55-64.

The principle of minimum discrimination information estimation is described and used to generate estimates for tests of hypotheses concering various interactions and effects in the analysis of multidimensional contingency tables. All classical hypotheses for contingency tables can be generated by the use of this principle when certain marginals are considered as fixed. Analysis of information tables are given for a four-way contingency table.

Kvist, H K (1975). Log-lineære modeller for kontingenstabeller. Rapport fra Nordisk møde om statistisk metodearbejde, Statens Samfundsvidenskabelige Forskningsråd.

Mit foredrag ved mødet var en gennemgang af visse dele af A H Andersen (1) reviewartikel om de log lineære modeller for kontingenstabeller.

I det følgende vil jeg i stedet anvende denne teori på 3 eksempler. Disse 3 eksempler er baseret på de udtrukne personer til en SFI-undersøgelse. Udtrækningsprocedure er nærmere beskrevet i den til denne rapport svarende rapport fra Stockholm, marts 1976.

Lee, S K (1977). On the asymptotic variances of $\hat{u}$ terms in log-linear models of multidimensional contingency tables. Journal of the American Statistical Association 72, 412-419.

Loglinear models are classified as direct or indirect depending on whether the maximum likelihood estimates of cell values are explicit functions of the sufficient statistics or not. For saturated (hence, direct) models, Goodman (1970) and Bishop, Fienberg and Holland (1975) used the δ method to calculate the asymptotic variances of various $\hat{u}$ terms in the loglinear models. In the present paper, this approach has been generalized to direct unsaturated hierarchical log-linear models. General rules for determining closed form expressions for asymptotic variances in such situations are obtained; bounds for the asymptotic variances of $\hat{u}$ terms in indirect models are considered; and these rules are compared with other methods of producing asymptotic variances.

Key words: Multidimensional contingency tables, log-linear models, maximum likelihood estimates, δ method, asymptotic variances.

Lee, S K (1978). An example for teaching some basic concepts in multidimensional contingency table analysis. The American Statistician 32, 69-71.

A data set in the form of a 2x2x2 contingency table is presented and analyzed in detail. For instructional purposes, the analysis of the data can be used to illustrate some basic concepts in the log-linear model approach to the analysis of multidimensional contingency tables.

Key words: Log-linear models, analysis of multidimensional contingency tables, standardized cell residuals.

Leonard, T (1975). Bayesian estimation methods for two-way contingency tables. Journal of the Royal Statistical Society, Ser B, 37, 23-37.

Estimation methods are proposed for the row, column and interaction effects in two-way contingency tables, the one-way table being treated as a special case. The methods are appropriate when the parameters are thought a priori to be related to each other. The posterior estimates have the practical effects of smoothing the contingency table, and are valid even if some of the cell frequencies are zero. The main case treated is where particular assumptions of exchangeability are

reasonable a priori for the unkown parameters. Some possible relaxations of the exchangeability assumptions are discussed. The methods are used to provide a numerical analysis of a mobility table originally due to Karl Pearson, and to measure the association between the occupations of fathers and sons in this table.

Key words: Contingency tables, multinomial distributions, multivariate logits, log-linear models, marginal and interaction effects, zero cell frequencies, exchangeability, shrinkage of estimates, likelihood approximations, ordered relationships, occupational mobility tables, fourfold exchangeability, measures of association.

Madsen, M (1976). Statistical analysis of multiple contingency tables. Two examples. Scandinavian Journal of Statistics 3, 197-106.

The paper describes in detail how the general log-linear model for contingency tables works out in two practial examples. Only that part of the theory, which is strictly necessary for understanding the analysis is described. The paper does not give any new result but discusses some of the problems to which the theory does not give any answers.

Key words: contingency table, log-linear model, hierarchical model, interactions, fitted marginals.

Mantel, N (1970). Incomplete contingency tables. Biometrics 26, 291-304.

Goodman's work on quasi-independence and missing values for contingency tables is unified so as to cover in general incompleteness, as here defined. Cyclic computational procedures are provided for maximum likelihood fitting of incomplete data. Methods are given for determining appropriate degrees of freedom, whether by identifying separable or semiseparable subtables or by elimination of cell isolates. There is discussion of how incompleteness might arise in other contingency-table situations, e.g. in testing symmetry for square contingency tables. But it is suggested that use of some power-increasing test might be preferable for detecting departures from symmetry.

Nagnur, B N (1969). Locally asymptotically most stringent test (L A M S T) and the hypothesis of no three-factor interaction in contingency tables. Journal of the American Statistical Association 64, 207-215.

A new class of tests is presented for testing the hypothesis of no second order interaction in three-way contingency tables. This hypothesis is expressed first in the form of linear contrasts in logarithms

of the parameters of a multinomial experiment and the test is based on the general theory of locally asymptotically most stringent tests. Specific test criteria are then given for testing no second order interaction in 2x2x2, 2x2xK and IxJxK contingency tables. Two examples are discussed.

Nelder, J A (1974). Log-linear models for contingency tables: A generalization of classical least squares. Journal of the Royal Statistical Society, C (Applied Statistics) 23, 323-329.

Log-linear models for contingency tables of counts are formulated as a special case of generalized linear models with an additive systematic component Y, Poisson errors for the data and an exponential linking function connecting the expected values of the observations with the predicted Y. Dichotomous response variates can be treated by an extension of this model or equivalently as another generalized linear model with binomial errors. A program package is described for fitting these models, and some redundancies in the literature noted.

Key words: Log-linear model, generalized linear model, contingency table, least squares, iterative weighted regression, poisson errors.

Nerlove, M och Press, S J (1973). Univariate and multivariate log-linear and logistic models. Rand Corporation Technical Report R-1306-EDA/NIH, Santa Monica, California.

I Introduction
II One dichotomous qualitative variable
III One polytomous qualitative variable
IV Several Qualitative polytomous variables
V Empirical applications

Appendix:

A Computational techniques
B Program listing

Bibliography

Pokorny, D och Havranek, T (1978). On some procedures for identifying sources of depence in contingency tables. COMPSTAT 1978, 221-227.

The question of identifying sources of dependence in, in a sense, multidimensional contingency tables intractable by classical methods is considered. Some general features of effective computer procedures are presented and then illustrated on the case of 2x2x ...x2 tables. Finally, a procedure for a representation of an RxC table is described.

Key words: contingency tables, derived and collapsed tables, chi-square statistic, hypotheses formation.

Reynolds, H T (1977). Some comments on the casual analysis of surveys with log-linear models. American Journal of Sociology 83, 127-143.

Recent developments in the analysis of cross-classified data have given social scientists powerful tools for investigating relationships among qualitative variables. Since investigators can analyze cross-classifications with concepts similar to those used in regression and path analysis, they may feel that the level of measurement problem has been solved. This study shows, however, that at least one approach, log-linear analysis, does not by itself solve every measurement problem. Unless the technique is applied carefully, it may produce highly misleading results. The conditions under which log-linear models can be misleading are explored within the context of causal analysis of surveys.

Simon, G (1974). Alternative analyses for the singly-ordered contingency table. Journal of the American Statistical Association 69, 971-976.

This article considers the RxC contingency table in which the C columns represent ordered categories. Two models are developed to take account of the order, and these models provide estimated cell frequencies as well as tests of the hypothesis that the relevant row parameters are equal. One model is of the log-linear variety, and the other examines accumulated logits within rows.

Sundberg, R (1975). Some results about decomposable (or Markov-type) models for multidimensional contingency tables: Distribution of marginals and partitioning of tests. Scandinavian Journal of Statistics 2, 71-79.

For the so-called decomposable or Markov-typ models for contingency tables of arbitrary dimension it is shown that the probability of a minimal set of fitted marginals may be expressed in a closed form, analogous to that of the maximum likelihood estimate. As a consequence a closed form expression can be given for the so-called exact test statistic in a test of a decomposable model. Finally a conjecture by A H Andersen is proved, stating that when the models are decomposable the exact test statistic and the likelihood ratio may both be completely factorized into exact test statistics and likelihood ratios, respectively, for testing homogeneity in one-dimensional or independence in two-dimensional contingency tables.

Key words: contingency table, decomposable model, distribution of marginals, exact test, likelihood ratio, test partitioning, homogeneity, independence.

Yassaee, H (1978). Exact comparison of several estimating procedures in 2x2 contingency tables. COMPSTAT 1978, 228-235.

Under independence model, parameters of an rxc contingency table are estimated by maximum likelihood, minimum X^2_P, minimum X^2_N, and minimum discrimination information procedures. These procedures produce estimators which are asymptotically equivalent. In separate papers we have derived formulas for estimators and have shown computational methods generate stable solutions for parameters under investigation. In this paper, by the use of each method of estimation we study on biasedness and mean square error of estimators for parameters of a 2x2 contingency table under the model mentioned earlier. Although our program is written in general, we generate all possible 2x2 contingency tables whose total frequency is specified. Then we compute exact mean and expected mean square accordning to almost all values of parameters and several values of total frequencey. We compare estimators obtained by different procedures in terms of exact values of parameters and total frequency.

Key words: Contingency tables, biasedness, mean square error, minimum discrimination information statistic, iterative method.