UNIVERSITY OF LJUBLJANA, Faculty of Social Sciences,
Institute of Social Sciences – Center of Methodology and Informatics

STATISTICAL SOCIETY OF SLOVENIA

International Conference on

APPLIED STATISTICS

PROGRAM and ABSTRACTS

September 15 – 17, 1997

Hotel BOR and Castle HRIB

Preddvor, Slovenia

International Conference on

APPLIED STATISTICS

ABSTRACTS

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Preddvor, Slovenia

Sponsored by

Statistical Society of Slovenia

Supported by

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Published by:	Center of Methodology and Informatics Institute of Social Sciences at Faculty of Social Sciences University of Ljubljana, Slovenia
Edited by:	Andrej Mrvar and Anuška Ferligoj
Printed by:	Statistical Office of Republic of Slovenia

Program

SUNDAY, September 14, 1997

9.00 – 17.00 IRMCS Meeting

17.30 – 19.00 Registration and informal meeting in Castle Hrib

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MONDAY, September 15, 1997

8.00 – 9.00 Registration in Castle Hrib

9.00 Opening of the conference

9.15 INVITED ADDRESS: *Chair: A. Ferligoj*

Karl G. Jöreskog, University of Uppsala, Sweden
Analysis of ordinal variables in longitudinal studies:
The PRELIS-LISREL approach

10.15 BREAK

10.30 LISREL Approach *Chair: K. G. Jöreskog*

1. **The multiplicative effects of sample size reliability and model specification on the behavior of GFI and RMSEA in confirmatory factor analysis**
   Mark Shevlin and Jeremy Miles
   (University of Ulster at Jordanstown, N. Ireland)

2. **Systematic and random method effects – Estimating method bias and method variance**
   Germà Coenders (University of Girona, Spain)

3. **MTMM analysis in case of nonattitudes**
   Willem Saris (University of Amsterdam, The Netherlands)

12.00 BREAK

12.15 MTMM Approach *Chair: W. Saris*

1. **Planned missing value patterns in MTMM using the EM algorithm**
   Brendan Bunting and Gary Adamson
   (University of Ulster at Jordanstown, N. Ireland)

2. **Meta analysis of MTMM studies in Russia**
   William van der Veld, Ferry Reith, and Willem Saris
   (University of Amsterdam, The Netherlands)
   Anna Andreenkova (Institute for Comparative Research, Moscow, Russia)

3. **Quality of different measurement scales in social network analysis**
   Anuška Ferligoj and Valentina Hlebec
   (University of Ljubljana, Slovenia)

13.45 LUNCH

15.15 Measurement *Chair: G. Coenders*

1. **Testing n-variable bisymmetry**
   Ákos Münnich (Kossuth Lajos University, Debrecen, Hungary)

2. **Plausible values for estimates of ability parameters in Rasch models**
   Mojca Trobec (Educational Research Institute, Slovenia)
   Mihael Perman (University of Ljubljana, Slovenia)

15.15 BREAK

16.30 Survey Methodology *Chair: A. Scherpenzeel*

1. **Balancing MSE and number of contacts**
   Katja Lozar and Vasja Vehovar (University of Ljubljana, Slovenia)
2. **Analysis of randomized response data**
   Eszter Bornemisza (TARKI, Budapest, Hungary)
3. **How to develop an expert system for choosing an appropriate measurement instrument**
   Jasna Horvat, Nataša Šarlija (University of Osijek, Croatia)
   Anuška Ferligoj (University of Ljubljana, Slovenia)

18.00 BREAK

18.15 Social Science Applications *Chair: K. Košmelj*

1. **Effects of rank versus category in measuring subjective social inequality**
   Jürgen H.P. Hoffmeyer-Zlotnik (ZUMA, Mannheim, Germany)
   Dagmar Krebs (Justus-Liebig University, Giessen, Germany)
2. **Potential emigration of scientists from Slovenia in the mid 90s – Methods of analysis and results**
   Milena Bevc (Institute for Economic Research, Ljubljana, Slovenia)

19.30 WELCOME RECEPTION

Offered by Tomaž Banovec, director of the Statistical Office of the Republic of Slovenia

TUESDAY, September 16, 1997

9.00 INVITED ADDRESS: *Chair: A. Ferligoj*

Michael Schemper, Vienna University, Austria
Explained variation and overfit in logistic regression

10.00 BREAK

10.15 Biostatistics *Chair: M. Schemper*

1. **Least squares regression with censored survival data**
   Janez Stare (University of Ljubljana, Slovenia)
   Harald Heinzl (Vienna University, Austria)

2. **Dangers of using 'optimal' cutpoints in the evaluation of cyclical prognostic factors**
   Harald Heinzl (Vienna University, Austria)

3. **A multiplicative exponential cure model and its application to recidivism data**
   Mohamed E. Ghitany (Kuwait University, Kuwait)

11.45 BREAK

12.00 Biostatistics 2 *Chair: H. Friedl*

1. **Modelling the yield law: Single nutrient response curves**
   Predrag Šesek and Katarina Košmelj
   (University of Ljubljana, Slovenia)

2. **All-cause mortality and outdoor NO2 in Zagreb**
   Diana Šimić, Anamarija Jazbec, Mladen Pavlović, and Janko Hršak
   (Institute for Medical Research and Occupational Health, Croatia)

3. **A WHO cross-national survey (1986-1990-1994): Evolution of health-related behaviour in school-aged children in Spain**
   J. M. Batista-Foguet, R. Mendoza, M. Perez, and R. Rius
   (ESADE, Spain)

13.30 LUNCH

15.00 Modeling *Chair: B. Bunting*

1. **The mixture index of fit for L-1 regression**
   Tamas Rudas (Central European University and TARKI, Hungary)
2. **Comparison of L1 and L2 criteria in the linear switching regression: A Monte Carlo simulation**
   Polona Tominc and Lada Bele Tominc
   (University of Maribor, Slovenia)
3. **Non-linear relations: What they are and some suggestions on what to do about them**
   Ambrožič Franci (University of Ljubljana, Slovenia)
4. **Normal-ogive model versus linear model**
   Ferry Reith (University of Amsterdam, The Netherlands)

17.00 BREAK

17.15 Sampling *Chair: D. Krebs*

1. **Non-response and socio-demographic characteristics of enumeration areas's**
   Vasja Vehovar (University of Ljubljana, Slovenia)
   Metka Zaletel (Statistical Office of Republic of Slovenia)
2. **The optimal composite sample design and its application**
   Katarina Košmelj, Anton Cedilnik (University of Ljubljana, Slovenia)
   Polona Kalan (Slovenian Forestry Institute, Ljubljana, Slovenia)
3. **Does the ILO definition of unemployment produce a biased sample?**
   Ray Thomas (Open University, England)

18.45 BREAK

19.00 Applications in Economy *Chair: J. M. Batista-Foguet*

1. **The use of bank services by the companies in Slovenia**
   Jože Rovan, Dušan Mramor, and Igor Horvat
   (University of Ljubljana, Slovenia)

2. **Antecedents and consequences of customer satisfaction: A LISREL model application**
   Vesna Žabkar (University of Ljubljana, Slovenia)

WEDNESDAY, September 17, 1997

9.00 INVITED ADDRESS: *Chair: A. Ferligoj*

Michael Greenacre, University Pompeu Fabra, Barcelona, Spain
Data coding and visualization

10.00 BREAK

10.15 Data Analysis 1 *Chair: M. Greenacre*

1. **Exploring data analysis: Simple yet effective**
   Andrej Blejec (University of Ljubljana, Slovenia)
2. **Visualizing ordered structures**
   Matjaž Zaveršnik and Vladimir Batagelj
   (University of Ljubljana, Slovenia)
3. **Pajek – A program package for visualization and analysis of large networks**
   Andrej Mrvar and Vladimir Batagelj (University of Ljubljana, Slovenia)

11.45 BREAK

12.00 Data Analysis 2 *Chair: M. Hussain*

1. **Description of non-precise data**
   Reinhard Viertl (Technical University Wien, Austria)
2. **Fuzzy partitions**
   Slavka Bodjanova (Texas A&M University, USA)
3. **Clustering large networks**
   Simona Korenjak Černe and Vladimir Batagelj
   (University of Ljubljana, Slovenia)

13.30 LUNCH

15.00 Dissimilarities *Chair: Á. Münnich*

1. **Metric index – Examples of data analysis methods with transformed dissimilarities**
   Matevž Bren (University of Maribor, Slovenia)
   Vladimir Batagelj (University of Ljubljana, Slovenia)

2. **Dissimilarity based property prediction**
   Damijana Keržič and Vladimir Batagelj
   (University of Ljubljana, Slovenia)

16.00 BREAK

16.15 Clustering Applications *Chair: S. Bodjanova*

1. **Motivation and job orientation: A cluster analytical approach**
   Dagmar Krebs and Martin Berger
   (Justus-Liebig University, Giessen, Germany)

2. **Analysis of Osp marriages**
   Tamara Bartok and Vladimir Batagelj
   (University of Ljubljana, Slovenia)

17.15 BREAK

17.30 Measuring TV audience *Chair: T. Rudas*

1. **The influence of data collection techniques on the TV viewing research results**
   Jasna Pocajt and Patricia Cucin (Mediana, Slovenia)

2. **TV audience measurement: The influence of different data collection methods on the results**
   Blaž Vodopivec, Rudi Tavčar, and Tomaž Arh
   (Gral Marketing doo, Slovenia)

3. **Measuring TV audience migrations**
   Zenel Batagelj (CATI, Ljubljana, Slovenia)
   Andraž Zorko (Dotični, Ljubljana, Slovenia)

19.00 Closing

THURSDAY, September 18, 1997

9.00 Bus departure to Dolenjska (Novo Mesto, Castle Otočec, Kostanjevica, Castle Brežice)

Abstracts

Non-Linear Relations: What They Are and Some Suggestions on What to do About Them
Franci Ambrožič

Classical methods of analysing relations (either bivariate or multivariate) are all based on the Pearson product-moment correlation coefficient. This coefficient (among other things) supposes that the relation between the two variables is linear, that is, that the regression line is in fact a straight line ($Y = a + bX$) and not a curvilinear function. There are, however, both theoretical reasons and available data that show that this is not always a valid supposition. The question is then, what can one do about it?
The first problem is, of course, one of identification – is (are) the relation(s) between the variables under question linear or non-linear? If there is no 'illness', there is no 'cure' necessary and classical methods can be applied. However, when the relation proves to be non-linear, we do indeed need a cure – some method that does not require linearity. In the article several means of identifying and (statistically) 'proving' nonlinearity are shown – graphical representation of the relation, testing the difference between the Pearson correlation coefficient (r) and the correlation ratio coefficient (?), polynomial regression, etc.
The second problem (analysing relations that have been proven to be non-linear) can be addressed in two ways, by linearising the data or by using non-linear methods. In the article we present some of the methods to do this for pair-wise relations (bivariate methods) – curve fitting, polynomial regression, non-linear transformation of data and approximation of non-linear functions with linear splines. For multivariate cases non- linear factor, canonical correlation and multiple regression analysis are shown.
Most of the presented methods are available in the SAS or SPSS statistical packages, some were tried in the WINKS statistical programme, while for testing the statistical significance of the difference between r and eta a special programme PETA was written in Borland's Delphi for the PC computer running Windows '95.

Measuring TV Audience Migrations
Zenel Batagelj and Andraž Zorko

TV market with more than one TV station is confronted with a problem of TV audience migrations. Under this term we understand every TV channel switching (including entering or leaving the audience) within two successive time intervals. While this is a well known problem in developed TV markets, the former monopolistic TV markets are yet to deal with this problem. First the satellite TV became available and within last few years new TV stations emerged, mostly with attractive programme that changed TV viewing habits. The problem is important for both the TV stations and for advertisers. As seen through the eyes of advertiser the high level of migration in certain time period represents a greater risk for the effectiveness of the advertisement placed in this time period. As seen through the eyes of the TV station programme scheduler the problem is much more complicated. For him high migration level could represent both the possibility to attain or to lose the audience.
In the paper we will discuss various possibilities for the use of several statistical methods for measuring TV audience migrations. We are seeking for the most appropriate methods to measure the level of migration and the ways to graphically represent them. We will start with the most simple approach, i.e. with the comparison of frequency distributions in two successive time periods which is used when only ratings for both are available. When one has an access to raw data then the more complex approaches, i.e. crosstabulation analysis, can be used. Several statistics based on crosstabs will be applied on existing data base of 15 minutes intervals for TV viewing in Slovenia in June 1997.

A Who Cross-National Survey (1986-1990-1994): Evolution of Health-Related Behaviour in School-Aged Children in Spain
J. M. Batista-Foguet, R. Mendoza, M. Perez, and R. Rius

This paper is part of a study on health-related behaviour among school children (HBSC) sponsored by the European Office of the World Health Organization. The study got underway in the early 1980s when researchers in number of European countries began analyzing young people's life styles and identifying a need to promote health-related behaviour among this segment of the population. Twenty-three countries are currently participating in the study, the methodology of which is described in the general research protocol (WHO, 1985a) as well as in the specific protocol statements for each edition of the study (Aaro et al., 1986b; Aaro and Woold, 1989).

Prior to 1986 there were no studies on health-related behaviour among school children in Spain. The information from the 1986 and 1990 studies was analyzed separately and the conclusions published in *Conductas de los escolares espanoles relacionadas con la salud* (R. Menoza, M. R. Sagrera and J. M. Batista-Foguet, 1994.CSIC).

The current study focuses on health-related behaviour among Spanish school children aged 11, 13, 15 and 17 and its evolution over time. The data used are taken from the questionnaires used in the 1986, 1990 and 1994 WHO studies.

Recent strategy proposals for multivariate contexts use the roles played by active and supplementary variables in factor methods (Morineau, 1992) to specifically assess evolution. Lebat et al. (1995, 1984) and Ibrahim (1981) suggest additional applications related to studies over time.

Our strategy involved determining the factorial structure of all the content variables of the questionnaire which were common in the three editions of the study. Socio-demographic variables related to age or the year the study was made were treated as supplementary variables, which enabled us to assess how adolescents' health-related behaviour evolves over time. The principal statistics package used in our studies was SPAD-N (version 3).

Our conclusion should be viewed from two angles: methodology and content. Although the interest of any study is generally to be found in its content, the original methodology the authors apply in their study of how behaviour evolves in a population in the process of 'growing up' is important in determining the correctness of the research results.

The paper reveals that up to now some interpretations of the HBSC study data have been spurious because they failed to take the longitudinal perspective into account. This is the first time the methodology presented here has been used for studying behaviour evolution and the results lead the authors to recommend that it should be used in future HBSC studies and even extended to include country-wide studies on the comparative evolution of behaviour in a variety of countries.

As regards content, the authors emphasize first and foremost that health-related behaviour in school-age children cannot be considered globally. There are at least two types of behaviour, depending on whether the children are above or below the age of thirteen. The paper demonstrates that if behaviour is considered for the group as a whole, the effect of age on behaviour is confused with the effect of evolution over time. This makes it appear that with the passage of time children's behaviour becomes less 'healthy' and leads to a falsely negative perception of their development.
In contrast, when the age variable was explicitly considered, the behaviour of school-age children involved positively over the years regardless of their regional origin, gender or particular age group. Furthermore, specific studies of each age group clearly revealed the characteristics of the different ages, demonstrating, that the lack of understanding typical of the youngest children is one of the main sources of those missing values that do so much to distort statistical analyses.
The strategy applied enabled the authors to successfully study health-related behaviour among school-age children and its evolution over time in Spanish children aged 11, 13 and 15. The conclusions drawn bear out assumptions of typical behaviour for children of these ages.

Analysis of Osp Marriages

Tamara Bertok and Vladimir Batagelj

In this paper some results of the analyses of marriages in parochial office Osp between years 1924 and 1940 are presented. First the basic characteristics of the data are analyzed. Afterward a basic behaviour model of our data is determined.
Each marriage is described in the register of marriages by several properties. In our analyses we consider the following: age of the bride and the bridegroom, birth place, birth district, profession, and previous matrimonial state.
The basic characteristics of the data are summarized by the following distributions of marriages:

Age difference between bride and groom: Data show that in most cases age difference between bride and groom was small. Among all marriages, there were 374 cases, where groom was older and only 71 cases, where bride was older. In most cases the groom was 0 to 5 years older or the bride was 1 year older. In the cases of bigger age difference grooms or brides were mostly widowers or widows.

Profession: There were 438 marriages where the brides were housekeepers, and only 20 marriages where the bride was of any other profession. The most frequent jobs among men were farmer and workman. Therefore most marriages were between professions: farmer-housekeeper and workman-housekeeper.

Distance and profession: The influence of groom profession on the distance between bride's and groom's birth place is considered with air distance as the default distance. Data show that grooms, who were either farmers, workmen, blacksmiths, gendarme or sailors, married brides, who lived more than 20 km away from the groom's birth place.

Districts: Districts had the same meaning as town community. It is a administrative district, containing one big and several neighbouring small towns, places and villages. Most brides and grooms were from district Milje. District Dekani took second place. It was also the geographic center of the area, covered by parochial office Osp, also contained in this district.

The marriage network (vertices = districts, lines = (groom's district, bride's district)) was analyzed using blockmodeling methods. A perfect fit into four clusters was obtained:

1. cluster: Bertoki, Bistrica, Rodik
2. cluster: Catania, Chioggia, Monfalcone, Nova Vas, Piran, Račice, Roncoferraro, Ščedna, Treviso, Udine
3. cluster: Dekani, Dolina, Milje, Trst
4. cluster: Draga, Hrpelje, Koper, Kozina, Marezige, Materija, Šmarje, Sočerga, Truške

Districts with highest number of marriages (Milje, Dekani, Dolina, Trst) are all in the same cluster. All grooms from districts in the first cluster married brides from district Dekani in the third cluster. All grooms from second cluster married brides from district Milje in the third cluster. Fourth cluster represents all districts, where brides married grooms from the third cluster. Districts Koper, Marezige and Kozina, from the fourth cluster, are slightly different from others, because there were also grooms from these districts, that married brides from the third cluster.

Potential Emigration of Scientists from Slovenia in the mid 90s – Methods of Analysis and Results
Milena Bevc

External migration especially of the most educated persons is in most countries an unknown, or a very weakly registered phenomenon. Also in Slovenia, having good statistics on migration in comparison to many countries on the basis of the available statistical sources (census of population, register of population) no uniform conclusion has been established regarding the extent of this phenomenon since the late 80s. On the other hand, the potential brain drain can not be investigated on the basis of statistical data. For the analysis of this topic, the survey of individuals is one of the main approaches. For this reason the inclusion of Slovenia in the international project on brain drain of researchers in Eastern and Central European countries (COST A2 project: Europe92s Integration and the Labour Force Brain Drain) on the basis of an almost unique methodology is important. The paper presents the methodology and the results of the analysis of potential emigration of researchers from Slovenia (within the above-mentioned project the 'potential internal' brain drain and 'real external' brain drain in the period 1988-1994 were analysed as well).
The paper has three main goals: firstly, to present the methods used in surveying of researchers and in analysing data; secondly, to present the comparison of the sample, the population and the part of it that responded to the questionnaire; and thirdly, to present some of the main results on the phenomenon analysed. The paper also addresses some main methodological problems in the process of surveying and data analysis and compares the results for Slovenia with other 9 countries also included in the above-mentioned international project.
In Slovenia 1012 researchers with master's or doctor's degrees (29% o f 'population') were surveyed on the basis of random sampling, 64% of them answered, which accounts for almost 1/5 (18%) of the 'population'. For the

following reasons the conclusions on the basis of the survey of researchers are of great importance for the state policy in the science sector in Slovenia: use of random sampling, large sample, the similarity of the structure of respondents to the questionnaire to the structure of the whole population of researchers in many aspects (age, gender, education, scientific field). For this reason at the end of the paper some policy recommendations are presented as well.

Exploratory Data Analysis: Simple Yet Effective
Andrej Blejec

Exploratory Data Analysis (EDA) was introduced as a new approach to statistical analysis of data. EDA is a collection of simple and intuitive analytical techniques. They provide understandable methods, requiring little or no assumptions.
But EDA is more than that, it is also a different way of approach to data analysis. EDA is an assumption free modelling method, an interactive model searching method, based on the knowledge of subject matter.
EDA is very useful as the introductory analytical method, preceding the classical and more powerful statistical analysis. It has great potential in statistical education. Its simple methods can be introduced into schools in an early grade.

Fuzzy Partitions
Slavka Bodjanova

Classification is a key issue in reasoning, learning and decisions making. In the real world, classes are often inexact and categories vague. Researchers, especially in social and other human sciences, often have to deal with information expressed in linguistic terms. Using natural language, one cannot partition objects into nicely bounded classes. Belongingness of an object in a collection is a matter of degree. Mathematical description of belongingness, or membership of objects in a collection, was introduced by Lotfy Zadeh (1965) in the theory of fuzzy sets. A fuzzy set A in a given set X is characterized by a membership function, which associates with each element of X

a real number in the interval $[0, 1]$, with values of this function representing grade of membership of the corresponding element in A. A fuzzy partition is a special collection of fuzzy sets. There is an amount of literature dealing with the theory of fuzzy sets. Studies concerned with the mathematical properties of fuzzy partitions are still rare.

First of all we will present several approaches to the definition of the notion of a fuzzy partition (Ruspini (1969), Butnariu (1983), Dubois and Prade (1990), Bezdek (1981), Klir and Yuan (1995)). In practice, a fuzzy partition is a result of a search for structure in a data set. Techniques of search (pattern recognition) are applicable to medical records, psychological profiles, demographic features, aerial photos, etc. Both the diversity of pattern recognition techniques are the number of different scientific disciplines in which these have been developed are striking. The first fuzzy clustering algorithm was developed by Ruspini (1969). Dunn (1973) proposed a fuzzy k-means algorithm, which was generalized by Bezdek (1981). This algorithm results in the fuzzy k-partitions of a data set. The number of fuzzy classifications techniques has been growing, but the fuzzy k-means algorithm is still undoubtedly the most popular. We still study the space of degenerate fuzzy k-partitions P_{fko} of a finite set of objects X.

As a result of different classification procedures or because of the different opinions of several experts, the same data set can be partitioned into several partitions. A question arises: how to compare them and how to combine them. We propose a partial ordering of fuzzy k-partitions based on their α-sharpness and a partial ordering of fuzzy k-partitions based on their m-importance. Relation α-sharpness captures the intuitive idea that the closer the coefficients of belongingness are to 1 or 0, the sharper is the partition. Coefficients greater or equal to α are considered to be large and coefficients less than α are considered to be small. In general, the m-importance of a fuzzy partition U of a set X is determined by the values and the locations of the maximal coefficients of membership of object $x_j \in X$, $j \in \{1, ..., n\} = N_m$ in fuzzy clusters $u_i \in U$, for $i \in \{1, ..., k\} = N_k$. This relation is meaningful in situations when we have some reason for ranking of classes (e.g. products of high quality, medium quality, or defective products). We also present several quantitative characterizations of fuzzy k-partitions and we discuss how they can be used in order to measure the amount of α-sharpness or the amount of m-importance of a fuzzy partition.

Then we focus on the following problem: Let $\mathcal{S} = \{U_1, ..., U_m\}$ be a collection

of fuzzy k-partitions and let the $\mathbf{R}$ be a relation of partial order on P_{fko}. We want to find a fuzzy partition $W \in P_{fko}$ such that $W \ \mathbf{R} \ U_t$ for all $t \in N_m$. W will be called a lower bound of $\mathcal{S}$ with respect to $\mathbf{R}$. Analogously, we want to find a fuzzy partition $Z \in P_{fko}$ such that $U_t \ \mathbf{R} \ Z$ for all $t \in N_m$. Z will be called an upper bound of $\mathcal{S}$ with respect to $\mathbf{R}$.
Let $\mathbf{R}$ be the relation of m-importance. Because (P_{fko}, m-sharpness) forms a lattice, a lower and an upper bound exists for any collection $\{U_1, ..., U_m\}$ of fuzzy partitions from P_{fko}. We will describe an algorithm for construction of these bounds.
In general, a lower and an upper bound for a collection of fuzzy k-partitions with respect to relation α-sharpness does not exist. However, we might be able to find these bounds for a collection of α-equivalent fuzzy partitions. Fuzzy k-partitions are considered to be α-equivalent if all their large coefficients (with respect to α) and all their small coefficients (with respect to α) are at the same locations. We present a method which allows one to find nontrivial α (it means α at which neither all coefficients are large nor all coefficients are small), at which given fuzzy partitions are α-equivalent. Then we specify conditions under which the lower and the upper bound of a collection of α-equivalent fuzzy k-partitions exist and we provide an algorithm how to find these bounds.

Analysis of Randomized Response Data
Eszter Bornemisza

Survey methods are the widespreadly used in investigating human populations. Although these are very useful tools for collecting information about the society, some measurement problems may arise when studying certain sensitive topics. In case the questionnaire contains threatening or embarrassing inquiries the researcher has to cope with serious measurement errors which will bias the results of the analyses. One way of overcoming these problems is to build in the error factors into the models fitted to analyse the data but in most of the cases the probability of the errors are unknown and that makes the model building difficult.
The other solution is to put sensitive questions in such way that respondents anonymity is fully protected. The tools which satisfy this requirement are the various randomized response techniques. In this method the respondent

answers the sensitive question or an alternative question depending on the outcome of a random experiment which is not known by the interviewer. Supposed that the respondent feels protected and gives the true answers the researcher can obtain unbiased prevalence rates of a phenomena knowing the probabilities of the outcomes of the random experience. The disadvantage of this method beyond the inflation of variance is that multivariate analyses cannot be directly applied on these data since the true values for each item are known only with a certain probability.
The paper shows an example of multivariate analysis of mixed straight and randomized response variables which were measured on nominal scale. The topics of the survey was alcohol consumption, but as an exercise for the respondent before the real question three other sensitive questions were asked by the same method. The data obtained by randomized response were considered as misclassified data with known misclassification matrices and the results published by several authors for analysing misclassified data were adopted. Tests of independence between randomized response variables are shown in the paper with the investigation of the loss in power due to randomization and log-linear models are fitted to the data.
The study was completed on a special sample where the true distribution of one of the attributes asked by randomized response was known, thus a validation study of the randomized response technique applied was accomplished which is presented in the paper.

Metric Index – Examples of Data Analysis Methods with Transformed Dissimilarities
Matevž Bren and Vladimir Batagelj

In our previous works on metric index we presented several results on the power transformation that provides an arbitrary nonnegative dissimilarity measure to be metric. Therefore it transforms an even dissimilarity into a semi-distance, or definite dissimilarity into a distance.
In this talk we present some results on applications of improved dissimilarities in data analysis and compare them with results obtained using standard approaches: cluster analysis, multidimensional scaling.

Planned Missing Value Patterns in MTMM Using the EM Algorithm

Brendan Bunting and Gary Adamson

In MTMM research the same question is repeated on a number of occasions, with the question at each time point being evaluated using a different method. This is the most widely used design for assessing validity. Its advantage is in its ability to partition variance due to the construct, from that arising as a result of the method used. However, a practical drawback with the procedure is that the same question has got to be repeatedly asked of the same respondents. This paper examines some designs for the effective use of the EM algorithm in minimizing the burden of data collection in the context of MTMM models.

Systematic and Random Method Effects – Estimating Method Bias and Method Variance

Germà Coenders

Two lines of research have been usually followed to assess the effect of the method on measurement quality. Split-ballot experiments allowed researchers to assess the effect of the measurement method on the marginal distribution of the responses and to make assessments of relative bias. Structural equation models allowed researchers to assess the effect of the method on reliability and validity.

This paper develops and illustrates a strategy based on fitting mean-and-covariance structure models to multitrait-multimethod data, which allows researchers to assess relative bias, reliability and validity simultaneously. A restricted confirmatory factor analysis model is used in which method factors account for method variance (method effects which vary across respondents) and in which intercepts in the measurement equations account for method bias (method effects which are constant across respondents).

A complete sequence of statistical tests of relative unbiasedness of methods is provided and applied on data from a survey of general life satisfaction.

Two major advantages of the approach presented in this paper over split-ballot designs are that relative bias is assessed after partialling out the effects of random measurement errors and that several definitions of relative bias are possible.

Quality of Different Measurement Scales in Social Network Analysis
Anuška Ferligoj and Valentina Hlebec

This paper evaluates the validity and reliability of network measurements. The results of two experiments, designed to systematically analyse the quality of three measurement scales, are presented and discussed. Binary scale, numerical estimation and lineproduction method are used to estimate the strength of interpersonal relations. Similar results are reported from both experiments even though there was a reverse ordering of the method in the second experiment. The binary scale had the lowest reliability in both experiments. Reliability and validity were assessed using a MTMM approach.

A Multiplicative Exponential Cure Model and its Application to Recidivism Data
Mohamed E. Ghitany

In this paper we consider a multiplicative exponential cure model under random right censoring scheme. Maximum likelihood method is used to estimate the model parameters which in turn are used to find the observed standard errors of the obtained estimates.
To quantify the effect of different censoring schemes on the accuracy and precision of the obtained estimates, a simulation study is carried out under fixed, uniform, and exponential censoring distributions having the same mean. The study suggests that, in large randomly right censored data, the form of the censoring distribution does not seem to have much impact on the accuracy of the estimates and their precisions.
A goodness-of-fit criterion for the model under consideration is proposed. Finally, application of the model under consideration to recently published recidivism data is given.

Data Coding and Visualization
Michael Greenacre

Scientists studying and collecting data on social phenomena need to gain an understanding of their observed data before passing on to the modelling phase. Conventional descriptive tools are inadequate for the large data sets regularly collected in the social sciences. A combination of data coding and visualization using a graphical method such as correspondence analysis can fill this gap. Various examples are given which illustrate this strategy, including some recent work on square asymmetric tables in which the use of coding can lead to an improved interpretation of the data.

Dangers of Using 'Optimal' Cutpoints in the Evaluation of Cyclical Prognostic Factors
Harald Heinzl

It is common strategy in medical research to categorize a continuous covariable before evaluating its prognostic impact on clinical outcome. In most cases the covariable is divided into just two groups. The chosen cutpoint is either a value already published in other studies, or certain sample quantile like the median, or a so-called 'optimal cutpoint', that is the value which corresponds to the most significant relation with outcome. Because the multiple testing problem is ignored, the term 'optimal' is misleading in this context. Altman et al. (1994) suggested to use 'minimum P-value approach' instead, and present simulation and asymptotic results of the inflation of the type I error rate.
Recently the influence of the menstrual status at the time of surgery on the prognosis of women suffering from breast cancer was discussed in the medical literature. Although the paper, which triggered the discussion, reported a high relative risk of death in patients who underwent breast cancer surgery during the perimenstrual period, almost all of the subsequently published work could not confirm this result in retrospective studies.
The menstrual status at the time of breast cancer surgery is a clinical covariable. Its splitting into two segments is a similar strategy of analysis like the categorization of a continuous covariable. In case that this splitting is based on a minimum P-value search, the problem of multiple testing has

to be taken into account, too. Following Altman et al. (1994) a simulation study was performed to get some insight into the relation of the actual versus nominal type I error rate with regard to the breast cancer example.

Effects of Rank Versus Category in Measuring Subjective Social Inequality
Jürgen H.P. Hoffmeyer-Zlotnik and Dagmar Krebs

In a postindustrial society with high levels of division of labor social differentiation occurs mainly in two ways: First, the subjective self-perception of the individual and second, an objective ascription of the individual's location in the status hierarchy.
In survey research the subjective perception of the individual's own location in the stratification system is either measured by a question confronting the respondent with categories of social stratification or by letting allocate himself on an open ranking scale. In both instances, the researcher has no information about the criteria underlying the respondent's choice for a specific category or a specific scale point:

- With respect to the 'categorical' measure the researcher not only assumes that the respondent understands the categories but also is able to apply these categories to locate himself in the stratification system.
- With respect to the open ranking it is implicitly assumed that status in society is identically perceived by each respondent, regardless of the respondent's own location within the status hierarchy.

What can we do with subjective location in a stratification system where the respondent is forced to use an abstract categorical or an unspecific open ranking measure? and: what are the differences between these measures?
We will demonstrate that the device of the measure influence the results, where respondents tend to assign themselves different positions on the ranking and on the categorical measure; we will demonstrate that judgements on the ranking and categorical measure are more or less independent of each other because people locating themselves into the middle category do not necessarily assign themselves a middle rank position but use the whole range of the ranking scale; and we will demonstrate that the choice of a category

depends on the category label describing one social stratum. In contrast the choice of a rank position seems to indicate the relative social distance within the social reality to which the respondent is used.

How to Develop an Expert System for Choosing an Appropriate Measurement Instrument

Jasna Horvat, Nataša Šarlija, and Anuška Ferligoj

The purpose of this paper is to create an algorithm for constructing quality measurement instruments. The algorithm should contain: knowledge base of measurement instruments, knowledge base of scales, and knowledge base of quality criteria for the survey.
To use the suggested expert system, the researcher should first establish the general field of his research, then choose the specific branch in the field, and then the phenomenon in the chosen branch. Then, (s)he should select the appropriate measurement instrument, which he would be free to modify. The researcher could browse through scientific fields, branches and sub-branches, and select from different measurement instruments applicable for the phenomenon, in such a way that (s)he could not only select from predefined sets of measurement instruments, but also create the new sets. For each intervention upon the supplied measurement instrument, the whole set of measurement instruments would be tested, to assure the given characteristics of instruments.
The ability to rebuild the existing databases, their selectivity, the ability to interchange among themselves and to be tested, are the foundation for the process of building the knowledge bases of measurement instruments and scales. In order for knowledge base of quality criteria to be rebuilt, the process of permanent monitoring and implementing new theoretical achievements is essential, as much as the ability to define new criteria and redefine the existing ones.
The suggested expert system would give the researcher the ability to select the measurement instrument from the existing knowledge bases, or creating the new one. The precondition for using the measurement instrument is running the pilot survey and correcting it with help from the expert system, according to the information contained in the knowledge base of quality criteria for the measurement instrument. To bring the suggested expert system

to life, and to get it to regulate itself, the system should be deployed over the Internet, and the researchers should be wowed to begin using it.

Analysis of Ordinal Variables in Longitudinal Studies: The PRELIS-LISREL Approach
Karl G. Jöreskog

The situation where some ordinal variables (Likert Scales) are measured at several occasions on the same individuals is considered. These variables may or may not be considered as indicators of latent variables. It is assumed that there is a continuous variable underlying each observed variable such that a response in an ordered category correspond to a value of the underlying variable in an interval between two thresholds. By assuming that the thresholds are the same over all occasions, one can estimate the mean vector and covariance matrix of the underlying variables on a scale common to all occasions. These can then be subjected to any LISREL model just as if the underlying variables were observed. In particular, it is possible to estimate over-time differences in means, variances and covariances both for manifest and latent variables. The effects of background variables can also be studied. The analysis is done in two steps: First PRELIS estimates the mean vector and covariance matrix of the underlying variables from the data on the ordinal variables. Then the modeling is done with LISREL. The procedures are illustrated by two-wave data on Political Efficacy and by four-wave artificial data.

Dissimilarity Based Property Prediction
Damijana Keržič and Vladimir Batagelj

Let $\mathcal{E}$ be set of units and $\mathcal{L}$ a learning set (set of examples), $\mathcal{L} \subset \mathcal{E}$. On the learning set $\mathcal{L}$ the property p is known, $p : \mathcal{L} \to \mathbb{R}$. The property prediction problem can be expressed as follows: *For the unit $Z \in \mathcal{E} \setminus \mathcal{L}$ predict the value $p(Z)$.* In property prediction problem we assume that the property values in general change smoothly over similar units. The prediction of $p(Z), Z \in \mathcal{E} \setminus \mathcal{L}$ is based on the values of the known units (from $\mathcal{L}$) in the neighborhood of Z with respect to a selected dissimilarity.

Usually units are described by vectors of (measured) properties. Naturally some parts of obtained description are more 'correlated' with the property we predict and some of them less. This can be considered by weights in the formula for selected dissimilarity. In the paper we discuss two approaches to determine suitable weights:

- by considering 'independence' measured by Raiski coefficient, and
- by optimization of prediction efficiency on the learning set.

A combination of both approaches will be illustrated on some applications.

Clustering Large Networks
Simona Korenjak-Černe and Vladimir Batagelj

There are several methods to determine clusters (groups) in a network. Often these methods can be used only on networks of moderate size (up to some hundreds of vertices).
In the paper an overview of efficient approaches to determine clusters in large networks is presented:

- *graph theory methods*: connectivity methods, cliques, cores, kernels, ...,
- *eigen values/vectors methods*,
- *clustering methods*: leader method, adding hierarchical method, ...,
- *blockmodeling methods*.

Most of these methods are / will be included in program `Pajek`.

The Optimal Composite Sample Design and its Application
Katarina Košmelj, Polona Kalan, and Anton Cedilnik

In ecological studies, substances such as soil, water, plant material, etc. are under study. In general, investigators are interested in their chemical characteristics such as soil acidity, contents of particular metals, etc. The sampling procedure is usually as follows. The research area is divided into subplots according to an arbitrary grid. The sampling procedure is carried out in two steps. In the first step n subplots are selected from N subplots, in the second step m sampling sites are obtained within each of the n selected subplots. Hence nm samples are collected and transferred to the laboratory for chemical analysis.

The idea of composite samples comes from the challenge of diminishing expensive laboratory analysis. From each of n subplots, m field samples are mixed into a composite sample. In the laboratory n composite samples are analysed. Consequently, total expenses decrease considerably, though some disadvantages can be expected as well.

To evaluate the composite sample design we model the composite sample mean as the weighted average of the pooled values corresponding to sites; the weights correspond to masses that contribute to the composite sample mass. We derive the expected value and the variance of the composite sample mean. The derivation shows that in the case of equal weights and no correlation between observations from different subplots the variance of the composite sample mean equals the variance of the corresponding two-stage sample mean.

In general, the quality of a design can be expressed in terms of the product 'total cost x variance of the mean'. We compare the relative advantage of the composite sample design over the corresponding two-stage design as the ratio of these two values. We discuss the situations where composite sample design is preferable to the two-stage design. The main objective of our work is to assess the optimal composite sample design. We start from the fact that total cost should not exceed an imposed value and derive the formulas for the optimal number of sampling sites m and subplots n.

We apply the obtained results to a ecological study of forest soils in Slovenia. A two-stage sampling has been undertaken 1993 on two different locations. The research plot was divided into 25 subplots. On five of them three sampling sites were selected. Chemical characteristics of soil (e.g. `pH`, `N`, `C`, `Cd`) were under study. The collected soil samples were transferred in the laboratory where stones and organic material were removed. Afterwards, each soil sample was dried, milled and sieved. The obtained material was weighted and stored in one liter plastic box, what we call a laboratory sample. For each subplot a composite sample was prepared as well: masses proportional to total mass of sieved soil in from each sampling site were mixed. The ob-

tained laboratory samples and composite laboratory samples were submitted to chemical analysis.
Statistical analysis was accomplished for the two-stage sampling design and for the corresponding composite sample design. We compare the mean and variance estimates with the expected values from our theory. The optimal composite sample design for this situation will be presented and discussed.

Motivation and Job Orientation – A Cluster Analytical Approach
Dagmar Krebs and Martin Berger

What do students expect from a later job? The paper presents results of an inquiry of students regarding their job-motivation and their job-preferences. With respect to these two variables special attention is given to differences between students of economy, law and social sciences. Based on a cluster analysis a typology of motivation is developed describing the motivational structure of students of different subjects. This typology contains not only job-motivation but also achievement motivation and power motivation.
As can be expected, students of economy constitute another motivational type than students of social sciences, with students of law between these two types; in their motivational structure the law students are more similar to the economy students than to social science students. The results from different countries (Slovenia, USA, Germany) are compared.

Balancing MSE and Number of Contacts
Katja Lozar and Vasja Vehovar

Different survey techniques are often discussed without concentrating on their costs. Survey methodologists often deal with survey errors, but rarely with survey costs. They discuss how to minimize errors that occur with sampling, preparing questionnaires and during the process of collecting data, but rarely discuss how the effort to minimize these errors enlarge the survey costs. This leads to inconsistency between theory and practice as in practice a researcher has only a limited budged for a certain survey. As survey costs and errors are connected (enlargening one means minimizing other) the optimum ratio between survey costs and errors is necessary.

The problem of optimal ratio between survey costs and errors (measured by mean square error – MSE) is the topic of our paper. We want to find out the optimal number of contacts with potential respondents by searching minimum MSE at fixed costs or by searching minimum costs at fixed MSE. We test the method of balancing MSE and costs on two examples of mail surveys. The method can be used also for establishing the optimal number of contacts in face-to-face or telephone surveys.

Pajek – A Program Package for Visualization and Analysis of Large Networks

Andrej Mrvar and Vladimir Batagelj

Large networks (networks having thousands of vertices and lines) can be found in many different areas, e.g: flow graphs of programs, moleculae, computer networks, transportation networks, social networks, intra/inter organisational networks...Many standard network algorithms are very time and space consuming when analysing such networks.

In the article we present some approaches for analysing and presenting large networks. implemented in program package `Pajek`. Program is freely available at: `http://vlado.fmf.uni-lj.si/pub/networks/pajek/`

The main goals in the design of `Pajek` are:

- to support *abstraction* by (recursive) factorization of a large network into several smaller networks that can be treated further using more sophisticated methods;
- to provide the user with some powerful *visualisation* tools;
- to implement a selection of *efficient* network algorithms.

Testing n-variable Bisymmetry
Ákos Münnich

Integrating attribute-wise evaluations of multi-attribute stimuli is basic in many areas such as the study of ability, intelligence, attitudes, personal impressions, information integration, decision analysis and consumer behaviour. This talk, based on a generalisation of bisection and the associated property of bisymmetry to n variables, concerns the problem of information integration for attribute-wise evaluations of multi-attribute stimuli. Bisymmetry (or bisection) of two variables is known and empirically investigated earlier in psychophysical experiments, and now we present an experiment which gives explicit connection of the n-variable bisymmetry equation and n-component bisection (applying the multi-attribute-bisymmetric-integration response model MABI of Munnich, Mokken, Saris, 1997) by a psychophysical measurement procedure.

The influence of data collection techniques on the TV viewing research results
Jasna Pocajt and Patricia Cucin

In the paper different but useful and in Slovenia especially actual method of data collecting about TV viewing will be presented. The paper results from theoretical knowledge, achieved at the Faculty and practical experiences acquired by leading continuous longitudinal projects, multimedia research, Mediana Reading, Viewing, Listening and Mediana Teve CATI, daily research of viewing TV. The differences and similarities of both researches of viewing TV, summarised into three basic areas will be discussed: the research project, the presentation of results of multimedia research and daily computer supported telephone research, and the applicability of data.
The Research Project
The differences of both longitudinal researches of viewing TV, Mediana BGP and Mediana Teve CATI, daily research of TV watching will be explained by presenting the research plans of both themes. They will be focused on the first stage of research project – data collecting – which determines all sequent stages in a lot of ways. In the framework of data collecting for both research project the following points will be discussed: the method of data

collecting, the formation of patterns, the contents of questionnaire and how to carry out the research, in what way to control its performance.

Presentation of Research

The authors will try to define and analyse the differences collected basic measured of TV viewing two researches as accurately as possible. In spite of methodological differences the comparability of basic measures of TV viewing is made possible by both researches. Actual data of Slovene main TV channels (for the year 1997) are going to be analysed by the help of TV ratings within the time slots, audience shares of individual TV channel and the covering areas or awareness of receiving.

The Usefulness of Data

The aim of multimedia research of Mediana BGP was discovering at first, now it is continuous reproduction of Slovene media image. On the base of data research media (print, radio, TV) one can find out how large is their audience, what is their socio-demographic and geographic structure, so the programme can be adequately formed and adapted according to the circumstances. The advertising agencies and advertisers can use the same data which help them to plan their media project professionally and carry out their advertising actions in the same way. By developing commercial TV channel's the need for current and more exact data concerning TV viewing was assessed. The aim of The Research Mediana Teve CATI – the daily research of TV viewing, is to present daily audience share, daily data about watching Slovenian TV channels and review of the structure of audience of individual programmes.

Normal-Ogive Model Versus Linear Model

Ferry Reith

In modern psychometry different item response models are used for analyzing data with different item formats. Mellenbergh has made the relations between the different psychometric models explicit by postulating 'generalized linear item response theory' (GLIRT). The different psychometric models can be seen as special cases of GLIRT. In this presentation Lord's two-parameter normal- ogive model and Joereskog's model for congeneric item responses are being compared from the perspective that both models are special cases of GLIRT. Two adapted versions of a hidden figures test were used. This is a cognitive achievement test. An item of this test consists of a complex pattern and a simple figure. The subject is asked whether the simple figure is part of the complex pattern. In the version with a dichotomous item format the subject has to choose between the alternatives '*yes*', '*no*' and '*don't know*'. The 'don't know' alternative is always scored wrong. In the version with a continuous item format the subject has the mark a line which runs from 0% to 100% which indicates the subjective probability of the simple figure being part of the complex pattern. Subjects were 349 psychology freshmen. Each subject filled out both versions of the test which resulted in two data-sets, one with dichotomous data and one with continuous data. Lord's two-parameter normal-ogive model and Joereskog's model for congeneric item responses are both fitted to the dichotomous data and to the continuous data. The estimates of item parameters, item information and subject parameters are compared. The results will be presented.

The Use of Bank Services by the Companies in Slovenia
Jože Rovan, Dušan Mramor, and Igor Horvat

The banking system is one of the most important parts of the economic system of former socialist economies that has to be completely restructured in the process of transition. Banks are less and less operating on a *seller's market* of financial products. Understanding the needs and potentials of customers that differ substantially among countries is becoming one of the most important issues of successful management of banks in these countries. In this research we are interested in the structures of several variables that represent bank services (leasing, different kinds of credits and deposits) and characteristics of the companies (age, growth and sector of activity) as their customers. Using multiple correspondence analysis (MCA) we shall try to identify the patterns of use of bank services by different groups of companies in the Republic of Slovenia. We are especially interested in the following two questions:

1. What is the structure and frequency of bank financing of companies in a different stage of maturity?

2. Which companies grouped in sectors of activity are more frequent users of *classical* bank services and what types of services do they use?

It was first found that the use of bank financing by more mature companies is in accordance with expectations and that it is very weak by the young companies (upto 3 years in business). As it was also found that the great majority of young companies is growing, it could be concluded, that because of their growth the need of bank financing is strong. Therefore, banks could be advised that young companies present potentially larger market for their services. This market could be reached by improved credit analysis and other measures of lowering credit risk coupled with appropriate marketing.
Secondly, concerning the activity of the company, bank services are most frequently used by the companies in manufacturing sectors and transport and communications. These companies predominantly use financing services. Companies in service and government owned sectors are less frequent users of bank services and they make time deposits more frequently than they use financing services. It should be quite a surprising result for the banks that even at the time when Slovenia is trying to reduce the budget spending substantially. the state owned companies make time deposits much more frequently than they use bank financing.

The Mixture Index of Fit for L-1 Regression
Tamas Rudas

While curve fitting with the method of least squares is the optimal procedure if the errors are normal, other error distributions may require the application of different fitting methods. L-1 regression minimizes the sum of the absolute deviations between observed and predicted data. Unfortunately, this quantity lacks calibration and cannot be used to compare the goodness- of-fit of different models, or for variable selection. The talk demonstrates that a symmetric version of the mixture index of fit can be defined in this case and leads to a transformation of the sum of absolute deviations which can be given a natural goodness-of-fit interpretation. This approach measures the fit of the regression model by estimating the smallest fraction of the population which cannot be described by the model. Application of the method will be illustrated on data about real estate prices.

MTMM Analysis in Case of Nonattitudes
Willem E. Saris

In 1964 Converse introduced the problem of nonattitudes. This means that people give answers in interviews on attitude questions although they do not have a very strong opinion. This lack of opinion can be shown by studying the fluctuation of their answers through time. In studies on the quality of survey questions the reliability and validity of questions is evaluated using MTMM models (Andrews 1984, Saris and Andrews 1991 etc.) assuming that people have an opinion. If this assumption does not hold it means that the reliability and validity of questions is underestimated because part of the fluctuation in the responses is not due to measurement errors but to lack of an opinion. In this paper procedures will be suggested to cope with these problems in order to get better estimates of reliability and validity taking into account the fact that at least a part of the sample has no opinion on the issue.

Explained Variation and Overfit in Logistic Regression
Michael Schemper

This presentation focuses attention on two distinct topics which are of interest to the applied statistician but are not covered in textbooks of logistic regression.
The proportion of the variation of a dependent variable explained by prognostic factors is a useful concept to describe to what extent prognostic factors determine the outcome for an individual patient, or similarly, how much is known about the course of a disease.
Different measures of the proportion of variation in a dependent variable explained by covariates are reported by different standard programs for logistic regression. Twelve measures that have been suggested or might be useful to measure explained variation in logistic regression models are reviewed. The definitions of these measures are discussed, their performance is compared in an empirical study and they are judged with respect to their compliance to certain criteria which we think a suitable measure of explained variation for logistic regression should meet.
Some of the measures are obviously not suitable because they do not even

fulfil simple requirements, e.g. to assume a value of 1 if and only if there is a perfect prediction. Other measures, though ranging between the extremes of 0 and 1, are quite differently scaled between the extremes. Two of the measures, which we recommend, squared Pearson correlation between the binary outcome and the predicted values, and the proportional reduction of squared Pearson residuals by the use of covariates, give almost identical results, agree well with the multiple R^2 of the general linear model in data sets where either model would be equally adequate and have an intuitively clear interpretation.
This topic has been recently dealt with by Mittlbock and Schemper (1996). The second topic of the paper deals with issues of overfit and shrinkage the importance of which have been recently demonstrated by Harrell (1995).
Overfit occurs if the ratio Q of parameters to be estimated by regression and of the size of a sample for which fitting is performed is 'too high'. As a consequence parameter estimates become unstable and the predictive accuracy for a model is overestimated. Certain thresholds for Q, such as the 1:4, 1:10 or 1:20 rules have been recommended to guard against major overfit. In a simulation projects these rules have been investigated for suitable combinations of sample sizes (10 – 1000), # parameters of a model (1 – 30) and overall response proportions (50% – 95%). In this project overfit is described by two different criteria: the average inflation of the length of confidence intervals for parameters and the 'relative optimism of a prediction rule' (Efron, 1986). As a major result of the study in the particular the 1:10 rule receives empirical justification and should be considered in the planning and analysis of prognostic factor studies. The controversy whether in logistic regression the smaller number of binary outcomes or the total sample size should be used for the 1:10 rule is clearly resolved in favor of the latter.
Finally recommended concepts for both, explained variation and overfit, are exemplified by an analysis of a prognostic factor study.

The Multiplicative Effects of Sample Size, Reliability and Model Specification on the Behaviour of GFI and RMSEA in Confirmatory Factor Analysis

Mark Shevlin and Jeremy Miles

Confirmatory factor analysis (CFA) involves specifying a model, estimating

the parameters of the model, and evaluating how well the proposed model accounts for the observed variances and covariances. To determine whether the model accounts for the observed data, a number of indices are used. This paper describes a Monte Carlo investigation, examining the behaviour of two such indices: the Goodness of Fit Index (GFI) and the Root Mean Square Error of Approximation (RMSEA).
Three factors were manipulated in the study: reliability of measured variables (3 levels), degree of mis-specification of the model (3 levels) and sample size (5 levels), making a total of 45 cells. For each cell, 200 covariance matrices, sampled from multivariate normally distributed data, were generated, and analysed using LISREL 8. The GFI and RMSEA from each of the analyses were collated and analysed.
The main effects of each of the factors were large, however, the analysis reveals that the mean values of the fit indices were effected by the interaction between factors.
The results of the study are used to make recommendations about the appropriateness of using the GFI and RMSEA to determine model fit.

Least Squares Regression with Censored Survival Data
Janez Stare and Harald Heinzl

Survival analysis with covariates is dominated by Cox's proportional hazards (PH) model. While the model is flexible and has proven useful in many situations, its applications in practice are often not appropriate. To think that all data that have been fit using Cox model really obeyed the PH assumptions is much more than just unrealistic.
The Buckley & James (1979) estimation method for linear regression models with right-censored response variable and unknown error distribution has been generally preferred over other known approaches. Heller & Simonoff (1992) even concluded that in terms of prediction the Buckley & James method often performs better than the Cox model.
Although we don't agree with Heller & Simonoff's conclusions we find the Buckley & James method to be a valuable tool for analysis of censored data. The most important issue in using this model is whether it actually fits the data. There has been little theoretical work in this area, and we present here some empirical findings. Specifically we address the question of linearity

assumption and to some extent the question of heteroscedasticity.
We assume that one of the reasons for little usage of the method is lack of existing programs. We hope to correct this situation by offering our programs written in S-plus and SAS/IML languages.

Modelling the Yield Law: Single Nutrient Response Curves
Predrag Šesek and Katarina Košmelj

In agricultural applications the yield law represents the response of the crop yield to one or more growth factors. Precise formulation of the yield law still does not exist but there are some functions that are accepted as an approximation of it. We consider the single factor situation, where the growth factor under study is a nutrient, and assume that all other growth factors are present in nonlimiting levels.
The first approximation of the yield law was proposed by Mitscherlich (1909): $y = A(1 - 10^{-cx})$ where y represents the yield, x the nutrient level and A the asymptotic plateau. The curve asymptotically approaches the maximal value A as x is increased.
Field experiences showed that yield decreases as nutrient levels are increased further. Therefore, Mitscherlich and Behrens (1928) advanced the first approximation with the component describing the negative nutrient effect. This second approximation of the yield law is: $y = A(1 - 10^{-cx})10^{-kx^2}$
Boguslawski and Schneider (1960) proposed a four-parameter function based on Mitscherlich functions. Later (1962, 1963) they generalised it to a five-parameter function and called it the third approximation of the yield law:

$$y = M10^{-z|\log \frac{x+i}{m+i}|^n}, n > 1$$

Parameter m denotes the nutrient level where maximum yield is obtained and M is the corresponding maximum yield. Parameter i can be considered as the quantity of plant available nutrient in soil without any supply. Parameters z and n define the shape of the curve: z determines the S-shape, the steepness of the increasing part and the width of the curve around maximum, n the shape around maximum. The main advantage of the third approximation is the fact that parameters M, m, and i are easily interpretable in agricultural sense.

Many authors use quadratic polynomial for the response curve because of its simplicity. Its main disadvantage is the symmetry about the maximum. Nelder (1966) suggested inverse polynomials are a possibility to model the response curves. The idea is that is related to an ordinary polynomial. In particular, the inverse quadratic polynomial

$$y = \frac{x+\alpha}{\beta_0 + \beta_1(x+\alpha) + \beta_2(x+\alpha)^2}$$

is widely used as fertilizer response curve (e.g. Sparrow, 1979). The β parameters define the shape of the curve, α defines its position on the x-axis; x_{max}, $y(x_{max})$ are expressed in terms of them. Design of experiments for estimating inverse quadratic polynomial responses was of great interest for many statisticians since (e.g. Cobby et al, 1986).
In Slovenia, the effect of mineral nitrogen on the grain yield of three different crops (maize, wheat and barley) was under study in a field experiment with three-years crop rotation (Jable, 1993-96). Four levels of mineral nitrogen were included in the experiment. We shall present several response curves obtained on one dataset (winter wheat in 1996). The models will be compared, advantages and disadvantages of different models will be discussed.

All-Cause Mortality and Outdoor NO2 in Zagreb
Diana Šimić, Anamarija Jazbec, Mladen Pavlović, and Janko Hršak

Many recent studies analyze the short-term effects of air pollution on human health (morbidity and mortality). In some cases association between the concentration of air pollutants and number of hospital emergency room visits or deaths was found even for concentrations below the limit and/or recommended values. In European Union there is a collaboration group APHEA, which works on the assessment of the short-term effects of air pollution on mortality and morbidity using epidemiological time-series data. Our results show that there is an association between the weekly number of emergency room visits due to asthma in children and adults and outdoor NO_2 concentrations. In this paper we have used the same methodology aiming to assess the possible association between the number of deaths due to all causes and outdoor NO_2 concentration.
Methods: Data on the number of deaths in Zagreb for 1994 and 1995 were

provided by the Croatian Central Bureau of Statistics. The 24-hour average levels of NO_2 were measured by the staff of the Department of Environmental Hygiene, Institute for Medical Research and Occupational Health, Zagreb. We had measurements for the period from July 1994 to December 1995. This time series had 11 missing values. Information on average temperature, air pressure and relative humidity was collected by the Hydrometeorological Institute of Croatia. We have used the weekly averages, to enable comparison with previous results. This resulted in time series with 78 data points. Average weekly concentrations of NO_2 for weeks with missing values were estimated using the available data. Except for the first and the last week, we had 5 weeks with 6, and one week with 5 available values.
Time series of the number of deaths approximately followed the Poisson distribution and was overdispersed and positively autocorrelated. We have used logarithmic transformation on the count data. In order to account for the observed and some of the unobserved confounding variables, we have adjusted both NO_2 and death count series with respect to trend, seasonal variation and weather variables. Effects of trend and seasonal variation were estimated using the locally weighted regression (LOESS) with a bandwidth of 12 weeks. For number of deaths complete series (104 data points) was used for trend and seasonality assessment. Association between the residuals of NO_2 and the number of deaths was analyzed using autoregressive linear regression. All analyses were performed on a PC 486 using SAS 6.12 for Windows.
Results: Average weekly number of deaths in Zagreb in 1994 and 1995 was 152.2 (SD = 17.3, Var= 300.8) with skewness 0.64 and Kurtosis 0.41. It ranged from 119 to 204. Concentration of NO_2 was within the limit ($C_{\text{avg}} = 50\mu g/m^3$, $C_{98} = 120\mu g/m^3$), but above the recommended daily value (limit ($C_{\text{avg}} = 30\mu g/m^3$, $C_{98} = 60\mu g/m^3$; our daily: $\overline{x} = 45$, $SD = 18.4$, range 5.5 to 169.8; weekly: $\overline{x} = 45$, $SD = 9.1$, range 24.5 to 64.9).
Autoregressive linear regression revealed no autocorrelation of residuals, and the coefficient for weekly NO_2 concentration was 0.002769 ($SE = 0.00134$, $p = 0.0423$). This coefficient corresponds to a relative risk associated with the increase of $10\mu g/m^3$ in average weekly NO_2 concentration equal to 1.028 (95% CL 1.001 to 1.056).
Discussion: We have found a weak association between weekly NO_2 concentration and the number of deaths in Zagreb. The associated relative risk seems lower than that found for emergency room cases of hyperreactive lung

diseases in children and adults in the same period in Zagreb (asthma in children $RR = 1.137$, 95% CL 1.005 to 1.287, in adults $RR = 1.098$, 95% CL 1.002 to 1.203; all respiratory causes in children $RR = 1.067$, 95% CL 1.002 to 1.136, in adults $RR = 1.019$, 95% CL 0.990 to 1.049). The widths of confidence limits are relatively large, and longer period of monitoring is necessary to establish weather there are significant differences between the estimated effects for child and adult morbidity and all cause mortality.

Does the ILO Definition of Unemployment Produce a Biased Sample?
Ray Thomas

There is, as would be expected, high negative correlation between number of registered unemployed in Britain and the numbers in employment. But the application of the ILO definition of unemployment in Britain produces statistics which are relatively insensitive to changes in the level of employment. The sensitivity of the ILO unemployment statistics to changes in the level of employment depends wholly upon the number of respondents registered as unemployed. In an attempt at explanation the paper hypothesises that the ILO's retrospective 'seeking work' criterion produces a sample biased towards respondents who are becoming economically inactive, and biased against 'go-getters' who move directly between economic inactivity and employment. The paper discussed major differences between the British labour market and that of other countries, such as the high proportion of women in the labour force, which help explain this pattern and considers the implications of the findings for the application of the ILO definitions in other countries.

Comparison of L1 and L2 Criteria in the Linear Switching Regression: a Monte Carlo Simulation
Polona Tominc and Lada Bele Tominc

A Monte Carlo simulation has been provided with the purpose to enable the estimation of the regression coefficients in the piecewise linear sales-response function, where the disturbance terms are not normally distributed.

The least squares procedure or L_2 criterion, is a theory and in practice generally used to estimate the regression coefficients of the linear model as well as of the linear switching regression model with deterministic and a priori known switch. One of the assumptions underlying the L_2 criterion is that the disturbance terms are normally distributed. But there are many cases, and the piecewise linear sales-response function is often among them, where the disturbance terms are not normally distributed. Therefore, to use of some other criteria could be legitimate. We assume that the least absolute value or L_1 criterion when the linear switching regression model is estimated.
The Monte Carlo simulation has the following procedure:
1) The piecewise linear function with deterministic and a priori known switch has been expressed by the use of a dummy variable. The two-variable regression model has been used.
2) A random samples of normally distributed and contaminated normally distributed disturbances were generated. The values of the independent variable were selected as a random standard normal variates.
3) After calculating the values of the dependent variable, where the values of disturbances were determined in the step (1), both least squares and least absolute value criteria were applied to the resulting data.
The comparison of the L_1 and L_2 criteria is based on the comparison of the standard errors. The results show that the least absolute value estimates of the regression coefficients have smaller standard errors than the least squares estimates, when the switching regression model with contaminated normal error distribution is estimated. However, in the case of normal error distribution, as would be expected, the least squares estimates have smaller standard errors.
The results of this kind of investigations for the linear regression model, already reported in the literature, are therefore confirmed also for the linear switching regression model.
The least absolute value criterion has another advantage, especially in the cases, where the switch is not known in advance. Using the least absolute value criterion the estimation problem can be formulated and solved as a linear mixed integer optimization model. If the switch is known in advance (a priori) the optimization model is linear.
An example of the estimation of the piecewise linear sales-response function has been included into this paper, since the methodology described has already been used in the practice.

Plausible Values for Estimates of Ability Parameters in Rasch Models

Mojca Trobec and Mihael Perman

Rasch models and their derivations and/or adaptations have a number of properties which make them a popular statistical tool to model data gathered in studies of educational achievements. In Rasch model, the probability of a particular person answering a particular item correctly depends on two parameters, difficulty of the item and ability of the person. Assuming binary 0/1 items, each person's response to each item gives a response matrix of 0's and 1's from which the two sets of parameters need to be estimated. Both sets of parameters can be estimated either simultaneously or one after another. Maximum likelihood methods which give consistent and asymptotically normal estimates first employ maximum likelihood only for item difficulties with person abilities being considered as nuisance parameters. These methods were discussed at the conference Methodology and Statistics in 1996.
In the talk, methods for estimating the ability parameters in Rasch models considering item difficulties as known constants will be discussed. Educationalists often debate how the person's ability reflects her home and educational background. An educational study where these issues strongly needed to be considered was the Third International Mathematics and Science Study (TIMSS) which started in 1991 under the auspices of the International Association for the Evaluation of Educational Achievement (IEA) with more than 45 countries and/or educational systems participating, including Slovenia where the study was carried out by the Center for IEA Studies at the Educational Research Institute Ljubljana. TIMSS was an assessment of two curriculum areas on three populations of students; although the definitions of populations were age-based, in most countries the population 1 were 3&4-grade students, population 2 were 7&8-grade students, and population 3 were students enrolled in the final year of secondary education.
Student achievements in mathematics and science were measured through written tests requiring to select the correct response or solve problems and answer questions in a free-response format. TIMSS sought to measure student achievement in light of their attitudes, home background, the nature of the mathematics and science curricula, instructional practices of their teachers and other classroom activities. In educational studies this is usually done

by trying to explain the variance in students' achievement by grouping students according to the values of some combination of background variables. This is an investigation of relations between student achievement and student background after their abilities have already been estimated in some way or another. But another approach to this investigation is to define and control the process how the information in background variables influences the student ability. The relation between the ability and the background variables therefore has to be defined prior to estimation of ability itself. Additionally, the aim of an educational study usually is not to estimate the abilities of individual students but rather the average ability of population of students. Therefore we do not necessarily have to obtain the values of the individual ability parameters before calculating the average of population.

In the talk we will describe the method of plausible values for estimating the average ability in the population. This method is based on the assumption that individual student ability is a random variable with a normal prior distribution of which the mean is a regression estimate from several background variables. The posterior distribution of the ability random variable is then estimated from student responses to the written test. The reader can recognise this as Bayesian approach. In this way, for each student an ability distribution is obtained. The population average is then obtained as the average of independent random draws from each of the student's posterior distribution. These random draws are called plausible values. This approach does not give the best estimates for the abilities of individual students but more accurate estimates of population average. However, if there is a need to estimate the ability of a particular student, one can take several draws from that student's ability distribution and then take an average of the draws. In TIMSS, the average of five plausible values was considered to be a good enough estimate for individual students abilities.

As always when results based on samples are used for estimation of the population parameters, the estimates of standard errors have to be given as well. The procedures for estimation of standard errors range from purely analytical to pragmatical computerised procedures and the choice, of course, heavily depends on the sampling design of the study. We will briefly describe the bootstrap and the jackknife which are two examples of practical methods for estimating standard errors. The TIMSS sampling design required the pragmatical approach of jackknifing and a description of both, the sample design and the jackknife results will be given.

Non-Response and Socio-Demographic Characteristics of Enumeration Area's
Vasja Vehovar and Metka Zaletel

The data from different administrative sources (e.g., Central Register of Population, Census data, Tax Register, Register of Territorial Units, etc.) were aggregated at the level of enumeration areas (EA) for the territory of Slovenia. A typical EA contains 50 – 100 households. The estimates of travel expenses of the interviewers were also calculated using GIS data, the centroids of the EA and actual expenses of different official household surveys. The non-response rate and the refusal rates at the EA level were linked to this data and dependence models were created. It shown that the costs and the response rates are relatively stable given the socio-demographic predictors at the EA level.

Meta Analysis of MTMM Studies in Russia
William van der Veld, Ferry Reith, Anna Andreenkova, and Willem Saris

In this presentation the results will be given of the analysis of the meta analysis of the MTMM studies which have been done during the last 4 years in RUSSIA by the organisation CESSI. In total the quality of more than 250 questions have been studied. The data have been collected from a representative sample of the Russia population. The sample size varied through time from 4000 to 2000 persons. The results provide inside in the effect of different research decisions on the validity and reliability of the questions.

Description of Non-Precise Data
Reinhart Viertl

Environmental data obtained from measurements are usually non precise numbers of vectors. They are more or less non-precise. This kind of uncertainty is different from measurement errors. The description of such non-precise data is possible using the concept of *fuzzy numbers* and *fuzzy vectors*. Fuzzy numbers are characterized by so-called *characterizing functions*, and fuzzy vectors are characterized by so called *vectorcharacterizing functions*.

Characterizing functions as well as vectorcharacterizing functions are special forms of membership functions of fuzzy sets.
For samples of non-precise observations of stochastic quantities statistical inference procedures must be generalized to that kind of data. This is possible and generalized inference procedures are already published. Details will be given in the contribution.

TV audience measurement: The Influence of Different Data Collection Methods on the Results
Blaž Vodopivec, Rudi Tavčar, and Tomaž Arh

Detailed information about audience size and structure, and about audience use are of vital import to several groups of people: program and film makers and broadcast schedulers, media owners selling to manufacturers and other organizations opportunities to communicate with an audience through advertising and sponsorships, the advertisers as buyers of such opportunities, advertising agencies, media consultants and market research agencies. Many data collection methods exist and as usually there can always be a dispute about the choice and about the pluses and minuses of different data collection methods. Currently in Slovenia, regarding TV audience measurement, exist two different data collection methods: telephone interviewing (a day back recall), dairy interviewing. In this paper we would like to compare the results of TV audience measurement gathered with this two methods. As a basis we took the results of one week in year 1997 for two different TV programs: program A, completely commercial, program B, not commercial. The basic comparison is made on the basis of TV ratings (the percent of measured population watching the particular TV program). Differences in ratings regarding intervals from 7.30 a.m., during all day and to 1 a.m. of the next day will be shown. Further analysis consists of the differences in the measured PUT (people using TV) and in the demographics of the sample.

Visualizing Ordered Structures in 3D
Matjaž Zaveršnik and Vladimir Batagelj

The theory of ordered sets and lattices provides a natural setting in which to

discuss and analyze hierarchies and other structures, which often occur within mathematics and in the real world. There is a growing demand for graphical representations of lattices and other ordered structures. Line diagrams of ordered sets have been proven of substantial use for the exploration of data. Often it is even desirable to draw many pictures of the same structure, which renders possible different views of the data. Since it is quite costly to produce line diagrams by hand, there is a need for computer programs aiding the drawing of diagrams.
In the paper we present different approaches to visualize ordered structures in 3D based on VRML. A program `ORDER3D` supports some of them.

Antecedents and Consequences of Customer Satisfaction – A Lisrel Model Application
Vesna Žabkar

One of the best known models with customer satisfaction as a focal construct was developed by Fornell (1992). According to his model, customer satisfaction is determined by customer expectations and perceived quality. Satisfaction increases customer loyalty and decreases switching behaviour.
Our study proposes a multi-stage customer satisfaction model with antecedents in encounter quality (expectations) and relationship quality (perceived quality). Additionally, loyalty represents a consequence to customer satisfaction in our model. The model is applied to client-advertising agency relationship setting and attempts to enrich our understanding of relationships between customer satisfaction, value and loyalty.
Drawing upon presented conceptual work in the area, groupings of multiple indicators for constructs of encounter quality, relationship quality, customer satisfaction and loyalty were developed. A pre-test assessment of the substantive validity for the item measures was conducted through a pre-test item-sort task. A minimum of three measurement items were kept for each of the constructs.
In order to test the model in a real setting, a sample of 200 main advertisers were selected. A questionnaire was prepared for computer assisted telephone interviewing and tested. Telephone interviews with 153 managerial people of major Slovenian advertisers were conducted. Based on a two-step approach (Anderson, Gerbing, 1988), a confirmatory measurement model was run, and

a series of nested structural models were estimated. A converged LISREL solution for the model was not rejected.

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