RESEARCH INTERESTS IN DEPARTMENT

Financial applications of LULU smoothing procedures
A new class of data smoothing procedures has been developed by CH Rohwer over the last 15 years. They are called LULU smoothers, are based on combinations of the minimum and maximum operators (and thus nonlinear) and have very attractive mathematical properties, especially compared to other nonlinear smoothers. LULU smoothers have already been applied successfully to many problems in eg the earth sciences. However, to date they have not yet been applied to financial data. In this project we consider such applications. In particular, application to data series consisting of returns and volatility are being investigated. These types of data are extremely important in many financial applications and the role of outliers in such data need to be properly understood and their influence on predictions must be properly controlled. The behaviour of LULU in such cases is being investigated as well as the comparison of LULU with other smoothing procedures.
WJ Conradie, T de Wet and CH Rohwer

Loss of degrees-of-freedom in quadratic goodness-of-fit tests.
In many goodness-of-fit statistics one has a number of unknown parameters which have to be estimated from the data in order to apply the procedure. Quadratic-type goodness-of-fit statistics have asymptotic distributions equivalent to that of a weighted sum of independent chi-square random variables, each with one degree-of-freedom. For some of these quadratic statistics, estimation of the unknown parameters can lead to a loss of terms in the sum of chi-squares. This has become known in the literature as the property of "losing degrees-of-freedom". Under this project, this property was investigated for Wasserstein type distance measures and conditions found where the property holds. In particular it was shown how it holds for location and scale families separately. Further work is in progress to consider related statistics for which the property holds jointly for location-scale families. *T de Wet*

Saddlepoint approximation and areas of application
Suppose we are interested in the density of some statistic, based on identical independent observations with an underlying density. Unless the sample statistic and/or the underlying density have special forms, one cannot usually compute analytically the distribution of the statistic and one has to rely on an asymptotic distribution. The latter however, often does not provide a good approximation unless the sample size is (very) large. Moreover, such approximations tend to be inaccurate in the tails of the distribution, where one often wants to use them. Saddlepoint approximation together with the Edgeworth expansion often lead to a very accurate approximation to a required distribution, even for very small sample sizes. Furthermore saddlepoint approximations do not show the polynomial-like waves exhibited for instance by Edgeworth expansions per sé. The success of this approach has led to the study of more general areas of application, inter alia regressions quantiles. *T de Wet and PJU van Deventer*

Regression Quantiles
Regression quantiles (RQ's) are the analogues of order statistics in a regression setting and as such they are beginning to play a similar central role in statistical inference. A very unexplored area of RQ's is that of so-called extreme RQ's. It was only during 2000 that the first substantial theoretical result on this was published and much remains to be done. They have important applications to eg financial modeling where quantities like Value at Risk (VAR) are important indicators to assess an institution's risk, being essentially extreme quantiles. Since in many cases the VAR is also dependent on covariates, the application of extreme regression quantiles is immediate. In this project the properties of extreme RQ's are investigated to see how they perform under various model assumptions on the underlying distribution as well as the covariates. In a similar vein, regression depth estimators as recently proposed by Rousseeuw, are extended to depth quantiles and in particular extreme depth quantiles, and their properties are being investigated. Applications of these to problems in the financial field are considered. *T de Wet, PJ de Jongh (PU vir CHO) and J Beirlant (KUL, België).*

Measuring financial success and long term survival in capital versus non-capital intensive companies

The degree of capital intensity/labour intensity of an enterprise may effect financial decision-making. Moreover, predominantly capital intensive enterprises may react differently to a decline phase or upswing phase in the economy than predominantly labour intensive enterprises. In this study an instrument based on financial ratios is developed to measure the degree of capital intensity/labour intensity. This instrument is applied to enterprises listed on the JSE. The behaviour of capital intensive enterprises and of labour intensive enterprises as measured by various financial indicators (ratios) are compared. Comparisons are made for both an upswing and a decline in the economic cycle. *IJ Lambrechts, JZ Bloom and JN le Roux.*

Non-parametric principal components, discriminant analysis and related biplot displays
Linear discriminant analysis (LDA) is used in multidimensional statistical analysis for optimal separation of two or more groups as well as the classification of a new observation. If the assumption of equal covariance matrices is not satisfied quadratic discriminant analysis (QDA) can be used as alternative. The use of QDA drastically increases the number of parameters to be estimated, restricting the efficiency of QDA. Various non-parametric generalisations of discriminant analysis and principal components are investigated as well as related biplot displays. *NJ le Roux and S Gardner*

A statistical analysis of differentiation in the education of South African youth based on the Living standards and Development Survey 1993
This study investigates associations between years of education completed, literacy scores, numeracy scores, demographic variables and socio-economic variables. Modern multivariate graphical techniques are used to provide summaries of these relationships and to provide a base line for comparison with future data collected on education and socio-economic background.
NJ le Roux, S van der Berg and LC Wood

Bayesian analysis of cancer survival data using the lifetime model
Bayes estimators for some of the lifetime distribution parameters, such as the mean survival time, the hazard function and the survival distribution function are derived for survival data from various lifetime models. The estimators are derived using a selection of loss functions. The survival data are normally censored and the theory is based on right-censored data – other types of censoring are also investigated – non-parametrically and parametrically. Various types of prior distribution are used in this study.
PJ Mostert, JJJ Roux (University of South Africa) and A Bekker (University of South-Africa).

Forecasting by identification of linear structure in a time series
Forecasting is an important and difficult problem in time series analysis. Traditional methods are based on fitting a model to the available data, and extrapolating to future time points. An example is the class of Box-Jenkins models. In this research a new model-free approach is investigated, based on the principal components structure of the so-called time-delay matrix. *SJ Steel, J de Klerk and T de Wet*.

Variable selection in discriminant analysis: measuring the influence of individual cases
In this study the influence of individual data cases in discriminant analysis, specifically in the case where an initial variable selection step precedes the analysis, is considered. Existing influence measures proposed in the literature in a non-selection context are extended to a selection context, and a new, more informative measure of selection influence is proposed. Application of these measures in practical cases is investigated. *SJ Steel and N Louw.*

Influential data cases in the application of variable selection in multiple linear regression
Variable selection is frequently the first step in the analysis of a multivariate data set. It is, however, known that variable selection is an unstable process in the sense that small perturbations of the data may substantially influence which variables are selected. Against this background the identification of selection influential data cases is investigated. Modifying the selection process to take such cases into account, is also studied. *SJ Steel, JO van Vuuren and DW Uys.*

Repairable systems in Reliability: Bayesian Approaches
Research on repairable systems and their evaluation of their performance in terms of reliability and availability. Multi-unit systems are investigated. A Bayesian method of assessing reliability is of primary interest, since very little is published on this topic. PJ Mostert, VSS Yadavalli (University of Pretoria) & A Bekker (UNISA).

Process prior for hazard in Cox regression from a Bayesian viewpoint
Process prior methodology within the Cox regression models and non-parametric Bayesian survival analysis are investigated. Estimation of the baseline hazard and cumulative baseline hazard with or without ties are the main focus. Estimation is done using the Bayesian approach. With Mr Chris Muller (Department of Statistics and Actuarial Science, Stellenbosch)

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