Departement Statistiek en Aktuariële Wetenskap
Department of Statistics and Actuarial Science

Nuusbrief | Newsletter

July 2021

SASA 2021 and the Department's 75th Birthday

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CHAIRPERSON'S MESSAGE

Thank you to staff and students

In the last newsletter, I mentioned a date that we, as staff in the Department of Statistics and Actuarial Science, will never forget: 16 March 2020. This was the last day that our undergraduate students attended in-person classes in 2020.

This year, on 15 March 2021, a year later with one day to spare, our undergraduate students returned to campus for in-person lectures. The format is known as Augmented Remote Teaching, Learning and Assessment (ARTLA). Timetables have been adjusted, lecture venues' capacity limits have been changed to comply with the latest COVID-19 protocols and students' attendance must be recorded – all to keep our students and staff safe. Our postgraduate students, however, returned at the end of January for their Introduction to R module presented in block format, while the rest of the postgraduate students returned on 2 February for in-person lectures.

2021 therefore started with new demands due to the current global situation and all the staff in the Department have once again demonstrated their professionalism, diligence and commitment to our student body, colleagues and the University as a whole.

The Department celebrates its 75th anniversary in 2021, making it one of the oldest Statistics departments in South Africa. In 1946 the Department had only a handful of permanent lecturers with Faantjie Pretorius as first professor of Mathematical Statistics. The Department now has 28 permanent academic staff members and five supporting staff members. Furthermore, it is a privilege that many of our emeritus professors are still involved in the Department.

The Department's academic offering has grown since, with the addition of Actuarial Science in 1985 and Financial Risk Management in 2000. The newest addition to the Department's academic offering is the Bachelor of Data Science (BDatSci) that kicked off this year. The focal areas of Statistical Learning, Computer Science and Behavioural Economics seem to be the most popular subject choices at this stage. The Department is also offering a new module, Statistics and Data Science 188, under the convenorship of Luca Steyn and his team, to all students in our faculty. This new module replaces the modules Statistics 186 and Statistical Methods 176, with the addition of much needed Data Science topics.

Coinciding with the 75th anniversary of the Department, we will host the South African Statistical Association (SASA) annual conference on campus. The conference will be offered in December in a hybrid format, leaving options open to attend in person or remotely (more detail in the included article).

These are but a few of the highlights of 2021, but one cannot fail to acknowledge the huge contribution industry and trust funds make towards the Department and its students. We are fortunate that, as part of a new agreement with FirstRand, they have offered generous financial support in the form of bursaries to our students for the next few years. The confidence these entities have in the Department's programmes and their investment in the future of our students is heart-warming.

On this note, I would like to congratulate Ms Jamie Stolk, who recently received the prestigious CGW Schumann Medal – an annual award presented to the best postgraduate student in the Faculty of Economic and Management Sciences. Jamie completed her BCom Honours in Actuarial Science with distinction

Prof Paul Mostert

Chairperson: Department of Statistics and Actuarial Science

BDatSci students start their Data Science journey

2021 has been an exciting year for the Department of Statistics and Actuarial Science at Stellenbosch University (SU). This year has seen the implementation of the BDatSci degree, which is a first-of-its-kind degree in South Africa. What makes this degree unique is that it is truly a collaboration across multiple departments and even faculties within the University, which is a reflection of the cross-disciplinary nature of Data Science itself.

The Department of Statistics and Actuarial Science coordinates the implementation of this novel student offering between the various departments and focal areas. This year has seen the first intake of registered students: a joyous culmination of many months of planning, design and negotiating logistical challenges. It is something worth celebrating.

The Department not only played a coordinating role in the planning stages, but also heads up one of the focal areas within Data Science for which students can register, namely Statistical Learning. This focal area emphasises the statistical paradigm (together with computational skills the student acquires in other departments) to answer complex questions in a new and insightful way. The vision is that the graduating student will be able to add value, not only in a single area of application, but in any discipline such as finance or health by applying the fundamental skills and concepts of Data Science.

Naturally, with such a groundbreaking, cross-disciplinary programme, the degree has attracted interest from students with equally varied backgrounds and motivations to study Data Science at SU. We interviewed a few first-year students registered for the Statistical Learning focal area and asked them about their views on Data Science, problems they think should be investigated through an application of Data Science, and their future aspirations. Here is what a few of them had to say:

Jaime Kruger

As children, we do not impose limits on ourselves – our imaginations are left boundless, and the pessimism of our grand ideas is absent. Throughout my life my curiosity has been evident; it has always been inadequate to do something 'just because'. This is the basis behind my choice to study Data Science and, consequently, my decision to study at Stellenbosch University. The field of Data Science provides an opportunity to think differently and seek alternative ways to solve problems without boundaries prescribing the 'correct' method. It not only allows for intellectual stimulation and debate but can be used to retain data, which can then be analysed and used to implement interventions that can benefit our surrounding community.

Artificial intelligence, in particular, is a multi-faceted environment, which needs not only individuals who have studied information systems but also individuals who understand human ethics and values. It is therefore important to listen to groups of diverse individuals' experiences and perspectives so that we can learn and grow, consequently allowing for new innovations to prosper.

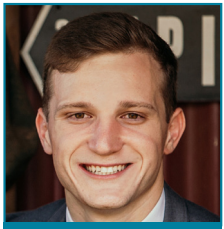
I have frequently been consumed by the unknown and endless possibilities. I have never been a person who views a proposal and thinks that it is impossible; I would rather think: how can I prove that it is possible. Although I am still at the beginning of the degree, I have enjoyed being challenged and look forward to increasing my knowledge around all the relevant facets.

Albert du Plessis

My brother (who attended Maties) piqued my interest in Data Science and after attending the open day I felt it was the course that was tailor-made for me, given the modules included. I chose Stellenbosch since few other universities offer Data Science, and also due to the positive experience my brother had here. My choice of Statistical Learning as a focal area was influenced by my desire to be part of the Faculty of Economic and Management Sciences and should enable me to look for trends and patterns in data and then create a mathematical model to make predictions. This sounds exactly like my kind of career!

I have found that there is a big demand for data scientists all over the world and therefore I think that this course is a big step for Stellenbosch University, and I am very glad they introduced it at this time. My career aspirations are to find a job that allows me to work with financial data and apply this to the modelling of future business profits, amongst others.

I am enjoying the course very much so far, and particularly the mathematics. I am also looking forward to the future modules – all in all, it seems like a course that will suit me perfectly.



AD Kotze

I chose to enroll for the BDatSci degree since I believe that this recently-introduced programme at Stellenbosch University fits my talents, interests and personality like a glove. I am fond of mathematics, programming and analysis. I am also curious to understand machine learning and determining outcomes. Statistical Learning was an obvious choice as my focal area.

The BDatSci programme is a 4-year degree. After completing the degree, I want to be able to continue with my master's degree and become an expert in a specific field of Data Science. Data Science provides more career opportunities in a world driven by artificial intelligence and data analysis. Because of the interest I have in most of my subjects, my experience thus far in studying Data Science has only been positive.

Gelene Henning

I decided to study Data Science because I knew that if I could get this degree, I could do basically anything. I knew it was going to be a challenge but would be worth it in the end.

Data scientists are in high demand worldwide, so I remain assured that I will be able to step into the adult world knowing I will have access to great work opportunities. I chose Stellenbosch University because it is one of the top universities in South Africa and I know that I will not regret getting my degree here. It's only 50 minutes away from home which is also a bonus. I chose Statistical Learning as my focal area because I love Statistics: in matric, it was my favourite part of mathematics.

I don't have exact plans for my career; I am just focusing on getting my degree for now. What I do know is that I really want to own my own business one day and I want to be able to work anywhere I want. I think the BDatSci degree will really help me achieve these goals.

This year has been tough, but I enjoy the challenge. I think the toughest part for me is doing Computer Science – it was definitely one of my hardest modules this semester – especially because I didn't have any previous experience in coding. Another priority for me is to be able to maintain a good balance between my studies, friends and family. I am enjoying my degree, and I can't wait to start with modules that are more specialised in my focal area.

LATEST NEWS

SU to host 62nd SASA annual conference

The Department of Statistics and Actuarial Science is excited to host the 62nd annual conference of the South African Statistical Association (SASA) from 1 to 3 December 2021, in conjunction with the Department's 75th birthday celebration. The aim of the conference is to provide an opportunity for researchers, mainly from South Africa, to come together and discuss key scientific issues in technical developing areas of research. Topics include the interaction of Mathematical Statistical Biology, Data Science and Quantitative Finance.

The conference typically provides young researchers with the chance to meet fellow researchers from other universities and to network with the international plenary speakers. We envisage that the conference will play a significant role in introducing Southern African researchers to recent developments in the rest of the world and consequently give a boost to current research trends.

The conference model consists of a hybrid setup with a maximum of 100 delegates in person with an additional 200 virtual delegates. It is designed in such a way that the setup incorporates the dynamics of COVID-19 national response policies and regulations. The conference will span five days, with two days of pre-conference workshops (presented online on 29 and 30 November) followed by the three-day conference (hybrid).

The workshops are specifically designed to upskill participants in topics such as machine learning, financial risk management, mathematical methods and grant writing. Some of these workshops are presented in collaboration with the School for Data Science and Computational Thinking at Stellenbosch University.

Parallel sessions will include both in-person and online presentations. Poster sessions will be available online with the option to post questions in an interactive mode. Most of the plenary speakers will be international guests and will have a virtual presence at the conference. Local plenary speakers, who prefer to attend the conference in person, will present during live sessions which will be streamed.

In addition, a community outreach programme is planned in collaboration with the SASA education committee and the School for Data Science and Computational Thinking. Workshops will be available to matriculants and educators to introduce the participants to statistical ideas and statistical programming. The workshops will also address lessons learnt and new opportunities for Statistics education following the COVID-19 pandemic, with support from the International Association on Statistics Education (IASE).

For more information, please visit the website:
https://app.glueup.com/event/sasa2021-33624/

Generous financial support to students of the Department

The Department continues to cherish the strategic partnership it has with industry. This collaborative effort with industry makes a positive difference, especially in these challenging times and with the tertiary education sector under extreme financial pressure.

The partnerships provide financial support in terms of bursaries to our students and also support research in our Department. The Department continues to hone our forward-thinking initiatives and to reconfigure the way various departmental activities are funded, developed and delivered. This will broaden the experience of our students, identify and implement cutting-edge research into relevant industry and community problems, and increase employment opportunities for students. The Department proactively develops our relationships with industry to maximise the collaborative benefits.

The followings bursary schemes are active in our Department:

1. Correlation Risk Partners has been very involved in the Department since 2016 and they are continuing their donations to the Department. The Department once again received R1 Million in 2021 which has already been awarded to bursary holders (students across all disciplines in the Department).
2. SASA-NRF bursaries were awarded to two second-year master's students in Mathematical Statistics and Statistics, with a combined value of R200 000.
3. The Faantjie and Lettie Pretorius Bursary scheme provides bursaries to third-year students in Statistics and Mathematical Statistics.

Multivariate Quantiles and Applications to Risk Measurement

Author: Sven Buitendag

Introduction

Fundamental empirical probabilistic measures, such as the sample quantile function and the empirical distribution function, cannot be extended in generality from the univariate setting to the multivariate domain due to the absence of the canonical ordering of $\mathbb{R}^d$ $(d > 1)$.

This has a wide range of implications, including the struggle to extend univariate risk measures to the multivariate realm. All univariate risk measures are directly or indirectly related to quantiles, and therefore to the canonical ordering of $\mathbb{R}$. Empirical quantiles allow for the construction of empirical estimates of risk measures such as value-at-risk and expected shortfall.

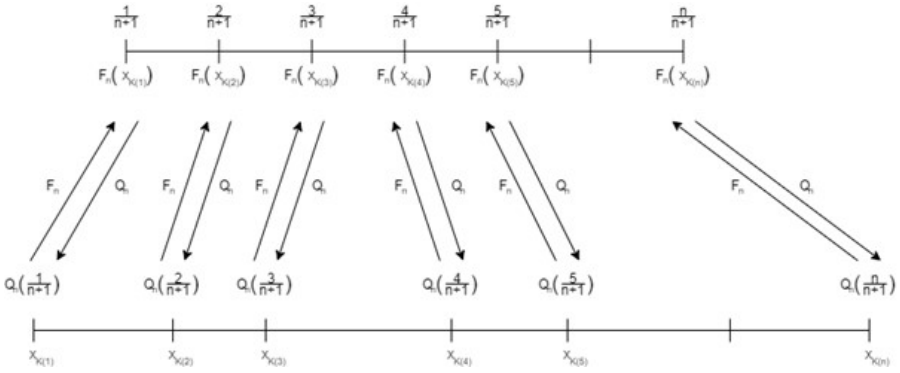
This theoretical obstacle has recently been overcome by Hallin (2017) by viewing a univariate empirical function as a coupling rather than an ordering. Therewith Hallin defined multivariate empirical probabilistic measures as an optimal transport (a coupling from a multivariate domain with known quantiles to the sample space with unknown quantiles) that has several key properties, such as the Glivenko-Cantelli property.

This article provides an overview of Hallin's approach to defining empirical probabilistic measures in the multivariate space and then briefly discusses some of the resulting multivariate risk measures.

Ordering vs Coupling

Canonical ordering is a fundamental property of the real line $\mathbb{R}$: any two of its elements can be ordered. This allows for the creation of the sample quantile function and the empirical distribution function.

Another way in which to see the empirical distribution function and its inverse, the sample quantile function, is a coupling $\kappa: \{1,2,\dots n\} \to \{1,2,\dots .n\}$ of the uniform points $\frac{1}{n+1}, \frac{2}{n+1}, \dots, \frac{n}{n+1}$ to the observed sample $x_1, x_2, \dots, x_n$ which minimises $\sum_{i=1}^{n} \left| \frac{i}{n+1} - x_{\kappa(i)} \right|^2$.



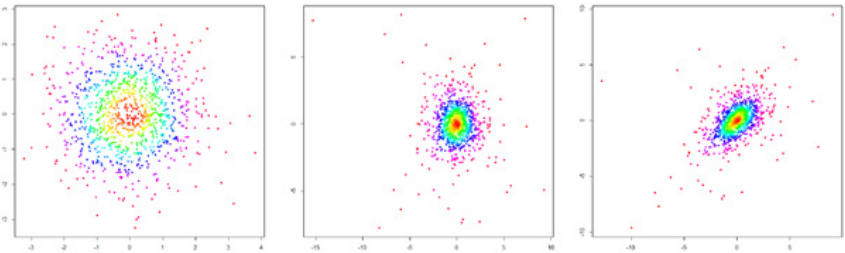
Viewing the empirical distribution function and its inverse as a coupling rather than an ordering means that it can easily be extended to the multivariate space whilst maintaining many of the univariate function's important properties.

The centre-outward quantile function

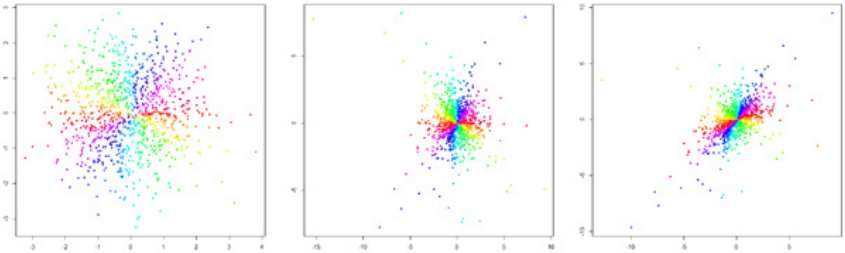
The centre-outward quantile function is an extension of the above-mentioned coupling to any d-dimensional space $\mathbb{R}^d$ with two adjustments:

- Instead of coupling points in $[0,1]$ to the observed sample points we now couple points in the unit sphere $\mathbb{S}^d = \{\underline{u} \in \mathbb{R}^d : \|u\| < 1\}$. This is equivalent to constructing $2F^{(n)} - 1$ in the multivariate space and is denoted by $\underline{F}_{\pm}^{(n)}$ in the literature.
- The coupling of points $\underline{u}_1, \underline{u}_2, \ldots, \underline{u}_n$ in the unit sphere to the observed sample points $\underline{x}_1, \underline{x}_2, \ldots, \underline{x}_n$ minimises $\sum_{i=1}^{n} \|\underline{u}_i - \underline{x}_{K(i)}\|^2$

The centre-outward distribution function is illustrated for the bivariate normal (left), Student-t (centre) and elliptical hyperbolic distribution (right) below:

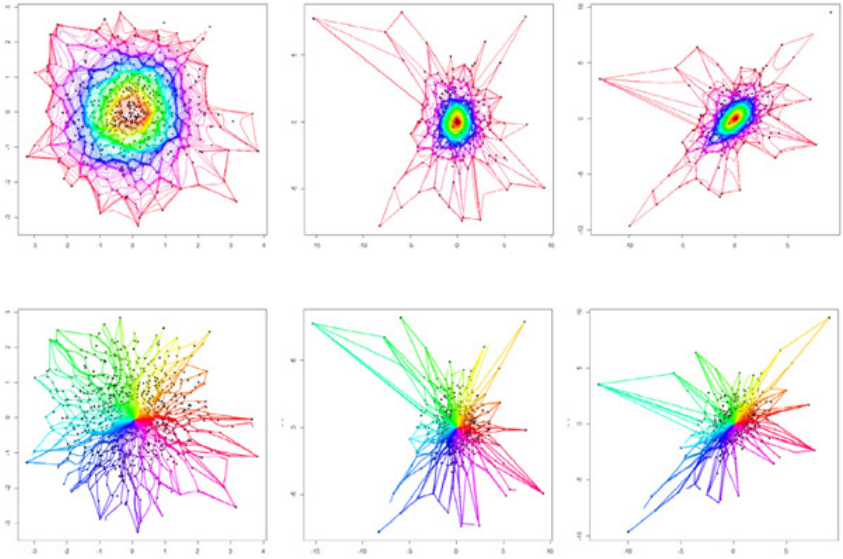


Another useful property is that the directions can also be displayed:



A major shortcoming of coupling points in the unit ball to the observed sample points is that it is a discrete function. This can be addressed by applying a Moreau envelope or kernel smoother which maps the entire unit ball to the sample space.

The kernel smoothed centre-outward distribution function is again illustrated for the bivariate normal (left), Student-t (centre) and elliptical hyperbolic distribution (right) below:



Applications to Risk Measurement

All univariate risk measures are directly or indirectly related to quantiles. Any coherent risk measure ρ can be written as $\rho = \int_0^1 w(u)\ Q(u)\ du$ where Q is the quantile function and $w: [0,1] \to [0,1]$ is some weighting function. Two examples of such risk measures are Value-at-Risk where $w = Ind(u = p)$ and expected shortfall where $w = \frac{1}{1-p} Ind\,(u > p)$.

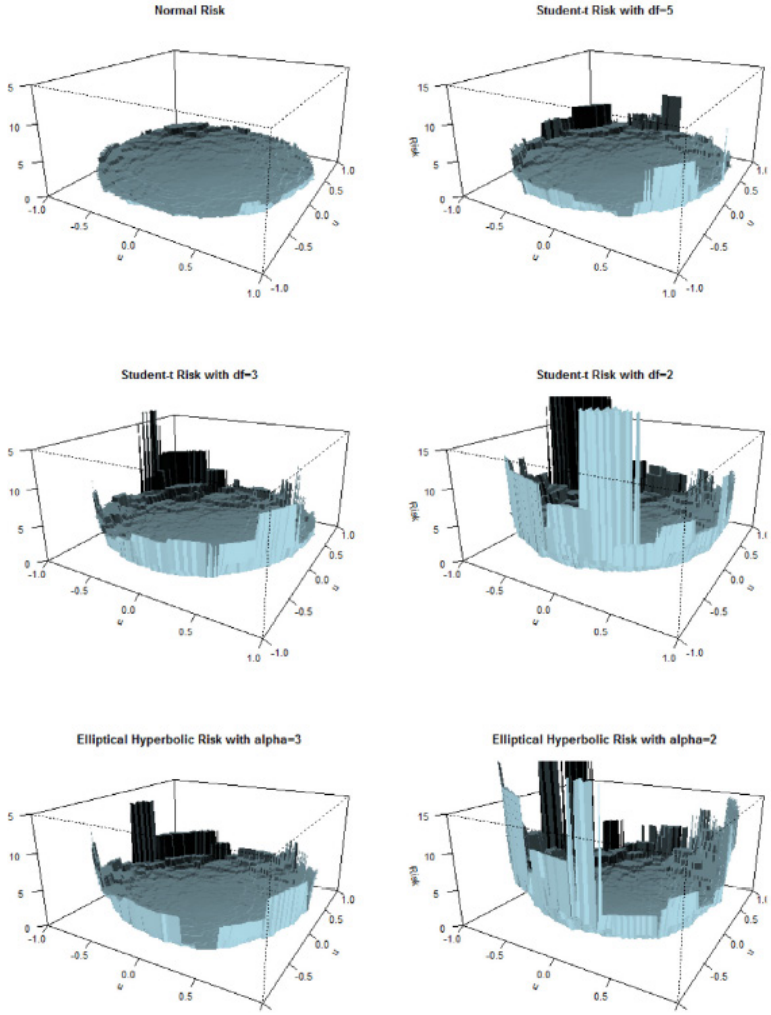
The risk measure ρ can be extended to the multivariate space by defining

$$\rho = \int_{u \in \mathbb{S}^d} \langle \underline{w}(\underline{u}) \,,\, \underline{Q}_{\pm}(\underline{u}) \rangle \; du_1 \ldots du_d$$

whose empirical counterpart is given by

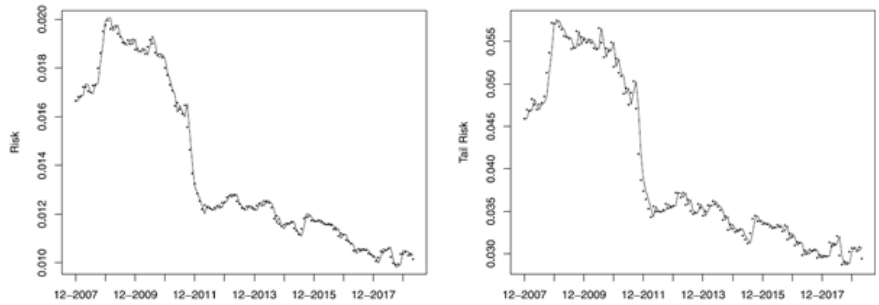
$$\hat{\rho}^{(n)} = \frac{1}{n} \sum_{i=1}^{n} \langle \underline{w}(\underline{u}_i) \,,\, \underline{x}_{\kappa(i)} \rangle$$

As an example, if we take $\underline{w}(\underline{u}) = \underline{u}$ then we get the empirical estimate of the maximum correlation risk measure with respect to the baseline distribution $\underline{U} \sim Unif(\mathbb{S}^d)$ from Ekeland et al. (2012). The maximum correlation risk measure can be illustrated by plotting $\langle \underline{u}_i, \underline{x}_{\kappa(i)} \rangle$ as a function of $\underline{u}$:

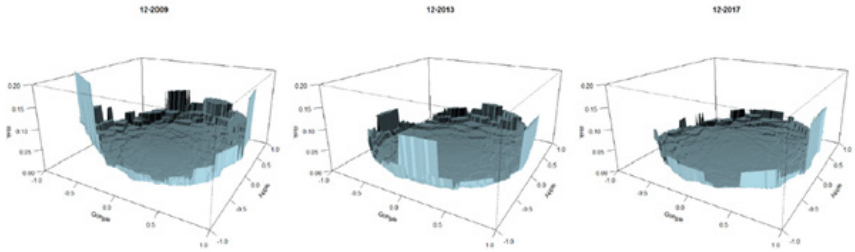


The quantities $\langle \underline{w}(\underline{u}_i), \underline{x}_{\kappa(i)} \rangle$ are not only useful for calculating risk but can also be used to determine the extremity of the sample or to identify outliers.

An application of this risk measure to the daily log-returns of Google and Apple share prices from 2007 to 2017 yields the following results:



The risk plot on the left corresponds to $\hat{\rho}^{(n)} = \frac{1}{n}\sum_{i=1}^{n} \langle u_i , x_{\kappa(i)} \rangle$ and the tail risk plot on the right corresponds to the risk measure $\hat{\rho}^{(n)} = \frac{1}{n}\sum_{i=1}^{n} \langle \underline{w}(\underline{u}_i) , \underline{x}_{\kappa(i)} \rangle$ where $\underline{w}(\underline{u}) = \underline{u}\, Ind(\|\underline{u}\| > 0.95)$.



Concluding remarks

The approach with which Hallin (2017) extends fundamental empirical probabilistic measures, specifically the centre-outward distribution and quantile functions, from the univariate setting to the multivariate domain is discussed and illustrated.

The application of these multivariate quantiles to risk measurement yields variants of the maximum correlation risk measure of Ekeland et al. (2012). The daily log-returns of Google and Apple share prices is used as a case study to illustrate the application of the proposed risk measures.

The full article is available at https://www.sciencedirect.com/science/article/abs/pii/S0167668720301165

Bibiliography

Hallin, M., 2017. Distribution and quantile functions, ranks and signs in Rd: A measure transportation approach. Working Papers ECARES 2017-34, ULB, https://ideas.repec.org/p/eca/wpaper/2013-258262.html.

Ekeland, I., Galichon, A., Henry, M., 2012. Comonotonic measures of multivariate risks. Math. Finance 22, 109-132.

STAFF MATTERS

StatCon 2020

The StatCon 2020 Online Workshops were presented from 9 November 2020 to 2 December 2020 in association with the North-West University (NWU) and the University Capacity Development Programme National Collaborative Project (UCDP). Online workshops and mini presentations on various topics in Statistics were held. As part of StatCon, our Department contributed two presentations to the Multivariate Data Analysis Group (MDAG) Workshop.

The first was "A Classification Challenge in the Wine Industry" with authors Niël le Roux, Sugnet Lubbe (both from the Department of Statistics and Actuarial Science, SU), Marina Cornelissen, and Hélène Nieuwoudt (both from the Institute of Wine Biotechnology, SU) with Niël as the presenter.

Wine quality is adversely affected by rot infection. Although chemical analyses can be performed for disease markers, this is time consuming. The challenge is how to use infrared spectroscopy at the weighbridge for objective, rapid and cost-effective assessment of the sanitary status in machine-harvested wine grapes. In this study, the data originated from an observational study and included vintage, infrared spectroscopy instrument, cultivar, presence of rot and spectra. Spectra were converted into wavelengths and the intensity at each wavelength was measured together with percentage rot in the sample.

"The first challenge was to align wave numbers originating from different instruments. We suggested B-splines for this challenge. The next challenge was to decide which wave numbers to include as predictors of rot. We started by selecting 1 000 equally spaced wave numbers in the region of interest. Then we used an Artificial Contrasts with Ensembles (ACE) algorithm for subset selection to find a 'best' subset of wave numbers to use in a canonical variate analysis (CVA) to optimally separate different rot groups. Our analysis was completed by several CVA biplots to identify how the selected wave numbers were able to distinguish the rot groups from one another. Finally, these marker wave numbers were then related to various chemical compounds," the presenters explained.

The second presentation, by Carl van der Merwe, was titled: "Classifying yield spread movements in sparse data through triplots, plus other biplot developments". This presentation focused on the use of biplots with classification techniques. Specifically, triplots were applied to a financial problem where it needed to be determined whether there was sufficient evidence that the spread had moved. The resulting triplot allowed for various ways in which to classify the results, and also visualise it marginally. Recent developments in biplot research that could be incorporated were also discussed.

Our Wedding Story – Zeenat Abdul-Azeez and Hassan Sadiq

Mr Hassan Sadiq, lecturer in Statistics, and Ms Zeenat Abdul-Azeez celebrated their wedding in Nigeria on 16 January 2021.

"We first had an introduction ceremony according to religious and traditional rites. At the event, we had to officially state our intention to get married in the presence of our families. That was followed by a legal registration of our marriage. We then had a main event where we entertained family and friends. Most of the event planning had to be done by our parents because we both had to travel from outside the country. That made it challenging to limit the guest list and fanfare. To the best of our abilities, we ensured that guests used face masks to avoid the spread of COVID. However, nothing could tame the fanfare that has always been the hallmark of a typical "Nigerian Wedding Party"! Above all, it was an amazing, beautiful and memorable day. Despite travel limitations that have kept us apart since then, our journey together has been blissful."

STUDENT ACHIEVEMENTS

2020 CGW Schumann Medal goes to Jamie Stolk

The prestigious CGW Schumann Medal has been awarded annually since 1986 to the best postgraduate student in the Faculty of Economic and Management Sciences and is the highest student accolade in the faculty. For an amazing third year in a row, this medal was awarded to a student from the Department of Statistics and Actuarial Science.

Ms Jamie Stolk completed the BCom (Actuarial Science) degree cum laude in 2019. As a result of her outstanding undergraduate performance, she was awarded the prizes for being the top student in both Actuarial Science and Mathematical Statistics in her final year. This is something which is only rarely achieved. She also received the Rector's Award for excellent academic achievement. Jamie went on to graduate cum laude and in the top position for BComHons (Actuarial Science) in 2020, thereby receiving the coveted CGW Schumann Medal.

Jamie grew up in George and matriculated from Glenwood House Secondary School. In addition to her academic achievements, Jamie was a member of her residence's Connect Committee in 2018, heading up the sponsorships team as part of the fundraising initiatives. The funds were used for social impact projects. She served as a tutor throughout her time in Stellenbosch and played netball, table tennis and hockey for her residence as well.

Jamie now works in the Global Markets Division of Standard Bank's Corporate Investment Banking in Johannesburg.

PhD graduate

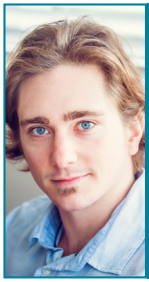
Student: Ivona Contardo-Berning
Degree: PhD in Statistics
Supervisor: Prof Sarel Steel
Title of thesis: Feature Selection for Multi-label Classification

Abstract: In the multi-label setting, a data instance can be associated simultaneously with a set of labels instead of only a single label. The nature of multi-label datasets typically means that these datasets are complex and dimensionality reduction might aid in the analysis of these datasets. The notion of feature selection is therefore introduced and discussed briefly in this dissertation. A new procedure for multi-label feature selection is proposed. This new procedure, Relevance Pattern Feature Selection (RPFS), utilises the methodology of the graphical technique of Multiple Correspondence Analysis (MCA) biplots to perform feature selection. An empirical evaluation of the proposed technique is performed using a benchmark multi-label dataset and synthetic multi-label datasets. The empirical evaluation of the procedure shows that the results achieved by the reduced sets of features are better than those achieved with a full set of features for the majority of the methods.

Hyperlink to thesis: https://scholar.sun.ac.za/handle/10019.1/109247

STUDENT ACHIEVEMENTS

Master's degree graduates



Student: Robert Cronje
Degree: MCom (Financial Risk Management)
Supervisor: Dr CJ van der Merwe
Title of thesis: The appropriateness of ISDA SIMM for delta risk margin calculations in the South African over-the-counter interest rate swap market

Abstract: The appropriateness of the calibrations in the ISDA SIMM for calculating delta risk initial margin (IM) in the current over-the-counter interest rate swap market in South Africa is considered. Three main experiments are conducted that include novel ways of delineating and uncovering potential risks in the ISDA SIMM. By comparing the delta risk IM obtained using the standard model and that of a filtered historical simulation expected shortfall model that is calibrated to the South African swaps index curve, the IM appropriateness can be inspected for various profiles based on their relative sensitivities to the tenors of the swap curve. The experiments show that the ISDA SIMM is appropriate in most cases, but due to its broad calibrations, some shortfalls are shown to exist. The results are standardised throughout and are independent of absolute size, as liquidity and concentration features are deliberately excluded. This makes the results more generally applicable.

Hyperlink to thesis: http://hdl.handle.net/10019.1/109302

Student: Corine de Koker
Degree: MCom (Mathematical Statistics)
Supervisor: Dr David Hofmeyr & Mr Hans-Peter Bakker
Title of thesis: Validation of Independent Component Analysis using a hypothesis testing approach

Abstract: The main focus of this thesis is the validation of Independent Component Analysis (ICA), a popular technique used in signal processing. In a typical application, the purpose of ICA is to extract non-Gaussian signals representing the source signals from observed signals that are mixtures of the source signals in the case where the source signals are unavailable or unknown. This thesis only considers the FastICA implementation of ICA which extracts non-Gaussian signals through the maximisation of negentropy. The more non-Gaussian the source signals, the more closely the signals extracted represent the source signals. Amongst other things, this thesis demonstrates a novel approach using hypothesis testing with negentropy as a test statistic to determine the degree of non-Gaussianity of the source signals. Results provide evidence that hypothesis testing could potentially be used as an alternative method to indicate the degree of non-Gaussianity of mixtures of source signals.

Hyperlink to thesis: http://hdl.handle.net/10019.1/109149

Student: Christiaan Hugo le Roux
Degree: MCom (Financial Risk Management)
Supervisor: Prof T de Wet & Prof W Conradie
Title of thesis: Lévy processes and quantum mechanics: An investigation into the distribution of log returns

Abstract: It is well known that log returns on stocks do not follow a normal distribution as is assumed under the Black-Scholes pricing formula. This study investigates alternatives to Brownian Motion which are better suited to capture the stylized facts of asset returns. Lévy processes and models based on Quantum Mechanical theory are described and fit to daily log returns for various JSE indices. Maximum likelihood estimation is used to estimate the parameters of the Lévy processes, and the Cramer-von Mises goodness of fit statistic is minimised to estimate the parameters of the Quantum Mechanical models. Q-Q plots and the Kolmogorov-Smirnov fit statistic is presented to assess the fit of the various models. The results show that the Lévy processes, specifically the Normal Inverse Gaussian process, are the best among the processes considered. The performance of the Quantum Mechanical models could be improved if more eigenstates are considered in the approximation, however the computational expense of these models makes them impractical.

Hyperlink to thesis: https://scholar.sun.ac.za/handle/10019.1/109864

Student: Megan Wendy Payne
Degree: MCom (Mathematical Statistics)
Supervisor: Dr Justin Harvey
Title of thesis: Bayesian Machine Learning: Theory and applications

Abstract: Machine learning problems in general are concerned with the ability of different methods and algorithms to extract useful and interpretable information from large datasets. Bayesian methods have been present for several centuries; however, it was the advent of improved computational power (allowing computation of complex integrals that are often analytically intractable) that catalysed the use of Bayesian modelling approaches in a wider range of scientific fields. This thesis considers a Bayesian approach to statistical modelling. A comprehensive overview of several machine learning topics is covered from a Bayesian perspective and, in many cases, compared with their frequentist counterparts as a means of illustrating some of the benefits that arise when making use of Bayesian modelling. The topics covered are focused on the more popular methods in the machine learning literature.

Hyperlink to thesis: http://hdl.handle.net/10019.1/109270

Student: Willem Pretorius
Degree: MCom (Mathematical Statistics)
Supervisor: Dr Morne Lamont
Title of thesis: A deep Convolutional Neural Network architecture for image classification

Abstract: Convolutional Neural Networks (CNNs) are well-known for their state-of-the-art results obtained in computer vision and deep learning tasks. The availability of a large amount of data and improvement in hardware technology has accelerated the research done in CNNs, and recently interesting deep CNN architectures have been reported. The objective of this thesis is based on image classification and object detection tasks, that is, creating custom-designed CNN architectures for deployment on real-world datasets while comparing these custom-designed architectures to those state-of-the-art architectures found in the literature. The most promising modern CNN architectures with associated hyperparameters are explored by means of empirical work. The empirical work done is complemented by additional coded notebooks that could be used to implement state-of-the-art techniques, as well as for comparative and model assessment experiments.

Hyperlink to thesis: http://hdl.handle.net/10019.1/109135

Student: David Rodwell
Degree: MCom (Financial Risk Management)
Supervisor: Dr CJ van der Merwe
Title of thesis: Categorical CVA biplots

Abstract: In a world where data is becoming a sought-after asset, techniques to visualise and understand large amounts of data are paramount. In most settings, this data is usually of a high-dimensional nature which further stresses the need for effective visualisation techniques. Hence, this paper expands upon a multivariate visualisation technique called biplots in cases where categorical variables are present. In particular, a new biplot construction methodology named CVA(Hr), which incorporates concepts from both non-linear principal component analysis and canonical variate analysis, is developed. This technique is then showcased using the Iris dataset where two variables are binned to form categorical variables. It is shown that this novel method improves upon existing biplot construction in terms of classification accuracy and class separation. Moreover, an interactive web-based application was built demonstrating the various biplot construction methodologies on four additional datasets.

Hyperlink to thesis: http://hdl.handle.net/10019.1/109122

Student: Delia Sandilands
Degree: MCom (Financial Risk Management)
Supervisor: Dr CJ van der Merwe
Title of thesis: Exploding biplots with density axes in Plotly

Abstract: Biplots are visual approximations to multidimensional datasets and are very useful in data-driven procedures. However, certain issues occur when dealing with a large number of observations or variables. A proposed solution to the former would be moving the variable axes orthogonally to the edges of the plot with an automatic procedure. This unclutters the centre of the plot and makes it easier to interpret specific observations. When dealing with a large number of observations the datapoints become indifferentiable from one another and this could be difficult to interpret. This problem was addressed by creating densities on the variable axes. Along with these proposed enhancements, an interactive element to biplot plotting was introduced via the use of Plotly in R. This allows the user to dissect the biplot even further. A web-based Shiny application was built as supplement to this paper and can be found at https://carelvdmerwe:shinyapps:io/ExplodingBiplots/. Here the user can interact with the datasets, proposed methodology and functionalities presented in this research.

Hyperlink to thesis: http://hdl.handle.net/10019.1/109127

Stellenbosch alumni admitted as Fellow members of the Actuarial Society

Being admitted as a Fellow of the Actuarial Society of South Africa (FASSA) is a big achievement which requires many years of dedicated study. The following alumni from Stellenbosch University were admitted as Fellows and the Department would like to congratulate them.

They are:

Y Acker; JJ Ainslie; PS Bernard, C Bezuidenhout; L Brits; DJ Broeksma; ID Buchanan; DK Dharsey; PJ Edwards; DJ Erasmus; TJ Fick; MS Fourie; P Govindasamy; R Hechter; A Henning; DL Hill; SM Hinteregger; W Jacobs; I Kok; J Koorts; JH Kritzinger; LE Kritzinger; HA Kruger; LV Lanz; K Lubbinge; HF Marais; JI Minnaar; JC Nortier; EG Olivier; CW Opperman; SJ Opperman; G Petersen; K Steyn; K Swanepoel; I Swart; C Terblanche; C van der Westhuizen; N van Druten; TJ van Rooyen; H Wenhold; JHW Wessels.

Alumnus talks about 'exciting time to work in quantitative risk management'

In December 2012 **Edward Venter** met two Deloitte UK partners for a glass of Sauvignon Blanc in a South African-run wine bar, Vivat Bacchus, in London. At the time, he was a summer vacation student at Old Mutual in London and his boss had offered him the opportunity to expand his network in the city. Little did he know that a couple of naïve questions about Value-at-Risk (VaR) models over a glass of wine would ultimately be the starting point for a career in Financial Risk Management (FRM) at Deloitte UK.

In 2012, Edward had just finished his BCom (Mathematical Sciences in FRM) at Stellenbosch University (SU). Having done well at mathematics at his Alma Mater, Paul Roos High School, he originally pursued a BCom (Actuarial Science) before moving to FRM in his second year: "The second-best decision I made in my academic career was transitioning over to FRM. This opened doors for me when I started my career".

Following his undergraduate degree, Edward went on to complete his BComHons (Financial Risk Management) in 2013 whilst completing an internship with Deloitte UK in London following his first semester. During this time, he was a resident of Dagbreek Men's Residence, serving on the house committee for two years. The last chapter of his studies at SU was his MCom (Financial Risk Management) which he passed cum laude.

"Doing my master's degree in FRM was the best decision I made in my academic career. The presentation skills I learned during my studies for the degree itself, and the opportunity that I received to teach Statistics 188 at the end of my master's degree, taught me how to explain complicated subject matter and built my confidence as a presenter – this has proven invaluable to me in my career as a consultant." He has subsequently presented at international conferences on credit risk management.

He joined Deloitte UK in London in 2015 as an Assistant Manager in the Financial Risk Measurement team. At the start of his career Edward was using the strong mathematical and statistical foundation that he developed during his time at SU to develop Expected Credit Loss models aligned with the then new IFRS 9 requirements. Six years later, Edward is now a director in the same team, leading a team of risk-modelling professionals. His team specialises in the development and application of credit risk models to support financial institutions on capital allocation, loan impairment modelling and, more broadly, financial risk management.

Edward says: "I love working with our clients to strategically transform the way they manage risk. I'm especially interested in innovation and technology and how this can improve risk management, either through automation or analytics."

He believes that it is an incredibly exciting time to work in quantitative risk management and that there are plenty of opportunities in the financial industry for strong mathematicians and statisticians who understand finance and risk.

"The role of the risk manager has grown significantly over the last decade. I think the credit risk industry is evolving now more than ever. Currently we see regulatory requirements becoming more complex and

more stringent. Technology is also evolving at an ever-increasing pace and there's been a significant rise in data and computing power, opening doors to a world of possibilities to improve risk management using artificial intelligence and machine learning. This introduces interesting challenges – as George Box said: 'All models are wrong; it is just that some are more useful than others.' Therefore, the question becomes: How do you own the model risk and make sure that decisions made based on the model output are explainable and in line with the business need?

"Another hot topic for us is the financial risk of climate change – this is not only a problem for the international community but poses real challenges for financial institutions. Recently the international regulators published an interesting framework for climate risk that includes helpful advice on how a financial institution can integrate climate hazards within its existing risk taxonomy, and we are currently looking at how lenders should quantify these risks to better understand potential future losses stemming from climate change. I also think this is a great area for postgraduate research."

Outside of work Edward is a keen endurance athlete. He has completed two Ironman triathlons, as well as ultramarathons and ultradistance cycling events.

"One of the things I love most about London is that it really is an active city. I love going for a nice run through the various parks spread across the city or a cycle down in Surrey with friends. Staying active helps me to clear my mind. I've learned that taking care of one's mental and physical health is extremely important."

Edward also recently got engaged to his girlfriend, whom he met at SU.

"My fiancée is originally from Germany. She decided to do her master's degree in Industrial Engineering at Stellenbosch. After completing her degree, she decided to follow me to London and the rest is history."

He offers the following advice to our students: "Never stop learning, ask questions and challenge your thinking! Also enjoy Stellies, it really is an amazing place."

PUBLISHED PAPERS AND CHAPTERS

Published papers

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Chapters in Books

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Upcoming Seminars

Stellenbosch University Department of Statistics and Actuarial Science	
13 August	Sven Buitendag (Capitec, Stellenbosch) Simulation-based capital adequacy assessment using extreme value theory
27 August	Mesias Alfeus (Department of Statistics and Actuarial Science, SU) Quantitative methods in finance: Toward a general framework for modelling roll-over risk
10 September	Simon Louw (Department of Statistics and Actuarial Science, SU) An introduction to applied ethics
1 October	Samuel Cohen (University of Oxford, United Kingdom) Arbitrage-free neural SDE market models
15 October	Erik Schlögl (University of Technology, Sydney, Australia) Short rate dynamics: A fed funds and SOFR perspective
29 October	Briance Mathebula (Swiss Re, Cape Town) The impact of COVID-19 on medical insurance business

The seminars on the 1st and 15th of October can only be attended via Microsoft Teams. All other seminars start at 13:00 in room 2058 of the Van der Sterr Building, c/o Victoria and Bosman Streets, Stellenbosch, but can also be attended via Microsoft Teams.

Please contact Ms E Huysamen at krugere@sun.ac.za for a link to the Microsoft Teams meetings.

All other enquiries can be sent to Prof Danie Uys (dwu@sun.ac.za).