Departement Statistiek en Aktuariële Wetenskap
Department of Statistics and Actuarial Science

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CHAIRPERSON'S MESSAGE

Department celebrates 75 years

After another challenging and difficult year for Stellenbosch University and the Faculty of Economic and Management Sciences, as well as for staff members and students of the Department of Statistics and Actuarial Science, we can look back on many successes and feel-good stories. However, this does not mean that we should ignore the hardships and challenges we faced, because they were very real.

This was the year in which the first intake of Bachelor of Data Science (BDatSci) students officially started their journey to become data scientists. This is also the year in which the Department celebrated its 75th anniversary, which coincided with the very first hybrid South African Statistical Association conference (SASA 2021). Due to COVID-19 protocols and restrictions, a maximum number of 100 delegates were able to attend in person, while the balance of the delegates participated online, and plenary speakers connected from many international destinations.

Being able to organise such an event in the face of such extreme constraints is truly remarkable. The local organising committee under Sugnet Lubbe as chair did an excellent job. On behalf of the Department, I would also like to acknowledge and thank – in no particular order – Carel van der Merwe, Johané Nienkemper-Swanepoel, Elizna Huysamen, Trudie Sandrock, Mesias Alfeus, Tertius de Wet, Danie Uys and Morné Lamont for their diligence and hard work.

The Department is privileged to have two thought leaders of Statistics in our midst, awarded to Profs Niël le Roux and Tertius de Wet by the South African Statistical Association.

It is with sadness that we say goodbye to Prof Willie Conradie (see article on P3), who is retiring, and Dr Carel van der Merwe, who has resigned with effect from the end of 2021. We are, however, fortunate that Willie will join our group of emeritus professors in the Department and still be actively involved with specialised teaching and supervision. Willie is retiring after a remarkable 47 years of dedicated service to the University, colleagues and students.

It is evident that the Department experienced a full and eventful year whilst facing many challenges. I would like to thank every staff member for contributing to the success of the Department. My wish is that we all enjoy a well-deserved break and return in 2022 with new and revived energy.

Prof Paul Mostert

Chair of the Department of Statistics
and Actuarial Science

As 2021 is the 75th anniversary of the Department, we look back on a few highlights from when it all started in 1946:

1920-1942: Statistics was first presented to Agriculture students (in the 1920s), Elementary Statistics to Business students (in 1936) and Statistical Mathematics as a major in Commerce (in 1942).

1946: Prof SJ Pretorius (1946-1956) was appointed as the first professor of Statistics. He later became the Registrar of Stellenbosch University from 1956-1966.

1946: Department of Statistics was established.

1952: Statistical Mathematics was recognised as a major in the Faculty of Science.

1956: Prof DEW Schumann was appointed as a professor of Statistics.

1970s: Professors Schoeman and Bouwer were appointed, and they intermittently served as chairpersons of the Department until the late 1990s.

1984: First Actuarial Science courses presented.

1985: The Centre of Statistical Consultation was established.

1988: Prof Greeff was appointed as the first professor of Actuarial Science.

1997: Department was renamed as Statistics and Actuarial Science.

2000: HonsBCom Financial Risk Management was presented.

2003: BCom Financial Risk Management as focal area is offered in Mathematical Sciences programme.

2015: HonsBCom in Mathematical Science was first presented with focal area in Data Science.

2019: BCom in Mathematical Science was first presented with focal area in Data Science.

2021: Department of Statistics and Actuarial Science was part of a group of academic departments that were instrumental in offering the new BDatSci degree programme, the only one of its kind in South Africa.

Prof Conradie says goodbye after 47 years

In 1972, BCom student Willie Conradie registered for Mathematical Statistics as one of his second-year subjects. Little did he know then that his association with this Department would last 50 years, until his retirement at the end of 2021. During this time – after 47 years as lecturer – he saw the development of modules and programmes in, amongst others, Actuarial Science and Financial Risk Management as well as the establishment of the Bachelor of Data Science degree in 2021.

Whilst he was a junior lecturer, Prof Conradie became the first person to complete a master's degree under the supervision of Prof Niël le Roux, now an emeritus professor in the Department. After completing his PhD under the supervision of Prof Cas Troskie at the University of Cape Town in 1980, he was promoted to senior lecturer at SU in 1981 and associate professor in 1985. He also served as Chair of the Department of Statistics and Actuarial Science from 2012-2016.

Many things changed dramatically during his tenure at Stellenbosch University. "In 1975, the Department had seven lecturers and we shared support staff with the Departments of Accounting and Economics. Today we have 27 full-time academic staff members and five administrative staff members.

"During my first 25 years at the Department, the focus was more on teaching, and it wasn't unusual to present up to 14 undergraduate lectures and three postgraduate lectures per week. There was little time for research. The situation started changing in the early 2000s thanks to staff expansion and greater support for research. Today, the Department is one of the top departments in South Africa in terms of research outputs."

The advances in technology over the past 50 years have been phenomenal. "In the 1970s we wrote Fortran programmes to do statistical analyses. The code was captured on punch-cards, read by a card reader, and processed by the mainframe of the University at the computing centre in the Engineering building. In later years, we had a terminal in the Department where we could initiate analyses, but we still had to fetch the output from the computing centre.

"These days, all academic staff have powerful computers and access to the most advanced software to handle big datasets, perform simulations and conduct advanced modelling and statistical analyses. Even students have access to advanced software in various computer user areas and electronic classrooms."

The Department's academic offering has increased from approximately 15 undergraduate semester modules in the 1970s to 40 modules in 2021, and student numbers have also shown unprecedented growth. Prof Conradie believes this arises from the broad public realisation that undergoing training in the disciplines offered by the Department is extremely valuable if graduates want to enter the increasingly data-driven and technologically advanced work environment of a modern economy.

Prof Willie Conradie and his daughter Katryn, wife Dalene and son Scholtz.

With his background in Mathematical Statistics, Prof Conradie has been instrumental in developing and managing the Financial Risk Management programmes in the Department since the early 2000s.

He states that he will miss the interaction with his colleagues and especially the students. "Not a year has gone by that I have not learnt something from a student. Their questions and comments have helped me to stay relevant."

After his retirement, he will still maintain his involvement with the Department as and when his expertise is needed, and he hopes that he will have more time to read and to explore South Africa with his wife and their new Bush Lapa Boswa.

"The Department is in good hands and can only go from strength to strength. May it always be a space where academic standards are non-negotiable and where students are more than a name and a student number on an assignment or exam paper."

Centre for Multi-dimensional Data Visualisation to be launched

MuViSU (Centre for Multi-dimensional Data Visualisation) will formally be established in the Department of Statistics and Actuarial Science in July 2022. The aim is to establish MuViSU as a central contact point for multi-dimensional data visualisation needs – theoretical, applications and software – in the international research community.

Research in the field of biplots started in the Department in 1996 with the publication of the book *Biplots* by Gower and Hand. Prof Niël le Roux thoroughly studied the book and immediately prescribed it for a master's module where student, Sugnet Gardner, studied the material.

The duo continued research on the biplots theme for Sugnet's PhD and beyond, forming a close collaborative relationship with Prof John Gower from The Open University in the United Kingdom, until his passing in 2019. More than 100 research outputs (including refereed papers, refereed conference proceedings, workshops, and books) have since resulted from these and other collaborations. Over the past 25 years many students have studied biplots as postgraduate modules and as part of their master's or PhD research projects in the Department of Statistics and Actuarial Science.

Recent appointments contributed to an increase in momentum in the research on biplots and multi-dimensional data visualisation in general. Dr Carel van der Merwe joined the Department in 2016, Prof Sugnet Gardner-Lubbe in 2017 and Dr Johané Nienkemper-Swanepoel in December 2020. Both Dr Van der Merwe and Dr Nienkemper-Swanepoel completed their PhDs in 2019/2020, making extensive use of biplots in their theses.

The time was therefore ripe for the establishment of a formal centre for research in multi-dimensional visualisation. The first management committee of MuViSU consists of Prof Sugnet Lubbe (Director), Prof Niël le Roux (Deputy Director), Dr Johané Nienkemper-Swanepoel (Secretary) and Dr Carel van der Merwe (Financial officer). Apart from a management committee, MuViSU invites individuals who are prominent researchers in the field of multi-dimensional data visualisation to become members. The first group of members will be ratified by the governing board during their first meeting in 2022.

The first project to be tackled by MuViSU will involve collating all the visualisation-related code developed by many individuals over a long period of time into a new comprehensive user-friendly R package published on CRAN. The functionality of new developments in R such as the packages Shiny and Plotly will be incorporated in the new package.

Any person interested in becoming part of MUVISU's activities is invited to contact one of the management committee's members (contact details are available on the Department's website).

Carel van der Merwe resigns

Dr Carel van der Merwe, a senior lecturer in Financial Risk Management, will be leaving the permanent employ of the Department at the end of 2021. Carel joined the Department in 2016 after working in industry for some years. Having obtained his master's degree in 2010, Carel went on to obtain his PhD while working at the Department. This was a joint PhD with Ghent University, titled "Classifying Yield Spread Movements in Sparse Data Through Triplots".

Carel is leaving to become an independent consultant in the quantitative finance domain. However, he will continue to lecture some postgraduate modules, as well as assist with supervision in the Department. Additionally, he will be involved in the Centre for Multi-dimensional Data Visualisation. So, while this might be a goodbye, it is not a farewell. We wish him well in all these endeavours.

You can also follow Carel's work via his site: **https://carelvdmerwe.wixsite.com/cjvdm**

Kaggle competition introduced in Statistics 244

With the introduction in March 2020 of remote learning, a period of intense innovation and change was enforced on both lecturers and students alike. Survival was the order of the day and module renewal often took a back seat on the journey. It is therefore encouraging to note that some lecturers still found the time for innovation.

Luca Steyn, a lecturer from the Department of Statistics, is an example of such an academic. Together with his co-lecturer, Justin Harvey, he took up the challenge to improve the content of the second-year Statistics linear models module. Historically, one of the assessment components has been a project with structured questions based on a specific dataset. The team from Statistics 244 transformed this traditional project component into a Kaggle competition between classmates (**www.kaggle.com/c/S244** and **www.kaggle.com/c/statistics-244-project-part-2**).

Kaggle is a leading data science, machine learning and AI platform, where companies submit problems they need solved by posing their question as a competition (with some relevant datasets to test solutions on). Individuals and data science teams, academics and enthusiasts are then invited to solve the problem or simply find a better solution. Often the rewards are substantial and the benefit to society or industry is clear.

For Statistics 244, datasets were supplied, and test sets were held out to assess the performance of the submitted statistical models. Students worked in groups of four or five and competed in two fully operational Kaggle competitions (one on regression and the other on classification). Part of the final project mark was based on the ranking of the teams on Kaggle's leaderboard. Students could gauge their own efforts and the intention was to reward groups who continuously revised their submission to improve their predictions as far as possible – resulting in some intense competition between some of the groups.

The project was purposefully open-ended: students were allowed to use any valid statistical approach that would lead to the greatest improvement in prediction over a simple means-based approach. Other than that, there were no incorrect answers and students were encouraged to flex their intellectual creativity "muscles" in building a model that performs well on a previously unseen test set of data.

Justin Harvey and Luca Steyn

Innovative approach to module renewal leads to rich, relevant and rewarding educational experience.

Several valuable skills were developed: a mastery of the theory, the ability to work efficiently in a data science group (a valuable "soft skill" required in most work environments) and the improvement of R programming skills. Comments received from groups indicated a positive experience overall.

Hearty congratulations to Luca Steyn for the effort and innovation (and he is already working on the 2022 competition). The innovative and rewarding experience in the Statistics 244 module was an important proof-of-concept that can be applied to many courses in future that may provide a rich, relevant and rewarding educational experience to students.

Department hosts first hybrid SASA conference

The Department of Statistics and Actuarial Science hosted the annual South African Statistical Association (SASA) conference from 29 November to 3 December 2021. This is the first conference the Faculty of Economic and Management Sciences has hosted in a hybrid mode (a combination of online and in-person conference).

The advantage of this conference format is that participants from all over the world could attend via the online platform, even when travelling restrictions were imposed at the last minute. There were participants from as far as Denmark, the Czech Republic, Ghana, Nigeria, Malawi, Iran and Saudi Arabia. It was exciting to see so many statisticians coming together to discuss recent developments in the changing world and to deep dive into the current research trends. At least 19 universities in South Africa were represented. Representatives from the private sector and government entities also attended. More than 104 abstracts were submitted on theoretical works including on the COVID-19 pandemic, HIV & AIDS, banking and finance.

It was very momentous for the Department to host this conference this year because it is also the Department's 75th birthday, which makes it one of the oldest departments of Statistics in South Africa. In particular, the Department is proud to have played a leading role in establishing the first Bachelor of Data Science degree, with the first intake in 2021. This degree requires collaboration across four faculties through the initiatives of data science and computational thinking.

The conference continued for five days, with the first two days being devoted to online workshops. The School of Data Science and Computational Thinking hosted two workshops, one in natural language processing and the second one concentrating on the introduction to Python for high school learners. The workshops also included other interesting topics across various disciplines such as multivariate statistics, extreme value and financial risks, and grant writing. The last three days were devoted to conference presentations, both online and in-person. A postgraduate poster competition and a postgraduate oral presentation competition were held.

Prof Ingrid Woolard, dean of the Faculty of Economic and Management Sciences, addressed the SASA 2021 conference opening. She praised the Department for its great efforts in hosting this event during such

an unprecedented time as the COVID-19 pandemic and for prioritising research and collaboration.

"The Faculty of Economic and Management Sciences embraces our relationship with the Department of Statistics and Actuarial Science. We don't take it for granted. Statistics interact with all other disciplines in the Faculty such as agriculture, health, economics, science, and finance. Statistics is part of our family/community, and we appreciate the collegiality framework within the Faculty and university at large," Prof Woolard stated.

Prof Ingrid Woolard

Apart from contributed talks and posters, delegates were treated to six keynote lectures by:

Prof Jonathan Crook, Emeritus Professor of Business Economics, University of Edinburgh Business School: Stress Testing Behavioural and Macroeconomic Risks in Credit Portfolios.

Prof Gareth James, Deputy Dean & E. Morgan Stanley Chair in Business Administration and Professor of Data Sciences and Operations, University of Southern California: Irrational Exuberance: Correcting Bias in Probability Estimates.

Dr Ali Joglekar, Adjunct Professor, University of Minnesota - GEMS: Supporting Data-Driven Agri-Food Innovation from Molecules to Markets.

Prof Saralees Nadarajah, Reader in the School of Mathematics, University of Manchester: The Drastic Under-Representation of African Researchers in Africa-Related Research.

Prof Emmanuel Lesaffre, Emeritus Professor of Biostatistics, KU Leuven: Incorporation of Historical Information in the Analysis of Current Data – A Review of Bayesian Methods with Applications in Pharmaceutical Research.

Dr McElory Hoffmann and Dr Johan van der Merwe, Praelexis: Ethical Machine Learning in Managing a Health Pandemic.

Recognitions at SASA 2021 conference

SASA President Dr Warren Brettenny and Prof Tertius de Wet

Prof Tertius de Wet received the prestigious Sichel Medal for a paper written jointly with Sven Buitendag and Jan Beirlant. The paper's title is "Confidence Intervals for Extreme Pareto-Type Quantiles" published in the Scandinavian Journal of Statistics in 2020. The paper is based on work done in Sven's PhD, under the joint supervision of Tertius de Wet and Jan Beirlant.

Students win 3rd prize

Two of the Department's honours students, Mokgeseng Ramaisa and George Claude Meyer, under the supervision of Dr Johané Nienkemper-Swanepoel, scooped up the third prize in the 2020/2021 SASA Honours Project Competition with a project entitled "Biplot Visualisations for Nominal Qualitative Incomplete Data".

Mokgeseng Ramaisa, Dr Johané Nienkemper-Swanepoel (supervisor), George Claude Meyer

Natalie van Zyl wins prize at the Actuarial Society of South Africa convention

A presentation on a Proposed Basic Income Grant for South Africa delivered by Ms Natalie van Zyl, a lecturer in Actuarial Science, won the prize for the best oral presentation at the Actuarial Society of South Africa's annual convention in October.

In her presentation she provides an overview of the current cost estimates of a basic income grant, but also summarises the various perspectives on this proposal. These include social justice considerations, reducing food poverty, social cohesion, and impact of scarcity on cognitive function and behaviour control. She also shared research published on the attitudes of SA citizens towards increasing tax to expand social grants and the multiplier effects of government social grant spending in seven sub-Saharan countries.

Ms van Zyl is currently busy with a master's degree, where her research will focus on social security. The prize-winning video is available HERE.

Regularization Effect on Model Calibration

Mesias Alfeus[1], Xin-Jiang He[2], Song-Ping Zhu[3]

Abstract
As it is well-known, that the centrepiece of model calibration is regularization which plays an important role of ushering an ill-posed calibration problem into a stable and well-formulated one. Empirically, this realm of research has not been explored in much detail in the literature. This paper explores regularization to understand and to provide insights concerning the pricing accuracy of financial derivatives using the parameters from a correctly posed calibration problem in comparison to the parameters inferred from a relaxed calibration. Empirical findings of this paper indicate that regularized model calibration is only recommended when performing out-of-sample pricing for an extended time horizon.

Keywords
Model Calibration — Regularization — Option Pricing Model

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Introduction

Any model that is used for pricing financial derivatives requires the risk-neutral parameter set Θ as input to fully reflect the dynamics of such a model. Calibrating a model means finding numerical values of its parameters such that the prices of market instruments computed within the model, at a given time, coincide with their observed market prices. Liquid market prices are thus actually used by models in the "reverse-financial engineering" mode that consists in calibrating a model to market prices. A model calibration procedure involves a choice of an objective function which is to be minimized so that the optimal model parameter set that defines a particular market underlying the benchmark instruments can be inferred. In most cases, these objective functions are nonlinear, inverse with non-convex constraints, being computationally expensive, and in general, calibration problems are regarded as an ill-posed problem (see [1]). Practitioners are often looking for a robust model calibration, and rely on an optimizer that converges globally.

In finance, classical models are not time-dependent, and a model has to be recalibrated several times daily in order to reproduce daily option market quotes. It is desirable that the parameters stay relatively stable between consecutive days especially if the market conditions have not changed much, instead of finding parameter values that are different but produce a similar volatility surface. Thus, a method which not only provides a good fit, but also gives stable parameters is usually desirable. Regularization is often used to usher the originally ill-posed calibration problem into a stable problem and enhance the speed of convergence to the optimal solution by issuing a penalty to the objective function. In this context, the penalty term behind regularization helps the calibration to stay in reasonable limits and makes the calibration more stable. A popular choice of the regularization term adopted in the literature is the relative entropy which measures the discrepancy between two probability measures. [2] propose a regularization approach with a penalty term as a function of the calibrated parameters. This paper provides empirical evidences that this choice of the regularization leads to the most efficient model calibration approach.

Financial Models

This paper considers two popular stochastic volatility option pricing models namely, the Stochastic Alpha Beta Rho (SABR) [3] and the Heston model [4]. The stochastic dynamics of the SABR model under the forward measure $\mathbb{Q}^F$ is given by:

$$\begin{aligned} dF_t &= \alpha_t F_t^{\beta} dW_1(t) \\ d\alpha_t &= \nu \alpha_t dW_2(t), \\ d\langle W_1, W_2\rangle &= \rho dt, \\ \Theta &= \{\alpha_0, \nu, \beta, \rho\} \end{aligned}$$

and the Heston model dynamics are:

$$\begin{aligned} dF_t &= \sqrt{V_t} F_t dW_1(t) \\ dV_t &= \kappa(\theta - V_t)dt + \sigma\sqrt{V_t} dW_2(t), \\ d\langle W_1, W_2\rangle &= \rho dt, \\ \Theta &= \{V_0, \kappa, \theta, \sigma, \rho\}. \end{aligned}$$

For the square-root process in the Heston model, the variance stays positive and if the Feller condition, $2\kappa\theta > \sigma^2$, holds,

then the variance V_t never reaches zero $\forall t \in [0,T]$. In both models above, the correlation between the driving Brownian motions W_1 and W_2 is captured by the parameter ρ.

A Black-Scholes implied volatility formula under SABR model is available in closed-form and it was first derived in [3]. No analytical expression for the Black-Scholes implied volatility under the Heston model exists. In that case, the approach is to price options via Fourier transform methods and then use these prices to get Black-Scholes implied volatilities.

Model Calibration

Model calibration is a procedure of inferring the model parameters given a sample of the market data. In this case, market data are the option implied volatilities, with moneyness $m := S/K$ and time to maturity $\tau = T - t$. We define the Objective function in term of implied volatility root mean squared errors (IVRMSE) by:

$$\text{IVRMSE}(\Theta) = \sqrt{\frac{1}{N}\frac{1}{M}\sum_{i=1}^{N}\sum_{j=1}^{M}\omega_{ij}\left[\sigma_{ij} - \sigma_{ij}(\Theta)\right]^2} \quad (1)$$

where Θ is the vector of admissible model parameters, σ_{ij} and $\sigma_{ij}(\Theta)$ are implied Black-Scholes volatilities corresponding to the market option price and model option price produced by the parameter set Θ, respectively. We choose the calibrating weight factor ω_{ij} to be inversely proportional to the bid-ask spreads i.e., $\omega_{ij} = \frac{1}{(C_{ij}^{\text{ask}} - C_{ij}^{\text{bid}})^2}$, where C_{ij} is the market price for a call option with strike K_i and maturity T_j. Choosing such a weight is crucial because it take into account the liquidity of the calibration instruments. Here, N and M represents the dimensions of the available calibration instruments for the number of strike prices and maturities respectively.

The model calibration goal is to determine a model parameter set that minimizes the above objective function in a least square sense, i.e.,

$$\hat{\Theta} = \arg\min_{\Theta \in \mathscr{O}} \text{IVRMSE}(\Theta). \quad (2)$$

where $\mathscr{O}$ is the space for all permissible parameter sets under a risk-neutral pricing martingale measure. Although in most cases model volatility $\sigma_{ij}(\Theta)$ is highly dependent on the parameter set θ and the parameter space $\mathscr{O}$ contains a finite number of bounded parameters, which outputs a solution under the root mean square error formulation, the minimization problem is complicated to solve as in general the function to be minimized is not convex, and this poses interesting challenges. The resulting problem of parameter estimation is ill-posed problem in the sense that a solution may not exist or there may be many solutions, and the solution may not depend on the option prices in a stable way, so regularization techniques have to be applied to obtain stable results. This process involves adding a penalty (parameter dependent constraint) to the objective function defined in Equation (2) to get

$$\text{IVRMSE}_\lambda(\Theta) = \text{IVRMSE}(\Theta) + \lambda||\Theta - \Theta_0||^2, \quad (3)$$

where Θ_0 is an appropriate a-priori best guess for a starting parameter set (see [5]).

Equation (3) has two parts: the regularization term $\lambda||\Theta - \Theta_0||^2$ which is convex in its argument and the quadratic pricing error which measures the precision of the calibration. This formulation is called the zero-order Tikhonov regularization, related to the postulated prior distribution of the exact solution. The coefficient λ, called the regularization parameter, defines the relative importance of the two terms; it characterizes the trade-off between prior knowledge and the new information contained in option prices.

Numerical Results

Data collected are the time series for the US NASDAQ index prices and implied volatilities of call options with various strikes, maturities, bid and ask option premiums, dividend yields and Greeks for the sample time period from January 2007 through to December 2017, covering a period of ten years. The data are obtained from Wharton Research Data Services (WRDS) through OptionMetrics IvyDB.

Option moneyness is defined as the underlying index price of the contract divided by the exercise price of the option, i.e., S/K for each option maturity. Five moneyness intervals, 0.86–0.975, 0.975–1, 1–1.025, 1.025–1.050, and 1.050–1.0755 are considered. In each of the moneyness intervals options are categorised across different days to maturity (DTM).

For robustness test, both in-sample and out-of-sample calibration analysis are adopted. In-sample errors are obtained by calibrating models each day in our sample and then using the calibrated parameters to price options on the same day. Ideally for an in-sample analysis one should get the distance between the model prices and market prices close to zero. Out-of-sample time series errors are obtained by using calibrated parameters of several days before to price options on the current day. Out-of-sample analysis has material benefits to market participants in terms of assessing the performance of the models under consideration. For 1-day out-of-sample calibration, the model is calibrated today and tested on tomorrow's option prices and for 5-day out-of-sample calibration, the model is calibrated today and tested on option prices prevailing 5 days ahead. In the case where the market did not change much one would expect the out-of-sample errors to be close to zero.

Two methods are adopted. Method 1 calibration uses Equation (2) and Method 2 calibration is based on the objective function defined in Equation (3) which introduces stability into the calibration procedure. As mentioned earlier, the additional parameter λ in Method 2 controls the trade-off between the quality of the fit to the data and the calibration stability. What is the optimal λ then? This paper recommends the regularization parameter to be chosen in such a way that it depends

on the data and is a function of the *daily change in option implied volatility*.

This approach is different to the approaches taken in the literature, e.g. in [5], two unique steps are proposed for a robust calibration. Step 1 calibrates initial variance for the hidden states, α_0 and V_0 from market ATM implied volatilities. Step 2 uses step 1 calibrated parameters from step 1 to infer the rest of the model parameters from observed market implied volatilities. One of the main procedural steps encapsulated in the process of model calibration is the optimization routine that is applied to solve the calibration problem in (2), and (3), which is often nonlinear and non-convex types. This paper uses a fast Newton solver based on a modified Sequential Quadratic Programming (ModSQP) method which finds local minima but converges globally.

	DTM≤91	91<DTM≤182	182<DTM≤273	All	DTM≤91	91<DTM≤182	182<DTM≤273	All
	SABR: In-sample - Method 1				SABR: Out-of-sample - Method 1			
S/K<0.975	5.81E-05	2.92E-05	5.41E-05	**1.42E-04**	2.82E-04	1.96E-04	2.20E-04	**6.98E-04**
0.975<S/K<1	2.92E-05	3.78E-05	4.71E-05	**1.14E-04**	2.18E-04	1.88E-04	2.07E-04	**6.13E-04**
1<S/K<1.025	2.81E-05	2.78E-05	3.61E-05	**9.20E-05**	2.76E-04	3.49E-04	1.00E-04	**7.25E-04**
1.025<S/K<1.05	2.83E-05	3.88E-05	5.51E-05	**1.22E-04**	2.09E-04	1.43E-04	2.04E-04	**5.55E-04**
1.05<S/K<1.075	5.91E-05	6.38E-05	1.00E-04	**2.23E-04**	2.80E-04	1.98E-04	1.88E-04	**6.65E-04**
All	**2.03E-04**	**1.97E-04**	**2.93E-04**	**6.93E-04**	**1.26E-03**	**1.07E-03**	**9.18E-04**	**3.26E-03**
	SABR: In-sample - Method 2				SABR: Out-of-sample - Method 2			
S/K<0.975	7.73E-05	3.00E-05	5.41E-05	**1.61E-04**	2.89E-04	1.95E-04	2.16E-04	**7.00E-04**
0.975<S/K<1	2.91E-05	6.05E-05	8.21E-05	**1.72E-04**	1.99E-04	1.98E-04	2.33E-04	**6.29E-04**
1<S/K<1.025	3.24E-05	4.03E-05	4.87E-05	**1.21E-04**	2.61E-04	3.54E-04	1.09E-04	**7.23E-04**
1.025<S/K<1.05	3.57E-05	2.32E-05	4.59E-05	**1.05E-04**	1.56E-04	8.91E-05	1.16E-04	**3.61E-04**
1.05<S/K<1.075	4.95E-05	3.95E-05	9.75E-05	**1.86E-04**	1.88E-04	1.13E-04	1.54E-04	**4.55E-04**
All	**2.24E-04**	**1.93E-04**	**3.28E-04**	**7.46E-04**	**1.09E-03**	**9.49E-04**	**8.27E-04**	**2.87E-03**
	Heston: In-sample - Method 1				Heston: Out-of-sample - Method 1			
S/K<0.975	1.17E-06	3.37E-06	2.40E-06	**6.95E-06**	2.69E-04	1.29E-04	9.93E-05	**4.97E-04**
0.975<S/K<1	1.32E-06	4.89E-06	1.40E-06	**7.60E-06**	1.76E-04	1.01E-04	6.13E-05	**3.39E-04**
1<S/K<1.025	1.69E-06	4.61E-06	2.11E-06	**8.40E-06**	1.60E-04	8.95E-05	6.18E-05	**3.11E-04**
1.025<S/K<1.05	2.83E-06	4.05E-06	3.09E-06	**9.96E-06**	1.67E-04	7.34E-05	5.33E-05	**2.94E-04**
1.05<S/K<1.075	3.00E-06	4.33E-06	3.23E-06	**1.06E-05**	2.37E-04	9.21E-05	3.12E-05	**3.60E-04**
All	**1.00E-05**	**2.12E-05**	**1.22E-05**	**4.35E-05**	**1.01E-03**	**4.85E-04**	**3.07E-04**	**1.80E-03**
	Heston: In-sample - Method 2				Heston: Out-of-sample - Method 2			
S/K<0.975	1.20E-06	3.63E-06	2.75E-06	**7.58E-06**	2.90E-04	1.32E-04	9.52E-05	**5.17E-04**
0.975<S/K<1	1.70E-06	5.50E-06	2.05E-06	**9.24E-06**	1.85E-04	1.04E-04	5.95E-05	**3.49E-04**
1<S/K<1.025	2.56E-06	5.68E-06	3.25E-06	**1.15E-05**	1.93E-04	9.61E-05	6.08E-05	**3.50E-04**
1.025<S/K<1.05	4.28E-06	5.25E-06	4.57E-06	**1.41E-05**	1.69E-04	8.04E-05	5.48E-05	**3.04E-04**
1.05<S/K<1.075	3.55E-06	5.20E-06	6.30E-06	**1.51E-05**	2.38E-04	1.11E-04	3.38E-05	**3.83E-04**
All	**1.33E-05**	**2.53E-05**	**1.89E-05**	**5.75E-05**	**1.07E-03**	**5.24E-04**	**3.04E-04**	**1.90E-03**

Table 1. In-sample and out-of-sample calibration measure, 2007 - 2017

Table 1 shows the average in-sample and out-of-sample errors of each model across different moneyness and maturities. In-sample errors are very small compared to out-of-sample errors. This is expected because in-sample errors are measured with priced that the model was calibrated to. The Heston model in all cases outperforms SABR model. One would expect this because Heston has more parameters than SABR. Methods 1 generally performs worse in both in-sample and out-of-sample errors as compared to Method 2, but the difference between these two methods is marginal. Table 2 shows out-of-sample pricing performance using a moving window of 5-days and 20-days. From these tables, out-of-sample results that Method 2 outperforms Method 1. It turned out that parameter constantization is useful for pricing when consider a wider window out-of-sample performance. It can be observed that the calibration of the SABR model was not stable for the entire sample period, and using Method 2 helps to bring stability into the calibration, hence resulting in a good performance for the out-of-sample measure. The calibration of the Heston model proves to be stable over the whole sample period.

Conclusion

This paper compares two methods to calibrate two popular models that are widely used for stochastic volatility modeling,

	DTM≤91	91<DTM≤182	182<DTM≤273	All	DTM≤91	91<DTM≤182	182<DTM≤273	All
	SABR: 5-days Out-of-sample - Method 1				SABR: 20-days Out-of-sample - Method 1			
S/K<0.975	1.84E+00	1.76E+00	1.97E+00	**5.57E+00**	2.63E+00	2.72E+00	3.00E+00	**8.35E+00**
0.975<S/K<1	7.24E-01	3.27E-01	2.74E-01	**1.32E+00**	1.12E+00	5.20E-01	3.98E-01	**2.03E+00**
1<S/K<1.025	5.32E-01	4.33E-01	2.15E-01	**1.18E+00**	7.09E-01	5.38E-01	3.11E-01	**1.56E+00**
1.025<S/K<1.05	1.61E-01	1.76E-01	1.55E-01	**4.92E-01**	2.12E-01	2.33E-01	2.01E-01	**6.46E-01**
1.05<S/K<1.075	1.86E-02	2.56E-02	1.77E-02	**6.19E-02**	5.35E-02	5.23E-02	3.55E-02	**1.41E-01**
All	**3.27E+00**	**2.73E+00**	**2.63E+00**	**8.63E+00**	**4.72E+00**	**4.06E+00**	**3.95E+00**	**1.27E+01**
	SABR: 5-days Out-of-sample - Method 2				SABR: 20-days Out-of-sample - Method 2			
S/K<0.975	1.73E+00	1.72E+00	1.94E+00	**5.39E+00**	2.54E+00	2.69E+00	2.99E+00	**8.22E+00**
0.975<S/K<1	6.57E-01	3.23E-01	2.78E-01	**1.26E+00**	1.01E+00	4.78E-01	3.83E-01	**1.87E+00**
1<S/K<1.025	5.02E-01	4.37E-01	2.10E-01	**1.15E+00**	6.39E-01	5.07E-01	2.82E-01	**1.43E+00**
1.025<S/K<1.05	1.54E-01	1.58E-01	1.40E-01	**4.52E-01**	2.09E-01	1.97E-01	1.59E-01	**5.66E-01**
1.05<S/K<1.075	1.53E-02	1.44E-02	1.05E-02	**4.03E-02**	4.07E-02	2.36E-02	2.50E-02	**8.93E-02**
All	**3.06E+00**	**2.65E+00**	**2.58E+00**	**8.29E+00**	**4.44E+00**	**3.89E+00**	**3.84E+00**	**1.22E+01**
	Heston: 5-days Out-of-sample - Method 1				Heston: 20-days Out-of-sample - Method 1			
S/K<0.975	2.44E+00	2.00E+00	2.09E+00	**6.53E+00**	3.74E+00	3.40E+00	3.59E+00	**1.07E+01**
0.975<S/K<1	8.71E-01	3.23E-01	2.59E-01	**1.45E+00**	1.42E+00	5.50E-01	3.97E-01	**2.36E+00**
1<S/K<1.025	6.11E-01	4.37E-01	2.02E-01	**1.25E+00**	8.02E-01	5.30E-01	3.10E-01	**1.64E+00**
1.025<S/K<1.05	1.67E-01	1.61E-01	1.34E-01	**4.63E-01**	2.31E-01	2.14E-01	1.80E-01	**6.24E-01**
1.05<S/K<1.075	2.18E-02	1.39E-02	7.01E-03	**4.27E-02**	4.91E-02	3.22E-02	1.57E-02	**9.70E-02**
All	**4.11E+00**	**2.94E+00**	**2.69E+00**	**9.74E+00**	**6.24E+00**	**4.72E+00**	**4.50E+00**	**1.55E+01**
	Heston: 5-days Out-of-sample - Method 2				Heston: 20-days Out-of-sample - Method 2			
S/K<0.975	2.45E+00	2.00E+00	2.06E+00	**6.51E+00**	3.77E+00	3.31E+00	3.46E+00	**1.05E+01**
0.975<S/K<1	8.73E-01	3.23E-01	2.56E-01	**1.45E+00**	1.42E+00	5.46E-01	3.90E-01	**2.36E+00**
1<S/K<1.025	6.20E-01	4.38E-01	2.01E-01	**1.26E+00**	8.12E-01	5.29E-01	3.06E-01	**1.65E+00**
1.025<S/K<1.05	1.75E-01	1.62E-01	1.33E-01	**4.71E-01**	2.36E-01	2.15E-01	1.77E-01	**6.28E-01**
1.05<S/K<1.075	2.90E-02	1.46E-02	7.18E-03	**5.07E-02**	5.12E-02	3.26E-02	1.56E-02	**9.93E-02**
All	**4.15E+00**	**2.94E+00**	**2.66E+00**	**9.74E+00**	**6.29E+00**	**4.64E+00**	**4.35E+00**	**1.53E+01**

Table 2. 5-days and 20-days out-of-sample calibration measure, 2007 - 2017

i.e., the SABR and Heston models, with the time series of options written on Nasdaq 100 index, to examine the regularization effect on the out-of-sample pricing performance. We test the out-of-sample pricing accuracy using 1-day, 5-days and 20-days moving window. Our results agree with the calibration literature that adding an extra penalty to an objective function for calibration increases in-sample pricing errors while surprisingly, on a long time horizon, parameters obtained from a regularized calibration yield better out-of-sample performance.

Full paper available at Social Science Research Network: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3515199.

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Students receive Rector's Awards


Matthys Carstens


Micaela Giltrow


Josh Putterill

The Rector's Award is an annual award made to students for excellence in fields ranging from academics and leadership through to service provision.

This year's awards ceremony, which was hosted online, was aptly themed "Excellence Through Adversity – Moving Forward Together", reflecting the challenges of the past year as the global pandemic continued to affect all sectors, including higher education.

In his opening address, Stellenbosch University (SU) Rector and Vice-Chancellor Prof Wim de Villiers paid tribute to SU's students, all academic and non-academic staff as well as student leadership structures for having shown "real resilience in the face of adversity".

In total 12 students from the Faculty of Economic and Management Sciences received the Rector's Awards for their academic excellence this year. The Department would like to congratulate three students from our Department – Micaela Giltrow, Matthys Carstens and Joshua Putterill – who all excelled academically in their very challenging Actuarial Science programme despite the difficult circumstances and were awarded Rector's Awards for Excellent Achievement.

Actuarial students register the Stellenbosch Actuarial Students' Society

Actuarial Science students were not exempt from the many challenges brought about by the pandemic. With the demanding nature of the degree, the founders of SUSAS (Stellenbosch University Students' Actuarial Society) realised how quickly adaptability became imperative for survival in the new norm.


2021 SUSAS executive committee. Front row: Anrais Coetzer, Precious Nhamo and Mieke Nauta. Back row: Shaun Steenkamp, Ansaar Dollie, Pieter Slabbert, Waldo Reinach and Matthew Wille.

The objective of SUSAS is to support actuarial students at Stellenbosch University with the many challenges affecting aspiring student actuaries worldwide. They believe in leveraging opportunities granted by the University and partners to support meaningful change and impact in actuarial students' lives. This year SUSAS arranged various webinars with a diverse network of qualified actuaries, from companies across the globe, sharing their insight with SUSAS members.

The Society hopes to continue encouraging, supporting and nurturing brilliance as a culture where imagination and achievement are unlimited.

STUDENT ACHIEVEMENTS

2021 Honours project presentations

Honours students in the Statistics, Mathematical Statistics and Financial Risk Management streams arrived on campus during the week of 18 to 22 October to give presentations on their research projects.

It was a momentous week and a tribute to the hard work and dedication of both students and supervisors over the previous nine months. It was also a cause for celebration, given that the oral presentation of research works did not take place in a face-to-face seminar setting in 2020. However, for the first time, these presentations were also live-streamed, which allowed for a wider audience of family, friends and other interested parties to join in.

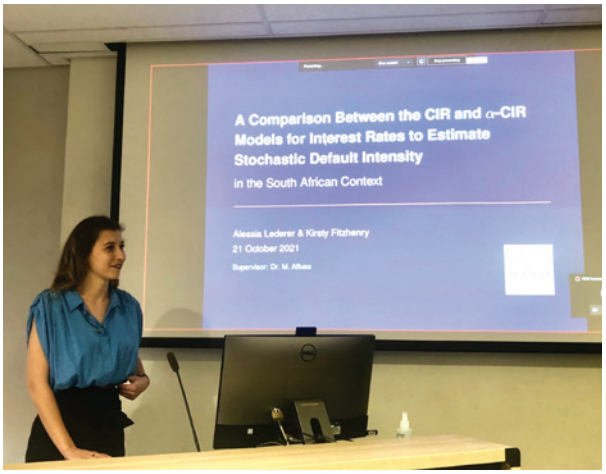
As in previous years, projects had a variety of different topics and themes. Supervisors suggested topics to students based on their aligned interests, but the Department also collaborated with industry partners.

Capitec, as part of its long-standing collaboration with the Department of Statistics and Actuarial Science, once again supplied many interesting and relevant projects for students to choose from. In addition, the South African Medical Research Council (SAMRC) and the Department joined forces for a second year to provide alternative project ideas, with perhaps more emphasis on biostatistics, for students whose interests do not lie in the financial industry.

The Department has recently established a partnership with FirstRand, who proposed a research topic to Financial Risk Management (FRM) honours students. The topic concerns improving estimates for 3-month realised asset class volatility by using market data available in South Africa to estimate the realised volatility over 3-month forward period for the asset classes such as bonds, equities, and ZAR.

Listed below are all the presentations:

Dr Mesias Alfeus and FRM students



Kirsty Fitzhenry in action

STUDENTS	RESEARCH TOPIC
Callum Pet and Matthew Parfitt	Analysis of three statistical classification methods on the Two Oceans marathon race
Bongani Babeli and Tendai Musendo	Determining the impact of training load on distance running performance using machine learning techniques
Landela Dlulane and Zara Moorgas	A comparison of the risk profile for developing illness-related medical encounters in marathon runners
Matthew Zackey and Jana van Tonder	Client selection for marketing using tree ensemble methods
Samantha Bijsters	Customer segmentation
Susana Maganga and Cara van der Vyfer	Classification of treatment options based on client response profiles

STUDENT ACHIEVEMENTS

Jason Kreyfelt and Ingrid Baartman	Using statistical methods to analyse the use and effects of instant messaging groups among university students
Eben Rossouw and Luan Roos	An overview of generative adversarial networks
Cassandra Posthumus	High-dimensional co-occurrence modelling with an application in disease co-morbidity
Leah Molyneux and Nicholas Donnelly	The statistical differences between a developed and a developing country during the COVID-19 pandemic
Peter Manefeldt and Daniel de Wet	Investigating the use of resampling to address class imbalance in MRI brain tumor recognition
Setsoto Makoele and Alexandra Dickson	An ensemble approach to feature selection
Carla Albertyn	Capitec Bank income estimation model with interpretability
Kgothatso Malapane	Using regression techniques to build income estimation models
Katerine van der Spuy	A heuristic approach to finding classification boundaries
Mari-Leigh D'Emiljo	Biplots for compositional data
Justice Madzivhandila and Megan Engel	Building an income estimation model using regression and classification techniques
Lebogang Omoregie and Nomzamo Nyoni	A quantitative analysis using various classification methods to predict clients' participation in credit offerings
Keara-Lin Stapelberg and Reed Naidoo	A comparison of classification methods for a multi-label credit marketing problem
Reze de Villiers and Anesu Kachikoti	Technical analysis on equity funds
Amani Pillay and Terri Harker	On local regime-switching models: A risk management approach
Alessia Lederer and Kirsty Fitzhenry	A comparison between the CIR and alpha: CIR models for interest rates to estimate stochastic default intensity in the South African context
Lineo Diana Mokoaleli and Phuthehang Maphatsoe	Improving estimates for 3-month realised asset class volatility
Muofhe Magada and Tumi Mosegane	Optimal collateral allocation
Lungelo Mkhungo and Krynauw Strydom	A study of the volatility feedback effect: Different international indices, different volatility models and different periods
James Dodd and Piet Jansen van Rensburg	A machine-learning model to 'Nowcast' GDP / economic activity in South Africa
Gomolemo Moche and Boitumelo Ragoleka	Investigating different study loan structures globally and assessing their viability for the South African market
Ruan Buys and Anja Wolstenholme	Polygonal tiling of the biplot hyperplane
Meeka-el Hendricks	The issue of an increasing unemployment rate in South Africa and its impact on the economy
Cresswell Leah	A study of the volatility feedback effect: Different international indices, different volatility models and different periods
Elrencia Carinus and Charissa Tallie	Application of GGE biplots to finance

More about Prof Edmore Ranganai

In 2003, Edmore Ranganai enrolled as a PhD student in Mathematical Statistics under guidance from Prof Tertius de Wet. We caught up with him during his return to Stellenbosch for the recent SASA 2021 conference and reflected with him on his past, as well as his future plans. Here is what he had to say…

Q: Can you share a little of your background, education and your passion for Mathematics and Statistics?
I grew up mostly under the care of my grandmothers in Masvingo, the southern province of Zimbabwe, completing my ordinary ('O') level there in 1984, after which my mother looked for a place for me to train as a teacher at Morgenster Mission Teachers' college near Great Zimbabwe. This was an idea I did not want to entertain. So, to avoid the tension, I went to my paternal grandmother's home, which was within walking distance. My grandmother gave me Z$10, which was a fair amount of money before the advent of hyperinflation in Zimbabwe. On that same day I took an afternoon bus to Masvingo town to look for temporary teaching opportunities.

In those days there was less corruption and people used to queue at the Education Staffing Offices and get the jobs by merit. When I got to these offices it was close to 16:00, knocking-off time. There was no queue, as job seekers had already left, but I took a chance. When I approached the door, the staffing officer, Mr Ngara, was opening the door to leave, but his phone rang. So, he attended to the call and asked me to come in and show him my 'O' level results. After checking them he asked me why I didn't enrol for 'A' levels. I told him that my mother could not afford the schools. He said that he was ready to give me a temporary teaching post on condition that I saved the money and enrolled for 'A' levels the following year. To cut a long story short, the next year I enrolled at Hippo Valley High School, taking Mathematics, Chemistry and Biology.

I passed my 'A' levels and enrolled for a BSc general degree at the University of Zimbabwe, majoring in Mathematics and Statistics. After completing my general degree in 1995 I became an 'A' level Mathematics teacher for two years before I enrolled for a BSc Special Honours in Statistics at the same institution. After passing my honours degree I became a tutor, whilst studying for my MSc in Statistics, which I completed in 2001.

Q: How did you end up registering for a PhD at Stellenbosch University (SU)?
In 2002, I was appointed as a lecturer at Bindura University of Science Education in Mashonaland Central Province. Before finishing my MSc, I had never thought of studying for a PhD, but now I was in the academic sector and became very interested in Statistics and a career in academia.

So, I began looking for the top four research universities in South Africa as I prefer to live in Africa. I sent an enquiry to Prof De Wet and he requested that I visit him at SU armed with my academic transcripts and syllabi of the modules I had completed. It was about September 2002 when I made the visit. On my first visit we went for dinner in the Strand where we watched the sun setting into the sea like a big ball of fire. This was amazing as I come from a land-locked country.

We agreed that Prof De Wet was going to be my promoter with Dr De Klerk, working on a topic in singular spectrum analysis for time series. I registered as an affiliate student and began work on the topic and fully enrolled for my PhD in 2003. However, during the second half of 2003 Dr De Klerk decided to take up a career in the financial sector. We therefore had to come up with a new proposal and supervision arrangement. It was agreed that Prof De Wet would become both my promoter and

supervisor with Dr Van Vuuren as my co-supervisor in the area of quantile regression and elemental regressions (as robust estimator alternatives).

Q: What you have been doing since you completed your PhD?

In 2007, I received a doctoral degree in Statistics from Stellenbosch University. My PhD thesis was entitled "Aspects of Model Development using Regression Quantiles and Elemental Regressions". Upon completion of my doctoral degree, I was appointed as a full-time lecturer (February 2008 to December 2012) at the University of KwaZulu Natal (UKZN) before subsequently being appointed as a full-time senior lecturer (January 2013 to December 2017) and as associate professor (January 2018 – present) at the University of South Africa (UNISA).

My research in the field of quantile regression (QR) focuses on QR diagnostics and related model development aspects, such as variable selection and regularisation in QR. In applied research my interests are in time series modelling: probabilistic load and renewable energy (solar and wind) forecasting including the optimisation of grid integration of renewable energies and value at risk (VAR) using QR and related methods. My research competence evolved to integrate analytic approaches; simulation studies balanced with a strong empirical dimension so that sustainable development goals mitigation can be effectively pursued.

In 2014 UNISA awarded me its research bursary, "Vision Keepers", to embark on a research visit to the University of Manchester's School of Mathematics for three months. My standing as a researcher is also evident in my international and national involvement and leadership. I have been involved in numerous article reviews for journals such as the Journal of Statistical Planning and Inference and Statistics & Probability Letters. Also, I have participated in NRF review panels such as the Competitive Programme for Rated/Unrated Researchers Physics and Astronomy & Mathematics and ICT Peer Review Panel (2018) and the South Africa Fellowships for L'Oréal-UNESCO For Women in Science Programme (2020). I am a member of South African Statistical Association (SASA), International Biometric Society (IBS), Multivariate Data Analysis Group (MDAG) and have been invited to present sessions at SASA.

Most recently I was rated by the NRF and achieved a C2 rating.

Q: What is your perspective on the future of Statistics and the role it will play in society/the economy in future?

The role of Statistics in making informed decisions in every aspect of human endeavours cannot be over-emphasised. Critical decisions need to be taken in social, health, financial, economic and scientific spheres, etc. The aspect of data quality is also critical. Thus, Statistics and Data Science will be indistinguishable in the future.

STAFF NEWS

David and Aeysha welcome Gabriel to their family

Gabriel Bhatti Hofmeyr was born to David (senior lecturer in the Department) and Aeysha on 19 July 2021. Although initially forecast to be a hefty newborn, mom and dad (mostly mom) were relieved when he clocked in "within one standard deviation of the mean" – 3.45 kg. Gabe is doing well at four months old, and his folks are looking forward to the next adventure he'll send them on (especially if it's at an appropriate time of day).

PRESENTATIONS AND CONFERENCES

Data Science, Statistics and Visualisation conference

The Data Science, Statistics and Visualisation (DSSV) conference is held annually and the 2021 conference was the second virtual DSSV, due to the current pandemic. Profs Sugnet Lubbe and Niël le Roux presented a paper in the invited session of the Journal for Data Science, Statistics and Visualisation on the analysis and visualisation of spectroscopy data. Unfortunately, there were some technical issues, but the audience got a glimpse of using functional data analysis for pre-processing of infra-red spectroscopy data from the wine industry as well as a comparison of several methods to select a suitable subset of variables for classification of rot in wine grapes.

DEPARTMENTAL SEMINARS

Seminar programme: First semester 2022

Department of Statistics and Actuarial Science

25 February	Johan Eybers (Ernst & Young, Cape Town) *A spatial agent-based model of the COVID-19 pandemic in South Africa*
11 March	Helgard Raubenheimer (Centre for Business Mathematics and Informatics, NWU) *Combining historical data sources in operational risk capital estimation*
25 March	Francois Kamper (Department of Statistics and Actuarial Science, SU) *Transformer models*
22 April	Gerard Heuvelink (Wageningen University & Research, The Netherlands) *Machine learning in space and time for modelling soil organic carbon change*
6 May	Alex Backwell (AIFMRM, UCT) *Short-rate modelling with expected and unexpected jumps*
20 May	Isaac Singini (Department of Statistics, University of Pretoria) *Joint modelling comparing latent class joint model and diagnostics from shared parameters (random effects) model*

All seminars start at 13:00 in room 2048 of the Van der Sterr Building, c/o Victoria and Bosman streets, Stellenbosch, but can also be attended via Microsoft Teams by using **THIS LINK**.

We hope you enjoyed this edition of the Department's newsletter.

The Department of Statistics and Actuarial Science wishes its alumni, industry partners, students and staff a blessed festive season.

Please contact Elizna Huysamen (ekruger@sun.ac.za) to be added to the newsletter distribution list.