The 47^{th} Actuarial Research Conference

2012

PROGRAM and ABSTRACTS

UNIVERSITY OF MANITOBA

August 1 - 4, 2012

Winnipeg, Manitoba, Canada

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The University of Manitoba

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	10.10 – 10.30	Coffee in E2-229		
	10.30 – 11.20	P6A: Genetic algorithms	P6B: How to be a CAE?	
	11.25 – 11.50	Closing session		
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17.00–20.00 **Registration and welcome reception at University Centre 204**

Join us for an opportunity to meet participants and enjoy fruit, cheese, hot hors d'oeuvre, and drinks at Marshall McLuhan Hall (UC204).

8.00–8.30 **Breakfast** (E2-229)

8.30–9.20 **Opening session** (E3-270)

- Jeffrey Pai to open the conference
- Welcome by Michael Benarroch, Dean of Asper School of Business
- Welcome by Sunny Oh, Vice President, Great-West Life Assurance Co.

9.20–10.10 **Feature session 1** (E3-270) *Chair: Jeffrey Pai*

Ethics and Professionalism in Actuarial Practice *Charly Pazdor*

10.10–10.30 **Coffee break** (E2-229)

10.30–12.10 **P1A: Finance I** (E3-270) *Chair: Rui Zhou*

1. **Analytic Solution for Ratchet Guaranteed Minimum Death Benefit Options Under a Variety of Mortality Laws** *Eric R. Ulm*
2. **Pricing of Debt and Loan Guarantees using Stochastic Delay Differential Equations** *Elisabeth Kemajou*
3. **Estimation and Pricing with a Diffusion Model with Jumps** *Claire Bilodeau and Andrew Luong*
4. **Model Selection in Regime-switching Models of Various Types** *Brian Hartman and Chris Groendyke*
5. **Pricing and Hedging GMWBs in a Binomial Model** *Menachem M. Wenger*

10.30–12.10 **P1B: Entreprise risk management** (E2-399) *Chair: Ken Seng Tan*

1. **Economic capital approaches and solvency of UK annuity portfolios** *Mayukh Gayen*
2. **Estimating the required surplus, benchmark profit, and optimal reinsurance retention for an insurance enterprise using the compound Poisson distribution** *Joseph Boor*
3. **The Marginal Cost of Risk, Risk Measures, and Capital Allocation** *Daniel Bauer and George Zanjani*
4. **Loss Given Default in the Presence of Multivariate Regular Variation. Part 1: Introduction** *Qihe Tang and Zhongyi Yuan*
5. **Loss Given Default in the Presence of Multivariate Regular Variation. Part 2: Main Results** *Qihe Tang and Zhongyi Yuan*

10.30–12.10 **P1C: Risk theory I** (E2-350) *Chair: Arnold Shapiro*

1. **Optimal Asset Allocation for Endowment Management** *Rina Ashkenazi, Sandra Paterlini and Francesco Pattarin*

2. **VaR and ruin probabilities for the Geometric Brownian motion with jump model** *Yu Zhao and Jiandong Ren*
3. **Analysis of a bivariate risk model** *Jingyan Chen and Jiandong Ren*
4. **The application of the number of IBNR claims for Erlang (n) inter-arrival times** *David Landriault , Ya Fang Wang and Gordon E. Willmot*
5. **Ultimate Ruin Probability with Correlation** *Emmanuel Thompson and Rohana S. Ambagaspitiya*

12.10–13.50 **Lunch at University Centre 210**

- During the conference lunch, Simon Curtis, President of CIA, will give a speech from 1:05-1:25. Simon Curtis then is to present a gift to Michael Benarroch, Dean of Asper School of Business.
- CKER lunch meeting at Souris Hall (UC224B). Please pick up lunch from UC210 first.

14.00–14.50 **Feature session 2** (E3-270) *Chair: Jeffrey Pai*

The Canadian Institute of Actuaries' University Accreditation Program *Rob Stapleford*

14.50–15.40 **Feature session 3** (E3-270) *Chair: Elias Shiu*

Open Forum for MLC Teachers *Elias Shiu, Aaron Tenenbein and Heekyung Youn*

15.40–16.00 **Coffee break** (E2-229)

16.00–17.20 **P2A: Agricultural risk management** (E3-270) *Chair: Donald Behan*

1. **Factors Affecting the Use of Futures Hedging by Commodity Producing Firms: A Multifactor Risk Management Approach** *Charles Grant*
2. **An Actuarial Framework for Modeling Loss Cost Ratio's in Crop Insurance: Trend Testing, Data Detrending, and Pricing, Using an Erlang Mixture Distribution** *Wenjun Zhu, Lysa Porth and Ken Seng Tan*
3. **Modeling Spatial Dependence and Optimal Retention for a Reinsurance Decision Model Under a Copula Framework** *Lysa Porth, Milton Boyd and Jeffrey Pai*
4. **A Framework for Developing Livestock Insurance** *Milton Boyd, Jeffrey Pai and Lysa Porth*

16.00–17.20 **P2B: Statistical methods I** (E2-399) *Chair: David Promislow*

1. **Log-Folded-t Models for Insurance Loss Data** *Vytaras Brazauskas and Andreas Kleefeld*
2. **Small Sample Stochastic Tail Modeling: Tackling Sampling Errors and Sampling Bias by Pivot-Distance Sampling and Parametric Curve Fitting Techniques** *Yvonne C. Chueh and Paul H. Johnson*
3. **Predictive Modeling in Healthcare Costs using Regression Techniques** *Michael V. Loginov, Emily Marlow and Victoria Potruch*
4. **An Introduction to Causal Analysis on Observational Data using Propensity Scores** *Margie Rosenberg, Brian Hartman and Shannon Lane*

17.30–21.00 **Centennial dinner at University Centre 204**

8.00–8.30 **Breakfast** (E2-229)

8.30–9.20 **Feature session 4** (E3-270) *Chair: Xuemiao Hao*

Complexity Science – what it is and why you want to know about it *Dave Snell*

9.20–10.10 **Feature session 5** (E3-270) *Chair: Xuemiao Hao*

Usage Based Insurance and the Evolving Analytics Environment *Gary Wang*

10.10–10.30 **Coffee break** (E2-229)

10.30–12.10 **P3A: Finance II** (E3-270) *Chair: Phelim Boyle*

1. **Optimal Allocation and Consumption with Guaranteed Minimum Death Benefits with Labor Income and Term Life Insurance** *Jin Gao and Eric R. Ulm*
2. **Capital asset pricing model with fuzzy returns and hypothesis testing** *Moussa Alfred Mbairadjim, J. Sadefo Kamdem, Arnold F. Shapiro and M. Terraza*
3. **Revisiting the Risk-Neutral Approach to Optimal Policyholder Behavior: A Study of Withdrawal Guarantees in Variable Annuities** *Thorsten Moenig and Daniel Bauer*
4. **Hyperbolic Discounting: Implications for Actuarial Science and Financial Risk Management** *Rick Gorvett*
5. **Risk analysis of annuity conversion options in a stochastic mortality environment** *Alexander Kling, Jochen Russ and Katja Schilling*

10.30–12.10 **P3B: Actuarial education** (E2-399) *Chair: Curtis Huntington*

1. **What do you want your students to know? What are you doing?** *Mark M. Maxwell*
2. **Society of Actuaries Education Update** *Stuart Klugman*
3. **Variance of a Single Deferred Annuity - A Simpler Way** *Claire Bilodeau*
4. **Technology Enhanced Learning Project for Actuarial Science Education** *Douglas J. Bujakowski*
5. **The Society of Actuaries' New Research Strategy** *Sara Teppema*

10.30–12.10 **P3C: Mortality** (E2-350) *Chair: Ian Duncan*

1. **Modeling and Forecasting Mortality Rates** *Patrick L. Brockett, Daniel Mitchell, Rafael Mendoza-Arriaga and Kumar Muthuraman*
2. **Longitudinal Analysis of Mortality Risk Factors** *Daniel H. Alai and Michael Sherris*
3. **Investigating Causal Mortality using the Multinomial Logistic Model** *Daniel H. Alai, Severine Gaille and Michael Sherris*
4. **Assessing systematic bias in mortality prediction of the Lee-Carter model** *Defang Wu, Xiaoming Liu and Yu Hao*

5. **Dynamic Population Structure with Stochastic Mortality and Fertility Rates** Yu Lin *and Xiaoming Liu*

12.10–13.50 **Lunch at University Centre 210**

- During the conference lunch, David Cummins from Temple University will give a speech on "Next Year's ARC".
- E&R lunch meeting at Souris Hall (UC224B). Please pick up lunch from UC210 first.

14.00–14.50 **Feature session 6** (E3-270) *Chair: Sam Cox*

Divided by a common language: communicating applied research in actuarial science *Mary Hardy*

14.50–15.40 **Feature session 7** (E3-270) *Chair: Sam Cox*

The shape of the insurance marketplace in 2020 *Linda Golden*

15.40–16.00 **Coffee break** (E2-229)

16.00–17.00 **P4A: Pensions** (E3-270) *Chair: Ron Gebhardtsbauer*

1. **Mortality Improvement for Canadian Pensioners: Proposed Projection Scales** *Louis Adam*
2. **On the Impact of Raising the Full Retirement Age in the Social Security Program** *Kidane Testfu*
3. **The Impact of Investment Strategy of DC Pension Plan on Reirement Age Distribution** Minxian Lv*, Xiaoming Liu and Yu Hao*

16.00–17.00 **P4B: Statistical methods II** (E2-399) *Chair: Jed Frees*

1. **A Multivariate Analysis of Intercompany Loss Triangles** *Peng Shi*
2. **Implementing Fuzzy Random Variables** *Arnold F. Shapiro*
3. **Approximate Copula Regression** Paul G. Ferrara *and Rahul A. Parsa*

16.00–17.00 **P4C: Applications of Actuarial Models** (E2-350) *Chair: Margie Rosenberg*

1. **Forward transition rates in a multi-state model** *Marcus C. Christiansen and* Andreas J. Niemeyer
2. **Paid Claims Projection and Cash Flow Testing Models. Illustrative Approach.** *Natalia A. Humphreys*
3. **Incurred but Unreported Deaths in Life Settlements** *Donald F. Behan*

18.00–22.00 **Conference banquet at Manitoba Club**

8.00–8.30 **Breakfast** (E2-229)

8.30–10.10 **P5A: Finance III** (E3-270) *Chair: Yafang Wang*

1. **Combinatorics for Moments of a Randomly Stopped Quadratic Variation Process** *James G. Bridgeman*
2. **Positive Weights on the Efficient Frontier** *Phelim Boyle*
3. **Market dependent fees for GMMB and GMDB riders** *Anne MacKay, Carole Bernard and Mary Hardy*
4. **Modeling Trades in the Life Market as Nash Bargaining Problems** *Rui Zhou, Johnny S.H. Li and Ken Seng Tan*
5. **A Comonotonicity-based Valuation Method for Annuity-linked Contracts** *Xiaoming Liu, Rogemar Mamon and Huan Gao*

8.30–10.10 **P5B: Casualty** (E2-399) *Chair: Sam Cox*

1. **Insurance Ratemaking and a Gini Index** *E. W. (Jed) Frees, Glenn Meyers and A. David Cummings*
2. **A renewal model for medical malpractice** *Ghislain Leveille and Emmanuel Hamel*
3. **Micro-Level Loss Reserving Models for P&C Insurance** *Xiaoli Jin*
4. **An Experience Rating Approach to Insurer Projected Loss Ratios** *Marc-André Desrosiers*
5. **Experience Rating in Motor Insurance** *Pervin Baylan-Irven and Jeffrey Pai*

8.30–10.10 **P5C: Risk theory II** (E2-350) *Chair: Lysa Porth*

1. **First- and Second-order Asymptotics for the Tail Distortion Risk Measure of Extreme Risks** *Fan Yang*
2. **Default risk of a jump-diffusion model subject to Chapter 7 and Chapter 11 bankruptcy codes** *Bin Li, Qihe Tang and Xiaowen Zhou*
3. **Credibility Theory in a Fuzzy Environment** *Arnold F. Shapiro and Marie-Claire Koissi*
4. **Analysis of Disability Insurance Portfolios with Stochastic Interest Rates** *Yu Xia*

10.10–10.30 **Coffee break** (E2-229)

10.30–11.20 **P6A: Genetic algorithms** (E3-270) *Chair: Xuemiao Hao*

Genetic Algorithms - what they are and how to apply them to actuarial problems *Dave Snell*

10.30–11.20 **P6B: How to be a CAE?** (E2-399) *Chair: Warren Luckner*

Being or becoming a Society of Actuaries Center of Actuarial Excellence: Challenges and Opportunities *Sam Broverman, Ron Gebhardtsbauer, Warren Luckner and Kris Presler*

11.25–11.50 **Closing session** (E3-270) *Chair: Jeffrey Pai*

- Closing remarks by Mark Whitmore, Dean of the Faculty of Science
- Closing remarks by David Stangeland, Associate Dean of Asper School of Business
- Jeffrey Pai to end the 47^{th} Actuarial Research Conference

11.50 **Box lunch** (E2-229)

ABSTRACTS

Feature session 1

Ethics and Professionalism in Actuarial Practice

Charly Pazdor

Eckler Ltd, Winnipeg, Canada; cpazdor@eckler.ca

Actuaries are 'Professionals'. The hallmarks of the learned professions are generally seen to be:

1. Having specialized training skill and knowledge;
2. Being relied on by the public/serving in the public interest;
3. Being subject to a Code of Ethics;
4. Self policing.

It also means that it is not enough for an actuary's work simply to be (barely) legal. While it is important to do work that will not subject the actuary to litigation, that bar is too low.
New FSAs attend the Fellowship Admissions Course (FAC), a 3-day course designed to expose them to professionalism and ethics issues. It includes several case studies designed to highlight ethical dilemmas and to show that working as an actuary means going beyond actuarial text books. This session is intended to give you an appreciation of the FAC: i.e. what you or your students will face as you/they complete the qualification process.
Attendees should be familiar with the Code of Conduct of the Society of Actuaries; however, the session is not about a review of the Code, nor about the discipline process.
The session will include a brief overview of the theoretical aspects of ethics. We will also review, through the use of case studies, some examples of the challenges to professionalism that can be faced by practicing actuaries.
Note: Active participation by the attendees is not only helpful, it is critical to the success of session.

P1A: Finance I

Analytic Solution for Ratchet Guaranteed Minimum Death Benefit Options Under a Variety of Mortality Laws

Eric R. Ulm

Georgia State University, Atlanta, GA, USA; eulm@gsu.edu

We derive a number of analytic results for GMDB ratchet options. Closed form solutions are found for DeMoivre's Law, Constant Force of Mortality, Constant Force of Mortality with an endowment age and constant force of mortality with a cutoff age. We find an infinite series solution for a general mortality laws and we derive the conditions under which this series terminates. We sum this series for at-the-money options under Makeham's Law of Mortality which provides a realistic approximation for human mortality in many circumstances.

Pricing of Debt and Loan Guarantees using Stochastic Delay Differential Equations

Elisabeth Kemajou

University of Minnesota, Twin-cities, USA; isakema@siu.edu

Most companies in the business world, use debt to operate. In addition to equity, corporate bonds (debt nancing) are the main source of funds for many businesses. However, depending on the ability of the managers or other reason, a company may become insolvent. Company insolvency may lead to bankruptcy or company reorganization. When a company becomes insolvent, the stock value decreases to zero and the equity holders lose on their investment. Naturally, debtholders would like to make sure that their investments are secured. In order to support companies in this situation and encourage new investments, some government agencies provide loan guarantees. In this paper, we use delay equations to derive a formula for the price of an option used for the pricing of corporate debt and adopt this approach to the valuation of government loan guarantees for companies in nancial distress. Overall, our analysis shows that loan guarantees may be an ecient way to protect debtholders' investments which may lead to company reorganization.

Estimation and Pricing with a Diffusion Model with Jumps

Claire Bilodeau[1] *and Andrew Luong*[2]

Université Laval, Québec, Canada
[1]Claire.Bilodeau@act.ulaval.ca
[2]andrew.luong@act.ulaval.ca

The Black-Scholes formula is a staple in finance. The formula for option pricing hinges on a diffusion model for stock prices. Yet, there are other ways of modeling stock prices. While Press proposed a diffusion model with normal jumps but no drifts, Merton extended Press's idea by adding a drift term. Whereas the diffusion model alone has a neat probability density function and thus lends itself well to standard estimation methods, including maximum likelihood, the diffusion model with jumps does not. However, all these models have nice characteristic functions which can be used in quadratic distance estimation. After estimating the parameters of the enhanced model (and yet avoiding the problems encountered with moment-type estimators), we look at ways of pricing options under that model. We finish with some numerical examples based on real data.

Model Selection in Regime-switching Models of Various Types

Brian Hartman[1] *and Chris Groendyke*[2]

[1]University of Connecticut, Storrs, USA; brian.hartman@uconn.edu
[2]Robert Morris University, Moon Township, USA; groendyke@rmu.edu

Simulated asset returns are used in many areas of actuarial science. For example, life insurers use them to price annuities, life insurance, and investment guarantees. The quality of those simulations has come under increased scrutiny during the current financial crisis. When simulating the asset process, properly choosing which model or models to use, and accounting for your uncertainty in that choice is essential. We investigate how to best choose a model from a flexible set of regime-switching models where the individual regimes are not constrained to be from the same distributional family.

Pricing and Hedging GMWBs in a Binomial Model

Menachem M. Wenger

Concordia University, Montreal, Canada; wmendy@gmail.com

We consider the Guaranteed Minimum Withdrawal Benefits (GMWB) variable annuity rider under a static withdrawal strategy but allowing for early surrenders. We briefly present and extend results from the literature for a continuous-time model where the underlying asset is log-normally distributed. Particular attention is paid to the unique perspectives of both the insured and the insurer. We construct a binomial model in several steps. The price processes are first stated assuming no surrenders and it is proven that the fair fee rate enables a dynamic delta hedging strategy. Similar results hold when optimal surrenders are assumed. Finally we introduce mortality and demonstrate through simulations that delta hedging results in a perfect hedge only in the limit as mortality risk diversification is attained. We conclude by applying approximation methods which significantly improve the computational efficiency of the binomial asset pricing model for the GMWB product.

P1B: Enterprise risk management

Economic capital approaches and solvency of UK annuity portfolios

Mayukh Gayen

University of Kent, Canterbury, United Kingdom; mg267@kent.ac.uk

Insurance firms are required by regulators to back their risks using adequate amounts of risk-based economic capital. Proposed introduction of Solvency 2 regulations in 2014 shows a move towards such risk-based assessments. However, economic capital calculation approaches can have different philosophies, and implications of those on the solvency of a business could be different. Here we present a hypothetical example of a UK term annuity firm and study its solvency over the period 1985-2010 under various economic capital calculation approaches. We found that not all definitions can ensure solvency under actual movements of UK economy and demography over the period.

Estimating the required surplus, benchmark profit, and optimal reinsurance retention for an insurance enterprise using the compound Poisson distribution

Joseph Boor

Florida State University, Tallahassee, USA; joeboormath@gmail.com

This paper presents an analysis of the capital needs, needed return on capital, and optimal reinsurance retention for insurance companies, all within the context of the compound Poisson distribution. As an alternative to much of the present practice, it focuses on closed form expressions and closed form approximations, rather than ocusing on how to estimate such values using Monte Carlo simulation. The analysis is also done using a distribution-free approach with respect to the loss severity distribution. It shows how the risk of extreme aggregate losses that is inherent in insurance operations may be understood (and, implicitly, managed) by using key values from the loss severity distribution. The capital and surplus needs of a company are then estimated using a VaR approach. A tractable formula for the benchmark pro t need of a company is developed. An analysis of the economically optimal reinsurance retention/policy limit is performed as well. It shows that that the marginal (across loss caps) profit need should equal to the marginal reinsurer loading on losses. Analytical expressions are then developed for the optimal reinsurance retention. Approximations to the optimal retention based on the normal distribution are developed and their error is analyzed in great detail. For sample data that is known to be difficult to approximate with a normal distribution, the results indicate the normal approximation to the optimal retention is acceptable. The impacts of those results on other aspects of insurance company operations are discussed. It discusses that their is a logical limit on insurance bene ts beyond which the cost of the insurance outweighs the benefits. Also, the benchmark loading for profit and the amount needed to recompense investors for diversifiable risk is discussed. An analysis of whether or not the loading for diversifiable risk is needed is performed, suggesting that some small load for the randomness of insurance clams is required to support the capital employed by an insurance company. The profit load needed in the rates is shown to be independent of how an insurance company invests its assets, and as such is mostly independent of the CAPM "beta" of the company as a whole. It is shown to be related strictly to the risk-free rate and the asset structure of an insurance company in the most common cases.

The Marginal Cost of Risk, Risk Measures, and Capital Allocation

Daniel Bauer[1] *and George Zanjani*[2]

Georgia State University, Atlanta, USA
[1]dbauer@gsu.edu
[2]gzanjani@gsu.edu

The Euler (or gradient) allocation technique defines a financial institution's marginal cost of a risk exposure via calculation of the gradient of a risk measure evaluated at the institution's current portfolio position. The technique, however, relies on an arbitrary selection of a risk measure. We reverse the sequence of this approach by calculating the marginal costs of risk exposures for a profit maximizing financial institution with risk averse counterparties, and then identifying a closed-form solution for the risk measure whose gradient delivers the correct marginal costs. We compare the properties of allocations derived in this manner to those obtained through application of the Euler technique to Expected Shortfall (ES), showing that ES generally yields economically inefficient allocations.

Loss Given Default in the Presence of Multivariate Regular Variation. Part 1: Introduction

Qihe Tang[1] *and Zhongyi Yuan*[2]

University of Iowa, Iowa City, USA
[1]qihe-tang@uiowa.edu
[2]zhongyi-yuan@uiowa.edu

Consider a portfolio of n obligors such as loans, corporate bonds and other instruments subject to possible default. We propose a new model for the loss given default (LGD), which takes the depth of default into consideration. A multivariate regular variation (MRV) structure is used to capture the heavy-tailedness and asymptotic dependence of losses. We derived asymptotic formulas for the upper tail of the LGD. The traditional t-distribution model and Archimedean copula model are revisited.

Loss Given Default in the Presence of Multivariate Regular Variation. Part 2: Main Results

Qihe Tang[1] *and Zhongyi Yuan*[2]

University of Iowa, Iowa City, USA
[1]qihe-tang@uiowa.edu
[2]zhongyi-yuan@uiowa.edu

Consider a portfolio of n obligors such as loans, corporate bonds and other instruments subject to possible default. We propose a new model for the loss given default (LGD), which takes the depth of default into consideration. A multivariate regular variation (MRV) structure is used to capture the heavy-tailedness and asymptotic dependence of losses. We derived asymptotic formulas for the upper tail of the LGD. The traditional t-distribution model and Archimedean copula model are revisited.

P1C: Risk theory I

Optimal Asset Allocation for Endowment Management

Rina Ashkenazi[1], *Sandra Paterlini*[2] *and Francesco Pattarin*[3]

[1]University of Minnesota, Minneapolis, USA; ashke004@umn.edu
[2]Univ. of Modena and Reggio E., Modena, Italy; sandra.paterlini@unimore.it
[3]Univ. of Modena and Reggio E., Modena, Italy; francesco.pattarin@unimore.it

The management of educational endowment or other income-producing portfolio requires determining the endowment asset allocation and the spending rule. We aim to propose a quantitative framework, which jointly considers the endowment spending policy and the asset allocation decision à-la Markowitz. In particular, we propose a new asset allocation framework to determine the optimal spending rule given a probability of ruin (the so-called Sustainable Spending Rate Portfolio), or, the optimal probability of ruin given a spending rule (the so-called Safety First Portfolio). Models are validated by empirical data.

VaR and ruin probabilities for the Geometric Brownian motion with jump model

Yu Zhao[1] *and Jiandong Ren*[2]

University of Western Ontario, London, Canada
[1]williamzhaodream@gmail.com
[2]jren@stats.uwo.ca

Value-at-risk (VaR) is an important risk measure for financial and insurance firms. In fact, EU Solvency II sets a solvency capital requirement (SCR) of 1-year 99.5% VaR of liabilities. In this paper, we model an insurer's surplus as a Geometric Brownian motion with Poisson jumps. By comparing one-year VaR to ruin probability, especially the ruin probability with a relatively long time horizon, we concluded that the ruin probability could provide additional information to the insurers and can complement VaR as a useful risk measure.

Analysis of a bivariate risk model

Jingyan Chen[1] *and Jiandong Ren*[2]

[1]University of Western Ontario, London, Canada; jchen567@uwo.ca
[2]The University of Western Ontario, London, Canada; jren@stats.uwo.ca

In this paper, we first introduce a bivariate compound loss model describing the aggregate losses from two lines of insurance businesses. This model allows dependencies between claim frequencies as well as among claim sizes. We then present methods of calculating the probability that at least one line of business will get ruined as well as the probability that both lines of business get ruined. Numerical examples are given to show how the dependencies between the two type of losses aect the ruin probabilities.

The application of the number of IBNR claims for Erlang (n) inter-arrival times

David Landriault [1], *Ya Fang Wang* [2] *and Gordon E. Willmot* [3]

[1]University of Waterloo, Waterloo, Canada ; dlandriault@uwaterloo.ca
[2]University of Manitoba, Winnipeg, Canada; wangyafang2004@yahoo.ca
[3]University of Waterloo, Waterloo, Canada ; gewillmo@uwaterloo.ca

The IBNR claims are a key issue for insurance firms or risk businesses to determine the reserve. For Poisson or mixed Poisson processes, the distribution of the number of IBNR claims is well known and governed by nonhomogeneous Poisson processes. Here we generalize Poisson process to a renewal process, especially Erlang (n) renewal processes. Homogeneous differential equations are derived for the probability generating function of the number of IBNR claims. For Applications, we compare differences between classical risk model and Erlang (n) renewal risk model. This work gives insurers more flexible choice to fit their risk models. This research work also leads to some results for the number of busy servers with infinity servers.

Ultimate Ruin Probability with Correlation

Emmanuel Thompson[1] *and Rohana S. Ambagaspitiya*[2]

Department of Mathematics and Statistics, University of Calgary, Calgary, Canada
[1]thompsoe@ucalgary.ca
[2]ambagasp@ucalgary.ca

In the Sparre-Andersen model, claim sizes and claim occurrence times are assumed to be independent. The independence assumption was used for simplicity in the literature. In this talk, we introduce correlation and consider two classes of bivariate distributions to model claim sizes and claim occurrence times. We derive exact expressions for the ultimate ruin probability and establish the effect of correlation on ruin probability using the Wiener-Hopf factorization.

Feature session 2

The Canadian Institute of Actuaries' University Accreditation Program

Rob Stapleford

Mercer, Toronto, Canada; rob.stapleford@mercer.com

The goal of the UAP is to provide exemptions for some preliminary examinations while maintaining the strong standards of the exam-based entrance to the profession. The CIA believes that the UAP will allow for a rich and rewarding university experience that will make travel time to the FCIA designation more predictable and produce stronger, more capable actuaries for the future. The UAP policy, approved by the CIA Board in March 2011, provides for exemptions for exams FM/2, MFE/3F, MLC/3L and C/4. No exemptions are available for the Probability Exam. Students will be required to complete the examination of the SOA/CAS/CIA for exam P/1 as well as the Fellowship exams, modules and other eligibility requirements for the Associate (ACIA) and Fellow (FCIA) designations of the CIA.Beginning in September 2012, accredited universities will be able to offer courses which will provide students with the option of applying to the CIA to gain exemptions from writing the examinations noted above.

Feature session 3

Open Forum for MLC Teachers

Elias Shiu[1]*, Aaron Tenenbein*[2] *and Heekyung Youn*[3]

[1]University of Iowa, Iowa City, USA; elias-shiu@uiowa.edu
[2]New York University, New York, USA;
[3]St. Thomas University, USA;

Beginning in 2012, there is a new syllabus for the MLC (Models for Life Contingencies) examination. For many teachers and students, the syllabus is somewhat confusing. Two textbooks are listed, with an accompanying statement that "[e]ither of reading sources ... may be used as a source in preparing for the examination." This seems to mean that the syllabus is the INTERSECTION of the two books. However, the syllabus also contains a paragraph indicating that the examination is based on the UNION of the two books. The Society of Actuaries has released the May MLC examination. It is long and computational. Although the pass mark was set at 50%, only 30.6% of all candidates passed (35.9% effective). (For comparison, the pass mark for the April MFE exam was 76%, with 48.1% of all candidates passing.) Upon reviewing the MLC questions, it seems that the examination was based mainly on one textbook and its supplementary notes. The purpose of this forum is to provide an opportunity for MLC teachers to discuss various issues arising from this new syllabus, such as

- Do we need to ask students to buy both textbooks?
- How many courses are needed to cover the entire syllabus?
- Difficulties in the new syllabus, e.g., notation, continuous-time Markov chains, joint-life and last-survivor in the context of multiple-life models, ...
- Exam strategies. For the examination last May, if a candidate could do 11 questions correctly and randomly guessed the remaining 19, the expected score is 14.8, which is very close to the 50% pass mark. A less knowledgeable student could have an advantage as the student would probably not have wasted any time on the more difficult questions. Should we teach half of the MLC syllabus really well, and tell students to guess answers for questions from the other half? Should we spend more efforts teaching an easy exam such as MFE to ensure that students will pass a "preliminary" exam beyond P and FM?

P2A: Agricultural risk management

Factors Affecting the Use of Futures Hedging by Commodity Producing Firms: A Multifactor Risk Management Approach

Charles Grant

University of Manitoba, Winnipeg, Manitoba; charles_grant@umanitoba.ca

The objective of this paper is to review earlier research and identify the major factors affecting the use of futures hedging by commodity producers. This approach seeks to provide a conceptual multifactor model in order to gain a broader and more complete understanding of commodity producer behavior and risk management. Traditionally, the rationale for hedging has focused primarily on a few factors such as output price volatility, risk aversion, and basis risk. However, this paper seeks to bring to together all major factors found in the literature that affect the use of futures hedging by commodity producers. This should assist in bringing about a more complete understanding of futures hedging decisions and behavior regarding commodity producers. The paper focuses on factors that directly impact hedging. These include industry characteristics, business operation characteristics, management characteristics, futures hedging costs, and substitute risk management instruments. The five factors are further disaggregated into subfactors in order to more specifically explain factors affecting the use of hedging. This may be of interest to commodity producing firms and researchers, as it attempts to explain the factors which may influence a commodity producer's decision to hedge with futures.

An Actuarial Framework for Modeling Loss Cost Ratio's in Crop Insurance: Trend Testing, Data Detrending, and Pricing, Using an Erlang Mixture Distribution

Wenjun Zhu[1], *Lysa Porth*[2] *and Ken Seng Tan*[3]

Department of Statistics and Actuarial Science, University of Waterloo, Waterloo, Canada
[1]w25zhu@uwaterloo.ca
[2]lporth@uwaterloo.ca
[3]kstan@uwaterloo.ca

In the design and rating of crop insurance products, it is crucial to gain confidence surrounding the underlying trending process of the data, and remove the trends accordingly. This helps to ensure that the loss models can be constructed more scientifically, which promotes actuarial risk management and pricing. The objective of this study is to review by simulation the current tools available for testing trends in time series. Further, this study constructs and compares alternative probability distribution models, using a unique and comprehensive data set that represents the entire crop insurance sector of Canada. The focus of this study is on a unique aggregate level data set comprised of actual indemnities and liabilities from 1979 through 2010, across 276 crop types, and 10 geographic regions in Canada. From this, the loss cost ratio's are calculated in order to normalize the loss exposure, due to significant increases in liabilities and yields observed over time. In this study, a family of Erlang mixture distributions, which is shown to capture the tails of the data far better than conventional distributions is proposed. Preliminary results also show that the Erlang distribution performs well in forecasting. Moreover, the models' predictive power can be further improved using the resulting Erlang mixture distribution, and constructing a forecasting model using credibility theory.

Modeling Spatial Dependence and Optimal Retention for a Reinsurance Decision Model Under a Copula Framework

Lysa Porth[1], *Milton Boyd*[2] *and Jeffrey Pai*[3]

[1]University of Waterloo, Waterloo, Canada; lysaporth@gmail.com
[2]University of Manitoba, Winnipeg, Canada; Milton.Boyd@ad.umanitoba.ca
[3]University of Manitoba, Winnipeg, Canada; Jeffrey.Pai@ad.umanitoba.ca

Insurance losses due to adverse weather, including agricultural insurance, are often found to be spatially correlated across geographic regions, particularly for extreme events. If loss characteristics are non-normal with unique tail behaviour, ignoring nonlinear dependencies (correlation) can result in biased estimates of the risk profile for the agricultural crop insurance firm. This paper develops a fully integrated approach to spatial reinsurance questions, and maps the nonlinear dependencies of loss cost ratio's (LCR's, which are calculated as the ratio of indemnities to liabilities) across geographic regions in a country via a copula method. Using a comprehensive data set that covers the four largest crop insurance regions in Canada, which includes actual indemnities and liabilities, over 32 historical years, and across 155 crop types, several copula methods (i.e. Normal, t, Frank, Clayton, and Gumbel) are calibrated to a set of proposed actuarial risk measures, including surplus, survival probability, and deficit at ruin. This evaluation contributes to the body of literature that analyzes the importance of considering nonlinear dependencies, and further, recommends that copulas should be calibrated to the particular data set in order to fully consider the impact of copula choice, and reinsurance contract structure, on the calculated risk assessment. Ultimately, careful attention to calibration of copula methods to the particular data set will help to improve estimates of risk measures, financial requirements, and operational decision-making, which may lead to value creation for the adopting insurance firm.

A second objective of this paper is to investigate the optimal retention for a reinsurance decision model, employing efficient frontier analysis to determine the extent to which pooling is possible in agricultural crop insurance. This is considered by extending the framework set forth in Porth (2011), which develops a flexible reinsurance portfolio model with combinatorial optimization and a genetic algorithm. The calibrated copulas are applied to the reinsurance decision model, and the optimal allocation ratio (retention) is solved by considering the discrete grouping of crop risks in the portfolio that should be retained in the self managed reinsurance pool (i.e. the optimal extent to which pooling can be used), and the proportion of crop risks that should be ceded to private reinsurers, such that the variance to the joint pool is minimized. This evaluation shows that when nonlinear dependencies are considered via a copula approach, private reinsurance is needed in addition to pooling, if pooling is to be successful. This approach provides an innovative way for insurance firms to gain efficiencies, providing a lower-cost alternative for some crop insurance firms who currently do not purchase private reinsurance.

A Framework for Developing Livestock Insurance

Milton Boyd[1]*, Jeffrey Pai*[2] *and Lysa Porth*[3]

[1]University of Manitoba, Winnipeg, Canada; Milton.Boyd@ad.umanitoba.ca
[2]University of Manitoba, Winnipeg, Canada; Jeffrey.Pai@ad.umanitoba.ca
[3]University of Waterloo, Waterloo, Canada; lysaporth@gmail.com

This paper provides a framework for the development of livestock insurance, and examines how livestock insurance may be developed, using Canada as an example. Both multi-peril and disease only livestock insurance are discussed. Despite the increased interest in livestock insurance, livestock insurance is not commercially widespread, and has been relatively slow in development, mainly because there are a number of challenges associated with developing successful livestock insurance. The relatively slow development of livestock insurance is in contrast to crop insurance, which is well established, and has been in widespread commercial operation for many years in a number of countries. Livestock insurance often includes beef cattle, dairy cattle, poultry, pigs, and other livestock, however, this paper examines livestock insurance for pigs in Canada. As well, a number of potential challenges related to developing livestock insurance are also discussed, such as moral hazard and adverse selection.

P2B: Statisitcal methods I

Log-Folded-t Models for Insurance Loss Data

Vytaras Brazauskas[1] *and Andreas Kleefeld*[2]

[1]University of Wisconsin-Milwaukee, Milwaukee, USA; vytaras@uwm.edu
[2]Branderburgische Technische Universitat, Cottbus, Germany; kleefeld@TU-Cottbus.De

A rich variety of probability distributions has been proposed in the actuarial literature for fitting of insurance loss data. Examples include: lognormal, log-t, various versions of Pareto, loglogistic, Weibull, gamma and its variants, and generalized beta of the second kind distributions, among others. In this paper, we supplement the literature by adding the log-folded-normal and log-folded-t families. Shapes of the density function and key distributional properties of the "folded" distributions are presented along with three methods for the estimation of parameters: method of maximum likelihood, method of moments, and method of trimmed moments. Further, large- and small-sample properties of these estimators are studied in detail. Finally, we fit the newly proposed distributions to data which represent the total damage done by 827 fires in Norway for the year 1988. The fitted models are then employed in a few quantitative risk management examples, where point and interval estimates for several value-at-risk measures are calculated.

Small Sample Stochastic Tail Modeling: Tackling Sampling Errors and Sampling Bias by Pivot-Distance Sampling and Parametric Curve Fitting Techniques

Yvonne C. Chueh[1] *and Paul H. Johnson*[2]

[1]Department of Actuarial Science, Statistics, and Mathematics, Central Washington University, Ellensburg, WA, USA; chueh@cwu.edu
[2]Department of Mathematics, University of Illinois at Urbana-Champaign, Champaign, IL, USA; pjohnson@illinois.edu

Practitioners and researchers are challenged to make credible inferential statements about population distributions of critical variables even after implementing high speed computational hardware, innovative computing technology, and widely-tested scenario reduction and model compression techniques or systems. Successful projection of the universe of critical financial outcomes for a large population of policyholders under complicated matrices of risk drivers, currently demanded by risk management and regulatory mandates, is important for pricing innovative products, setting reserves, testing cash flows, and budgeting risk capital for new business and liabilities in force.
Funded by The Actuarial Foundation, this paper investigates easy-to-implement techniques and tools developed to reduce sample-run errors and sampling bias arising from using small risk scenario samples to replicate a very large population distribution at the tails. Two open source software tools are being developed to assist practitioners and researchers in tackling model efficiency challenges via streamlined implementation methods: (1) CSTEP for reducing sampling errors, and (2) AMOOF2 for correcting sampling bias and fitting population distribution models. Both CSTEP and AMOOF2 will be introduced and tested using simulations and real model runs.

Predictive Modeling in Healthcare Costs using Regression Techniques

Michael V. Loginov[1], *Emily Marlow*[2] *and Victoria Potruch*[3]

UC Santa Barbara, Santa Barbara, USA
[1]mloginov@umail.ucsb.edu
[2]ecmarlow@umail.ucsb.edu
[3]vpotruch@gmail.com

After President Obama signed the Patient Protection and Affordable Care Act, as well as the Health Care and Education Reconciliation Act of 2010, the United States healthcare system became subject to extensive changes in patient eligibility requirements. The Congressional Budget Office (2010) projected that these acts will reduce the number of uninsured nonelderly people by about 32 million, with only 23 million nonelderly citizens remaining uninsured by 2019. Using data from an insurance provider, we investigated healthcare expenditures and applied variable selection to produce models for predicting the cost that insurers will spend on covered members. Statistical techniques such as data transformation, linear regression, and least angle regression were used to develop the models. We pinpointed the effect of high cost factors and developed a method of predicting a member's cost to the insurer by analyzing claims cost data. In this project, we used a dataset provided by a private insurance company which contained demographic, cost, and diagnostic data. Our analysis allowed us to determine which factors drove costs up and how these factors will affect the total cost for future years. We used linear regression and least angle regression (LAR) techniques to develop the models. We also implemented the special modification least absolute shrinkage and selection operator (lasso) to reduce the number of independent variables for our predictive model. These statistical techniques were performed using the open source statistical software R, including the lars package that implements LAR and lasso. Using Lars, we picked 13 key predictors for our model for determining the cost of insuring an individual, while maintaining an adjusted R^2 of 0.4 which is consistent with the models published by the Society of Actuaries.

An Introduction to Causal Analysis on Observational Data using Propensity Scores

Margie Rosenberg[1], *Brian Hartman*[2] *and Shannon Lane*[3]

[1]University of Wisconsin-Madison, Madison, USA; mrosenberg@bus.wisc.edu
[2]University of Connecticut, Storrs, USA; brian.hartman@uconn.edu
[3]CBB Summer Research Program University of Wisconsin-Madison, Madison, USA; selane@csbsju.edu

In health care studies, randomized trials are the gold standard to assess whether an intervention has a direct causal impact on an outcome. In a clinical trial, the participants are randomized into at least two groups, a control group and at least one treatment group. These groups are balanced through the randomization process by covariates such as sex, age, health status, and comorbidities. Balanced groups result in the treatment assignment being independent of the outcome so that causal effects can be estimated.

These clinical trials are expensive and time-consuming. Furthermore, they can be unethical by providing inferior treatment to those when a more effective treatment is available. Even results from clinical trials have shortcomings as they only provide an upper bound on the efficacy of the intervention and do not assess the effectiveness of the treatment in the general population. In real-life, there are issues with drug adherence and broader use as to whom receives the treatment.

In observational studies, the researcher does not control the assignment of participant to group. For example, employers are providing employee discounts on health care premiums for their participation in biometrics screening programs. These programs are voluntary. If the impact of the program is to be assessed, a way to balance the groups, those who participate and those who do not, would be needed.

In this presentation, The use of the propensity score can minimize biases stemming from non-random treatment assignment, and lead to appropriate conclusions on the effect of the intervention.

Feature session 4

Complexity Science – what it is and why you want to know about it

Dave Snell

RGA, Chesterfield MO, USA; dsnell@rgare.com

A major revolution has taken place in mathematics, finance and economics. Many real world applications, such as the stock market, housing prices and portfolio optimization cannot be adequately addressed by traditional methods. Traditional modeling techniques may be necessary, but not sufficient. This session is an engaging and mind opening, but relatively painless, introduction to Complexity Sciences. It will introduce the attendee to new methods such as Experimental Mathematics, Genetic Algorithms, Predictive Modeling, Deterministic Chaos, Fractal Geometry, Behavioral Economics, Cellular Automata and other topics in the new paradigm of Complexity Sciences. Attendees will come away from the session with an overview of the Complexity Sciences and a basic understanding of the terminology and taxonomy of Complexity. You will not come away an expert in any of them; but they will be much more than just fancy phrases to you. Complexity is the science of the 21st century (per Stephen Hawking) - be a part of it!

Feature session 5

Usage Based Insurance and the Evolving Analytics Environment

Gary Wang

Pinnacle Actuarial Resources Inc, Bloomington IL, USA; gwang@pinnacleactuaries.com

Usage based insurance utilizing telematics data is gaining traction in the US auto insurance market. What challenges and opportunities does this evolution offer to the actuaries who support the auto insurance products? This session will present an overview of the current predictive modeling practices in the auto insurance industry, the challenges telematics presents in the current analytics environment and how the actuaries need to evolve to meet the challenges.

P3A: Finance II

Optimal Allocation and Consumption with Guaranteed Minimum Death Benefits with Labor Income and Term Life Insurance

Jin Gao[1] *and Eric R. Ulm*[2]

[1]Lingnan University, Hong Kong, China; jingao@ln.edu.hk
[2]Georgia State University, Atlanta, GA, USA; eulm@gsu.edu

Because human capital is often the largest asset an investor possesses when he is young, protecting human capital from potential risks should be considered as a part of overall investment advice. The risk of the loss of the policyholder's human capital - the mortality risk - to the household can be partially hedged by a term life insurance policy. Guaranteed Minimum Death Benefits (GMDB) in Variable Annuities (VA) can also help policyholders hedge the risk of the loss of human capital. Therefore, GMDB options and term life insurance can be considered as substitute goods. However, they are not perfect substitutes as GMDB and term life have their own properties: Term life insurance has no correlation with equity markets, and it is regarded purely as a protection for human capital; the variable annuity products follow the performance of equity markets, and the GMDB is a protection against downside risks on equity markets as well as human capital. We implement a lifetime utility model including both GMDB options and term life insurance and allowing the policyholder to optimize both consumption and fund allocation decisions. We find that fairly priced GMDB options fail to add value to a VA contract if a term life policy is available.

Capital asset pricing model with fuzzy returns and hypothesis testing

Moussa Alfred Mbairadjim[1], *J. Sadefo Kamdem*[2], *Arnold F. Shapiro*[3] *and M. Terraza*[4]

[1]Université Montpellier I, Montpellier, France; moussa_alf@yahoo.fr
[2]Université Montpellier I, Montpellier, France;
[3]Penn State University, State College PA, USA; afs1@psu.edu
[4]Université Montpellier I, Montpellier, France;

Over the last four decades, several estimation issues of the beta have been discussed extensively in a large literature. An emerging consensus is that the betas are time-varying and their estimates are impacted upon the return interval and the length of the estimation period. These findings lead to the prominence of the practical implementation of the Capital Asset Pricing Model. Our goal in this paper is two-fold: After studying the impact of the return interval on the beta estimates, we analyze the sample size effects on the preceding estimation. Working in the framework of fuzzy set theory, we first associate the returns based on closing prices with the intraperiod volatility for the representation by the means of a fuzzy random variable in order to incorporate the effect of the interval period over which the returns are measured in the analysis. Next, we use these fuzzy returns to estimate the beta via fuzzy least square method in order to deal efficiently with outliers in returns, often caused by structural breaks and regime switches in the asset prices. A bootstrap test and an asymptotic test are carried out to determine whether there is a linear relationship between the market portfolio fuzzy return and the given asset fuzzy return. Finally, the empirical results on French stocks reveal that our beta estimates seem to be more stable than the ordinary least square (OLS) estimates when the return intervals and the sample size change.

Revisiting the Risk-Neutral Approach to Optimal Policyholder Behavior: A Study of Withdrawal Guarantees in Variable Annuities

Thorsten Moenig[1] *and Daniel Bauer*[2]

Georgia State University, Atlanta, USA
[1]thorsten@gsu.edu
[2]dbauer@gsu.edu

Policyholder exercise behavior presents an important risk factor for life insurance companies. Yet, most approaches presented in the academic literature-building on value maximizing strategies akin to the valuation of American options-do not square well with observed prices and exercise patterns. For instance, several papers indicate that Guaranteed Minimum Withdrawal Benefits (GMWB) in U.S. Variable Annuities appear to be significantly underpriced. The present paper demonstrates that this pricing gap vanishes when the value maximization is carried out from the policyholders' perspective, that is when accounting for the fact that variable annuities grow tax-deferred.
To that effect, we develop a risk-neutral valuation methodology that takes different tax structures into consideration, and apply it to a simplified withdrawal guarantee as well as a representative empirical Variable Annuity contract. We find that the consideration of taxes reduces withdrawals, and thus the value of a GMWB, tremendously. In particular, the withdrawal guarantee fee from the empirical product roughly accords with its marginal price to the insurer.

Hyperbolic Discounting: Implications for Actuarial Science and Financial Risk Management

Rick Gorvett

University of Illinois at Urbana-Champaign, Urbana, IL, USA; gorvett@illinois.edu

One of the foundational concepts in actuarial science and financial risk management is "present value" or "net present value": the idea that the theoretical value of any asset or liability is the present (or discounted) value of its future cash flows. Underlying even simple applications of this idea, however, are several essential assumptions, including (1) that we can appropriately identify both the timing and amount of the future cash flows; and (2) that we can determine the appropriate rate(s) at which to discount each cash flow.

With respect to assumption (2), specific interest and discount rates potentially depend upon the totality of the environment in which the present value calculation is being made: current and expected financial and economic conditions, the degree of certainty regarding the cash flow being discounted, the behavioral characteristics (including the degree of risk aversion) of the individual or firm determining the PV, etc.

Studies have shown that the traditional "exponential" discount factor framework does not necessarily describe empirical evidence about how people actually value things in the future. Instead, empirical studies have often observed a "hyperbolic" discounting pattern: relatively greater discounting in the short-term, and relatively lower discounting in the long-term.

And yet, the "exponential" approach to discounting is typically employed as the basis for the valuation of financial and risk management products and situations.

This presentation focuses on the mathematical underpinnings associated with the process of discounting future cash flows. We also investigate the economic and utility-theory framework underlying discounting, including from a behavioral perspective. We then examine the implications of potential alternatives such as hyperbolic discounting for actuarial science and financial risk management. Considering the current state of the economy, and the impact of recent risk management and valuation issues, this project is both timely and relevant.

Risk analysis of annuity conversion options in a stochastic mortality environment

Alexander Kling[1], *Jochen Russ*[2] *and Katja Schilling*[3]

[1]Institut fuer Finanz- und Aktuarwissenschaften (ifa), Ulm, Germany; a.kling@ifa-ulm.de
[2]Institut fuer Finanz- und Aktuarwissenschaften (ifa) and University of Ulm, Ulm, Germany; j.russ@ifa-ulm.de
[3]University of Ulm, Ulm, Germany; katja.schilling@uni-ulm.de

While extensive literature exists on the valuation and risk management of financial guarantees embedded in insurance contracts, both, the corresponding longevity guarantees as well as interactions between financial and longevity guarantees are usually ignored. The present paper provides a framework for a joint analysis of financial and longevity guarantees and applies this framework to different annuity conversion options in deferred unit-linked annuities. In particular, we analyze and compare different versions of so-called guaranteed annuity options (GAO) and guaranteed minimum income benefits (GMIB) with respect to the value of the option and the resulting risk for the insurer. The analysis is based on a combined stochastic model which means that both, the financial market as well as future survival probabilities, are modeled stochastically. This allows us to identify the main risk drivers for each annuity conversion option. Additionally, we examine whether and to what extent the insurance company is able to reduce the risk by risk management measures. We show that different annuity conversion options have significantly different option values and that different risk management strategies lead to a significantly different risk for the insurance company. By means of sensitivity analyses we see that the question whether GAOs or GMIBs imply a higher risk for the insurer highly depends on the parameter assumptions. The lower the long term interest rate level and the higher the volatility of mortality, the higher is the risk of GAOs. In contrast, GMIBs are less sensitive with respect to the interest rate level and mortality, but show a much higher sensitivity to equity volatility. Altogether, comparing the risk drivers, the risk of decreasing fund values seems to be the predominant risk in GMIBs, whereas for GAOs interest and mortality risks are of higher importance. In particular, for all considered annuity conversion options the mortality risk seems to be more substantial than generally assumed.

P3B: Actuarial education

What do you want your students to know? What are you doing?

Mark M. Maxwell

University of Texas at Austin, Austin, USA; maxwell@math.utexas.edu

Last fall, a freshman enrolled in Introduction to Philosophy was assigned to interview a faculty member. His questions included "What do you know?" and "How do you know?" I have been thinking about better answers to the questions for the past eight months. Academicians will be asked to contribute their goals for students and their techniques used to accomplish these goals. Practitioners can answer the modified questions "What do you want your new hires to know?" and "How to you try to determine this knowledge?" Our group will discuss various knowledge goals, student characteristics and techniques used to reach students.

Society of Actuaries Education Update

Stuart Klugman

Society of Actuaries, Schaumburg, USA; sklugman@soa.org

This presentation will provide an update on the education activities of the Society of Actuaries including recent changes to the CERA requirements, forthcoming changes to the FSA requirements, and the new general insurance track.

Variance of a Single Deferred Annuity - A Simpler Way

Claire Bilodeau

Université Laval, Québec, Canada; Claire.Bilodeau@act.ulaval.ca

In textbooks, the formula given for the variance of a deferred annuity is the most intricate one (compared to whole life or temporary). Yet, there is a much simpler way of finding the variance. Come and find out!

Technology Enhanced Learning Project for Actuarial Science Education

Douglas J. Bujakowski

University of Wisconsin-Madison, Madison, USA; bujakowski.1@gmail.com

The Technology Enhanced Learning (TEL) Project for Actuarial Science Education aims to help budding actuaries solve actuarial examination questions and master classroom material. The project focuses on the first five technical exams, VEE course material, and applied statistics. TEL tools are freely available for the public and include video clips, electronic flashcards, explanations, and interactive demonstrations. As a supplement to classroom instruction, these tools provide new ways for students to enhance their learning experience.

The Society of Actuaries' New Research Strategy

Sara Teppema

Society of Actuaries, USA; steppema@soa.org

Sara is a new research actuary at the SOA, overseeing our new practice research area and helping to implement the SOA's new research strategy. She was formerly the Health Fellow at the SOA, and before that spent many years in health actuarial consulting.
We invited her to speak on the SOA's new research strategy and recent research projects.
— Program Committee

P3C: Mortality

Modeling and Forecasting Mortality Rates

Patrick L. Brockett[1], *Daniel Mitchell*[2], *Rafael Mendoza-Arriaga*[3] *and Kumar Muthuraman*[4]

University of Texas at Austin, Austin, USA
[1]brockett@mail.utexas.edu
[2]daniel.mitchell@phd.mccombs.utexas.edu
[3]rafael.mendoza-arriaga@mccombs.utexas.edu
[4]kumar.muthuraman@mccombs.utexas.edu

We show that by modeling the time series of mortality rate changes rather than mortality rate levels we can better model human mortality. Leveraging on this, we propose a model that expresses log mortality rate changes as an age group dependent linear transformation of a mortality index. The mortality index is modeled as a Normal Inverse Gaussian. We demonstrate, with an exhaustive set of experiments and data sets spanning 11 countries over 100 years, that the proposed model significantly out performs existing models. We further investigate the ability of multiple principal components, rather than just the first component, to capture differentiating features of different age groups and find that a two component NIG model for log mortality change best fits existing mortality rate data.

Longitudinal Analysis of Mortality Risk Factors

Daniel H. Alai[1] *and Michael Sherris*[2]

University of New South Wales, Sydney, Australia
[1]daniel.alai@unsw.edu.au
[2]m.sherris@unsw.edu.au

Individual risk factors such as education, marital status and health status are known to influence survival probabilities. Data at an individual level is required to assess the relative importance of these risk factors. This study investigates important drivers of retirement age mortality using the U.S. health and retirement study (HRS). Two distinct representations are used that preserve both the cross-sectional as well as the temporal nature of the data. The first is for continuous survival data analysis and the second is for discrete panel data analysis. Proportional hazard models are fit to the survival data and marginal models to the panel data. We show the relationship between the two approaches and how, in contrast to the proportional hazard models, the marginal models are able to explicitly incorporate external covariates. The analysis of the HRS data quantifies the significance of these risk factors and explores the extent to which external risk factors, such as GDP, unemployment and health expenditures, explain individual survival probabilities in contrast to individual risk factors.

Investigating Causal Mortality using the Multinomial Logistic Model

Daniel H. Alai[1]*, Severine Gaille*[2] *and Michael Sherris*[3]

[1]University of New South Wales, Sydney, Australia; daniel.alai@unsw.edu.au
[2]University of Lausanne, Lausanne, Switzerland; severine.gaille@unil.ch
[3]University of New South Wales, Sydney, Australia; m.sherris@unsw.edu.au

We separate mortality into component parts in order to analyze observed trends over time. The components are based on internationally classified cause-of-death categories and the data obtained from the World Health Organization. We model causal mortality simultaneously in a multinomial logistic framework, which naturally accounts for the inherent dependence amongst the competing causes. This framework allows us to investigate the effects of improvements in, or the elimination of, cause-specific mortality in a sound probabilistic way. We quantify the subsequent change in aggregate mortality using residual life expectancies.

Assessing systematic bias in mortality prediction of the Lee-Carter model

Defang Wu[1], *Xiaoming Liu*[2] *and Yu Hao*[3]

Department of Statistical and Actuarial Sciences, University of Western Ontario, London, Canada
[1]fannie_wood@hotmail.com
[2]xliu@stats.uwo.ca
[3]hyu@stats.uwo.ca

This paper studies the mortality prediction performance of the Lee-Carter model. It has been found in literature that there exists systematic bias when using the Lee-Carter model for mortality prediction. The main purpose of this paper is to measure the magnitude of the bias using the bootstrap method and also to provide suggestions on how to correct the bias. We consider applying bias correction to two interested variables, mortality rate and life expectancy. We illustrate the effectiveness of correction through examining the forecast performance on simulated data as well as real mortality data from different countries.

Dynamic Population Structure with Stochastic Mortality and Fertility Rates

Yu Lin[1] *and Xiaoming Liu*[2]

[1]University of Western Ontario, London, Canada; ylin287@uwo.ca
[2]University of Western Ontatio, London, Canada; xliu@stats.uwo.ca

The impact of a stochastic population structure on the labour force stability is very important for pension risk management and investigated in this study. We propose a stochastic population structure model based on the Leslie matrix, in which we use a Lee-Carter model framework to describe the future mortality and fertility changes. This population structure model is then combined with investment return models to examine the impact of a Defined Contribution (DC) pension systems on the labour force stability, if the population follows the current changing patterns in mortality and fertility rates. U.S. population data from 1933-2008 is used to validate the population projection and dependency ratio (the ratio of retirees to workers) is calculated to illustrate the labour force stability over time.

Feature session 6

Divided by a common language: communicating applied research in actuarial science

Mary Hardy

University of Waterloo, Waterloo, Canada; mary.hardy@uwaterloo.ca

In this talk I will give some examples of more successful and less successful communications from my own research experience in actuarial risk management, including:

- Risk measures and maturity guarantees
- Embedded guarantees in pension plans
- Guaranteed minimum income benefits (GMIBs)

I will draw some conclusions, and address the actions that could be taken on both sides of the academic/practitioner divide in actuarial science to benefit the profession and the science.

Feature session 7

The shape of the insurance marketplace in 2020

Linda Golden

University of Texas at Austin, Austin, USA; utlindagolden@gmail.com

Insurers and financial intermediaries will face a dramatically different marketplace by the year 2020. Mobile technology will reign supreme. Platforms, as well as the most popular brands, will be continually dynamic. Demographic shifts and the increasingly digitally savvy customer will place unprecedented demands on marketplace suppliers and producers in all industries, including insurance. In addition, global economic shifts and regulatory infrastructures will place further pressures on financial structures and compliance needs. Fraud protection will be extremely important to some customers and not to others. Firms will be expected to deliver secure mobile marketplace interactive systems. The more convenient to the customer, the more likely the firm will be able to avoid customer defection. In the year 2020, it will be even easier for customers to defect to competitors making brand share maintenance increasingly difficult.

Successful firms in the year 2020 will need to understand marketplace dynamics and changes, better listen to and anticipate customer wants and needs, develop strong social media platforms, develop strong mobile platforms, and be facile in building relationships with a variety of different types of customers. This presentation will highlight technological, demographic, cultural, criminal, regulatory, and global market changes that foreshadow threats to survival, if the firm is not proactive in anticipating and responding.

P4A: Pensions

Mortality Improvement for Canadian Pensioners: Proposed Projection Scales

Louis Adam

Université Laval, Québec, Canada; Louis.Adam@act.ulaval.ca

This presentation is related to a research project sponsored in part by the CIA. Some of the results will be published shortly by the CIA and will also be shown at the CIA Annual Meeting in Toronto in June 2012. This work will be useful in the determination of the next standards applicable for pension plan valuation in Canada, depending upon further decisions to be made by the Actuarial Standard Board-Conseil des norms actuarielles.

On the Impact of Raising the Full Retirement Age in the Social Security Program

Kidane Testfu

University of Nebraska-Lincoln, Lincoln, USA; kidane.tesfu@huskers.unl.edu

The issue of reducing Social Security deficit in the United State, in the near future has been of great interest and generated numerous debates among academics, practitioners, and politicians alike. In this report, we investigate the extent of increasing the Social Security full retirement age in order to reduce the program's funding deficit. In particular, we analyze the feasibility of the proposal and address social and financial implications of the full retirement age increase. Overall, given the feasibility and the substantial financial savings of the proposal, we support raising the Social Security full retirement age from 67 to 70. By increasing the full retirement age to 70, our estimations of the total savings range between $1.3 trillion and $2 trillion with in thirty years, representing significant reduction in the Social Security funding deficit.

The Impact of Investment Strategy of DC Pension Plan on Reirement Age Distribution

Minxian Lv[1], *Xiaoming Liu*[2] *and Yu Hao*[3]

Dept. of Statistical & Actuarial Sciences, University of Western Ontario, London, Canada
[1]mlv@uwo.ca
[2]xliu@stats.uwo.ca
[3]hyu@stats.uwo.ca

Many employer-sponsored pension plans now have shifted from defined benefit (DB) to defined contribution (DC) pension plans. It is notorious that DC plans transfer the risk from employer to employee. We are interested in studying the risk inherent in DC pension plans on an individual and aggregate basis. We adopt a retirement decision model based on replacement ratio exceeding a specified minimum level. We consider a modified Wilkie's investment model to investigate the impact of various investment strategy on the retirement age distribution. All investment portfolios are made of cash, bond and stock. We investigate the one-asset portfolios, mixed-asset portfolios, and a dynamic investment portfolio which allows a switch from an aggressive portfolio to a relatively conservative one at middle ages. For individuals, portfolio achieving earlier retirement age with lower risk is favoured. However, such a portfolio may not be beneficial to maintain a stable ratio of number of retirees to the number of working people.

P4B: Statistical methods II

A Multivariate Analysis of Intercompany Loss Triangles

Peng Shi

Northern Illinois University, DeKalb, IL, USA; pshi@niu.edu

The prediction of insurance liabilities often requires aggregating experience of loss payment from multiple insurers. The resulting dataset of intercompany loss triangles displays a multilevel structure of claim development, where a portfolio consists of a group of insurers, each insurer several lines of business, and each line various cohorts of claims. Current studies on loss reserving methods, thought emphasizing the dependency among business lines, have been focusing on single company experience. In this paper, we propose a Bayesian hierarchical model to analyze intercompany claim triangles. Some features of our approach are: Within triangles, both parametric and semi-parametric formulations are considered for modeling the process of loss development over time; The association among triangles of each individual firm is accommodated through a parametric copula; A hierarchical structure is specified on major parameters to allow for information-sharing across insurers. Numerical analysis is performed for a insurance portfolio of multivariate loss triangles from the National Association of Insurance Commissioners. The Bayesian inference enables us to derive the predictive distributions of outstanding payments at different levels of interest, be it industry, company, business line, or year. We show that prediction could be improved through borrowing strength within and between insurers based on training and hold-out observations.

Implementing Fuzzy Random Variables

Arnold F. Shapiro

Penn State University, State College, USA; afs1@psu.edu

Three definitions of fuzzy random variables (FRVs) have been cited in the current literature: the first is due to Kwakernaak (Information Sciences, 1978, 15(1), 1-29), who viewed a FRV as a vague perception of a crisp but unobservable RV; the second is due to Puri and Ralescu (Journal of Mathematical Analysis and Applications, 1986, 114, 409-422), who regarded FRVs as random fuzzy sets; and the third is due to Liu and Liu (Fuzzy Optimization and Decision Making, 2003, 2(2), 143-160), whose notion of FRV was based on a concept they called credibility measure. Given the different rationales, three questions arise: (1) how is each of these views of FRVs conceptualized; (2) what are the differences and similarities between the metrics for each of these views, and (3) how are the metrics for these three views implemented. The purpose of this presentation is to explore the answers to these questions.

Approximate Copula Regression

Paul G. Ferrara[1] *and Rahul A. Parsa*[2]

Drake University, Des Moines, USA
[1]pgf2r@virginia.edu
[2]rahul.parsa@drake.edu

Regression analysis is one of the most commonly used statistical methods for analyzing relationships in data. However, in its basic form, ordinary least squares (OLS) is often not suitable for actuarial applications because of the non-linear relationship between variables and non-normal, and often heavy-tailed, distributions of the data. In this paper several issues surrounding the 2011 paper Copula Regression, Variance volume 5-issue1, by Rahul A. Parsa and Stuart A. Klugman, will be discussed. First, several different approximations to the exact form of Copula Regression will be presented and applied to several heavy-tailed data sets. Formulas for these approximations will be presented, and the relationship to the aforementioned form of Copula Regression will be analyzed. In the process, the utility of Copula Regression for analyzing data with non-linear relationships and non-normal marginals will be reinforced. In addition, the relationship between what the authors have dubbed Approximate Copula Regression and OLS regression will be illustrated, and investigated.

P4C: Applications of Actuarial Models

Forward transition rates in a multi-state model

Marcus C. Christiansen[1] *and Andreas J. Niemeyer*[2]

University of Ulm, Ulm, Germany
[1]marcus.christiansen@uni-ulm.de
[2]andreas.niemeyer@uni-ulm.de

In the last decade the idea of forward rates was transferred from the interest world to the mortality framework. Forward mortality rates are mostly used in the context of securitization of mortality and longevity risk. In the course of the introduction of Solvency II the valuation of insurance products by means of forward rates becomes more and more important, since forward rates are a helpful tool for calculating market values. While there exists a lot of literature on forward mortality rates, forward transition rates in multi-state models are hardly discussed. We start our investigation by discussing the definition of forward rates in general and give a generally valid definition of forward rates. Thereby, we take into account that the forward rates depend on the considered product, so that this definition is even valid in cases where forward rates seem to be contradictory. Our paper continues the work of Norberg (Insurance: Mathematics and Economics, 2010, 47(2), 105-112) who made the first attempt to define general forward transition rates. While he calculates forward rates only for products that are traded on a financial market, we show (under certain circumstances) how market prices can be decomposed to single risks and then reassembled in order to price other products that are not traded on the market. More precisely, we discuss cycle-free multi-state models in more detail. By assuming independence between transition rates that go to different states and a certain dependency between transition rates that go to the same state, we are able to define forward rates for single risks and apply them to calculate the prices of complex products. Other dependency structures can also be incorporated. We demonstrate our results for joint life insurance and disability insurance. Furthermore, we discuss how forward rates can be defined via Kolmogorov forward equations.

Paid Claims Projection and Cash Flow Testing Models. Illustrative Approach.

Natalia A. Humphreys

UT Dallas, Richardson, USA; natalia.humphreys@utdallas.edu

Insurance companies use actuarial models to set appropriate reserves and adequately price products. We provide illustrative examples of using a Paid Claims Projection model to estimate claim reserves for products in the runoff and a Cash Flow Testing model to determine longevity and profitability of existing products.

Incurred but Unreported Deaths in Life Settlements

Donald F. Behan

Georgia State University, Roswell, USA; dbehan@gsu.edu

The traditional application of incurred but unreported claims adds unreported claims to reported claims, and evaluates the relationship to the policies in force. This is inaccurate for life settlements. Unreported life-settlement mortality causes a significant overstatement of the number of policies in force. Unreported deaths in life settlements have different issues than typical insurance unreported claims. The method described in this paper uses the estimated unreported deaths in earlier periods to adjust the current policies in force, which is more appropriate for this evaluation, and produces unreported values that are more consistent with the actual number of unreported deaths. The unreported claims for life settlement are evaluated by the underwriters, but some deaths are never reported to the life settlement underwriters. Some deaths for life settlements are permanently unreported, while no claims are permanently unreported in the insurance industry. The unreported claims for life insurance are different from other types of insurance. There can be only one claim for life insurance, but almost all other insurance can have multiple claims.

Other than life insurance, the number of prior unreported claims can increase the future number of unreported claims. For example, health insurance claims that are unreported can be caused by a health provider whose claims are delayed, and prior unreported claims can indicate even more current unreported claims. If a death was unreported, that person is no longer alive, and there can never be another unreported death for that person. Thus, in the case of life insurance, prior unreported deaths actually decrease the current potential unreported deaths.

A death that is never reported is generally not recorded as an insurance death, but the policy is recorded as not having continued, because premiums are no longer paid. Life settlements differ from insurance, because deaths are measured by the underwriters, but some deaths that actually cause a claim to the life insurance company are never reported to the underwriter. Most life settlement underwriters identify deaths from Social Security. The percentage of deaths that are never reported can be several percent.

Life settlement mortality rates are much higher than the average for life insurance. Life settlement unreported deaths cause a significant overstatement of policies in force. The reduction of policies by the rate of unreported deaths from prior years produces results that represent the true unreported rate. The overstatement of expected deaths by the traditional method is caused by applying mortality rates to lives that did not survive.

Traditional unreported methods tend to overestimate the unreported deaths for life settlements. High estimates of unreported claims are conservative in insurance, because the level of claim costs increases. The life settlement industry has the opposite result. Life settlement purchasers receive benefits on the basis of mortality. For this reason it is important for life settlement underwriters not to overestimate unreported deaths.

P5A: Finance III

Combinatorics for Moments of a Randomly Stopped Quadratic Variation Process

James G. Bridgeman

University of Connecticut, Storrs, USA; bridgeman@math.uconn.edu

A random process that includes jumps will in general have a quadratic variation process that itself forms a non-trivial random process. One might be interested in moments of the quadratic variation process, for example in order to characterize it or to approximate it by a known process. The paper proposes a combinatoric approach to express higher moments of the quadratic variation process in terms of higher order variations of the original process and autocorrelations of the original process. These lend themselves to calculation by Laplace transforms in the example that suggested the problem.

Positive Weights on the Efficient Frontier

Phelim Boyle

Wilfrid Laurier University, Waterloo, Canada; pboyle@wlu.ca

One of the fundamental insights of the CAPM is that the market portfolio is mean variance efficient. Since the market portfolio has positive weights on all assets the conditions under which frontier portfolios have this property are of interest. This paper derives a simple explicit solution for an efficient portfolio with positive weights. Assuming the covariance matrix is given we obtain an expected return vector such that there is a compatible frontier portfolio. This portfolio is derived from the dominant eigenvector of the correlation matrix and provides a proxy for the market portfolio. Examples are provided to illustrate the basic idea.

Market dependent fees for GMMB and GMDB riders

Anne MacKay[1], *Carole Bernard*[2] *and Mary Hardy*[3]

University of Waterloo, Waterloo, Canada
[1]a3mackay@uwaterloo.ca
[2]c3bernar@uwaterloo.ca
[3]mary.hardy@uwaterloo.ca

Guaranteed minimum maturity benefit (GMMB) riders can be seen as a put option on the fund value of a variable annuity. Typically, this guarantee is paid for by a continuous fee that is set as a fixed percentage of the fund value. In order to make the GMMB more attractive, some insurers may want to deduct the fee only when the option is in the money. In this presentation, we suppose that the fund follows a geometric Brownian motion and we obtain the fair fee in the case where this fee is paid only when the option is in the money. Strong model assumptions are needed to solve for the fair rate but the problem can be solved using Monte Carlo techniques under fairly general assumptions. In a numerical example, we compare the fee obtained to the one deducted throughout the contract. We also extend the example to GMDB riders.

Modeling Trades in the Life Market as Nash Bargaining Problems

Rui Zhou[1], *Johnny S.H. Li* [2] *and Ken Seng Tan*[3]

[1]University of Manitoba, Winnipeg, Canada; r4zhou@uwaterloo.ca
[2]University of Waterloo, Waterloo, Canada; shli@uwaterloo.ca
[3]University of Waterloo, Waterloo, Canada; kstan@uwaterloo.ca

Zhou et al. (2010) proposed an approach to price mortality-linked securities in a competitive market. However, its underlying assumption of market competitiveness is not satisfied in today's embryonic life market, which has few participants and few products. We consider the pricing in a non-competitive market and model the pricing process as a bargaining game. Nash's bargaining solution is then applied to obtain a unique trading contract. With no requirement of competitiveness, our approach is more appropriate for current market. A comparison of these two approaches is also provided.

A Comonotonicity-based Valuation Method for Annuity-linked Contracts

Xiaoming Liu[1], *Rogemar Mamon*[2] *and Huan Gao*[3]

University of Western Ontario, London, Canada
[1]xliu@stats.uwo.ca
[2]rmamon@stats.uwo.ca
[3]hgao46@uwo.ca

We consider the valuation of a guaranteed annuity option (GAO) under a generalised modelling set-up where both interest and mortality risks are stochastic and correlated. Changes of probability measures are employed to obtain more implementable valuation formulae for mortality-linked contracts. Comonotonicity theory is applied to derive upper and lower bounds for the annuity rate in the convex order sense. These bounds provide accurate approximations for the value of GAOs. Numerical demonstrations are included to show the accuracy and reasonableness of our comonotonic approximations for the GAO values.

P5B: Casualty

Insurance Ratemaking and a Gini Index

E. W. (Jed) Frees[1], *Glenn Meyers*[2] *and A. David Cummings*[3]

[1]University of Wisconsin-Madison, Madison, USA; jfrees@bus.wisc.edu
[2]Deerfield NH, USA; ggmeyers@metrocast.net
[3]ISO Innovative Analytics, Bloomington, USA; DCummings@iso.com

In 1905, Max Otto Lorenz displayed skewed income distributions using a graph now known as the Lorenz curve. In 1912, Corrado Gini summarized this curve with a statistic now known as the Gini index. Both devices are widely used in welfare economics, among other fields. This paper extends these concepts to a financial context by ordering risks; the ordering variable is a risk based score relative to price, known as a relativity.
Using the relativity ordering, we develop a Lorenz curve and Gini index that can cope with adverse selection and measure potential profit. We provide a detailed example using homeowners insurance. Further, we show that the Gini index can be written in terms of covariance operators, thus expanding the scope of interpretations. We implement theory to calibrate sample sizes, establishing that the number of observations typically encountered in insurance practice is sufficient for reliable estimation.

A renewal model for medical malpractice

Ghislain Leveille[1] *and Emmanuel Hamel*[2]

Université Laval, Québec, Canada
[1]ghislain.leveille@act.ulaval.ca
[2]emmanuel.hamel.1@ulaval.ca

A renewal model for the aggregate discounted payments and expenses assumed by the insurer is proposed for the "medical malpractice" insurance, where the real interest rates could be stochastic and the dependencies are examined through the theory of copulas.
As a first approach to this problem, we thus present formulas for the first two raw moments and the first joint moment of this aggregate risk process. Examples are given for Erlang claims inter-arrival times and the dependency is illustrated by an Archimedean copula, in which the autocovariance and the autocorrelation functions are also examined.

Micro-Level Loss Reserving Models for P&C Insurance

Xiaoli Jin

University of Wisconsin-Madison, Madison, USA; xjin22@wisc.edu

Accurate loss reserve is essential for insurers to decide capital allocation, to maintain adequate capital and to efficiently price their insurance products. Loss reserving for Property & Casualty insurance is usually based on aggregated data in a run-off loss triangle and the chain-ladder technique is the most widely used approach. The key assumption of chain-ladder technique is that claims recorded to date will continue develop in a similar manner in the future. However, in many real world practice, there are significant changes in environment, such as changes in product mix, benefit level, regulation, inflation, and claim adjusting process, which could break this assumption and bias the reserve estimates generated by chain-ladder approach. Actuaries sometimes "trend" the aggregated loss data to adjust for the changing environment, but due to the inability to use micro-level data, these "trending" techniques are usually not as flexible or responsive as needed to fully capture the changes in environment. In contrast, micro-level (individual claim level) reserving models are likely to respond to environmental changes in a more flexible way. The use of policy, claim or even transaction level covariates provides a way to directly incorporate environmental changes in the reserving model and may help to generate more accurate reserve estimates.

In this study, we simulated claims data under different environmental changes and applied both chain-ladder and a micro-level model to each simulated data set. The performance of both methods was evaluated by comparing the reserve estimates, not only the point estimates, but also the entire distribution, to the realized loss data.

The environmental changes we explored here include changing product mix, changes in benefit level, changes in claims adjusting schemes, and inflation. When changes are small, chain-ladder and micro-model give similar results and both are close to the true reserve. When changes get more significant, chain-ladder generates bigger and bigger reserve errors while micro-model still gives reserve estimates with reserve errors within a reasonable range.

An Experience Rating Approach to Insurer Projected Loss Ratios

Marc-André Desrosiers

University of Wisconsin-Madison, Madison, USA; mdesrosiers@bus.wisc.edu

The traditional approach to Property/Casualty rate indications starts with a methodology that uses internal data to forecast the Ultimate Loss Ratio, losses making up about half of the expenses. For parties that are external to the insurer, this approach to forecasting a key component of future profitability is impractical as they generally do not have access to the data. External parties that are tasked with solvency surveillance, stock pricing, bond pricing, reinsurance underwriting, etc. need a Loss Ratio forecasting approach that relies on publicly available data. Using publicly available information, that is, National Association of Insurance Commissioners Schedule P of the statutory financial statements from 1992 to 2010, we develop by line of business forecasts of the relativity to the industry Loss Ratio. To develop these forecasts, we use a weighted regression methodology that incorporates key ideas from fixed-effects regression, instrumental variables regression, credibility theory, as well as a flexible covariance structure for residuals. From fixed-effects regression (Frees, Longitudinal and panel data: analysis and applications in the social sciences 2004, 51), we borrow the idea that the forecasts incorporate a (weighted) average of past results. From instrumental variables regression (Frees, Meyers and Cummings, Predictive Modeling of Multi-Peril Homeowners 2011, 3), we borrow the idea that other lines of business can share result-drivers in common, like similar strategies, similar clients or similar perils. From credibility theory, we borrow the idea that rating values vary by size of individual. We also use a Toeplitz, or Moving Average, intra-insurer/line of business structure for residuals over time (Frees, Longitudinal and panel data: analysis and applications in the social sciences 2004, 281). In line with more traditional experience rating methodologies, the forecasted relativities can be thought of as a modifier to a base rate, which is here the forecast of the by line industry Loss Ratio. These forecasts can reflect outlooks concerning the economy as a whole, the softness/hardness of the market, etc. Preliminary results indicate that the proposed approach of using lagged relativities from insurer own and other lines of business can provide adequate fits for many lines of business and for the combined results of the insurer as a whole. For solvency surveillance usage, we recommend that a regulator or a rating agency supplement the model with measured rate changes so as to better anticipate large changes in the Loss Ratio than are not due to smooth changes.

Experience Rating in Motor Insurance

Pervin Baylan-Irven[1] *and Jeffrey Pai*[2]

[1]Dokuz Eylul University, Izmir, Turkey; pervin.baylan@deu.edu.tr
[2]University of Manitoba, Winnipeg, Canada; Jeffrey.Pai@ad.umanitoba.ca

The fact that the number of the motor vehicles registered in the world increased has caused an increase in the number of the accidents as well as in the number of the death and injured which are resulted from these accidents. This situation has confronted all actuaries with the problem of how the structure of the tariff, which fairly allocates the burden of the damage for the policy owners. Furthermore, the improper models adopted in the calculation of the premiums lead to the determination of the low amount of the premiums and thus rise in the risk of the sector failure. In fact, the accurate calculation of the premiums which is the keystone of the sector plays a key role with regard to the prevention of suffering loss of the insurance sector. Thus, the presence of an implementation that will not damage the sector is possible by procuring every policyholder with the payment of the premium equaled to the risk group to which the policyholder belongs. One of the basic models, which provides this implementation is bonus-malus system, and the other one is credibility theory.
In many European and Asian countries, as well as in North-American states or provinces, insurers use experience rating in order to relate premium amounts to individual past claims experience in auto insurance. In experience rating systems such as bonus-malus systems, bonuses can be earned by not filing claims, and a malus is incurred when many claims have been filed after a basic premium is determined using rating factors like age, profession, and capacity of the car. This a posteriori ratemaking is a very efficient way of classifying policyholders according to their risk. On the other hand, the trend towards more classification factors has led the authorities to exclude certain risk factors from the tariff structure although they may be significantly correlated to losses, whereas many states consider items that are beyond the control of the insured, such as gender or age. This situation causes that individuals appear to be bad drivers even if they are in reality good drivers who will never cause any accident. Thus, actuarial credibility models make a balance between the likelihood of being an unlucky good driver and the likelihood of being a truly bad driver.
The purpose of this study is to set up an experience rating system to determine next year's premium, taking into account not only the individual experience with the group, but also the collective experience. Many problems in actuarial science involve the building of a mathematical model that can be used to forecast insurance costs in the future. Hence, model selection is based on a balance between simplicity, which is measured in terms of such things as the number of unknown parameters, and fit, which is measured in terms of the discrepancy between the data and the model. Also in this study, an adequate model will be selected by looking into the results of statistical analysis on real insurance data obtained from Canada, and insurance premiums in the future will be determined according to this selected model.

P5C: Risk theory II

First- and Second-order Asymptotics for the Tail Distortion Risk Measure of Extreme Risks

Fan Yang

University of Iowa, Iowa city, USA; fan-yang-2@uiowa.edu

The tail distortion risk measure at level p was first introduced in Zhu and Li (2012), where the parameter $p \in (0, 1)$ indicates the confidence level. They established first-order asymptotics for this risk measure, as $p \uparrow 1$, for the Fréchet case. In this paper, we extend their work by establishing both first-order and second-order asymptotics for the Fréchet, Weibull and Gumbel cases. Numerical studies are also carried out to examine the accuracy of both asymptotics.

Default risk of a jump-diffusion model subject to Chapter 7 and Chapter 11 bankruptcy codes

Bin Li[1]*, Qihe Tang*[2] *and Xiaowen Zhou*[3]

[1]University of Iowa, Iowa City, USA; bin-li@uiowa.edu
[2]University of Iowa, Iowa City, USA; qihe-tang@uiowa.edu
[3]Concordia University, Montreal, Canada; xzhou@mathstat.concordia.ca

We are interested in the default risk of a firm. Let $a < b$ and $c > 0$ be three exogenously determined constants, with a interpreted as the liquidity threshold, b as the reorganization threshold and c as the grace period. The firm is considered as defaulted whenever its value either goes below level a or constantly stays below level b for c units of time. Economic justifications for this concept of default are the US bankruptcy codes Chapter 7 (Liquidation) and Chapter 11 (Reorganization). We model the firm value by a jump-diffusion process and derive an explicit formula for the default probability.

Credibility Theory in a Fuzzy Environment

Arnold F. Shapiro[1] *and Marie-Claire Koissi*[2]

[1]Pennsylvania State University, State College PA, USA; afs1@psu.edu
[2]Western Illinois University, Macomb IL, USA; mk122@wiu.edu

In insurance, credibility theory (CT) is used to develop a weighted average of the claims experience of an individual contract and the experience for the whole portfolio, where the weight factor is the credibility attached to the individual experience. Recently, Liu and Liu (2002) and Liu (2007), in the study of the behavior of fuzzy phenomena, formulated an alternate version of credibility theory, which involves a weighted average based on the concepts of possibility measure and necessity measure. This latter version of credibility theory will hereafter be referred to as credibility theory in a fuzzy environment (CT-F).
The purpose of this presentation is to present an overview of CT-F and to discuss its implications.
References:
Liu, B., Liu, Y-K., 2002, "Expected value of fuzzy variable and fuzzy expected value models," IEEE Transactions on Fuzzy Systems 10(4), 445-450.
Liu, B., 2007, Uncertainty Theory, 2nd ed., Springer-Verlag, Berlin.

Analysis of Disability Insurance Portfolios with Stochastic Interest Rates

Yu Xia

Simon Fraser University, Burnaby, Canada; yux@sfu.ca

The purpose of this presentation is to show our study on a long-term disability insurance portfolio under stochastic interest rates. We assume that transitions for policyholders among healthy, temporarily disabled, permanently disabled and the deceased statuses follow a Markov chain process, and the benefit payments are annuities for disability and lump sums for death. The cash flow method is developed to study the moments of the present value of future benefit payments and to evaluate the riskiness of our insurance portfolio. This methodology can be used to analyze general insurance portfolios such as long-term care insurance portfolios.

P6A: Genetic algorithms

Genetic Algorithms - what they are and how to apply them to actuarial problems

Dave Snell

RGA, Chesterfield MO, USA; dsnell@rgare.com

Genetic algorithms are being used in many scientific professions to solve problems too difficult to solve with standard deterministic techniques. A genetic algorithm is an inductive, rather than deductive approach that learns as it goes along. This session will give an in-depth look at genetic algorithms - what they are, why they are important for actuaries, when to use them, and how to create them. It starts with the origin of genetic algorithms and their relation to genetics. Next, it shows a couple of applications that teach the basic principles. Later, it shows an actuarial application where the genetic algorithm approach gives a higher degree of optimization than that achieved by more traditional actuarial techniques. Finally, it provides a set of guidelines for when and how to utilize them. At the conclusion of the session, attendees will be able to: apply simple genetic algorithms to actuarial problems; determine if a problem is suitable for the application of a genetic algorithm; develop further applications of genetic algorithms based on their own experiments and research; and explain genetic algorithms at a basic level to their colleagues.

P6B: How to be a CAE?

Being or becoming a Society of Actuaries Center of Actuarial Excellence: Challenges and Opportunities

Sam Broverman[1]*, Ron Gebhardtsbauer*[2]*, Warren Luckner*[3] *and Kris Presler*[4]

[1]University of Toronto, Toronto, Canada; sam@utstat.toronto.edu
[2]Penn State University, USA; rug16@psu.edu
[3]University of Nebraska-Lincoln, Lincoln, USA; wluckner@unlnotes.unl.edu
[4]University of Wisconsin-Eau Claire, USA; preslekk@uwec.edu

The session is intended to be a sharing of thoughts on being or becoming a CAE school. The panel will provide a few thoughts from their perspectives, and then open it up for discussion among all attendees.

Biographies of Featured Speakers and Performers

Sam Broverman, ASA
University of Toronto

Sam Broverman was born and raised in Winnipeg, Manitoba in a home filled with music. His mother was a piano teacher and great opera fan. His father was also a music lover and had a beautiful voice and participated in various choirs in Winnipeg. Music of all sorts was heard in his home as he grew up. Radio broadcasts from the Metropolitan opera competed with vaudeville and early swing played on old 78 recordings that Sam's grandfather brought from New York to Winnipeg. His uncle played jazz records of all kinds, while rock and roll began to take over the airwaves.

Sam Broverman has been singing and doing mathematics for most of his life. He performed in high school and college musicals and rock and roll bands. He finished second in the 1968 Manitoba High School Mathematics Competition, behind his former classmate, Robert Israel, Professor Emeritus of Mathematics at UBC. He began singing professionally at the age of 20, appearing in Winnipeg theatre and cabaret productions as well as on nationally televised music and variety shows, including "Hymn Sing" and "The Doug Crosley Show". The income from his performing helped fund his university education. After completing an undergraduate degree in mathematics at the University of Manitoba, Sam applied for graduate studies in mathematics at U of Manitoba, and at the same time he auditioned for the U of Manitoba Faculty of Music to pursue vocal studies. He was accepted into both programs, but university rules allowed him to enrol in only one. Sam chose graduate studies in mathematics but continued informal vocal studies at the Faculty of Music, and continued to perform in Winnipeg.

After receiving a PhD in mathematics, he moved to Toronto to take up postdoctoral work in mathematics. After that, Sam spent two years as a professor of actuarial mathematics at the University of Texas at Austin. He then returned to Toronto to take a position as a professor of actuarial mathematics at the University of Toronto, and shortly after began singing with the Toronto Mendelssohn Choir.

The responsibilities of an academic position allowed Sam a limited amount of time to devote to music, but in the past several years, Sam has once again started to pursue his musical passions. He recorded a "demo" EP of five songs titled "Five Standards", and this became a springboard to getting regular gigs in jazz clubs around Toronto. Since then he has performed in Winnipeg, Vancouver, Hong Kong, and in May, 2012 he had his debut performance in New York at the Metropolitan Room. The Metropolitan Room performance got a rave review on the New York entertainment website `broadwayshowbiz.com`.

Sam's book "Mathematics of Investment and Credit", published by ACTEX publications is one of the listed references for the SOA FM/CAS 2 exam and the EA-1 exam. He has recently finished recording his first full jazz album, Dream Maker, Heartbreaker: Sam Broverman sings Johnny Mercer, which was produced by Juno Award-winner Ken Whiteley.

Linda Golden
Meyerson Centennial Professorship in Business
University of Texas at Austin

From her web site: `http://acsprod.mccombs.utexas.edu/facstaff/displayRecord.aspx?uid=306`:
Dr. Golden received her Ph.D. from the University of Florida in 1975. Published in the areas of attribution theory, comparative advertising, retail image and patronage behavior, methodological scaling issues, and social marketing (health and ecological issues), and risk management. She is currently holds the Judd Neff Fellowship at IC2 and is a University of Texas Humanities Institute Fellow. Journals in which Professor Golden has published include the Journal of Marketing Research, Journal of Consumer Research, Journal of Educational Research, Journal of Urban Analysis, and Management Science, among others. Selected Publications: Golden, Linda L. and Andrea K. Suder (1994), "Disease Demarketing: The College AIDS Challenge," Health Marketing Quarterly, Volume 11, Number 3/4, 105-123. Brockett, Patrick L., William C. Cooper, Linda L. Golden, and Utai Pitaktong (1994), "A Neural Network Method for Obtaining an Early Warning of Insurer Involvency," Journal of Risk and Insurance, September, 402-424. Brockett, Patrick L., Linda L. Golden, and Harry L. Panjer (1996), "Flexible Purchase Frequency Modeling," Journal of Marketing Research, February, 94-107. Brockett, Patrick L., W.W. Cooper, Linda L. Golden, X. Xia (1997), "A Case Study in Applying Neural Networks to Predicting Insolvency for Property and Casualty Insurers," Journal of the Operational Research Society, Volume 48, 1153-1162. Brockett, Patrick L. and Linda L. Golden (2007), "Biological and Psychobehavioral Correlates of Risk Taking, Credit Scores, and Automobile Insurance Losses: Toward and Explication of Why Credit Scoring Works," Journal of Risk and Insurance, Volume 74, Number 1, 23–63. AWARD: 2008 American Risk and Insurance Association (ARIA) Award for Most Outstanding Research Contribution to Casualty Actuarial Science in 2007. Brockett, Patrick L., Linda L. Golden, Montserrat Guillen, Jens Perch Nielsen, Jan Parner, and Ana Maria Perez–Marin (2008), "Survival Analysis of A Household Portfolio of Insurance Policies: How Much Time Do You Have to Stop Total Customer Defection?" Journal of Risk and Insurance, Volume 75, Number 3, 713–737. Brockett, Patrick L., William W. Cooper, Linda L. Golden, Subal C. Kumbhakar, Michael J. Kwinn, Jr., Brian Layton, and Barnett R. Parker (2008), "Estimating Elasticities with Frontier and Other Regressions in Evaluating Two Advertising Strategies for U.S. Army Recruiting," Socio–Economic Planning Sciences. Volume 42, 1–17. Stanaland, Andrea and Linda L. Golden (2009), "Consumer Receptivity to Social Marketing Information: The Role of Self–Rated Knowledge and Knowledge Accuracy," Academy of Marketing Studies Journal, Volume 13, Number 2, 25–34. Ai, Jing, Patrick L. Brockett, and Linda L. Golden (2009), "Assessing Consumer Fraud Risk in Insurance Claims: An Unsupervised Learning Technique Using Discrete and Continuous Predictor Variables," North American Actuarial Journal, Volume 13, Number 4, 438–458. Gilligan, Colin and Linda L. Golden (2009), "Rebranding Social Good: A Social Profit Approach," Academy of Marketing Studies Journal, Volume 13, Number 2, 97–117. Brockett, Patrick L., Linda L. Golden, Ming Wen and Chuanhou Yang (2009), "Pricing Weather Derivatives Using the Indifference Approach," North American Actuarial Journal, Volume 13, Number 3, 303–315.

Mary Hardy, FIA, FSA, CERA
CIBC Chair in Financial Risk Management
University of Waterloo

From her web site: `http://sas.uwaterloo.ca/Faculty/Hardy.shtml`
Professor Hardy is a Fellow of the Society of Actuaries and of the Institute of Actuaries, and is a Chartered Enterprise Risk Analyst. She is a frequent speaker at SOA meetings, and is involved in the SOA education system, on the Education Executive committee, and as a trainer of education volunteers. Her research in applied risk management has led to several industry oriented project. In particular, she was a member of the task force of the Canadian Institute of Actuaries charged with developing a methodology for capital requirements for segregated fund guarantees.
Professor Hardy is the Editor of *North American Actuarial Journal* and is Associate Editor of —emphASTIN Bulletin and *Insurance: Mathematics and Economics*. She was previously Editor of *Annals of Actuarial Science*.
Mary Hardy develops methods for managing risk; adapting financial mathematical techniques to the particular problems of insurance companies. In today's global economy, diversification and new investment opportunities have changed the way risk affects investment and insurance strategies. Insurance companies need to have viable, sustainable action plans and contingencies in place for low-risk, high-loss eventualities.
Two of Mary's books have been adopted by the Canadian Institute of Actuaries and the Society of Actuaries as a textbook for professional exams. *Actuarial Mathematics for Life Contingent Risk*, co-authored by David Dickson and Howard Waters, is the designated text for the MLC exams starting in 2012. *Investment Guarantees: Modelling and Risk Management for Equity Linked Life Insurance* is a required text for students specialising in individual life insurance. Helping student and professional actuaries apply new models to manage risk, contracts, and the economical capital required to meet liabilities is part of Mary's work.
Mary was designated the CIBC Chair in Financial Risk Management in 2004. The funding from CIBC means additional resources and focus can be applied to supporting risk management in a broader financial context.
Professor Hardy was elected to the Board of Governors for the Society of Actuaries in 2004 and was elected Vice President for 2007-2009. This position allowed her to influence policy, stewardship and ensure the quality of training and resources. "Actuaries have a huge responsibility for ensuring that insurance and pension payments are there when they are needed. The Society of Actuaries is responsible for credentialing. That, in turn, places the SOA leadership in a critical role in determining standards for risk management education." says Mary. "It's very gratifying to make a difference."

Charly Pazdor, FSA, FCIA
Eckler Ltd

Charly Pazdor is the Managing Principal of the Winnipeg office of Eckler Ltd. — an independent Canadian firm of actuaries and consultants One of the more experienced pension actuaries in Manitoba, he has 14 years' experience with a major life insurer and over 20 years consulting to clients in the public and private sectors.
Charly's experience on consulting and professional areas has spanned a broad spectrum over the years, including:

- Accumulating extensive experience in the design, valuation and management of retirement plans, including assisting his clients with funding and accounting issues associated with defined benefit plans.
- Consulting to clients on self-insured disability plans, addressing both funding and accounting challenges,
- Being accepted as an expert witness for the for the purpose of presenting actuarial evidence before the courts in Manitoba.
- Serving on a variety of Committees and Task Forces for the Canadian Institute of Actuaries and the Society of Actuaries,
- In particular, he has served as a volunteer on the Professionalism Education Management Committee of the Society of Actuaries (and its predecessors) for over 20 years.
- Charly is a recipient of the Canadian Institute's Bronze volunteer recognition award.
- Presenting on a variety of topics at a variety of industry meetings, including those of the Canadian Institute of Actuaries and the Canadian Pension and Benefits Institute.

At the Fellowship Admissions Course, in addition to serving as a facilitator since the mid–1990's, Charly has been a regular presenter on the subject of Professionalism. He has also led panel discussions on Professional Ethics at meetings of the Society of Actuaries and the Conference of Consulting Actuaries. Charly holds a Bachelor of Science degree from the University of Manitoba, majoring in mathematics; he has been a qualified Fellow of both the Society of Actuaries and the Canadian Institute of Actuaries since 1986.

Dave Snell, ASA, MAAA, FLMI, CLU, ChFC, ARA, ACS, MCP
Technology Evangelist
RGA Reinsurance Company

Dave Snell's title is Technology Evangelist, and despite the whimsical sound, it seems to fit him.
In September, 2007, Dave took early retirement from his position as VP, Asia-Pacific Technology for RGA Reinsurance Company, where, based in Sydney, Australia, he managed new and existing technology for all of Asia and Australia. That was on a Friday. On Monday, he returned home to the U.S. as a consultant to the Vice Chair of RGA, where he networks with kindred spirits among actuaries and technology associates to identify and overcome actuarial obstacles through better use of technology tools.
Dave has written thousands of programs in dozens of programming languages - including an artificial intelligence based expert system for underwriting in use in over a dozen countries and several languages.
A frequent speaker at SOA meetings, Dave is currently Chair of the Actuary of the Future section, Editor of the Forecasting and Futurism section newsletter, a past Chair of the Technology section and a past Chair of the St. Louis Actuaries Club. He also serves on the Actuarial Science program Advisory Board at Maryville University, in St. Louis, Missouri.
In what seems now like previous lifetimes, he was a Mechanical Engineer, and later a life insurance agent and brokerage manager. Over the years, Dave has seen the actuaryŐs role overshadowed by other, more vocal, entities and he wants us to step up and take a more prominent role in helping to solve the issues facing our society.

Rob Stapleford, FCIA, FSA
Partner, Mercer

Rob Stapleford is a Partner with Mercer Investment Consulting, and a senior investment consultant in the Toronto practice. Rob is an actuary and the Market Business Leader for investment consulting in Central Canada. Rob has many years of consulting experience on a wide range of investment and retirement issues including asset allocation employing asset-liability modelling techniques. He also advises his clients on manager monitoring and search, governance and general investment consulting. His clients include sponsors of both defined benefit and defined contribution pension plans, as well as foundations.

Rob has been with Mercer since 1991. He joined the Investment Consulting Practice in 2001, after ten years in the Retirement Practice. Rob has chaired Mercer's Asset-Liability Specialist Group, which is responsible for developing Mercer's tools and intellectual capital in the area of asset-liability modelling, risk management and liability-driven investment strategies. Before joining Mercer, Rob worked for a major insurance company for 16 years where he held positions of increasing responsibility. He worked in the investment/finance, group pension, group life and health, and individual insurance areas.

Rob has an Honours Bachelor of Arts in Mathematics from the University of Western Ontario. He is a Fellow of both the Canadian Institute of Actuaries and the Society of Actuaries. and has served on various committees of both professional organizations. Rob is currently on the Board of Directors for the Canadian Institute of Actuaries and serves as chair of the Accreditation Committee. He served for several years as a General Officer on the Education and Examination Committee of the Society of Actuaries.

Gary C. Wang, FCAS, MAAA
Pinnacle Actuarial Resources, Inc

Gary Wang is a Consulting Actuary with Pinnacle Actuarial Resources, Inc. in the Bloomington, Illinois office. He holds a Bachelor of Science degree in mathematics from the University of Illinois and a Master of Science degree in mathematics education from Northern Illinois University. He also has extensive graduate level coursework in Theoretical and Applied Mathematics from Northern Illinois University. He has over ten years of actuarial experience in the property/casualty insurance industry.

Mr. Wang is a Fellow of the Casualty Actuarial Society (FCAS) and a Member of the American Academy of Actuaries (MAAA). He currently serves the Casualty Actuarial Society (CAS) as a member of the Ratemaking and Product Management Planning Committee and the Examination Committee. Mr. Wang is a SAS ® Certified Predictive Modeler Using SAS ® Enterprise Miner™ 5.

Before joining Pinnacle, Mr. Wang was employed as a pricing actuary for Allstate Insurance Company, for Kemper Insurance Companies, and for Scor Reinsurance Company. His pricing experience includes standard homeowners rate indications, commercial auto rate indications, and reinsurance treaty pricing for both personal and commercial lines. In addition, he has experience in reserving analyses for commercial auto and market trend analyses for commercial auto and workers compensation.

At Pinnacle, Mr. Wang has worked extensively on the application of advanced statistical modeling techniques to the insurance process. His experience in predictive analytics applications include rating and underwriting plan design, homeowners by-peril analysis, auto vehicle characteristics analysis and scorecard development, and territory boundary development. Mr. Wang has made numerous presentations on topics relating to predictive modeling, ratemaking, and insurance credit-based scoring.

Engagement Experience

- Involved with design and implementation of rating plans and underwriting scorecards for over 20 companies
- Assisted clients with incorporating data sources into classification plans
- Enhanced territory classification utilizing advanced analytical methodologies for client companies
- Designed custom vehicle classification scorecards for client companies
- Peer reviewed and advised companies on their analytics processes

Professional Presentations

"Usage Based Insurance: A Step by Step Guide for Small and Medium Sized Companies," CAS: In Focus, 2011 "Vehicle History: The New Pillar in Auto Policy Pricing," CAS: In Focus, 2011 "Trends in Predictive Modeling," CIA Annual Meeting, 2011 "Moving Beyond the Credit Score," CAS Ratemaking and Product Management Seminar, 2011 "Vehicle Rating Using Predictive Modeling Techniques," Pinnacle ApexWebinar, 2011

INDEX OF AUTHORS

Index of Authors

LIST OF PARTICIPANTS

Last Name	First Name	Company Name	Email
Adam	Louis	Universite Laval	louis.adam@act.ulaval.ca
Alai	Daniel	The University of New South Wales	daniel.alai@gmail.com
Amador	Ken	Wawanesa Insurance	
Anquandah	Jason	Knust	jasanq@yahoo.com
Anseeuw	Amber	Wawanesa Insurance	
Ashkenazi	Rina	University of Minnesota	ashke004@umn.edu
Badescu	Alex	University of Calgary	abadescu@math.ucalgary.ca
Bakija	Maja	University of Manitoba	
Ban	Chunsheng	The Ohio State University	ban.1@osu.edu
Bauer	Daniel	Georgia State University	dbauer@gsu.edu
Baylan Irven	Pervin		pervin.baylan@deu.edu.tr
Beckley	Jeffrey	Purdue University	jeffbeckley@indy.rr.com
Behan	Donald	Georgia State University	dbehan@gsu.edu
Benarroch	Michael	University of Manitoba	
Bilodeau	Claire	Université Laval, École D'Actuariat	claire.bilodeau@act.ulaval.ca
Bolton	Bev		
Boor	Joseph	Florida Dept of Financial Services	Joe.Boor@fldfs.com
Boyd	Milton	University of Manitoba	windsurf45@hotmail.com
Brazauskas	Vytaras	University of Wisconsin-Milwaukee	vytaras@uwm.edu
Bridgeman	James	University of Connecticut	bridgeman@math.uconn.edu
Broverman	Samuel	University of Toronto	sam@utstat.toronto.edu
Brown	David	Retired	
Bujakowski	Douglas		bujakowski.1@gmail.com
Byrne	Donna		
Carey	Bill	University of Manitoba	
Challes	Gord	Great-West Life Assurance Co	
Chen	Jingyan		ChenJingYan@hotmail.com
Christiansen	Sarah	SMC Actuarial Consultants Inc	actuarysmc@suddenlink.net
Clark	Ken	Eckler Ltd.	
Coates	Jason	University of Manitoba	
Cortez	Krista	University of Manitoba	
Cox	Samuel	University of Manitoba	sam.cox@ad.umanitoba.ca
Cummins	John	Temple University	cummins@temple.edu
Curtis	Simon	Manufacturers Life Insurance Co	simon_curtis@manulife.com
Degrave	Rhys	Great-West Life Assurance Co	
Derechin	Laurie	University of Minnestoa	lderechi@umn.edu
Desrosiers	Marc-Andre	Uw-madison/Intact Fiancial Corporation	mdesrosiers@bus.wisc.edu
Devos	Denis		
Devos	Debbie		
Dong	EnXi		
Douglas	Peter	University of Regina	Peter.Douglas@uregina.ca
Duncan	Ian	University of California - Santa Barbara	duncan@pstat.ucsb.edu
Edwalds	Thomas	Munich Re	tedwalds@munichre.com
Elford	Eric	Sun lIfe Financial	
Engler	David	Brigham Young University	engler@byu.edu
Evangelista	Hannah	Wawanesa Insurance	
Failor	Michael	SCOR Global Life Americas	mfailor@scor.com
Falkenberg	Jon	Great-West Life Assurance Co	jon.falkenberg@gwl.ca
Faulds	Ty	Great-West Life Assurance Co	
Ferrara	Paul	Drake University	pgf2r@virginia.edu
Firman	Stephen	Great-West Life Assurance Co	steve.firman@gwl.ca
Fischer	Don	Great-West Life Assurance Co	
Frees	Edward	University of Wisconsin	jfrees@bus.wisc.edu
French	Brenda	University of Manitoba	Brenda.French@ad.umanitoba.ca

Friesen	John		
Fuhrer	Charles	The Segal Company	cfuhrer@segalco.com
Gao	Huan	University of Western Ontario	georgiaghgh@hotmail.com
Gayen	Mayukh	University of Kent	mg267@kent.ac.uk
Gebhardtsbauer	Ronald	Penn State University	rug16@psu.edu
Gibson	Katherine-Mary		
Gibson	Barry		
Girard	Luc		
Girard	Dolores		
Golden	Linda	University of Texas At Austin	utlindagolden@gmail.com
Gorvett	Richard	University of Illinois	gorvett@illinois.edu
Grant	Charles	University of Manitoba	charles_grant@umanitoba.ca
Guarina	Shawnee	Great-West Life Assurance Co	
Gudmundson	Julia	University of Manitoba	
Guenther	Keri	University of Manitoba	
Hao	Xuemiao	University of Manitoba	xuemiao.hao@ad.umanitoba.ca
Hardy	Mary	University of Waterloo	mrhardy@uwaterloo.ca
Hartman	Brian	University of Connecticut	brian.hartman@uconn.edu
Herman	Shelby	Great-West Life Assurance Co	
Huang	Ling	Great-West Life Assurance Co	
Hudak	David	Robert Morris University	hudak@rmu.edu
Humphreys	Natalia	University of Texas at Dallas	natalia.humphreys@utdallas.edu
Huntington	Curtis	University of Michigan	chunt@umich.edu
Hur	Man-Gyu	Oregon State University	manny.hur@math.oregonstate.edu
Huynh	Raymond	Great-West Life Assurance Co	
Iverson	Bruce	Society of Actuaries	biverson@soa.org
Jamal	Arshil	Great-West Life Assurance Co	
Jansen	Chris	Great-West Life Assurance Co	
Jin	Xiaoli	University of Wisconsin - Madison	goosy23@hotmail.com
Johnson	Paul	University of Illinois, Urbana-Champaign	pauljohnson_jr@yahoo.com
Kazun	Karen	Wawanesa Insurance	
Kemajou	Elisabeth	University of Minnesota	isakema@yahoo.fr
Kim	Martin	University of Manitoba	
Klippenstein	Malanie	Wawanesa Insurance	
Klugman	Stuart	Society of Actuaries	sklugman@soa.org
Koissi	Marie Claire	Western Illinois University	koissimc@hotmail.com
Leveille	Ghislain	Ecole D'Actuariat, Universite Laval	ghislain.leveille@act.ulaval.ca
Li	Bin	The University of Iowa	binlimath@gmail.com
Li	Winson	Wawanesa Insurance	
Lin	Xiaodong	University of Toronto	sheldon@utstat.utoronto.ca
Lin	Yu		mango_ly@hotmail.com
Liu	Xiaoming	Western University	xiaoming99@gmail.com
Loewen	Brian	Great-West Life Assurance Co	Brian.Loewen@gwl.ca
Loginov	Michael	UC Santa Barbara	BrLgn8@aol.com
Loney	Allen	Great-West Life Assurance Co	
Lu	Minxian		yywx18@qq.com
Luckner	Warren	University of Nebraska-Lincoln	wluckner2@unl.edu
MacDonald	Ian	Wawanesa Insurance	
MacKay	Anne	University of Waterloo	a3mackay@uwaterloo.ca
MacKinnon	Brett	Wawanesa Insurance	
MacNicholas	Garry	Great-West Life Assurance Co	
Maxwell	Mark	University of Texas at Austin	maxwell@math.utexas.edu
Maynard	Monique	Great-West Life Assurance Co	
Mazurkewich	Lauren	Great-West Life Assurance Co	
McCarney	James	Guy Carpenter	James.R.McCarney@guycarp.com

McCullogh	Scott	University of Manitoba	
McGorman	Scott	Wawanesa Insurance	
McGorman	Tim	Aon Consutling	
Mills	Buff		
Morgan	Evan	Penn State	morganevan@yahoo.com
Murphy	Carol	Great-West Life Assurance Co	
Nay	Twyla	University of Manitoba	
Niemeyer	Andreas	University of Ulm	andreas.niemeyer@uni-ulm.de
Nighswander-Rempe	Stephen	Great-West Life Assurance Co	snighrem@yahoo.ca
Nord	Dan	Madison Financial Services Inc.	
Oh	Sunyung	Great-West Life Assurance Co	syoh@gwl.ca
Ostapowich	Cherity	Wawanesa Insurance	
Pai	Jeffrey	University of Manitoba	jpai@cc.umanitoba.ca
Palantick	Kimberly	Wawanesa Insurance	
Parsa	Rahul	Drake University	rahul.parsa@drake.edu
Pazdor	Charly	Eckler Ltd	cpazdor@eckler.ca
Pendleton	Robert	Retired	gamester5525@gmail.com
Peppler	Bryn	University of Manitoba	
Poapst	A Douglas	Eckler Ltd	DPoapst@eckler.ca
Porth	Lysa	University of Waterloo	lysaporth@gmail.com
Presler	Kris	University of Wisconsin - Eau Claire	
Promislow	S. David	York University	promis@mathstat.yorku.ca
Pruitt	Patricia	US Railroad Retirement Board	patricia.p0907@att.net
Pursaga	Jared	Wawanesa Insurance	
Rankin	Laird		
Robertson	Marcus		mrobertson@re-a.com
Rosenberg	Marjorie	University of Wisconsin	mrosenberg@bus.wisc.edu
Rothery	Paul	Great-West Life Assurance Co	
Santos	Maja Dos	Wawanesa Insurance	
Scheffer	Brigitte	Wawanesa Insurance	
Schilling	Katja	University of Ulm	katja.schilling@uni-ulm.de
Schulty	Erika	Society of Actuaries	eschulty@soa.org
Scoles	Steven		steve_scoles@hotmail.com
Scollnik	David	University of Calgary	scollnik@math.ucalgary.ca
Shapiro	Arnold	Penn State University	afs1@psu.edu
Sherris	Michael	University of New South Wales	m.sherris@unsw.edu.au
Sherry	Andrea	Wawanesa Insurance	
Shi	Peng	Northern Illinois University	pshi@niu.edu
Shiu	Elias	University of Iowa	elias-shiu@uiowa.edu
Snell	David	RGA	dsnell@rgare.com
Snell	Jim	Great-West Life Assurance Co	
Stephen	Bruce	Agriculture & Agri-Food Canada	Bruce.Stephen@agr.gc.ca
Stryker	Ronora	Society of Actuaries	rstryker@soa.org
Talbot	Robert	University of Manitoba	
Tan	Ken Seng	University of Waterloo	kstan@uwaterloo.ca
Tang	Qihe	Dept of Statistics & Actuarial Science	qihe-tang@uiowa.edu
Tenenbein	Aaron	New York University	atenenbe@stern.nyu.edu
Teppema	Sara	Society of Actuaries	steppema@soa.org
Thiagarajah	Ranee	Illinois State University	kthiaga@ilstu.edu
Thompson	Emmanuel	University of Calgary	tomsca2002@yahoo.co.uk
Trimble	James	University of Connecticut	James.Trimble@uconn.edu
Ulm	Eric	Georgia State University	eulm@gsu.edu
Vadiveloo	Jeyaraj	University of Connecticut	jay.vadiveloo@towerswatson.com
Van Hellemond	Scott	Great-West Life Assurance Co	
Wang	Gary	Pinnacle Actuarial Resources Inc	gwang@pinnacleactuaries.com

Wang	Ya Fang	University of Manitoba	wangyafang2004@yahoo.ca
Wenger	Menachem	Concordia University	wmendy@gmail.com
Worden	Merv		
Worden	Luke		
Wu	Defang		fannie_wood@hotmail.com
Wuttunee	Wanda	University of Manitoba	
Xia	Yu		zebra20001@hotmail.com
Xie	Wei	Great-West Life Assurance Co	
Yang	Fan	University of Iowa / Drake University	stellarfan@gmail.com
Yanofsky	Aaron	University of Manitoba	
Youn	Heekyung	University of St Thomas	hkyoun@stthomas.edu
Yuan	Zhongyi	University of Iowa	yuan_zhongyi@163.com
Zhang	Li	University of Iowa	371zl@163.com
Zhang	Zhou Yuan	Manitoba Public Insurance	
Zhao	Yu	University of Western Ontario	williamzhaodream@gmail.com
Zhou	Rui	University of Manitoba	r4zhou@uwaterloo.ca
Zhu	Wenjun	University of Waterloo	zwjsoar@hotmail.com