November 5, 2017

Information Paper
for
CAS Board of Directors

Subject: Annual Research Report

Responsible Officer: David Cummings, Vice President – Research and Development

1. Background

   The Board of Directors receives an annual report on CAS research activities at its November meeting.

2. Information

   The 2017 Report is attached. The report consists of two components:

   A. Overview and Status of 2016-2017 CAS Research Activities
      Details on CAS research projects are provided in this attachment, organized by topic.

   B. CAS Research Commitments and Expenditures (2003-2017)
      Annual funding commitments to research projects and call paper programs are summarized in a spreadsheet.

November 5, 2017

CAS Research: 2017 Overview

During the 2016 – 2017 year the CAS Research Department completed a number of significant projects, including

- Allocation of the Costs of Holding Capital
- 2017 Reinsurance Call for Papers (four papers)
- Update of the RPP II literature survey, and Risk Assessment Database (RAD)
- The Actuaries Climate Index was launched in November 2016
- JRMS projects: Parameter Uncertainty and annual Emerging Risks Survey

Notable work currently in progress includes

- Actuarial Climate Volatility Index RFP, Phase 2 (construction of Actuarial Climate Risk Index)
- Developing Adaptive Climate Indices for Evaluation of the Impact of Climate Change on Insurance Risks
- The Effect of Health Insurance Coverage Expansion on Property Casualty Claims (report completed under review by RAND prior to publication on its site)
- Research use of Automated Vehicles and their impact on the industry (three articles under final review)
- 2018 Ratemaking Call for Papers (four papers in one-year cycle published, three in two-year cycle under review)
- Several projects jointly sponsored with TAF and the SOA (Individual Grants Competition)
- Two projects with the Canadian Institute of Actuaries: Actuarial Review of Insurer Impairments/Insolvencies and Future Preventions and Flood and other Catastrophe Model Results in Pricing and Underwriting Strategies
- JRMS project: Country Risk Officer
- Cyber Risk Management Healthcare Breeches RFP

We are seeing progress on the CAS Research Priorities approved by the Executive Council last year. With assistance by the CAS Staff Actuary, these five project areas are:

1) Predictive modeling and data analytics
2) Modeling in general
3) Reserving
4) Economic scenarios and stress-testing
5) Cyber risk

In 2017, four working parties wrapped up and submitted papers to E-Forum or presented their research at a CAS event. Five working parties are currently under way (two of which began this summer) and a sixth is set to begin after this year's annual meeting.

The Ratemaking Committee is in the process of finding real data for research purposes and education in the hopes of providing it for use in a future RFP, or even as a basis for exam questions as part of the iCAS credential.

The CAS has also continued to pursue cooperation with other actuarial organizations. We are a key partner and funder of ERM-related research through the Joint Risk Management

Section, which is jointly sponsored by the CIA, SOA and the CAS (several JRMS projects are listed below). The CAS also partners with the SOA and the CIA on other research projects (some relevant projects listed below).

We continue to work with organizers of the Actuarial Research Conference each year to offer P&C-related sessions. We have made progress on a collaborative project with the SOA and the Property Casualty Insurers Association on auto loss cost trends. Earlier this year we initiated a Young Researchers Competition to fund travel for two young actuarial researchers to Berlin for ICA 2018.

CAS Research continues to work with Professional Education to disseminate the results of research projects to the membership and to sponsor projects that will advance the technical skills of the CAS members.

I am confident that the incoming Vice President, Research and Development, Avraham Adler, together with the CAS Research staff and Research chairs and volunteers, will make continued progress during the 2017-2018 year. I thank you for the opportunity to serve you in this capacity since 2014.
Sincerely,

David Cummings
VP – Research & Development

November 5, 2017

Status of 2017 CAS Research Activities

Research Projects by Topic

1. Climate Change

- **Project: Actuarial Climate Volatility Index RFP, Phase 2**
  Project Oversight Group: Climate Change Committee
  Contact: Doug Collins, Caterina Lindman
  Purpose/Topic: This project continues the work started in Phase 1 of the project by working to build both an Actuaries Climate Index and an Actuaries Climate Risk Index. The Actuaries Climate Index will be a global index, and will educate the general public about how Climate is changing, while the Actuaries Climate Risk Index (ACRI) will be an Index that measures economic or insured risk in Canada and the U.S.
  Funding Approved: $25,000. Total funding of $63,000 will come from all three sponsoring organizations (SOA, CAS, and CIA). Additional funding of $15,000 approved in September 2014 for Web site development.
  Status: The project was begun in August 2013 by Solterra Solutions, who completed Phase 1 of the project as well. The Actuaries Climate Index was launched in November, 2016. It is intended to provide a useful monitoring tool—an objective indicator of the frequency of extreme weather and the extent of sea level change. ACI and ACRI data is updated quarterly on the website, based on data for each meteorological season (3 months ending February, May, August, and November). Since its launch, more than 22,000 visitor sessions from 134 countries have been tracked, and more than 1,600 data downloads have been made.

- **Project: Developing Adaptive Climate Indices for Evaluation of the Impact of Climate Change on Insurance Risks**
  Project Oversight Group: Climate Change Committee
  Contact: Doug Collins
  Purpose/Topic: This project has two purposes**:** 1.) To perform a statistical analysis of a number of claims due to floods, heavy rain and storms with respect to varying frequencies and magnitudes of climatic events; and 2.) to develop a new data-driven adaptive climate risk index that links future climate projections with insurance risks.
  Funding Approved: $31,500
  Status: This project is underway. Researchers checking in every other month with updates.

2. Enterprise Risk Management (also including JRMS research projects)

- **Project: Parameter Uncertainty**
  Date Announced: 2015
  Project Oversight Group: Joint Risk Management Section
  Purpose/Topic: To create a resource to help actuarial practitioners advance the development of best practices for evaluating and measuring parameter uncertainty. The Joint Risk Management Section Research Committee is seeking a researcher(s) to: 1. Perform a review of existing literature related to insurance risks summarizing

research on parameter uncertainty. Insurance risks include life, pension, health, and general insurance. In addition to actuarial literature, the researcher is encouraged to survey literature in other disciplines where the same challenges exist. 2. Develop a practical methodology for calculating parameter uncertainty for insurance risks. The practical methodology can be focused on one insurance specialty.
Funding: $10,475 from JRMS
Seminar/Meeting Presentations: TBD
Publication: Available on CAS website. Published in April 2017.
Status: Complete.

- **Project: Annual Emerging Risk Survey (since 2007)**
  Date Announced: Yearly.
  Project Oversight Group: Joint Risk Management Section
  Purpose/Topic: This annual survey attempts to track the thoughts of risk managers about emerging risks across time.
  Funding: $20,000 from JRMS.
  Seminar/Meeting Presentations: At various CAS events.
  Publication: Available on CAS website. Last report: 2016 published in October 2017.
  Status: Annual. Recurring. Report printed the following year.

- **Project: Country Risk Officer**
  Date Announced: July 2015
  Project Oversight Group: Joint Risk Management Section and the CIA ERM Research Subcommittee
  Purpose/Topic: To advance the practice of ERM at a country level to serve the public, beyond its traditional applications in the financial sector, by introducing a Country Risk Officer position.
  Funding: $30,000 from JRMS
  Seminar/Meeting Presentations: TBD
  Publication: Report is being readied for publication.
  Status: Completed.

3. Health Care

- **Project: The Effect of Health Insurance Coverage Expansion on Property Casualty Claims**
  Date Announced/Completed: Announced in December 2014
  Project Oversight Group: Committee on Health Care Issues
  Contact: Annie Petrides, Glen Leibowitz
  Purpose/Topic: RAND is investigating the relationship between expanded health care coverage from the Affordable Care Act and the propensity to file auto and workers compensation claims.
  Funding Approved: $50,000
  Presentations: 2015 Casualty Loss Reserve Seminar, 2016 Spring Meeting, 2016 Annual Meeting
  Status: Project is underway and nearly finished. WC report available on RAND Web site. Auto report completed but still being edited for publication on RAND site.

4. Ratemaking

- **Project: 2018 Ratemaking Call for Papers**
  Date Announced: Announced in March, 2016
  Project Oversight Group: Ratemaking Committee
  Contact: Morgan Bugbee
  Purpose/Topic: Papers on Ratemaking topics are accepted.
  Funding Approved: $2,500, for the best papers.
  Seminar/Meeting Presentations: Ratemaking & Product Management Seminar, March 2017, March 2018
  Publication: Papers will be peer-reviewed this time around with the intention of publishing them in *Variance.*
  Status: Four papers were accepted into the one-year cycle, and three of those four papers were published in the 2017 Spring Eforum. Three papers remain in the two-year cycle and are in the final stages of review. It will be determined if they will be published in December, 2017.

- **Project: Predictive Modeling RFP**
  Date Announced: TBD
  Project Oversight Group: Ratemaking Committee
  Contact: Morgan Bugbee
  Purpose/Topic: To put forth an RFP related to Predictive Modeling in which the CAS will provide data for researchers to use.
  Funding Approved: TBD.
  Seminar/Meeting Presentations: TBD
  Publication: TBD
  Status: Members of the committee are currently working with Rick Gorvett to try and obtain a dataset that researchers can use since that sort of material can be very difficult to come by. The committee has created a draft for an RFP, as well as three other topics that have the potential for future RFPs, one of which has already resulted in a working party being formed on the topic of "Best Practices". Data is still needed for these projects, but the committee is trying to move forward with the ideas and projects as much as possible in the meantime.

5. Reinsurance

- **Project: 2017 Reinsurance Call for Papers**
  Date Announced: May 2016
  Project Oversight Group: Committee on Reinsurance Research
  Contact: Gerry Palisi
  Purpose/Topic: The Committee welcomes all papers on Reinsurance topics. Areas related directly to topics of current interest were preferred: Sub-prime mortgage, moving towards International Accounting Standards, risk inflation, and risk transfer.
  Funding Approved: $5,000
  Funding Expended: $5,000
  Presentation: Two papers presented at 2017 Seminar on Reinsurance.
  Publication: Both papers published in Spring 2017 issue of E-Forum.
  Status: Complete.

6. Reserves

- **Project: Bornhuetter-Ferguson-Initial Expected Losses Working Party**
  Date Announced/Completed: Announced in September 2004

Project Oversight Group: Committee on Reserves
Contact: Lynne Bloom
Purpose/Topic: The goal of this working party is to produce a paper regarding the initial expected loss assumption in the Bornhuetter-Ferguson reserving method. The working party is not expected to engage in primary research, but instead will leverage initial expected loss approaches already in use. With many competent actuaries using the Bornhuetter-Ferguson method, there are probably many very good initial expected loss approaches already in use, but not documented.
Presentations of Interim Reports: 2005 CLRS, 2005 Annual Meeting
Presentation of Final Results: 2013 CLRS, 2015 Annual Meeting
Publication: Upcoming issue of E-Forum.
Status: Final report published in Fall 2016 E-Forum.

- **Project: 2018 Reserves Call for Papers**
  Date Announced: To be announced in November 2017
  Project Oversight Group: Committee on Reserves
  Contact: Nancy Arico, Denise Ambrogio
  Purpose/Topic: Papers requested on the topics of: opinion issues; best estimates, variability, and ranges; methodologies; unique or changing exposures; and other matters affecting reserving. Committee is trying the non-technical twist again to see if more papers will be published.
  Funding Approved: $6,000 ($5,000 for the best papers and $1,000 for the best practical tool)
  Presentations: Authors of winning papers may be invited to speak at the 2018 CLRS
  Publication: Accepted papers will be published electronically in the CAS *E-Forum* and will be available on the CAS Web Site prior to the 2018 CLRS.
  Status: Ongoing.

7. Risk Theory

- **Project: Risk Premium Project Update RFP**
  Date: August 2017
  Project Oversight Group: Theory of Risk Committee
  Contact: Alietia Caughron
  Purpose/Topic: The CAS wishes to capitalize on the extensive review of the actuarial and financial literature review by the Risk Premium Project through 2000 by updating that review. Prof. Eling has agreed to continually update the project at a cost of $10,000 for two years.
  Funding: $10,000
  Presentations:
  Publication: 2016 Update available on CAS Website
  Status: The CAS posted Eling's 2016 update in June of 2017 which fulfills year two of his two-year agreement. At this point the committee is determining the value of the project and hopes to continue to work with Eling on some form of literature update, it just remains to be seen in what capacity.

- **Project: Allocation of Costs of Holding Capital**
  Date: January, 2015
  Project Oversight Group: Theory of Risk Committee
  Contact: Alietia Caughron

Purpose/Topic: The CAS signed researchers Zanjani and Bauer to another contract to expand on their 2015 original report. They're going to expand on the research in order to generate comparable results for more conventional property and casualty lines. In addition to securing suitable data and adjusting the parameters to corresponding data, extensions of the theory need to be explored.
Funding: $30,000
Presentations:
Publication: TBD
Status: The final report was completed in June 2017 and accepted by the committee. The researchers are deciding where to have their findings published (either Eforum or Variance), and plan to present at both the 2017 CAS Annual Meeting, and the 2018 ICA in Berlin, Germany.

8. **Open-Source Software Committee**

9. **Valuation, Finance & Investments (merged with Accounting Changes Committee into new Financial Reporting and Analysis Committee)**

- **Project: Credit Risk Resources Compendium and Application of Property-Casualty Actuarial Methodologies to Credit Risk: Development of a Theory and Model RFP**
  Date Announced/Completed: Funding was awarded in May 2012.
  Researcher(s): Mathieu Boudreault and Jean-Philippe Boucher, University of Quebec at Montreal.
  Project Oversight Group: Committee on Valuation, Finance & Investments
  Contact: Rasa McKean
  Purpose/Topic: The two goals of this project are: (1), to develop an organized set of resources on credit risk for the practicing actuary. The resources will be tailored to actuarial applications such as reinsurance credit risk, mortgage guaranty insurance and actuarial modeling of fundamental credit risk of assets/investments for cash flow modeling, intrinsic valuations of structured credits, and enterprise risk management purposes. (2), to describe the general US P&C actuarial approach to mortgage credit risk management, by surveying knowledgeable CAS members and consolidating their responses. Identified members will be asked how they would apply an "actuarial approach" if they had risk management responsibility for mortgage credit risk, primarily in the context of mortgage insurance. Other mortgage credit risk contexts (e.g., bonds, other investments including derivatives, reinsurance) may also be considered provided actuarial methods have been applied by the survey respondents.
  Funding: $32,500
  Status: Completed. Work published in Spring 2017 issue of E-Forum.

10. **Data**

- **Project: Data & Technology Working Party**
  Date Announced/Completed: Announced in August 2014
  Project Oversight Group: Research Oversight Committee
  Contact: Peter Bothwell, Mary Jo Kannon
  Purpose/Topic: The Data & Technology Working Party seeks to research and identify the knowledge and skills actuaries must possess to participate in the changes brought about by a rapidly evolving technology supporting data and analytics. With more formal education and research on these topics, CAS actuaries will be better positioned to partner with IT to use the combination of technology and analysis to

improve insurance generally.
Presentations: 2016 RPM Seminar, 2016 Annual Meeting
Publications: Upcoming issue of E-Forum.
Status: Final report published in Fall 2016 E-Forum.

11. Automated Vehicles Task Force

- **Project: Research use of Automated Vehicles and their impact on the industry**
  Date Announced: Announced in November, 2013
  Project Oversight Group: Research Oversight Committee
  Contact: Michael Stienstra
  Purpose/Topic: The CAS Taskforce on Automated Vehicles aims to clarify the risks surrounding this developing technology by highlighting the technological and regulatory developments to the actuarial community, performing analyses that further the understanding of the technology's riskiness, and identifying opportunities for the CAS and the insurance industry to influence and improve the risk identification and quantification process.
  Presentations/Publications: Currently working on several reports.
  Status: The task force is finalizing reports with assistance from Rick Gorvett. Three upcoming white papers will be published and promoted.

12. Cyber Risk

- **Project: Fundamental Approach to Cyber Risk**
  Date Announced: February 2015
  Project Oversight Group: Cyber Risk Task Force
  Contact: Dave Cummings
  Purpose/Topic: A researcher from Innsbruck University in Austria was contracted to produce a research document discussing an overview of the existing research most relevant to the analysis of cyber risk for cyber insurance and proposing a general approach and methodology for cyber insurance modeling, building on the previous research by the professor and the latest developments in cyber insurance and cyber risk modeling research, as specified in the research proposal, the terms of which are incorporated herein by reference.
  Funding: $30,000
  Presentations/Publications: A final report was submitted to the task force in May 2016; they are working with the researcher to have it submitted for publication to *Variance.*
  Status: The researcher has been paid; once the report is published it will be complete. It is still in the queue for *Variance*.

- **Project: Cyber Risk Management: Identification and Quantification of Unreported Healthcare Data Breaches**
  Date Announced: Contracted April, 2016
  Project Oversight Group: Cyber Risk Task Force
  Contact: Dave Cummings
  Purpose/Topic: A researcher from Drexel University was contracted to provide an article describing the research involving quantitative analysis of healthcare data breaches and its conclusions (the "Article") performed as part of the research described in Appendix A.

Funding: $30,000
Presentations/Publications: TBD
Status: The contract has been signed and the researchers were able to obtain the data needed in January 2017. The report is due for task force review in December, 2017.

13. Other Topics

- **Project: Actuarial Review of Insurer Impairments/Insolvencies and Future Preventions**
  Date Announced: Contracted July 2016
  Project Oversight Group: CIA, CAS, SOA
  Contact: Dale Hall, SOA
  Purpose/Topic: The Canadian Institute of Actuaries (CIA), Casualty Actuarial Society (CAS) and Society of Actuaries (SOA) are sponsoring this research project educating the profession on past insurer impairments and insolvencies. The study will look at their causes, the decisions made by management, regulators and policyholders as situations unfolded. In turn, the study will look at ways the profession can be equipped to prevent or mitigate future insolvency situations. In addition to directly benefitting the profession, the work will also help assist other insurance industry practitioners understand the complexities of insurance company solvency and the benefit of keeping the actuarial profession in the forefront of company management, operations and regulatory communication.
  Funding: $32,000 (CAS)/$50,650 (SOA)/$15,000 (CIA)
  Presentations/Publications: TBD
  Status: Final report to be completed by October 31, 2017.

- **Project: Flood and other Catastrophe Model Results in Pricing and Underwriting Strategies**
  Date Announced: Contracted September 2016
  Project Oversight Group: Canadian Institute of Actuaries Research Committee
  Contact: Étienne Plante-Dubé, on behalf of CIA
  Purpose/Topic: Damage from water and other climate related perils have emerged in recent years to replace fire and theft as the largest claims cost for Canada's property insurers. Given these upward trends, Canadian insurers are becoming more interested in extending coverage for personal property to include residential flood protection. In the view of the CIA, significant knowledge gaps exist for Canadian P&C actuaries attempting to properly incorporate results from catastrophe models (e.g. earthquake, flood, wind/hail, etc.) into their pricing and underwriting strategy. The goal of this research project is thus intended to alleviate this gap by stimulating the development of innovative pricing approaches that better incorporate existing catastrophe model output into traditional pricing and underwriting strategies of P&C insurers.
  Funding: $25,000 (CAS)/$22,000 (SOA)/CAD$28,000 (CIA)
  Presentations/Publications: TBD
  Status: By the end of September 2017, 70% of the project was completed.

- **Project: Flexible Predictive Model for Pure Premium Estimation**
  Date Announced: June 2011
  Researcher(s): John B. Henry, III, and Edward Yorty
  Topic: To present theoretical and empirical arguments for how a new pricing model outperforms GLMs.
  Funding Sources: $22,000 (CAS)
  Status: The paper is complete. The authors have received the second allotment of the

payment, due when the CAS received evidence that the paper had been submitted to *Variance.*

- **Project: IAA Educational Monograph**
  Date Announced: August 2011
  Purpose/Topic: The EC passed a motion to approve a maximum contribution of $15,000, contingent on the project's addressing P&C issues, for development of the IAA educational monograph on issues associated with the application of risk and uncertainty to the measurement of the liability of insurance contracts in the context of general purpose accounting as adopted by the IASB.
  Status: The CAS received an invoice for only $8,550, as that is all that is needed by the researchers from the CAS. The project is progressing, albeit somewhat slower than what had originally been hoped for. The monograph was discussed in Budapest in April, and is now going through a final review. It is expected that any final revisions will be completed prior to year-end and the monograph itself published in 2018.

- **Project: Factor copula approaches for assessing spatially dependent high-dimensional risks**
  Date Announced/Completed: Funding was awarded in June 2014
  Researcher(s): Lei Hua, PhD, ASA, Sanjib Basu, PhD, and Michelle Xia, PhD
  Topic: The project aims to develop factor copula models for assessing insurance risks that exhibit spatial dependence. The researchers will develop models that capture the spatial dependence structure and perform case studies using real loss data.
  Funding Sources: $9,000 (CAS), $9,000 (SOA)
  Status: Report completed. Under review by *NAAJ*.

- **Project: Reinsurance, Dividends and Capital Optimisation in General Insurance Companies**
  Date Announced/Completed: Funding was awarded in June 2014
  Researcher(s): Corina Constantinescu, PhD, Joseph Lo, PhD, and David Siska, PhD
  Topic: The aim of the project is to investigate the optimal level of reinsurance versus capital reserve an insurance company should have, given its current risks and historical claim data.
  Funding Sources: $20,800 (CAS)
  Status: The paper is in progress. The authors have received the second allotment of the payment, due when the CAS received evidence that the paper had been received by a referred journal.

- **Project: Flexible Bayesian nonparametric credibility models**
  Date Announced/Completed: Funding was awarded in April 2015
  Researcher(s): Liang Hong and Ryan Martin
  Topic: The first objective is to propose a flexible Bayesian nonparametric model. The second objective is to provide numerical examples that demonstrate the benefit of the researchers' model compared to others in the credibility theory literature.
  Funding Sources: $8,750 (CAS), $8,750 (SOA)
  Status: Report completed. Under review by *NAAJ*.

- **Project: Risk Measurement Based on Available Information**
  Date Announced/Completed: Funding was awarded in April 2015

Researcher(s): Yiqing Chen and Rahul Parsa
Topic: In this project, the researchers will focus on the measurement of a risk variable associated with a few other risk variables, interpreted for example as risk factors, which are exactly or partially known.
Funding Sources: $6,000 (CAS)
Status: The paper is being revised and will be re-submitted to *Variance* this year.

- **Project: Numerical Optimization for Actuarial Applications**
  Date Announced/Completed: Funding was awarded in March 2016
  Researcher(s): Alexandru Valentin Asimit, PhD; Junlei Hu; and Tao Gao
  Topic: Therefore, the objectives of our project are: a) Provide a review of related decisional problems that aim to identify the "best possible" risk transfer for two or a group of insurance players; b) Explain how to implement numerical optimization methods to solve such problems and discuss the advantages and drawbacks of various methods for specific problems; c) Identify numerical solutions for non-convex problems that are usually more problematic, indicating appropriate algorithms to solve our sought problems,
  Funding Sources: $8,500 (CAS), $8,500 (SOA)
  Status: Agreement signed. Work in progress.

- **Project: Enhanced Predictive Modeling for Usage-Based Auto Insurance**
  Date Announced/Completed: Funding was awarded in March 2016
  Researcher(s): Jennifer, Chan, PhD; Boris Choy, PhD; and Udi E. Makov, PhD
  Topic: In this research project, the researchers explore the plausibility and benefits of machine learning procedures in enhancing UBI-based predictive models. In particular, the aim is to explore how machine learning algorithms can boost the classical GLM, resulting in new methodologies which retain a modeling context familiar to actuaries and DOI's, while relieving the GLM of inadequacies in rooted in telematics data.
  Funding Sources: $7,000 (CAS), $7,000 (SOA)
  Status: Agreement signed. Work in progress.

- **Project: Nonparametric Estimation for Data Modified by Truncation and Censoring**
  Date Announced/Completed: Funding was awarded in March 2016
  Researcher(s): Sam Efromovich, PhD; Wenui Lu, FSA; and Jerome Tuttle, FCAS, CPCU; Pankaj K. Choudhary, PhD
  Topic: Intellectual Merit of the proposal is defined by the following three objectives. (1) To advance knowledge and understanding of nonparametric (that is assuming no parametric formula/shape) estimation of the hazard rate and related distribution functions, develop the theory of sharp minimax nonparametric estimation of the hazard rate with left truncated and right censored data. This theory will allow actuaries and data-analysts to know how the truncation and censoring affect the constant of the MISE convergence. Furthermore, the theory should shed light on choosing the interval of estimation. Developing this theory is based on the recent result Efromovich (2015a) on estimation of the hazard rate for direct data. (2) Expand the asymptotic theory of optimal estimation to statistical inference including confidence bands and hypotheses testing. (3) Based on the asymptotic theory, suggest feasible data-driven statistical estimators, together with inference procedures, for "small" samples.
  Funding Sources: $20,000 (CAS)

Status: Agreement signed. Work in progress.

- **Project: Machine Learning and 'Big Data' Methodologies for Policyholders' Retention and Conversion Modeling**
  Date Announced/Completed: Funding was awarded in March 2016
  Researcher(s): Giorgio Alfredo Spedicato, PhD, ACAS; Luca Lombardi; and Christophe Dutang, PhD
  Topic: The project subject of funding proposal aims to investigate to what extent machine learning methodologies improve policyholders' retention and conversion estimation with respect to classical GLM. The investigation will both review the machine learning algorithms currently used in business application and develop a practical application of such algorithms on a real insurance data set to compare their performance with a standard logistic GLM approach.
  Funding Sources: $6,500 (CAS), $6,500 (SOA)
  Status: Agreement signed. Work in progress.

- **Project: Embedded predictive analysis of misrepresentation risk in GLM ratemaking models**
  Date Announced/Completed: Funding was awarded in March 2016
  Researcher(s): Michelle Xia, PhD
  Topic: For the current project, we aim to develop GLM ratemaking models that embed predictive analyses of misrepresentation risk. The particular objectives include: (1) to confirm whether the proposed model gives valid inference on how various risk factors affect the probability of misrepresentation, when we model the relationship under the GLM framework with regular ratemaking data; (2) to verify whether the ratemaking model can identify the misrepresentation probabilities and risk effects, when there are multiple risk factors subject to misrepresentation; (3) to assess the possible impact from and on other risk factors that do not suffer from misrepresentation; (4) to conduct simulation studies to confirm the theoretical findings, as well performing case studies using the Medical Expenditure Panel Survey (MEPS, [1]) data.
  Funding Sources: $12,500 (CAS)
  Status: Agreement signed. Work in progress.

- **Project: Text Mining and Sentiment Analysis in Insurance**
  Date Announced/Completed: Funding was awarded in April 2017
  Researcher(s): Diego Zappa,; M. Borrelli; G.P. Clemente, Ph.D.; N. Savelli, Ph.D.; and G.Spedicato Ph.D.
  Topic: This proposal fits into the big data paradigm [1], which nowadays is more and more frequent both in applications and in scientific research. A strict definition of what it refers to does not yet exist. Generally speaking, big data may be depicted as an unstructured, large, heterogeneous and unstable dataset that often hides latent relevant information not measurable through a standard sampling process. Big data may be documents, the flow of tweets on the web, any social network, sentiment about the health of the economy, the status of either a country or a company, or the flow of documents produced during daily work (e.g. reports, recipes, phone calls, mails) and so on.
  Funding Sources: $10,000 (CAS)
  Status: Agreement signed. Work in progress.

- **Project: An Efficient Algorithm For Approximating Independent And Dependent Sums Of Log-Normally Distributed Losses**
  Date Announced/Completed: Funding was awarded in April 2017
  Researcher(s): Edward Furman, Ph.D.; Daniel Hackmann, Ph.D., C.P.A.; and Alexey Kuznetsov, Ph.D.
  Topic: This project aims at developing an efficient algorithm for approximating the sums of log-normally distributed insurance losses. Remarkably, by merging tools from probability theory and advanced numerical analysis, we are able to compute the cumulative distribution functions (c.d.f.) of the just-mentioned sums with very high precision, e.g., an error of 1:0e-12, or less. Moreover, our algorithm is fast and can tackle equally well sums with just a few or thousands of stochastically independent or even dependent summands. We propose to illustrate the superiority of the new algorithm in the contexts of the collective risk model, economic capital determination and allocation, and stochastic loss reserving.
  Funding Sources: $18,000 (CAS)
  Status: Agreement signed. Work in progress.

- **Project: Pricing Cyber Insurance for a Large-scale Network**
  Date Announced/Completed: Funding was awarded in April 2017
  Researcher(s): L. Hua, Ph.D./Northern Illinois University
  Topic: This project aims to develop a novel frequency-severity model for modeling and assessing cyber risks for a large-scale network based a reasonably small set of underwriting information, while accounting for the heterogeneity of the network nodes and their interdependence. The proposed methodology is able to account for the unique features of cyber risks and is expected to have an immediate impact on the actuarial practice for modeling cyber risks. Moreover, the theory and innovative models proposed will contribute fundamentally to the literature for risk modeling of general scale-free networks that widely exist in the real world (see many examples of scale-free networks in [2]).
  Funding Sources: $20,000 (SOA/CAS)
  Status: Agreement signed. Work in progress.

- **Project: Pricing Cyber Insurance for a Large-scale Network**
  Date Announced/Completed: Funding was awarded in April 2017
  Researcher(s): Jing Ai, Ph.D.; and Tianyang Wang, Ph.D., ASA, FRM
  Topic: The threat of cyber risk is ubiquitous and increasing. FBI notifies over 3,000 U.S. companies each year, from financial institutions to defense contractors to mega retailers, that they were victims of cyber security breaches (Segal, 2016). Most recently, in a public statement on December 14, 2016, Yahoo's Chief Information Security Officer reported a security breach that are "associated with more than one billion user accounts," subsequent to a separate security breach report back in September 2016, in which 500 million accounts were affected. According to PwC's 2014 *Global Economic Crime Survey*, an astounding 19% of U.S. organizations have claimed losses between $50,000 and $1 million, and 7% of U.S. organizations lost over $1 million due to cybercrime in the previous year. The Center for Strategic and International Studies has estimated the annual cost of cybercrime and economic espionage to the world economy at more than $445 billion, or almost 1 percent of the global GDP.
  Funding Sources: $40,000 (CAS)
  Status: Agreement signed. Work in progress.

November 5, 2017