

WELCOME

to the

49th Actuarial Research Conference

at UC Santa Barbara



YOU ARE INVITED

49th Actuarial Research Conference

University of California, Santa Barbara
July 13-16, 2014

Scientific Committee:

Michael Ludkovski (*UCSB, Chair*)
Ian Duncan (*UC Santa Barbara*)
Rick Gorrivett (*UI Urbana-Champaign*)
Stuart Klugman (*SOA and Drake U.*)
Angus Macdonald (*Heriot-Watt U.*)
Loren Nickel (*AON, San Francisco*)
Margie Rosenberg (*U. of Wisconsin*)
John Xu (*AAA NCNU Insurance Exchange*)

Plenary Speakers:

Paul Embrechts (*ETH Zurich*)
Wayne Fisher (*CAS, President*)
Mark Freedman (*SOA, President*)

Local Organizing Committee:

Ian Duncan (*co-Chair*)
Raya Feldman (*co-Chair*)
Esteban Chavez
Jean-Pierre Fouque
Tomoyuki Ichiba
Michael Ludkovski

ARC2014@pstat.ucsb.edu

www.pstat.ucsb.edu/ARC.htm



Canadian
Institute of
Actuaries



Institut
canadien
des actuaires

Thank you to our sponsors!



Results Matter. Trust NAG.



Springer

the language of science



It Takes One To Know One ... An Actuary Placing Actuaries



UC Santa Barbara

- Member of the prestigious Association of American Universities, one of 61-research-intensive institutions.
- Five Nobel Prize winners in the past 15 years.
- 2009 Alum received Nobel Laureate in Physiology or Medicine
- Number 10 among all public universities, according to U.S. News and World Report's guide, "America's Best Colleges."
- Home to 11 national institutes and centers.



"If there's a more beautiful campus than this one at the edge of the Pacific, we haven't seen it," said Newsweek.

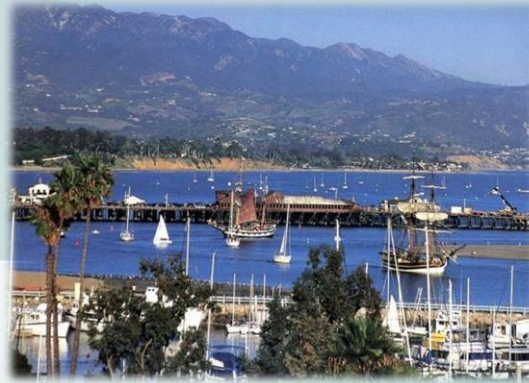


UC Santa Barbara

- 5 major colleges and divisions with over 200 majors
 - College of Creative studies
 - College of Engineering
 - College of Letters and Science
 - Donald Bren School of Environmental Science and Management
 - Gevirtz Graduate School of Education



Santa Barbara



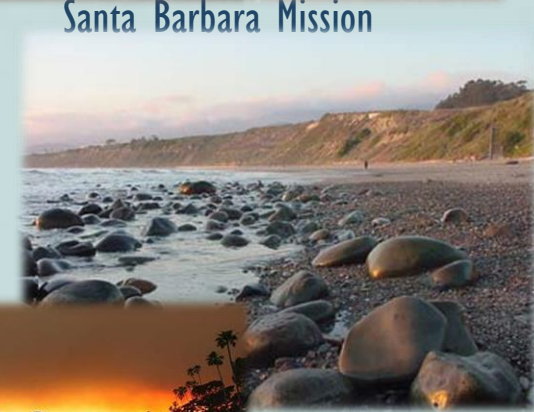
Wharf



Santa Barbara Mission



Santa Barbara Courthouse



Waterfront



Santa Barbara & Goleta Beaches



Wine Country



Down Town State Street

Statistics and Applied Probability



- Established in 1989
- 11 permanent ladder faculty
- 5-8 long-term visiting researchers annually
- Center for Research in Financial Mathematics and Statistics (CRFMS) created in 2006, director: Dr. Jean-Pierre Fouque
- CRFMS renamed Center for Financial Mathematics and Actuarial Research (CFMAR) in 2014



Statistics and Applied Probability



- Undergraduate students: over 500
 - B.S. in Actuarial Science, B.S. in Financial Math and Statistics, B.S. & B.A in Statistical Science, Minor: Statistical Science
- Graduate students: 65
 - M.S. in Actuarial Science, M.A in Statistical Science
 - Ph.D. in Statistics & Applied Probability, Ph.D Emphasis in Financial Mathematics and Statistics



Class of 2014



Class of 2014





UCSB Actuarial Program

- The only university on the west coast with B.S and M.S in Actuarial Science
- 200 Actuarial undergraduates as of Spring 2014
- Courses cover 5 preliminary SOA/CAE exams
- Adding FAP in 2015
- SOA-approved courses for all VEE Subjects
- Annual Actuary Day & Annual Actuarial Career Fair





Actuarial Association

- Networking
- Job & internship recruitment
- Educational workshops
- Guest speakers program
- Exam Reimbursement
- Intramural athletics



2013-2014 Club Officers



Beach Day

Club Fair Tabling



Basketball Intramurals



Soccer Intramurals

Bowling Night



Storke Tower

Department Events



UCSB's 3rd Annual

Actuarial Career Fair

Thursday
October 16, 2014

SRB MPR- Student Resource Center

Actuarial Association

Member Exclusive

11:00 AM — 12:00 PM

All Majors

12:00 PM — 03:00 PM



4th ANNUAL
UNIVERSITY OF CALIFORNIA SANTA BARBARA
ACTUARY DAY

APRIL 25th
1-4 P.M.

THEATER &
DANCE WEST 1701

1:00-1:45 P.M. **INTRODUCTION TO REINSURANCE**

LARRY STERN FSA, MAAA, PRESIDENT,
CANTERBURY CONSULTING LLC, CHARLOTTE, NC

1:50-2:35 P.M. **ACTUARIES IN HEALTHCARE**

TIM REILLY '80, CHIEF FINANCIAL OFFICER,
L.A. CARE HEALTH PLAN

2:35-2:50 P.M. **RAMA THORGORATI AWARD &
ACTUARIAL ASSOCIATION BOARD, 2014-2015**

2:50 P.M. - 3:30 P.M. **Q&A PANEL**



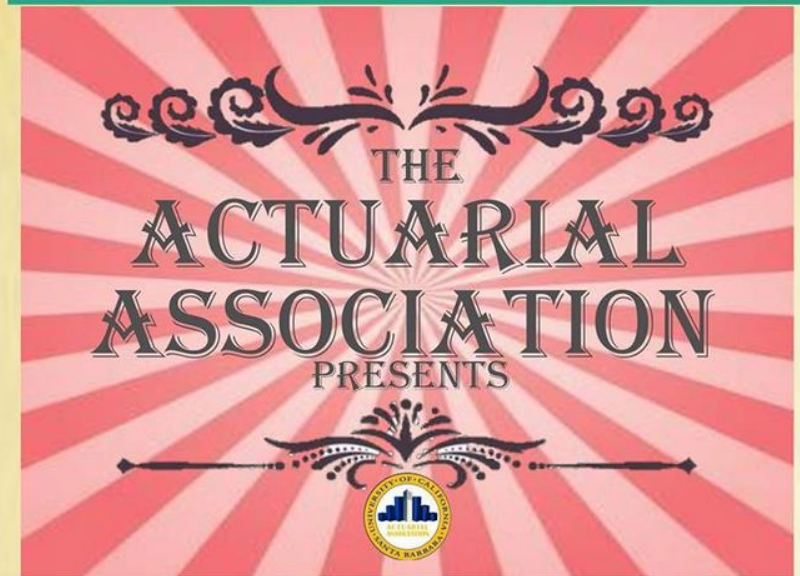
FOR MORE INFO:
www.pstat.ucsb.edu www.ucsbactuary.org
(805) 893-2129



Past Events



★ FRIDAY, JANUARY 17th ★ 2:00PM - 3:30PM ★



★ FIRST MEETING OF WINTER QUARTER ★

LOCATED IN THE FLYING A STUDIOS
IN THE UPPER FLOOR OF UCEN



TOPICS:

- ★ The Actuarial Profession and where it ranks
- ★ Actuarial Science Study Abroad Programs
- ★ Upcoming Events

Networking Breakfast for Lady Actuaries

May 21, 2014

9:00-10:30 am

Sobel Room SH 5607F

Come network & enjoy a bagel breakfast with
future lady actuaries!
Please RSVP by May 16th, 12pm.

DO YOU HAVE
**WHAT IT
TAKES**
TO GET HIRED AS AN ACTUARY?

COME TO THE NEXT
**ACTUARIAL
ASSOCIATION
MEETING**

TO GET AN INSIDE LOOK ON THE
RECRUITER PERSPECTIVE FROM
GUEST SPEAKER AND ACTUARIAL
RECRUITER **JACOB GALECKI**

FRIDAY, APRIL
18th AT 3:00 PM
IN THE FLYING
A STUDIOS
LOCATED
WITHIN UCEN.



PRESIDENT

WEB MASTER

VICE
PRESIDENT

**ACTUARIAL
ASSOCIATION
OFFICER
ELECTIONS 2014**

PUBLIC
RELATIONS

TREASURER

JOURNALIST

FRIDAY
APRIL 11th
3:00 PM

FLYING A STUDIOS
IN UCEN

THE ACTUARIAL ASSOCIATION

PRESENTS SPECIAL GUEST SPEAKER:

VICE PRESIDENT AT PACIFIC LIFE

FRANK ZHANG

CFA, FRM, FSA, MSCF, PRM

SPEAKING ABOUT:

- Actuarial Science and Financial Engineering in the Life Insurance Industry

FRIDAY, FEB 21 AT 2PM LOCATED IN THE FLYING A ROOM IN THE UPPER FLOOR OF UCEN



2014

ACTUARIAL ASSOCIATION

CLUB MEETING

FRIDAY, JANUARY 31st
2PM – 3PM

LOCATION: FLYING A ROOM
IN THE UPPER FLOOR OF
UCEN.

GUEST SPEAKER



JANET DUNCAN
VP and Senior Reserving Officer of
CNA Insurance Company

Undergraduate Actuarial Research



- **Actuarial Research Projects:**
 - 2010-2011: AAA NCNU
 - 2011- 2012: Towers Watson
 - 2012-2013: Solucia Inc.
 - 2012-2013: Towers Watson
 - 2013-2014: CSAA
 - 2013-2014: Towers Watson
 - 2013-2014: Blue Shield CA
 - 2014-2015: CSAA
 - 2014-2015: Blue Shield CA

Predictive Healthcare Cost Modeling Using Regression Splines

by

Andrew Mackenzie, Tiffany Sun, Roger Wu, Ian Duncan & Michael Ludkovski

{andrewmackenzie, tmsun, rcwu}@umail.ucsb.edu,
{duncan, ludkovski}@pstat.ucsb.edu

Department of Statistics and Applied Probability
University of California at Santa Barbara

Abstract

Increasing the accuracy of predictive health modeling has many applications and benefits. In light of the ongoing health care reform in the United States, it is now more important than ever to build models that will successfully and accurately predict the cost of future health care claims and identify risk-levels of different groups. Better predictive modeling will improve the efficiency of our health care system, mitigate solvency concerns of insurers, and allow more productive allocation of resources. Given data provided by an insurance company, we used regression analysis to study current year expenditures and to predict the cost that insurers will incur on covered members. We looked specifically at how current expenditures, demography, and medical conditions may impact future claims. Known for its ability to handle nonlinearities and a large quantity of variables, we applied a procedure termed Multivariable Adaptive Regression Splines (MARS). A related work by Mena, Moat, and Wang made use of Classification and Regression Trees (CART) to approach the same problem. With the aid of R, we ran MARS and developed and compared models that selected key predictor variables. Of the 133 variables we considered, the five most important variables were current costs, number of primary care visits, current drug expenditures, current inpatient costs, and the age of the insured. We found that models created on partitioned sets of data like gender and individuals with no medical claims in the current year did not produce superior results to models created on the entire, un-partitioned data set. Our findings were comparable to the results produced by CART.

Undergraduate Actuarial Research



Public Scores in Auto Insurance Risk Modeling

Karina Gaeta, Daniel Porter, and Mengnan Qi

Faculty Advisor: Michael Ludkovski

Department of Statistics and Applied Probability, University of California Santa Barbara



Introduction

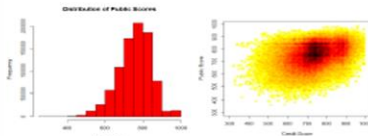
- ◆ Criticism over the use of Credit Scores in auto insurance has recently increased, causing a few states in the U.S. to prohibit the use of Credit Scores to determine premium rates for auto insurance policies.
- ◆ This has led to the search for an alternative predictor to replace Credit Score: Public Score.
- ◆ Public Score, a variable created by LexisNexis, is a score similar to Credit Score, but one that is based off of public driver information.

Objectives

- ◆ Using predictive modeling, determine whether Public Score is a suitable replacement for, or a suitable addition to, Credit Score as a predictive variable for loss frequency.
- ◆ Loss frequency refers to the amount of auto insurance claims a policy will produce, regardless of the loss amount (or loss severity) of each claim.
- ◆ Predictive Modeling: The process of predicting and assigning auto loss frequency risk to policies based on the explanatory variables available.
- ◆ Identify any possible interactions and correlations between Public Score and the other variables using multivariate loss cost modeling approach.

Data

- ◆ Two sets of auto insurance data ranging within 3 years (2010-2012) were used for this research: Auto Property Damage and Collision data provided by CSAA, which consisted of:
 - 1 million records and 19 variables each
 - 2 binary variables (Gender, Marital Status)
 - 10 banded categorical variables (ex: Public Score, Credit Score)
 - 4 numeric variables (ex: Driver Points, Insurance Persistency)
 - 2 response variables (Number of Claims, Total Losses)
 - 1 Offset vector: Earned Exposure
- ◆ Histogram of Public Scores (left): Most policies have Public Scores between 600 and 900.
- ◆ Correlation Plot of Credit Score vs. Public Score (right): Slight connection between Public Score and Credit Score.
- ◆ Darker regions indicate higher concentration of observations for that area.
- ◆ A policy with a high (or low) Credit Score tends to also have a high (or low) Public Score.



Approach

- ◆ Generalized Linear Models and General Additive Models were used to perform the predictive modeling.
- ◆ Generalized Linear Models (GLM): exponential family of distributions.
- Model claim frequency using a Poisson distribution with log link function.
- Earned Exposure variable is used as an offset vector.
- ◆ Generalized Additive Models (GAM): deals with continuous rating variables by grouping them into intervals.
- ◆ Building and Comparing Models:
 - ◆ Compare scaled deviance between models: measures how much the fitted values differ from the observations in a model.

Citations, and Acknowledgments

- [1] CSAA Memo, 2013.
- [2] Dunsan Anderson et al., 2007. *A Practitioner's Guide to Generalized Linear Models*, Casualty Actuary Society, Arlington, Virginia.
- [3] Bjørn Ohlsson, Björn Johansson, 2010. *Non-Life Insurance Pricing with Generalized Linear Models*, Springer Heideberg Dordrecht London New York.
- [4] John Fox, 2008. *Applied Regression Analysis and Generalized Linear Models*, SAGE Publication Inc., Thousand Oaks, CA.

◆ We would like to thank CSAA and our faculty advisors Mike Ludkovski and Raya Feldman for their assistance, guidance, and enthusiasm for this research.

GLM

- ◆ Characteristics
 - ◆ Each component of response \vec{Y} is independent and is from one of the exponential family of distributions
 - ◆ A linear predictor based on the predictor variables X_{i1}, \dots, X_{in-1} is utilized, denoted by $X_i\beta$:

$$X_i\beta = \beta_0 + \beta_1 X_{i1} + \dots + \beta_{n-1} X_{i,n-1}$$

- ◆ The link function g relates the linear predictor to the mean response:

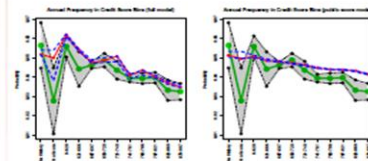
$$E[\vec{Y}] = g^{-1}(X_i\beta)$$

- ◆ Link Function: specifies a nonlinear transformation of the predicted values in order to ensure that the distribution is within the exponential family, for example:

$$\text{Log link: } g(x) = \ln(x), g^{-1}(x) = e^x$$

Results and Predictions

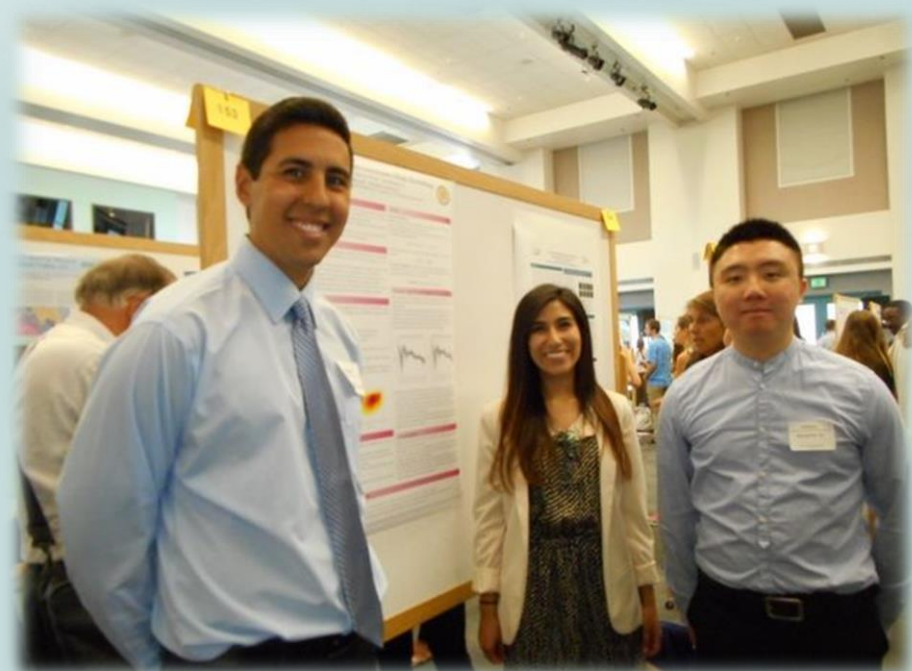
- ◆ Chi square tests using the change in deviance between two nested models were used to determine the significance of Public Score in each model.
- ◆ These tests resulted in high significance of Public Score for most subsets in the Full Model and even higher significance of Public Score for all subsets in the Model that Excludes Credit Score.
- ◆ GLM Predictions for Public Score within: **The Full Model** (left) and **The Model that Excludes Credit Score** (right)



- ◆ Each plot depicts the observed loss frequency provided by CSAA (in green) with the corresponding loss frequency range (in grey), as well as the calculated loss frequency prediction (in red) with the corresponding loss frequency prediction range (in blue).
- ◆ Almost all predictions for both models are within 0.5% of the actual observed loss frequencies.
- ◆ The predictions using the Full Model (left) are closer to the actual observed loss frequencies than the predictions using the Model that Excludes Credit Score (right).

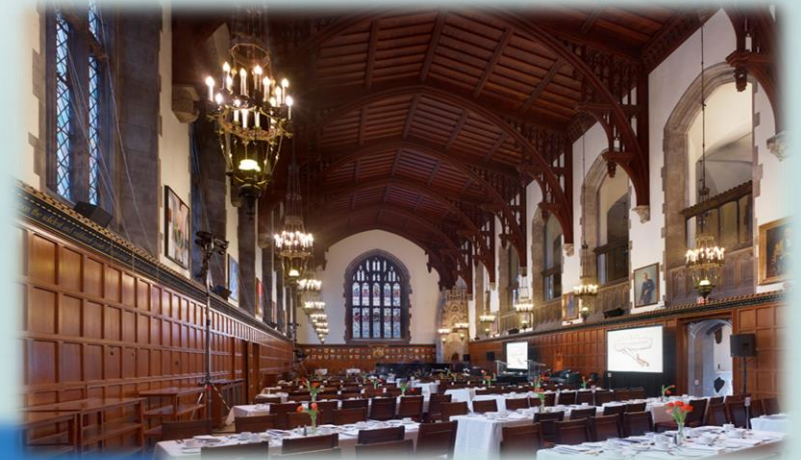
Conclusions

- ◆ Our results show that Public Score has a fairly strong ability to predict auto loss frequency.
- ◆ Public Score is not as significant of a predictor when Credit Score is included, but Public Score is, in fact, a stronger predictor when Credit Score is not included.
- ◆ Although Public Score is not as strong of a predictive variable as Credit Score for loss frequency, it would be prudent to incorporate Public Score in areas where Credit Score is prohibited in determining auto insurance premiums.

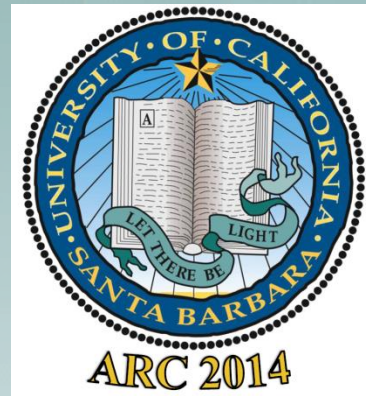




See you at ARC 2015-Toronto!



PROGRAM CHANGES

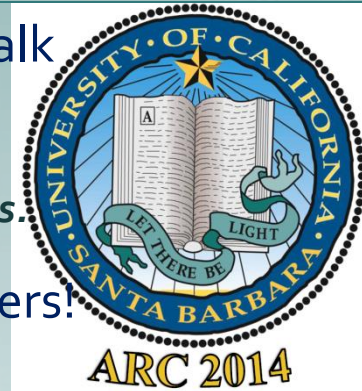


C1, 1:30-1:50pm talk by Paul Embrechts, ETH Zurich
Copula Theory and Applications: Quo Vadis?
talk by N.D. Shyamalkumar is cancelled

C1, 1:55-2:15pm talk by Patrick Brockett, UT Austin
Optimal Capital Budgeting and Risk Management
with Shared and Dependent Risks
talk by Ed Furman is cancelled

Cancellation: Poster #1 by Francisca Amoatema

Title correction: A2, Retirement Panel . Talk by Craig Turnbull
Market-Consistent Valuation of Pension Sponsor Support
and its Use in Risk-Based Capital Assessment



ARC 2014 PHOTO: 10am Monday, following Professor Embrecht's talk
Please arrive promptly at steps in front of UCEN building

ARC 2014 EXHIBITS: Monday-Tuesday MCC Lounge *open during breaks.*

ARC 2014 POSTER SESSION at Corwin East: Vote for the best posters!
Presenters will be available to answer questions 5.10pm-6pm; voting from 5.10-6pm

SEE NOTICE BOARD FOR PROGRAM/SPEAKER CHANGES

WINE & CHEESE RECEPTION: 5.10-6.00pm Monday, Lagoon Plaza

SPEED NETWORKING SESSION: 5.30-6.30pm Monday, Corwin West, **Now closed**
Note: participants have 20 min to grab food, vote on posters and get their seat.

WEDNESDAY WINE TOUR: Unfortunately full. A waitlist in case of cancelation.

BUSES TO/FROM DOWNTOWN SANTA BARBARA: Monday evening. Leave campus: 6pm & 7.10 pm from Santa Rosa, 7pm from Manzanita Village circle
Drop-off and pick-up places: Paseo Nuevo near California Kitchen & Wharf circle
Pick-up times: 9pm and 10pm (about 15 minutes later at Paseo Nuevo)
Buses will stop at Santa Rosa for people with cars at lot #3 and at Manzanita Village.

EVENINGS: bring a sweater/jacket!