



Incorporating Predictive Analytics into an Actuarial Curriculum

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Outline



- 1 The Curriculum Foundations
 - Utilizing R to Promote Analytics
 - The Role of Loss Data
- 2 Analytics Core in an Actuarial Curriculum
- 3 Advanced Analytics
- 4 Appendices
 - Wisconsin Actuarial Program Statistics
 - Open Actuarial Textbooks
 - Predictive Modeling Book Series



Wisconsin Actuarial Program



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- Started in 1948, one of longest standing actuarial science programs in the country
- A Center of Actuarial Excellence since program inception in 2009
- Primarily resides in the Wisconsin School of Business in the Department of Risk and Insurance with 20% of students majoring in Math, Statistics, or Economics
 - Inter-connected with the Risk Management and Insurance program at UW-Madison that is consistently ranked in the top 3 in the country
 - Composed of a robust faculty team, including six full-time faculty (plus one adjunct faculty member) focused on Actuarial Science. In addition there are four full-time faculty in Risk Management and Insurance (multiple adjunct faculty) and two full-time faculty in Business Analytics
- Faculty are highly regarded for their teaching, research and their service to the profession
- Offers coursework that covers the learning objectives for all of the preliminary exams required by both the SOA and the CAS
- Offers course options to fulfill all of the Validation by Educational Experience (VEE) requirements for actuarial professional certification



Utilizing R to Promote Analytics



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- At UW-Madison, research faculty are essentially applied statisticians
 - This drives our curriculum philosophy
 - We have moved from a heavy emphasis of applied probability modeling to one that emphasizes data reasoning
- To promote data analytics, we now incorporate the statistical package **R** into our first courses
 - Interest theory for us
 - At comparable programs (e.g., KU Leuven), students are required to do an online *Introduction to R* (through Datacamp) before starting the loss data sequence



Loss Data Analytics



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- In anticipation of curriculum changes, beginning in 2016-17 we changed the role of *loss data*
 - Switched from an applied probability to an applied statistics course
 - Recognizing this, we now call it *Loss Data Analytics* (not *Loss Models*)
 - Switched the order between loss data and actuarial mathematics.
 - Loss data is a year-long sequence, taken in 3rd year
 - Actuarial mathematics also a year-long sequence, taken in 4th year
- For required readings, we have been working with other academics to develop a free, online text book



Open Actuarial Textbooks Vision



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To have a set of actuarial texts covering the **foundations** of actuarial science. These texts will be an interactive, online, and freely available.

- The online version contains many interactive objects (quizzes, computer demonstrations, interactive graphs, video, and the like) to promote **deeper learning**.
- A subset of the book is available for offline reading in pdf and EPUB formats.
- The online text will be available in multiple languages to promote access to a *worldwide audience*.

To learn more, go to

<https://ewfrees.github.io/>



Analytics Core in an Actuarial Curriculum



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- We hope to develop more analytics for actuarial mathematics but that represents next steps
- Now, our “analytics core” consists of a regression course and comparable course in health analytics
 - The regression class covers traditional linear and generalized linear models, with a speck of time series
 - The health analytics course also involves methods as well as healthcare policy knowledge.
- Both classes use a hybrid teaching model, addressing many of the learning outcomes of the new SOA “Predictive Analytics” Exam
 - About 60% of each class period is spent on hands-on activities (using R to analyze data) where students team with one another
 - These classes require a written project
 - In some classes, students also present their projects. In other classes, students present regression/health applications.



Advanced Analytics



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- We developed a *Predictive Modeling Book Series*, sponsored by the Canadian Institute of Actuaries and the Casualty Actuarial Society.
 - Although designed for practicing actuaries, some universities are using this for their masters programs
- At UW, we have been discussing introducing a course on statistical learning. Faculty are eager to teach it but we are not sure how we can get enough undergrads to this level to warrant a course
- For our doctoral program, students have many, many options for courses and interested faculty across campus



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Thanks for Attending!



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- Summary of **Actuarial Science Club** from 2016 - 2017
 - Over 420 student members
 - 16 Employer-sponsored actuarial specific presentations
 - Social events including karaoke night, a SERF sports social and a Halloween pumpkin patch outing
 - Active student led mentorship program
- Department of Risk and Insurance **Co-Curricular Learning Board (CCLB)** offered their second case competition
- Sixty-one companies attended the 2016 **Risk and Insurance Career Fair** in September
- Statistics from 2016 - 2017 academic year
 - 93 actuarial graduates
 - 92% of domestic graduates found full time placement within 6 months of graduation
 - 76% of international graduates found either full time placement within 6 months of graduation or chose to further their education
 - 91% of domestic undergraduates who graduated had at least one summer internship while in school
 - 88% of last academic year's graduates had passed two or more professional actuarial science exams
 - Passed 2.8 professional exams on average by graduation
 - Over 35,000 USD awarded in scholarships to students who passed professional exams
 - Over 55,000 USD in general scholarships awarded to students
 - Over 25,000 USD awarded in experiential scholarships to students as course assistants, graders and project support



Open Actuarial Textbooks Vision



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Audience



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- Society of Actuaries (2016 Annual Report)
 - 27,000 members, 15% located outside of North America
 - 37,000 candidates, 22% located outside of North America
- Casualty Actuarial Society
 - 7,600 members
- Institute and Faculty of Actuaries
 - 29,000 members (December 2016)
 - 46% of members are based outside the UK, 52% of members are students
- Japanese Institute of Actuaries (2015 Annual Report)
 - 1,600 Fellows, 1,300 Associates, 2,000 students
- Institute of Actuaries of Australia (2016 Annual Report)
 - 2,200 Fellows, 700 Associates, 1,700 students



International Actuarial Association



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- “The IAA represents more than 60,000 actuaries worldwide”
- 70 Full members, e.g.,
 - Egyptian Society of Actuaries (Egypt)
 - Asociación Centroamericana de Actuarios (ACEA)
 - Caribbean Actuarial Association
 - Consejo Profesional de Ciencias Económicas de la Ciudad Autónoma de Buenos Aires (Argentina)
 - Actuaries Institute Australia (Australia)
 - Aktuarvereinigung Österreichs (AVÖ) (Austria)
 - Institut des Actuaire en Belgique (Belgique)
 - Aktuarsko Društvo U Bosni I Hercegovini (Bosnia and Herzegovina)
 - Instituto Brasileiro de Atuária (IBA) (Brazil)
 - Bulgarian Actuarial Society (Bulgaria)
 - Canadian Institute of Actuaries/Institut Canadien des Actuaire (Canada) , ...
- 28 Associate members, e.g.,
 - Channel Islands Actuarial Association ()
 - Albanian Actuarial Association (Albania)
 - Instituto Actuarial Argentino (Argentina)
 - Actuarial Society of Armenia (Armenia)
 - Actuarial Association of Azerbaijan (Azerbaijan)
 - Actuarial Society of Bangladesh (Bangladesh)
 - Association des Actuaire Beninois (Benin)
 - Actuarial Association of the Republic of Srpska (Bosnia and Herzegovina)
 - Instituto de Actuarios Matemáticos de Chile (Chile), ...



Open Educational Resources



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- An online text is a type of open educational resource (OER)
- Benefits of OERs
 - It equalizes access to knowledge, thus permitting a broader community to learn about the actuarial profession.
 - Has the capacity to engage viewers through **active** learning that **deepens** the learning process, producing analysts more capable of solid actuarial work.
- This movement is analogous to the development by the statistical community of the open-source statistical package **R**
 - **Vision** – An actuarial community that will work collaboratively in developing actuarial textbooks of the future



OER Examples



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- Many terrific examples of online texts
 - Online stats book, available on the web (<http://onlinestatbook.com/>) and in IBook format
 - The American *Yawp* is a free and online collaboratively built textbook on American History (<http://www.americanyawp.com/>).
 - A library of OERs at the OpenStax College (<https://cnx.org/>) initiative sponsored by Rice University
- For *Loss Data*, see
 - Marcel B. Finan, *An Introductory Guide in the Construction of Actuarial Models* (2013) (<http://faculty.atu.edu/mfinan/actuarieshall/CGUIDE.pdf>).
 - Mario Wütrich, *Non-Life Insurance: Mathematics & Statistics* (2017) (https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2319328)
- Overview of online resources at a page by Myron Hlynka, <http://web2.uwindsor.ca/math/hlynka/>.



R Bookdown and GitHub



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- **R** and **R-Studio** have recently implemented a new package called **Bookdown**
 - Allows one to author books and technical documents using R's version of *markdown*.
 - This package allows us to create .html, .pdf, and .EPUB versions of the same file.
- **GitHub** provides a platform for developing computer software code collaboratively. We use it for developing textbooks.
 - Provides an easy way to upload, store, and download versions of the book
 - Provides a straightforward method for keeping track of changes using the *git* software



Interactive Features of Online Version



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- The online version promotes **active learning**
 - The objective is to provide **formative assessment** tools - designed to make the viewer pay attention at the first reading
- To illustrate, the current versions includes:
 - *Javascript show/hide* for **R** codes
 - *Javascript show/hide* for solutions to problems
 - Multiple choice questions to provide immediate feedback
 - Online dictionary of terms (mouse rollover)
 - Links to current topics on the web
 - Online discussion forums - comment on the book
 - Dynamic graphs
 - Video explanations of selected topics
 - More to come



Incorporating Alternative Languages



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- Bookdown input files are text-based - in principle easy to convert to other languages
- Some test cases appear promising - we'll see

Git Magic
Preface
"Thanks!"
License
1. Introduction
 Work is Play
 Version Control
 Distributed Control
 A Silly Superstition
 Merge Conflicts
2. Basic Tricks
 Saving Space
 Add, Delete, Rename
 Advanced Undo/Redo
 Reverting
 Changelog Generation
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 The Bleeding Edge
 Instant Publishing
 What Have I Done?
 Exercise
3. Clipping Around
 Sync Computers
 Clone, Source Control
 Secret Source
 Bare repositories
 Push versus pull
 Forking a Project
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Preface

Git is a version control Swiss army knife. A reliable versatile multipurpose revision control extraordinary flexibility makes it tricky to learn, let alone master.

As Arthur C. Clarke observed, any sufficiently advanced technology is indistinguishable from magic. Git newcomers can ignore its inner workings and view Git as a gizmo and infuriate enemies with its wondrous abilities.

Rather than go into details, we provide rough instructions for particular effects. After reading you will understand how each trick works, and how to tailor the recipes for your needs.

Translations

- **Simplified Chinese:** by Junjie Meng and Jiangwei. Converted to **Traditional Chinese** by 許家豪.
- **French:** by Alexandre Garel, Paul Gaborit, and Nicolas Deram. Also hosted at [itaaip](#)
- **German:** by Benjamin Bellue and Armin Stebich; also [hosted on Armin's website](#).
- **Italian:** by Mattia Rigotti.
- **Korean:** by Jung-Ho (John) Han; also [hosted on John's website](#).
- **Polish:** by Damian Michna.
- **Brazilian Portuguese:** by José Inácio Serafini and Leonardo Siqueira Rodrigues.
- **Russian:** by Tikhon Tarnovsky, Mikhail Dymnikov, and others.
- **Spanish:** by Rodrigo Toledo and Ariset Llerena Tapia.
- **Ukrainian:** by Volodymyr Bodenchuk.
- **Vietnamese:** by Trần Ngọc Quân; also [hosted on his website](#).



Project Status



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- Go to GitHub, search for *Loss-Data-Analytics*. Go up to "ewfrees" and find four repositories
 - ➊ *Loss-Data-Analytics* is a draft of a textbook. Many chapters are complete. Detailed notes for other chapters. The online version has several interactive components (that do not work in the .pdf and .epub versions)
 - ➋ *LossDataAnalyticsRCode* provides illustrative R code (with data) that students can work through as they read the book
 - ➌ *LossDataAnalyticsOverheads* provides overheads, suitable for use in classroom presentation
 - ➍ *LifeCon* provides three sets of life contingency/actuarial mathematics lecture notes.
- At the GitHub site, you will find links to the project site as well as WordPress site



Loss Data Analytics



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Why loss data analytics?

- One has to start somewhere
- Given the dramatic changes in the way that actuaries treat data, loss data seems like a natural place to start.
- The name *loss data analytics* – integrate classical loss data models from applied probability with modern analytic tools.
 - Emphasis is applications of loss analytic techniques including pricing, reserving, and claims management
 - Emphasis on *empirical* (data) aspects (not applied probability)
- Big data (e.g., social media and usage based insurance) and high speed computation are here to stay



Call for Volunteers



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How to be involved

- Have your students use the materials as they develop. Critique. Suggest ways to improve.
- Comment on chapters as they develop
- Contribute problems/data/case studies
- Write a chapter yourself
- Help direct the development of the resource - give talks to interested groups
- Help to develop resources for the project
- Many other volunteer opportunities



Predictive Modeling Book Series



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- We coordinated and co-authored this two volume set, published by *Cambridge University Press* and co-sponsored by the *Casualty Actuarial Society*, that provides evidence to identify our program as a leader in insurance analytics
 - I am a co-Editor, along with Glenn Meyers and Richard Derrig
 - Thirty one author teams in total (over two volumes)
 - I, Peng Shi, and Margie Rosenberg have authored chapters, along with others from 7 different countries



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 - I, Peng Shi, and Margie Rosenberg have authored chapters, along with others from 7 different countries
- Volume I appeared in 2014 - we are pleased with the response to it
 - Japanese Institute of Actuaries purchased 760 copies and we have completed the translation
- Volume II, on case studies, appeared August 2016
- Book URL
<http://research.bus.wisc.edu/PredModelActuaries>



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TOGETHER
FORWARD

Predictive Modeling Applications in Actuarial Science

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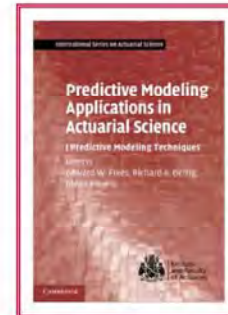
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- ▾ Predictive Modeling Foundations
- ▾ Predictive Modeling Methods
- ▾ Bayesian and Mixed Modeling
- ▾ Longitudinal Modeling
- School of Business Research
- Jed Frees - Research

Welcome!

This is the new website for *Predictive Modeling Applications in Actuarial Science*, a two volume series that we are creating

This website currently focuses on Volume 1. We provide content preview, data (txt or csv format) and R code (R format) for each chapter here. Contact authors for further information about data and code.



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4. Regression with Count Dependent Variables
5. Generalized Linear Models
6. Frequency and Severity Models

Predictive Modeling Methods

7. Longitudinal and Panel Data Models
8. Linear Mixed Models
9. Credibility and Regression Modeling
10. Fat-Tail Regression Models
11. Spatial Statistics
12. Unsupervised Learning

Bayesian and Mixed Modeling

13. Bayesian Computational Methods
14. Bayesian Regression Models
15. Generalized Additive Models and Nonparametric Regression
16. Non-Linear Mixed Models

Longitudinal Modeling

17. Time Series Analysis
18. Claims Triangles/Loss Reserves
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Predictive Modeling – Volume II



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Available Summer 2016

Volume II: Case Studies in Insurance

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2. Applying Generalized Linear Models to Insurance Data: Frequency-Severity Versus Pure Premium Modeling
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5. Using Multilevel Modeling for Group Health Insurance Ratemaking: A Case Study from the Egyptian Market
6. Clustering in General Insurance Pricing
7. Advanced Unsupervised Learning Methods Applied to Insurance Claims Data: Applications of Two Unsupervised Learning Techniques to Questionable Claims: PRIDIT and Random Forest
8. The Predictive Distribution of Loss Reserve Estimates Over a Finite Time Horizon
9. Finite Mixture Model and Workers Compensation Large Loss Regression Analysis
10. A Framework for Managing Claim Escalation Using Predictive Modeling
11. Predictive Modeling for Usage-Based Auto Insurance