Math 417C   Loss Models III   Spring 2018
11:00 – 11:50 (Bouillon 210 M, BU 103 W, SS 115 F)

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Prerequisite: Math 417A or by permission.

Text:
1. Required: Stuart A. Klugman, Harry H. Panjer, Gordon E. Willmot, <u>Loss Models</u>, Wiley 2012.
2. Optional: Samuel A. Broverman, Actex C/4 Study Manual, or ASM Study manual
3. Required: Adapt Classroom for Exam C online subscription, please renew your subscription online.

The students will be introduced to useful frequency and severity models. They will be required to understand the steps involved in the modeling process and how to carry out these steps in solving business problems. The students should be able to:
  (i) analyze data from an application in a business context;
  (ii) determine a suitable model including parameter values; and
  (iii) provide measures of confidence for decisions based upon the model.
The students will be introduced to a variety of tools for the calibration and evaluation of the models.

Learning outcomes:
After taking this sequence, the students are expected to be familiar with survival, severity, frequency and aggregate probability models, and use statistical methods to estimate parameters of such models given sample data. The students are further expected to identify steps in the modeling process, understand the underlying assumptions implicit in each family of models, recognize which assumptions are applicable in a given business application, and appropriately adjust the models for impact of insurance coverage modifications.

LEARNING OUTCOMES for the course sequence Math 417A,B,C—Math 417C in purple
The student is expected to be familiar with survival, severity, frequency and aggregate models, and use statistical methods to estimate parameters of such models given sample data. The student is further expected to identify steps in the modeling process, understand the underlying assumptions implicit in each family of models, recognize which assumptions are applicable in a given business application, and appropriately adjust the models for impact of insurance coverage modifications.
A. Severity Models
    1. Calculate the basic distributional quantities:
        a) moments
        b) Percentiles
        c) Generating functions
    2. Describe how changes in parameters affect the distribution.
    3. Recognize classes of distributions and their relationships.
    4. Apply the following techniques for creating new families of distributions:
a) Multiplication by a constant
        b) Raising to a power
        c) Exponentiation,
        d) Mixing
    5. Identify the applications in which each distribution is used and reasons why.
    6. Apply the distribution to an application, given the parameters.
    7. Calculate various measures of tail weight and interpret the results to compare the tail weights.
    8. *Identify and describe two extreme value distributions.*
B. Frequency Models

For the Poisson, Mixed Poisson, Binomial, Negative Binomial, Geometric distribution and mixtures thereof:

1. Describe how changes in parameters affect the distribution,
2. Calculate moments,
3. Identify the applications, for which each distribution is used and reasons why,
4. Apply the distribution to an application given the parameters.
5. Apply the zero-truncated or zero-modified distribution to an application given the parameters

C. Aggregate Models
1. Compute relevant parameters and statistics for collective risk models.
2. Evaluate compound models for aggregate claims.
3. Compute aggregate claims distributions.

D. For severity, frequency and aggregate models
1. Evaluate the impacts of coverage modifications:
   a) Deductibles
   b) Limits
   c) Coinsurance
2. Calculate Loss Elimination Ratios.
3. Evaluate effects of inflation on losses.

E. Risk Measures
1. Calculate VaR, and TVaR and explain their use and limitations.

F. Construction of Empirical Models
1. Estimate failure time and loss distributions using:
   a) Kaplan-Meier estimator
   b) Nelson-Åalen estimator
   c) Kernel density estimators
2. Estimate the variance of estimators and confidence intervals for failure time and loss distributions.
3. Apply the following concepts in estimating failure time and loss distribution:
   a) Unbiasedness
   b) Consistency
   c) Mean squared error

G. *Estimation of decrement probabilities from large samples*
1. *Estimate decrement probabilities using both parametric and nonparametric approaches for both individual and interval data*
2. *Approximate the variance of the estimators*

H. Construction and Selection of Parametric Models
1. Estimate the parameters of failure time and loss distributions using:
   a) Maximum likelihood
   b) Method of moments
   c) Percentile matching
   d) Bayesian procedures
2. Estimate the parameters of failure time and loss distributions with censored and/or truncated data using maximum likelihood.
3. Estimate the variance of estimators and the confidence intervals for the parameters and functions of parameters of failure time and loss distributions.
4. Apply the following concepts in estimating failure time and loss distributions:
   a) Unbiasedness
   b) Asymptotic unbiasedness
   c) Consistency
   d) Mean squared error
   e) Uniform minimum variance estimator
5. Determine the acceptability of a fitted model and/or compare models using:
   a) Graphical procedures
   b) Kolmogorov-Smirnov test
   c) Anderson-Darling test
   d) Chi-square goodness-of-fit test

      e) Likelihood ratio test
      f) Schwarz Bayesian Criterion

I. Credibility
1. Apply limited fluctuation (classical) credibility including criteria for both full and partial credibility.
2. Perform Bayesian analysis using both discrete and continuous models.
3. Apply Bühlmann and Bühlmann-Straub models and understand the relationship of these to the Bayesian model.
4. Apply conjugate priors in Bayesian analysis and in particular the Poisson-gamma model.
5. Apply empirical Bayesian methods in the nonparametric and semiparametric cases.

J. Simulation

1. Simulate both discrete and continuous random variables using the inversion method.
2. *Simulate from discrete mixtures, decrement tables, the (a,b,0) class, and the normal and lognormal distributions using methods designed for those distributions*
3. Estimate the number of simulations needed to obtain an estimate with a given error and a given degree of confidence.
4. Use simulation to determine the p-value for a hypothesis test.
5. Use the bootstrap method to estimate the mean squared error of an estimator.
6. Apply simulation methods within the context of actuarial models.

Grading policy:
1. Class participation, attendance, professionalism (20 points)
2. Assignments (up to 100 points) Problems of the Day
3. Adapt quizzes (up to 100 points) Two attempts, take the average or the first attempt, whichever is higher.
4. Two tests   (200 points) Questions from the in-class examples and Adapt quizzes
5. Three Labs (100 points)
6. Final exam   (100 points) Questions from the above 2.~5. You may use Excel on the final exam.

Total Up to 620 points

Final grades will be assigned according to the following scale:

A 100-93%   **A-** 92.9-90%
B+ 89.9-87%   **B** 86.9-83%   **B-** 82.9-80%
C+ 79.9-77%   **C** 76.9-73%   **C-** 72.9-70%
D+ 69.9-67%   **D** 66.9-63%   **D-** 62.9-60%
F 59.9% and below

Class Expectations
- *Think critically*. This course will require critical thinking. People that analyze, infer, evaluate, and make reasoned judgments do better in college and career, make better daily decisions, and have greater professional success. Developing critical thinking and reasoning should be a key goal of every student.

- *Apply yourself.* This course will take a lot of time and energy. You should have high learning expectations and challenge yourself. Success in this course will require significant effort (several hours of study time for each hour of class). Depending on your mathematical background, you may need to spend more or less study time. Attend class regularly, be on time, and budget your time to accommodate the workload.

- ***Ask questions***. Loss Modeling is fascinating, but it can be confusing sometimes, too. Ask questions. If you aren't clear on something, there are likely others who are equally unclear on the specific detail or area. Asking questions also help your peers and the instructor deliver/facilitate effective lessons.

- ***Be informed***. People sometimes use information to manipulate others' behaviors and decision-making in ways not always to your benefit. If you don't understand the mathematical basis of a claim about data, you can't make an informed decision about it. Be curious; try and find out all you can about a topic before you make a decision that may profoundly affect your life and career.

- ***Communicate clearly***. Effective written and oral communication of difficult concepts and techniques indicates an intelligent mind and true understanding. Clarity, proper format, spelling, and grammar are expected of every student.

- ***Use common sense***. Cheating on assignments or exams, plagiarizing others' work, and turning in late assignments is unacceptable. Any infractions may result in a zero for the assignment, a failing course grade, and the possibility of disciplinary action by the university. I won't accept *anything* late unless you have written documentation from an appropriate source or have made prior arrangements with me. If you have a problem that prohibits you from turning something in on time, let me know ahead of time. In all instances, communicate with me so we can prevent future problems.

Tentative Schedule (Any change will be announced in class and Canvas.)

Week	Reading Assignment (Please check Canvas for other assignments due)	
0. 3/27-3/30	Chapter 13 (13.1, 13.2)	MLE, MME, PME; MLE on Censored and/or Truncated data;
	Adapt Quiz 1 (Friday 3/30)	**Lab1: Simulation**
1. 4/2-4/6	Chapter 13 (13.3, 13.4)	Variance and Interval Estimation; Delta Method; MLE of decrement Probabilities
	Adapt Quiz 2 (Friday 4/6)	
2. 4/9-4/13	Chapter 14 (14.1~14.6)	MLE for discrete distributions
	Adapt Quiz 3 (Friday 4/13)	
3. 4/16-4/20	Chapter 16 (16.1~16.4)	Model selection: KS, AD, Chi, LR Tests **Lab 2: Model Testing**

Adapt Quiz 4 (Friday 4/20)

4. 4/23-4/27	Chapter 16 (16.5)	Selecting a model: Judgement-based approaches

Adapt Quiz 5 (Friday 4/27)

5. 4/30-5/4	**Test 1 (Covers the above sections)**	
	Chapter 17 (17.1~17.5)	Full Credibility, Partial Credibility

Adapt Quiz 6 (Friday 5/4)

6. 5/7-5/11	Chapter 18 (18.1~18.4)	Bayesian credibility
	Adapt Quiz 7 (Friday 5/11)	
7. 5/14-5/18	Chapter 15 (15.1~15.3)	Bayesian Estimation
	Adapt Quiz 8 (Friday 5/18)	
8. 5/21-5/25	Chapter 18 (18.5~18.7)	Buhlmann Model Buhlmann-Straub
9. 5/28-6/1	**Test 2 (Covers the above sections after Test 1)**	
	Lab 3: TBD	
10. 6/4-6/8	**Final Exam (comprehensive)**	

The **Final Exam** will be in class following the university schedule.