Math 417C Loss Models III Spring 2016
11:00 – 11:50 (Bouillon 112 M&W, Bouillon 103 F)

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Prerequisite: Math 417B or by permission.

Text:
1. Required: Stuart A. Klugman, Harry H. Panjer, Gordon E. Willmot, Loss Models, Wiley 2012.
2. Required: Samuel A. Broverman, Actex C/4 Study Manual

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 (You have done most work through WS#3 and Lab 2 in 417B, so this quarter you can apply this to your research project when suitable and refer to the textbook and Actex manual if you need reference.). 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**. Students are expected to develop a research project (team or individual) by reaching out to the real-world data and providing modeling and analysis to be presented at the CWU SOURCE event.

LEARNING OUTCOMES for SOA Exam C (Construction and Evaluation of Actuarial Models)
The candidate 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 candidate 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.
Specifically, the candidate is expected to be able to perform the tasks listed below. Items in italic font are additions or replacements with respect to the June 2013 SOA syllabus.
Sections A–E have a combined weight of 15-20%.
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.

Sections F and G have a combined weight of 20-25%.

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 (25-30%)
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 (20-25%)

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 (5-10%)

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.

Course outlines:

	Topic	Days (one day is one-hour)
I	Aggregate loss models (Chapter 9 Re-visit 9.7, 9.8) 1. Aggregate claims 2. Compound models 3. The individual risk model 4. Compound Poisson approximation	4
II	Model Selection (Chapter 16) 1. Representations of the data and model 2. Graphical comparison of the density and distribution functions 3. Hypothesis tests: K-S test, Anderson-Darling test, Chi-square Goodness-of-fit test, Likelihood ratio test 4. Selecting a model: Judgment-based and score-based	8
III	Credibility, Empirical Bayes parameter estimation (Chapter 17, 18, 19)	10
IV	Data Modeling Project (Friday lab for course content or SOURCE project) *Check out Canvas weekly for assignment update! We basically Implement the theories to Excel workbook as far as we can. The Excel workbook will be the class project that can be used to Your research project.*	5

TESTING (Test date will be announced at least a week ahead)	3
TOTAL	30

Class format: Mixture of lectures, in-class problem solving, and computer lab. Students present their solutions of the assigned problems and answer questions raised by the instructor and other students. Group discussions to explain concepts and work on modeling projects.

Grading policy:

1.	Research Project Written Report	(100 points)
2.	SOURCE presentation	(50 points)
3.	Homework Assignments	(75 points)
4.	Attendance (in-class Work, active learning)	(25 points)
5.	Two Quizzes	(150 points)
6.	Final exam	(100 points)
Total:		**500 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

- ***Attendance.*** Attendance will be taken every class and corresponds to 5% of the total grade. Students are expected to actively participate in class by answering questions, working on in-class exercises, joining online discussion board, giving presentations as individuals or as a part of their team projects, and sharing personal experiences and opinions related to the topics discussed. Students who do not participate in class or **miss more than 3 classes** without a pre-approved and written excuse will have their attendance points deducted by 15 points and final grades reduced by one grade (e.g. A- to B+). Be sure to contact me **BEFORE** you miss a class. If you miss a class, you will be responsible for the information covered – please contact another classmate to determine what you have missed. You are also expected to check your CWU e-mail and the canvas on a regular basis for updated course announcements and materials.

- ***Assignments.*** All homework is to be completed individually unless notified otherwise. Students will volunteer or be asked to discuss homework due that class period. While I encourage collaboration among your peers, please do not share potential solutions. Please refer to CWU policy on cheating (specified in Student Judicial Code) for more information. ***Late Policy***: All homework is to be handed in b the due dates as specified. If you have a special circumstance, let me know in advance. It is always better to turn in your current work for partial credit than turn in nothing. As a "grade period", once during the course you can turn in a homework assignment after it is due with an accompanying reduction of 20% of the earned grade for each day late. When it is not in on time the 2nd time or thereafter, **late homework will not be accepted**.

- ***Quizzes.*** The best way to study for the quizzes is to fulfill the homework assignments, understand well the concepts and examples covered in class, and make sure you have gained skills to practically apply the class knowledge in practice. Both quizzes will be in-class and closed-book tests. I will provide a practice quiz and review guide prior to the quiz to help you prepare for the quiz.

- ***Research (SOURCE) Project.*** The purpose of the research project is to reinforce understanding and application of key LM concepts and techniques and use a structured modeling approach to analyze real-world data set. Each team member should plan to spend 15-30 hours total on the research project in spring quarter, including some time in class when time is available. The research project will be presented on the SOURCE Day in the form of either poster or oral presentation. Typically a delivered SOURCE presentation will earn 45-50 points and Award Winning presentation will earn extra 5 points. The final project report is due soon after the SOURCE Day (**May 20th**). For detailed rubrics please refer to the Report Rubrics handout.

- ***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 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.

- ***Extra Credit Points***. You can earn extra points for things such as providing a helpful and insightful answer during the lecture discussions, and finding errors in class notes and textbook examples. Extra credit points will be added to your final grade and can compensate some missed points. Altogether, you can earn up to 10 extra points (2% of the total grade), however, together with these extra points you can't earn more than 500 points over the duration of the course.

- ***Re*-grading assignments/quizzes/exam.** The instructor is always willing to clarify what is required for a deliverable or why you received a particular grade. Students may meet with me to get feedback regarding their performance throughout the quarter. While I will always correct mistakes in the arithmetic computation of grades and grade recording errors, final letter grades are not negotiable and I will not entertain challenges to final letter grades.

- ***Students with Disability.*** Students with disabilities who require academic adjustments in this class are encouraged to meet with me during my office hours to discuss their disability-related needs. Please bring a copy of your Confirmation of Eligibility for Academic Adjustments. We will then discuss how the approved adjustments will be implemented in this class. Students without this but in need of requesting services should contact the CDS for additional information at Bouillon 205, or via cdsrecept@cwu.edu or 963-2171.

- ***Academic Integrity.*** Academic integrity is an important value at CWU. By enrolling in this course, each student assumes the responsibilities of an active participant in Actuarial scholarly community in which everyone's academic work and behavior are held to the highest standards of honesty and integrity. Cheating, fabrication, plagiarism, and helping others to commit these acts are all forms of academic dishonesty (Please refer to the CWU Student Judicial Code for more details). Academic misconduct will result in disciplinary action that may include, but is not limited to, failure of the course, suspension or dismissal.

Schedule:
Below is a tentative schedule of lecture topics, readings, assignments, due dates, and other activities. The instructor reserves the right to adjust this schedule for any reason, but will make every effort to advise students of any changes well in advance.

<table>
<tr><th colspan="2">Week/Dates</th><th>*Topic</th><th>Reading</th><th>Assignment/Activity</th></tr>
<tr><td>1</td><td>3/29~4/1</td><td rowspan="2">Aggregate loss models</td><td>Syllabus & §9</td><td>Review §9
Assignment #1 Modeling-Problem Set 20 LM-283~291 Due (4/8)</td></tr>
<tr><td>2</td><td>4/4~4/8</td><td>§9</td><td>SOURCE Abstract submission online</td></tr>
<tr><td>3</td><td>4/11~4/15</td><td rowspan="3">Model Selection (and Evaluation/Testing)</td><td rowspan="3">§16</td><td>SOURCE submission closed at noon 4/14
Quiz 1 Practice. (4/15)
No class on 4/15</td></tr>
<tr><td>4</td><td>4/18~4/22</td><td>Quiz 1 (4/22)</td></tr>
<tr><td>5</td><td>4/25~4/29</td><td>*Excel Lab. Demonstration: AMOOF</td></tr>
<tr><td>6</td><td>5/2~5/6</td><td rowspan="2">Credibility</td><td>§17</td><td>*Excel Lab. Demonstration: Model Evaluation
Assignment #2 Credibility-problem Set 1 CR-1~22 Due (5/13)</td></tr>
<tr><td>7</td><td>5/9~5/13</td><td>§18</td><td>Quiz 2 Practice</td></tr>
<tr><td>8</td><td>5/16~5/20</td><td colspan="2">*SOURCE Day 5/18, 19</td><td>Final Project Report due 5/20
No class on 5/16, 18</td></tr>
<tr><td>9</td><td>5/23~5/27</td><td rowspan="2">Credibility</td><td>§19</td><td>Quiz 2 (5/27)</td></tr>
<tr><td>10</td><td>5/30~6/3</td><td></td><td>Final Exam Practice</td></tr>
<tr><td colspan="5">Research Project Written Report due by noon of 5/20/2016
Final Exam (in class) will be scheduled by registrar's office (possible dates (6/6-6/10)</td></tr>
</table>

Note *: The content belonging to a topic is only partially presented on the table.