STAT:4560
Statistics for Risk Modeling
Course Syllabus
Fall 2019

MWF, 112 MH
11:30 a.m. – 12:20 p.m.
Th, 113 MLH
12:30 p.m. – 1:20 p.m.

COLLEGE OF
LIBERAL ARTS & SCIENCES

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Actuarial Science

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1   Contact Information

- **Instructor:** Professor Ambrose Lo, PhD, FSA, CERA

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  (Note: Please put "STAT:4560" in the subject line)

  ▷ *Personal homepage:* `https://sites.google.com/site/ambroseloyp`
  (Feel free to visit it from time to time for latest updates on my courses and books!)

  ▷ *Office hours:*
Wednesday	:	3:30 p.m. – 4:30 p.m.
Thursday	:	2:30 p.m. – 3:30 p.m.
Friday	:	3:30 p.m. – 4:30 p.m.

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- **Grader:** Mr. Hong Beng (Ben) Lim

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2 Course Description and Objectives

Prerequisites: STAT:4101 (Mathematical Statistics II) with a minimum grade of C+
or STAT:5101 (Statistical Inference II) with a minimum grade of C+

Building upon students' prior exposure to actuarial science and preparation in mathematical statistics, this applied statistics course for B.S. and M.S. in Actuarial Science students covers the theory and applications of linear regression models, generalized linear models, tree-based models, and regression-based time series models, as required in the **Statistics for Risk Modeling (SRM) Exam** offered by the Society of Actuaries (SOA). Emphasis is placed on the parameter estimation, statistical inference, prediction, variable selection, and diagnostic checking issues surrounding these models. Practical implementations of these models with real data in actuarial and financial contexts by means of the R programming language will be demonstrated to give you some hands-on data analysis experience. This is an important way to put the theory we learn in the course into practice. Although the use of R is not strictly required for Exam SRM, it is essential for the **Predictive Analytics (PA) Exam**, which has SRM as the prerequisite.

Structure-wise, this course consists of the following three central strands:

Strand I.	Linear Regression Models	(approx. 9 weeks)
Strand II.	Generalized Linear Models	(approx. 3 weeks)
Strand III.	Decision Trees	(approx. 3 weeks)

Note that this course emphasizes not only the ability to perform and interpret computer-based statistical analyses, but also the mathematical rationale behind the construction of various estimators, hypothesis tests, and point/interval predictions. By strongly discouraging the black-box approach adopted by conventional regression courses, this course will inculcate students with a genuine understanding of why a particular statistical methodology works or does not work. If you do not plan to take Exam SRM or prefer a more elementary and less technical course, consider taking STAT:3200 *Applied Linear Regression* instead.

After taking this course, the successful student is expected to:

- Understand the ideas and assumptions underlying the statistical methods covered in the course.

- Apply appropriate statistical methods to real-world problems that are amenable to such techniques.

- Implement and interpret a computer-based statistical analysis using R.

- Take and, most importantly, pass Exam SRM in January 2020 with considerable ease.

- Be equipped with the conceptual underpinnings to take Exam PA in June/December 2020.

3 Exam SRM

Exam SRM is a three and one-half hour computer-based exam consisting of 35 multiple-choice questions, each of which includes five answer choices identified by the letters (A), (B), (C), (D), and (E), only one of which is correct. Offered for the first time in September 2018 by the SOA,

this new exam is a replacement of the old Validation by Educational Experience (VEE) Applied Statistics requirement and serves as the formal prerequisite for the new PA exam. The construction of Exam SRM, which revolves around making use of various statistical models to draw inferences and make predictions for the future, is an important step that the SOA takes to incorporate more statistics, most notably predictive modeling, into the modern-day actuarial curriculum. More information about Exam SRM can be found at `https://www.soa.org/education/exam-req/edu-exam-srm-detail.aspx`.

Out of the six topics in the SRM exam syllabus, this course is largely dedicated to

Topic 1: Basics of Statistical Learning (7.5-12.5%),

Topic 2: Linear Models (40-50%),

Topic 5: Decision Trees (10-15%),

and, if time permits, Topic 3: Time Series Models (12.5-17.5%).

Together, these topics account for about 70% of the exam syllabus. To learn Topic 4: Principal Components Analysis (2.5-7.5%) and Topic 6: Cluster Analysis (10-15%), consider taking STAT:4540 *Statistical Learning*, in addition to STAT:4560, in this fall semester.

One distinguishing characteristic of Exam SRM compared to other multiple-choice ASA-level exams is that most of the questions in this exam are *conceptual* in nature, testing the uses, motivations, pros and cons, do's and don'ts of, and similarities and differences between different statistical methods. As the SOA publicly admits in the 2019 Actuarial Teaching Conference,[i] "there are a lot of qualitative questions" in Exam SRM. You are typically given three statements and asked to pick the correct one(s). The generic structure of these questions is as follows:

Determine which of the following statements about *[...a particular statistical concept/method...]* is/are true.

   I. (blah blah blah...)

  II. (blah blah blah...)

 III. (blah blah blah...)

(A) I only

(B) II only

(C) III only

(D) I, II, and III

(E) The correct answer is not given by (A), (B), (C), or (D).

or

(A) None

(B) I and II only

(C) I and III only

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[i]See https://www.soa.org/globalassets/assets/files/e-business/pd/events/2019/actuarial-teaching-conference/2019-atc-presentation-klugman.pdf.

(D) II and III only

(E) The correct answer is not given by (A), (B), (C), or (D).

Do not be under the impression that these conceptual questions are easy. The conceptual items being tested can be tricky and at times controversial: Rather than an absolute "yes" or "no," the statement is more a matter of extent. Sadly, if you get any of Statements I, II, or III incorrect, you will likely be led to the incorrect final answer. By the way, Answer (E) occasionally turns out to be the right answer—it is not a filler!

Logistically, Exam SRM is offered three times every year (in January, May, and September). In January 2020, it will be offered via computer-based testing (CBT) from **January 6 to January 12**. The registration deadline is December 3, 2019 (please refer to `https://www.soa.org/education/exam-req/exam-day-info/edu-2020-cbt-test-schedule/`). It is strongly suggested that you take the exam in **January 2020** shortly after you learn the material, do the homework, and study for the quizzes and exams in this course (as the old saying goes, "strike while the iron is hot!"). You will have time to study for Exam SRM because ACTS:4280 *Life Contingencies II*, which prepares you for Exam LTAM, will end in late October. In the unlikely event that you cannot pass the exam in January 2020, you should retake it in May 2020 when your memory is still fresh. The bottom line is:

> You should aim to have at least four professional exams under your belt, namely, P, FM, IFM, LTAM, and/or SRM by the time you graduate.

4 Textbook

The text of this course is

> *ACTEX Study Manual for SOA Exam SRM* (Fall 2019 Edition), 2019, by Feng, R., Linders, D., **Lo, A. (yours truly)**, ACTEX Learning, New Hartford, CT. ISBN: 978-1-63588-723-5

This study manual not only addresses all important topics required in the SRM exam syllabus, but also presents lots of intuition for you to understand the subject matter deeply, and a wide variety of examples and practice problems for exam preparation. In this course, we will cover the following chapters in the manual:

Chapter 1: Simple Linear Regression

Chapter 2: Multiple Linear Regression

Chapter 3: Model Diagnostics

Chapter 4: Selected Topics in Linear Models

Chapter 5: Generalized Linear Models

Chapter 8: Decision Trees

(Time permitting) Chapters 6: Fundamentals of Time Series Analysis and Chapter 7: Time Series Forecasting

During lectures, the instructor will provide a framework, cover the main ideas, point out subtleties, and go over representative examples with you. You should put down additional details, work out examples together with the instructor, and take supplementary notes to better understand concepts.

5   Grading System

Assessment in this course comprises the following items:

- **Attendance and Attitude:** $\pm\varepsilon\%$[ii]

  You may choose to attend or not to attend classes, but everyone needs to be aware that unexcused absences from classes can adversely affect your final grade. It is also impossible for absentees to get a copy of course material they miss, inquire about announcements made in class, or seek out-of-class help from the instructor. Likewise, your participation, preparedness, and work ethic may affect your final grade (positively or negatively).

- **Homework Assignments: 18%**

  There will be weekly homework assignments usually consisting of 3 to 5 problems, assigned on Friday and due the following Friday. Refer to the course schedule on pages 7 and 8. Any exceptions will be announced in class or on ICON (`http://icon.uiowa.edu`). Some assignment problems will require some simple data analysis, which you are expected to perform using R. Late homework will be severely penalized (see the generic assignment instructions on ICON). For students' guidance, illustrative solutions will be posted on ICON shortly after each homework is due.

  A note on collaboration: Discussion with other students on homework problems is encouraged. However, you should always write up your own solutions.

- **Short Quizzes: 17%**

  There will be a total of six 15-minute quizzes held on Mondays. These quizzes are intended to motivate you to study regularly (not just cram before the Midterm and Final Exams!) and will consist of relatively straightforward questions. The quiz with the lowest score will be dropped when it comes to computing the final grade; accordingly, missed quizzes due to illness cannot be made up under any circumstances.

- **Midterm Examination: 25%**

  There will be a two-hour Midterm Examination to be held in the evening (6:30 p.m. – 8:30 p.m.) of **November 4, 2019 (Monday)** at 140 SH covering Chapters 1 to 4 of this course. It will consist of multiple-choice questions which emphasize how to make use of summarized model output to perform estimation, statistical inference, and/or prediction, and . You will find that the in-text examples and end-of-chapter problems in the SRM study manual are useful in preparing for the Midterm Exam.

- **Final Examination: 40%**

  A two-hour comprehensive Final Examination will take place in the week of December 16–20, 2019. Like the Midterm Exam, the Final Exam will comprise a series of multiple-choice questions similar in style to typical SRM problems. The exact date and time will be announced by the Registrar in mid-September. Please do not plan your end-of-semester travel plans until the final exam schedule is made public. It is your responsibility to know the date, time, and place of the Final Exam.

[ii]In mathematics, ε usually denotes a small positive number.

All quizzes and exams in this course are closed-book. The SRM tables (posted on ICON) will be provided if needed, and you are not allowed to bring your own formula sheets (the same applies to the real SRM exam as well!). Only calculators listed on Point 9 of the SOA exam rules and regulations/instructions (see `https://www.soa.org/Files/Edu/edu-rules-reg-instructions.pdf`) are permitted.

A note on absence from exams. If, because of illness, you are unable to take any exams in this course as scheduled, you should inform the course instructor *within 24 hours* after the exam has ended and explain why you are medically unfit to take the exam on the scheduled date. Otherwise, a zero score will be awarded. Approval for absences for other reasons such as mandatory religious obligations, certain University activities, or unavoidable circumstances should be sought well in advance with documentation provided.

Grading scheme. Plus/minus grades will be given in this course, and undergraduate and graduate students will be treated as two separate groups when it comes to assigning final grades. An *approximate* guide is as follows:

Undergraduate students					
A-	$[83.5, 89)$	A	$[89, 94.5)$	A+	$[94.5, 100]$
B-	$[67, 72.5)$	B	$[72.5, 78)$	B+	$[78, 83.5)$
C-	$[50.5, 56)$	C	$[56, 61.5)$	C+	$[61.5, 67)$
D-	$[34, 39.5)$	D	$[39.5, 45)$	D+	$[45, 50.5)$
F	$[0, 34)$				

Graduate students					
A-	$[85, 90)$	A	$[90, 95)$	A+	$[95, 100]$
B-	$[70, 75)$	B	$[75, 80)$	B+	$[80, 85)$
C-	$[55, 60)$	C	$[60, 65)$	C+	$[65, 70)$
D-	$[40, 45)$	D	$[45, 50)$	D+	$[50, 55)$
F	$[0, 40)$				

These are not completely absolute scales and the instructor reserves the "option" to adjust the cutoffs, depending on the difficulty of the exams. Note that with this grading scheme you are not "graded on a curve," and so you are not competing with fellow students. Therefore, you are not penalized in any way for working together to better understand concepts and to perform better in this course.

IMPORTANT NOTE

This is *not* an easy course for most students, even if you have prior exposure to regression analysis. Each week you should spend at least 3 hours outside of class meetings reviewing the SRM study manual and working on the end-of-chapter problems. It is fine to work harder, but working less is risky. Let me know if you encounter any problems with your learning.

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6 Tentative Teaching, Assignment, and Quiz Schedule

The approximate schedule below will be updated as needed as the semester unfolds.

Teaching Week	Lecture	Date	Topic (Refer to study manual)
Part I: Linear Regression Models			
1	1	August 26, 2019 (Mon)	Overview and Chapter 1
	2	August 28, 2019 (Wed)	Chapter 1
	3	August 29, 2019 (Thur)	Chapter 1
	4	August 30, 2019 (Fri)	Chapter 1
2	—	September 2, 2019 (Mon)	(University Holiday)
	5	September 4, 2019 (Wed)	Chapter 1
	6	September 5, 2019 (Thur)	Chapter 1
	7	September 6, 2019 (Fri)	Chapter 1, **Assignment 1**
3	8	September 9, 2019 (Mon)	Chapter 1, **Quiz 1**
	9	September 11, 2019 (Wed)	Chapter 1
	10	September 12, 2019 (Thur)	Chapter 2
	11	September 13, 2019 (Fri)	Chapter 2, **Assignment 2**
4	12	September 16, 2019 (Mon)	Chapter 2
	13	September 18, 2019 (Wed)	Chapter 2
	14	September 19, 2019 (Thur)	Chapter 2
	15	September 20, 2019 (Fri)	Chapter 2, **Assignment 3**
5	16	September 23, 2019 (Mon)	Chapter 2, **Quiz 2**
	17	September 25, 2019 (Wed)	Chapter 2
	18	September 26, 2019 (Thur)	Chapter 3
	19	September 27, 2019 (Fri)	Chapter 3, **Assignment 4**
6	20	September 30, 2019 (Mon)	Chapter 3
	—	October 2, 2019 (Wed)	(No class due to job fair)
	21	October 3, 2019 (Thur)	Chapter 3
	22	October 4, 2019 (Fri)	Chapter 3, **Assignment 5**
7	23	October 7, 2019 (Mon)	Chapter 4
	24	October 9, 2019 (Wed)	Chapter 4
	25	October 10, 2019 (Thur)	Chapter 4
	26	October 11, 2019 (Fri)	Chapter 4, **Assignment 6**
8	27	October 14, 2019 (Mon)	Chapter 4, **Quiz 3**
	28	October 16, 2019 (Wed)	Chapter 4
	29	October 17, 2019 (Thur)	Chapter 4
	30	October 18, 2019 (Fri)	Chapter 4, **Assignment 7**
9	31	October 21, 2019 (Mon)	Chapter 4
	32	October 23, 2019 (Wed)	Chapter 4
	33	October 24, 2019 (Thur)	Chapter 4
	—	October 25, 2019 (Fri)	(No class due to LTAM Exam!)
Strand II: Generalized Linear Models			
10	34	October 28, 2019 (Mon)	Chapter 5, **Quiz 4**
	35	October 30, 2019 (Wed)	Chapter 5
	36	October 31, 2019 (Thur)	Chapter 5
	37	November 1, 2019 (Fri)	Chapter 5
11	—	November 4, 2019 (Mon)	**(No class. Midterm in evening!)**

	38	November 6, 2019 (Wed)	Chapter 5
	39	November 7, 2019 (Thur)	Chapter 5
	40	November 8, 2019 (Fri)	Chapter 5, **Assignment 9**
12	41	November 11, 2019 (Mon)	Chapter 5
	42	November 13, 2019 (Wed)	Chapter 5
	43	November 14, 2019 (Thur)	Chapter 5
	44	November 15, 2019 (Fri)	Chapter 5, **Assignment 10**
Strand III: Decision Trees			
13	45	November 18, 2019 (Mon)	Chapter 8, **Quiz 5**
	46	November 20, 2019 (Wed)	Chapter 8
	47	November 21, 2019 (Thur)	Chapter 8
	48	November 22, 2019 (Fri)	Chapter 8, **Assignment 11**
—	—	November 25, 2019 (Mon)	(Thanksgiving Week—No class!)
	—	November 27, 2019 (Wed)	
	—	November 28, 2019 (Thur)	
	—	November 29, 2019 (Fri)	
14	49	December 2, 2019 (Mon)	Chapter 8, **Quiz 6**
	50	December 4, 2019 (Wed)	Chapter 8
	51	December 5, 2019 (Thur)	Chapter 8
	52	December 6, 2019 (Fri)	Chapter 8, **Assignment 12**
15	53	December 9, 2019 (Mon)	Chapter 8
	54	December 11, 2019 (Wed)	Chapter 8
	55	December 12, 2019 (Thur)	Chapter 8
	56	December 13, 2019 (Fri)	Chapter 8 / Final Review
—	—	December 16–20, 2019	**Final Examination**
⋮	⋮	⋮	⋮
—	—	January 6-12, 2020	January 2020 Exam SRM

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More about the Instructor ("Shameless" Self-introduction...)

Professor Ambrose Lo is currently Associate Professor of Actuarial Science with tenure at the Department of Statistics and Actuarial Science at The University of Iowa. He earned his B.S. in Actuarial Science (first class honors) and Ph.D. in Actuarial Science from The University of Hong Kong in 2010 and 2014, respectively. He joined The University of Iowa in August 2014 as an Assistant Professor of Actuarial Science. He is a Fellow of the Society of Actuaries (FSA) and a Chartered Enterprise Risk Analyst (CERA). His research interests lie in dependence structures, quantitative risk management as well as optimal (re)insurance. His research papers have been published in top-tier actuarial journals, such as *ASTIN Bulletin: The Journal of the International Actuarial Association*, *Insurance: Mathematics and Economics*, and *Scandinavian Actuarial Journal*.

Besides dedicating himself to actuarial research, Ambrose attaches equal importance to teaching, through which he nurtures the next generation of actuaries and serves the actuarial profession. He has taught courses on financial derivatives, mathematical finance, life contingencies, credibility theory, advanced probability theory, and regression and time series analysis. His emphasis in teaching is always placed on the development of a thorough understanding of the subject matter complemented by concrete problem-solving skills. Besides coauthoring the *ACTEX Study Manual for SOA Exam SRM* (Fall 2019 Edition), he is also the sole author of the *ACTEX Study Manual for CAS Exam MAS-I* (Fall 2019 Edition), *ACTEX Study Manual for SOA Exam PA* (December 2019 Edition), and the textbook *Derivative Pricing: A Problem-Based Primer* (2018) published by Chapman & Hall/CRC Press.

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College of Liberal Arts & Sciences: Policies and Procedures

Absences and Attendance   Students are responsible for attending class and for contributing to the learning environment of a course. Students are also responsible for knowing their course absence policies, which will vary by instructor. All absence policies, however, must uphold the UI policy related to student illness, mandatory religious obligations, including Holy Day obligations, unavoidable circumstances, or University authorized activities (`https://clas.uiowa.edu/students/handbook/attendance-absences`). Students may use this absence form to aid communication; the instructor will decide if the absence is excused or unexcused (`https://clas.uiowa.edu/sites/default/files/ABSENCE%20EXPLANATION%20FORM2019.pdf`).

Academic Integrity   All undergraduates enrolled in courses offered by CLAS have, in essence, agreed to the College's Code of Academic Honesty. Misconduct is reported to the College, resulting in suspension or other sanctions, with sanctions communicated with the student through the UI email address (`https://clas.uiowa.edu/students/handbook/academic-fraud-honor-code`).

Accommodations for Disabilities   UI is committed to an educational experience that is accessible to all students. A student may request academic accommodations for a disability (such as mental health, attention, learning, vision, and physical or health-related condition) by registering with Student Disability Services (SDS). The student is then responsible for discussing specific accommodations with the instructor. More information is at `https://sds.studentlife.uiowa.edu/`.

Administrative Home of the Course   The College of Liberal Arts and Sciences (CLAS) is the administrative home of this course and governs its add/drop deadlines, the second-grade-only option, and related policies. Other colleges may have different policies. CLAS policies may be found here: `https://clas.uiowa.edu/students/handbook`.

Communication and the Required Use of UI Email   Students are responsible for official correspondences sent to their UI email address (uiowa.edu) and must use this address for all communication within UI (Operations Manual, III.15.2).

Complaints   Students with a complaint about an academic issue should first visit with the instructor or course supervisor and then with the Chair of the department or program offering the course; students may next bring the issue to the College of Liberal Arts and Sciences. For more information, see

> `https://clas.uiowa.edu/students/handbook/student-rights-responsibilities`.

Final Examination Policies   The final exam schedule is announced around the fifth week of classes; students are responsible for knowing the date, time, and place of a final exam. Students should not make travel plans until knowing this information. No exams of any kind are allowed the week before finals. Visit

> `https://registrar.uiowa.edu/final-examination-scheduling-policies`.

Nondiscrimination in the Classroom   UI is committed to making the classroom a respectful and inclusive space for all people irrespective of their gender, sexual, racial, religious or other identities. Toward this goal, students are invited to optionally share their preferred names and pronouns with their instructors and classmates. The University of Iowa prohibits discrimination and harassment against individuals on the basis of race, class, gender, sexual orientation, national origin, and other identity categories set forth in the University's Human Rights policy. For more information, contact the Office of Equal Opportunity and Diversity (`diversity.uiowa.edu`).

Sexual Harassment   Sexual harassment subverts the mission of the University and threatens the well-being of students, faculty, and staff. All members of the UI community must uphold the UI mission and contribute to a safe environment that enhances learning. Incidents of sexual harassment must be reported immediately. For assistance, please see `https://osmrc.uiowa.edu/`.

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END OF COURSE SYLLABUS

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