
THE UNIVERSITY OF IOWA
College of Liberal Arts and Sciences
Department of Statistics and Actuarial Science

STAT:4510 Regression, Time Series, and Forecasting

Fall 2016

1:30 p.m. – 2:20 p.m., MWF, at 112 MH

1 Contact information

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2 Course description and objectives

This course, primarily for B.S. and M.S. in Actuarial Science students (other students are welcome!), is designed to satisfy the Validation by Educational Experience (VEE) requirement for Applied Statistical Methods of the Society of Actuaries (SOA). It consists of the following three central themes in statistical modeling:

Theme I. Linear regression (approx. 7 weeks)

Theme II. Logistic regression (approx. 2 weeks)

Theme III. Introductory time series analysis (approx. 6 weeks)

The detailed course contents align closely with the following topics stipulated by the SOA: (see the guidelines from the SOA attached to this syllabus)

Regression analysis

- Least square estimates of parameters
- Simple linear regression
- Multiple linear regression
- Hypothesis testing and confidence intervals in linear regression models
- Testing of models, data analysis and appropriateness of models

Time series/forecasting

- Linear time series models
- Moving average, regression-based and/or ARIMA models
- Estimation, data analysis and forecasting with time series models
- Forecast errors and confidence intervals

Note that this course emphasizes not only being able to make sense of the summarized results from a given statistical model, but also the mathematical rationale behind the construction of various hypothesis tests (e.g. why the t -statistic has a t -distribution, why the F -statistic has an F -distribution, under appropriate null hypotheses) and point/interval forecasts. 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.

After completing the course, you should be able to:

- Understand the ideas and assumptions behind the statistical methods covered in the course
- Apply the methods (linear regression in particular) to real-world problems that are amenable to such techniques
- Interpret the results from a statistical analysis

3 CAS Exam S

Students who aspire to specialize in property and casualty (P&C) will probably take Exam S of the Casualty Actuarial Society (CAS), Sections C and D of which will be partially covered in this course. In Fall 2016, Exam S will take place on October 31, 2016 (Monday). The registration deadline is September 1. More information about Exam S (e.g. syllabus, sample questions) can be found at <http://www.casact.org/admissions/syllabus/index.cfm?fa=Ssyllabi&parentID=345>.

4 Texts

As in ACTS:4130 and ACTS:4380, there are no required textbooks in this course. We shall follow closely the course lecture notes, regarded as a mini-textbook, which will be **distributed in class** and made available on ICON (<http://icon.uiowa.edu>) chapter by chapter. These notes represent the instructor's personal summaries of ideas from different sources, some of which include:

1. *Regression Modeling with Actuarial and Financial Applications*, 2010, by Edward W. Frees

Written by a renowned actuarial science professor in the University of Wisconsin-Madison, this textbook is adopted by a number of courses for VEE Applied Statistics in North America. The main attraction of this book is that it is geared towards actuarial students with frequent references to actuarial applications. However, it suffers from a relatively terse treatment of time series analysis. Chapters 1–8 and 11 of this book are particularly germane to Parts I and II of this course respectively.

2. *An Introduction to Statistical Modelling*, 1998, by Wojtek J. Krzanowski

This text is characterized by its exceptionally lucid exposition on regression analysis. Its downsides are that it tends to skip mathematical proofs and that it lacks exercises. Both deficiencies are remedied by the course notes. Chapters 3 and 6 of this book pertain to Parts I and II of this course respectively.

3. *Introduction to Regression Modeling*, 2006, by Bovas Abraham and Johannes Ledolter

This technically-oriented book is the required textbook of STAT:5200 (Applied Statistics I) offered to MS in Statistics students of our department. It is suitable for students who are deeply interested in the mathematical aspects of regression analysis. Read Chapters 2 to 7 of the book if you are interested.

4. *Introductory Time Series with R*, 2009, by Paul S.P. Cowpertwait and Andrew V. Metcalfe

This is the required textbook for the time series portion of CAS Exam S, with Chapters 2, 4, 6 and 7 being most relevant to Part III of our course. Note that our treatment of time series analysis will be at a level higher than that of this book.

As a UI student, you are entitled to download the book *legally* from <http://link.springer.com/book/10.1007/978-0-387-88698-5> (use a computer on campus) and buy a softcover version of the book at a discounted price of \$24.99.

5. *Time Series Analysis with Applications in R*, Second Edition, 2008, by Jonathan D. Cryer and Kung-Sik Chan

Being the required textbook of STAT:6560 (Applied Time Series Analysis) offered to advanced statistics undergraduates and MS in Statistics students of our department, this is an intermediate-level textbook on time series analysis written by two celebrated UI statistics professors. Chapters 2, 4, 6–9 of this book are most relevant to Part III of our course.

You can check out the book's web page at <http://www.stat.uiowa.edu/~kchan/TSA.htm> for errata and R scripts that reproduce the figures and analysis in the book. Again, as a UI student, you are entitled to download the book legally from <http://link.springer.com/book/10.1007/978-0-387-75959-3> and buy a softcover version of the book.

5 Tentative teaching schedule

Given that this is the first time that I teach this course, I expect that some fine-tuning to the teaching schedule below is needed as the semester progresses.

| Teaching Week | Lecture | Date | Topic |
|-------------------------------------|---------|--------------------------|--------------------------------------|
| Part I: Linear regression | | | |
| 1 | L01 | August 22, 2016 (Mon) | Chapter 1* |
| | L02 | August 24, 2016 (Wed) | Chapter 2 |
| | L03 | August 26, 2016 (Fri) | Chapter 2 |
| 2 | L04 | August 29, 2016 (Mon) | Chapter 2 |
| | L05 | August 31, 2016 (Wed) | Chapter 2 |
| | L06 | September 2, 2016 (Fri) | Chapter 2 |
| 3 | — | September 5, 2016 (Mon) | (University Holiday) |
| | L07 | September 7, 2016 (Wed) | Chapter 2 |
| | L08 | September 9, 2016 (Fri) | Chapter 2 |
| 4 | L09 | September 12, 2016 (Mon) | Chapter 3 |
| | L10 | September 14, 2016 (Wed) | Chapter 3 |
| | L11 | September 16, 2016 (Fri) | Chapter 3 |
| 5 | L12 | September 19, 2016 (Mon) | Chapter 3 |
| | L13 | September 21, 2016 (Wed) | Chapter 3 |
| | L14 | September 23, 2016 (Fri) | Chapter 3 |
| 6 | L15 | September 26, 2016 (Mon) | Chapter 3 |
| | — | September 28, 2016 (Wed) | (No class due to Actuarial Job Fair) |
| | L16 | September 30, 2016 (Fri) | Chapter 4 |
| 7 | L17 | October 3, 2016 (Mon) | Chapter 4 |
| | L18 | October 5, 2016 (Wed) | Chapter 4 |
| | L19 | October 7, 2016 (Fri) | Chapter 4 |
| Part II: Logistic regression | | | |
| 8 | L20 | October 10, 2016 (Mon) | Chapter 5 |
| | L21 | October 12, 2016 (Wed) | Chapter 5 |
| | L22 | October 14, 2016 (Fri) | Chapter 5 |

| | | | |
|---------------------------------------|-----|-------------------------|---------------------------------------|
| 9 | L23 | October 17, 2016 (Mon) | Chapter 5 |
| | L24 | October 19, 2016 (Wed) | Chapter 5 |
| | L25 | October 21, 2016 (Fri) | Chapter 5 |
| Part III: Time series analysis | | | |
| 10 | L26 | October 24, 2016 (Mon) | Chapter 6 |
| | L27 | October 26, 2016 (Wed) | Chapter 6 |
| | — | October 28, 2016 (Fri) | (No class due to MLC Exam - hurrray!) |
| 11 | L28 | October 31, 2016 (Mon) | Chapter 6 |
| | L29 | November 2, 2016 (Wed) | Chapter 6 |
| | — | November 4, 2016 (Fri) | (No class due to Midterm Exam) |
| 12 | L30 | November 7, 2016 (Mon) | Chapter 6 |
| | L31 | November 9, 2016 (Wed) | Chapter 6 |
| | L32 | November 11, 2016 (Fri) | Chapter 6 |
| 13 | L33 | November 14, 2016 (Mon) | Chapter 7 |
| | L34 | November 16, 2016 (Wed) | Chapter 7 |
| | L35 | November 18, 2016 (Fri) | Chapter 7 |
| — | — | November 21, 2016 (Mon) | (Thanksgiving Week - No class!) |
| | — | November 23, 2016 (Wed) | |
| | — | November 25, 2016 (Fri) | |
| 14 | L36 | November 28, 2016 (Mon) | Chapter 7 |
| | L37 | November 30, 2016 (Wed) | Chapter 7 |
| | L38 | December 2, 2016 (Fri) | Chapter 8 |
| 15 | L39 | December 5, 2016 (Mon) | Chapter 8 |
| | L40 | December 7, 2016 (Wed) | Chapter 8 |
| | L41 | December 9, 2016 (Fri) | Chapter 8 / Review |

* Refer to the numbering in the lecture notes

6 Grading system

Assessment in this course comprises the following items:

1. Attendance and participation: 10%

Everyone should be able to score all of these 10 points by regularly attending and paying attention in lectures. If you are absent from any class without a valid reason, it is impossible to get a copy of any course material you miss and inquire about any announcements made in class.

2. Assignments: 20%

There will be weekly (or, at my mercy, biweekly!) assignments consisting of a few end-of-chapter problems in the lecture notes, usually assigned on Monday and due the following Monday. A few assignment problems may require some simple data analysis, which you can complete using any computer software (even Excel is good enough!). Late homework will be

severely penalized (see the instructions on the assignment sheet). Illustrative solutions will be posted on ICON.

A note on collaboration: Discussion with other students on homework problems is encouraged. However, what you hand in must ultimately be your own work.

3. Midterm Exam: 30%

There will be a two-hour written Midterm Exam to be held in the evening (6:30 p.m. – 8:30 p.m.) of **November 4, 2016 (Friday)** covering Part I (Linear Regression) of this course. It will consist of several structured questions which emphasize how to make use of summarized model output to perform statistical inference. You will find that end-of-chapter problems in the lecture notes are useful in preparing for this exam.

4. Final Examination: 40%

A two-hour written examination covering Parts II and III of this course will take place in the week of December 12–16, 2016. Like the Midterm Exam, it comprises several structured questions. 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.

Unlike ACTS:4130 and ACTS:4380, a formula sheet will be provided for each of the Midterm Exam and Final Exam. Still only SOA/CAS-approved calculators listed on Point 9 of <https://www.soa.org/Files/Edu/edu-rules-reg-instructions.pdf> are allowed.

Note on absence from exams. If, for medical reasons, you are unable to take any exam in this course, you should inform the course instructor *within 48 hours* of the exam, and submit original documentation as soon as possible. Otherwise, a zero score will be awarded. Absence for other reasons will not be allowed, unless approval from the instructor is sought well in advance.

Grading scheme. Plus or minus grading system will be used 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. 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 about 3 hours outside of class meetings reviewing the course notes 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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About the instructor. Professor Ambrose Lo 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 Department of Statistics and Actuarial Science at The University of Iowa in August 2014 as an Assistant Professor in 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 *Insurance: Mathematics and Economics* and the *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 and advanced probability theory. His emphasis in teaching is always placed on concrete problem-solving skills complemented by a thorough understanding of the subject matter. He is also the sole author of ACTEX CAS Exam S Study Manual (Fall 2016 Edition).

College of Liberal Arts & Sciences: Policies and Procedures

Administrative Home

The College of Liberal Arts and Sciences is the administrative home of this course and governs matters such as the add/drop deadlines, the second-grade-only option, and other related issues. Different colleges may have different policies. Questions may be addressed to 120 Schaeffer Hall, or see the CLAS Academic Policies Handbook at <http://clas.uiowa.edu/students/handbook>.

Electronic Communication

University policy specifies that students are responsible for all official correspondences sent to their University of Iowa e-mail address (@uiowa.edu). Faculty and students should use this account for correspondence (Operations Manual, III.15.2. Scroll down to k.11).

Accommodations for Disabilities

The University of Iowa is committed to providing an educational experience that is accessible to all students. A student may request academic accommodations for a disability (which includes but is not limited to mental health, attention, learning, vision, and physical or health-related conditions). A student seeking academic accommodations should first register with Student Disability Services (SDS) and then meet with the course instructor privately in the instructor's office to make particular arrangements. Reasonable accommodations are established through an interactive process between the student, instructor, and SDS. See <http://sds.studentlife.uiowa.edu/> for information.

Academic Honesty

All CLAS students or students taking classes offered by CLAS have, in essence, agreed to the College's Code of Academic Honesty: "I pledge to do my own academic work and to excel to the best of my abilities, upholding the IOWA Challenge. I promise not to lie about my academic work, to cheat, or to steal the words or ideas of others; nor will I help fellow students to violate the Code of Academic Honesty." Any student committing academic misconduct is reported to the College and placed on disciplinary probation or may be suspended or expelled (CLAS Academic Policies Handbook).

CLAS Final Examination Policies

The final examination schedule for each class is announced by the Registrar generally by the fifth week of classes. Final exams are offered only during the official final examination period. **No exams of any kind are allowed during the last week of classes.** All students should plan on

being at the UI through the final examination period. Once the Registrar has announced the date, time, and location of each final exam, the complete schedule will be published on the Registrar's web site and will be shared with instructors and students. It is the student's responsibility to know the date, time, and place of a final exam.

Making a Suggestion or a Complaint

Students with a suggestion or complaint should first visit with the instructor (and the course supervisor), and then with the departmental DEO. Complaints must be made within six months of the incident (CLAS Academic Policies Handbook).

Understanding 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 have a responsibility to uphold this mission and to contribute to a safe environment that enhances learning. Incidents of sexual harassment should be reported immediately. See the UI Comprehensive Guide on Sexual Harassment for assistance, definitions, and the full University policy.

Reacting Safely to Severe Weather

In severe weather, class members should seek appropriate shelter immediately, leaving the classroom if necessary. The class will continue if possible when the event is over. For more information on Hawk Alert and the siren warning system, visit the Department of Public Safety website.

****END OF COURSE SYLLABUS****



Canadian
Institute of Actuaries



Casualty
Actuarial Society



Society
of Actuaries

Guidelines for Approval of VEE Courses and Educational Experiences

The following guidelines for the three Validation by Educational Experience (VEE) requirements are used by the VEE Administration Committee to determine whether or not specific courses or educational experiences are appropriate to fulfill the VEE requirements. The “Application for Approval of Course/Experience for Validation by Educational Experience Credit” must be submitted to the VEE Administration Committee along with the required documentation. If a course/educational experience is approved, it will be added to the “Directory of Approved VEE Courses/Experiences” or the “Standardized Exams and Other Educational Experiences” list on the CAS (www.casact.org) and SOA (www.soa.org) Web Sites.

VEE–Applied Statistical Methods

Courses that meet this requirement may be taught in the mathematics, statistics, or economics department, or in the business school. In economics departments, this course may be called Econometrics. The material could be covered in one course or two. The mathematical sophistication of these courses will vary widely and all levels are intended to be acceptable. Some analysis of real data should be included. All of the topics listed below should be covered:

Regression analysis

- Least square estimates of parameters
- Single linear regression
- Multiple linear regression
- Hypothesis testing and confidence intervals in linear regression models
- Testing of models, data analysis and appropriateness of models

Time series/forecasting

- Linear time series models
- Moving average, regression-based and/or ARIMA models
- Estimation, data analysis and forecasting with time series models
- Forecast errors and confidence intervals

VEE–Corporate Finance

The typical corporate finance program covers the topics below in two semesters with an introductory course followed by a more advanced semester. If the second course covers most of the topics, then only the second course will be required. Where the topics are split across two semesters or courses, both will be required. The exceptional case where the corporate finance topics are covered in only one course, with no finance prerequisite, will also be considered, however, this will typically be at a more advanced level than a course designed for general business students. Most of the topics listed below should be covered:

- Definitions of key finance terms: stock company; capital structure
- Key finance concepts: financing companies; characteristics and uses of financial instruments; sources of capital; cost of capital; dividend policy; personal and corporate taxation