Math 5637
Statistics for Actuarial Modeling

Course instructor

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Office hours

All office hours will be done through Webex (https://uconn-cmr.webex.com/meet/emv07002) on Mondays, 10 am - 1 pm. For other appointments, please request by email.

Course description

Data analysis for actuaries, linear models including generalized linear models, time series, principal component analysis, decision trees, cluster analysis, statistical computing with R, actuarial applications. See https://math.uconn.edu/fall-2026-courses/course/MATH/5637/.

Prerequisites

- two-semester course in probability and statistical inference; some exposure in linear algebra or matrix theory
- Math 3160 (Probability); Stat 3375 (Introduction to Mathematical Statistics); Math 2210Q (Applied Linear Algebra)

Course goals

Students will learn the basic fundamentals and applications of modern statistical methods using R programming, communicate technical results in oral and written formats, and develop teamwork skills. We cover several topics on data analysis and statistical learning prescribed by the International Actuarial Association (IAA). In particular, it is designed to cover the learning objectives for the SOA's Statistics for Risk Modeling (SRM) Exam. We also cover parts of the syllabus for the CAS Modern Actuarial Statistics (MAS-I and MAS-II) Exams.

Learning outcomes

Upon completion of this course, students will be able to:

- Investigate and analyze data using:
  - supervised learning: linear regression, generalized linear models (GLMs), tree-based models (or classification and regression trees)
  - unsupervised learning: data clustering, principal component analysis (PCA)
  - time series models
- Use R as a statistical computing tool for data analysis
- Understand the applicability and limitations of models based on case studies
- Interpret model results
- Write technical reports and communicate results

UConn HuskyCT

All lecture and related video materials, supplements, solved exercises, and annotations will be provided in http://www.huskyct.uconn.edu/.

Textbooks

Main: *Regression Modeling with Actuarial and Financial Applications* by E. W. Frees, Cambridge University Press, 2009. Book website:
https://users.ssc.wisc.edu/~ewfrees/ActuarialRegression2009/

SOA references:

- *Actuarial Statistics with R: Theory and Case Studies* by G. Gan and E. A. Valdez, ACTEX, 2018. https://www.actexmadriver.com/product.aspx?id=453143268
- *An Introduction to Statistical Learning, with Applications in R* by G. James, D. Witten, T. Hastie, and R. Tibshirani, Springer, 2013. A free PDF version of the text can be downloaded at https://www.statlearning.com/

Suggested reference: *Linear Models with R* by J. J. Faraway. Preprint may be freely available at https://julianfaraway.github.io/faraway/LMR/

Software

R, an open source software for statistical computing and graphics, will be used for this course. You can download and install R from http://www.r-project.org/.

Exams

We will have two midterm exams and scheduled in-person during lecture hours. There is no final exam for this course, but your written project will be due when our final exam is scheduled.

Course project

A very exciting and important portion of this course will be the preparation and presentation of an analysis of a complex dataset. You will develop and compare several statistical models to interpret the data. You can work in teams of three or four. Everyone on the team will receive the same grade on the project. We expect the whole project to take around 50 hours per team member. If you have any questions or need guidance, please feel free to contact me. There are two parts to this project: the final report and the project presentation.

Data: The data set should contain at least 10 predictor variables and at least 300 observations. More data is definitely better and your results are also likely to be more significant. You can find datasets in the following websites (or google search):

- https://www.soa.org/sections/technology/technology-data-analytics-resources/
- http://archive.ics.uci.edu/ml/
- http://www.kaggle.com

Project Proposal: Around the 9th or 10th week of the semester, you need to form a team and submit a project proposal, which contains the dataset you will use, a problem you want to solve,

and your plan for solving the problem. You will give a presentation of your project proposal (to be announced).

Final paper: Your report must be no more than 15 pages long (including all figures, tables, and appendices, 11 point font, spacing of at least 1.15, and 1" margins). The paper should be written for an intelligent client with moderate statistical expertise. Focus your report on the results and how the client can apply what you have discovered. Overly technical justification should be put in the appendix. Remember that there is no unique solution to the problems you will be solving. I am interested not only in the final result, but your justification and process. I would expect a sufficient project to start with at least 11 variables (response and predictors) and at least 300 observations. More data is definitely better and your results are also likely to be more significant. Please follow the structure provided below.

Your paper should include the following sections:

1. Title and Abstract/Executive Summary. Title should be concise and to the point. Be sure to respond to such questions as:
    - What problem was studied?
    - How was it studied? Describe source of data and techniques used to solve the problem.
    - What were the findings?
2. Introduction. The introduction should be partitioned into three sections:
    - Orientation Material
        - describe purpose
    - Key Aspects of the Report
    - A Plan of the Paper
3. Data Characteristics:
    - Describe the data provided and the data used in the analysis.
        - Document the source of the data.
    - Briefly discuss difficulties in acquiring the data.
    - Present various summary statistics and plots to allow the reader to understand the basic structure and pattern of the data.
    - Use the plots, and concomitant summary statistics, to identify unusual points that are worthy of special consideration.
    - The details presented in this section should foreshadow the development of the model in the subsequent section.
    - Any plots which do not need to be in the main body of the text, but still add to the report could be put in the appendix.
4. Model Selection and Interpretation:
    - First, present your hypotheses about the effect of the various covariates. Which variables will have a significant effect on the outcome and in what direction?
    - Describe the purpose behind the model selection (understanding versus forecasting).
    - Recommend a model. Describe why you chose this model from all the possible explanatory variables. Consider using stepwise regression, full vs. reduced, AIC, R_a^2, etc. Examine a few nonlinear (i.e. x^2) terms and some interactions.
    - Discuss alternative models.

- Interpret the model, parameter estimates and any broad implications of the model.
- Justify the model. Consider using , s, t-ratios, residual plots, and out-of-sample validation.
- Outline a heuristic thought process leading up to this model.
- Examine outliers, leverage points, collinearity, and missing data (if any). Describe what actions you took to address these concerns.

5. Summary and Concluding Remarks

   - Present the results of the report in a concise fashion, in different words than the executive summary.
   - Comment on the quality of data and reliability of your inferential statements (what type of data would improve the reliability of your statements)?
   - Include ideas that you have about future investigation.

6. References and Appendix

   - Include the source of the data and any other books or papers you examined.
   - Clearly label all figures and plots referenced in the paper.

Sample (previous) projects will be posted on HuskyCT.

Your final paper will be evaluated according to the following rubrics:

Component	**Weight**
Grammar/Spelling/General Flow	10%
Title/Abstract/Executive Summary	5%
Introduction	5%
Data Characteristics	25%
Model Selection and Interpretation	50%
Summary and Conclusion	5%

Presentation: You will also give a 20-minute presentation on your findings to the entire class at the end of the semester. Make sure you finish your presentation within the time slot.

Expectations

Class attendance is highly recommended from all students. Please email me if you need to miss a class. You also need to spend enough out-of-class time on studying this course. This will significantly influence your progress during this course. Attendance at the project presentations for the other members of the class will factor heavily into your personal project grade.

Course assessment

Homework	none
Midterm exam 1	25%
Midterm exam 2	25%
Project	50% (Attendance: 2%; Proposal: 3%; Presentation: 10%; Paper: ~~25~~ 35%)

Your final grade is determined as follows (may be adjusted if necessary):

Grade	A	A-	B+	B	B-	C+
Points	[90, 100)	[87, 90)	[84, 87)	[81, 84)	[78, 81)	[75, 78)
Grade	C	C-	D+	D	D-	F
Points	[70, 75)	[65, 70)	[60, 65)	[55, 60)	[50, 55)	[0, 50)

For additional information on graduate grading policies see here (note that effective Fall, 2020, the grade of A+ no longer exists) https://gradcatalog.uconn.edu/grad-school-info/academic-regulations/.

Policy Against Discrimination, Harassment and Related Interpersonal Violence

The University is committed to maintaining an environment free of discrimination or discriminatory harassment directed toward any person or group within its community – students, employees, or visitors. Academic and professional excellence can flourish only when each member of our community is assured an atmosphere of mutual respect. All members of the University community are responsible for the maintenance of an academic and work environment in which people are free to learn and work without fear of discrimination or discriminatory harassment. In addition, inappropriate amorous relationships can undermine the University's mission when those in positions of authority abuse or appear to abuse their authority. To that end, and in accordance with federal and state law, the University prohibits discrimination and discriminatory harassment, as well as inappropriate amorous relationships, and such behavior will be met with appropriate disciplinary action, up to and including dismissal from the University. Additionally, to protect the campus community, all non-confidential University employees (including faculty) are required to report sexual assaults, intimate partner violence, and/or stalking involving a student that they witness or are told about to the Office of Institutional Equity. The University takes all reports with the utmost seriousness. Please be aware that while the information you provide will remain private, it will not be confidential and will be shared with University officials who can help.

More information is available at https://equity.uconn.edu/ and https://equity.uconn.edu/title-ix/.

Sexual Assault Reporting Policy

To protect the campus community, all non-confidential University employees (including faculty) are required to report assaults they witness or are told about to the Office of Diversity and Equity under the Sexual Assault Response Policy. The University takes all reports with the utmost seriousness. Please be aware that while the information you provide will remain private, it will not be confidential and will be shared with University officials who can help.

More information is available at sexualviolence.uconn.edu.

Statement on Absences from Class Due to Religious Observances and Extra-Curricular Activities

Faculty and instructors are strongly encouraged to make reasonable accommodations in response to student requests to complete work missed by absence resulting from religious observances or participation in extra-curricular activities that enrich their experience, support their scholarly development, and benefit the university community. Examples include participation in scholarly presentations, performing arts, and intercollegiate sports, when the participation is at the request of, or coordinated by, a University official. Such accommodations should be made in ways that do not dilute or preclude the requirements or learning outcomes for the course. Students anticipating such a conflict should inform their instructor in writing within the first three weeks of the semester, and prior to the anticipated absence, and should take the initiative to work out with the instructor a schedule for making up missed work. For conflicts with final examinations, students should contact the Office of the Dean of Students.

Faculty and instructors are also encouraged to respond when the Counseling Program for Intercollegiate Athletes (CPIA) requests student progress reports. This will enable the counselors to give our students appropriate advice.

Academic integrity

A fundamental tenet of all educational institutions is academic honesty; academic work depends upon respect for and acknowledgement of the research and ideas of others. Misrepresenting someone else's work as one's own is a serious offense in any academic setting and it will not be condoned.

Academic misconduct includes, but is not limited to, providing or receiving assistance in a manner not authorized by the instructor in the creation of work to be submitted for academic evaluation (e.g. papers, projects, and examinations); any attempt to influence improperly (e.g. bribery, threats) any member of the faculty, staff, or administration of the University in any matter pertaining to academics or research; presenting, as one's own, the ideas or words of another for academic evaluation; doing unauthorized academic work for which another person will receive credit or be evaluated; and presenting the same or substantially the same papers or projects in two or more courses without the explicit permission of the instructors involved.

A student who knowingly assists another student in committing an act of academic misconduct shall be equally accountable for the violation, and shall be subject to the sanctions and other remedies described in The Student Code.

Tentative lecture schedule

Week	Date	Lecture	Due
1	31-Aug-2026	Course introduction	
		Supervised Learning	
1	2-Sep-2026	Introduction to data analytics (Chapter 1)	
2	7-Sep-2026	Labor Day	holiday
2	9-Sep-2026	Multiple linear regression (Chapter 3)	
3	14-Sep-2026	continued	
3	16-Sep-2026	Case study	
4	21-Sep-2026	Simple linear regression (Chapter 1)	
4	23-Sep-2026	Case study	
5	28-Sep-2026	Variable Selection (Chapter 5)	
5	30-Sep-2026	Interpreting regression results (Chapter 6)	Project Group
6	5-Oct-2026	Case study	
6	7-Oct-2026	Midterm exam 1	
7	12-Oct-2026	Generalized linear models (Chapter 13)	
7	14-Oct-2026	Case study	
8	19-Oct-2026	Binary/Count regression models (Chapters 11-12)	
8	21-Oct-2026	Case study	
9	26-Oct-2026	Decision trees (supplement)	
9	28-Oct-2026	Case study	Project Proposal
		Unupervised Learning	
10	2-Nov-2026	Data clustering (supplement)	
10	4-Nov-2026	Case study	
11	9-Nov-2026	Principal component analysis (supplement)	
11	11-Nov-2026	Case study	
		Time Series Models	
12	16-Nov-2026	Modeling trends (Chapter 7)	
12	18-Nov-2026	Midterm exam 2	
13	23-Nov-2026	Thanksgiving break	
13	25-Nov-2026	Thanksgiving break	
14	30-Nov-2026	Autoregressive models (Chapter 8)	
14	2-Dec-2026	Forecasting (Chapter 9)	
15	7-Dec-2026	Presentation	
15	9-Dec-2026	Presentation	
16	Finals - TBA		Project Paper

Code of Conduct for Candidates

Effective December 1, 2008, revised June 2023

The purpose of the Society of Actuaries (SOA) *Code of Conduct for Candidates* ("Candidate Code") is to require Actuarial Candidates to adhere to the high standards of conduct, practice, and qualifications of the actuarial profession, thereby supporting the actuarial profession in fulfilling its responsibility to the public. An Actuarial Candidate must comply with both the letter and spirit of the Candidate Code. An Actuarial Candidate who commits a material violation of the provisions of the Candidate Code shall be subject to the discipline procedures of the SOA.

An "Actuarial Candidate" is a person who has contacted the SOA with an intent to register for, has registered for, or completed any SOA educational or evaluative activity (e.g., exams, modules, exercises, assessments, validations or courses), but is not a member of the SOA as an Associate (ASA), Chartered Enterprise Risk Analyst (CERA) or Fellow (FSA).

In situations where an Actuarial Candidate performs actuarial work, the candidate's client or employer is defined as the "Principal." "Actuarial Services" are professional services provided to a Principal by an individual acting in the capacity of an actuary. Such services include the rendering of advice, recommendations, findings, or opinions based upon actuarial considerations.

RULE 1: An Actuarial Candidate shall act honestly, with courtesy, integrity, and competence, to uphold the reputation of the actuarial profession.

RULE 2: An Actuarial Candidate shall not engage in any professional conduct involving dishonesty, fraud, deceit, or misrepresentation or commit any act that reflects adversely on the actuarial profession.

RULE 3: An Actuarial Candidate shall act with professional courtesy and respect in all interactions with the SOA.

RULE 4: An Actuarial Candidate shall perform Actuarial Services with professional courtesy and respect and shall cooperate with others in the Principal's interest.

RULE 5: An Actuarial Candidate shall strictly comply with the letter and spirit of all rules and regulations associated with any component of the SOA Education system for which the SOA awards credit. These include but are not limited to the SOA Rules and Regulations for Examinations SOA Terms and Conditions Agreement for e-Learning Candidates.

RULE 6: Actuarial Candidates are not authorized to use, and therefore must never use membership designations of the SOA until they are admitted to membership by the SOA Board of Directors. Actuarial Candidates shall not claim credit for any SOA credentials or micro-credentials that have not been awarded to them.

RULE 7: An Actuarial Candidate shall not disclose to another party any confidential information unless authorized to do so by the Principal or required to do so by law, statute, or regulation. Confidential information includes information of a proprietary nature and information that is legally restricted from circulation.

RULE 8: An Actuarial Candidate shall respond promptly, truthfully, and fully to any request for information by, and cooperate fully with, the appropriate disciplinary body of the SOA in connection with any disciplinary or other proceeding relating to the Candidate Code. The Actuarial Candidate's responsibility to respond shall be subject to applicable restrictions listed in Rule 7 and those imposed by law, statute, or regulation.

Casualty Actuarial Society
Code of Professional Ethics for Candidates
(As Introduced January 1, 2008)

The purpose of the Casualty Actuarial Society (CAS) Code of Professional Ethics for Candidates (Candidate Code) is to require actuarial candidates to adhere to the high standards of conduct, practice, and qualifications of the actuarial profession, thereby supporting the actuarial profession in fulfilling its responsibility to the public. An actuarial candidate shall comply with the Candidate Code. An actuarial candidate who commits a material violation of the provisions of the Candidate Code shall be subject to the counseling and discipline procedures of the CAS.

"Actuarial candidates" are those persons who have registered for a CAS specific exam but have yet to fulfill all of the requirements for admission into the CAS. In situations where actuarial candidates perform actuarial work, their "principal" is defined as their client or employer. "Actuarial services" are professional services provided to a principal by an individual acting in the capacity of an actuary. Such services include the rendering of advice, recommendations, findings, or opinions based upon actuarial considerations.

Rule 1: An actuarial candidate shall act honestly, with integrity and competence, to uphold the reputation of the actuarial profession.

Rule 2: An actuarial candidate shall not engage in any professional conduct involving dishonesty, fraud, deceit, or misrepresentation or commit any act that reflects adversely on the actuarial profession.

Rule 3: An actuarial candidate shall perform actuarial services with courtesy and professional respect and shall cooperate with others in the principal's interest.

Rule 4: An actuarial candidate shall adhere to the CAS Policy on Examination Discipline.

Rule 5: Actuarial candidates are not authorized to use membership designations of the CAS until they are admitted to membership by the CAS Executive Council.

Rule 6: An actuarial candidate shall not disclose to another party any confidential information unless authorized to do so by the principal or required to do so by law, statute, or regulation. Confidential information includes information of a proprietary nature and information that is legally restricted from circulation.

Rule 7: An actuarial candidate shall respond promptly, truthfully, and fully to any request for information by, and cooperate fully with, appropriate counseling and disciplinary body of the CAS in connection with any disciplinary, counseling or other proceeding of such body relating to the Candidate Code. The actuarial candidate's responsibility to respond shall be subject to applicable restrictions listed in Rule 6 and those imposed by law, statute, or regulation.

(The CAS Board of Directors approved the code above on November 12, 2006, effective with the Spring 2008 exam sitting.)

A copy of the Casualty Actuarial Society Rules of Procedure for Disciplinary Actions Involving Candidates is available in the Exams & Admissions section of the CAS website under "Candidate's Code of Ethics."