

STA 321 –Topics in Advanced Statistics

(Individualized Instruction)

Spring 2022

CONTACT INFORMATION

Instructor: Cheng Peng, Ph.D.

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Zoom Office Hours: Mon/Tue/Wed: 3:00 PM - 5:00 PM

Zoom Link: click the link to the course web page to enter my Zoom office

COURSE DESCRIPTION

The course will cover select topics in categorical analysis, non-parametric, and time series analysis. Emphasis will be placed on statistical programming, particularly simulations.
Prerequisites: STA 321 requires prerequisites of C or better in STA 311, STA 319, STA 320, and MAT 421.

COURSE LEARNING OUTCOMES

After finishing this course, students will be able to

1. use appropriate statistical methods and models to address real-world problems.
2. use a statistical programming language to perform rigorous data analysis.
3. correctly utilize data and identify sources of bias and misinterpretations.
4. use a software program to prepare formal statistical reports.
5. communicate statistical results effectively with both technical and non-technical audiences with appropriate visual aids.

MEETING & ASSESSING STUDENT LEARNING OUTCOMES

Course projects will be used to assess students' learning outcomes. The detailed evaluation components are listed in the next section of grading and evaluation.

EVALUATION & GRADING

The course grade will be determined by the following components:

- (1). Four mini-projects on data analysis (4 mini-projects, 15% each, total 60%)
Mini-project #1: non-parametric bootstrap and normal linear regression
Mini-project #2: Binary logistic regression
Mini-project #3: Regression with counts and rates
Mini-project #4: Time series – exponential smoothing
- (2). Weekly data analysis assignments (30% each)
- (3). Project presentation (10%).

A letter grade will be assigned based on performance in the course according to the following scale:

Grade	Quality Points	Percentage Equivalents	Interpretation
A	4.00	93-100	Excellent
A-	3.67	90-92	
B+	3.33	87-89	Superior
B	3.00	83-86	
B-	2.67	80-82	
C+	2.33	77-79	Average
C	2.00	73-76	
C-	1.67	70-72	
D+	1.33	67-69	Below Average
D	1.00	63-66	
D-	0.67	60-62	
F	0	< 60%	Failure

Refer to the Undergraduate Catalog for a description of NG (No Grade), W, Z, and other grades.

MAJOR REFERENCES

This is an advanced topics class. The topics to be covered are taken from different texts. I will not assign a required textbook for this class. Instead, I provide a list of eBooks that are freely available in WCU's library in the following

1. [Introduction to Computer-Intensive Methods of Data Analysis in Biology](#)
2. [Applied Regression and Modeling: A Computer-Integrated Approach](#)
3. [Modern Regression Techniques Using R: A Practical Guide](#)
4. [Regression Analysis with R: Design and Develop Statistical Nodes to Identify Unique Relationships Within Data at Scale](#)

5. [Regression Models for Categorical, Count, and Related Variables: Applied Approach](#), by John Hoffmann, University of California Press, 2016.
6. [Practical Time Series Analysis](#)

TENTATIVE TOPICS

Following is the list of tentative topics to be covered in the semester. I may modify the list as we move forward during the semester. The course web page will provide an up-to-date list of topics every week.

Week 1: Setting up computing tools - getting started with R, RStudio, and R Markdown

1. Introduction: class structure, topics, assessments, and logistics.
2. Install R, RStudio, and possibly MikTeX
3. Create R Markdown document- Knit HTML, PDF, and WORD file
4. Getting started with R: basic operations, vectors, data frames (R data sets).
5. Install and load R libraries

Week 2: Nonparametric Bootstrap Inferences

1. Review of simple random sampling (SRS) plan
2. Sampling from empirical distribution – Bootstrap sampling
3. Bootstrap confidence intervals
4. Bootstrap hypothesis tests
5. **R Applications:** Case study – CI and testing about population means

Week 3: Review: Correlation and Simple Linear Regression

1. Relationship between two numerical variables
2. Linear relationship: the strength of linear correlation -coefficient of correlation
3. Least square regression model – structure, assumptions, and interpretation
4. Diagnostics, R square, and interpretation
5. **R Applications:** Case study - simple linear regression (SLR) with R.

Week 4: Multiple Regression

1. Turn categorical predictor variables into dummy variables
2. Assumptions, Goodness-of-fit measures, and diagnostics
3. Variable selection methods
4. Summarizing output and interpreting coefficients and R square
5. **R Applications:** Case study - MLR with R

Week 5: Nonparametric Bootstrapping Regression Modeling

1. Bootstrapping records
2. Bootstrapping residuals
3. Bootstrap confidence intervals of regression coefficients

4. Bootstrapping test for regression coefficients
5. **R Applications:** Case study – Bootstrapping regression modeling
6. **Mini Project #1:** [Project Report – multiple regression model: Normal and Bootstrap](#)

Week 6: Categorical Regression – Simple Logistic Regression

1. Practical question and model formulation
2. Structure of the model
3. Interpretation of the regression coefficients
4. **R Applications:** Case study – fitting logistic regression with R

Week 7: Categorical Regression – Multiple Logistic Regression

1. Models with only categorical predictor variables – Dummy variable
2. Interpretation of coefficients
3. Variable selection methods and criteria
4. **R Applications:** Case study - logistic regression with R
5. **Mini Project #2:** [Data analysis – multiple logistics regression model](#)

Week 8: Frequency Regression - Simple Poisson Regression

1. Practical question and model formulation
2. Model structure and interpretation
3. Regression on rates
4. **R Applications:** Case-study - fitting counts and rates in biology

Week 9: Frequency Regression - Multiple Poisson Regression

1. Poisson regression with more than one predictor variable
2. Categorical predictor variable – dummy variables must be defined
3. Issues of overdispersion and underdispersion
4. **R Applications:** Case-study -multiple Poisson regression model with medical data

Week 10: Frequency Regression - Negative Binomial Regression

1. The negative binomial is not a universal solution but an option
2. Obsolete the assumption of the equality of mean and variance in Poisson
3. Negative binomial regression assumes a different relationship between the mean and variance
4. **R Applications:** Case study – multiple negative binomial regression for counts and rates
5. **Mini Project #3:** [Data analysis – Regression with count and rate response](#)

Week 11: Concepts of Time Series

1. The nature of time series data – Dependency between observations
2. The purpose for time series – forecasting
3. Autocorrelation and moving average
4. Measures of goodness-of-forecasting
5. Types and approaches to time series modeling

6. **R Applications:** Illustrative examples of time series using R

Week 12: Moving Average and LOESS Smoothing

1. Decompose a time series: trend, seasonality, and random error.
2. Additive and multiplicative models
3. The moving average (MA) and double MA models
4. LOESS smoothing model: fitting, forecasting, and evaluating
5. **R Applications:** Case study – LOESS smoothing and forecasting

Week 13: Exponential Smoothing Models

1. Single exponential smoothing models
2. Holt's trend models
3. Holt-Winters' seasonal models
4. Model selection – measures of accuracy.
5. **R Applications:** Case-study – examples of exponential smoothing.
6. **Mini Project #4:** Data analysis – Modeling data with both trend and seasonality

Week 14: Wrap up and Prepare Presentation

1. The types of models: Linear models, GLM, and time series model (smoothing)
2. Choose one of the three projects to present to the class
3. **Submit a PPT presentation by the end of Friday via D2L.**
4. Each presentation allows 15 minutes: 10 minutes for presenting and 5 minutes for QA.

COVID-19 STATEMENT

Part of West Chester University's response to the COVID-19 pandemic was to switch the vast majority of instruction to remote. This decision was made out of an abundance of caution to protect the health of all members of the WCU community. Faculty have been asked to make every effort to adapt their courses to this novel situation while still meeting the critical learning outcomes of the course. Students are asked to discuss any problems with the new course format and schedule directly with their instructors. Patience and flexibility on everyone's behalf are critical to our community's navigation of this public health crisis.

For this particular course, the following alternative modalities are being utilized: *Remote Asynchronous (RA) Instruction*.

ACADEMIC & PERSONAL INTEGRITY

It is the responsibility of each student to adhere to the university's standards for academic integrity. Violations of academic integrity include any act that violates the rights of another student in academic work, that involves misrepresentation of your work, or that disrupts the instruction of the course. Other violations include (but are not limited to): cheating on assignments or examinations; plagiarizing, which means copying any part of another's work and/or using ideas of another and presenting them as one's own without giving proper credit to the source; selling, purchasing, or exchanging of term papers; falsifying of information; and using your work from one class to fulfill the assignment for another class without significant modification. Proof of academic misconduct can result in the automatic failure and removal from this course. For questions regarding Academic Integrity, the No-Grade Policy, Sexual Harassment, or the Student Code of Conduct, students are encouraged to refer to the Department Graduate Handbook, the Graduate Catalog, the *Ram's Eye View*, and the University website at www.wcupa.edu.

STUDENTS WITH DISABILITIES

If you have a disability that requires accommodations under the Americans with Disabilities Act (ADA), please present your letter of accommodations and meet with me as soon as possible so that I can support your success in an informed manner. Accommodations cannot be granted retroactively. If you would like to know more about West Chester University's Services for Students with Disabilities (OSSD), please visit them at 223 Lawrence Center. The OSSD hours of Operation are Monday – Friday, 8:30 a.m. – 4:30 p.m. Their phone number is 610-436-2564, their fax number is 610-436-2600, their email address is ossd@wcupa.edu, and their website is at www.wcupa.edu/ussss/ossd.

REPORTING INCIDENTS OF SEXUAL VIOLENCE

West Chester University and its faculty are committed to assuring a safe and productive educational environment for all students. To meet this commitment and to comply with Title IX of the Education Amendments of 1972 and guidance from the Office for Civil Rights, the University requires faculty members to report incidents of sexual violence shared by students to the University's Title IX Coordinator, Ms. Lynn Klingensmith. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred to the person designated in the University protection of minors'

policy. Information regarding the reporting of sexual violence and the resources that are available to victims of sexual violence is set forth at the webpage for the Office of Social Equity at http://www.wcupa.edu/_admin/social.equity/.

EXCUSED ABSENCES POLICY

Students are advised to carefully read and comply with the excused absences policy, including absences for university-sanctioned events, contained in the WCU Graduate Catalog. In particular, please note that the “responsibility for meeting academic requirements rests with the student,” that this policy does not excuse students from completing required academic work, and that professors can require a “fair alternative” to attendance on those days that students must be absent from class to participate in a University-Sanctioned Event.

EMERGENCY PREPAREDNESS

All students are encouraged to sign up for the University’s free WCU ALERT service, which delivers official WCU emergency text messages directly to your cell phone. For more information, visit www.wcupa.edu/wcualert. To report an emergency, call the Department of Public Safety at 610-436-3311.

ELECTRONIC MAIL POLICY

It is expected that faculty, staff, and students activate and maintain regular access to University-provided e-mail accounts. Official university communications, including those from your instructor, will be sent through your university e-mail account. You are responsible for accessing that mail to be sure to obtain official University communications. Failure to access will not exempt individuals from the responsibilities associated with this course.