Course Overview

Instructor Information

Instructor: Thomas Metzger, PhD
Email: metzger.181@osu.edu; **do not use my Buckeyemail address.** Messages sent through Carmen often go into my spam folder; for fastest communication, use **metzger.181@osu.edu**.
Office hours: Wednesday and Friday, 11:30 am - 12:30 pm, Pomerene 161, or by appointment
Grader/TA: Mr. Jae Chang.2090

Course Delivery

This course meets Tuesdays and Thursdays in Cockins 312 from 9:35 am - 10:55 am. If it is safe and healthy for you to do so, attendance is mandatory. Attendance will be taken daily. Each meeting will be labeled with a week number and a letter, "A" (Tuesday meeting) or "B" (Thursday meeting). For example, the Thursday meeting of week 3 will be Meeting 3B.

Office hour attendance is highly encouraged but is not required. The purpose of office hours is to provide supplemental time for questions, discussion, or assistance that you may need. Any topics related to the course, or to college life, professional development, or personal issues affecting your academic career at Ohio State are relevant and welcome topics. Office hours will be held as virtual or in-person meetings (Pomerene Hall 161). Attendance is always optional but you are welcome to attend as frequently as you would like.

Click here to join virtual office hours.

Course Description

Applied statistics topics in a sports context, including regression, categorical analysis, fixed and random effect models, machine learning and predictive models, time series, supervised and unsupervised clustering.

Course Learning Outcomes

By the end of this course, students should successfully be able to:

- Propose and test measurable, relevant research questions and statistical hypotheses in sports contexts
- Apply statistics and data science methods in sports contexts
- Read and critique published academic work on research related to statistics and data science in sports contexts
- Create professional, rigorous visualizations and reports on statistical analyses

Materials

Text

Required text: Stat 4194 Course Notes (electronic, on Carmen)

Recommended text resources:
• James, Witten, Hastie, Tibshirani: An Introduction to Statistical Learning with Applications in R, 2nd edition. (https://statlearning.com/)
• Applied Linear Regression Models, 4th edition, by Kutner, Nachtsheim, and Neter, 2004

Software

• Required software: we will extensively use the statistical software package called R (The R Project for Statistical Computing; http://www.r-project.org/). This software package is available for free. You can download R for Windows, Mac, and Linux, from the CRAN archive at https://cran.r-project.org. An in-depth introduction to R is available at http://cran.r-project.org/doc/manuals/R-intro.pdf. Tutorials are available in the Swirl system, which you can learn about at http://swirlstats.com/. "R Programming: The basics of programming in R" is an appropriate first tutorial for students who have never used R.
• Required software: we will also use the R interface RStudio. This package is available for Windows, Mac, and Linux and can be downloaded for free from http://rstudio.org. Note that RStudio requires R to be installed.
• Required software: Microsoft Office 365 ProPlus. All Ohio State students are now eligible for free Microsoft Office 365 ProPlus through Microsoft's Student Advantage program. Each student can install Office on five PCs or Macs, five tablets (Windows, iPad® and Android™) and five phones. Students are able to access Word, Excel, PowerPoint, Outlook and other programs, depending on platform. Users will also receive 1 TB of OneDrive for Business storage. Office 365 is installed within your BuckeyeMail account. Full instructions for downloading and installation can be found https://ocio.osu.edu/kb04733.

Grades and Assignments

Homework

Homework assignments will comprise 20% of your grade for the course. Assignments will only be accepted through Carmen as a .pdf file submission, with clear and organized work and relevant code and output provided. Every assigned problem should be completed, but only a subset of problems may be graded. You are encouraged to collaborate on homework assignments, but ultimately the work you submit must be your own. **All homework assignments will be included in your final grade.**

Quizzes

Quizzes will comprise 10% of your grade for the course. These short assignments will frequently be given during lectures, and may be unannounced. The lowest quiz grade will

be dropped. Quizzes missed due to an excused absence must be made up during office hours within one business day of the missed class.

Projects

The course will include three projects, each comprising 20% of your grade. They will roughly be due in Weeks 5, 11, and during final exam week.

Attendance

Attendance will be taken daily and will comprise 10% of your course grade. All students will get one free absence with no questions asked. Additional absences will be considered on a case by case basis. You can strengthen your case by reaching out farther in advance, attending office hours to discuss the missed material, and providing documentation such as a doctor's note. Two tardies will be counted as one absence.

Late Assignments

Late homeworks and projects will be accepted for 48 hours after the original due date with a 2% deduction per hour. **After this, no late assignments will be accepted.** Do not wait until the last moment to begin working on assignments. Unexpected obstacles will occur in life - it is your responsibility to be prepared for them. If something unexpected comes up 2 hours before an assignment is due that impedes your ability to submit on time, then you should have started the assignment earlier. Submitting the wrong document - such as the blank assignment template, an incomplete version, or a corrupted version of the file - is not a valid excuse. It is your responsibility to ensure you have submitted the proper document in the proper format.

For emergencies, each student can have one late waiver throughout the semester, no questions asked. You still have to turn in the assignment within 48 hours, but I'll waive the late penalty for one assignment of your choosing if something unexpected comes up and submit it within 48 hours of the due date.

Academic Integrity

I take academic integrity very seriously. There is no place at The Ohio State University for academic misconduct, and I have submitted many students in the past for violations including copying other students' work and receiving unauthorized assistance on exams.

- Homework assignments: you are encouraged to collaborate with other students in small groups if you are comfortable doing so, but ultimately the work you submit must be your own. Directly copying another student's work is not permitted.
- Quizzes: All work must represent your unique, individual effort. Directly copying another student's code, work, or file is not permitted.
- Reusing past work: In general, you are prohibited in university courses from turning in work from a past class to your current class, even if you modify it. If you want to build on past research or revisit a topic you've explored in previous courses, please discuss the

situation with me.
• Falsifying research or results: All research you will conduct in this course is intended to be a learning experience; you should never feel tempted to make your results or your library research look more successful than it was.
• Collaboration and informal peer-review: The course includes many opportunities for formal collaboration with your classmates. While study groups and peer-review of major written projects is encouraged, remember that comparing answers on an exam is not permitted. If you're unsure about a particular situation, please feel free just to ask ahead of time.
• Artificial intelligence: copying code or text from AI platforms such as Microsoft Copilot or ChatGPT is not permitted, as it does not represent your unique work or contribution.

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-48.7 (B)). For additional information, see the Code of Student Conduct (https://trustees.osu.edu/bylaws-and-rules/code).

Health, Safety, and Accommodations

Illness

If you are ill and need to miss class, including if you are staying home and away from others while experiencing symptoms of a viral infection or fever, please let me know immediately. In cases where illness interacts with an underlying medical condition, please consult with Student Life Disability Services to request reasonable accommodations. You can connect with them at slds@osu.edu; 614-292-3307; or slds.osu.edu.

Title IX Policy

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu.

Student Services and Accessibility Accommodations for Students with Disabilities

The University strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability (including mental health, chronic or temporary medical conditions), please let me know immediately so that

we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

If you have accommodations, it is your responsibility to communicate these with me in a timely and efficient manner.

Student academic services: http://advising.osu.edu/welcome.shtml

Student support services: http://ssc.osu.edu

Diversity and Inclusion

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

Mental Health

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-TALK or at suicidepreventionlifeline.org.

Religious Accommodations

Ohio State has had a longstanding practice of making reasonable academic accommodations for students' religious beliefs and practices in accordance with applicable law. In 2023, Ohio State updated its practice to align with new state legislation. Under this new provision, students must be in early communication with their instructors

regarding any known accommodation requests for religious beliefs and practices, providing notice of specific dates for which they request alternative accommodations within 14 days after the first instructional day of the course. Instructors in turn shall not question the sincerity of a student's religious or spiritual belief system in reviewing such requests and shall keep requests for accommodations confidential.

With sufficient notice, instructors will provide students with reasonable alternative accommodations with regard to examinations and other academic requirements with respect to students' sincerely held religious beliefs and practices by allowing up to three absences each semester for the student to attend or participate in religious activities. Examples of religious accommodations can include, but are not limited to, rescheduling an exam, altering the time of a student's presentation, allowing make-up assignments to substitute for missed class work, or flexibility in due dates or research responsibilities. If concerns arise about a requested accommodation, instructors are to consult their tenure initiating unit head for assistance.

A student's request for time off shall be provided if the student's sincerely held religious belief or practice severely affects the student's ability to take an exam or meet an academic requirement and the student has notified their instructor, in writing during the first 14 days after the course begins, of the date of each absence. Although students are required to provide notice within the first 14 days after a course begins, instructors are strongly encouraged to work with the student to provide a reasonable accommodation if a request is made outside the notice period. A student may not be penalized for an absence approved under this policy.

If students have questions or disputes related to academic accommodations, they should contact their course instructor, and then their department or college office. For questions or to report discrimination or harassment based on religion, individuals should contact the Office of Institutional Equity. (Policy: Religious Holidays, Holy Days and Observances)

Disclaimer

The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

This syllabus should be taken as a fairly reliable guide for the course content. However, you cannot claim any rights from it and in particular we reserve the right to change due dates or the methods of grading and/or assessment if necessary. Any changes will be communicated to you through official course announcements.

Topics, Tentative Schedule, and Readings

Semester-long points of emphasis:

- Effective data visualizations
- Reading and reviewing peer-reviewed academic research
- Coding and reproducible research in R
- Professional reports
- Effective communication with non-statisticians and sports decision-makers
- Wrangling large, messy, and/or unstructured data sets

Week 1: Fundamentals Review:

- Frequently used probability densities and distributions
- Confidence intervals
- Hypothesis tests
- Homework: random variables and hypothesis testing

Week 2: ANOVA and Regression Review

- One- and Two-way ANOVA
- Simple linear regression
- t-tests and F-tests
- Homework: regression in R

Chatzakis, Prokopios, et al. “Effect of performance standard and sex on 24 h ultra-marathon pacing profiles.” Journal of Sports Analytics 7.4 (2021): 247-253.

Week 3: Multiple Regression

- Checking regression assumption
- Collinearity and variable selection
- Goodness of fit
- Homework: multiple regression
- Project 1 introduction

Week 4: GLMs, Logistic, Poisson, and Negative Binomial Regression

- GLM framework and link functions
- Poisson and negative binomial distributions
- Overdispersion
- Homework: GLMs

Mihalik, Jason P., et al. “Do head injury biomechanics predict concussion clinical recovery in college American Football players?.” Annals of biomedical engineering 48 (2020): 2555-2565.

Week 5: Introductory Time Series and Longitudinal Data

- Autocorrelation
- Stationary processes
- AR(1) processes
- Homework: fitting time series in R
- Project 1 due

Morgulev, Elia, et al. “Longitudinal trends in human accuracy: A five-decade analysis (1969–2019) of free-throw shooting in the NBA.” Journal of Sports Analytics 8.3 (2022): 211-219.

Week 6: Random Effects Models

- Fixed and random effects definitions
- Random intercepts
- Random slopes
- Homework: random effects models in R with lmer and glmer
- Project 2 introduction

Week 7: Prediction and Prediction Error

- Predictive models
- Model assessment
- MSE and RMSE
- Homework: predictive models

Week 8: Cross-Validation

- K-fold cross-validation
- Bagging and boosting
- Homework: assessing predictive models

Montoye, Alexander HK, et al. “Cross-validation and out-of-sample testing of physical activity intensity predictions with a wrist-worn accelerometer.” Journal of Applied Physiology (2018).

Week 9: Variable Selection and Dimension Reduction

- Stepwise regression
- Principal components analysis

- Model selection

Week 10: Classification and Regression Trees

Week 11: Random Forests

Lampis, Tzai, et al. “Predictions of European basketball match results with machine learning algorithms.” Journal of Sports Analytics 9.2 (2023): 171-190.

Week 12-13: Unsupervised Clustering

Week 14: Missing Data

Nguyen, Quang, and Gregory J. Matthews. “Filling the gaps: A multiple imputation approach to estimating aging curves in baseball.” Journal of Sports Analytics 10.1 (2024): 77-85.

Week 15-16: Neural Networks

Lee, Jae Sik. “Prediction of pitch type and location in baseball using ensemble model of deep neural networks.” Journal of Sports Analytics 8.2 (2022): 115-126.

Project 1: Explaining an Outcome

Choose a continuous dependent outcome variable over a season - such as wins, yards, or points scored - that you believe can be explained by independent variables - such as payroll, height, division, or position. Use regression to quantify and explain the relationship between the independent variables and dependent variable of interest.

Main focus will be regression analysis with hypothesis testing, with an emphasis on verifying assumptions, creating effective visualizations, and reporting in an accessible, professional format.

Project 2: NCAA Basketball Tournament Challenge

Each student is required to submit a bracket for either the 2025 NCAA Division I Men’s or Women’s Basketball Tournament. The brackets are announced on Sunday, March 16, and your submission(s) are due Wednesday, March 19.

Your picks must reflect who the *data* suggest will win each matchup, not your intuition. Grades will reflect the rigor and depth of the statistical justification of your picks, not the accuracy of your bracket.

Students may submit brackets for both the Men’s and Women’s Tournament for extra credit.

Project 3: Coach/Player of the Year

Each student is required to choose a season and league to propose a Coach or Player of the Year, based on reproducible, rigorous, statistically and mathematically defensible comparisons and criteria.

To avoid bias, criteria for the award should be established first, then, the analysis should be conducted and the winner selected.