Module 0: Welcome to STA 310

Rebecca C. Steorts (slide and course adaptation from Maria Tackett)

Welcome!

Teaching Team

Instructor:
Professor Rebecca Steorts
Old Chem 208
rebecca.steorts@duke.edu

Teaching assistants
Deva Bag, PhD Student

Announcements

- We will meet on Friday, January 9th for lecture, so please come prepared for lecture and not lab (as the PhD student is traveling and not available for lab). I will be sure to give you this lecture back at the end of the semester.
- The course webpage (https://resteorts.github.io/teach/generalized.html) will be updated on roughly a weekly basis, so please check this frequently for any updates.

Course logistics

Lectures

Tuesday and Thursday, 11:45 - 1:00 pm, Perkins 127

Labs (Office Hour or Alternate Lecture Time)

Lab 01: Friday, 11:45 - 1:00 pm, Old Chemistry 001

Generalized Linear Models

In statistics, a generalized linear model (GLM) is a flexible generalization of ordinary linear regression. The GLM generalizes linear regression by allowing the linear model to be related to the response variable via a link function and by allowing the magnitude of the variance of each measurement to be a function of its predicted value.[1]

[1] Souce: Generalized linear model

Generalized Linear Models

In statistics, a generalized linear model (GLM) is a flexible generalization of ordinary linear regression. The GLM generalizes linear regression by allowing the linear model to be related to the response variable via a link function and by allowing the magnitude of the variance of each measurement to be a function of its predicted value.[1]

Example: Logistic regression

$$\pi = P(y = 1|x) \;\Rightarrow\; \text{Link function: } \log\left(\frac{\pi}{1-\pi}\right)$$
$$\Rightarrow \log\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1\, x$$

[1] Souce: Generalized linear model

Course learning objectives

By the end of the semester, you will be able to . . .

- describe generalized linear models (GLMs) as a unified framework.

Course learning objectives

By the end of the semester, you will be able to . . .

- describe generalized linear models (GLMs) as a unified framework.
- explain how specific models fit into the GLM framework

Course learning objectives

By the end of the semester, you will be able to . . .

- describe generalized linear models (GLMs) as a unified framework.
- explain how specific models fit into the GLM framework
- identify the appropriate model given the data and analysis objective.

Course learning objectives

By the end of the semester, you will be able to . . .

- describe generalized linear models (GLMs) as a unified framework.
- explain how specific models fit into the GLM framework
- identify the appropriate model given the data and analysis objective.
- analyze real-world data by fitting and interpreting GLMs.

Course learning objectives

By the end of the semester, you will be able to . . .

- describe generalized linear models (GLMs) as a unified framework.
- explain how specific models fit into the GLM framework
- identify the appropriate model given the data and analysis objective.
- analyze real-world data by fitting and interpreting GLMs.
- use R for analysis and write reports

Course learning objectives

By the end of the semester, you will be able to . . .

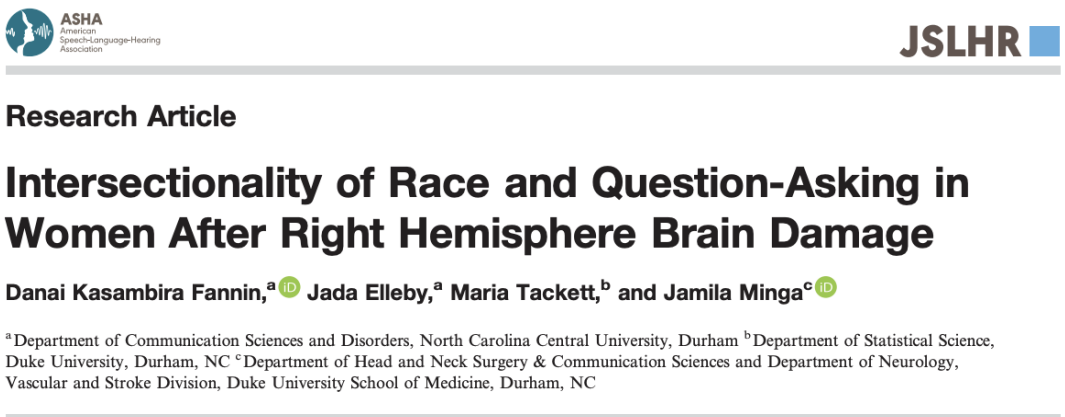
- describe generalized linear models (GLMs) as a unified framework.
- explain how specific models fit into the GLM framework
- identify the appropriate model given the data and analysis objective.
- analyze real-world data by fitting and interpreting GLMs.
- use R for analysis and write reports
- effectively communicate results from statistical analyses to a general audience in writing.

Course topics

Generalized Linear Models

- Review of distributions, likelihoods, and regression
- Introduce models for non-normal response variables
- Estimation, interpretation, and inference
- Mathematical details of GLMs as a unified framework

GLMs in practice



ASHA American Speech-Language-Hearing Association JSLHR

Research Article

Intersectionality of Race and Question-Asking in Women After Right Hemisphere Brain Damage

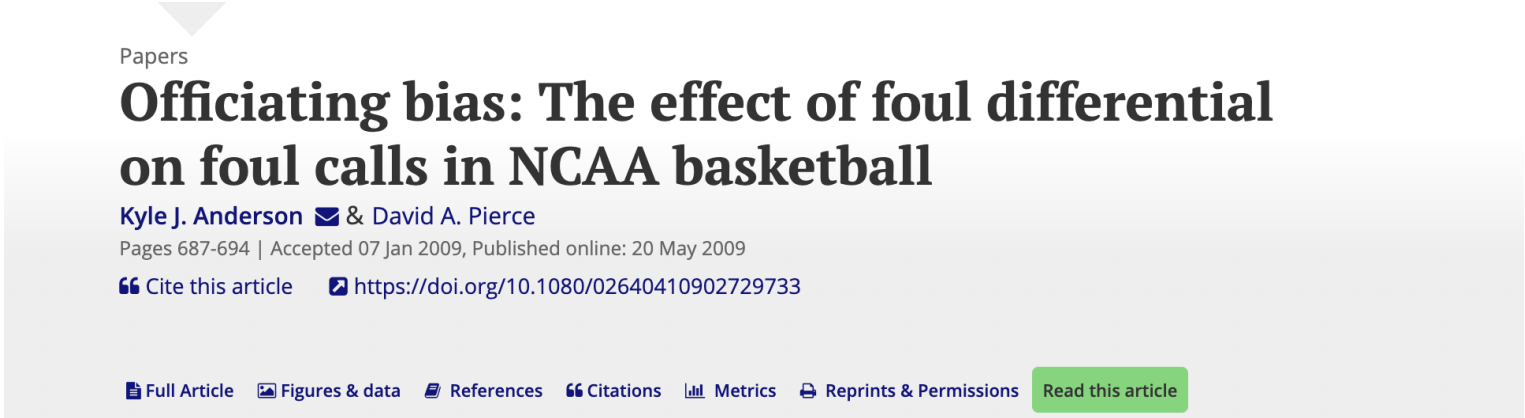
Danai Kasambira Fannin,[a] Jada Elleby,[a] Maria Tackett,[b] and Jamila Minga[c]

[a]Department of Communication Sciences and Disorders, North Carolina Central University, Durham [b]Department of Statistical Science, Duke University, Durham, NC [c]Department of Head and Neck Surgery & Communication Sciences and Department of Neurology, Vascular and Stroke Division, Duke University School of Medicine, Durham, NC

*". . . we used **negative binomial regression** to model the association between the number of questions produced, race, and group after adjusting for the additional covariates age and years of education. **Poisson and zero-inflated Poisson regression models** were also considered. . . the negative binomial model was a good fit for the data given the **overdispersion** in the distribution of number of questions asked."*[2]

[2] *Fannin, D. K., Elleby, J., Tackett, M., & Minga, J. (2023). Intersectionality of Race and Question-Asking in Women After Right Hemisphere Brain Damage. Journal of Speech, Language, and Hearing Research, 66(1), 314-324.*

GLMs in practice



Papers

Officiating bias: The effect of foul differential on foul calls in NCAA basketball

Kyle J. Anderson & David A. Pierce

Pages 687-694 | Accepted 07 Jan 2009, Published online: 20 May 2009

Cite this article https://doi.org/10.1080/02640410902729733

Full Article Figures & data References Citations Metrics Reprints & Permissions Read this article

*" . . . a **logistic regression model** is used to test how the likelihood of a foul is affected by which team is the home team, the foul differential, and the score differential. . . The logistic regression was run under several specifications . . . using **clustered observation standard errors**, with each game as a cluster. This is done as an attempt to adjust for the fact that **observations may not be independent** as required under the logistic specification.*[3]

[3] *Anderson, K. J., & Pierce, D. A. (2009). Officiating bias: The effect of foul differential on foul calls in NCAA basketball. Journal of sports sciences, 27(7), 687-694.*

Meet your classmates!

- Get in groups of 2 - 3
- Each person in the group...
  - Introduce yourself
  - Share a boring fact about yourself
- Everyone will introduce one person from your group to the class

Course details

Pre-reqs

Pre-reqs

STA 210 and STA 230 / STA 240

Background knowledge

Statistical methods

- Linear and logistic regression
- Statistical inference
- Basic understanding of random variables

Computing

- Using R for data analysis
- Writing reports using Rmd
- Understanding of github
- Understanding reproducibility

Course toolkit

Course webpage:
https://resteorts.github.io/teach/generalized.html

- Course information and course schedule

Canvas

- Changes to Schedule
- Ed Discussion
- Homework uploads

Gradescope (link on course webpage)

- Homework uploads (make sure to upload to Canvas as well).

Ed Discussion (link on course webpage)

- Course discussion

Class Meetings

Lectures

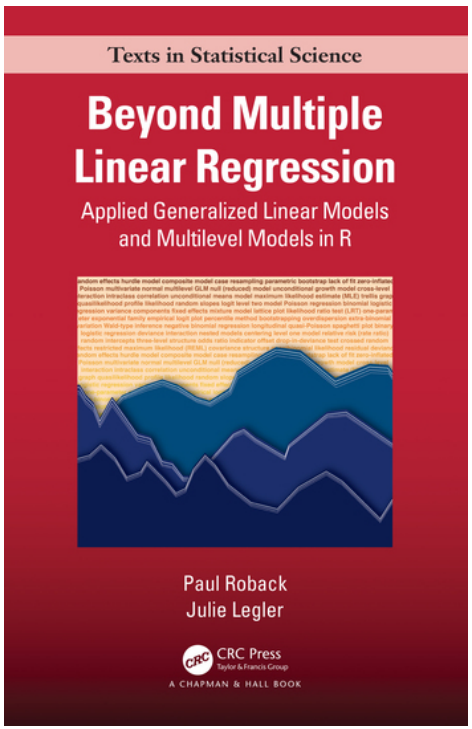
- Some traditional lecture
- Short individual and group activities
- Bring fully-charged laptop / tablet to use R

Labs (start January 10)

- Work on class assignments with TA support
- Time for clarifying questions regarding course material
- Alternative lecture time when needed

Attendance is strongly expected (if you are healthy!)

Readings



- Primary textbook: *Beyond Multiple Linear Regression* by Roback and Legler
- Other texts:
  - *R for Data Science (2nd edition)* by Wickham, Çetinkaya-Rundel, and Grolemund
  - Tidy Modeling with R by Kuhn and Silge
- Articles and videos periodically assigned

Computing toolkit

R and RStudio

- Install R and RStudio on your laptop
- Click here for instructions to install RStudio and configure git

or

Access RStudio through Docker container provided by Duke OIT

- Reserve a generic **RStudio** container (there is no course specific container)

Canvas and Gradescope

- All homework assignments will be uploaded to Gradescope and Canvas.
- Gradescope allows more fair and balanced grading.
- Canvas allows us to check the reproducibility of your work.
- Unfortunately, there is no platform that does both (to my knowledge).
- Feedback will be given in Gradescope and is individual and private.

Ed Discussion

- Online discussion forum (like Piazza, etc.)
- Platform to ask questions about course content, logistics, assignments, etc.
- Content organized by channels. Before posting, please browse previous posts to see if your question has already been answered. If not, please post your question in the relevant channel.
- Questions about grades, absences, and other private matters should be emailed to me with "STA 310" in the subject line.

Activities & Assessment

Homework (40%)

- Individual assignments
- Combination of conceptual questions, guided analyses, and open-ended analyses
- Lowest homework grade is dropped

Quizzes (60%)

- Individual online quizzes
- Covers content since the previous quiz, including readings, lecture notes, in-class activities, and homework
- Lowest quiz grade is dropped

Grading

Final grades will be calculated as follows

Category	Percentage
Homework	40%
Quizzes	60%

See the course syllabus for letter grade thresholds.

Course community

Course community

- Uphold the Duke Community Standard:
  - *I will not lie, cheat, or steal in my academic endeavors;*
  - *I will conduct myself honorably in all my endeavors;*
  - *I will act if the Standard is compromised.*
- Commit to respect, honor, and celebrate our diverse community
- Commit to being part of a learning environment that is welcoming and accessible to everyone

Accessibility

- The Student Disability Access Office (SDAO) is available to ensure that students are able to engage with their courses and related assignments.
- If you have documented accommodations from SDAO, please send the documentation within the first week to make sure all accommodations can be put in place as quickly as possible!
- I am committed to making all course activities and materials accessible. If any course component is not accessible to you in any way, please don't hesitate to let me know.

Support

- **Office hours** to meet with a member of the teaching team.
  - Find the course schedule on the course webpage
  - Office hours begin January 16
  - Please see me after class if you have questions before then.
- **Ed Discussion** for questions about course logistics, content, and assignments
- **Email** for questions not appropriate for Ed Discussion, e.g., regarding personal matters or grades
  - Please put **STA 310** in the subject line

See the syllabus regarding additional academic and mental health and wellness resources.

Latex Resources

1. https://wch.github.io/latexsheet/latexsheet.pdf
2. https://www.bu.edu/math/files/2013/08/LongTeX1.pdf
3. https://www.docx2latex.com/tutorials/mathematical-equations-latex/

Questions

Questions?