BIOST/STAT 570
Advanced Regression Methods for Independent Data
Fall 2024

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Office Hours: See `Canvas`

Course Meeting Times: MWF 1:30-2:20 PM, BAG 154
Website: `Canvas`

Course Description
This course covers linear models, generalized linear models, and non-linear models, with a focus on inferential tools. In the first part of the course, we cover inference for fully parametric models using maximum likelihood and Bayesian estimation. In the second part, we aim to relax some of these assumptions using least squares, quasi-likelihood, M-estimation, sandwich estimators, and, time permitting, the bootstrap. The course also touches on the computation of estimators, comparison of approaches, and model diagnostics. A selection of 'special topics' on more advanced topics will also be covered.

Official Course Description
Covers linear models, generalized linear and non-linear regression models. Includes interpretation of parameters, including collapsibility and non-collapsibility, estimating equations; likelihood; sandwich estimations; the bootstrap; Bayesian inference: prior specification, hypothesis testing, and computation; comparison of approaches; and diagnostics.

Prerequisites
Either STAT 512 and STAT 513, or BIOST 522 and BIOST 523; and either STAT 502 and STAT 504/CS&SS 504, or BIOST 514 and BIOST 515. Matrix algebra from a course at the level of BIOST 533/STAT 533. *Contact the instructor for permission to take the course if you are not a graduate student in Biostat/Stat and if you are not certain whether this course is right for you.*

Learning objectives:
Upon completion of this course, students should be able to:

Methodology

- Understand and apply inferential tools for parametric regression models, using likelihood-based and Bayesian inference.
- Understand to what extent classical distributional assumptions are necessary to achieve valid inference, and develop tools to robustify the inference to misspecification.

Application/Interpretation

- Explain the differences in interpretation between linear, log-linear, logistic-linear regression, and nonlinear methods for use with univariate, independent outcomes.
- Implement modern multivariate regression methods for univariate and independent outcomes, interpreting point estimates, intervals, and hypothesis-testing output from statistical software in language suitable for collaboration with non-statisticians.
- Suggest scientifically appropriate multivariate regression approaches for use with univariate, independent outcomes.
- Assess the appropriateness of models using regression diagnostics.

Evaluation and Grading:

- **Homework (50%):** Homework assignments will be due approximately every two weeks. Each of the **four** assignments will be worth the same amount.
  - You are permitted to brainstorm in groups while working on the assignments, but your final submitted homework assignment must be your own.
  - You may not copy or make use of solutions from the web, other students, or other sources.
  - You will be given two "free late days" that you may use without penalty on your homework assignments **over the course of the quarter**. After you have used your two "free late days", each additional late day will result in 20% credit being docked from the assignment. No exceptions will be made to this late-day policy.
  - **Any assignment that is more than 3 days (72 hours) late will receive no credit.** This is required in order to ensure that solution keys can be promptly posted online for the benefit of all students.
- **Midterm (20%)**.
- **Final exam (30%)**.

Course Textbook:

Wakefield, J.C. (2013). *Bayesian and Frequentist Regression Methods*. Springer. Errata: `http://faculty.washington.edu/jonno/book/Errata.pdf`

Other useful references:

Agresti, A. (2015). *Foundations of Linear and Generalized Linear Models*, Wiley.

Davison, A.C. (2003). *Statistical Models*. Cambridge University Press.

Casella, G. and Berger, R.L. (2002). *Statistical inference*, Duxbury.

Gelman, A., Carlin, J.B., Stern, H., Dunson, D., Vehtari, A. and Rubin, D.R. (2013). *Bayesian Data Analysis*, Third Edition, CRC Press.

Generalized Linear Models, Second Edition, Chapman and Hall.

Seber, G.A.F. and Lee, A.J. (2003). *Linear Regression Analysis*, Second Edition, Wiley.

Acknowledgment: This course builds on materials developed by previous instructors, including Jon Wakefield, Barbara McKnight, Ken Rice, and Mauricio Sadinle.

Course expectations: Though attendance is not required, it is strongly recommended. Students may brainstorm ideas for homework assignments, but may not copy solutions from other students or other sources.

Computing: We will use the `R` programming language (`www.r-project.org`) throughout this course.

Communication: The `Canvas` course webpage will serve as an archive of homework and other materials. Announcements concerning course logistics will also be placed on the webpage.

Discussions page: We will be using the `Canvas` Discussions page. Please use this feature to ask questions about homework or other course topics. Please do not e-mail the instructor or TA questions about the homework assignments: such questions will be re-directed to the `Canvas` discussion board.

Important Notes

- lectures will be recorded and posted on `Canvas` together with slides, homework assignments, and other course-related materials;
- questions and discussions during the lectures are welcome and encouraged.

Topics Covered (This is subject to change – See also canvas webpage!)

- Fully parametric models:
  - Normal linear model;
  - Generalized linear models;
  - Bayesian inference.
- Inference under weaker assumptions:
  - Least squares;
  - Quasi-likelihood;
  - M-estimation;
  - Sandwich estimators;
- A selection of 'special topics' (time permitting).

Communication Skills Communication through writing and speaking is an important transferable skill for all career pathways. Establishing a strong foundation in communication skills will help you be successful throughout your future coursework and career. Therefore, this course includes assignments with the goal of helping you identify areas of strength

and improvement in your communication. If you feel that you could benefit from additional opportunities to improve your writing skills in particular, a list of resources at the UW and others accessible online can be found on the SPH website at `https://sph.washington.edu/sites/default/files/inline-files/Writing-Resources-4.3.19.pdf`.

ILLNESS PROTOCOL

If you feel ill or exhibit respiratory or other symptoms, you should not come to class. Seek medical attention if necessary and notify your instructor(s) as soon as possible by email. UW Environmental Health & Safety recommends that you wear a well fitting mask while you are symptomatic.

Additional recommendations include getting your annual flu shot and getting boosted with the updated COVID vaccines (available at clinics and pharmacies, as well as through UW Medicine and local health agencies).

Please check your email and CANVAS announcements daily BEFORE coming to class. If we need to conduct class remotely because the instructor or a guest speaker is unable to attend in person, we will send all registered students an email and/or post a CANVAS announcement with a Zoom link for remote instruction or a plan for making up the class.

IMPORTANT POLICIES & RESOURCES

Academic Integrity: Students at the University of Washington (UW) are expected to maintain the highest standards of academic conduct, professional honesty, and personal integrity. The UW School of Public Health (SPH) is committed to upholding standards of academic integrity consistent with the academic and professional communities of which it is a part. Plagiarism, cheating, and other misconduct are serious violations of the University of Washington Student Conduct Code (WAC 478-121). We expect you to know and follow the university's policies on cheating and plagiarism, and the SPH Academic Integrity Policy. Any suspected cases of academic misconduct will be handled according to University of Washington regulations. For more information, see the University of Washington Community Standards and Student Conduct website.

Class or TA Concerns: If you have any concerns about the class or your TA, please see the TA about these concerns as soon as possible. If you are not comfortable talking with the TA or not satisfied with the response that you receive, you may contact the Department of Biostatistics Associate Director of Academic Affairs (biostgp@uw.edu). If you are still not satisfied with the response that you receive, you may contact the Department of Biostatistics Chair (bchair@uw.edu)..

Access and Accommodations: Your experience in this class is important to me. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course.

If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not

limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 206-543-8924 or uwdrs@uw.edu or disability.uw.edu. DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between you, your instructor(s) and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

Religious Accommodations: Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy (https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/). Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form (https://registrar.washington.edu/students/religious-accommodations-request/).

Inclusion & Diversity Diverse backgrounds, embodiments and experiences are essential to the critical thinking endeavor at the heart of University education. In SPH, we are expected:

1. To respect individual differences, which may include, but are not limited to, age, cultural background, disability, ethnicity, family status, gender, immigration status, national origin, race, religion, sex, sexual orientation, socioeconomic status and veteran status.

2. To engage respectfully in the discussion of diverse worldviews and ideologies embedded in course readings, presentations and artifacts, including those course materials that are at odds with personal beliefs and values.

3. To encourage students with concerns about classroom climate to talk to their instructor, adviser, a member of the departmental or SPH EDI Committee, the Assistant Dean for EDI, or the program's director.

Classroom Climate: We are co-creators of our learning environment. It is our collective responsibility to develop a supportive learning environment for everyone. Listening with respect and an open mind, striving to understand others' views, and articulating your own point of view will help foster the creation of this environment. We engage our differences with the intent to build community, not to put down the other and distance our self from the other. Being mindful to not monopolize discussion and/or interrupt others will also help foster a dialogic environment.

The following guidelines can add to the richness of our discussion:

- We assume that persons are always doing the best that they can, including the persons in this learning environment.

- We acknowledge that systematic oppression exists based on privileged positions and specific to race, gender, class, religion, sexual orientation, and other social variables and identities.

- We posit that assigning blame to persons in socially marginal positions is counter-productive to our practice. We can learn much about the dominant culture by looking at how it constructs the lives of those on its social margins.
- While we may question or take issue with another class member's ideology, we will not demean, devalue, or attempt to humiliate another person based on her/his experiences, value system, or construction of meaning.
- We have a professional obligation to actively challenge myths and stereotypes about our own groups and other groups so we can break down the walls that prohibit group cooperation and growth. [Adapted from Lynn Weber Cannon (1990). Fostering positive race, class and gender dynamics in the classroom. Women Studies Quarterly, 1 & 2, 126-134.]

We are a learning community. As such, we are expected to engage with difference. Part of functioning as a learning community is to engage in dialogue in respectful ways that supports learning for all of us and that holds us accountable to each other. Our learning community asks us to trust and take risks in being vulnerable.

Here are some guidelines that we try to use in our learning process:

- Listen well and be present to each member of our group and class.
- Assume that I might miss things others see and see things others miss.
- Raise my views in such a way that I encourage others to raise theirs.
- Inquire into others' views while inviting them to inquire into mine.
- Extend the same listening to others I would wish them to extend to me.
- Surface my feelings in such a way that I make it easier for others to surface theirs.
- Regard my views as a perspective onto the world, not the world itself.
- Beware of either-or thinking.
- Beware of my assumptions of others and their motivations.
- Test my assumptions about how and why people say or do things.
- Be authentic in my engagement with all members of our class.

Pronouns We share our pronouns because we strive to cultivate an inclusive environment where people of all genders feel safe and respected. We cannot assume we know someone's gender just by looking at them. So we invite everyone to share their pronouns.

Bias Concerns The Office of the Dean has a student concern policy, a faculty concern policy and standard HR procedures for staff concerns. Our 2018 climate survey states that most people in SPH do not report bias incidents because they do not know where to go. Students are encouraged to report any incidents of bias to someone they feel comfortable with, including instructors, advisers or department staff. They can email dcinfo@uw.edu for immediate follow up. Bias concerns can be anonymously and confidentially reported

at this link. Data is collected by the Assistant Dean for EDI and the Director of Program Operations for Student and Academic Services and tracked for resolution and areas are identified for further training.

Sexual Harassment Sexual harassment is a form of harassment based on the recipient's sex that is characterized by:

1. Unwelcome sexual advances, requests for sexual favors, or other verbal or physical conduct of a sexual nature by a person who has authority over the recipient when:
    - Submission to such conduct is an implicit or explicit condition of the individual's employment, academic status, or ability to use University facilities and services, or
    - Submission to or rejection of the conduct affects tangible aspects of the individual's employment, academic status, or use of University facilities.
2. Unwelcome and unsolicited language or conduct that creates an intimidating, hostile, or offensive working or learning environment, or has the purpose or effect of unreasonably interfering with an individual's academic or work performance.

If you believe that you are being harassed, or have observed harassment, you can report it to SPH using the bias concerns link. The University also has designated offices to help you: SafeCampus; Office of the Ombud; Title IX Investigation Office; and University Complaint Investigation and Resolution Office.

LAND ACKNOWLEDGEMENT

The University of Washington acknowledges the Coast Salish people of this land, the land which touches the shared waters of all tribes and bands within the Duwamish, Suquamish, Tulalip and Muckleshoot nations.