LIFS5310 Biostatistics: Theory and Application in Life Science Research, Fall 2024

Instructor

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Office Hour: TBA

Meeting Time and Venue

Lectures: Wed, 1:30pm to 4:20pm at Rm 2463 (Lift 25-26)

Course description

Statistical analysis has become an essential component in research for testing hypotheses and designing experiments. This course is tailored to PG students in Life Science and related disciplines. We will introduce common methodologies used in research, such as ANOVA, linear regression, nonparametric methods, and bootstrapping. The students will also gain practical skills in using R for analysis.

Prerequisite

The students are expected (i) to know calculus and basic probability and (ii) to have some experience of programming (in any language). **Requirement (ii) can be satisfied by learning any R tutorial on their own before the course.**

No auditing policy: Please register. Commitment and participation are essential for this course. The homework assignments will take time to complete but are necessary to ensure effective learning.

Exclusion

None

Weekly outline

Week 1,2 Introduction, basic probability review
Week 3 Hypothesis testing, t test and p-values
Week 4 Analysis of variance (ANOVA)
Week 5 Experimental design
Week 6 Adjusting for multiple testing
Week 7 Model assumptions and nonparametric tests
Week 8 Linear regression
Week 9 Conditional dependence and partial correlation
Week 10 Model selection
Week 11 Logistic regression and generalized linear model
Week 12 Resampling methods
Week 13 Review and synthesis

Intended Learning Outcomes

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

1. Know how to translate scientific questions into appropriate statistical models and hypothesis
2. Know how to perform statistical analysis using R given experimental data
3. Know how to interpret analysis results in the scientific context
4. Know how to determine the power of hypothesis testing and use it to guide experimental design
5. Develop statistical thinking and understand the basic theories, potential pitfalls, and limitations of main methods

Teaching and Learning Activities

Scheduled weekly activities: 3 hours

Teaching Activities	Course ILOs
Lecture	1,2,3,4,5

Evaluation

Credit points: 3

Assessment	Course ILOs
Homework 50%	1,2,3,4
In-class discussions, quizzes, and participation 20%	1,3,4,5
Final project 30%	1,2,3,5

Homework is open-book and includes derivations, proofs, and numerical, and programming problems, and will be conducted on Canvas.
Final project is short review report on a statistical analysis or issue in life science research that includes questions and example data analysis. More details and suggested topics will be provided.

We will send all course announcements via Canvas. So make sure to turn on the notification or check it regularly.
Preferred channel for questions: Office Hour (just walk-in for the weekly designated time) and the Discussion tab on Canvas (others can see it and may also help to answer).

Important: You can and are encouraged to discuss and collaborate with classmates on homework, as long as each person writes and submits their own answers (copy-and-paste is not allowed). Each student should work on the final project independently.

Generative AI Policy

You are free to use generative AI tools for homework, final project, and any other aspects of course study. However, you are reminded that you still need to understand the concepts and knowledge of the course, because the answers and code given by the AI tools may not always be correct and appropriate.

Assessment Feedback Timeline
To give you timely feedback, we will release homework and other assessments grades on Canvas within 10 working days.

References
Lecture slides are the primary reference materials and will be uploaded to Canvas before the lecture (usually the evening before).

Optional textbook/reference:
Biostatistical analysis by J. Zar [reserved at HKUST library]
Introductory Statistics with R by P. Dalgaard [available online from HKUST library]

Acknowledgment
The course has benefited from related course materials from Chi-Wai Yu, Dong Xia, Thomas Lumley.