Quantitative Methods

Human Sciences
Michaelmas and Hilary terms, 2020–2021

Contact information

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Logistics

- ⋆ Lectures: Thursdays at 2–3pm in the Pauling Centre.
- ⋆ Tutorials: Thursdays 3–4pm in the Pauling Centre or online on Fridays 2–3pm.
- ⋆ Laptops are needed to complete hands-on computational exercises during tutorials. During lectures, students are encouraged to put their laptops away and take notes by hand.
- ⋆ Weekly problem sheets will be provided and are to be submitted by email 24 hours before each lecture.
- ⋆ All course materials will be uploaded on Canvas and on eliasnosrati.github.io.

Course description

This course offers a solid foundation in quantitative methods and data analysis, building on and extending your first-year introduction to statistics. We will cover four principal topics: (1) probability theory, (2) theories of statistical inference, (3) counterfactual inference, including causality and prediction, and (4) descriptive inference, including the study of spatial data and clustering algorithms. Emphasis is placed on combining formal ideas with practical intuition by translating between statistical concepts and real-world problems. For this purpose, we will use R to wrangle, tidy, explore, analyse, and visualise data.

Assessment

The option is examined by one take-home assignment (25%) in Hilary Term and one online open-book exam (75%) at the end of Trinity Term. You will also be given weekly problem sheets that are due 24 hours before each lecture. These will not be marked but will be used to monitor progress and inform tutorial discussions.

Readings

There is no single course textbook, but the following books are useful for consultation. Key references are marked with an asterisk.

*Blitzstein, Joseph K. and Jessica Hwang. 2019. *Introduction to Probability*. 2nd ed. Boca Raton, FL: CRC Press.

Fox, John. 2015. *Applied Regression Analysis and Generalized Linear Models*. 3rd ed. Los Angeles, CA: Sage.

*Grolemund, Garrett. 2014. *Hands-On Programming with R*. O'Reilly. Freely available here.

Healy, Kieran. 2018. *Data Visualization: A Practical Introduction*. Princeton, NJ: Princeton University Press. Online draft freely available here.

*Hernán, Miguel A. and James M. Robins. 2020. *Causal Inference: What If*. Boca Raton, FL: CRC Press. Freely available here.

*Imai, Kosuke. 2017. *Quantitative Social Science: An Introduction*. Princeton, NJ: Princeton University Press. Accompanying website here.

King, Gary. 1998. *Unifying Political Methodology: The Likelihood Theory of Statistical Inference*. Ann Arbor: University of Michigan Press.

Morgan, Stephen and Christopher Winship. 2014. *Counterfactuals and Causal Inference*. 2nd ed. New York, NY: Cambridge University Press.

Spiegelhalter, David. 2019. *The Art of Statistics. Learning from Data*. London: Routledge.

VanderWeele, Tyler J. 2015. *Explanation in Causal Inference. Methods for Mediation and Interaction*. New York, NY: Oxford University Press.

*Wickham, Hadley and Garrett Grolemund. 2017. *R for Data Science*. O'Reilly. Freely available here.

Wickham, Hadley, Danielle Navarro, and Thomas Lin Pedersen. 2020. *ggplot2: Elegant Graphics for Data Analysis*. 3rd ed. Online draft here.

Course schedule

1. Introduction to probability.
2. Conditional probability.
3. Random variables and their distributions.
4. Features of probability distributions.
5. Mid-term revision.
6. Theories of statistical inference.

7. Introduction to causal inference.
8. Three forms of systematic bias.
9. Designs for causal inference.
10. Introduction to descriptive inference.
11. Revision lecture.

Elias Nosrati, October 2020.