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. To sign up for tutorials, click here.

⋆ 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.

⋆ Due to COVID-19, course logistics may change as the term unfolds. Our provisional arrangement is twofold. On the one hand, live lectures and tutorials will take place as normal. During these sessions, everyone is required to wear a face mask and maintain a 2-metre distance from each other. On the other hand, all lectures will be video-recorded and online tutorials will take place on Fridays for those who prefer this.

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, networks, 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.

*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.

Michaelmas schedule

1. Introduction to probability.

2. Conditional probability.

3. Random variables and their distributions.

4. Expectation and limit theorems.

5. Theories of statistical inference.

6. Introduction to causality.

7. Three forms of systematic bias.

8. Designs for causal inference.