

1 Chapter 1: Introduction

Why conduct experiments? Experiments versus observational studies. Trying to infer causation.

Treatments, units, and assignment method specify the experimental design. Terms and concepts. Experimental versus measurement (observational) units. Primary responses versus other responses.

2 Chapter 2: Randomization and Design

In a true experiment we randomize treatments to experimental units. Note the distinction between randomized assignment and haphazard assignment! Although randomization is widely used today, a great article by Raper discusses how revolutionary the idea was when R.A. Fisher first proposed it in 1918 (Raper, 2019). We primarily think of randomization in an experiment as a way to protect against confounding, but randomization is useful in other stages of research studies. Design for known problems, randomize everything else.

2.1 Performing a randomization, the randomization approach to inference

The text discusses the distinction between physical and numerical randomization. Numerical randomization uses pseudo-random numbers. The remaining part of the chapter (section 2.4) presents an approach to inference that is based only on the randomization of treatments to experimental units, and does not make the standard normal-theory assumptions. It is very useful to understand this approach to inference, but in this course we will rely on (and check the validity of) the normal-theory approach to inference for our data analyses.

3 References

- Casella, G. 2008. *Statistical Design*, Springer.
- Kuehl, R.O. 2000. *Statistical Principles of Research Design and Analysis* (second edition), Duxbury Press.
- Kirk, R.E. 1994. *Experimental Design: Procedures for Behavioral Sciences* (third edition), Wadsworth Publishing.
- Oehlert, G.W. 2000. *A First Course in Design and Analysis of Experiments*, W.H. Freeman. (now out of print, but available for free under Creative Commons license at Prof. Oehlert's website at the University of Minnesota)
- Raper, S. 2019. Turning points: Fisher's random idea, *Significance*, 16 (1), 20-23.

Two more advanced, specialized books are:

- Stroup, W.W. 2012. *Generalized linear mixed models. Modern concepts methods and applications*, CRC Press.
- Zuur, A.F., Ieno, E.N., Walker, N.J., Saveliev, A.A., and Smith, G.M. 2009. *Mixed Effects Models and Extensions in Ecology with R*, Springer.