Let's get started!

What does it mean to make a statistical inference? As opposed to just reporting descriptive statistics for the data you collected from a sample, statistical inference is a process where you use data from a sample to describe properties of the distribution of data in the population. When you test a hypothesis, calculate a confidence interval, or estimate an effect size, you are making statistical inferences.

The first thing you need to know is that there are different approaches to making statistical inferences. In this course, we will discuss Frequentist, Likelihood, and Bayesian approaches. All these different approaches have strengths and weaknesses, as you will discover in Lecture 1.1. It's also useful to realize that within Frequentist statistics (which defines the probability of the outcome of a study in light of its frequency in a very large number of repetitions of the study) there are two different approaches to using *p*-values: One proposed by Ronald Fisher, and one by Jerzy Neyman. People often use *p*-values in a hybrid approach that randomly combines things from the Neyman-Pearson approach and the Fisherian approach, but this has been widely criticized.

To improve your inferences, you need to know how to differentiate these approaches, and how to apply them in a consistent manner. I will mainly recommend the Neyman-Pearson approach, which stresses controlling your error rates (Lecture 1.3). Fisher tried to use *p*-values as measures of evidence, but if you want to quantify evidence, likelihood approaches and Bayesian statistics (the topic of the lectures in Week 2) are more appropriate.

Some researchers believe science would improve if we stopped using *p*-values. I don't think it's so easy. What we need, is for people to understand how to correctly interpret *p*-values. In this lecture, you will see how *p*-values are a function of the power of the test, and will learn how to interpret *p*-values correctly (Lecture 1.2). You will experience how *p*-values behave through simulations in assignment 1.1.

Can't get enough? Some suggestions for additional reading:

Lecture 1.1:

A great accessible overview of different perspectives to draw statistical inferences is provided by Zoltan Dienes (although it has Psychology in the title, it is really relevant for all empirical sciences using statistics):

Dienes, Z. (2008). Understanding psychology as a science: An introduction to scientific and statistical inference. Palgrave Macmillan.

A good overview of Frequentist statistics (with a strong focus on confidence intervals and estimation) that is full of educational information is provided in a book by Cumming:

Cumming, G. (2013). Understanding the new statistics: Effect sizes, confidence intervals, and meta-analysis. Routledge.

Lecture 1.2

The ultimate discussion of p-values and how to interpret them is provided by:

Nickerson, R. S. (2000). Null hypothesis significance testing: a review of an old and continuing controversy. Psychological methods, 5(2), 241-301.

Lecture 1.3

An accessible introduction to hypothesis testing, Type 1 and Type 2 errors, power, and p-values can be found in most textbooks, but a clear open access summary is available in:

Banerjee, A., Chitnis, U. B., Jadhav, S. L., Bhawalkar, J. S., & Chaudhury, S. (2009). Hypothesis testing, type I and type II errors. Industrial Psychiatry Journal, 18(2), 127.

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