Bootstrapping and Randomisation tests

MI Stefan

Semester 2, 2018/19

Introduction

Learning Objectives

Rattus Binomialis

Problem

A rat is performing a "2-alternative forced choice" (2AFC) task in which it must identify an odor presented at a central port. If it detects odor 'A' it should choose the right-hand port for a reward; if it detects odor 'B' is should choose the other port.

Early in the rat's training, you want ot know whether the rat has learned the task yet. So you decide to do a test and keep track of his correct rate for a block of 50 trials. After 50 trials, we see that the rat has gotten 31 trials correct (19 trials wrong) for an average of 62 percent correct. You want to know if the rat has learned the task or if he is still guessing.

All hypothesis tests are the same . . .

Since we are performing a hypothesis test, we need to ask ourselves what the world would look like if the Null Hypothesis was correct. What is the Null Hypothesis?

Simulate one experiment under Ho

Assume the Null Hpothesis is true, then the rat is just guessing, with a 50-50 chance of getting the correct answer in each trial. If we code a correct guess as "1" and a wrong guess as "0", how would you simulate a block of 50 trials? [1]

[1] Recall what you learned in lecture 20 about drawing random numbers in R.

```
block <- sample(c(0, 1), 50, replace = TRUE)
block
```

```
##  [1] 0 1 1 0 0 0 0 1 1 0 0 1 1 1 1 1 1 0 1 1
## [21] 1 1 0 0 1 1 0 1 0 1 0 1 0 1 0 1 0 1 1 1
## [41] 0 1 1 0 1 0 0 1 1 1
```

Out of the 50 trials, how many did the rat guess correctly?

```
correct <- sum(block)
```

Simulate 10000 experiments under Ho

Now is where the simulation-based magic happens. Let's say we have not just 1 rat that behaves as if Ho is true, but ten thousand rats. How would you simulate that?[2]

[2] Recall what you learned about loops in R.

First, we define a vector that will hold the number of correct answers per trial.

```
number_correct <- vector(mode = "numeric")
```

Next, we loop over a counter that goes from 1 to 10000. In each loop, we do a trial just like the one we did before and store the result in `number_correct`

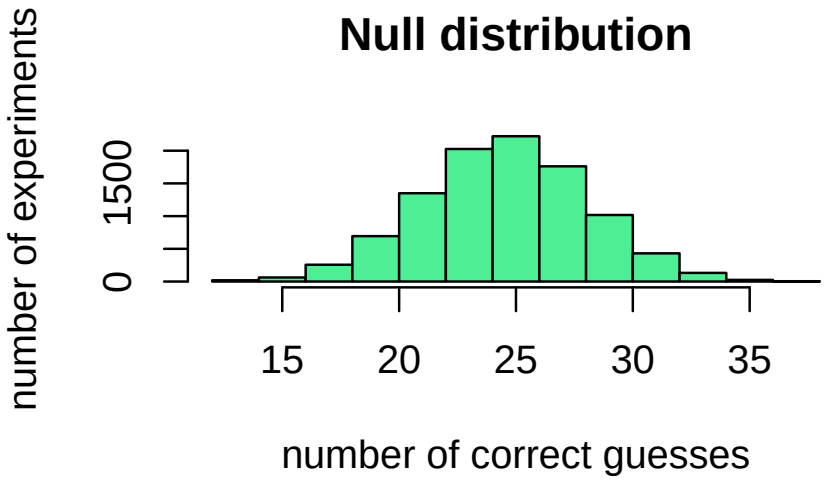
```
for (i in 1:10000) {
    block <- sample(c(0, 1), 50, replace = TRUE)
    correct <- sum(block)
    number_correct = c(number_correct, correct)
}
```

Visualise simulation results

We have now run the experiment 10000 times assuming Ho is true, and kept track of the number of correct guesses for each experiment. How can we best visualise our results? For instance, by drawing a histogram. Before we do that, answer the following questions for yourself:

- What would you expect the histogram to look like?
- Where would you expect the peak to be?
- Do you remember the name of what this histogram shows you?

```
hist(number_correct, col = "seagreen2", main = "Null distribution",
    xlab = "number of correct guesses", ylab = "number of experiments")
```



The histogram shows the "Null distribution", i.e. the distribution of outcomes, assuming the Null Hypothesis is correct.

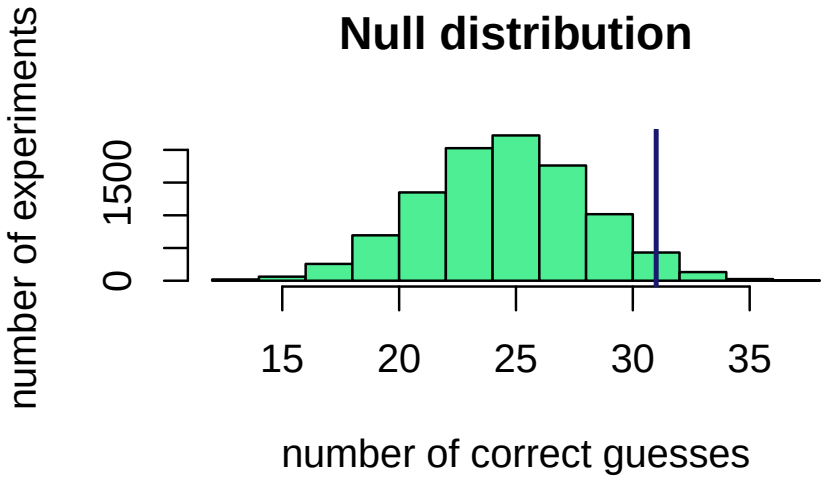
How likely is it to see my experimental results if Ho is true?

As in any hypothesis test, we ask ourselves: "How likely are we to see results as extreme (or even more extreme) as in our experiments if Ho is true?"

First, let's visualise our experimental result (31 out of 50 correct) by adding it as a line to the histogram. This can be done using the abline() function[3], which draws a straight line at a given set of coordinates. What do you see?

[3] Haven't encountered this function before? Remember, you can get more information about any function in R by using help().

```
hist(number_correct, col = "seagreen2", main = "Null distribution",
    xlab = "number of correct guesses", ylab = "number of experiments")
abline(v = 31, col = "midnightblue", lwd = 2)
```



Most of the experiments in the Null distribution are to the left of the blue line (i.e. less extreme than the results we found). But sometimes, even a rat that is guessing gets 31 or more trials correct. But how often exactly? Well, we can just count!

Do men and women have different forearm lengths?

Acknowledgments