Practical 2.1: Comparing multiple groups using simulation

ADS2

Semester 2, 2023/24

Work through this guide alone or in groups. Facilitators are here to help. The time it takes to complete this practical can vary between individuals - this is OK. Do not worry if you do not finish within the session.

Learning Objectives

- Design and interpret a simulation-based hypothesis test
- Use a simulation-based test to compare more than two means

Introduction to the dataset

In this practical, we are looking at a study where two different drugs against chronic pain (creatively named "Drug A" and "Drug B") were tested. In addition, there is a control group that was given a Placebo.

Chronic pain patients were randomly assigned to one of three groups (Placebo, Drug A, Drug B). They were treated for 2 weeks, and then their relative pain levels were assessed through a medical questionnaire (zero means average compared to other adults in the same age range, positive values mean more pain, negative values mean less pain).

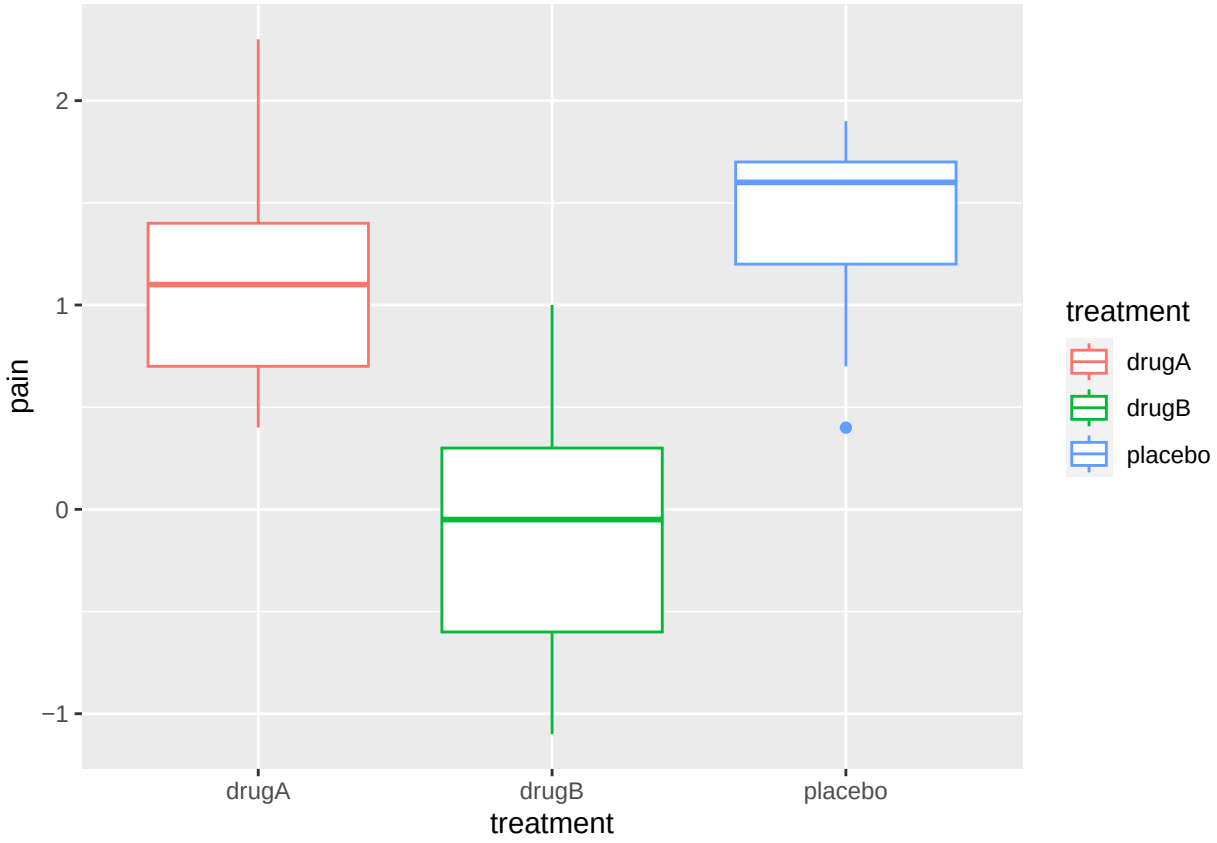
If we had just one drug and one control group, we could easily do a t-test. But now we are comparing three different groups, so things are a tad more complicated.

Today, we are going to just answer the first question: Is there any difference at all between those three groups or are they all the same?

Looking at the dataset

Import the drug trial dataset into a data frame called trial

Let's have a look first: Plot the data in some useful format



Reminding ourselves of H0 and HA

Are those groups the same or are they different? What are the Null and Alternative Hypotheses?

H0: _____

HA: _____

Looking back to the lecture, one way to think about it is this: If you draw two data points at random from different groups, would they be more different from each other than if you draw two data points at random from the same group? Re-formulate H0 and HA with this in mind:

H0: _____

HA: _____

Getting a sense of variability

Let's try this first. Draw two data points at random from the "trial" dataset. You can do this by sampling from the total number of rows. (Remember that the sample() command samples without replacement as a default, which conveniently is exactly what we want.)

```
# randomly draw two data points
sample_index <- sample(1:nrow(trial),2)
trial[sample_index,]
```

```
##    treatment pain
## 17     drugA  0.4
```

```
## 28     drugA  1.4
```

What is the (absolute) difference in their "pain index" between the two? And are they in the same group or in different groups?

Do this a few times to see a few examples of differences within groups and between groups.

If we only draw two samples, it is easy to just look at the two lines and see what the absolute difference in pain index is. But can you also write code that will compute it? Likewise, can you write code that tells you whether the two samples come from the same or different groups?

Useful R concepts for this part of the practical:

- *sample()*
- *dataframe[row,column]*
- *abs()*
- ==

Here is some pseudocode that may be helpful:

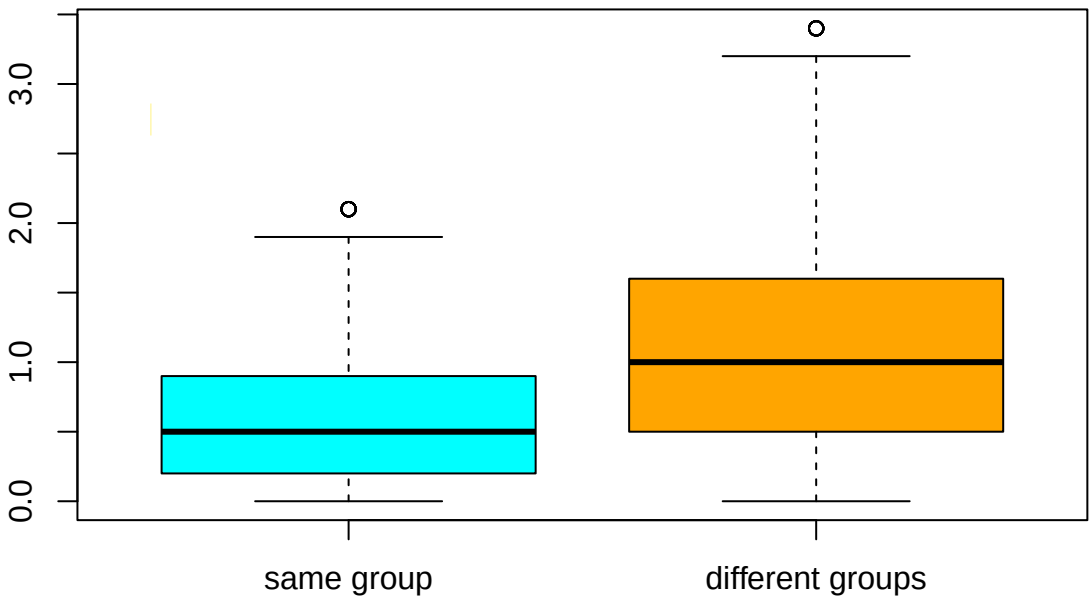
```
# choose 2 (different) rows from the total number of rows

# read out those two rows from trial. This is your sample
# (maybe save it as a separate object, but it's not necessary)

# For the two points in your sample, read out the pain indices
# and determine their absolute difference

# For the two points in your sample, decide whether they belong
# to the same or to different treatment groups
```

We can now write a loop to repeat this many times, so that we get a large number of sample pairs.



Do they look the same, do they look different? If we compare the means, we get

```
## [1] 0.609195
```

for the distances between data points within the same groups and

```
## [1] 1.104638
```

for the distances between data points in different groups. (The exact values may be a bit different for you, since we obtained them using random sampling!)

The difference between those means is

```
## [1] 0.4954426
```

Is this a significant difference?

Run a test to find out!

We now have only two groups that need comparing: absolute differences between participants belonging to the same group (placebo, drug A or drug B), and absolute differences between participants belonging to different groups.

How do we compare two groups? A t-test is not a good idea here (why not?), but you could run a non-parametric alternative, such as the Wilcoxon rank sum test.

What p-value do you get, and how do you interpret this? Be very careful to relate this back to your original Hypotheses.

Also, what information do you think is still missing?

What's next?

This test has shown us that variation between groups is larger than variation within groups. This means not that not all groups are the same. But are they all different? Or is it just one that's different from the other two?

Now that you know there is a difference, you may be tempted to run t-tests to compare each individual pair of groups.

But remember what we said in the lecture about the problem with false-positive rates when we do that.

Roughly, can you think of a way out of this problem?

(We will discuss this in more detail in next week's lecture!)
