Biostatistics: Exercise 04

Beate Sick, Lisa Herzog

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Exercise 01: Neck and shoulder disorders

Musculosceletal neck-and-shoulder disorders are common among office staff who perform repetitive tasks using visual display units. A study was carried out to determine whether varying working conditions have an impact on arm movement. The accompanying data was obtained from a sample of $n = 16$ subjects (s. below). Each observation is the time (in minutes), expressed as a proportion of the total observation time during which arm elevation was below 30 degrees. For each subject, the two measurements were obtained 18 months apart. During this period, working conditions were changed and subjects were allowed to engage in a wider variety of working tasks.

```r
# before
before <- c(83, 86, 86, 83, 90, 86, 95, 73, 74, 74, 72, 81, 66, 72, 56, 75)

# after change
after <- c(80, 90, 78, 79, 84, 67, 91, 70, 58, 64, 70, 59, 66, 60, 65, 73)

# pairwise difference
diff <- after - before
```

- Does the data suggest that the true average time during which elevation is below 30 degrees differs before and after changing working conditions? Perform an appropriate test at the 10% significance level (R-Hint: `t.test(..., alternative="...", paired=..., conf.level=...)`).

Exercise 02: Muscle activation training

In order to minimize the forces acting on the spine when flying a sports airplane, it is important that pilots activate certain groups of muscles in the belly and the back during the flight. To test the effectiveness of a new training program, the muscle activation of 10 pilots was measured during a flight before and after training. This was done by using electrodes on the skin. The dataset `training.txt` can be downloaded from the webpage. (R-Hint: Since it is a .txt file, which is separted by \t, you have to read it in with `dat <- read.table(..., sep="\t", header=TRUE)`)

- Is the design of the experiment paired or unpaired?
- Use an appropriate plot to check whether muscle activity before and after training is normally distributed. Interpret your plot.
- Perform a pairwise, two-sided t-test at the 5% significance level to investigate whether muscle activation changes by training. Interpret your results. What happens if you remove the outlier? (**R-Hint**: In order to remove an observation (a row) from a dataset, you can write `dat[-row,]`.)
- As seen in the lecture and the previous task, a t-test is not robust against outlier. Additionally, the t-test shouldn't be applied to small datasets (≤ 10) because we can't ensure that the data is normally distributed. Apply a more appropriate test (R-Hint: `wilcox.test(..., alternative="...", paired=...)`)

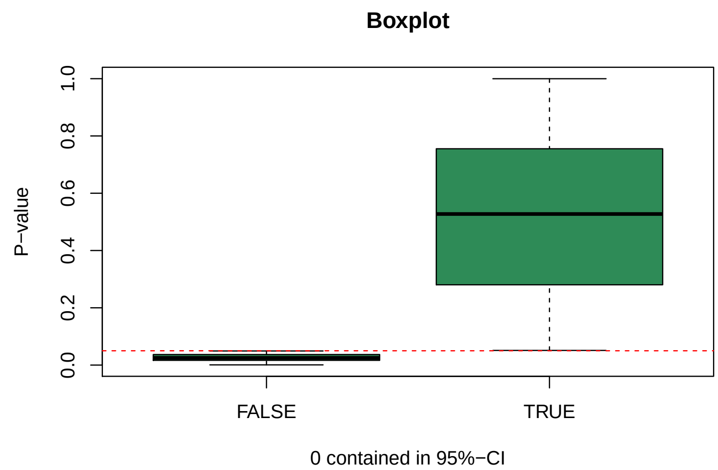
Exercise 03: t-test with simulated data

With the following code we perform a simulation study. Read carefully through the code, execute it line by line and try to understand it.

```
set.seed(3004)
p_val <- c()
ci_lower <- c()
ci_upper <- c()
mean_diff <- c()

for(i in 1:1000){
  mean_sim  <- 1
  sd_sim <- 0.5
  n_sim <- 500
  groupa <- rnorm(n_sim, mean = mean_sim, sd = sd_sim)
  groupb <- rnorm(n_sim, mean = mean_sim, sd = sd_sim)
  test <- t.test(groupa, groupb, mu = 0, paired = FALSE)

  p_val <- c(p_val, test$p.value)
  ci_lower <- c(ci_lower, test$conf.int[1])
  ci_upper <- c(ci_upper, test$conf.int[2])
  mean_diff <- c(mean_diff, abs(diff(test$estimate)))
}

dat <- data.frame("experiment" =  1:1000,
                  "estimate" = mean_diff,
                  "ci_lower" = ci_lower,
                  "ci_upper" = ci_upper,
                  "p_val" = p_val)

dat$ci_zero <- ifelse(dat$ci_lower< 0 & dat$ci_upper > 0, TRUE, FALSE)
```

- Explain, what the code is doing
- Explain what you can see in the boxplots generated using the following code

```
boxplot(dat$p_val~dat$ci_zero, col = "seagreen", main = "Boxplot",
        xlab = "0 contained in 95%-CI", ylab = "P-value")
abline(h=0.05, col="red", lty=2)
```



- What is the number of significant tests you would expect in this experiment?
- If you would change the mean to $\mu = 0$ and keep the standard deviation, would you expect more, less or the same number of significant test results?
- Adapt the code from above so that the true mean difference between `groupa` and `groupb` is 0.1 times the standard deviation. How many significant tests do you get now? Play around with the true difference between the groups - what do you learn? In addition, change the number of observations. What do you observe?