Exercise 1 (Interpretation of a Confidence Interval)

In a prospective study, researchers compare the mean weight loss (in kg) in adults under diet with additional medication (treatment) and diet only (placebo). They report a mean difference (μ) of 2kg in weight loss and a corresponding 95% CI of [0.53,3.47]. Which of the following results are true, which are wrong?

- ☐ 95% of the study participants have a weight loss between 0.53 kg and 3.47 kg.
- ☐ The confidence interval covers the true difference in weight loss between treatment and placebo with a probability of 95%.
- ☐ The treatment effect is statistically significant from 0 at the 5% level.
- ☐ We have no evidence against $H_0 : \mu = 0$ at the 5% level.

Exercise 2 (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 more varied work conditions would have any impact on arm movement. The accompanying data was obtained from a sample of $n = 16$ subjects (s. below). Each observation is the amount of time (in minutes), expressed as a proportion of total time observed, during which arm elevation was below 30 degrees. The two measurements from each subject were obtained 18 months apart. During this period, working conditions were changed and subjects were allowed to engage in a wider variety of work tasks.

```
# before
before <- c(81, 87, 86, 82, 90, 86, 96, 73, 74, 75, 72, 80, 66, 72, 56, 82)

# after change
after  <- c(78, 91, 78, 78, 84, 67, 92, 70, 58, 62, 70, 58, 66, 60, 65, 73)

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

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

Exercise 3 (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 programme, the muscle activation during a flight of 10 pilots was measured before and after the training. This can be done by the aid of electrodes on the skin. The dataset `training.txt` can be downloaded from the webpage:

`https://bsick.github.io/Biostatistics-Fall-2018/`

(**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)`)

(a) Is the design of the experiment paired or unpaired?

(b) Use an appropriate plot to check whether muscle activity before and after training is normally distributed. Interpret your plot.

(c) Perform a pairwise, two-sided t-test at the 5% level to investigate whether muscle activation changes by training. Interpret your results. What happens if you remove the outlier? (**R-Hint**: For the test you can use the function `t.test(..., alternative="...", paired=...)`. In order to remove an observation (a row) from a dataset, you can write `dat[-row,]`.)

(d) As seen in the lecture and the previous task, a t-test is not robust against outliers. 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=...)`)