SGA How to test a drug

You perform a clinical trial to study new drug. You have 20 volunteers with some disease. You randomly split all the volunteers into two groups (10 volunteers in each): the treatment group and the control group. Volunteers in the treatment group receive the new drug, volunteers in the control group receive placebo (pills that looks like a drug but do not have active substance). You conclude that new drug is effective if people who take the drug will recover faster (on average) than people in the control group. If your drug is effective, you will invest in its production, otherwise you will look for another drug. Assume that you obtained the following data (disease duration in days).

Control group (sample 0): (6, 7, 7, 5, 7, 8, 8, 7, 7, 7)

Treatment group (sample 1): (7, 6, 6, 5, 5, 6, 7, 5, 5, 8)

Describe this problem in terms of statistical hypothesis testing framework. How would you model your data in terms of random variables? State the null hypothesis and the alternative. Will your alternative be one-sided or two-sided? Why? What kind of statistical test will you use? Why this test? Use this test (apply Python if necessary and provide your code), analyse the results and provide a conclusion in mathematical and real-life terms. Would you invest into production of this drug?

We can assume that data we've obtained are samples of two different random variables X (sample 0) and Y (sample 1).

$\bar{x} = 6.9$ is mean of sample 0;
$\bar{y} = 6$ is mean of sample 1.

At first glance it seems that $\bar{x} > \bar{y}$, so we might assume that $EX > EY$ and try to check such a hypothesis. But we shouldn't state hypothesis on the data we use to test it.

As such, the first thing we actually should check is if there is any significant difference between expected values of X and Y at all based on these samples.

So null hypothesis would be that there is no significant difference, while alternative hypothesis would be that expected values of X and Y do differ significantly.

$H_0: EX = EY$

$H_1: EX \neq EY$

We have two samples of data, so we have to use two-sample t-test to test our hypothesis. We can't use paired t-test as there is no common ground for these two samples.

Also, there is no information suggesting that random variables X and Y have same variance, so in this test we will assume that $VarX$ and $VarY$ are different.

As this is related to healthcare, we want our chance of making mistakes (type I errors) as small as possible, so we should set significance level at $\alpha = 0.01$ at most.

Here is Python code to calculate the p-value of our t-test:

```
sample0 = (6, 7, 7, 5, 7, 8, 8, 7, 7, 7)
sample1 = (7, 6, 6, 5, 5, 6, 7, 5, 5, 8)
t_stat, pvalue = ttest_ind(sample0, sample1, equal_var=False, alternative='two-sided')
print(f'p-value is {pvalue}')
```

We get **p-value** equal to ***0.052905708062698176***.

As p-value is larger than α, there is no reason to reject H_0. Actually, the p-value we've got is much higher than I'd want it to be in case of drugs testing, we would reject H_1 even at significance level of 0.05.

This means that we don't have enough data to reject H_0 in favor of H_1.

At the same time, it doesn't mean, that H_0 is true. It might be that we just have insufficient data to accept alternative hypothesis over H_0, for example, we might get different results if we had larger samples of data for both control and testing group.

Still, considering results of this test, there is no reason to believe that new drug is effective. As such, there is no reason to invest into its production. At least until it was proven effective after more testing on other data samples.