Exercise 6. Hypothesis testing

1. The file `cloud.txt` contains data collected from a U.S. experiment in the early 1970s that dropped silver nitrate crystals from aircraft to 'seed' clouds and make rain. The data are the rainfall amounts (in acre-feet!) from a sample of 26 unseeded clouds and a sample of 26 seeded clouds. Explore the distributions of the two samples, noting any similarities and differences.

2. The experimenters want to know if seeding a cloud affects the amount of rainfall. One way to do this is to assess whether or not the two samples come from populations with different means. Write down the null and alternative hypotheses. Which statistical test can be used to test these hypotheses? Select an appropriate level of significance for the test.

3. What assumptions does your chosen test make about the data? Are these assumptions reasonable for the rainfall data? If not, transform the data (by taking square roots for example) so that the test will be appropriate.

4. Compute the test statistic for your test by hand. Write down the distribution of your test statistic and sketch its probability density. Use your statistical tables to determine critical regions for your test and add them to your sketch. Use the tables to obtain an approximate p-value for your test statistic. Now perform the test using `R`, note the p-value and compare it with your chosen level of significance. Write down clearly what conclusion you draw from the test and what this tells the experimenters about cloud seeding.

5. Does the result change if you perform the test without transforming the data?

6. Shortly after the introduction of the euro coins in 2002, BBC on-line news published this article:

   'Meanwhile, two Polish statisticians have discovered something about euro coins that should gladden the hearts of confidence tricksters. The coin apparently favours heads. When Tomas Gliszczynski and Waclaw Zawadowski of the Podlaska Academy spun one Belgian euro coin 250 times, it came up with King Albert's head 140 times. "The euro is struck asymmetrically," Mr Gliszczynski told Germany's Die Welt newspaper. He said he hoped to experiment with German euro coins at a maths conference next month. "I know the phenomenon from other coins like the two zloty piece, which we have thrown more than 10,000 times," he said.'

   Write a short note describing a statistical test for the hypothesis that the Belgian euro is biased given these results, and comment on Mr Gliszczynski's claim.