

Design and Analysis of Experiments

Homework #1

For a high voltage network, uniform cables of great tensile strength are required. Each cable is composed of wires which are manufactured in one length. In order to examine the tensile strengths a sample is taken from each wire and tested. The table below shows the tensile strength of 9 cables each with 12 wires. The unit for strength is kgs (now outdated).

1	2	3	4	5	6	7	8	9
345	329	340	328	347	341	339	339	342
327	327	330	344	341	340	340	340	346
335	332	325	342	345	335	342	347	347
338	348	328	350	340	336	341	345	348
330	337	338	335	350	339	336	350	355
334	328	332	332	346	340	342	348	351
335	328	335	328	345	342	347	341	333
340	330	340	340	342	345	345	342	347
337	345	336	335	340	341	341	337	350
342	334	339	337	339	338	340	346	347
333	328	335	337	330	346	336	340	348
335	330	329	340	338	347	342	345	341

- Make a graphical display of data.
- Find mean and standard deviation for the individual cables.
- Test if there is difference between the variations within the cables.
- Test if there is difference between the cables.

- e) Find the significant distance between pairs of cables by Tukey's test. Which cables are different; can they be split in discrete groups or is there overlap? (As significance level, use $\alpha = 0.05$.)

A more detailed examination of the manufacturing process revealed that the cables had been manufactured from raw materials taken from different lots, cables Nos. 1-4 having been made from lot A and cables Nos. 5-9 from lot B. In the following exercises we test lot A and B separately as well as compare the two lots.

- f) Compute SS_A , the sum of squares for comparing the four cables in lot A. Similarly, compute SS_B for the five cables in lot B. (Hint: splitting the data into lots A and B, and using `aov` and `anova` is useful for calculating these).
- g) State a contrast C for comparing the two lots and compute SS_C , i.e. its sum of squares. (Hint: You will probably need the formulas from the slides/book, as **R** will not do this automatically).
- h) Check that the sum of those three sum of squares equals the sum of squares for comparing the nine cables. What about degrees of freedom?
- i) Remake the ANOVA table from (d) by exchanging the row for the sum of squares for comparing all cables replaced by three rows for the above-mentioned effects. Which one(s) is/are significant? (Hint: You already have SS and df, and MS can mostly be extracted from the ANOVA tables you have already made. However, you will have to calculate the three F-statistics and corresponding P-values yourself)

You can submit your solutions in paper or by e-mail, individually or in groups of max. 3 persons. Remember to give all your names. I will consider this a signature that all members of the group have contributed.