

STAT 512 Homework 9

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Part 1: O&L data

For this problem use the data described in Ott & Longnecker problem 19.23 (p 1080 in the 7th Edition). We will verify that this is a BIBD in parts A, B. Note that Person acts as the blocking variable.

Question 1

Identify t , r , b and k . (4 pts) Hint: Use the `table()` function.

Question 2

Compute λ (and make sure it is an integer).

Question 3

Treat Person (block) as fixed. Fit an appropriate model (using `lm()`) and include the Type 3 ANOVA table (using `Anova(, type = 3)`) in your assignment.

Question 4

Treat Person (block) as fixed. Calculate `emmeans` and Tukey adjusted p-values for their differences. Summarize using a `cld` display and include it in your assignment. (4 pts)

Question 5

Treat Person (block) as fixed. Calculate Tukey's HSD value by hand. Hint: See the ExpDesign 3 slide 104. Recall that you can check your calculation using the SE value from the previous question.

Question 6

Note: Be sure to detach the `emmeans` package. Then load the `lme4`, `lmerTest`, `pbkrtest` and `emmeans` packages.

Treat Person (block) as random. Fit an appropriate model (using `lmer()` from `lme4` package) and include the Type 3 ANOVA table (using `anova(, ddf="Kenward-Roger")`)

Question 7

Treat Person (block) as random. Calculate emmeans and Tukey adjusted p-values for their differences. Summarize using a cld display and include it in your assignment. (4 pts)

Question 8

Treat Person (block) as random. Comparing your results from #4 and #7, you should find that the emmeans are not the same. Is the ranking of the treatments the same? Are the conclusions about significant differences the same?

Part 2: Variety

In a variety trial, a total of 7 varieties (Var) of wheat are considered. For each variety, $n=3$ reps are randomly assigned to positions in a single field. The response variable is the Yield at the end of the trial. The data is available from Canvas as “Varieties.csv”. *Note: You may need to detach the emmeans package and then reload it for this group of questions.*

Question 9

Treat Variety as fixed and fit a one-way ANOVA model using `lm()`. Fit an appropriate model and construct the ANOVA table (using `Anova(, type = 3)`).

Question 10

In the ANOVA table, you should find a test corresponding to Variety. Specifically, $F = 18.26$ and p-value $< .0001$. State the null hypothesis for this test.

Question 11

Give the emmeans for each variety.

Question 12

Treat Variety as random and fit a one-way random effects model using `lmer()`. Fit an appropriate model and include “Random Effects” table (giving the variance component estimates) in your assignment.

Question 13

Use the `rand()` function to get a test corresponding to Variety. Specifically, $\text{Chi.sq} = 19$ and p-value < 0.0001 . State the null hypothesis for this test.

Question 14

Give the BLUPs for each variety. Remember to include the intercept in the BLUP estimation.

Appendix

```
# load packages
library(tidyverse)
library(janitor)
# library(kableExtra)
# library(car)
# library(broom)
# library(emmeans)
# set global options
knitr::opts_chunk$set(fig.width = 6,
                      fig.height = 4,
                      fig.path = "figs/",
                      echo = FALSE,
                      warning = FALSE,
                      message = FALSE)
```