

STAT 8020 R Lab 7: Completely Randomized Designs

your name here, (the names of any collaborators)

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The dataset `PlantGrowth` contains results from an experiment comparing yields (measured by the dried weight of plants) obtained under a control condition and two different treatment conditions.

Data Source: Dobson, A. J. (1983) *An Introduction to Statistical Modelling*. London: Chapman and Hall.

In this lab, you will analyze the data using methods for a Completely Randomized Design (CRD).

For each question:

- Include the necessary R code
- Briefly explain what the code is doing
- Interpret the results in context of the problem

Simply providing code without explanation and interpretation is not sufficient.

0. Load and Examine the Dataset

Let's load the dataset first.

Code:

```
data(PlantGrowth)
str(PlantGrowth)
```

```
## 'data.frame':  30 obs. of  2 variables:
## $ weight: num  4.17 5.58 5.18 6.11 4.5 4.61 5.17 4.53 5.33 5.14 ...
## $ group : Factor w/ 3 levels "ctrl","trt1",...: 1 1 1 1 1 1 1 1 1 1 ...
```

Briefly describe:

- the response variable
- the treatment variable
- the number of treatment groups

1. Compute Summary Statistics

Compute the treatment means and standard deviations for each treatment group.

Code:

Answer:

Briefly explain:

- how the summary statistics were computed
- which treatment appears to have the largest mean
- whether the variability looks similar across groups

2. Create Side-by-Side Boxplots

Make side-by-side boxplots of plant weight by treatment group.

Code:

Answer:

Briefly comment on:

- differences in treatment centers
- spread/variability across groups
- possible outliers or unusual observations

3. Write Down the Effects Model

Write down the effects model for this Completely Randomized Design and explain each term in the model.

Also state the assumptions regarding the random error terms.

Answer:

Your explanation should include:

- the response variable
- treatment effects
- random error terms
- assumptions of independence, normality, and equal variance

4. Perform the Overall ANOVA F-Test

Perform a one-way ANOVA to test whether the treatment means differ.

State:

- the null and alternative hypotheses
- the test statistic
- the p-value
- your decision
- your conclusion in context

Code:

Answer:

Briefly explain:

- what the ANOVA F-test is testing
- whether there is evidence of treatment differences

5. Conduct Pairwise Comparisons

Use Tukey's HSD procedure to compare all treatment pairs.

Interpret the results.

Code:

Answer:

Briefly discuss:

- which treatment pairs are significantly different
- how the confidence intervals support your conclusions

6. Assess the Normality Assumption

Use a QQ-plot to examine the normality assumption of the residuals.

Code:

Answer:

Briefly comment on:

- whether the points approximately follow a straight line
- whether the normality assumption appears reasonable

7. Assess the Equal Variance Assumption

Create a residual plot to assess whether the equal variance assumption is reasonable.

Code:

Answer:

Briefly discuss:

- whether the spread of residuals appears constant
- whether any obvious patterns are present

8. Perform Levene's Test

Perform Levene's test for equal variance.

Code:

Answer:

State:

- the null and alternative hypotheses
- the p-value
- whether there is evidence of unequal variance

Also briefly compare the formal test result with your residual plot assessment.