

Tutorial Problems

Question 1

- (a) A standard Latin square is a Latin square in which the elements of the first row and the first column are arranged alphabetically. Show that there are 4 standard 4×4 Latin squares. (Lecture 26)
- (b) For the modified tread tyre loss experiment from the Latin square design lecture test the contrast $H_0 : 3\gamma_A = \gamma_B + \gamma_C + \gamma_D$. The data is

Position	Car				Total
	1	2	3	4	
1	12 <i>C</i>	11 <i>D</i>	13 <i>A</i>	8 <i>B</i>	44
2	14 <i>B</i>	12 <i>C</i>	11 <i>D</i>	13 <i>A</i>	50
3	17 <i>A</i>	14 <i>B</i>	10 <i>C</i>	9 <i>D</i>	50
4	13 <i>D</i>	14 <i>A</i>	13 <i>B</i>	9 <i>C</i>	49
Total	56	51	47	39	193

with Brand totals equal $A : 57, B : 49, C : 43, D : 44$ (Lecture 26)

```
library(tidyverse)
dat <- data.frame(
  Y=c(12, 14, 17, 13, 11, 12, 14, 14, 13, 11, 10, 13, 8, 13, 9, 9),
  brand=c("C", "B", "A", "D", "D", "C", "B", "A", "A", "D", "C", "B", "B", "A", "D", "C"),
  position=factor(rep(1:4, times=4)),
  car=factor(rep(1:4, each=4)))
M0 <- lm(Y ~ car + position + brand, data=dat)
deviance(M0)
```

```
## [1] 5.375
```

```
qt(c(0.95, 0.975), 6)
```

```
## [1] 1.943180 2.446912
```

Question 2

- Several studies have suggested that drinking red wine gives some protection against heart disease, but it is not known whether the effect is caused by the alcohol or by some other ingredient of red wine.
- To investigate this, medical scientists enrolled 40 volunteers into a trial lasting 28 days.
- For the first 14 days, half the volunteers drank two glasses of red wine per day, while the other half had two standard drinks of gin.

- For the remaining 14 days the drinks were reversed: those who had been drinking red wine changed to gin, while those who had been drinking gin changed to red wine.
- On days 14 and 28, the scientists took a blood sample from each volunteer and measured the amount of inflammatory substance in the blood.

What are the treatments? Identify the experimental units and observational units. How many are there of each? Describe any blocking structure in the experiment. (Lecture 24)

Computer Problems

Question 1

A management information systems consultant conducted a small-scale study of five different daily summary reports. The amount of detail as A to E where A is the greatest amount of detail and E is the least amount of detail.

Five sales executives were used in the study. Each was given one type of daily report for a month and then was asked to rate its helpfulness on a 25-point scale (0: no help; 25: extremely helpful).

Over a five-month period, each executive received each type of report for one month according to the design shown below. The helpfulness ratings were:

Executive	Month				
	March	April	May	June	July
Harrison	21 (D)	8 (A)	17 (C)	9 (B)	16 (E)
Smith	21 (A)	10 (E)	3 (B)	12 (C)	15 (D)
Carmichael	21 (C)	10 (B)	15 (E)	22 (D)	12 (A)
Loeb	21 (B)	17 (D)	3 (A)	9 (E)	10 (C)
Munch	21 (E)	16 (C)	20 (D)	7 (A)	11 (B)

This data is entered in R as follows:

```
exec <- rep(c("H", "S", "C", "L", "M"), each=5)
month <- factor(rep(c("Mar", "Apr", "May", "Jun", "Jul"), 5))
detail <- factor(c("D", "A", "C", "B", "E",
                  "A", "E", "B", "C", "D",
                  "C", "B", "E", "D", "A",
                  "B", "D", "A", "E", "C",
                  "E", "C", "D", "A", "B"))
hness <- c(21, 8, 17, 9, 16,
          21, 10, 3, 12, 15,
          21, 10, 15, 22, 12,
          21, 17, 3, 9, 10,
          21, 16, 20, 7, 11)
dat <- data.frame(exec, month, detail, hness)
```

- Why is this design a Latin square design? (Lecture 26)
- Fit an appropriate ANOVA model and show the corresponding ANOVA table. (Lecture 26)
- What does the means of the response by treatment suggest about the effects of the five types of reports?
- Test whether or not the five types of reports differ in mean helpfulness at a type I error rate of 2%. (Lecture 26)