# Assignment 5

STAT3373

Isaac Shoebottom

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```
library(tidyverse)
```

## Question 1

### a)

```
latin_data <- tribble(
  ~sunlight,      ~soil,   ~treatment, ~growth,
  "Sunny",        "Sandy", "C", 45,
  "Sunny",        "Loamy", "A", 52,
  "Sunny",        "Clay",  "B", 48,
  "Sunny",        "Sandy", "B", 43,
  "Sunny",        "Loamy", "C", 50,
  "Sunny",        "Clay",  "A", 49,
  "Sunny",        "Sandy", "A", 47,
  "Sunny",        "Loamy", "B", 51,
  "Sunny",        "Clay",  "C", 46,

  "Partial Sun",  "Sandy", "A", 41,
  "Partial Sun",  "Loamy", "B", 44,
  "Partial Sun",  "Clay",  "C", 38,
  "Partial Sun",  "Sandy", "B", 39,
  "Partial Sun",  "Loamy", "C", 42,
  "Partial Sun",  "Clay",  "A", 40,
  "Partial Sun",  "Sandy", "C", 40,
  "Partial Sun",  "Loamy", "A", 43,
  "Partial Sun",  "Clay",  "B", 41,

  "Shade",        "Sandy", "B", 32,
  "Shade",        "Loamy", "C", 35,
  "Shade",        "Clay",  "A", 33,
  "Shade",        "Sandy", "C", 31,
  "Shade",        "Loamy", "A", 36,
  "Shade",        "Clay",  "B", 34,
  "Shade",        "Sandy", "A", 30,
  "Shade",        "Loamy", "B", 33,
  "Shade",        "Clay",  "C", 32
)

latin_data
```

```
## # A tibble: 27 x 4
##    sunlight    soil  treatment growth
##    <chr>       <chr> <chr>      <dbl>
##  1 Sunny       Sandy C             45
##  2 Sunny       Loamy A             52
##  3 Sunny       Clay  B             48
##  4 Sunny       Sandy B             43
##  5 Sunny       Loamy C             50
##  6 Sunny       Clay  A             49
##  7 Sunny       Sandy A             47
##  8 Sunny       Loamy B             51
##  9 Sunny       Clay  C             46
## 10 Partial Sun Sandy A             41
## # i 17 more rows
```

## b)

```
treatment_means <- latin_data %>%
  group_by(treatment) %>%
  summarise(mean_growth = mean(growth))

treatment_means
```

```
## # A tibble: 3 x 2
##   treatment mean_growth
##   <chr>           <dbl>
## 1 A                41.2
## 2 B                40.6
## 3 C                39.9
```

## c)

Mean Growth by Sunlight Level

```
sunlight_means <- latin_data %>%
  group_by(sunlight) %>%
  summarise(mean_growth = mean(growth))

sunlight_means
```

```
## # A tibble: 3 x 2
##   sunlight    mean_growth
##   <chr>             <dbl>
## 1 Partial Sun        40.9
## 2 Shade              32.9
## 3 Sunny              47.9
```

Mean Growth by Soil Type

```
soil_means <- latin_data %>%
  group_by(soil) %>%
  summarise(mean_growth = mean(growth))

soil_means
```

```
## # A tibble: 3 x 2
##   soil  mean_growth
##   <chr>       <dbl>
## 1 Clay         40.1
## 2 Loamy        42.9
## 3 Sandy        38.7
```

## d)

From the descriptive statistics:

Sunlight effects: Growth is highest under Sunny, moderate under Partial Sun, and lowest under Shade. This suggests sunlight has a strong positive effect on growth.

Soil effects: Loamy soil consistently produces higher growth than Sandy or Clay, indicating soil type is an important blocking factor.

Treatment effects: If the treatment means differ noticeably:

- The watering schedule with the highest mean appears most effective.
- Smaller differences suggest weaker treatment effects relative to blocking factors.
- Because the Latin square controls for sunlight and soil, observed treatment differences are less confounded.

## e)

A Latin square ANOVA partitions variation into:

- Sunlight (row effect)
- Soil type (column effect)
- Treatment effect
- Error

Expected Findings:

- Sunlight effect: Likely highly significant, given the strong gradient from Sunny to Shade.
- Soil effect: Likely significant, especially if Loamy soil dominates.
- Treatment effect:
  - Possibly significant if Daily watering shows consistently higher growth.
  - Could be marginal if differences among watering schedules are small compared to sunlight and soil.
- Error variance: Expected to be relatively small due to strong blocking.