Latin Square Design

Introduction

The Latin square design applies when there are repeated exposures/treatments and two other factors. This design avoids the excessive numbers required for full three way ANOVA.

These designs are used to simultaneously control (or eliminate) two sources of nuisance variability.

Procedure:

- Import the data set
- Determine the critical value and sample statistic using R functions
- Conclude the problem using R functions

<u>Example:</u>

When there are repeated exposures/treatments and two other factors, the Latin square design is used. With this design, the excessive numbers required for a full three-way ANOVA are avoided.

Consider analysing the productivity of five kinds of manure, five kinds of cultivation, and five kinds of crops. As follows, the data are organized in a latin square format:

	cultP	cultQ	cultR	cultS	cultT
manure1	"P42"	"R47"	"Q55"	"S51"	"T44"
manure2	"T45"	"Q54"	"R52"	"P44"	"S50"
manure3	"R41"	"P46"	"DS7"	"T47"	"Q48"
manure4	"Q56"	"S52"	"T49"	"R50"	"P43"
manure5	"S47"	"T49"	"P45"	"Q54"	"R46"

The three factors are: manure (manure1:5), cultivation (cultP:T), crop(P:T).

Code and Results:

```
#creating dataframes in R
manure=c(rep("manure1",1), rep("manure2",1), rep("manure3",1), rep("manure4",
1), rep("manure5",1))
cultivation=c(rep("cultP",5), rep("cultQ",5), rep("cultR",5), rep("cultS",5),
rep("cultT",5))
crop=c("P","T","R","Q","S", "R","Q","P","S","T", "Q","R","S","T","P", "S","P"
,"T","R","Q", "T","S","Q","P","R")
freq=c(42,45,41,56,47, 47,54,46,52,49, 55,52,57,49,45, 51,44,47,50,54, 44,50,
48,43,46)
data=data.frame(cultivation,manure,crop,freq)
data
```

```
##    cultivation  manure crop freq
## 1        cultP manure1    P   42
## 2        cultP manure2    T   45
## 3        cultP manure3    R   41
## 4        cultP manure4    Q   56
## 5        cultP manure5    S   47
## 6        cultQ manure1    R   47
## 7        cultQ manure2    Q   54
## 8        cultQ manure3    P   46
## 9        cultQ manure4    S   52
## 10       cultQ manure5    T   49
## 11       cultR manure1    Q   55
## 12       cultR manure2    R   52
## 13       cultR manure3    S   57
## 14       cultR manure4    T   49
## 15       cultR manure5    P   45
## 16       cultS manure1    S   51
## 17       cultS manure2    P   44
## 18       cultS manure3    T   47
## 19       cultS manure4    R   50
## 20       cultS manure5    Q   54
## 21       cultT manure1    T   44
## 22       cultT manure2    S   50
## 23       cultT manure3    Q   48
## 24       cultT manure4    P   43
## 25       cultT manure5    R   46
```

```
#recreating the original table, using the matrix function
matrix(data$crop,5,5)
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,] "P"  "R"  "Q"  "S"  "T"
## [2,] "T"  "Q"  "R"  "P"  "S"
## [3,] "R"  "P"  "S"  "T"  "Q"
## [4,] "Q"  "S"  "T"  "R"  "P"
## [5,] "S"  "T"  "P"  "Q"  "R"
```

```r
matrix(data$freq,5,5)
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]   42   47   55   51   44
## [2,]   45   54   52   44   50
## [3,]   41   46   57   47   48
## [4,]   56   52   49   50   43
## [5,]   47   49   45   54   46
```

```r
#creating the anova table
fit=lm(freq~manure+cultivation+crop,data)
anova(fit)
```

```
## Analysis of Variance Table
##
## Response: freq
##             Df Sum Sq Mean Sq F value   Pr(>F)
## manure       4  17.76   4.440  0.7967 0.549839
## cultivation  4 109.36  27.340  4.9055 0.014105 *
## crop         4 286.16  71.540 12.8361 0.000271 ***
## Residuals   12  66.88   5.573
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

<u>Interpretation:</u>

There is no significant difference between the groups considering fertilizer (p-value > 0.1).

There is a quite significant difference between the groups when tillage is considered (p-value 0.05).

There is a very significant difference between the groups considering seed (p-value = 0.001).