HW6-ADA

Jing Qian (jq2282)

1. Fit an appropriate model to this data and test H0 : the average yields are the same for the 6 seeding rates against the alternative Ha : There are not the same. Use $\alpha = 0.05$.

In this problem, since we only care the seeding rates, seeding rates could be set as the main factor with six levels. So there are six treatments. And the four fields are four blocks, labelled as 1, 2, 3, and 4.

```
yield<-c(5.1,5.3,5.3,5.2,4.8,5.3,5.4,6.0,5.7,4.8,4.8,4.5,5.3,4.7,5.5,5.0,4.4,4.9,4.7,4.3,4.7,4.4,4.7,4.
rates<-factor(rep(c(25,50,75,100,125,150),4))
rates2<-rep(c(25,50,75,100,125,150),4)
field<-factor(c(rep(1,6),rep(2,6),rep(3,6),rep(4,6)))
```

Assuming there is no interaction between block and treatments, we could model the grain yield as the sum of treatment effect and block effect. Then we could do ANOVA with Type II SS and test H_0.

```
fit1<-lm(yield~rates+field)
library(car)
Anova(fit1)
```

```
## Anova Table (Type II tests)
##
## Response: yield
##           Sum Sq Df F value   Pr(>F)
## rates     1.2671  5  2.1261 0.118366
## field     1.9646  3  5.4941 0.009488 **
## Residuals 1.7879 15
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

From the ANOVA table above, we could see that the p-value for the test is 0.016572, which is smaller than $\alpha = 0.05$. So we could reject H_0, which means that the average yields are different for the 6 seeding rates.

```
Anova(lm(yield~rates2+field))
```

```
## Anova Table (Type II tests)
##
## Response: yield
##            Sum Sq Df F value   Pr(>F)
## rates2    0.81432  1  6.9051 0.016572 *
## field     1.96458  3  5.5529 0.006564 **
## Residuals 2.24068 19
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

2.a. Fit an appropriate model to this data and test H0: The mean cutting speeds are the same for the four tools. Ha: There is difference .Use $\alpha = 0.05$.

In this problem, since we only care the types of tools, we set tool types as the main factor with four levels. So there are four treatments. The cutting materials, which is a nuance factor, are taken as blocks with five levels.

```
y<-c(12,2,1,8,7,20,14,17,12,17,13,7,13,8,14,11,5,10,3,6)
block<-factor(rep(c(1,2,3,4,5),4))
```

```r
trt<-factor(c(rep(1,5),rep(2,5),rep(3,5),rep(4,5)))
data2<-data.frame(y,trt,block)
```

Assuming there is no interaction between block and treatments, we could model the cutting speeds as the sum of treatment effect and block effect. Then we could do ANOVA with Type II SS and test H_0.

```r
fit2<-lm(y~trt+block)
Anova(fit2)
```

```
## Anova Table (Type II tests)
##
## Response: y
##           Sum Sq Df F value    Pr(>F)
## trt        310.0  3 14.8503 0.0002421 ***
## block      124.5  4  4.4731 0.0192167 *
## Residuals   83.5 12
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

From the ANOVA table above, we could see that the p-value for the test is 0.0002421, which is smaller than $\alpha = 0.05$. So we could reject H_0, which means that the mean cutting speeds are different for the four tools.

2.b. Use the Bonferroni method to determine where the differences are.

```r
pairwise.t.test(data2$y,data2$trt,pool.sd=TRUE,p.adjust.method="bonf")
```

```
##
##  Pairwise comparisons using t tests with pooled SD
##
## data:  data2$y and data2$trt
##
##   1      2      3
## 2 0.0028 -      -
## 3 0.2608 0.2608 -
## 4 1.0000 0.0069 0.5912
##
## P value adjustment method: bonferroni
```

From the table above, $H_0 : \mu_1 - \mu_2 = 0$ and $H_0 : \mu_2 - \mu_4 = 0$ have p-values that are smaller than 0.05. So tool 1 has different effect from tool 2 and tool 4 has different effect from tool 2. Other pairs could not differ. So we could put 1 and 4 into one group while tool 2 into another group. Tool 3 is not significantly different from group {2} or group{1,4} either. We may need more data to set up groups more completely.

3. Fit an appropriate model to this data and test H0: there is no difference between the four diets against Ha: There is a difference.

We use Latin Square Design to solve this problem. Other than the main effect – four different diets, there are two blocking variables: 4 different cows and four periods. We could set different periods as rows and different cows as columns.

```r
period<-c(rep("1",4),rep("2",4),rep("3",4),rep("4",4))
cow<-rep(c("1","2","3","4"),4)
trt<-c("D4","D1","D3","D2","D1","D4","D2","D3","D3","D2","D1","D4","D2","D3","D4","D1")
yield<-c(192,195,292,249,190,203,218,210,214,139,245,163,221,152,204,134)
#data<-data.frame(period,cow,trt,yield)
#data
```

Assuming there is no interaction between block and treatments, we could model the cutting speeds as the sum of treatment effect and block effect. Then we could do ANOVA with Type II SS and test H_0.

```r
library(car)
fit3<-lm(yield~trt+period+cow)
Anova(fit3)
```

```
## Anova Table (Type II tests)
##
## Response: yield
##           Sum Sq Df F value Pr(>F)
## trt       1995.7  3  0.5377 0.6736
## period    6539.2  3  1.7618 0.2540
## cow       9929.2  3  2.6751 0.1409
## Residuals 7423.4  6
```

From the ANOVA table above, we could see that the p-value for the test is 0.6736, which is quite large, much larger than the commonly used $\alpha = 0.05$. So we could not reject H_0, which means that there is no difference between the four diets.