Chapter 7(Eighth Edition): 7.1, 7.2, 7.13, 7.24, 7.25

Jeremy Ling & Emmanuel Mejia

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7.1

Consider the experiment described in Problem 6.1. Analyze this experiment assuming that each replicate represents a block of a single production shift.

```
# defining coded
coded=function(x) #a function to code variable x
{
  ifelse(x=="+", 1, -1)
}

# creating data table
factorA = rep(c("-","+","-","+","-","+","-","+"), times = 3)
factorB = rep(c("-","-","+","+","-","-","+","+"), times = 3)
factorC = rep(c("-","-","-","-","+","+","+","+"), times = 3)
Rep = rep(c("I", "II", "III"), each = 8)
yield = c(22,32,35,55,44,40,60,39,31,43,34,47,45,37,50,41,25,29,50,46,38,36,54,47)

#dataframe
cutting.speed.long = data.frame(factorA, factorB, factorC, Rep, yield)

cutting.aov = aov(yield~Rep+factorA*factorB*factorC, cutting.speed.long)
cutting.aov.og = aov(yield~factorA*factorB*factorC, cutting.speed.long)
summary(cutting.aov); summary(cutting.aov.og)
```

```
##                         Df Sum Sq Mean Sq F value   Pr(>F)
## Rep                      2    0.6     0.3   0.008 0.991571
## factorA                  1    0.7     0.7   0.019 0.891320
## factorB                  1  770.7   770.7  22.381 0.000322 ***
## factorC                  1  280.2   280.2   8.136 0.012789 *
## factorA:factorB          1   16.7    16.7   0.484 0.497998
## factorA:factorC          1  468.2   468.2  13.596 0.002438 **
## factorB:factorC          1   48.2    48.2   1.399 0.256623
## factorA:factorB:factorC  1   28.2    28.2   0.818 0.381072
## Residuals               14  482.1    34.4
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

##                         Df Sum Sq Mean Sq F value   Pr(>F)
## factorA                  1    0.7     0.7   0.022 0.883680
## factorB                  1  770.7   770.7  25.547 0.000117 ***
## factorC                  1  280.2   280.2   9.287 0.007679 **
## factorA:factorB          1   16.7    16.7   0.552 0.468078
## factorA:factorC          1  468.2   468.2  15.519 0.001172 **
## factorB:factorC          1   48.2    48.2   1.597 0.224475
## factorA:factorB:factorC  1   28.2    28.2   0.934 0.348282
## Residuals               16  482.7    30.2
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

We look at the analysis of variance we see that the block effect is insignificant because the p-value is small, but effect B, C, and AC are significant. We also make a comparison to the analysis of Variance without the blocking to see if there was a difference. In this case there is no difference at the coefficients of our effects.

7.2

Consider the experiment described in Problem 6.5. Analyze this experiment assuming that each one of the four replicates represents a block.

```
# creating data table
A <- rep(c("-","+","-","+"), times = 4)
B <- rep(c("-","-","+","+"), times = 4)
Rep <- rep(c("I","II","III","IV"), each = 4)
Vibes <- c(18.2, 27.2, 15.9, 41.0, 18.9, 24.0, 14.5, 43.9, 12.9, 22.4, 15.1, 36.3, 14.4, 22.5, 14.2, 39
router.long <- data.frame(A, B, Rep, Vibes)

for (j in 1:2)
  router.long[, j]=as.numeric(coded(router.long[, j]))

# defining coded
coded=function(x) #a function to code variable x
{
  ifelse(x=="+", 1, -1)
}

#######
router.long$Block=router.long$A * router.long$B
router.lm = lm(Vibes ~ Block + A * B, router.long)
router.lm.og = lm(Vibes ~ A * B, router.long)
summary(router.lm); summary(router.lm.og)
```

```
##
## Call:
## lm(formula = Vibes ~ Block + A * B, data = router.long)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -3.975 -1.550 -0.200  1.256  3.625
##
## Coefficients: (1 not defined because of singularities)
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  23.8312     0.6112  38.991 5.22e-14 ***
## Block         4.3562     0.6112   7.127 1.20e-05 ***
## A             8.3187     0.6112  13.611 1.17e-08 ***
## B             3.7688     0.6112   6.166 4.83e-05 ***
## A:B               NA         NA      NA       NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.445 on 12 degrees of freedom
## Multiple R-squared:  0.9581, Adjusted R-squared:  0.9476
## F-statistic: 91.36 on 3 and 12 DF,  p-value: 1.569e-08
```

```
##
## Call:
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##
## Residuals:
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##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  23.8312     0.6112  38.991 5.22e-14 ***
## A             8.3187     0.6112  13.611 1.17e-08 ***
## B             3.7687     0.6112   6.166 4.83e-05 ***
## A:B           4.3562     0.6112   7.127 1.20e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.445 on 12 degrees of freedom
## Multiple R-squared:  0.9581, Adjusted R-squared:  0.9476
## F-statistic: 91.36 on 3 and 12 DF,  p-value: 1.569e-08
```

After we analyze our variance we see that all main effects are significant including the Blocking effect. We see that there is no difference between coefficients, F-statistic of the model, R^2, and adjusted R^2. Which means blocking the replicates gives us a good model.

7.13

Using the data from the 2^4 design in Problem 6.22, construct and analyze a design in two blocks with ABCD confounded with blocks.

7.24

Suppose that in Problem 6.1 we had confounded ABC in replicate I, AB in replicate II, and BC in replicate III. Calculate the factor effect estimates. Construct the analysis of variance table.

7.25

Repeat the analysis of Problem 6.1 assuming that ABC was confounded with blocks in each replicate.