Homework 7

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7.21

8.11

```r
df <- read_excel("/Users/Earle/Documents/Stats 101B Datasets/CH 8 (P11).xlsx")
```

a

If the design generators are $I = ACE$ and $I = BDE$ then $D = BE$ and $E = AC$.

```r
design <- df[,1:5]
names(design) <- c("A","B","C","D", "E")
design$combination  <- c("e", "ad", "bde", "ab", "cd", "ace", "bc", "abcde")
design
```

```
##    A  B  C  D  E combination
## 1 -1 -1 -1 -1  1           e
## 2  1 -1 -1  1 -1          ad
## 3 -1  1 -1  1  1         bde
## 4  1  1 -1 -1 -1          ab
## 5 -1 -1  1  1 -1          cd
## 6  1 -1  1 -1  1         ace
## 7 -1  1  1 -1 -1          bc
## 8  1  1  1  1  1       abcde
```

```r
all((design$A*design$C) == design$E)
```

```
## [1] TRUE
```

```r
all((design$B * design$E) == design$D)
```

```
## [1] TRUE
```

b

Complete Defining Relation:

$$I = ACE = BDE = ABCD$$

A	$A * ACE = CE$	$A * BDE = ABDE$	$A * ABCD = CBD$
B	$B * ACE = ABCE$	$B * BDE = DE$	$B * ABCD = ACD$
C	$C * ACE = AE$	$C * BDE = BCDE$	$C * ABCD = ABD$
D	$D * ACE = ACDE$	$D * BDE = BE$	$D * ABCD = ACB$
E	$E * ACE = AC$	$E * BDE = BD$	$E * ABCD = ABCDE$
AB	$AB * ACE = BCE$	$AB * BDE = ADE$	$AB * ABCD = CD$
AD	$AD * ACE = CDE$	$AD * BDE = ABE$	$AD * ABCD = BC$

c

```
design$Yield <- df$Yield
m <- lm(Yield ~ A + B + C + D + E, design)
effects <- 2*m$coefficients[2:6]; effects
```

```
##      A      B      C      D      E
## -1.525 -5.175  2.275 -0.675  2.275
```

d

If we not interested in two and three factor interactions, since AB and AD are aliased with other two and three factor interactions, then we can use AB and AD as an estimate of error.

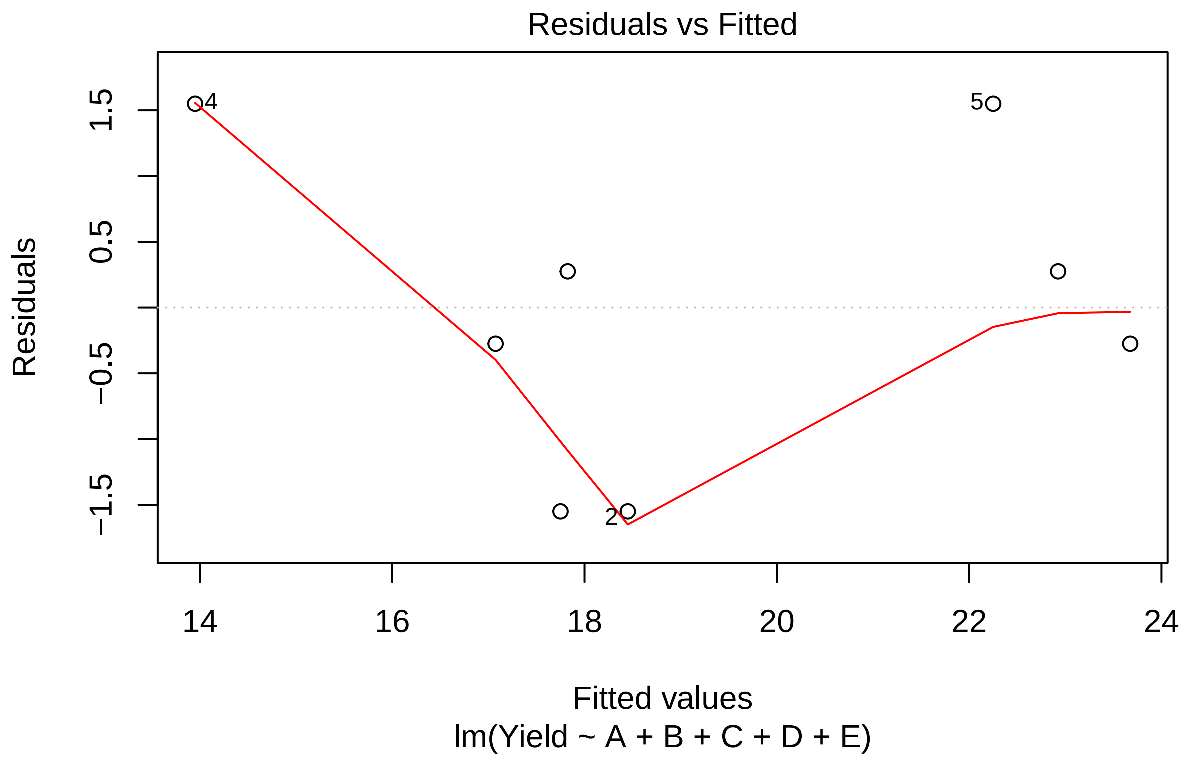
```
anova(m)
```

```
## Analysis of Variance Table
##
## Response: Yield
##           Df Sum Sq Mean Sq F value Pr(>F)
## A          1  4.651   4.651  0.9385 0.4349
## B          1 53.561  53.561 10.8068 0.0814 .
## C          1 10.351  10.351  2.0885 0.2853
## D          1  0.911   0.911  0.1839 0.7098
## E          1 10.351  10.351  2.0885 0.2853
## Residuals  2  9.913   4.956
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

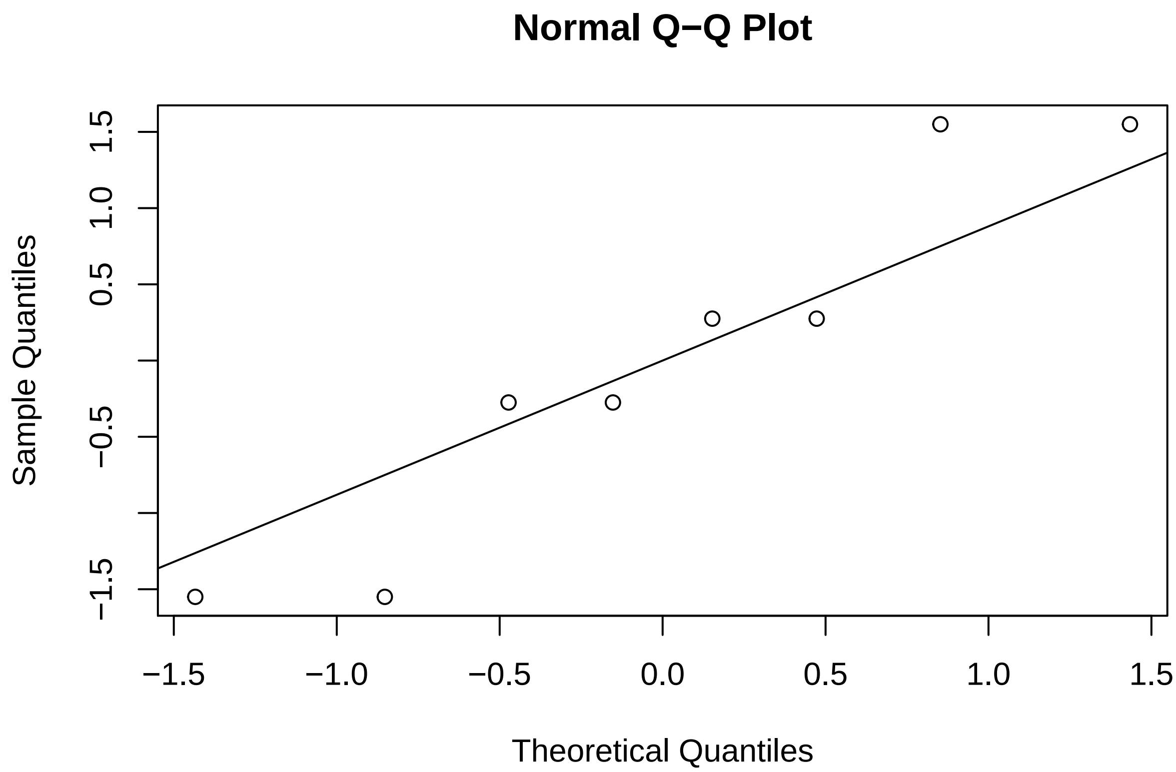
e

The residual plot is satisfactory. The Normal QQ plot of residuals shows that they are approximately normal.

```
plot(m, 1)
```




```r
qqnorm(m$residuals)
qqline(m$residuals)
```



8.23

```
df <- read_excel("~/Stats 101B Datasets/CH 8 (P 23).xlsx")
design <- df[,1:5]
names(design) <- c("A","B","C","D", "E")
```

a

Given generators $I = ABD$ and $I = BCE$ we get that $D = AB$ and $E = BC$. In addition the complete defining relation is $I = ABD = BCE = ACDE$ **Treatmen Combination**

```
design$combination  <- c("de", "ae", "b", "abd", "cd",
                         "ac", "bce", "abcde")
design
```

```
##    A  B  C  D  E combination
## 1 -1 -1 -1  1  1          de
## 2  1 -1 -1 -1  1          ae
## 3 -1  1 -1 -1 -1           b
## 4  1  1 -1  1 -1         abd
## 5 -1 -1  1  1 -1          cd
## 6  1 -1  1 -1 -1          ac
## 7 -1  1  1 -1  1         bce
```

```
## 8  1  1  1  1  1        abcde
```

```r
all((design$A*design$B) == design$D)
```

```
## [1] TRUE
```

```r
all((design$B * design$C) == design$E)
```

```
## [1] TRUE
```

Aliases

A	$A*ABD=BD$	$A*BCE=ABCE$	$A*ACDE=CDE$
B	$B*ABD=AD$	$B*BCE=CE$	$B*ACDE=ABCDE$
C	$C*ABD=ABCD$	$C*BCE=BE$	$C*ACDE=ADE$
D	$D*ABD=AB$	$D*BCE=BCDE$	$D*ACDE=ACE$
E	$E*ABD=ABDE$	$E*BCE=BC$	$E*ACDE=ACD$
AC	$AC*ABD=BCD$	$AC*BCE=ABE$	$AC*ACDE=DE$
AE	$AE*ABD=BDE$	$AE*BCE=ABC$	$AE*ACDE=CD$

Effect Estimates

```r
design$AC <- design$A*design$C
design$AE <- design$A*design$E
design$Avg_Annul_Cost <- df$`Avg Annual Cost`
m <- lm(Avg_Annul_Cost ~ A+B+C+D+E+AC+AE, design)
effects <- 2*m$coefficients[2:8]; effects
```

```
##     A     B     C     D     E    AC    AE
##  49.0  45.0  10.5 -18.0 -14.5  13.5 -14.5
```

b

This design was created by reversing the signs of column A.

```r
df <- read_excel("/Users/Earle/Documents/Stats 101B Datasets/CH8 (P.23b).xlsx")
design <- df[,1:6]
names(design) <- c("Blocks","A","B","C","D", "E")
design$combination  <- c("de", "ae", "b", "abd", "cd",
                         "ac", "bce", "abcde", "ade",
                         "e", "ab", "bd", "acd", "c",
                         "abce", "bcde")
```

c

8.37

8.39

8.48