Validation of 'sasLM' Package

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Contents

1 Tested Version and Books used for the Validation

1.1 Packages Used

- 'sasLM' version: 0.5.2
- 'SAS' version: 9.4 Licensed and University Edition
- 'car' version: 3.0.10
- R version: R version 4.0.5 (2021-03-31)

The 'car' package is not necessary for 'sasLM.' It is used for the comparison of the results.

If you see any difference betwwen 'car' and 'sasLM', 'SAS' results coincide with 'sasLM', not with 'car.'

Before 'sasLM' is available on CRAN, you can download using the following command in R.

```
install.packages("sasLM", repos="http://r.acr.kr")
```

1.2 Books and Articles used for the Test

1. Harvey WR. Least-Squares Analysis of Data with Unequal Subclass Frequencies. USDA, Agriculture Research Service, ARS 20-8. 1960. reprinted with corrections as ARS H-4, 1975, also reprinted 1979.
2. Snee RD. Computation and Use of Expected Mean Squares in Analysis of Variance. J Qual Tech. 1974:6(3);128-137.
3. Goodnight JH. The General Linear Models Procedure, Proceedings of the First International SAS User's Group, SAS Institute, Raleigh, N.C. 1976.
4. Littell RC, Stroup WW, Freund RJ. SAS for Linear Models 4e. John Wiley & Sons Inc. 2002.
5. Sahai H, Ojeda MM. Analysis of Variance for Random Models Volume 2 Unbalanced Data. 2005.
6. Federer WT, King F. Variations on Split Plot and Split Block Experiment Designs. John Wiley & Sons Inc. 2007.
7. Hinkelmann K, Kempthorne O. Design and Analysis of Experiments Volume 1 Introduction to Experimental Design. 2e. John Wiley & Sons Inc. 2008.
8. Hinkelmann K, Kempthorne O. Design and Analysis of Experiments Volume 2 Advanced Experimental Design. John Wiley & Sons Inc. 2005.
9. Lawson J. Design and Analysis of Experiments with SAS. Taylor and Francis Group. 2010.
10. Searle SR, Gruber MHJ. Linear Models 2e, Kindle Edition. John Wiley & Sons Inc. 2016.

2 ARS20-8

Reference

- Harvey WR. Least-Squares Analysis of Data with Unequal Subclass Frequencies. USDA, Agriculture Research Service, ARS 20-8. 1960. reprinted with corrections as ARS H-4, 1975, also reprinted 1979.

2.1 p8

(1) MODEL

```
p8 = read.csv("C:/G/Rt/ANOVA/ARS20-8p8.csv")
p8 = af(p8, c("PigNo", "Ration"))
ANOVA(Barrow ~ Ration, p8)
```

```
$ANOVA
Response : Barrow
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            2 11.111  5.5556  1.2626 0.3113
RESIDUALS       15 66.000  4.4000
CORRECTED TOTAL 17 77.111

$`Type I`
       Df Sum Sq Mean Sq F value Pr(>F)
Ration  2 11.111  5.5556  1.2626 0.3113

$`Type II`
       Df Sum Sq Mean Sq F value Pr(>F)
Ration  2 11.111  5.5556  1.2626 0.3113

$`Type III`
       Df Sum Sq Mean Sq F value Pr(>F)
Ration  2 11.111  5.5556  1.2626 0.3113
```

2.2 p42

(2) MODEL

```
p42 = read.csv("C:/G/Rt/ANOVA/ARS20-8p42.csv")
p42 = af(p42, c("Ration", "Pig", "Sire"))
ANOVA(Y ~ Sire + Ration, p42)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            3 20.819  6.9397  1.7259 0.2075
RESIDUALS       14 56.292  4.0209
CORRECTED TOTAL 17 77.111

$`Type I`
```

```
       Df  Sum Sq Mean Sq F value Pr(>F)
Sire    2 11.1111  5.5556  1.3817 0.2834
Ration  1  9.7079  9.7079  2.4144 0.1425

$`Type II`
       Df  Sum Sq Mean Sq F value Pr(>F)
Sire    2 15.6829  7.8414  1.9502 0.1790
Ration  1  9.7079  9.7079  2.4144 0.1425

$`Type III`
       Df  Sum Sq Mean Sq F value Pr(>F)
Sire    2 15.6829  7.8414  1.9502 0.1790
Ration  1  9.7079  9.7079  2.4144 0.1425
```

(3) MODEL

```
ANOVA(Y ~ Sire + Ration + Sire:Ration, p42)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value  Pr(>F)
MODEL            5 51.044 10.2089  4.6997 0.01311 *
RESIDUALS       12 26.067  2.1722
CORRECTED TOTAL 17 77.111
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
            Df  Sum Sq Mean Sq F value   Pr(>F)
Sire         2 11.1111  5.5556  2.5575 0.118799
Ration       1  9.7079  9.7079  4.4691 0.056129 .
Sire:Ration  2 30.2255 15.1127  6.9573 0.009859 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df  Sum Sq Mean Sq F value   Pr(>F)
Sire         2 15.6829  7.8414  3.6099 0.059238 .
Ration       1  9.7079  9.7079  4.4691 0.056129 .
Sire:Ration  2 30.2255 15.1127  6.9573 0.009859 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
            Df  Sum Sq Mean Sq F value   Pr(>F)
Sire         2 21.0007 10.5004  4.8339 0.028853 *
Ration       1  3.5919  3.5919  1.6535 0.222736
Sire:Ration  2 30.2255 15.1127  6.9573 0.009859 **
---
```

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

2.3 p101

(4) MODEL

```
p101 = read.csv("C:/G/Rt/ANOVA/ARS20-8p101.csv")
p101 = af(p101, c("Line", "Sire", "Dam", "Steer"))
ANOVA(Gain ~ Line + Sire + Dam + Line:Dam + Age + Weight, p101)
```

```
$ANOVA
Response : Gain
                Df Sum Sq  Mean Sq F value   Pr(>F)
MODEL           16 2.4972 0.156073  3.0675 0.001364 **
RESIDUALS       48 2.4422 0.050879
CORRECTED TOTAL 64 4.9394
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
         Df  Sum Sq  Mean Sq F value  Pr(>F)
Line      2 0.38009 0.190046  3.7352 0.03107 *
Sire      6 0.92634 0.154391  3.0345 0.01347 *
Dam       2 0.11894 0.059471  1.1689 0.31940
Line:Dam  4 0.64889 0.162222  3.1884 0.02113 *
Age       1 0.16462 0.164622  3.2356 0.07835 .
Weight    1 0.25828 0.258283  5.0764 0.02886 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
         Df  Sum Sq Mean Sq F value  Pr(>F)
Line      0
Sire      6 0.95299 0.15883  3.1217 0.01155 *
Dam       2 0.32039 0.16019  3.1485 0.05190 .
Line:Dam  4 0.46516 0.11629  2.2856 0.07373 .
Age       1 0.34830 0.34830  6.8456 0.01185 *
Weight    1 0.25828 0.25828  5.0764 0.02886 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
         Df  Sum Sq Mean Sq F value  Pr(>F)
Line      0
Sire      6 0.95299 0.15883  3.1217 0.01155 *
Dam       2 0.12469 0.06234  1.2253 0.30268
Line:Dam  4 0.46516 0.11629  2.2856 0.07373 .
Age       1 0.34830 0.34830  6.8456 0.01185 *
```

```
Weight    1 0.25828 0.25828  5.0764 0.02886 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(5) MODEL

```
ANOVA(Gain ~ Sire + Dam + Line:Dam, p101)
```

```
$ANOVA
Response : Gain
                Df Sum Sq  Mean Sq F value   Pr(>F)
MODEL           14 2.0743 0.148162  2.5856 0.006996 **
RESIDUALS       50 2.8651 0.057302
CORRECTED TOTAL 64 4.9394
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
         Df  Sum Sq  Mean Sq F value  Pr(>F)
Sire      8 1.30644 0.163305  2.8499 0.01089 *
Dam       2 0.11894 0.059471  1.0379 0.36172
Dam:Line  4 0.64889 0.162222  2.8310 0.03412 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
         Df  Sum Sq  Mean Sq F value  Pr(>F)
Sire      6 1.06000 0.176667  3.0831 0.01202 *
Dam       2 0.11894 0.059471  1.0379 0.36172
Dam:Line  4 0.64889 0.162222  2.8310 0.03412 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
         Df  Sum Sq  Mean Sq F value  Pr(>F)
Sire      6 1.06000 0.176667  3.0831 0.01202 *
Dam       2 0.02569 0.012844  0.2242 0.79999
Dam:Line  4 0.64889 0.162222  2.8310 0.03412 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

3 Snee EMS ANOVA 1974

Reference

- Snee RD. Computation and Use of Expected Mean Squares in Analysis of Variance. J Qual Tech. 1974:6(3);128-137.

(6) MODEL

```
Snee = read.csv("C:/G/Rt/ANOVA/Snee_EMS_ANOVA1974.csv")
Snee = af(Snee, c("Machine", "Analyst", "Test", "Day"))
ANOVA(Y ~ Day/Machine/Analyst/Test, Snee)
```

```
$ANOVA
Response : Y
                 Df Sum Sq Mean Sq F value Pr(>F)
MODEL           167 751.27  4.4986
RESIDUALS         0   0.00
CORRECTED TOTAL 167 751.27

$`Type I`
                          Df Sum Sq Mean Sq F value Pr(>F)
Day                       41 365.58  8.9166
Day:Machine               42 196.59  4.6807
Day:Machine:Analyst       42 118.80  2.8285
Day:Machine:Analyst:Test 42  70.30  1.6739

$`Type II`
                          Df Sum Sq Mean Sq F value Pr(>F)
Day                       41 365.58  8.9166
Day:Machine               42 196.59  4.6807
Day:Machine:Analyst       42 118.80  2.8285
Day:Machine:Analyst:Test 42  70.30  1.6739

$`Type III`
                          Df Sum Sq Mean Sq F value Pr(>F)
Day                       41 359.44  8.7669
Day:Machine               42 199.40  4.7477
Day:Machine:Analyst       42 118.80  2.8285
Day:Machine:Analyst:Test 42  70.30  1.6739
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(Y ~ Day/Machine/Analyst/Test, Snee), type=3, singular.ok=TRUE)
# NOT WORKING
```

4 Goodnight

Reference

- Goodnight JH. The General Linear Models Procedure, Proceedings of the First International SAS User's Group, SAS Institute, Raleigh, N.C. 1976.

4.1 Type I SS

4.1.1 p7

(7) MODEL

```
p7 = read.csv("C:/G/Rt/ANOVA/Goodnight-p7.csv")
p7 = af(p7, c("A", "B"))
ANOVA(y ~ A + B + A:B, p7)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            3 13.6027  4.5342   2.807 0.1721
RESIDUALS        4  6.4613  1.6153
CORRECTED TOTAL  7 20.0639

$`Type I`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 10.8113 10.8113  6.6929 0.06087 .
B    1  1.3122  1.3122  0.8123 0.41839
A:B  1  1.4792  1.4792  0.9157 0.39279
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 10.8113 10.8113  6.6929 0.06087 .
B    1  1.3122  1.3122  0.8123 0.41839
A:B  1  1.4792  1.4792  0.9157 0.39279
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 10.8113 10.8113  6.6929 0.06087 .
B    1  1.3122  1.3122  0.8123 0.41839
A:B  1  1.4792  1.4792  0.9157 0.39279
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(8) MODEL

```
ANOVA(y ~ A + A:B + B, p7)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            3 13.6027  4.5342   2.807 0.1721
RESIDUALS        4  6.4613  1.6153
CORRECTED TOTAL  7 20.0639

$`Type I`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 10.8113 10.8113  6.6929 0.06087 .
A:B  2  2.7914  1.3957  0.8640 0.48764
B    0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 10.8113 10.8113  6.6929 0.06087 .
A:B  1  1.4792  1.4792  0.9157 0.39279
B    1  1.3122  1.3122  0.8123 0.41839
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 10.8113 10.8113  6.6929 0.06087 .
A:B  1  1.4792  1.4792  0.9157 0.39279
B    1  1.3122  1.3122  0.8123 0.41839
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(9) MODEL

```
ANOVA(y ~ B + A + A:B, p7)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            3 13.6027  4.5342   2.807 0.1721
RESIDUALS        4  6.4613  1.6153
CORRECTED TOTAL  7 20.0639

$`Type I`
    Df  Sum Sq Mean Sq F value  Pr(>F)
B    1  1.3122  1.3122  0.8123 0.41839
A    1 10.8113 10.8113  6.6929 0.06087 .
B:A  1  1.4792  1.4792  0.9157 0.39279
```

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

$`Type II`
    Df  Sum Sq Mean Sq F value  Pr(>F)
B    1  1.3122  1.3122  0.8123 0.41839
A    1 10.8113 10.8113  6.6929 0.06087 .
B:A  1  1.4792  1.4792  0.9157 0.39279
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value  Pr(>F)
B    1  1.3122  1.3122  0.8123 0.41839
A    1 10.8113 10.8113  6.6929 0.06087 .
B:A  1  1.4792  1.4792  0.9157 0.39279
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(10) MODEL

```
ANOVA(y ~ B + A:B + A, p7)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            3 13.6027  4.5342   2.807 0.1721
RESIDUALS        4  6.4613  1.6153
CORRECTED TOTAL  7 20.0639

$`Type I`
    Df  Sum Sq Mean Sq F value Pr(>F)
B    1  1.3122  1.3122  0.8123 0.4184
B:A  2 12.2905  6.1452  3.8043 0.1187
A    0

$`Type II`
    Df  Sum Sq Mean Sq F value  Pr(>F)
B    1  1.3122  1.3122  0.8123 0.41839
B:A  1  1.4792  1.4792  0.9157 0.39279
A    1 10.8113 10.8113  6.6929 0.06087 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value  Pr(>F)
B    1  1.3122  1.3122  0.8123 0.41839
B:A  1  1.4792  1.4792  0.9157 0.39279
A    1 10.8113 10.8113  6.6929 0.06087 .
```

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

(11) MODEL

```
ANOVA(y ~ A:B + A + B, p7)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            3 13.6027  4.5342   2.807 0.1721
RESIDUALS        4  6.4613  1.6153
CORRECTED TOTAL  7 20.0639

$`Type I`
    Df Sum Sq Mean Sq F value Pr(>F)
A:B  3 13.603  4.5342   2.807 0.1721
A    0
B    0

$`Type II`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A:B  1  1.4792  1.4792  0.9157 0.39279
A    1 10.8113 10.8113  6.6929 0.06087 .
B    1  1.3122  1.3122  0.8123 0.41839
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A:B  1  1.4792  1.4792  0.9157 0.39279
A    1 10.8113 10.8113  6.6929 0.06087 .
B    1  1.3122  1.3122  0.8123 0.41839
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(12) MODEL

```
ANOVA(y ~ A:B + A + B, p7)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            3 13.6027  4.5342   2.807 0.1721
RESIDUALS        4  6.4613  1.6153
CORRECTED TOTAL  7 20.0639

$`Type I`
    Df Sum Sq Mean Sq F value Pr(>F)
A:B  3 13.603  4.5342   2.807 0.1721
```

```
A    0
B    0

$`Type II`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A:B  1  1.4792  1.4792  0.9157 0.39279
A    1 10.8113 10.8113  6.6929 0.06087 .
B    1  1.3122  1.3122  0.8123 0.41839
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A:B  1  1.4792  1.4792  0.9157 0.39279
A    1 10.8113 10.8113  6.6929 0.06087 .
B    1  1.3122  1.3122  0.8123 0.41839
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

4.2 Type II SS

4.2.1 p14

(13) MODEL

```
ANOVA(y ~ A + B + A:B, p7[-8,]) # p16
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            3 12.7672  4.2557  2.0088 0.2906
RESIDUALS        3  6.3555  2.1185
CORRECTED TOTAL  6 19.1227

$`Type I`
    Df Sum Sq Mean Sq F value Pr(>F)
A    1 9.9567  9.9567  4.6999 0.1187
B    1 1.9225  1.9225  0.9075 0.4111
A:B  1 0.8880  0.8880  0.4192 0.5635

$`Type II`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 11.1715 11.1715  5.2733 0.1053
B    1  1.9225  1.9225  0.9075 0.4111
A:B  1  0.8880  0.8880  0.4192 0.5635

$`Type III`
    Df Sum Sq Mean Sq F value Pr(>F)
A    1 9.5258  9.5258  4.4965 0.1241
```

```
B    1 1.3690  1.3690  0.6462 0.4803
A:B  1 0.8880  0.8880  0.4192 0.5635
```

4.2.2 p24

(14) MODEL

```
p24 = read.csv("C:/G/Rt/ANOVA/Goodnight-p24.csv")
p24 = af(p24, c("A", "B", "C"))
ANOVA(Y ~ A + B + C, p24) # p27
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value  Pr(>F)
MODEL            6 45.924  7.6540  9.1615 0.00499 **
RESIDUALS        7  5.848  0.8354
CORRECTED TOTAL 13 51.772
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
  Df Sum Sq Mean Sq F value  Pr(>F)
A  1  4.724  4.7235  5.6538 0.04904 *
B  3 37.998 12.6660 15.1606 0.00191 **
C  2  3.203  1.6013  1.9167 0.21686
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
  Df Sum Sq Mean Sq F value Pr(>F)
A  0
B  2 0.4424  0.2212  0.2648 0.7747
C  2 3.2025  1.6013  1.9167 0.2169

$`Type III`
CAUTION: Singularity Exists !
  Df Sum Sq Mean Sq F value Pr(>F)
A  0
B  2 0.4424  0.2212  0.2648 0.7747
C  2 3.2026  1.6013  1.9167 0.2169
```

4.3 Type III SS

4.3.1 p27

(15) MODEL

```
p27 = read.csv("C:/G/Rt/ANOVA/Goodnight-p27.csv")
p27 = af(p27, c("A", "B"))
ANOVA(y ~ A + B + A:B, p27) # p29
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value   Pr(>F)
MODEL            5 128.193 25.6386  53.469 6.77e-05 ***
RESIDUALS        6   2.877  0.4795
CORRECTED TOTAL 11 131.070
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value    Pr(>F)
A    2 89.580  44.790 93.4102 3.013e-05 ***
B    2 38.542  19.271 40.1901 0.0003351 ***
A:B  1  0.071   0.071  0.1471 0.7145464
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
A    2 126.778  63.389 132.1977 1.093e-05 ***
B    2  38.542  19.271  40.1901 0.0003351 ***
A:B  1   0.071   0.071   0.1471 0.7145464
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
A    2 126.778  63.389 132.1977 1.093e-05 ***
B    2  38.542  19.271  40.1901 0.0003351 ***
A:B  1   0.071   0.071   0.1471 0.7145464
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

4.3.2 p33

(16) MODEL

```r
p33 = read.csv("C:/G/Rt/ANOVA/Goodnight-p33.csv")
p33 = af(p33, c("A", "B"))
ANOVA(y ~ A + B + A:B, p33) # p35
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            4 34.905  8.7261
RESIDUALS        0  0.000
CORRECTED TOTAL  4 34.905

$`Type I`
```

```
    Df  Sum Sq Mean Sq F value Pr(>F)
A    2 11.3739  5.6870
B    1 23.5225 23.5225
A:B  1  0.0081  0.0081

$`Type II`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1  3.0276  3.0276
B    1 23.5225 23.5225
A:B  1  0.0081  0.0081

$`Type III`
CAUTION: Singularity Exists !
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1  3.0276  3.0276
B    1 23.5225 23.5225
A:B  1  0.0081  0.0081
```

```r
options(contrasts = c("contr.sum", "contr.poly"))
Anova(lm(y ~ A + B + A:B, p33), type=3, singular.ok=TRUE) # NOT WORKING
```

5 SAS for Linear Models 4e

Reference

- Littell RC, Stroup WW, Freund RJ. SAS for Linear Models 4e. John Wiley & Sons Inc. 2002.

5.1 Chapter 2

5.1.1 p5

(17) MODEL

```
p5 = read.table("C:/G/Rt/SAS4lm/p5.txt", head=TRUE)
ANOVA(COST ~ CATTLE, p5) # p6 Output 2.2
```

```
$ANOVA
Response : COST
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            1 6582.1  6582.1   59.34 6.083e-07 ***
RESIDUALS       17 1885.7   110.9
CORRECTED TOTAL 18 8467.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df Sum Sq Mean Sq F value    Pr(>F)
CATTLE  1 6582.1  6582.1   59.34 6.083e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
       Df Sum Sq Mean Sq F value    Pr(>F)
CATTLE  1 6582.1  6582.1   59.34 6.083e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
       Df Sum Sq Mean Sq F value    Pr(>F)
CATTLE  1 6582.1  6582.1   59.34 6.083e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.1.2 p12

(18) MODEL

```
p12 = read.table("C:/G/Rt/SAS4lm/p12.txt", head=TRUE)
ANOVA(COST ~ CATTLE + CALVES + HOGS + SHEEP, p12)
```

```
$ANOVA
Response : COST
```

```
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            4 7936.7 1984.18   52.31 2.885e-08 ***
RESIDUALS       14  531.0   37.93
CORRECTED TOTAL 18 8467.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df Sum Sq Mean Sq  F value    Pr(>F)
CATTLE  1 6582.1  6582.1 173.5265 2.801e-09 ***
CALVES  1  186.7   186.7   4.9213 0.0435698 *
HOGS    1  489.9   489.9  12.9145 0.0029351 **
SHEEP   1  678.1   678.1  17.8773 0.0008431 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
       Df  Sum Sq Mean Sq F value    Pr(>F)
CATTLE  1 2200.71 2200.71 58.0183 2.413e-06 ***
CALVES  1  136.08  136.08  3.5876 0.0790616 .
HOGS    1  113.66  113.66  2.9964 0.1054198
SHEEP   1  678.11  678.11 17.8773 0.0008431 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
       Df  Sum Sq Mean Sq F value    Pr(>F)
CATTLE  1 2200.71 2200.71 58.0183 2.413e-06 ***
CALVES  1  136.08  136.08  3.5876 0.0790616 .
HOGS    1  113.66  113.66  2.9964 0.1054198
SHEEP   1  678.11  678.11 17.8773 0.0008431 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(19) MODEL

```
ANOVA(COST ~ CATTLE + CALVES + SHEEP, p12)
```

```
$ANOVA
Response : COST
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            3 7823.1 2607.69  60.673 1.281e-08 ***
RESIDUALS       15  644.7   42.98
CORRECTED TOTAL 18 8467.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df Sum Sq Mean Sq  F value    Pr(>F)
```

```
CATTLE  1 6582.1  6582.1 153.1443 2.835e-09 ***
CALVES  1  186.7   186.7   4.3432 0.0546701 .
SHEEP   1 1054.3  1054.3  24.5306 0.0001735 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
       Df Sum Sq Mean Sq F value    Pr(>F)
CATTLE  1 2519.8  2519.8 58.6265 1.471e-06 ***
CALVES  1  260.6   260.6  6.0634 0.0263909 *
SHEEP   1 1054.3  1054.3 24.5306 0.0001735 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
       Df Sum Sq Mean Sq F value    Pr(>F)
CATTLE  1 2519.8  2519.8 58.6265 1.471e-06 ***
CALVES  1  260.6   260.6  6.0634 0.0263909 *
SHEEP   1 1054.3  1054.3 24.5306 0.0001735 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(20) MODEL

```
ANOVA(COST ~ CATTLE + CALVES + offset(1*HOGS) + SHEEP, p12)
```

```
$ANOVA
Response : COST
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            3 7823.1 2607.69  60.673 1.281e-08 ***
RESIDUALS       15  644.7   42.98
CORRECTED TOTAL 18 8467.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df Sum Sq Mean Sq  F value    Pr(>F)
CATTLE  1 6582.1  6582.1 153.1443 2.835e-09 ***
CALVES  1  186.7   186.7   4.3432 0.0546701 .
SHEEP   1 1054.3  1054.3  24.5306 0.0001735 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
       Df Sum Sq Mean Sq F value    Pr(>F)
CATTLE  1 2519.8  2519.8 58.6265 1.471e-06 ***
CALVES  1  260.6   260.6  6.0634 0.0263909 *
SHEEP   1 1054.3  1054.3 24.5306 0.0001735 ***
---
```

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

$`Type III`
       Df Sum Sq Mean Sq F value    Pr(>F)
CATTLE  1 2519.8  2519.8 58.6265 1.471e-06 ***
CALVES  1  260.6   260.6  6.0634 0.0263909 *
SHEEP   1 1054.3  1054.3 24.5306 0.0001735 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(21) MODEL

```
ANOVA(COST ~ CATTLE + CALVES + I(HOGS + SHEEP), p12)

$ANOVA
Response : COST
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            3 7936.7  2645.6  74.726 3.011e-09 ***
RESIDUALS       15  531.1    35.4
CORRECTED TOTAL 18 8467.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
                Df Sum Sq Mean Sq  F value    Pr(>F)
CATTLE           1 6582.1  6582.1 185.9151 7.406e-10 ***
CALVES           1  186.7   186.7   5.2726   0.03649 *
I(HOGS + SHEEP)  1 1168.0  1168.0  32.9896 3.883e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
                Df  Sum Sq Mean Sq F value    Pr(>F)
CATTLE           1 2215.48 2215.48 62.5775 9.887e-07 ***
CALVES           1  155.03  155.03  4.3788    0.0538 .
I(HOGS + SHEEP)  1 1167.96 1167.96 32.9896 3.883e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
                Df  Sum Sq Mean Sq F value    Pr(>F)
CATTLE           1 2215.48 2215.48 62.5775 9.887e-07 ***
CALVES           1  155.03  155.03  4.3788    0.0538 .
I(HOGS + SHEEP)  1 1167.96 1167.96 32.9896 3.883e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(22) MODEL

```
REG(COST ~ CATTLE + CALVES + I(HOGS + SHEEP) - 1, p12)
```

```
                Estimate Std. Error Df t value  Pr(>|t|)
CATTLE            3.3000    0.38314 16  8.6131 2.100e-07 ***
CALVES            1.9672    0.59108 16  3.3281  0.004259 **
I(HOGS + SHEEP)   0.8068    0.13800 16  5.8466 2.479e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.2 Chapter 3

5.2.1 p63

(23) MODEL

```
p63w = read.table("C:/G/Rt/SAS4lm/p63.txt", header=TRUE)
p63l = reshape(p63w,
        direction = "long",
        varying = list(names(p63w)[2:9]),
        v.names = "fruitwt",
        idvar = c("irrig"),
        timevar = "bloc",
        times = 1:8)
p63l = af(p63l, c("bloc"))
ANOVA(fruitwt ~ bloc + irrig, p63l) # p64
```

```
$ANOVA
Response : fruitwt
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           11 445334   40485   12.04 6.643e-08 ***
RESIDUALS       28  94147    3362
CORRECTED TOTAL 39 539481
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
bloc   7 401308   57330 17.0503 1.452e-08 ***
irrig  4  44026   11006  3.2734   0.02539 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
bloc   7 401308   57330 17.0503 1.452e-08 ***
irrig  4  44026   11006  3.2734   0.02539 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
      Df Sum Sq Mean Sq F value    Pr(>F)
bloc   7 401308   57330 17.0503 1.452e-08 ***
irrig  4  44026   11006  3.2734   0.02539 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.2.2 p72

(24) MODEL

```
p72 = read.table("C:/G/Rt/SAS4lm/p72.txt", header=TRUE)
p72 = af(p72, c("run", "pos", "mat"))
ANOVA(wtloss ~ run + pos + mat, p72) # p73
```

```
$ANOVA
Response : wtloss
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL            9 7076.5  786.28  12.837 0.002828 **
RESIDUALS        6  367.5   61.25
CORRECTED TOTAL 15 7444.0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value    Pr(>F)
run  3  986.5  328.83  5.3687 0.0390130 *
pos  3 1468.5  489.50  7.9918 0.0161685 *
mat  3 4621.5 1540.50 25.1510 0.0008498 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq F value    Pr(>F)
run  3  986.5  328.83  5.3687 0.0390130 *
pos  3 1468.5  489.50  7.9918 0.0161685 *
mat  3 4621.5 1540.50 25.1510 0.0008498 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value    Pr(>F)
run  3  986.5  328.83  5.3687 0.0390130 *
pos  3 1468.5  489.50  7.9918 0.0161685 *
mat  3 4621.5 1540.50 25.1510 0.0008498 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
ANOVA(shrink ~ run + pos + mat, p72) # p73
```

```
$ANOVA
Response : shrink
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL            9 265.75  29.528  9.8426 0.005775 **
RESIDUALS        6  18.00   3.000
CORRECTED TOTAL 15 283.75
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value   Pr(>F)
run  3  33.25  11.083  3.6944 0.081254 .
pos  3  60.25  20.083  6.6944 0.024212 *
mat  3 172.25  57.417 19.1389 0.001786 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq F value   Pr(>F)
run  3  33.25  11.083  3.6944 0.081254 .
pos  3  60.25  20.083  6.6944 0.024212 *
mat  3 172.25  57.417 19.1389 0.001786 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value   Pr(>F)
run  3  33.25  11.083  3.6944 0.081254 .
pos  3  60.25  20.083  6.6944 0.024212 *
mat  3 172.25  57.417 19.1389 0.001786 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.2.3 p75

(25) MODEL

```
p75w = read.table("C:/G/Rt/SAS4lm/p75.txt", header=TRUE)
p75l = reshape(p75w,
        direction = "long",
        varying = list(names(p75w)[4:9]),
        v.names = "Y",
        idvar = c("method", "variety", "trt"),
        timevar = "yield",
        times = 1:6)
p75l = af(p75l, c("variety", "yield"))
```

```r
ANOVA(Y ~ method*variety, p75l) # p78
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           14 1339.0  95.645  4.8674 2.723e-06 ***
RESIDUALS       75 1473.8  19.650
CORRECTED TOTAL 89 2812.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
               Df Sum Sq Mean Sq F value    Pr(>F)
method          2 953.16  476.58 24.2531 7.525e-09 ***
variety         4  11.38    2.85  0.1448   0.96476
method:variety  8 374.49   46.81  2.3822   0.02409 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
               Df Sum Sq Mean Sq F value    Pr(>F)
method          2 953.16  476.58 24.2531 7.525e-09 ***
variety         4  11.38    2.85  0.1448   0.96476
method:variety  8 374.49   46.81  2.3822   0.02409 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
               Df Sum Sq Mean Sq F value    Pr(>F)
method          2 953.16  476.58 24.2531 7.525e-09 ***
variety         4  11.38    2.85  0.1448   0.96476
method:variety  8 374.49   46.81  2.3822   0.02409 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.3 Chapter 4

5.3.1 p94

(26) MODEL

```r
p94w = read.table("C:/G/Rt/SAS4lm/p94.txt", head=TRUE)
p94l = reshape(p94w,
        direction = "long",
        varying = list(names(p94w)[3:8]),
        v.names = "ct",
        idvar = c("package"),
        timevar = "sample",
```

```
        times = 1:6)
p94l$sampleA = floor((p94l$sample + 1)/2)
p94l$sampleB = 2 - (p94l$sample) %% 2
p94l$logct = log10(p94l$ct)
p94l = af(p94l, c("sample", "sampleA", "sampleB", "package"))
ANOVA(logct ~ package + sampleA %in% package, p94l) # p97
```

```
$ANOVA
Response : logct
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            59 50.463 0.85531  22.229 < 2.2e-16 ***
RESIDUALS        60  2.309 0.03848
CORRECTED TOTAL 119 52.772
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
                Df Sum Sq Mean Sq F value    Pr(>F)
package         19 30.529 1.60680  41.760 < 2.2e-16 ***
package:sampleA 40 19.934 0.49836  12.952 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
                Df Sum Sq Mean Sq F value    Pr(>F)
package         19 30.529 1.60680  41.760 < 2.2e-16 ***
package:sampleA 40 19.934 0.49836  12.952 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
                Df Sum Sq Mean Sq F value    Pr(>F)
package         19 30.529 1.60680  41.760 < 2.2e-16 ***
package:sampleA 40 19.934 0.49836  12.952 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.3.2 p116

(27) MODEL

```
ANOVA(Y ~ method + variety + method:variety, p75l) # p116
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           14 1339.0  95.645  4.8674 2.723e-06 ***
RESIDUALS       75 1473.8  19.650
```

```
CORRECTED TOTAL 89 2812.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
               Df Sum Sq Mean Sq F value    Pr(>F)
method          2 953.16  476.58 24.2531 7.525e-09 ***
variety         4  11.38    2.85  0.1448   0.96476
method:variety  8 374.49   46.81  2.3822   0.02409 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
               Df Sum Sq Mean Sq F value    Pr(>F)
method          2 953.16  476.58 24.2531 7.525e-09 ***
variety         4  11.38    2.85  0.1448   0.96476
method:variety  8 374.49   46.81  2.3822   0.02409 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
               Df Sum Sq Mean Sq F value    Pr(>F)
method          2 953.16  476.58 24.2531 7.525e-09 ***
variety         4  11.38    2.85  0.1448   0.96476
method:variety  8 374.49   46.81  2.3822   0.02409 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.3.3 p122

(28) MODEL

```
p122 = read.table("C:/G/Rt/SAS4lm/p122.txt", header=TRUE)
p122 = af(p122, c("et", "wafer", "pos"))
ANOVA(resista ~ et + wafer %in% et + pos + et:pos, p122)
```

```
$ANOVA
Response : resista
                Df  Sum Sq Mean Sq F value   Pr(>F)
MODEL           23  9.3250 0.40544  3.6477 0.001263 **
RESIDUALS       24  2.6676 0.11115
CORRECTED TOTAL 47 11.9926
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df Sum Sq Mean Sq F value    Pr(>F)
et         3 3.1122 1.03739  9.3333 0.0002851 ***
et:wafer   8 4.2745 0.53431  4.8071 0.0012742 **
```

```
pos       3 1.1289 0.37630  3.3855 0.0345139 *
et:pos    9 0.8095 0.08994  0.8092 0.6125279
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
         Df Sum Sq Mean Sq F value    Pr(>F)
et        3 3.1122 1.03739  9.3333 0.0002851 ***
et:wafer  8 4.2745 0.53431  4.8071 0.0012742 **
pos       3 1.1289 0.37630  3.3855 0.0345139 *
et:pos    9 0.8095 0.08994  0.8092 0.6125279
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
         Df Sum Sq Mean Sq F value    Pr(>F)
et        3 3.1122 1.03739  9.3333 0.0002851 ***
et:wafer  8 4.2745 0.53431  4.8071 0.0012742 **
pos       3 1.1289 0.37630  3.3855 0.0345139 *
et:pos    9 0.8095 0.08994  0.8092 0.6125279
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.3.4 p136

(29) MODEL

```
p136 = read.table("C:/G/Rt/SAS4lm/p136.txt", header=TRUE)
p136 = af(p136, "rep")
ANOVA(drywt ~ rep + cult + rep:cult + inoc + cult:inoc, p136)
```

```
$ANOVA
Response : drywt
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           11 157.208 14.2917   20.26 4.594e-06 ***
RESIDUALS       12   8.465  0.7054
CORRECTED TOTAL 23 165.673
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df  Sum Sq Mean Sq F value    Pr(>F)
rep        3  25.320   8.440 11.9646 0.0006428 ***
cult       1   2.407   2.407  3.4117 0.0895283 .
rep:cult   3   9.480   3.160  4.4796 0.0249095 *
inoc       2 118.176  59.088 83.7631 8.919e-08 ***
cult:inoc  2   1.826   0.913  1.2942 0.3097837
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
          Df  Sum Sq Mean Sq F value    Pr(>F)
rep        3  25.320   8.440 11.9646 0.0006428 ***
cult       1   2.407   2.407  3.4117 0.0895283 .
rep:cult   3   9.480   3.160  4.4796 0.0249095 *
inoc       2 118.176  59.088 83.7631 8.919e-08 ***
cult:inoc  2   1.826   0.913  1.2942 0.3097837
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df  Sum Sq Mean Sq F value    Pr(>F)
rep        3  25.320   8.440 11.9646 0.0006428 ***
cult       1   2.407   2.407  3.4117 0.0895283 .
rep:cult   3   9.480   3.160  4.4796 0.0249095 *
inoc       2 118.176  59.088 83.7631 8.919e-08 ***
cult:inoc  2   1.826   0.913  1.2942 0.3097837
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.4 Chapter 5

5.4.1 p142

(30) MODEL

```
p142 = read.table("C:/G/Rt/SAS4lm/p142.txt", header=TRUE, na.strings=".")
p142 = af(p142, c("STUDY", "PATIENT"))
ANOVA(FLUSH ~ STUDY + TRT, p142) # Incomplete data, 56 lines are truncated.
```

```
$ANOVA
Response : FLUSH
                Df  Sum Sq Mean Sq F value  Pr(>F)
MODEL            5  3619.9  723.98   2.392 0.04607 *
RESIDUALS       71 21489.2  302.67
CORRECTED TOTAL 76 25109.1
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value  Pr(>F)
STUDY  4 3553.9  888.46  2.9355 0.02638 *
TRT    1   66.0   66.04  0.2182 0.64185
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value  Pr(>F)
```

```
STUDY  4 3599.4  899.85  2.9731 0.02496 *
TRT    1   66.0   66.04  0.2182 0.64185
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq F value  Pr(>F)
STUDY  4 3599.4  899.85  2.9731 0.02496 *
TRT    1   66.0   66.04  0.2182 0.64185
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(31) MODEL

```
ANOVA(FLUSH ~ TRT + STUDY + TRT:STUDY, p142) # Different data
```

```
$ANOVA
Response : FLUSH
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            9  4093.7  454.86  1.4501 0.1851
RESIDUALS       67 21015.4  313.66
CORRECTED TOTAL 76 25109.1

$`Type I`
          Df Sum Sq Mean Sq F value  Pr(>F)
TRT        1   20.5   20.49  0.0653 0.79906
STUDY      4 3599.4  899.85  2.8688 0.02956 *
TRT:STUDY  4  473.8  118.45  0.3776 0.82383
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df Sum Sq Mean Sq F value  Pr(>F)
TRT        1   66.0   66.04  0.2105 0.64783
STUDY      4 3599.4  899.85  2.8688 0.02956 *
TRT:STUDY  4  473.8  118.45  0.3776 0.82383
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df Sum Sq Mean Sq F value Pr(>F)
TRT        1    1.9    1.93  0.0062 0.9377
STUDY      4 3339.4  834.85  2.6616 0.0400 *
TRT:STUDY  4  473.8  118.45  0.3776 0.8238
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.5 Chapter 6

5.5.1 p171

(32) MODEL

```
p171 = read.table("C:/G/Rt/SAS4lm/p171.txt", header=TRUE)
ANOVA(score2 ~ teach, p171) # p173 Output 6.2, p174 Output 6.5
```

```
$ANOVA
Response : score2
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            2   49.74  24.868  0.5598 0.5776
RESIDUALS       28 1243.94  44.426
CORRECTED TOTAL 30 1293.68

$`Type I`
      Df Sum Sq Mean Sq F value Pr(>F)
teach  2 49.736  24.868  0.5598 0.5776

$`Type II`
      Df Sum Sq Mean Sq F value Pr(>F)
teach  2 49.736  24.868  0.5598 0.5776

$`Type III`
      Df Sum Sq Mean Sq F value Pr(>F)
teach  2 49.736  24.868  0.5598 0.5776
```

5.5.2 p188

(33) MODEL

```
p188 = read.table("C:/G/Rt/SAS4lm/p188.txt", header=TRUE)
p188 = af(p188, c("a", "b"))
ANOVA(y ~ a + b + a:b, p188) # p189
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL            5 63.711 12.7422   5.866 0.005724 **
RESIDUALS       12 26.067  2.1722
CORRECTED TOTAL 17 89.778
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value   Pr(>F)
a    1  7.803  7.8028  3.5921 0.082395 .
b    2 20.492 10.2459  4.7168 0.030798 *
a:b  2 35.416 17.7082  8.1521 0.005807 **
```

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

$`Type II`
    Df Sum Sq Mean Sq F value   Pr(>F)
a    1 15.850  15.850  7.2968 0.019265 *
b    2 20.492  10.246  4.7168 0.030798 *
a:b  2 35.416  17.708  8.1521 0.005807 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value   Pr(>F)
a    1  9.641  9.6407  4.4382 0.056865 .
b    2 30.866 15.4330  7.1047 0.009212 **
a:b  2 35.416 17.7082  8.1521 0.005807 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.5.3 p203

(34) MODEL

```
ANOVA(y ~ a + b + a:b,  p188[-8,])
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value  Pr(>F)
MODEL            4 45.816 11.4539  5.2729 0.01097 *
RESIDUALS       12 26.067  2.1722
CORRECTED TOTAL 16 71.882
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df  Sum Sq Mean Sq F value   Pr(>F)
a    1  2.9252  2.9252  1.3466 0.268432
b    2 13.3224  6.6612  3.0665 0.083997 .
a:b  1 29.5681 29.5681 13.6119 0.003095 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq F value   Pr(>F)
a    1  5.5652  5.5652  2.5620 0.135442
b    2 13.3224  6.6612  3.0665 0.083997 .
a:b  1 29.5681 29.5681 13.6119 0.003095 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
    Df  Sum Sq Mean Sq F value   Pr(>F)
a    1  0.3507  0.3507  0.1615 0.694881
b    2 16.0733  8.0367  3.6997 0.056021 .
a:b  1 29.5681 29.5681 13.6119 0.003095 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.5.4 p215

(35) MODEL

```
p215 = read.table("C:/G/Rt/SAS4lm/p215.txt", header=TRUE)
p215 = af(p215, c("irrig", "reps"))
ANOVA(yield ~ irrig/reps + cult + irrig:cult, p215) # p216 Book is wrong.
```

```
$ANOVA
Response : yield
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL           11  67.662  6.1511  0.6253 0.7636
RESIDUALS        6  59.023  9.8372
CORRECTED TOTAL 17 126.685

$`Type I`
           Df Sum Sq Mean Sq F value Pr(>F)
irrig       2  7.320  3.6600  0.3721 0.7042
irrig:reps  6 59.870  9.9783  1.0143 0.4933
cult        1  0.467  0.4672  0.0475 0.8347
irrig:cult  2  0.004  0.0022  0.0002 0.9998

$`Type II`
           Df Sum Sq Mean Sq F value Pr(>F)
irrig       2  7.320  3.6600  0.3721 0.7042
irrig:reps  6 59.870  9.9783  1.0143 0.4933
cult        1  0.467  0.4672  0.0475 0.8347
irrig:cult  2  0.004  0.0022  0.0002 0.9998

$`Type III`
           Df Sum Sq Mean Sq F value Pr(>F)
irrig       2  7.320  3.6600  0.3721 0.7042
irrig:reps  6 59.870  9.9783  1.0143 0.4933
cult        1  0.467  0.4672  0.0475 0.8347
irrig:cult  2  0.004  0.0022  0.0002 0.9998
```

```
# Compare with SAS output
```

(36) MODEL

```
ANOVA(yield ~ reps + irrig + reps:irrig + cult + cult:irrig, p215)
```

```
$ANOVA
Response : yield
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL           11  67.662  6.1511  0.6253 0.7636
RESIDUALS        6  59.023  9.8372
CORRECTED TOTAL 17 126.685

$`Type I`
           Df Sum Sq Mean Sq F value Pr(>F)
reps        2 49.703 24.8517  2.5263 0.1600
irrig       2  7.320  3.6600  0.3721 0.7042
reps:irrig  4 10.167  2.5417  0.2584 0.8944
cult        1  0.467  0.4672  0.0475 0.8347
irrig:cult  2  0.004  0.0022  0.0002 0.9998

$`Type II`
           Df Sum Sq Mean Sq F value Pr(>F)
reps        2 49.703 24.8517  2.5263 0.1600
irrig       2  7.320  3.6600  0.3721 0.7042
reps:irrig  4 10.167  2.5417  0.2584 0.8944
cult        1  0.467  0.4672  0.0475 0.8347
irrig:cult  2  0.004  0.0022  0.0002 0.9998

$`Type III`
           Df Sum Sq Mean Sq F value Pr(>F)
reps        2 49.703 24.8517  2.5263 0.1600
irrig       2  7.320  3.6600  0.3721 0.7042
reps:irrig  4 10.167  2.5417  0.2584 0.8944
cult        1  0.467  0.4672  0.0475 0.8347
irrig:cult  2  0.004  0.0022  0.0002 0.9998
```

5.6 Chapter 7

5.6.1 p232

(37) MODEL

```
p232 = read.table("C:/G/Rt/SAS4lm/p232.txt", header=TRUE)
p232 = af(p232, c("trt", "rep"))
ANOVA(final ~ trt + initial, p232) # p233
```

```
$ANOVA
Response : final
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            5 354.45  70.889  235.05 5.493e-13 ***
RESIDUALS       14   4.22   0.302
CORRECTED TOTAL 19 358.67
```

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

$`Type I`
        Df Sum Sq Mean Sq F value    Pr(>F)
trt      4 198.41  49.602  164.47 1.340e-11 ***
initial  1 156.04 156.040  517.38 1.867e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df  Sum Sq Mean Sq F value    Pr(>F)
trt      4  12.089   3.022  10.021 0.0004819 ***
initial  1 156.040 156.040 517.384 1.867e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
        Df  Sum Sq Mean Sq F value    Pr(>F)
trt      4  12.089   3.022  10.021 0.0004819 ***
initial  1 156.040 156.040 517.384 1.867e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.2 p240

(38) MODEL

```r
ANOVA(final ~ initial + trt + trt:initial, p232) # p240
```

```
$ANOVA
Response : final
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            9 355.84  39.537  139.51 2.572e-09 ***
RESIDUALS       10   2.83   0.283
CORRECTED TOTAL 19 358.67
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
            Df Sum Sq Mean Sq   F value    Pr(>F)
initial      1 342.36  342.36 1208.0336 9.211e-12 ***
trt          4  12.09    3.02   10.6645  0.001247 **
initial:trt  4   1.39    0.35    1.2247  0.360175
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df  Sum Sq Mean Sq  F value    Pr(>F)
```

```
initial      1 156.040 156.040 550.5987 4.478e-10 ***
trt          4  12.089   3.022  10.6645  0.001247 **
initial:trt  4   1.388   0.347   1.2247  0.360175
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
            Df Sum Sq Mean Sq  F value    Pr(>F)
initial      1 68.529  68.529 241.8091 2.472e-08 ***
trt          4  1.696   0.424   1.4963    0.2752
initial:trt  4  1.388   0.347   1.2247    0.3602
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.3 p241

(39) MODEL

```
p241 = read.table("C:/G/Rt/SAS4lm/p241.txt", header=TRUE)
p241 = af(p241, c("STORE", "DAY"))
ANOVA(Q1 ~ P1 + DAY + P1:DAY, p241) # p242
```

```
$ANOVA
Response : Q1
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           11 1111.52 101.048  4.6445 0.0008119 ***
RESIDUALS       24  522.15  21.756
CORRECTED TOTAL 35 1633.68
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df Sum Sq Mean Sq F value    Pr(>F)
P1      1 516.59  516.59 23.7444 5.739e-05 ***
DAY     5 430.54   86.11  3.9578  0.009275 **
P1:DAY  5 164.39   32.88  1.5112  0.223566
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
       Df Sum Sq Mean Sq F value    Pr(>F)
P1      1 696.73  696.73 32.0243 7.925e-06 ***
DAY     5 430.54   86.11  3.9578  0.009275 **
P1:DAY  5 164.39   32.88  1.5112  0.223566
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
       Df Sum Sq Mean Sq F value    Pr(>F)
```

```
P1      1 554.79  554.79 25.4999 3.665e-05 ***
DAY     5 201.17   40.23  1.8493    0.1412
P1:DAY  5 164.39   32.88  1.5112    0.2236
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.4 p243

(40) MODEL

```
ANOVA(Q1 ~ DAY + DAY:P1, p241)
```

```
$ANOVA
Response : Q1
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           11 1111.52 101.048  4.6445 0.0008119 ***
RESIDUALS       24  522.15  21.756
CORRECTED TOTAL 35 1633.68
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df Sum Sq Mean Sq F value    Pr(>F)
DAY     5 250.40  50.079  2.3018 0.0764717 .
DAY:P1  6 861.13 143.521  6.5967 0.0003239 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
       Df Sum Sq Mean Sq F value    Pr(>F)
DAY     5 250.40  50.079  2.3018 0.0764717 .
DAY:P1  6 861.13 143.521  6.5967 0.0003239 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
       Df Sum Sq Mean Sq F value    Pr(>F)
DAY     5 201.17  40.234  1.8493 0.1411648
DAY:P1  6 861.13 143.521  6.5967 0.0003239 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
REG(Q1 ~ DAY + DAY:P1 - 1, p241) # Ouput 7.10
```

```
        Estimate Std. Error Df t value  Pr(>|t|)
DAY1      18.675    14.4110 24  1.2959 0.2073286
DAY2      38.487    15.1094 24  2.5472 0.0176863 *
DAY3      45.330    26.1576 24  1.7329 0.0959384 .
DAY4      49.149    16.6092 24  2.9592 0.0068366 **
```

```
DAY5      77.899    27.5007 24  2.8326 0.0092034 **
DAY6      73.273    13.4837 24  5.4341  1.39e-05 ***
DAY1:P1   -0.220     0.2915 24 -0.7562 0.4568599
DAY2:P1   -0.624     0.2978 24 -2.0940 0.0470031 *
DAY3:P1   -0.611     0.5049 24 -1.2102 0.2379998
DAY4:P1   -0.796     0.3193 24 -2.4914 0.0200350 *
DAY5:P1   -1.196     0.5049 24 -2.3683 0.0262648 *
DAY6:P1   -1.225     0.2652 24 -4.6199 0.0001092 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(41) MODEL

```
ANOVA(Q1 ~ P1 + DAY + P1:DAY, p241)

$ANOVA
Response : Q1
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           11 1111.52 101.048  4.6445 0.0008119 ***
RESIDUALS       24  522.15  21.756
CORRECTED TOTAL 35 1633.68
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df Sum Sq Mean Sq F value    Pr(>F)
P1      1 516.59  516.59 23.7444 5.739e-05 ***
DAY     5 430.54   86.11  3.9578  0.009275 **
P1:DAY  5 164.39   32.88  1.5112  0.223566
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
       Df Sum Sq Mean Sq F value    Pr(>F)
P1      1 696.73  696.73 32.0243 7.925e-06 ***
DAY     5 430.54   86.11  3.9578  0.009275 **
P1:DAY  5 164.39   32.88  1.5112  0.223566
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
       Df Sum Sq Mean Sq F value    Pr(>F)
P1      1 554.79  554.79 25.4999 3.665e-05 ***
DAY     5 201.17   40.23  1.8493    0.1412
P1:DAY  5 164.39   32.88  1.5112    0.2236
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(42) MODEL

```
ANOVA(Q1 ~ STORE + DAY + P1 + P2, p241)
```

```
$ANOVA
Response : Q1
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           12 1225.37 102.114  5.7521 0.0001688 ***
RESIDUALS       23  408.31  17.753
CORRECTED TOTAL 35 1633.68
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
STORE  5 313.42   62.68  3.5310   0.01629 *
DAY    5 250.40   50.08  2.8210   0.03957 *
P1     1 622.01  622.01 35.0377 4.924e-06 ***
P2     1  39.54   39.54  2.2274   0.14917
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
STORE  5 223.83   44.77  2.5217  0.058346 .
DAY    5 433.10   86.62  4.8793  0.003456 **
P1     1 538.17  538.17 30.3150 1.342e-05 ***
P2     1  39.54   39.54  2.2274  0.149171
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq F value    Pr(>F)
STORE  5 223.83   44.77  2.5217  0.058346 .
DAY    5 433.10   86.62  4.8793  0.003456 **
P1     1 538.17  538.17 30.3150 1.342e-05 ***
P2     1  39.54   39.54  2.2274  0.149171
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.5 p250

(43) MODEL

```
p250 = read.table("C:/G/Rt/SAS4lm/p250.txt", header=TRUE)
p250 = af(p250, c("variety", "spacing", "plant"))
ANOVA(lint ~ bollwt + variety + spacing + variety:spacing + variety:spacing:plant,
     p250) # p252 Output 7.18, Parameter is different due to different order
```

```
$ANOVA
```

```
Response : lint
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            8 31.160  3.8950  80.704 < 2.2e-16 ***
RESIDUALS       40  1.931  0.0483
CORRECTED TOTAL 48 33.091
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
                      Df  Sum Sq Mean Sq  F value    Pr(>F)
bollwt                 1 29.0693 29.0693 602.3107 < 2.2e-16 ***
variety                1  1.2635  1.2635  26.1802 8.158e-06 ***
spacing                1  0.4666  0.4666   9.6689  0.003447 **
variety:spacing        1  0.0933  0.0933   1.9325  0.172169
variety:spacing:plant  4  0.2673  0.0668   1.3847  0.256548
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
                      Df  Sum Sq Mean Sq  F value    Pr(>F)
bollwt                 1 11.1186 11.1186 230.3745 < 2.2e-16 ***
variety                1  1.1973  1.1973  24.8084 1.259e-05 ***
spacing                1  0.4666  0.4666   9.6689  0.003447 **
variety:spacing        1  0.0933  0.0933   1.9325  0.172169
variety:spacing:plant  4  0.2673  0.0668   1.3847  0.256548
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
                      Df  Sum Sq Mean Sq  F value    Pr(>F)
bollwt                 1 11.1186 11.1186 230.3745 < 2.2e-16 ***
variety                1  0.9424  0.9424  19.5269 7.379e-05 ***
spacing                1  0.3748  0.3748   7.7666  0.008101 **
variety:spacing        1  0.0479  0.0479   0.9915  0.325350
variety:spacing:plant  4  0.2673  0.0668   1.3847  0.256548
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.6 p254 Output 7.20

(44) MODEL

```
ANOVA(lint ~ bollwt + variety + spacing, p250)
```

```
$ANOVA
Response : lint
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            3 30.799 10.2665  201.65 < 2.2e-16 ***
RESIDUALS       45  2.291  0.0509
```

```
CORRECTED TOTAL 48 33.091
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
        Df  Sum Sq Mean Sq  F value    Pr(>F)
bollwt   1 29.0693 29.0693 570.9531 < 2.2e-16 ***
variety  1  1.2635  1.2635  24.8172 9.777e-06 ***
spacing  1  0.4666  0.4666   9.1655  0.004072 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df  Sum Sq Mean Sq  F value    Pr(>F)
bollwt   1 11.5717 11.5717 227.2815 < 2.2e-16 ***
variety  1  1.1973  1.1973  23.5168 1.516e-05 ***
spacing  1  0.4666  0.4666   9.1655  0.004072 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
        Df  Sum Sq Mean Sq  F value    Pr(>F)
bollwt   1 11.5717 11.5717 227.2815 < 2.2e-16 ***
variety  1  1.1973  1.1973  23.5168 1.516e-05 ***
spacing  1  0.4666  0.4666   9.1655  0.004072 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.7 p256

(45) MODEL

```
p256 = read.table("C:/G/Rt/SAS4lm/p256.txt", header=TRUE)
p256b = af(p256, c("bloc", "type", "logdose"))
ANOVA(y ~ bloc + type + logdose + type:logdose, p256b) # p258 Output 7.22
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            8  816.50 102.063  6.0641 0.0014 **
RESIDUALS       15  252.46  16.831
CORRECTED TOTAL 23 1068.96
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
             Df Sum Sq Mean Sq F value    Pr(>F)
bloc          3 538.79 179.597 10.6709 0.0005223 ***
type          1  12.04  12.042  0.7155 0.4109264
```

```
logdose       2 121.58  60.792  3.6120 0.0524231 .
type:logdose  2 144.08  72.042  4.2804 0.0338265 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
             Df Sum Sq Mean Sq F value    Pr(>F)
bloc          3 538.79 179.597 10.6709 0.0005223 ***
type          1  12.04  12.042  0.7155 0.4109264
logdose       2 121.58  60.792  3.6120 0.0524231 .
type:logdose  2 144.08  72.042  4.2804 0.0338265 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
             Df Sum Sq Mean Sq F value    Pr(>F)
bloc          3 538.79 179.597 10.6709 0.0005223 ***
type          1  12.04  12.042  0.7155 0.4109264
logdose       2 121.58  60.792  3.6120 0.0524231 .
type:logdose  2 144.08  72.042  4.2804 0.0338265 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.8 p261 Output 7.27

(46) MODEL

```
p256 = af(p256, c("bloc", "type"))
p256$logd2 = (p256$logdose)^2
ANOVA(y ~ bloc + type + logdose + logd2 + type:logdose + type:logd2, p256)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            8  816.50 102.063  6.0641 0.0014 **
RESIDUALS       15  252.46  16.831
CORRECTED TOTAL 23 1068.96
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
             Df Sum Sq Mean Sq F value    Pr(>F)
bloc          3 538.79 179.597 10.6709 0.0005223 ***
type          1  12.04  12.042  0.7155 0.4109264
logdose       1 115.56 115.562  6.8662 0.0193005 *
logd2         1   6.02   6.021  0.3577 0.5586917
type:logdose  1 138.06 138.062  8.2031 0.0118242 *
type:logd2    1   6.02   6.021  0.3577 0.5586917
---
```

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

$`Type II`
             Df Sum Sq Mean Sq F value    Pr(>F)
bloc          3 538.79 179.597 10.6709 0.0005223 ***
type          1  12.04  12.042  0.7155 0.4109264
logdose       1   0.39   0.389  0.0231 0.8811262
logd2         1   6.02   6.021  0.3577 0.5586917
type:logdose  1   0.81   0.812  0.0483 0.8290541
type:logd2    1   6.02   6.021  0.3577 0.5586917
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
             Df Sum Sq Mean Sq F value    Pr(>F)
bloc          3 538.79 179.597 10.6709 0.0005223 ***
type          1  28.12  28.125  1.6711 0.2156736
logdose       1   0.39   0.389  0.0231 0.8811262
logd2         1   6.02   6.021  0.3577 0.5586917
type:logdose  1   0.81   0.812  0.0483 0.8290541
type:logd2    1   6.02   6.021  0.3577 0.5586917
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.6.9 p262 Output 7.28

(47) MODEL

```
ANOVA(y ~ bloc + type + type:logdose, p256b)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            8  816.50 102.063  6.0641 0.0014 **
RESIDUALS       15  252.46  16.831
CORRECTED TOTAL 23 1068.96
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
             Df Sum Sq Mean Sq F value    Pr(>F)
bloc          3 538.79 179.597 10.6709 0.0005223 ***
type          1  12.04  12.042  0.7155 0.4109264
type:logdose  4 265.67  66.417  3.9462 0.0220552 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
             Df Sum Sq Mean Sq F value    Pr(>F)
```

```
bloc          3 538.79 179.597 10.6709 0.0005223 ***
type          1  12.04  12.042  0.7155 0.4109264
type:logdose  4 265.67  66.417  3.9462 0.0220552 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
             Df Sum Sq Mean Sq F value    Pr(>F)
bloc          3 538.79 179.597 10.6709 0.0005223 ***
type          1  12.04  12.042  0.7155 0.4109264
type:logdose  4 265.67  66.417  3.9462 0.0220552 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.7 Chapter 8

5.7.1 p269

(48) MODEL

```
p269 = read.csv("C:/G/Rt/SAS4lm/fev1uni.csv")
p269 = af(p269, c("drug", "hour", "patient"))
ANOVA(fev1 ~ drug + patient %in% drug + hour + drug:hour, p269) # p271 Output 8.3
```

```
$ANOVA
Response : fev1
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            92 296.65  3.2244  51.078 < 2.2e-16 ***
RESIDUALS       483  30.49  0.0631
CORRECTED TOTAL 575 327.14
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
             Df  Sum Sq Mean Sq F value    Pr(>F)
drug          2  25.783 12.8913 204.212 < 2.2e-16 ***
drug:patient 69 247.412  3.5857  56.801 < 2.2e-16 ***
hour          7  17.170  2.4529  38.857 < 2.2e-16 ***
drug:hour    14   6.280  0.4486   7.106 1.923e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
             Df  Sum Sq Mean Sq F value    Pr(>F)
drug          2  25.783 12.8913 204.212 < 2.2e-16 ***
drug:patient 69 247.412  3.5857  56.801 < 2.2e-16 ***
hour          7  17.170  2.4529  38.857 < 2.2e-16 ***
drug:hour    14   6.280  0.4486   7.106 1.923e-13 ***
---
```

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

$`Type III`
             Df  Sum Sq Mean Sq F value    Pr(>F)
drug          2  25.783 12.8913 204.212 < 2.2e-16 ***
drug:patient 69 247.412  3.5857  56.801 < 2.2e-16 ***
hour          7  17.170  2.4529  38.857 < 2.2e-16 ***
drug:hour    14   6.280  0.4486   7.106 1.923e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.8 Chapter 11

5.8.1 p390

(49) MODEL

```
p390 = read.table("C:/G/Rt/SAS4lm/p390.txt", header=TRUE)
p390$ca = ifelse(p390$a == 0, -1, 1)
p390$cb = ifelse(p390$b == 0, -1, 1)
p390$cc = ifelse(p390$c == 0, -1, 1)
p390 = af(p390, c("rep", "blk", "a", "b", "c"))
ANOVA(y ~ rep/blk + ca*cb*cc, p390)
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           12  81.75  6.8125  33.601 6.618e-07 ***
RESIDUALS       11   2.23  0.2027
CORRECTED TOTAL 23  83.98
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
         Df Sum Sq Mean Sq  F value    Pr(>F)
rep       2  0.051   0.025   0.1256 0.8832237
rep:blk   3  7.432   2.477  12.2194 0.0007966 ***
ca        1 21.075  21.075 103.9487 6.090e-07 ***
cb        1  0.005   0.005   0.0224 0.8837872
ca:cb     1  1.723   1.723   8.4969 0.0140640 *
cc        1 37.776  37.776 186.3209 3.063e-08 ***
ca:cc     1  2.318   2.318  11.4332 0.0061285 **
cb:cc     1 11.340  11.340  55.9328 1.232e-05 ***
ca:cb:cc  1  0.031   0.031   0.1511 0.7049490
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
         Df Sum Sq Mean Sq  F value    Pr(>F)
```

```
rep       2  0.051   0.025   0.1256  0.883224
rep:blk   3  1.668   0.556   2.7416  0.093789 .
ca        1 21.075  21.075 103.9487 6.090e-07 ***
cb        1  0.005   0.005   0.0224  0.883787
ca:cb     1  1.723   1.723   8.4969  0.014064 *
cc        1 37.776  37.776 186.3209 3.063e-08 ***
ca:cc     1  2.318   2.318  11.4332  0.006129 **
cb:cc     1 11.340  11.340  55.9328 1.232e-05 ***
ca:cb:cc  1  0.031   0.031   0.1511  0.704949
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df Sum Sq Mean Sq  F value    Pr(>F)
rep       2  0.051   0.025   0.1256  0.883224
rep:blk   3  1.668   0.556   2.7416  0.093789 .
ca        1 21.075  21.075 103.9487 6.090e-07 ***
cb        1  0.005   0.005   0.0224  0.883787
ca:cb     1  1.723   1.723   8.4969  0.014064 *
cc        1 37.776  37.776 186.3209 3.063e-08 ***
ca:cc     1  2.318   2.318  11.4332  0.006129 **
cb:cc     1 11.340  11.340  55.9328 1.232e-05 ***
ca:cb:cc  1  0.031   0.031   0.1511  0.704949
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.8.2 p394

(50) MODEL

```
p394 = read.table("C:/G/Rt/SAS4lm/p394.txt", header=TRUE)
p394 = af(p394, c("a", "b", "c", "d"))
ANOVA(y ~ ca*cb*cc*cd, p394)
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            7 6.3559 0.90798
RESIDUALS        0 0.0000
CORRECTED TOTAL  7 6.3559

$`Type I`
            Df  Sum Sq Mean Sq F value Pr(>F)
ca           1 2.07061 2.07061
cb           1 0.59951 0.59951
ca:cb        1 0.00031 0.00031
cc           1 0.00551 0.00551
ca:cc        1 0.80011 0.80011
cb:cc        1 2.82031 2.82031
```

```
ca:cb:cc     1 0.05951 0.05951
cd           0
ca:cd        0
cb:cd        0
ca:cb:cd     0
cc:cd        0
ca:cc:cd     0
cb:cc:cd     0
ca:cb:cc:cd  0

$`Type II`
            Df Sum Sq Mean Sq F value Pr(>F)
ca           0
cb           0
ca:cb        0
cc           0
ca:cc        0
cb:cc        0
ca:cb:cc     0
cd           0
ca:cd        0
cb:cd        0
ca:cb:cd     0
cc:cd        0
ca:cc:cd     0
cb:cc:cd     0
ca:cb:cc:cd  0

$`Type III`
CAUTION: Singularity Exists !
            Df Sum Sq Mean Sq F value Pr(>F)
ca           0
cb           0
ca:cb        0
cc           0
ca:cc        0
cb:cc        0
ca:cb:cc     0
cd           0
ca:cd        0
cb:cd        0
ca:cb:cd     0
cc:cd        0
ca:cc:cd     0
cb:cc:cd     0
ca:cb:cc:cd  0
```

(51) MODEL

```
ANOVA(y ~ a*b*c*d, p394)
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            7 6.3559 0.90798
RESIDUALS        0 0.0000
CORRECTED TOTAL  7 6.3559

$`Type I`
        Df  Sum Sq Mean Sq F value Pr(>F)
a        1 2.07061 2.07061
b        1 0.59951 0.59951
a:b      1 0.00031 0.00031
c        1 0.00551 0.00551
a:c      1 0.80011 0.80011
b:c      1 2.82031 2.82031
a:b:c    1 0.05951 0.05951
d        0
a:d      0
b:d      0
a:b:d    0
c:d      0
a:c:d    0
b:c:d    0
a:b:c:d  0

$`Type II`
        Df Sum Sq Mean Sq F value Pr(>F)
a        0
b        0
a:b      0
c        0
a:c      0
b:c      0
a:b:c    0
d        0
a:d      0
b:d      0
a:b:d    0
c:d      0
a:c:d    0
b:c:d    0
a:b:c:d  0

$`Type III`
CAUTION: Singularity Exists !
```

```
        Df Sum Sq Mean Sq F value Pr(>F)
a        0
b        0
a:b      0
c        0
a:c      0
b:c      0
a:b:c    0
d        0
a:d      0
b:d      0
a:b:d    0
c:d      0
a:c:d    0
b:c:d    0
a:b:c:d  0
```

5.8.3 p399

(52) MODEL

```
p399 = read.table("C:/G/Rt/SAS4lm/p399.txt", header=TRUE)
p399 = af(p399, c("blk", "trt"))
ANOVA(y ~ trt + blk, p399)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value   Pr(>F)
MODEL            8 281.127  35.141  40.822 0.005606 **
RESIDUALS        3   2.583   0.861
CORRECTED TOTAL 11 283.710
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value   Pr(>F)
trt  3 102.26  34.086  39.596 0.006515 **
blk  5 178.87  35.774  41.558 0.005691 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq F value   Pr(>F)
trt  3  59.018  19.673  22.853 0.014388 *
blk  5 178.871  35.774  41.558 0.005691 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
```

```
    Df  Sum Sq Mean Sq F value   Pr(>F)
trt  3  59.017  19.672  22.853 0.014388 *
blk  5 178.871  35.774  41.558 0.005691 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.8.4 p403

(53) MODEL

```
p403 = read.table("C:/G/Rt/SAS4lm/p403.txt", header=TRUE)
p403 = af(p403, c("PATIENT", "VISIT"))
ANOVA(HR ~ SEQUENCE + PATIENT %in% SEQUENCE + VISIT + DRUG + RESIDS + RESIDT, p403)
```

```
$ANOVA
Response : HR
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           29 6408.7  220.99   3.912 3.127e-05 ***
RESIDUALS       42 2372.6   56.49
CORRECTED TOTAL 71 8781.3
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
                 Df Sum Sq Mean Sq F value   Pr(>F)
SEQUENCE          5  508.9  101.79  1.8019 0.133346
SEQUENCE:PATIENT 18 4692.3  260.69  4.6147 2.21e-05 ***
VISIT             2  146.8   73.39  1.2991 0.283499
DRUG              2  668.8  334.39  5.9194 0.005435 **
RESIDS            1  391.0  391.02  6.9219 0.011854 *
RESIDT            1    0.8    0.84  0.0149 0.903511
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
                 Df Sum Sq Mean Sq F value   Pr(>F)
SEQUENCE          5  701.2 140.237  2.4825  0.04665 *
SEQUENCE:PATIENT 18 4692.3 260.685  4.6147 2.21e-05 ***
VISIT             2  146.8  73.389  1.2991  0.28350
DRUG              2  344.0 171.975  3.0443  0.05826 .
RESIDS            1  309.2 309.174  5.4731  0.02414 *
RESIDT            1    0.8   0.840  0.0149  0.90351
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
                 Df Sum Sq Mean Sq F value   Pr(>F)
SEQUENCE          5  701.2 140.237  2.4825  0.04665 *
SEQUENCE:PATIENT 18 4692.3 260.685  4.6147 2.21e-05 ***
```

```
VISIT             2  146.8  73.389  1.2991  0.28350
DRUG              2  343.9 171.975  3.0443  0.05826 .
RESIDS            1  309.2 309.174  5.4731  0.02414 *
RESIDT            1    0.8   0.840  0.0149  0.90351
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(HR ~ SEQUENCE + PATIENT %in% SEQUENCE + VISIT + DRUG + RESIDS + RESIDT,
         p403), type=3, singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: HR
                 Sum Sq Df F values   Pr(>F)
SEQUENCE            0.0  0
VISIT             146.8  2   1.2991  0.28350
DRUG              344.0  2   3.0443  0.05826 .
RESIDS            309.2  1   5.4731  0.02414 *
RESIDT              0.8  1   0.0149  0.90351
SEQUENCE:PATIENT 4692.3 18   4.6147 2.21e-05 ***
Residuals        2372.6 42
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.8.5 p409 11.5

(54) MODEL

```
p409 = read.table("C:/G/Rt/SAS4lm/p409.txt", header=TRUE)
ANOVA(TS ~ SOURCE*AMT, p409) # p410 Output 11.21
```

```
$ANOVA
Response : TS
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL            5 258.727  51.745  263.71 1.785e-09 ***
RESIDUALS        9   1.766   0.196
CORRECTED TOTAL 14 260.493
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
           Df  Sum Sq Mean Sq F value    Pr(>F)
SOURCE      2  98.001  49.001 249.720 1.306e-08 ***
AMT         1 138.245 138.245 704.534 7.392e-10 ***
SOURCE:AMT  2  22.481  11.240  57.284 7.595e-06 ***
---
```

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

$`Type II`
           Df  Sum Sq Mean Sq F value    Pr(>F)
SOURCE      2  98.001  49.001 249.720 1.306e-08 ***
AMT         1 138.245 138.245 704.534 7.392e-10 ***
SOURCE:AMT  2  22.481  11.240  57.284 7.595e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
           Df  Sum Sq Mean Sq F value    Pr(>F)
SOURCE      2   0.070   0.035   0.179     0.839
AMT         1 138.245 138.245 704.534 7.392e-10 ***
SOURCE:AMT  2  22.481  11.240  57.284 7.595e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.8.6 p412

(55) MODEL

```
p412 = read.table("C:/G/Rt/SAS4lm/p412.txt", header=TRUE)
ANOVA(ts ~ source:amt, p412) # p413 Output 11.24
```

```
$ANOVA
Response : ts
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            3 393.01 131.002  903.34 < 2.2e-16 ***
RESIDUALS       16   2.32   0.145
CORRECTED TOTAL 19 395.33
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
           Df Sum Sq Mean Sq F value    Pr(>F)
source:amt  3 393.01     131  903.34 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
           Df Sum Sq Mean Sq F value    Pr(>F)
source:amt  3 393.01     131  903.34 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
           Df Sum Sq Mean Sq F value    Pr(>F)
source:amt  3 393.01     131  903.34 < 2.2e-16 ***
```

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

5.8.7 p414

(56) MODEL

```
p414 = read.table("C:/G/Rt/SAS4lm/p414.txt", header=TRUE)
p414 = af(p414, c("lackofit"))
ANOVA(loglivcu ~ level + lackofit, p414) # p415 Output 11.26
```

```
$ANOVA
Response : loglivcu
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            3 5.2310 1.74365  155.47 5.018e-14 ***
RESIDUALS       20 0.2243 0.01122
CORRECTED TOTAL 23 5.4553
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df Sum Sq Mean Sq F value    Pr(>F)
level      1 4.9859  4.9859 444.555 3.997e-15 ***
lackofit   2 0.2450  0.1225  10.924 0.0006216 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df  Sum Sq Mean Sq F value    Pr(>F)
level      0
lackofit   2 0.24504 0.12252  10.924 0.0006216 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
          Df  Sum Sq Mean Sq F value    Pr(>F)
level      0
lackofit   2 0.24504 0.12252  10.924 0.0006216 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.8.8 p417

(57) MODEL

```
p417 = read.table("C:/G/Rt/SAS4lm/p417.txt", header=TRUE)
p417 = af(p417, c("TRT", "POT", "PLANT"))
ANOVA(Y ~ TRT + POT %in% TRT, p417) # p418 Output 11.28
```

```
$ANOVA
Response : Y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL            7 267.226  38.175  12.433 7.522e-05 ***
RESIDUALS       13  39.917   3.071
CORRECTED TOTAL 20 307.143
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
        Df  Sum Sq Mean Sq F value    Pr(>F)
TRT      2 236.921 118.460  38.580 3.412e-06 ***
TRT:POT  5  30.306   6.061   1.974    0.1499
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df  Sum Sq Mean Sq F value    Pr(>F)
TRT      2 236.921 118.460  38.580 3.412e-06 ***
TRT:POT  5  30.306   6.061   1.974    0.1499
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
        Df  Sum Sq Mean Sq F value    Pr(>F)
TRT      2 200.111 100.055  32.586 8.626e-06 ***
TRT:POT  5  30.306   6.061   1.974    0.1499
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(Y ~ TRT + POT %in% TRT, p417), type=3, singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Y
          Sum Sq Df F values  Pr(>F)
TRT       22.310  1    7.266 0.01835 *
TRT:POT   30.306  5    1.974 0.14991
Residuals 39.917 13
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.8.9 p431

(58) MODEL

```
p431 = read.table("C:/G/Rt/SAS4lm/p431.txt", header=TRUE)
p431 = af(p431, c("line", "sire", "agedam", "steerno"))
ANOVA(avdlygn ~ line + line:sire + agedam + line:agedam + age + intlwt, p431)
```

```
$ANOVA
Response : avdlygn
                Df Sum Sq  Mean Sq F value   Pr(>F)
MODEL           16 2.5275 0.157966  3.1437 0.001091 **
RESIDUALS       48 2.4119 0.050248
CORRECTED TOTAL 64 4.9394
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
            Df  Sum Sq  Mean Sq F value  Pr(>F)
line         2 0.38009 0.190046  3.7821 0.02983 *
line:sire    6 0.92634 0.154391  3.0726 0.01260 *
agedam       2 0.11894 0.059471  1.1835 0.31497
line:agedam  4 0.64889 0.162222  3.2284 0.02000 *
age          1 0.18349 0.183487  3.6516 0.06200 .
intlwt       1 0.26970 0.269704  5.3674 0.02483 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df  Sum Sq Mean Sq F value   Pr(>F)
line         2 0.05526 0.02763  0.5498 0.580636
line:sire    6 0.97389 0.16231  3.2303 0.009543 **
agedam       2 0.33106 0.16553  3.2943 0.045640 *
line:agedam  4 0.45343 0.11336  2.2560 0.076821 .
age          1 0.38128 0.38128  7.5878 0.008277 **
intlwt       1 0.26970 0.26970  5.3674 0.024830 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
            Df  Sum Sq Mean Sq F value   Pr(>F)
line         2 0.13620 0.06810  1.3553 0.267560
line:sire    6 0.97389 0.16231  3.2303 0.009543 **
agedam       2 0.13011 0.06505  1.2946 0.283392
line:agedam  4 0.45343 0.11336  2.2560 0.076821 .
age          1 0.38128 0.38128  7.5878 0.008277 **
intlwt       1 0.26970 0.26970  5.3674 0.024830 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# p433 Output 11.40
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(avdlygn ~ line + line:sire + agedam + line:agedam + age + intlwt, p431),
      type=3, singular.ok=TRUE) # NOT OK for line
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison
Anova Table (Type III tests)

Response: avdlygn
             Sum Sq Df F values   Pr(>F)
line        0.00000  0
agedam      0.13011  2   1.2946 0.283392
age         0.38128  1   7.5878 0.008277 **
intlwt      0.26970  1   5.3674 0.024830 *
line:sire   0.97389  6   3.2303 0.009543 **
line:agedam 0.45343  4   2.2560 0.076821 .
Residuals   2.41192 48
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(59) MODEL

```
ANOVA(avdlygn ~ sire + agedam, p431) # # p434 Output 11.41
```

```
$ANOVA
Response : avdlygn
                Df Sum Sq  Mean Sq F value  Pr(>F)
MODEL           10 1.4254 0.142538  2.1904 0.03237 *
RESIDUALS       54 3.5140 0.065074
CORRECTED TOTAL 64 4.9394
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df  Sum Sq  Mean Sq F value  Pr(>F)
sire    8 1.30644 0.163305  2.5095 0.02138 *
agedam  2 0.11894 0.059471  0.9139 0.40707
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
       Df  Sum Sq  Mean Sq F value  Pr(>F)
sire    8 1.33017 0.166271  2.5551 0.01937 *
agedam  2 0.11894 0.059471  0.9139 0.40707
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
```

```
       Df  Sum Sq  Mean Sq F value  Pr(>F)
sire    8 1.33017 0.166271  2.5551 0.01937 *
agedam  2 0.11894 0.059471  0.9139 0.40707
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5.8.10 p437 ABSORB option in SAS

(60) MODEL

```
ANOVA(avdlygn ~ line + sire + agedam + line:agedam + age + intlwt, p431)
```

```
$ANOVA
Response : avdlygn
                Df Sum Sq  Mean Sq F value   Pr(>F)
MODEL           16 2.5275 0.157966  3.1437 0.001091 **
RESIDUALS       48 2.4119 0.050248
CORRECTED TOTAL 64 4.9394
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
            Df  Sum Sq  Mean Sq F value  Pr(>F)
line         2 0.38009 0.190046  3.7821 0.02983 *
sire         6 0.92634 0.154391  3.0726 0.01260 *
agedam       2 0.11894 0.059471  1.1835 0.31497
line:agedam  4 0.64889 0.162222  3.2284 0.02000 *
age          1 0.18349 0.183487  3.6516 0.06200 .
intlwt       1 0.26970 0.269704  5.3674 0.02483 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df  Sum Sq Mean Sq F value   Pr(>F)
line         0
sire         6 0.97389 0.16231  3.2303 0.009543 **
agedam       2 0.33106 0.16553  3.2943 0.045640 *
line:agedam  4 0.45343 0.11336  2.2560 0.076821 .
age          1 0.38128 0.38128  7.5878 0.008277 **
intlwt       1 0.26970 0.26970  5.3674 0.024830 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
            Df  Sum Sq Mean Sq F value   Pr(>F)
line         0
sire         6 0.97389 0.16231  3.2303 0.009543 **
agedam       2 0.13011 0.06505  1.2946 0.283392
```

```
line:agedam  4 0.45343 0.11336  2.2560 0.076821 .
age          1 0.38128 0.38128  7.5878 0.008277 **
intlwt       1 0.26970 0.26970  5.3674 0.024830 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# p437 Output 11.43
```

6 Sahai - Unbalanced

Reference

- Sahai H, Ojeda MM. Analysis of Variance for Random Models Volume 2 Unbalanced Data. 2005.

6.1 Table 11.2

(61) MODEL

```
T11.2 = read.table("C:/G/Rt/ANOVA/T11.2.txt")
colnames(T11.2) = c("Group", "Y")
T11.2 = af(T11.2, "Group")
ANOVA(Y ~ Group, T11.2) # p115
```

```
$ANOVA
Response : Y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL            4  80.401 20.1003  5.9884 0.0004103 ***
RESIDUALS       59 198.036  3.3565
CORRECTED TOTAL 63 278.438
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
Group  4 80.401    20.1  5.9884 0.0004103 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
Group  4 80.401    20.1  5.9884 0.0004103 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq F value    Pr(>F)
Group  4 80.401    20.1  5.9884 0.0004103 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

6.2 Table 12.6

(62) MODEL

```
T12.6 = read.table("C:/G/Rt/ANOVA/T12.6.txt")
colnames(T12.6) = c("Location", "Family", "Y")
T12.6 = af(T12.6, c("Location", "Family"))
ANOVA(Y ~ Location + Family, T12.6) # p184
```

```
$ANOVA
Response : Y
                Df Sum Sq  Mean Sq F value    Pr(>F)
MODEL            7 1.6144 0.230636  8.9562 7.223e-07 ***
RESIDUALS       45 1.1588 0.025752
CORRECTED TOTAL 52 2.7733
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
         Df  Sum Sq Mean Sq F value    Pr(>F)
Location  3 0.74036 0.24679  9.5833 5.219e-05 ***
Family    4 0.87410 0.21852  8.4859 3.436e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
         Df  Sum Sq Mean Sq F value    Pr(>F)
Location  3 0.83765 0.27921 10.8426 1.753e-05 ***
Family    4 0.87410 0.21852  8.4859 3.436e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
         Df  Sum Sq Mean Sq F value    Pr(>F)
Location  3 0.83765 0.27921 10.8426 1.753e-05 ***
Family    4 0.87410 0.21852  8.4859 3.436e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

6.3 Table 13.6

(63) MODEL

```
T13.6 = read.table("C:/G/Rt/ANOVA/T13.6.txt")
colnames(T13.6) = c("Site", "Worker", "Y")
T13.6 = af(T13.6, c("Site", "Worker"))
ANOVA(Y ~ Site + Worker + Site:Worker, T13.6)
```

```
$ANOVA
Response : Y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           11 2643.11 240.283  60.323 < 2.2e-16 ***
RESIDUALS       35  139.42   3.983
CORRECTED TOTAL 46 2782.52
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
```

```
            Df  Sum Sq Mean Sq F value    Pr(>F)
Site         2 1281.55  640.77 160.866 < 2.2e-16 ***
Worker       3  399.27  133.09  33.412 2.234e-10 ***
Site:Worker  6  962.29  160.38  40.264 2.720e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df  Sum Sq Mean Sq F value    Pr(>F)
Site         2 1322.24  661.12 165.973 < 2.2e-16 ***
Worker       3  399.27  133.09  33.412 2.234e-10 ***
Site:Worker  6  962.29  160.38  40.264 2.720e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
            Df Sum Sq Mean Sq F value    Pr(>F)
Site         2 804.83  402.42 101.026 2.887e-15 ***
Worker       3 430.88  143.63  36.058 8.310e-11 ***
Site:Worker  6 962.29  160.38  40.264 2.720e-14 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

6.4 Table 14.2

(64) MODEL

```
T14.2 = read.csv("C:/G/Rt/ANOVA/T14.2.csv")
T14.2 = T14.2[!is.na(T14.2$Y),]
T14.2 = af(T14.2, c("Day", "Machine", "Operator"))
ANOVA(Y ~ Day + Machine + Operator, T14.2)
```

```
$ANOVA
Response : Y
                 Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL             7  6345.4  906.48  8.1297 5.931e-08 ***
RESIDUALS       110 12265.3  111.50
CORRECTED TOTAL 117 18610.6
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df Sum Sq Mean Sq F value    Pr(>F)
Day        2 3737.8 1868.90 16.7611 4.426e-07 ***
Machine    2 2440.7 1220.33 10.9445 4.625e-05 ***
Operator   3  166.9   55.63  0.4989    0.6838
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
         Df Sum Sq Mean Sq F value    Pr(>F)
Day       2 3795.1 1897.56 17.0181 3.636e-07 ***
Machine   2 2464.8 1232.39 11.0526 4.227e-05 ***
Operator  3  166.9   55.63  0.4989    0.6838
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
         Df Sum Sq Mean Sq F value    Pr(>F)
Day       2 3795.1 1897.56 17.0181 3.636e-07 ***
Machine   2 2464.8 1232.39 11.0526 4.227e-05 ***
Operator  3  166.9   55.63  0.4989    0.6838
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

6.5 Table 15.3

(65) MODEL

```
T15.3 = read.table("C:/G/Rt/ANOVA/T15.3.txt")
colnames(T15.3) = c("Dam", "Sire", "pH")
T15.3 = af(T15.3, c("Dam", "Sire"))
ANOVA(pH ~ Dam/Sire, T15.3) # p301
```

```
$ANOVA
Response : pH
                 Df  Sum Sq   Mean Sq F value  Pr(>F)
MODEL            36 0.25804 0.0071678  2.8977 7.2e-06 ***
RESIDUALS       123 0.30425 0.0024736
CORRECTED TOTAL 159 0.56229
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
         Df   Sum Sq   Mean Sq F value    Pr(>F)
Dam      14 0.178017 0.0127155  5.1405 1.563e-07 ***
Dam:Sire 22 0.080024 0.0036374  1.4705   0.09662 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
         Df   Sum Sq   Mean Sq F value    Pr(>F)
Dam      14 0.178017 0.0127155  5.1405 1.563e-07 ***
Dam:Sire 22 0.080024 0.0036374  1.4705   0.09662 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
```

```
          Df    Sum Sq   Mean Sq F value    Pr(>F)
Dam       14 0.179405 0.0128146  5.1805 1.347e-07 ***
Dam:Sire  22 0.080024 0.0036374  1.4705   0.09662 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts = c("contr.sum", "contr.poly"))
Anova(lm(pH ~ Dam/Sire, T15.3), type=3, singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: pH
            Sum Sq  Df F values    Pr(>F)
Dam       0.081011   6   5.4584 4.898e-05 ***
Dam:Sire  0.080024  22   1.4705   0.09662 .
Residuals 0.304253 123
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

6.6 Table 16.3

(66) MODEL

```
T16.3 = read.csv("C:/G/Rt/ANOVA/T16.3.csv")
colnames(T16.3) = c("Plot", "Sample", "Subsample", "Residue")
T16.3 = af(T16.3, c("Plot", "Sample", "Subsample"))
ANOVA(Residue ~ Plot/Sample/Subsample, T16.3) # p344
```

```
$ANOVA
Response : Residue
                Df Sum Sq  Mean Sq F value    Pr(>F)
MODEL           54 3.1897 0.059069  5.8842 1.476e-05 ***
RESIDUALS       22 0.2208 0.010039
CORRECTED TOTAL 76 3.4106
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
                      Df  Sum Sq  Mean Sq F value    Pr(>F)
Plot                  10 1.84041 0.184041 18.3332 1.929e-08 ***
Plot:Sample           22 0.99175 0.045079  4.4906 0.0004209 ***
Plot:Sample:Subsample 22 0.35757 0.016253  1.6191 0.1330632
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
                      Df  Sum Sq  Mean Sq F value    Pr(>F)
```

```
Plot                  10 1.84041 0.184041 18.3332 1.929e-08 ***
Plot:Sample           22 0.99175 0.045079  4.4906 0.0004209 ***
Plot:Sample:Subsample 22 0.35757 0.016253  1.6191 0.1330632
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
                      Df  Sum Sq  Mean Sq F value    Pr(>F)
Plot                  10 1.78686 0.178686 17.7998 2.547e-08 ***
Plot:Sample           22 0.99175 0.045079  4.4906 0.0004209 ***
Plot:Sample:Subsample 22 0.35757 0.016253  1.6191 0.1330632
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
options(contrasts = c("contr.sum", "contr.poly"))
Anova(lm(Residue ~ Plot/Sample/Subsample, T16.3), type=3, singular.ok=TRUE)
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Residue
                       Sum Sq Df F values  Pr(>F)
Plot                  0.00000  0
Plot:Sample           0.36613 11   3.3156 0.00805 **
Plot:Sample:Subsample 0.35758 22   1.6191 0.13306
Residuals             0.22085 22
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
# NOT OK
```

7 Federer - Variations

Reference

- Federer WT, King F. Variations on Split Plot and Split Block Experiment Designs. John Wiley & Sons Inc. 2007.

7.1 Example 1.1

(67) MODEL

```
ex1.1 = read.table("C:/G/Rt/Split/Ex1.1-spex1.txt", header=TRUE)
ex1.1 = af(ex1.1, c("R", "A", "B"))
ANOVA(Y ~ R + A + R:A + B + A:B, ex1.1)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           27 4905.7 181.694   10.75 1.994e-10 ***
RESIDUALS       36  608.5  16.902
CORRECTED TOTAL 63 5514.2
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3  223.8   74.60  4.4138   0.00963 **
A    3  194.6   64.85  3.8370   0.01756 *
R:A  9  158.2   17.58  1.0402   0.42842
B    3 4107.4 1369.13 81.0030 4.441e-16 ***
A:B  9  221.7   24.64  1.4577   0.20117
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3  223.8   74.60  4.4138   0.00963 **
A    3  194.6   64.85  3.8370   0.01756 *
R:A  9  158.2   17.58  1.0402   0.42842
B    3 4107.4 1369.13 81.0030 4.441e-16 ***
A:B  9  221.7   24.64  1.4577   0.20117
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3  223.8   74.60  4.4138   0.00963 **
A    3  194.6   64.85  3.8370   0.01756 *
R:A  9  158.2   17.58  1.0402   0.42842
```

```
B    3 4107.4 1369.13 81.0030 4.441e-16 ***
A:B  9  221.7   24.64  1.4577   0.20117
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.2 Example 1.2

(68) MODEL

```
ex1.2 = read.table("C:/G/Rt/Split/Ex1.2-spex2.txt", header=TRUE)
ex1.2 = af(ex1.2, c("R", "A", "B"))
ANOVA(Y ~ R + A + R:A + B + A:B, ex1.2)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           47  35573  756.88  31.243 < 2.2e-16 ***
RESIDUALS       48   1163   24.23
CORRECTED TOTAL 95  36736
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
R    2    38.6    19.3   0.7963 0.4568480
A    7   763.2   109.0   4.5003 0.0006418 ***
R:A 14  1377.2    98.4   4.0608 0.0001343 ***
B    3 30774.3 10258.1 423.4386 < 2.2e-16 ***
A:B 21  2620.1   124.8   5.1502 1.327e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
R    2    38.6    19.3   0.7963 0.4568480
A    7   763.2   109.0   4.5003 0.0006418 ***
R:A 14  1377.2    98.4   4.0608 0.0001343 ***
B    3 30774.3 10258.1 423.4386 < 2.2e-16 ***
A:B 21  2620.1   124.8   5.1502 1.327e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
R    2    38.6    19.3   0.7963 0.4568480
A    7   763.2   109.0   4.5003 0.0006418 ***
R:A 14  1377.2    98.4   4.0608 0.0001343 ***
B    3 30774.3 10258.1 423.4386 < 2.2e-16 ***
A:B 21  2620.1   124.8   5.1502 1.327e-06 ***
```

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

7.3 Example 2.1

(69) MODEL

```
ex2.1 = read.table("C:/G/Rt/Split/sbex.txt", header=TRUE)
colnames(ex2.1) = c("Y", "R", "A", "B")
ex2.1 = af(ex2.1, c("R", "A", "B"))
ANOVA(Y ~ R + A + R:A + B + R:B + A:B, ex2.1)
```

```
$ANOVA
Response : Y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           41 274.750  6.7012  5.1475 0.0002305 ***
RESIDUALS       18  23.433  1.3019
CORRECTED TOTAL 59 298.183
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    1  2.817  2.8167  2.1636 0.1585807
A    9 77.683  8.6315  6.6302 0.0003456 ***
R:A  9 81.017  9.0019  6.9147 0.0002658 ***
B    2 35.433 17.7167 13.6088 0.0002510 ***
R:B  2 16.233  8.1167  6.2347 0.0087635 **
A:B 18 61.567  3.4204  2.6273 0.0236253 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    1  2.817  2.8167  2.1636 0.1585807
A    9 77.683  8.6315  6.6302 0.0003456 ***
R:A  9 81.017  9.0019  6.9147 0.0002658 ***
B    2 35.433 17.7167 13.6088 0.0002510 ***
R:B  2 16.233  8.1167  6.2347 0.0087635 **
A:B 18 61.567  3.4204  2.6273 0.0236253 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    1  2.817  2.8167  2.1636 0.1585807
A    9 77.683  8.6315  6.6302 0.0003456 ***
R:A  9 81.017  9.0019  6.9147 0.0002658 ***
B    2 35.433 17.7167 13.6088 0.0002510 ***
```

```
R:B  2 16.233  8.1167  6.2347 0.0087635 **
A:B 18 61.567  3.4204  2.6273 0.0236253 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.4 Example 2.2

(70) MODEL

```
ex2.2 = read.table("C:/G/Rt/Split/sbex2_2.txt", header=TRUE)
ex2.2 = af(ex2.2, c("Row", "Column", "R", "S"))
ANOVA(Y ~ Column + R + R:Column + S + S:Column + R:S, ex2.2)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           51  10328  202.51  0.8112 0.7688
RESIDUALS       48  11982  249.63
CORRECTED TOTAL 99  22310

$`Type I`
         Df Sum Sq Mean Sq F value Pr(>F)
Column    4 1318.6  329.66  1.3206 0.2758
R         4 1159.8  289.94  1.1615 0.3396
Column:R 16 2808.6  175.54  0.7032 0.7766
S         3  351.9  117.29  0.4699 0.7047
Column:S 12 3863.3  321.94  1.2897 0.2555
R:S      12  826.0   68.83  0.2757 0.9906

$`Type II`
         Df Sum Sq Mean Sq F value Pr(>F)
Column    4 1318.6  329.66  1.3206 0.2758
R         4 1159.8  289.94  1.1615 0.3396
Column:R 16 2808.6  175.54  0.7032 0.7766
S         3  351.9  117.29  0.4699 0.7047
Column:S 12 3863.3  321.94  1.2897 0.2555
R:S      12  826.0   68.83  0.2757 0.9906

$`Type III`
         Df Sum Sq Mean Sq F value Pr(>F)
Column    4 1318.6  329.66  1.3206 0.2758
R         4 1159.8  289.94  1.1615 0.3396
Column:R 16 2808.6  175.54  0.7032 0.7766
S         3  351.9  117.29  0.4699 0.7047
Column:S 12 3863.3  321.94  1.2897 0.2555
R:S      12  826.0   68.83  0.2757 0.9906
```

(71) MODEL

```
ANOVA(Y ~ Row + R + Row:R + S + Column:S + R:S + Column:R:S, ex2.2)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           99  22310  225.36
RESIDUALS        0      0
CORRECTED TOTAL 99  22310

$`Type I`
           Df  Sum Sq Mean Sq F value Pr(>F)
Row         4   147.4   36.86
R           4  1159.8  289.94
Row:R      16  3979.8  248.74
S           3   351.9  117.29
S:Column   12  3863.3  321.94
R:S        12   826.0   68.83
R:S:Column 48 11982.3  249.63

$`Type II`
           Df  Sum Sq Mean Sq F value Pr(>F)
Row         0
R           4  1159.8  289.94
Row:R       0
S           3   351.9  117.29
S:Column   12  3863.3  321.94
R:S        12   826.0   68.83
R:S:Column 48 11982.3  249.63

$`Type III`
CAUTION: Singularity Exists !
           Df  Sum Sq Mean Sq F value Pr(>F)
Row         0
R           4  1159.8  289.94
Row:R       0
S           3   351.9  117.29
S:Column   12  3863.3  321.94
R:S        12   826.0   68.83
R:S:Column 48 11982.3  249.63
```

(72) MODEL

```
ANOVA(Y ~ Row + R + S + R:S + Row:R + Column:S + Column:R:S, ex2.2)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           99  22310  225.36
RESIDUALS        0      0
```

```
CORRECTED TOTAL 99  22310

$`Type I`
           Df  Sum Sq Mean Sq F value Pr(>F)
Row         4   147.4   36.86
R           4  1159.8  289.94
S           3   351.9  117.29
R:S        12   826.0   68.83
Row:R      16  3979.8  248.74
S:Column   12  3863.3  321.94
R:S:Column 48 11982.3  249.63

$`Type II`
           Df  Sum Sq Mean Sq F value Pr(>F)
Row         0
R           4  1159.8  289.94
S           3   351.9  117.29
R:S        12   826.0   68.83
Row:R       0
S:Column   12  3863.3  321.94
R:S:Column 48 11982.3  249.63

$`Type III`
CAUTION: Singularity Exists !
           Df  Sum Sq Mean Sq F value Pr(>F)
Row         0
R           4  1159.8  289.94
S           3   351.9  117.29
R:S        12   826.0   68.83
Row:R       0
S:Column   12  3863.3  321.94
R:S:Column 48 11982.3  249.63
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(Y ~ Row + R + S + R:S + Row:R + Column:S + Column:R:S, ex2.2), type=3,
      singular.ok=TRUE) # NOT WORKING
```

7.5 Example 3.1

(73) MODEL

```
ex3.1 = read.table("C:/G/Rt/Split/spedsite.txt", header=TRUE)
ex3.1 = af(ex3.1, c("Site", "A", "B", "C", "Block"))
ANOVA(Yield ~ Site + Site:Block + A + B + A:B + A:Site + B:Site + A:B:Site +
    A:B:Site:Block + C + A:C + B:C + A:B:C + C:Site + A:C:Site + B:C:Site +
    A:B:C:Site, ex3.1)
```

```
$ANOVA
Response : Yield
```

```
                 Df     Sum Sq  Mean Sq F value    Pr(>F)
MODEL           239 2724374186 11399055  23.682 < 2.2e-16 ***
RESIDUALS       240  115521933   481341
CORRECTED TOTAL 479 2839896119
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
               Df     Sum Sq   Mean Sq  F value  Pr(>F)
Site            3  621230991 207076997 430.2082 < 2e-16 ***
Site:Block      8 1305369943 163171243 338.9928 < 2e-16 ***
A               1    1333205   1333205   2.7698 0.09737 .
B               4   47928577  11982144  24.8932 < 2e-16 ***
A:B             4      14849      3712   0.0077 0.99988
Site:A          3      33010     11003   0.0229 0.99531
Site:B         12      37932      3161   0.0066 1.00000
Site:A:B       12      11494       958   0.0020 1.00000
Site:Block:A:B 72    8239680    114440   0.2378 1.00000
C               3  739890389 246630130 512.3809 < 2e-16 ***
A:C             3       3233      1078   0.0022 0.99985
B:C            12      34961      2913   0.0061 1.00000
A:B:C          12      11077       923   0.0019 1.00000
Site:C          9      25983      2887   0.0060 1.00000
Site:A:C        9      22227      2470   0.0051 1.00000
Site:B:C       36      88610      2461   0.0051 1.00000
Site:A:B:C     36      98025      2723   0.0057 1.00000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
               Df     Sum Sq   Mean Sq  F value  Pr(>F)
Site            3  621230991 207076997 430.2082 < 2e-16 ***
Site:Block      8 1305369943 163171243 338.9928 < 2e-16 ***
A               1    1333205   1333205   2.7698 0.09737 .
B               4   47928577  11982144  24.8932 < 2e-16 ***
A:B             4      14849      3712   0.0077 0.99988
Site:A          3      33010     11003   0.0229 0.99531
Site:B         12      37932      3161   0.0066 1.00000
Site:A:B       12      11494       958   0.0020 1.00000
Site:Block:A:B 72    8239680    114440   0.2378 1.00000
C               3  739890389 246630130 512.3809 < 2e-16 ***
A:C             3       3233      1078   0.0022 0.99985
B:C            12      34961      2913   0.0061 1.00000
A:B:C          12      11077       923   0.0019 1.00000
Site:C          9      25983      2887   0.0060 1.00000
Site:A:C        9      22227      2470   0.0051 1.00000
Site:B:C       36      88610      2461   0.0051 1.00000
Site:A:B:C     36      98025      2723   0.0057 1.00000
```

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

$`Type III`
               Df     Sum Sq   Mean Sq  F value  Pr(>F)
Site            3  621230991 207076997 430.2082 < 2e-16 ***
Site:Block      8 1305369943 163171243 338.9928 < 2e-16 ***
A               1    1333205   1333205   2.7698 0.09737 .
B               4   47928577  11982144  24.8932 < 2e-16 ***
A:B             4      14849      3712   0.0077 0.99988
Site:A          3      33010     11003   0.0229 0.99531
Site:B         12      37932      3161   0.0066 1.00000
Site:A:B       12      11494       958   0.0020 1.00000
Site:Block:A:B 72    8239680    114440   0.2378 1.00000
C               3  739890389 246630130 512.3809 < 2e-16 ***
A:C             3       3233      1078   0.0022 0.99985
B:C            12      34961      2913   0.0061 1.00000
A:B:C          12      11077       923   0.0019 1.00000
Site:C          9      25983      2887   0.0060 1.00000
Site:A:C        9      22227      2470   0.0051 1.00000
Site:B:C       36      88610      2461   0.0051 1.00000
Site:A:B:C     36      98025      2723   0.0057 1.00000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(74) MODEL

```
ex3.1a = read.table("C:/G/Rt/Split/Ex3.1-example.txt", header=TRUE)
ex3.1a = af(ex3.1a, c("row", "P", "column", "R", "S"))
ANOVA(height ~ P + column + column:P + R + P:R + column:R + column:R:P + S +
   P:S + column:S + column:S:P + R:S + R:S:column + R:S:P + R:S:P:column, ex3.1a)
```

```
$ANOVA
Response : height
                 Df Sum Sq Mean Sq F value Pr(>F)
MODEL           199 7534.8  37.863
RESIDUALS         0    0.0
CORRECTED TOTAL 199 7534.8

$`Type I`
             Df Sum Sq Mean Sq F value Pr(>F)
P             1  253.1 253.125
column        4  109.4  27.357
P:column      4  207.9  51.987
R             4   90.6  22.657
P:R           4  505.0 126.238
column:R     16 3357.8 209.864
P:column:R   16 1442.6  90.163
S             3   16.4   5.458
```

```
P:S           3   14.3   4.765
column:S     12  265.4  22.121
P:column:S   12   96.5   8.044
R:S          12  195.1  16.254
column:R:S   48  365.5   7.615
P:R:S        12  100.3   8.361
P:column:R:S 48  514.7  10.723

$`Type II`
             Df Sum Sq Mean Sq F value Pr(>F)
P             1  253.1 253.125
column        4  109.4  27.358
P:column      4  208.0  51.988
R             4   90.6  22.657
P:R           4  504.9 126.237
column:R     16 3357.8 209.864
P:column:R   16 1442.6  90.162
S             3   16.4   5.458
P:S           3   14.3   4.765
column:S     12  265.5  22.121
P:column:S   12   96.5   8.044
R:S          12  195.0  16.254
column:R:S   48  365.5   7.615
P:R:S        12  100.3   8.361
P:column:R:S 48  514.7  10.723

$`Type III`
             Df Sum Sq Mean Sq F value Pr(>F)
P             1  253.1 253.125
column        4  109.4  27.358
P:column      4  208.0  51.988
R             4   90.6  22.657
P:R           4  505.0 126.238
column:R     16 3357.8 209.864
P:column:R   16 1442.6  90.163
S             3   16.4   5.458
P:S           3   14.3   4.765
column:S     12  265.4  22.121
P:column:S   12   96.5   8.044
R:S          12  195.0  16.254
column:R:S   48  365.5   7.615
P:R:S        12  100.3   8.361
P:column:R:S 48  514.7  10.723
```

(75) MODEL

```
ANOVA(height ~ row + R + P + S + S:R + row:P + R:P + row:R:P + S:P + S:P:row +
    S:R:P + R:S:P:row, ex3.1a)
```

```
$ANOVA
Response : height
                 Df Sum Sq Mean Sq F value Pr(>F)
MODEL           199 7534.8  37.863
RESIDUALS         0    0.0
CORRECTED TOTAL 199 7534.8

$`Type I`
          Df  Sum Sq Mean Sq F value Pr(>F)
row        4 2017.03  504.26
R          4   90.63   22.66
P          1  253.12  253.12
S          3   16.38    5.46
R:S       12  195.05   16.25
row:P      4  167.25   41.81
R:P        4  504.95  126.24
row:R:P   32 2933.52   91.67
P:S        3   14.29    4.76
row:P:S   24  234.68    9.78
R:P:S     12  100.33    8.36
row:R:P:S 96 1007.52   10.49

$`Type II`
          Df  Sum Sq Mean Sq F value Pr(>F)
row        4 2017.03  504.26
R          4   90.63   22.66
P          1  253.12  253.12
S          3   16.38    5.46
R:S       12  195.05   16.25
row:P      4  167.25   41.81
R:P        4  504.95  126.24
row:R:P   32 2933.52   91.67
P:S        3   14.29    4.76
row:P:S   24  234.68    9.78
R:P:S     12  100.33    8.36
row:R:P:S 96 1007.52   10.49

$`Type III`
          Df  Sum Sq Mean Sq F value Pr(>F)
row        4 2017.03  504.26
R          4   90.63   22.66
P          1  253.12  253.12
S          3   16.38    5.46
R:S       12  195.05   16.25
row:P      4  167.25   41.81
R:P        4  504.95  126.24
row:R:P   32 2933.52   91.67
P:S        3   14.30    4.77
```

```
row:P:S   24  234.68    9.78
R:P:S     12  100.33    8.36
row:R:P:S 96 1007.52   10.50
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(height ~ row + R + P + S + S:R + row:P + R:P + row:R:P + S:P +
         S:P:row + S:R:P + R:S:P:row, ex3.1a), type=3, singular.ok=TRUE)
         # NOT WORKING
```

```
alias(height ~ row + R + P + S + S:R + row:P + R:P + row:R:P + S:P + S:P:row +
    S:R:P + R:S:P:row, ex3.1a) # NO ALIAS
```

```
Model :
height ~ row + R + P + S + S:R + row:P + R:P + row:R:P + S:P +
    S:P:row + S:R:P + R:S:P:row
```

(76) MODEL

- p94 Appendix 3.1

```
ex3.1b = read.table("C:/G/Rt/Split/spexvar3.txt", header=TRUE)
ex3.1b = af(ex3.1b, c("rep", "var", "nit", "row", "col"))
ANOVA(yield ~ rep + var + rep:var + nit + var:nit, ex3.1b)
```

```
$ANOVA
Response : yield
               Df Sum Sq Mean Sq F value    Pr(>F)
MODEL          26  44017 1692.97  9.5603 4.779e-11 ***
RESIDUALS      45   7969  177.08
CORRECTED TOTAL 71  51986
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
        Df  Sum Sq Mean Sq F value    Pr(>F)
rep      5 15875.3  3175.1 17.9297 9.525e-10 ***
var      2  1786.4   893.2  5.0438  0.010557 *
rep:var 10  6013.3   601.3  3.3957  0.002251 **
nit      3 20020.5  6673.5 37.6856 2.458e-12 ***
var:nit  6   321.7    53.6  0.3028  0.932199
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df  Sum Sq Mean Sq F value    Pr(>F)
rep      5 15875.3  3175.1 17.9297 9.525e-10 ***
var      2  1786.4   893.2  5.0438  0.010557 *
rep:var 10  6013.3   601.3  3.3957  0.002251 **
nit      3 20020.5  6673.5 37.6856 2.458e-12 ***
var:nit  6   321.7    53.6  0.3028  0.932199
---
```

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

$`Type III`
        Df  Sum Sq Mean Sq F value    Pr(>F)
rep      5 15875.3  3175.1 17.9297 9.525e-10 ***
var      2  1786.4   893.2  5.0438  0.010557 *
rep:var 10  6013.3   601.3  3.3957  0.002251 **
nit      3 20020.5  6673.5 37.6856 2.458e-12 ***
var:nit  6   321.7    53.6  0.3028  0.932199
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(77) MODEL

```
ANOVA(yield ~ rep + var + rep:var + nit + var:nit + row + col, ex3.1b)

$ANOVA
Response : yield
               Df Sum Sq Mean Sq F value    Pr(>F)
MODEL          37  48090  1299.7  11.341 6.734e-11 ***
RESIDUALS      34   3896   114.6
CORRECTED TOTAL 71  51986
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
        Df  Sum Sq Mean Sq F value    Pr(>F)
rep      5 15875.3  3175.1 27.7056 4.391e-11 ***
var      2  1786.4   893.2  7.7939 0.0016359 **
rep:var 10  6013.3   601.3  5.2472 0.0001207 ***
nit      3 20020.5  6673.5 58.2331 1.754e-13 ***
var:nit  6   321.7    53.6  0.4679 0.8271333
row      9   900.9   100.1  0.8734 0.5575581
col      2  3171.5  1585.7 13.8373 4.012e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df  Sum Sq Mean Sq F value    Pr(>F)
rep      2  5942.5  2971.3 25.9273 1.449e-07 ***
var      2  2799.8  1399.9 12.2155 0.0001005 ***
rep:var  4   997.8   249.4  2.1767 0.0926008 .
nit      3 12559.3  4186.4 36.5308 9.683e-11 ***
var:nit  6   477.8    79.6  0.6949 0.6553307
row      9   945.0   105.0  0.9162 0.5230151
col      2  3171.5  1585.7 13.8373 4.012e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
CAUTION: Singularity Exists !
        Df  Sum Sq Mean Sq F value    Pr(>F)
rep      2  5942.5  2971.3 25.9273 1.449e-07 ***
var      2  2799.8  1399.9 12.2155 0.0001005 ***
rep:var  4   997.8   249.4  2.1767 0.0926008 .
nit      3 11977.9  3992.6 34.8397 1.775e-10 ***
var:nit  6   477.8    79.6  0.6949 0.6553307
row      9   945.0   105.0  0.9162 0.5230151
col      2  3171.5  1585.7 13.8373 4.012e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(yield ~ rep + var + rep:var + nit + var:nit + row + col, ex3.1b),
      type=3, singular.ok=TRUE) # NOT OK for var
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: yield
           Sum Sq Df F values    Pr(>F)
rep        5942.5  2  25.9273 1.449e-07 ***
var           0.0  0
nit       11977.9  3  34.8397 1.775e-10 ***
row         945.0  9   0.9162    0.5230
col        3171.5  2  13.8373 4.012e-05 ***
rep:var     997.8  4   2.1767    0.0926 .
var:nit     477.8  6   0.6949    0.6553
Residuals  3896.4 34
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.6 Example 4.1

(78) MODEL

```
ex4.1 = read.table("C:/G/Rt/Split/Ex4.1-example.txt", header=TRUE)
ex4.1 = af(ex4.1, c("row", "P", "column", "R", "S"))
ANOVA(height ~ P + column + column:P + R + P:R + column:R + column:R:P + S +
   P:S + column:S + column:S:P + R:S + R:S:column + R:S:P + R:S:P:column, ex4.1)
```

```
$ANOVA
Response : height
                 Df Sum Sq Mean Sq F value Pr(>F)
MODEL           199 1710.2  8.5937
RESIDUALS         0    0.0
CORRECTED TOTAL 199 1710.2
```

```
$`Type I`
             Df Sum Sq Mean Sq F value Pr(>F)
P             1  28.12 28.1250
column        4  34.33  8.5825
P:column      4  91.45 22.8625
R             4  31.03  7.7575
P:R           4  48.95 12.2375
column:R     16 467.92 29.2450
P:column:R   16 350.10 21.8813
S             3   3.77  1.2583
P:S           3   3.29  1.0983
column:S     12  74.55  6.2125
P:column:S   12  47.03  3.9192
R:S          12  36.65  3.0542
column:R:S   48 197.40  4.1125
P:R:S        12  26.33  2.1942
P:column:R:S 48 269.22  5.6087

$`Type II`
             Df Sum Sq Mean Sq F value Pr(>F)
P             1  28.13 28.1250
column        4  34.33  8.5825
P:column      4  91.45 22.8625
R             4  31.03  7.7575
P:R           4  48.95 12.2375
column:R     16 467.92 29.2450
P:column:R   16 350.10 21.8812
S             3   3.77  1.2583
P:S           3   3.30  1.0983
column:S     12  74.55  6.2125
P:column:S   12  47.03  3.9192
R:S          12  36.65  3.0542
column:R:S   48 197.40  4.1125
P:R:S        12  26.33  2.1942
P:column:R:S 48 269.22  5.6087

$`Type III`
             Df Sum Sq Mean Sq F value Pr(>F)
P             1  28.12 28.1250
column        4  34.33  8.5825
P:column      4  91.45 22.8625
R             4  31.03  7.7575
P:R           4  48.95 12.2375
column:R     16 467.92 29.2450
P:column:R   16 350.10 21.8813
S             3   3.77  1.2583
P:S           3   3.29  1.0983
```

```
column:S     12  74.55  6.2125
P:column:S   12  47.03  3.9192
R:S          12  36.65  3.0542
column:R:S   48 197.40  4.1125
P:R:S        12  26.33  2.1942
P:column:R:S 48 269.22  5.6088
```

(79) MODEL

```
ANOVA(height ~ row + R + P + S + S:R + row:P + R:P + row:R:P + S:P + S:P:row +
    S:R:P + R:S:P:row, ex4.1)
```

```
$ANOVA
Response : height
                 Df Sum Sq Mean Sq F value Pr(>F)
MODEL           199 1710.2  8.5937
RESIDUALS         0    0.0
CORRECTED TOTAL 199 1710.2

$`Type I`
          Df Sum Sq Mean Sq F value Pr(>F)
row        4 309.43  77.357
R          4  31.03   7.758
P          1  28.12  28.125
S          3   3.77   1.258
R:S       12  36.65   3.054
row:P      4 130.25  32.563
R:P        4  48.95  12.237
row:R:P   32 504.12  15.754
P:S        3   3.29   1.098
row:P:S   24 171.28   7.137
R:P:S     12  26.33   2.194
row:R:P:S 96 416.92   4.343

$`Type II`
          Df Sum Sq Mean Sq F value Pr(>F)
row        4 309.43  77.357
R          4  31.03   7.757
P          1  28.12  28.125
S          3   3.78   1.258
R:S       12  36.65   3.054
row:P      4 130.25  32.563
R:P        4  48.95  12.238
row:R:P   32 504.12  15.754
P:S        3   3.30   1.098
row:P:S   24 171.28   7.137
R:P:S     12  26.33   2.194
row:R:P:S 96 416.92   4.343
```

```
$`Type III`
          Df Sum Sq Mean Sq F value Pr(>F)
row        4 309.43  77.358
R          4  31.03   7.757
P          1  28.13  28.125
S          3   3.78   1.258
R:S       12  36.65   3.054
row:P      4 130.25  32.563
R:P        4  48.95  12.237
row:R:P   32 504.12  15.754
P:S        3   3.30   1.098
row:P:S   24 171.28   7.137
R:P:S     12  26.33   2.194
row:R:P:S 96 416.92   4.343
```

7.7 Example 5.1

(80) MODEL

```
ex5.1 = read.table("C:/G/Rt/Split/sbsp.txt", header=TRUE)
ex5.1 = af(ex5.1, c("R", "A", "C", "B", "Tx"))
ANOVA(Y ~ R + A + R:A + C + B + C:B + Tx + B:Tx, ex5.1)
```

```
$ANOVA
Response : Y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           20 193.583  9.6792  9.4176 2.969e-05 ***
RESIDUALS       15  15.417  1.0278
CORRECTED TOTAL 35 209.000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
     Df  Sum Sq Mean Sq F value    Pr(>F)
R     2  33.500 16.7500 16.2973 0.0001734 ***
A     1  16.000 16.0000 15.5676 0.0012951 **
R:A   2  32.167 16.0833 15.6486 0.0002133 ***
C     2   0.500  0.2500  0.2432 0.7871141
B     1   1.778  1.7778  1.7297 0.2081966
C:B   2   0.389  0.1944  0.1892 0.8295745
Tx    5 103.333 20.6667 20.1081  3.63e-06 ***
B:Tx  5   5.917  1.1833  1.1514 0.3770453
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
     Df  Sum Sq Mean Sq F value    Pr(>F)
R     2  23.047 11.5236 11.2122 0.0010520 **
A     1  12.375 12.3751 12.0406 0.0034285 **
```

```
R:A   2  27.164 13.5819 13.2148 0.0004907 ***
C     2   0.500  0.2500  0.2432 0.7871141
B     1   1.778  1.7778  1.7297 0.2081966
C:B   2   0.389  0.1944  0.1892 0.8295745
Tx    5 103.333 20.6667 20.1081  3.63e-06 ***
B:Tx  5   5.917  1.1833  1.1514 0.3770453
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
     Df  Sum Sq Mean Sq F value    Pr(>F)
R     2  22.451 11.2254 10.9220 0.0011828 **
A     1  15.001 15.0013 14.5958 0.0016719 **
R:A   2  27.164 13.5819 13.2148 0.0004907 ***
C     2   0.500  0.2500  0.2432 0.7871141
B     1   1.778  1.7778  1.7297 0.2081966
C:B   2   0.389  0.1944  0.1892 0.8295745
Tx    5 103.333 20.6667 20.1081  3.63e-06 ***
B:Tx  5   5.917  1.1833  1.1514 0.3770453
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(81) MODEL

```
ANOVA(Y ~ R + A + A:R + C + B + C:B + Tx + A:Tx, ex5.1)
```

```
$ANOVA
Response : Y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           20 194.188  9.7094  9.8323 2.254e-05 ***
RESIDUALS       15  14.813  0.9875
CORRECTED TOTAL 35 209.000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
     Df  Sum Sq Mean Sq F value    Pr(>F)
R     2  33.500 16.7500 16.9620 0.0001410 ***
A     1  16.000 16.0000 16.2025 0.0011013 **
R:A   2  32.167 16.0833 16.2869 0.0001739 ***
C     2   0.500  0.2500  0.2532 0.7795913
B     1   1.778  1.7778  1.8003 0.1996385
C:B   2   0.389  0.1944  0.1969 0.8233570
Tx    5 103.333 20.6667 20.9283 2.813e-06 ***
A:Tx  5   6.521  1.3042  1.3207 0.3078554
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
```

```
     Df  Sum Sq Mean Sq F value    Pr(>F)
R     2  33.500 16.7500 16.9620 0.0001410 ***
A     1  16.000 16.0000 16.2025 0.0011013 **
R:A   2  32.167 16.0833 16.2869 0.0001739 ***
C     2   0.807  0.4037  0.4088 0.6716130
B     1   1.757  1.7574  1.7797 0.2020905
C:B   2   0.030  0.0150  0.0152 0.9849064
Tx    5 103.333 20.6667 20.9283 2.813e-06 ***
A:Tx  5   6.521  1.3042  1.3207 0.3078554
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
     Df  Sum Sq Mean Sq F value    Pr(>F)
R     2  33.500 16.7500 16.9620 0.0001410 ***
A     1  16.000 16.0000 16.2025 0.0011013 **
R:A   2  32.167 16.0833 16.2869 0.0001739 ***
C     2   0.780  0.3902  0.3952 0.6803789
B     1   1.776  1.7756  1.7980 0.1999029
C:B   2   0.030  0.0150  0.0152 0.9849064
Tx    5 103.333 20.6667 20.9283 2.813e-06 ***
A:Tx  5   6.521  1.3042  1.3207 0.3078554
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(82) MODEL

```
ANOVA(Y ~ R + A + A:R + C + B + B:C + Tx + A:Tx + B:Tx, ex5.1)
```

```
$ANOVA
Response : Y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           24 196.238  8.1766  7.0476 0.0008758 ***
RESIDUALS       11  12.762  1.1602
CORRECTED TOTAL 35 209.000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
     Df  Sum Sq Mean Sq F value    Pr(>F)
R     2  33.500 16.7500 14.4373 0.0008391 ***
A     1  16.000 16.0000 13.7908 0.0034197 **
R:A   2  32.167 16.0833 13.8626 0.0009856 ***
C     2   0.500  0.2500  0.2155 0.8094766
B     1   1.778  1.7778  1.5323 0.2415358
C:B   2   0.389  0.1944  0.1676 0.8478141
Tx    5 103.333 20.6667 17.8131 6.055e-05 ***
A:Tx  5   6.521  1.3042  1.1241 0.4027183
B:Tx  4   2.050  0.5126  0.4418 0.7761730
```

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

$`Type II`
     Df  Sum Sq Mean Sq F value    Pr(>F)
R     2  23.116 11.5581  9.9622  0.003396 **
A     1  12.375 12.3751 10.6664  0.007519 **
R:A   2  27.426 13.7132 11.8197  0.001820 **
C     2   0.970  0.4850  0.4180  0.668392
B     1   1.757  1.7574  1.5148  0.244080
C:B   2   0.085  0.0424  0.0366  0.964202
Tx    5 103.333 20.6667 17.8131 6.055e-05 ***
A:Tx  4   2.655  0.6636  0.5720  0.688652
B:Tx  4   2.050  0.5126  0.4418  0.776173
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
     Df  Sum Sq Mean Sq F value    Pr(>F)
R     2  22.186 11.0928  9.5611  0.003924 **
A     1  15.185 15.1853 13.0886  0.004042 **
R:A   2  27.426 13.7132 11.8197  0.001820 **
C     2   1.010  0.5049  0.4352  0.657839
B     1   1.792  1.7922  1.5448  0.239751
C:B   2   0.085  0.0424  0.0366  0.964202
Tx    5 103.333 20.6667 17.8131 6.055e-05 ***
A:Tx  4   2.655  0.6636  0.5720  0.688652
B:Tx  4   2.050  0.5126  0.4418  0.776173
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
alias(Y ~ R + A + A:R + C + B + B:C + Tx + A:Tx + B:Tx, ex5.1)
```

```
Model :
Y ~ R + A + A:R + C + B + B:C + Tx + A:Tx + B:Tx

Complete :
       (Intercept) R1   R2   A1   C1   C2   B1   Tx1  Tx2  Tx3  Tx4  Tx5  R1:A1
B1:Tx5    0           0    0 -1/5    0    0 -1/5    0    0    0    0    0    0
       R2:A1 C1:B1 C2:B1 A1:Tx1 A1:Tx2 A1:Tx3 A1:Tx4 A1:Tx5 B1:Tx1 B1:Tx2 B1:Tx3
B1:Tx5    0     0     0   1/5    1/5    1/5    1/5     -1    1/5    1/5    1/5
       B1:Tx4
B1:Tx5  1/5
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(Y ~ R + A + A:R + C + B + B:C + Tx + A:Tx + B:Tx, ex5.1),
      type=3, singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Y
           Sum Sq Df F values    Pr(>F)
R          22.186  2   9.5611  0.003924 **
A           0.000  0
C           1.010  2   0.4352  0.657839
B           0.000  0
Tx        103.333  5  17.8131 6.055e-05 ***
R:A        27.426  2  11.8197  0.001820 **
C:B         0.085  2   0.0366  0.964202
A:Tx        2.655  4   0.5720  0.688652
B:Tx        2.050  4   0.4418  0.776173
Residuals  12.762 11
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(83) MODEL

```
ANOVA(Y ~ R + A + A:R + C + B + C:B + Tx + A:Tx + B:Tx + A:B:Tx, ex5.1)

$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL           28  204.2  7.2929  10.635 0.001719 **
RESIDUALS        7    4.8  0.6857
CORRECTED TOTAL 35  209.0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df  Sum Sq Mean Sq F value    Pr(>F)
R       2  33.500 16.7500 24.4271 0.0006969 ***
A       1  16.000 16.0000 23.3333 0.0018985 **
R:A     2  32.167 16.0833 23.4549 0.0007889 ***
C       2   0.500  0.2500  0.3646 0.7069339
B       1   1.778  1.7778  2.5926 0.1513998
C:B     2   0.389  0.1944  0.2836 0.7613494
Tx      5 103.333 20.6667 30.1389 0.0001357 ***
A:Tx    5   6.521  1.3042  1.9019 0.2123307
B:Tx    4   2.050  0.5126  0.7475 0.5896365
A:B:Tx  4   7.962  1.9905  2.9029 0.1038803
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
```

```
       Df  Sum Sq Mean Sq F value    Pr(>F)
R       2  31.838 15.9191 23.2153 0.0008139 ***
A       1  12.375 12.3751 18.0470 0.0038017 **
R:A     1   2.017  2.0174  2.9420 0.1300172
C       2   0.500  0.2500  0.3645 0.7069558
B       1   1.757  1.7574  2.5629 0.1534298
C:B     1   0.644  0.6445  0.9399 0.3646045
Tx      5 103.333 20.6667 30.1389 0.0001357 ***
A:Tx    4   2.655  0.6636  0.9678 0.4812226
B:Tx    4   2.050  0.5126  0.7475 0.5896365
A:B:Tx  4   7.962  1.9905  2.9029 0.1038803
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
       Df  Sum Sq Mean Sq F value    Pr(>F)
R       2  28.112 14.0562 20.4986 0.0011846 **
A       1  14.655 14.6551 21.3720 0.0024176 **
R:A     1   2.017  2.0174  2.9420 0.1300172
C       2   0.471  0.2356  0.3436 0.7205632
B       1   1.769  1.7694  2.5804 0.1522328
C:B     1   0.644  0.6445  0.9399 0.3646045
Tx      5 103.815 20.7630 30.2793 0.0001336 ***
A:Tx    4   2.951  0.7378  1.0760 0.4358837
B:Tx    4   3.553  0.8882  1.2954 0.3579988
A:B:Tx  4   7.962  1.9905  2.9029 0.1038803
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
alias(Y ~ R + A + A:R + C + B + C:B + Tx + A:Tx + B:Tx + A:B:Tx, ex5.1)
```

```
Model :
Y ~ R + A + A:R + C + B + C:B + Tx + A:Tx + B:Tx + A:B:Tx

Complete :
          (Intercept) R1   R2   A1   C1   C2   B1   Tx1  Tx2  Tx3  Tx4  Tx5
B1:Tx5       0           0    0 -1/5    0    0 -1/5    0    0    0    0    0
A1:B1:Tx5 -1/6           0    0    0    0    0    0  1/6  1/6  1/6  1/6 -5/6
A1:B1:Tx6    0         2/3    0 4/45  2/3 -2/3 4/45 -1/3  1/3 -1/3    0    0
          R1:A1 R2:A1 C1:B1 C2:B1 A1:Tx1 A1:Tx2 A1:Tx3 A1:Tx4 A1:Tx5 B1:Tx1
B1:Tx5       0     0     0     0   1/5    1/5    1/5    1/5     -1    1/5
A1:B1:Tx5    0     0     0     0     0      0      0      0      0      0
A1:B1:Tx6 -2/9   4/9  -2/9  -2/9  -1/5   -1/5   -1/5    4/5      0   -1/5
          B1:Tx2 B1:Tx3 B1:Tx4 A1:B1:Tx1 A1:B1:Tx2 A1:B1:Tx3 A1:B1:Tx4
B1:Tx5     1/5    1/5    1/5      0         0         0         0
A1:B1:Tx5    0      0      0      0         0         0         0
A1:B1:Tx6 -1/5   -1/5    4/5      1        -1         1         0
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(Y ~ R + A + A:R + C + B + C:B + Tx + A:Tx + B:Tx + A:B:Tx, ex5.1),
      type=3, singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison
```

```
Anova Table (Type III tests)

Response: Y
          Sum Sq Df F values   Pr(>F)
R         11.643  1  16.9793 0.004456 **
A          0.000  0
C          0.002  1   0.0025 0.961483
B          0.000  0
Tx        89.178  3  43.3503 6.87e-05 ***
R:A        2.017  1   2.9420 0.130017
C:B        0.644  1   0.9399 0.364604
A:Tx       0.543  3   0.2640 0.849381
B:Tx       3.384  3   1.6451 0.264128
A:B:Tx     7.962  4   2.9029 0.103880
Residuals  4.800  7
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.8 Example 7.1

(84) MODEL

```
ex7.1 = read.table("C:/G/Rt/Split/asped.txt", header=TRUE)
ex7.1 = af(ex7.1, c("R", "G", "F"))
ANOVA(Y ~ R + G + R:G + F + F:G, ex7.1)
```

```
$ANOVA
Response : Y
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            95 577.83  6.0824  5.3082 1.068e-05 ***
RESIDUALS        24  27.50  1.1458
CORRECTED TOTAL 119 605.33
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3  84.76 28.2528 24.6570 1.655e-07 ***
G   27 343.48 12.7216 11.1025 4.286e-08 ***
R:G  9  11.75  1.3056  1.1394    0.3749
F    2  59.85 29.9250 26.1164 9.481e-07 ***
G:F 54  77.98  1.4441  1.2603    0.2718
```

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

$`Type II`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3   5.75  1.9167  1.6727    0.1994
G   27 343.48 12.7216 11.1025 4.286e-08 ***
R:G  9  11.75  1.3056  1.1394    0.3749
F    2  59.85 29.9250 26.1164 9.481e-07 ***
G:F 54  77.98  1.4441  1.2603    0.2718
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3   5.75  1.9167  1.6727    0.1994
G   27 343.48 12.7216 11.1025 4.286e-08 ***
R:G  9  11.75  1.3056  1.1394    0.3749
F    2  50.51 25.2525 22.0385 3.686e-06 ***
G:F 54  77.98  1.4441  1.2603    0.2718
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(Y ~ R + G + R:G + F + F:G, ex7.1), type=3, singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Y
           Sum Sq Df F values    Pr(>F)
R           0.000  0
G         202.417  3  58.8848 3.258e-11 ***
F          50.505  2  22.0385 3.686e-06 ***
R:G        11.750  9   1.1394    0.3749
G:F        77.983 54   1.2603    0.2718
Residuals  27.500 24
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.9 Example 7.2

(85) MODEL

```
ex7.2 = read.table("C:/G/Rt/Split/aspedt.txt", header=TRUE)
ex7.2 = af(ex7.2, c("R", "T", "G"))
ANOVA(Y ~ R + T + R:T + G + G:T, ex7.2)
```

```
$ANOVA
Response : Y
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            99 538.70  5.4415  5.1892 1.286e-05 ***
RESIDUALS        24  25.17  1.0486
CORRECTED TOTAL 123 563.87
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df  Sum Sq Mean Sq F value    Pr(>F)
R    3  73.255 24.4183 23.2863 2.752e-07 ***
T    3  32.000 10.6667 10.1722 0.0001645 ***
R:T  9  28.402  3.1558  3.0095 0.0149568 *
G   21 309.908 14.7575 14.0734 7.158e-09 ***
T:G 63  95.140  1.5102  1.4401 0.1617931
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq F value    Pr(>F)
R    3   4.229  1.4097  1.3444 0.2834998
T    3  32.000 10.6667 10.1722 0.0001645 ***
R:T  9  10.854  1.2060  1.1501 0.3684706
G   21 309.908 14.7575 14.0734 7.158e-09 ***
T:G 63  95.140  1.5102  1.4401 0.1617931
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value    Pr(>F)
R    3   4.229  1.4097  1.3444  0.283500
T    3  22.668  7.5559  7.2056  0.001299 **
R:T  9  10.854  1.2060  1.1501  0.368471
G   21 309.908 14.7575 14.0734 7.158e-09 ***
T:G 63  95.140  1.5102  1.4401  0.161793
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.10 Example 7.3

(86) MODEL

```
ex7.3 = read.table("C:/G/Rt/Split/assped.txt", header=TRUE)
ex7.3 = af(ex7.3, c("R", "T", "G", "F"))
ANOVA(Y ~ R + T + R:T + G + G:T + R:T:G + F + F:T + F:G + F:G:T, ex7.3)
```

```
$ANOVA
Response : Y
```

```
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           155 656.12  4.2330  13.446 3.997e-14 ***
RESIDUALS        36  11.33  0.3148
CORRECTED TOTAL 191 667.45
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq  F value    Pr(>F)
R      3  27.06   9.019  28.6489 1.203e-09 ***
T      1  10.55  10.547  33.5018 1.334e-06 ***
R:T    3   2.97   0.991   3.1489  0.036705 *
G     22 389.01  17.682  56.1668 < 2.2e-16 ***
T:G   22  18.42   0.837   2.6601  0.004445 **
R:T:G 12   8.78   0.731   2.3235  0.025315 *
F      2 164.28  82.141 260.9173 < 2.2e-16 ***
T:F    2   0.84   0.422   1.3401  0.274574
G:F   44  23.47   0.533   1.6943  0.053191 .
T:G:F 44  10.74   0.244   0.7753  0.790640
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq  F value    Pr(>F)
R      3  12.49   4.162  13.2206 5.655e-06 ***
T      1  10.55  10.547  33.5018 1.334e-06 ***
R:T    3   1.15   0.384   1.2206  0.316281
G     22 389.01  17.682  56.1668 < 2.2e-16 ***
T:G   22  18.42   0.837   2.6601  0.004445 **
R:T:G 12   8.78   0.731   2.3235  0.025315 *
F      2 164.28  82.141 260.9173 < 2.2e-16 ***
T:F    2   0.84   0.422   1.3401  0.274574
G:F   44  23.47   0.533   1.6943  0.053191 .
T:G:F 44  10.74   0.244   0.7753  0.790640
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq  F value    Pr(>F)
R      3  12.49   4.162  13.2206 5.655e-06 ***
T      1  11.16  11.158  35.4430 8.021e-07 ***
R:T    3   1.15   0.384   1.2206  0.316281
G     22 389.01  17.682  56.1668 < 2.2e-16 ***
T:G   22  18.42   0.837   2.6601  0.004445 **
R:T:G 12   8.78   0.731   2.3235  0.025315 *
F      2 120.56  60.282 191.4828 < 2.2e-16 ***
T:F    2   0.82   0.411   1.3060  0.283432
G:F   44  23.47   0.533   1.6943  0.053191 .
```

```
T:G:F 44  10.74   0.244   0.7753  0.790640
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(Y ~ R + T + R:T + G + G:T + R:T:G + F + F:T + F:G + F:G:T, ex7.3),
      type=3, singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Y
           Sum Sq Df F values    Pr(>F)
R           0.000  0
T           0.000  0
G          73.444  2 116.6471 < 2.2e-16 ***
F         120.563  2 191.4828 < 2.2e-16 ***
R:T         0.000  0
T:G         5.778  2   9.1765 0.0006018 ***
T:F         0.822  2   1.3060 0.2834316
G:F        23.469 44   1.6943 0.0531910 .
R:T:G       8.778 12   2.3235 0.0253153 *
T:G:F      10.740 44   0.7753 0.7906401
Residuals  11.333 36
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.11 Example 8.1

(87) MODEL

```
ex8.1 = read.table("C:/G/Rt/Split/asbed.txt", header=TRUE)
ex8.1 = af(ex8.1, c("R", "A", "B"))
ANOVA(Y ~ R + A + R:A + B + B:R + A:B + A:B:R, ex8.1)
```

```
$ANOVA
Response : Y
                 Df Sum Sq Mean Sq F value Pr(>F)
MODEL           104 3951.8  37.999
RESIDUALS         0    0.0
CORRECTED TOTAL 104 3951.8

$`Type I`
      Df  Sum Sq Mean Sq F value Pr(>F)
R      2 1787.68  893.84
A     12  601.24   50.10
R:A    6   24.93    4.16
B      8  156.87   19.61
```

```
R:B    4  319.87   79.97
A:B   60 1012.26   16.87
R:A:B 12   49.00    4.08

$`Type II`
      Df  Sum Sq Mean Sq F value Pr(>F)
R      2  372.22 186.111
A     12  601.24  50.103
R:A    6   50.00   8.333
B      8  156.87  19.609
R:B    4   87.44  21.861
A:B   60 1012.26  16.871
R:A:B 12   49.00   4.083

$`Type III`
      Df  Sum Sq Mean Sq F value Pr(>F)
R      2  372.22 186.111
A     12  572.31  47.692
R:A    6   50.00   8.333
B      8  185.85  23.231
R:B    4   87.44  21.861
A:B   60 1012.26  16.871
R:A:B 12   49.00   4.083
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(Y ~ R + A + R:A + B + B:R + A:B + A:B:R, ex8.1), type="III",
      singular.ok=TRUE) # NOT WORKING
```

7.12 Example 9.1

(88) MODEL

```
ex9.1 = read.table("C:/G/Rt/Split/Ex9.1-spex1.txt", header=TRUE)
ex9.1 = af(ex9.1, c("R", "A", "B"))
ANOVA(Y ~ R + A + R:A + B + A:B, ex9.1)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           27 4920.8 182.251  10.594 5.927e-10 ***
RESIDUALS       34  584.9  17.203
CORRECTED TOTAL 61 5505.6
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3  218.7   72.89  4.2369   0.01199 *
A    3  194.9   64.96  3.7760   0.01930 *
```

```
R:A  9  186.9   20.76  1.2070   0.32287
B    3 4087.4 1362.47 79.2018 1.998e-15 ***
A:B  9  233.0   25.88  1.5047   0.18602
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3  157.8   52.61  3.0583   0.04134 *
A    3  227.2   75.73  4.4020   0.01014 *
R:A  9   94.5   10.50  0.6106   0.77932
B    3 4087.4 1362.47 79.2018 1.998e-15 ***
A:B  9  233.0   25.88  1.5047   0.18602
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3  171.0   57.01  3.3138   0.03143 *
A    3  209.7   69.92  4.0643   0.01431 *
R:A  9   94.5   10.50  0.6106   0.77932
B    3 4089.9 1363.29 79.2493 1.998e-15 ***
A:B  9  233.0   25.88  1.5047   0.18602
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.13 Example 9.2

(89) MODEL

```
ex9.2 = read.table("C:/G/Rt/Split/Ex9.2-sbex.txt", header=TRUE)
ex9.2 = af(ex9.2, c("rep", "hyb", "gen"))
ANOVA(yield ~ rep + hyb + rep:hyb + gen + gen:rep + gen:hyb, ex9.2)
```

```
$ANOVA
Response : yield
                Df  Sum Sq Mean Sq F value   Pr(>F)
MODEL           40 247.813  6.1953  4.4606 0.001119 **
RESIDUALS       16  22.222  1.3889
CORRECTED TOTAL 56 270.035
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
        Df Sum Sq Mean Sq F value    Pr(>F)
rep      1  0.239  0.2388  0.1719 0.6839085
hyb      9 66.796  7.4218  5.3437 0.0018370 **
rep:hyb  8 67.000  8.3750  6.0300 0.0011569 **
gen      2 36.351 18.1754 13.0863 0.0004293 ***
```

```
rep:gen  2 16.923  8.4616  6.0924 0.0107858 *
hyb:gen 18 60.504  3.3613  2.4201 0.0408545 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df Sum Sq Mean Sq F value    Pr(>F)
rep      1  0.167  0.1667  0.1200 0.7335481
hyb      9 66.796  7.4218  5.3437 0.0018370 **
rep:hyb  8 67.000  8.3750  6.0300 0.0011569 **
gen      2 36.351 18.1754 13.0863 0.0004293 ***
rep:gen  2 12.111  6.0556  4.3600 0.0308015 *
hyb:gen 18 60.504  3.3613  2.4201 0.0408545 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
        Df Sum Sq Mean Sq F value    Pr(>F)
rep      1  0.167  0.1667  0.1200 0.7335481
hyb      9 66.796  7.4218  5.3437 0.0018370 **
rep:hyb  8 67.000  8.3750  6.0300 0.0011569 **
gen      2 30.671 15.3356 11.0416 0.0009707 ***
rep:gen  2 12.111  6.0556  4.3600 0.0308015 *
hyb:gen 18 60.504  3.3613  2.4201 0.0408545 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(yield ~ rep + hyb + rep:hyb + gen + gen:rep + gen:hyb, ex9.2), type=3,
      singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: yield
          Sum Sq Df F values    Pr(>F)
rep        0.000  0
hyb       66.704  8   6.0033 0.0011847 **
gen       30.671  2  11.0416 0.0009707 ***
rep:hyb   67.000  8   6.0300 0.0011569 **
rep:gen   12.111  2   4.3600 0.0308015 *
hyb:gen   60.504 18   2.4201 0.0408545 *
Residuals 22.222 16
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.14 Example 10.1

(90) MODEL

```
ex10.1 = read.table("C:/G/Rt/Split/Ex10.1-new.txt", header=TRUE)
ex10.1 = af(ex10.1, c("Site", "Block", "A", "B", "C"))
f10.1 = Yield ~ Site/Block + A/Site + B/Site + A:B + A:B:Site + A:B:Site:Block +
        C + A:C + B:C + A:B:C + C:Site + A:C:Site + B:C:Site + A:B:C:Site
ANOVA(f10.1, ex10.1)
```

```
$ANOVA
Response : Yield
                 Df     Sum Sq Mean Sq F value    Pr(>F)
MODEL           239 1639561484 6860090    2162 < 2.2e-16 ***
RESIDUALS       240     761522    3173
CORRECTED TOTAL 479 1640323006
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
               Df     Sum Sq   Mean Sq    F value  Pr(>F)
Site            3     552717    184239 5.8064e+01 < 2e-16 ***
Site:Block      8    7062320    882790 2.7822e+02 < 2e-16 ***
A               4 1387680917 346920229 1.0933e+05 < 2e-16 ***
Site:A         12      34068      2839 8.9470e-01 0.55301
B               1  100939695 100939695 3.1812e+04 < 2e-16 ***
Site:B          3       1618       539 1.6990e-01 0.91662
A:B             4   31444008   7861002 2.4775e+03 < 2e-16 ***
Site:A:B       12      33737      2811 8.8600e-01 0.56185
Site:Block:A:B 72     186911      2596 8.1810e-01 0.84155
C               3   19356264   6452088 2.0334e+03 < 2e-16 ***
A:C            12   26075792   2172983 6.8483e+02 < 2e-16 ***
B:C             3   23901388   7967129 2.5109e+03 < 2e-16 ***
A:B:C          12   41996729   3499727 1.1030e+03 < 2e-16 ***
Site:C          9      47625      5292 1.6677e+00 0.09747 .
Site:A:C       36     104110      2892 9.1140e-01 0.61768
Site:B:C        9      61111      6790 2.1400e+00 0.02701 *
Site:A:B:C     36      82475      2291 7.2200e-01 0.87941
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
               Df     Sum Sq   Mean Sq    F value  Pr(>F)
Site            3     552717    184239 5.8064e+01 < 2e-16 ***
Site:Block      8    7062320    882790 2.7822e+02 < 2e-16 ***
A               4 1387680917 346920229 1.0933e+05 < 2e-16 ***
Site:A         12      34068      2839 8.9470e-01 0.55301
B               1  100939695 100939695 3.1812e+04 < 2e-16 ***
Site:B          3       1618       539 1.6990e-01 0.91662
```

```
A:B             4   31444008   7861002 2.4775e+03 < 2e-16 ***
Site:A:B       12      33737      2811 8.8600e-01 0.56185
Site:Block:A:B 72     186911      2596 8.1810e-01 0.84155
C               3   19356264   6452088 2.0334e+03 < 2e-16 ***
A:C            12   26075792   2172983 6.8483e+02 < 2e-16 ***
B:C             3   23901388   7967129 2.5109e+03 < 2e-16 ***
A:B:C          12   41996729   3499727 1.1030e+03 < 2e-16 ***
Site:C          9      47625      5292 1.6677e+00 0.09747 .
Site:A:C       36     104110      2892 9.1140e-01 0.61768
Site:B:C        9      61111      6790 2.1400e+00 0.02701 *
Site:A:B:C     36      82475      2291 7.2200e-01 0.87941
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
               Df     Sum Sq   Mean Sq    F value  Pr(>F)
Site            3     552717    184239 5.8064e+01 < 2e-16 ***
Site:Block      8    7062320    882790 2.7822e+02 < 2e-16 ***
A               4 1387680917 346920229 1.0933e+05 < 2e-16 ***
Site:A         12      34068      2839 8.9470e-01 0.55301
B               1  100939695 100939695 3.1812e+04 < 2e-16 ***
Site:B          3       1618       539 1.6990e-01 0.91662
A:B             4   31444008   7861002 2.4775e+03 < 2e-16 ***
Site:A:B       12      33737      2811 8.8600e-01 0.56185
Site:Block:A:B 72     186911      2596 8.1810e-01 0.84155
C               3   19356264   6452088 2.0334e+03 < 2e-16 ***
A:C            12   26075792   2172983 6.8483e+02 < 2e-16 ***
B:C             3   23901388   7967129 2.5109e+03 < 2e-16 ***
A:B:C          12   41996729   3499727 1.1030e+03 < 2e-16 ***
Site:C          9      47625      5292 1.6677e+00 0.09747 .
Site:A:C       36     104110      2892 9.1140e-01 0.61768
Site:B:C        9      61111      6790 2.1400e+00 0.02701 *
Site:A:B:C     36      82475      2291 7.2200e-01 0.87941
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(f10.1, ex10.1), type=3, singular.ok=TRUE) # NOT OK for Site:Block
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Yield
                  Sum Sq  Df   F values  Pr(>F)
Site              552717   3 5.8064e+01 < 2e-16 ***
A              1387680917   4 1.0933e+05 < 2e-16 ***
B               100939695   1 3.1812e+04 < 2e-16 ***
```

```
C                19356264   3 2.0334e+03 < 2e-16 ***
Site:Block             0    0
Site:A             34068   12 8.9470e-01 0.55301
Site:B              1618    3 1.6990e-01 0.91662
A:B              31444008    4 2.4775e+03 < 2e-16 ***
A:C              26075792   12 6.8483e+02 < 2e-16 ***
B:C              23901388    3 2.5109e+03 < 2e-16 ***
Site:C              47625    9 1.6677e+00 0.09747 .
Site:A:B            33737   12 8.8600e-01 0.56185
A:B:C            41996729   12 1.1030e+03 < 2e-16 ***
Site:A:C           104110   36 9.1140e-01 0.61768
Site:B:C            61111    9 2.1400e+00 0.02701 *
Site:Block:A:B     186911   72 8.1810e-01 0.84155
Site:A:B:C          82475   36 7.2200e-01 0.87941
Residuals          761522 240
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.15 Example 10.2

(91) MODEL

```
ex10.2 = read.table("C:/G/Rt/Split/Ex10.2-spbsite.txt", header=TRUE)
ex10.2 = af(ex10.2, c("Site", "Block", "A", "B"))
ANOVA(Yield ~ Site + Site:Block + A + A:Site + A:Site:Block + B + B:Site +
            B:Site:Block + A:B + A:B:Site, ex10.2)
```

```
$ANOVA
Response : Yield
                 Df     Sum Sq  Mean Sq F value    Pr(>F)
MODEL           227 6370995084 28066058   10814 < 2.2e-16 ***
RESIDUALS       252     654049     2595
CORRECTED TOTAL 479 6371649132
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
             Df     Sum Sq   Mean Sq    F value    Pr(>F)
Site          2  523573968 261786984 1.0086e+05 < 2.2e-16 ***
Site:Block    9 3756646710 417405190 1.6082e+05 < 2.2e-16 ***
A             4   29288163   7322041 2.8211e+03 < 2.2e-16 ***
Site:A        8     247899     30987 1.1939e+01 1.998e-14 ***
Site:Block:A 36    1783391     49539 1.9087e+01 < 2.2e-16 ***
B             7 1937592291 276798899 1.0665e+05 < 2.2e-16 ***
Site:B       14   15903698   1135978 4.3768e+02 < 2.2e-16 ***
Site:Block:B 63  105727288   1678211 6.4660e+02 < 2.2e-16 ***
A:B          28      91141      3255 1.2541e+00    0.1838
Site:A:B     56     140534      2510 9.6690e-01    0.5461
---
```

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

$`Type II`
             Df     Sum Sq   Mean Sq    F value    Pr(>F)
Site          2  523573968 261786984 1.0086e+05 < 2.2e-16 ***
Site:Block    9 3756646710 417405190 1.6082e+05 < 2.2e-16 ***
A             4   29288163   7322041 2.8211e+03 < 2.2e-16 ***
Site:A        8     247899     30987 1.1939e+01 1.998e-14 ***
Site:Block:A 36    1783391     49539 1.9087e+01 < 2.2e-16 ***
B             7 1937592291 276798899 1.0665e+05 < 2.2e-16 ***
Site:B       14   15903698   1135978 4.3768e+02 < 2.2e-16 ***
Site:Block:B 63  105727288   1678211 6.4660e+02 < 2.2e-16 ***
A:B          28      91141      3255 1.2541e+00    0.1838
Site:A:B     56     140534      2510 9.6690e-01    0.5461
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
             Df     Sum Sq   Mean Sq    F value    Pr(>F)
Site          2  523573968 261786984 1.0086e+05 < 2.2e-16 ***
Site:Block    9 3756646710 417405190 1.6082e+05 < 2.2e-16 ***
A             4   29288163   7322041 2.8211e+03 < 2.2e-16 ***
Site:A        8     247899     30987 1.1939e+01 1.998e-14 ***
Site:Block:A 36    1783391     49539 1.9087e+01 < 2.2e-16 ***
B             7 1937592291 276798899 1.0665e+05 < 2.2e-16 ***
Site:B       14   15903698   1135978 4.3768e+02 < 2.2e-16 ***
Site:Block:B 63  105727288   1678211 6.4660e+02 < 2.2e-16 ***
A:B          28      91141      3255 1.2541e+00    0.1838
Site:A:B     56     140534      2510 9.6690e-01    0.5461
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.16 Example 11.1

(92) MODEL

```
ex11.1 = read.table("C:/G/Rt/Split/Ex11.1-cov.txt", header=TRUE)
ex11.1 = af(ex11.1, c("R", "T", "S"))
ANOVA(Y ~ R + T + R:T + S + S:T, ex11.1)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value  Pr(>F)
MODEL           11    328 29.8182  3.1948 0.02875 *
RESIDUALS       12    112  9.3333
CORRECTED TOTAL 23    440
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
    Df Sum Sq Mean Sq F value  Pr(>F)
R    2     48      24  2.5714 0.11765
T    1     24      24  2.5714 0.13479
R:T  2     16       8  0.8571 0.44880
S    3    156      52  5.5714 0.01251 *
T:S  3     84      28  3.0000 0.07277 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq F value  Pr(>F)
R    2     48      24  2.5714 0.11765
T    1     24      24  2.5714 0.13479
R:T  2     16       8  0.8571 0.44880
S    3    156      52  5.5714 0.01251 *
T:S  3     84      28  3.0000 0.07277 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value  Pr(>F)
R    2     48      24  2.5714 0.11765
T    1     24      24  2.5714 0.13479
R:T  2     16       8  0.8571 0.44880
S    3    156      52  5.5714 0.01251 *
T:S  3     84      28  3.0000 0.07277 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(93) MODEL

```
ANOVA(Z ~ R + T + R:T + S + S:T, ex11.1)
```

```
$ANOVA
Response : Z
               Df Sum Sq Mean Sq F value  Pr(>F)
MODEL          11     46  4.1818  2.5091 0.06452 .
RESIDUALS      12     20  1.6667
CORRECTED TOTAL 23     66
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value Pr(>F)
R    2      9     4.5     2.7 0.1076
T    1      6     6.0     3.6 0.0821 .
R:T  2      1     0.5     0.3 0.7462
S    3      9     3.0     1.8 0.2008
```

```
T:S  3     21     7.0     4.2 0.0301 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq F value Pr(>F)
R    2      9     4.5     2.7 0.1076
T    1      6     6.0     3.6 0.0821 .
R:T  2      1     0.5     0.3 0.7462
S    3      9     3.0     1.8 0.2008
T:S  3     21     7.0     4.2 0.0301 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value Pr(>F)
R    2      9     4.5     2.7 0.1076
T    1      6     6.0     3.6 0.0821 .
R:T  2      1     0.5     0.3 0.7462
S    3      9     3.0     1.8 0.2008
T:S  3     21     7.0     4.2 0.0301 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(94) MODEL

```
ANOVA(Y ~ R + T + R:T + S + S:T + Z, ex11.1)

$ANOVA
Response : Y
               Df Sum Sq Mean Sq F value  Pr(>F)
MODEL          12 342.45 28.5375   3.218 0.03116 *
RESIDUALS      11  97.55  8.8682
CORRECTED TOTAL 23 440.00
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value  Pr(>F)
R    2  48.00   24.00  2.7063 0.11071
T    1  24.00   24.00  2.7063 0.12820
R:T  2  16.00    8.00  0.9021 0.43373
S    3 156.00   52.00  5.8637 0.01211 *
T:S  3  84.00   28.00  3.1574 0.06828 .
Z    1  14.45   14.45  1.6294 0.22807
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
```

```
    Df Sum Sq Mean Sq F value  Pr(>F)
R    2 18.300  9.1500  1.0318 0.38844
T    1  2.679  2.6786  0.3020 0.59359
R:T  2  9.450  4.7250  0.5328 0.60137
S    3 79.196 26.3985  2.9768 0.07822 .
T:S  3 37.474 12.4915  1.4086 0.29234
Z    1 14.450 14.4500  1.6294 0.22807
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value  Pr(>F)
R    2 20.209 10.1043  1.1394 0.35505
T    1  6.104  6.1038  0.6883 0.42439
R:T  2  9.450  4.7250  0.5328 0.60137
S    3 84.243 28.0810  3.1665 0.06782 .
T:S  3 37.474 12.4915  1.4086 0.29234
Z    1 14.450 14.4500  1.6294 0.22807
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.17 Example 11.2

(95) MODEL

```
ex11.2a = read.table("C:/G/Rt/Split/Ex11.2-sp3.txt", header=TRUE)
ex11.2a = af(ex11.2a, "A")
ex11.2a$MY = (ex11.2a$Y1 + ex11.2a$Y2)/sqrt(2)
ex11.2a$Z = 2*ex11.2a$Z/sqrt(2)
ANOVA(MY ~ Z + A, ex11.2a)
```

```
$ANOVA
Response : MY
                Df  Sum Sq Mean Sq F value  Pr(>F)
MODEL            2 234.639  117.32  9.5696 0.01953 *
RESIDUALS        5  61.298   12.26
CORRECTED TOTAL  7 295.937
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
  Df  Sum Sq Mean Sq F value  Pr(>F)
Z  1 190.148 190.148 15.5101 0.01098 *
A  1  44.492  44.492  3.6291 0.11512
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
  Df  Sum Sq Mean Sq F value Pr(>F)
```

```
Z  1 166.577 166.577 13.5874 0.0142 *
A  1  44.492  44.492  3.6291 0.1151
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
  Df  Sum Sq Mean Sq F value Pr(>F)
Z  1 166.577 166.577 13.5874 0.0142 *
A  1  44.492  44.492  3.6291 0.1151
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(96) MODEL

```
ex11.2b = read.table("C:/G/Rt/Split/Ex11.2-two.txt", header=TRUE)
ex11.2b = af(ex11.2b, c("sub", "A", "B"))
ANOVA(Y ~ A + A:sub + B + A:B, ex11.2b)

$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            9 382.06  42.451  39.954 0.0001135 ***
RESIDUALS        6   6.38   1.062
CORRECTED TOTAL 15 388.44
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df  Sum Sq Mean Sq F value    Pr(>F)
A      1  68.062  68.062 64.0588 0.0002029 ***
A:sub  6 227.875  37.979 35.7451 0.0001934 ***
B      1  85.562  85.562 80.5294 0.0001070 ***
A:B    1   0.562   0.562  0.5294 0.4942562
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df  Sum Sq Mean Sq F value    Pr(>F)
A      1  68.062  68.062 64.0588 0.0002029 ***
A:sub  6 227.875  37.979 35.7451 0.0001934 ***
B      1  85.562  85.562 80.5294 0.0001070 ***
A:B    1   0.562   0.562  0.5294 0.4942562
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df  Sum Sq Mean Sq F value    Pr(>F)
A      1  68.062  68.062 64.0588 0.0002029 ***
A:sub  6 227.875  37.979 35.7451 0.0001934 ***
```

```
B      1  85.562  85.562 80.5294 0.0001070 ***
A:B    1   0.562   0.562  0.5294 0.4942562
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(97) MODEL

```
ex11.2c = read.table("C:/G/Rt/Split/Ex11.2-spcov2.txt", header=TRUE)
ex11.2c = af(ex11.2c, c("block", "whole", "split"))
ANOVA(Y ~ block + whole + block:whole + split + split:whole, ex11.2c)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value  Pr(>F)
MODEL           11    328 29.8182  3.1948 0.02875 *
RESIDUALS       12    112  9.3333
CORRECTED TOTAL 23    440
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
            Df Sum Sq Mean Sq F value  Pr(>F)
block        2     48      24  2.5714 0.11765
whole        1     24      24  2.5714 0.13479
block:whole  2     16       8  0.8571 0.44880
split        3    156      52  5.5714 0.01251 *
whole:split  3     84      28  3.0000 0.07277 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df Sum Sq Mean Sq F value  Pr(>F)
block        2     48      24  2.5714 0.11765
whole        1     24      24  2.5714 0.13479
block:whole  2     16       8  0.8571 0.44880
split        3    156      52  5.5714 0.01251 *
whole:split  3     84      28  3.0000 0.07277 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
            Df Sum Sq Mean Sq F value  Pr(>F)
block        2     48      24  2.5714 0.11765
whole        1     24      24  2.5714 0.13479
block:whole  2     16       8  0.8571 0.44880
split        3    156      52  5.5714 0.01251 *
whole:split  3     84      28  3.0000 0.07277 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(98) MODEL

```
ANOVA(Z ~ block + whole + block:whole + split + split:whole, ex11.2c)
```

```
$ANOVA
Response : Z
                Df Sum Sq Mean Sq    F value    Pr(>F)
MODEL           11     38  3.4545 3.5903e+15 < 2.2e-16 ***
RESIDUALS       12      0  0.0000
CORRECTED TOTAL 23     38
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
            Df Sum Sq Mean Sq    F value Pr(>F)
block        2 36.000 18.0000 1.8707e+16 <2e-16 ***
whole        1  0.667  0.6667 6.9286e+14 <2e-16 ***
block:whole  2  1.333  0.6667 6.9286e+14 <2e-16 ***
split        3  0.000  0.0000 0.0000e+00      1
whole:split  3  0.000  0.0000 0.0000e+00      1
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df Sum Sq Mean Sq    F value Pr(>F)
block        2 36.000 18.0000 1.8707e+16 <2e-16 ***
whole        1  0.667  0.6667 6.9286e+14 <2e-16 ***
block:whole  2  1.333  0.6667 6.9286e+14 <2e-16 ***
split        3  0.000  0.0000 0.0000e+00      1
whole:split  3  0.000  0.0000 0.0000e+00      1
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
            Df Sum Sq Mean Sq    F value Pr(>F)
block        2 36.000 18.0000 1.8707e+16 <2e-16 ***
whole        1  0.667  0.6667 6.9286e+14 <2e-16 ***
block:whole  2  1.333  0.6667 6.9286e+14 <2e-16 ***
split        3  0.000  0.0000 0.0000e+00      1
whole:split  3  0.000  0.0000 0.0000e+00      1
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(99) MODEL

```
ANOVA(Y ~ block + whole + block:whole + split + split:whole + Z, ex11.2c)
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value  Pr(>F)
```

```
MODEL           11    328 29.8182  3.1948 0.02875 *
RESIDUALS       12    112  9.3333
CORRECTED TOTAL 23    440
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
            Df Sum Sq Mean Sq F value  Pr(>F)
block        2     48      24  2.5714 0.11765
whole        1     24      24  2.5714 0.13479
block:whole  2     16       8  0.8571 0.44880
split        3    156      52  5.5714 0.01251 *
whole:split  3     84      28  3.0000 0.07277 .
Z            0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df  Sum Sq Mean Sq F value  Pr(>F)
block        2  13.286   6.643  0.7117 0.51039
whole        1  16.000  16.000  1.7143 0.21495
block:whole  1  16.000  16.000  1.7143 0.21495
split        3 156.000  52.000  5.5714 0.01251 *
whole:split  3  84.000  28.000  3.0000 0.07277 .
Z            0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
            Df  Sum Sq Mean Sq F value  Pr(>F)
block        2  13.286   6.643  0.7117 0.51039
whole        1  16.000  16.000  1.7143 0.21495
block:whole  1  16.000  16.000  1.7143 0.21495
split        3 156.000  52.000  5.5714 0.01251 *
whole:split  3  84.000  28.000  3.0000 0.07277 .
Z            0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

7.18 Example 11.3

(100) MODEL

```
ex11.3 = read.table("C:/G/Rt/Split/Ex11.3-sbcov.txt", header=TRUE)
ex11.3 = af(ex11.3, c("block", "A", "B"))
ANOVA(Y ~ block + A + block:A + B + block:B + A:B, ex11.3)
```

```
$ANOVA
```

```
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           17 16.833  0.9902  1.9804 0.2038
RESIDUALS        6  3.000  0.5000
CORRECTED TOTAL 23 19.833

$`Type I`
        Df Sum Sq Mean Sq F value  Pr(>F)
block    3 4.5000  1.5000  3.0000 0.11696
A        1 1.5000  1.5000  3.0000 0.13397
block:A  3 0.5000  0.1667  0.3333 0.80220
B        2 8.3333  4.1667  8.3333 0.01855 *
block:B  6 1.0000  0.1667  0.3333 0.89648
A:B      2 1.0000  0.5000  1.0000 0.42188
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df Sum Sq Mean Sq F value  Pr(>F)
block    3 4.5000  1.5000  3.0000 0.11696
A        1 1.5000  1.5000  3.0000 0.13397
block:A  3 0.5000  0.1667  0.3333 0.80220
B        2 8.3333  4.1667  8.3333 0.01855 *
block:B  6 1.0000  0.1667  0.3333 0.89648
A:B      2 1.0000  0.5000  1.0000 0.42188
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
        Df Sum Sq Mean Sq F value  Pr(>F)
block    3 4.5000  1.5000  3.0000 0.11696
A        1 1.5000  1.5000  3.0000 0.13397
block:A  3 0.5000  0.1667  0.3333 0.80220
B        2 8.3333  4.1667  8.3333 0.01855 *
block:B  6 1.0000  0.1667  0.3333 0.89648
A:B      2 1.0000  0.5000  1.0000 0.42188
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(101) MODEL

```
ANOVA(Z ~ block + A + block:A + B + block:B + A:B, ex11.3)
```

```
$ANOVA
Response : Z
                Df Sum Sq Mean Sq F value  Pr(>F)
MODEL           17 31.167 1.83333     3.3 0.07324 .
RESIDUALS        6  3.333 0.55556
CORRECTED TOTAL 23 34.500
```

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

$`Type I`
        Df  Sum Sq Mean Sq F value  Pr(>F)
block    3  6.8333  2.2778     4.1 0.06689 .
A        1  6.0000  6.0000    10.8 0.01669 *
block:A  3  1.6667  0.5556     1.0 0.45472
B        2 13.0000  6.5000    11.7 0.00850 **
block:B  6  3.6667  0.6111     1.1 0.45542
A:B      2  0.0000  0.0000     0.0 1.00000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df  Sum Sq Mean Sq F value  Pr(>F)
block    3  6.8333  2.2778     4.1 0.06689 .
A        1  6.0000  6.0000    10.8 0.01669 *
block:A  3  1.6667  0.5556     1.0 0.45472
B        2 13.0000  6.5000    11.7 0.00850 **
block:B  6  3.6667  0.6111     1.1 0.45542
A:B      2  0.0000  0.0000     0.0 1.00000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
        Df  Sum Sq Mean Sq F value  Pr(>F)
block    3  6.8333  2.2778     4.1 0.06689 .
A        1  6.0000  6.0000    10.8 0.01669 *
block:A  3  1.6667  0.5556     1.0 0.45472
B        2 13.0000  6.5000    11.7 0.00850 **
block:B  6  3.6667  0.6111     1.1 0.45542
A:B      2  0.0000  0.0000     0.0 1.00000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(102) MODEL

```
ANOVA(Y ~ block + A + block:A + B + block:B + A:B + Z, ex11.3)
```

```
$ANOVA
Response : Y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL           18 17.8417 0.99120  2.4884 0.1589
RESIDUALS        5  1.9917 0.39833
CORRECTED TOTAL 23 19.8333

$`Type I`
        Df Sum Sq Mean Sq F value  Pr(>F)
```

```
block    3 4.5000  1.5000  3.7657 0.09378 .
A        1 1.5000  1.5000  3.7657 0.10999
block:A  3 0.5000  0.1667  0.4184 0.74788
B        2 8.3333  4.1667 10.4603 0.01634 *
block:B  6 1.0000  0.1667  0.4184 0.84059
A:B      2 1.0000  0.5000  1.2552 0.36163
Z        1 1.0083  1.0083  2.5314 0.17248
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df Sum Sq Mean Sq F value Pr(>F)
block    3 3.6203 1.20678  3.0296 0.1319
A        1 0.0000 0.00000  0.0000 1.0000
block:A  3 0.2583 0.08611  0.2162 0.8813
B        2 1.0317 0.51587  1.2951 0.3522
block:B  6 0.4210 0.07017  0.1762 0.9717
A:B      2 1.0000 0.50000  1.2552 0.3616
Z        1 1.0083 1.00833  2.5314 0.1725

$`Type III`
        Df Sum Sq Mean Sq F value Pr(>F)
block    3 3.6613 1.22045  3.0639 0.1297
A        1 0.0054 0.00536  0.0134 0.9122
block:A  3 0.2583 0.08611  0.2162 0.8813
B        2 0.7685 0.38427  0.9647 0.4423
block:B  6 0.4210 0.07017  0.1762 0.9717
A:B      2 1.0000 0.50000  1.2552 0.3616
Z        1 1.0083 1.00833  2.5314 0.1725
```

8 Hinkelmann & Kempthorne - Volume 1

Reference

- Hinkelmann K, Kempthorne O. Design and Analysis of Experiments Volume 1 Introduction to Experimental Design. 2e. John Wiley & Sons Inc. 2008.

8.1 Chapter 6

8.1.1 p202

(103) MODEL

```
v1p202 = read.table("C:/G/Rt/Kemp/v1p202.txt", head=TRUE)
v1p202 = af(v1p202,c("brand"))
ANOVA(miles ~ brand, v1p202) # OK
```

```
$ANOVA
Response : miles
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL            4 47.234  11.809  15.661 0.004924 **
RESIDUALS        5  3.770   0.754
CORRECTED TOTAL  9 51.004
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value   Pr(>F)
brand  4 47.234  11.809  15.661 0.004924 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value   Pr(>F)
brand  4 47.234  11.809  15.661 0.004924 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq F value   Pr(>F)
brand  4 47.234  11.809  15.661 0.004924 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.1.2 p205

(104) MODEL

```
v1p205 = read.table("C:/G/Rt/Kemp/v1p205.txt", head=TRUE)
v1p205 = af(v1p205,c("brand", "car"))
```

```
ANOVA(miles ~ brand + car %in% brand, v1p205) # OK
```

```
$ANOVA
Response : miles
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            9 140.05  15.561   80.21 1.017e-13 ***
RESIDUALS       20   3.88   0.194
CORRECTED TOTAL 29 143.93
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df  Sum Sq Mean Sq  F value    Pr(>F)
brand      4 133.243  33.311 171.7053 3.553e-15 ***
brand:car  5   6.803   1.361   7.0137 0.0006214 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df  Sum Sq Mean Sq  F value    Pr(>F)
brand      4 133.243  33.311 171.7053 3.553e-15 ***
brand:car  5   6.803   1.361   7.0137 0.0006214 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df  Sum Sq Mean Sq  F value    Pr(>F)
brand      4 133.243  33.311 171.7053 3.553e-15 ***
brand:car  5   6.803   1.361   7.0137 0.0006214 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.2 Chapter 7

8.2.1 p232

(105) MODEL

```
v1p232 = read.table("C:/G/Rt/Kemp/v1p232.txt", head=TRUE)
v1p232 = af(v1p232,c("trt"))
ANOVA(yield ~ trt, v1p232) # OK
```

```
$ANOVA
Response : yield
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            4 59.174  14.793  28.781 0.0012 **
RESIDUALS        5  2.570   0.514
CORRECTED TOTAL  9 61.744
---
```

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

$`Type I`
    Df Sum Sq Mean Sq F value Pr(>F)
trt  4 59.174  14.793  28.781 0.0012 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq F value Pr(>F)
trt  4 59.174  14.793  28.781 0.0012 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value Pr(>F)
trt  4 59.174  14.793  28.781 0.0012 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.2.2 p235

(106) MODEL

```
v1p235 = read.table("C:/G/Rt/Kemp/v1p235.txt", head=TRUE)
v1p235 = af(v1p235,c("density"))
ANOVA(yield ~ density, v1p235) # OK
```

```
$ANOVA
Response : yield
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            4 88.007 22.0017  32.198 1.095e-05 ***
RESIDUALS       10  6.833  0.6833
CORRECTED TOTAL 14 94.840
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
        Df Sum Sq Mean Sq F value    Pr(>F)
density  4 88.007  22.002  32.198 1.095e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df Sum Sq Mean Sq F value    Pr(>F)
density  4 88.007  22.002  32.198 1.095e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
        Df Sum Sq Mean Sq F value    Pr(>F)
density  4 88.007  22.002  32.198 1.095e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.3 Chapter 8

8.3.1 p265

(107) MODEL

```
v1p265 = read.table("C:/G/Rt/Kemp/v1p265.txt", head=TRUE)
v1p265 = af(v1p265,c("trt"))
ANOVA(y ~ trt + x, v1p265) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            3 84.678 28.2260  36.866 4.941e-06 ***
RESIDUALS       11  8.422  0.7656
CORRECTED TOTAL 14 93.100
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq F value    Pr(>F)
trt  2 66.868  33.434  43.668 5.858e-06 ***
x    1 17.810  17.810  23.262 0.0005333 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq F value    Pr(>F)
trt  2 83.147  41.573  54.299 1.996e-06 ***
x    1 17.810  17.810  23.262 0.0005333 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value    Pr(>F)
trt  2 83.147  41.573  54.299 1.996e-06 ***
x    1 17.810  17.810  23.262 0.0005333 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.3.2 p272

(108) MODEL

```
ANOVA(y ~ trt + x %in% trt, v1p265) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            5 85.711  17.142  20.881 0.0001046 ***
RESIDUALS        9  7.389   0.821
CORRECTED TOTAL 14 93.100
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
trt    2 66.868  33.434 40.7254 3.092e-05 ***
trt:x  3 18.843   6.281  7.6509  0.007578 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
trt    2 66.868  33.434 40.7254 3.092e-05 ***
trt:x  3 18.843   6.281  7.6509  0.007578 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df  Sum Sq Mean Sq F value   Pr(>F)
trt    2  6.1392  3.0696  3.7390 0.065769 .
trt:x  3 18.8433  6.2811  7.6509 0.007578 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.3.3 p273

(109) MODEL

```
ANOVA(y ~ trt + x + x %in% trt, v1p265) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            5 85.711  17.142  20.881 0.0001046 ***
RESIDUALS        9  7.389   0.821
CORRECTED TOTAL 14 93.100
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
```

```
      Df Sum Sq Mean Sq F value    Pr(>F)
trt    2 66.868  33.434 40.7254 3.092e-05 ***
x      1 17.810  17.810 21.6940  0.001189 **
trt:x  2  1.033   0.517  0.6294  0.554843
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
trt    2 83.147  41.573 50.6397 1.267e-05 ***
x      1 17.810  17.810 21.6940  0.001189 **
trt:x  2  1.033   0.517  0.6294  0.554843
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df  Sum Sq Mean Sq F value   Pr(>F)
trt    2  6.1392  3.0696  3.7390 0.065769 .
x      1 17.2071 17.2071 20.9597 0.001331 **
trt:x  2  1.0334  0.5167  0.6294 0.554843
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.4 Chapter 9

8.4.1 p344

(110) MODEL

```
v1p344 = read.table("C:/G/Rt/Kemp/v1p344.txt", head=TRUE)
v1p344 = af(v1p344,c("diet", "litter"))
ANOVA(gain ~ litter + diet, v1p344)
```

```
$ANOVA
Response : gain
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            9 4915.6  546.18  15.544 3.363e-07 ***
RESIDUALS       20  702.8   35.14
CORRECTED TOTAL 29 5618.4
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df Sum Sq Mean Sq F value    Pr(>F)
litter  5 4438.0   887.6 25.2608 5.298e-08 ***
diet    4  477.6   119.4  3.3981   0.02824 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
       Df Sum Sq Mean Sq F value    Pr(>F)
litter  5 4438.0   887.6 25.2608 5.298e-08 ***
diet    4  477.6   119.4  3.3981   0.02824 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
       Df Sum Sq Mean Sq F value    Pr(>F)
litter  5 4438.0   887.6 25.2608 5.298e-08 ***
diet    4  477.6   119.4  3.3981   0.02824 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.4.2 p349

(111) MODEL

```
v1p349 = read.table("C:/G/Rt/Kemp/v1p349.txt", head=TRUE)
v1p349 = af(v1p349,c("subject", "exercise"))
ANOVA(diast ~ subject + exercise + subject:exercise, v1p349) # OK
```

```
$ANOVA
Response : diast
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           14 1541.5 110.105  28.475 2.953e-08 ***
RESIDUALS       15   58.0   3.867
CORRECTED TOTAL 29 1599.5
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
                 Df Sum Sq Mean Sq F value    Pr(>F)
subject           4 905.13 226.283 58.5216 5.672e-09 ***
exercise          2 591.27 295.633 76.4569 1.357e-08 ***
subject:exercise  8  45.07   5.633  1.4569    0.2522
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
                 Df Sum Sq Mean Sq F value    Pr(>F)
subject           4 905.13 226.283 58.5216 5.672e-09 ***
exercise          2 591.27 295.633 76.4569 1.357e-08 ***
subject:exercise  8  45.07   5.633  1.4569    0.2522
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
                 Df Sum Sq Mean Sq F value    Pr(>F)
```

```
subject           4 905.13 226.283 58.5216 5.672e-09 ***
exercise          2 591.27 295.633 76.4569 1.357e-08 ***
subject:exercise  8  45.07   5.633  1.4569    0.2522
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.4.3 p354

(112) MODEL

```
v1p354 = read.table("C:/G/Rt/Kemp/v1p354.txt", head=TRUE)
v1p354 = af(v1p354,c("loc", "block", "HSF"))
ANOVA(height ~ loc + block %in% loc + HSF + loc:HSF + block:loc:HSF, v1p354) # OK
```

```
$ANOVA
Response : height
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           23  40782 1773.12  80.444 < 2.2e-16 ***
RESIDUALS       24    529   22.04
CORRECTED TOTAL 47  41311
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
              Df  Sum Sq Mean Sq  F value    Pr(>F)
loc            1 20336.3 20336.3 922.6314 < 2.2e-16 ***
loc:block      6  1462.3   243.7  11.0573 6.408e-06 ***
HSF            2 12170.7  6085.3 276.0832 < 2.2e-16 ***
loc:HSF        2  6511.2  3255.6 147.7013 3.242e-14 ***
loc:block:HSF 12   301.2    25.1   1.1386    0.3769
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
              Df  Sum Sq Mean Sq  F value    Pr(>F)
loc            1 20336.3 20336.3 922.6314 < 2.2e-16 ***
loc:block      6  1462.3   243.7  11.0573 6.408e-06 ***
HSF            2 12170.7  6085.3 276.0832 < 2.2e-16 ***
loc:HSF        2  6511.2  3255.6 147.7013 3.242e-14 ***
loc:block:HSF 12   301.2    25.1   1.1386    0.3769
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
              Df  Sum Sq Mean Sq  F value    Pr(>F)
loc            1 20336.3 20336.3 922.6314 < 2.2e-16 ***
loc:block      6  1462.3   243.7  11.0573 6.408e-06 ***
HSF            2 12170.7  6085.3 276.0832 < 2.2e-16 ***
loc:HSF        2  6511.2  3255.6 147.7013 3.242e-14 ***
```

```
loc:block:HSF 12   301.2    25.1   1.1386    0.3769
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.4.4 p357

(113) MODEL

```
v1p357 = read.table("C:/G/Rt/Kemp/v1p357.txt", head=TRUE)
v1p357 = af(v1p357,c("var", "N"))
ANOVA(y ~ var + N + var:N, v1p357) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL            9 4465.5  496.16  14.116 0.000142 ***
RESIDUALS       10  351.5   35.15
CORRECTED TOTAL 19 4817.0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
var    1  140.5  140.45  3.9957  0.073519 .
N      4 3393.7  848.42 24.1373 4.027e-05 ***
var:N  4  931.3  232.82  6.6238  0.007152 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
var    1  140.5  140.45  3.9957  0.073519 .
N      4 3393.7  848.43 24.1373 4.027e-05 ***
var:N  4  931.3  232.82  6.6238  0.007152 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq F value    Pr(>F)
var    1  140.5  140.45  3.9957  0.073519 .
N      4 3393.7  848.42 24.1373 4.027e-05 ***
var:N  4  931.3  232.83  6.6238  0.007152 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.4.5 p361

(114) MODEL

```
v1p361 = read.table("C:/G/Rt/Kemp/v1p361.txt", head=TRUE)
v1p361 = af(v1p361,c("block", "trt"))
ANOVA(y ~ block + trt, v1p361) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            4 241.33  60.333  40.222 0.1176
RESIDUALS        1   1.50   1.500
CORRECTED TOTAL  5 242.83

$`Type I`
      Df  Sum Sq Mean Sq F value  Pr(>F)
block  2  24.333  12.167  8.1111 0.24097
trt    2 217.000 108.500 72.3333 0.08286 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value  Pr(>F)
block  2    108    54.0  36.000 0.11704
trt    2    217   108.5  72.333 0.08286 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq F value  Pr(>F)
block  2    108    54.0  36.000 0.11704
trt    2    217   108.5  72.333 0.08286 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
y = model.frame(y ~ block + trt, v1p361)[,1]
x = ModelMatrix(y ~ block + trt, v1p361)
rx = lfit(x, y)
K = cbind(rep(1, 3), matrix(1/3, nrow=3, ncol=3), diag(3)) ; K
```

```
     [,1]      [,2]      [,3]      [,4] [,5] [,6] [,7]
[1,]    1 0.3333333 0.3333333 0.3333333    1    0    0
[2,]    1 0.3333333 0.3333333 0.3333333    0    1    0
[3,]    1 0.3333333 0.3333333 0.3333333    0    0    1
```

```
est(K, x$X, rx)
```

```
     Estimate  Lower CL Upper CL Std. Error  t value Df   Pr(>|t|)
[1,]     29.5 17.334735 41.66526  0.9574271 30.81175  1 0.02065434
[2,]     16.5  4.334735 28.66526  0.9574271 17.23369  1 0.03689905
[3,]     13.5  1.334735 25.66526  0.9574271 14.10029  1 0.04507394
attr(,"Estimability")
```

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

8.5 Chapter 10

8.5.1 p405

(115) MODEL

```
v1p405 = read.table("C:/G/Rt/Kemp/v1p405.txt", head=TRUE)
v1p405 = af(v1p405,c("trt", "Row", "Col"))
ANOVA(y ~ Row + Col + trt, v1p405) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value  Pr(>F)
MODEL           12 4094.7  341.23  2.3416 0.07739 .
RESIDUALS       12 1748.7  145.73
CORRECTED TOTAL 24 5843.4
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df  Sum Sq Mean Sq F value  Pr(>F)
Row  4  514.24  128.56  0.8822 0.50328
Col  4 1711.44  427.86  2.9360 0.06611 .
trt  4 1869.04  467.26  3.2064 0.05229 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq F value  Pr(>F)
Row  4  514.24  128.56  0.8822 0.50328
Col  4 1711.44  427.86  2.9360 0.06611 .
trt  4 1869.04  467.26  3.2064 0.05229 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value  Pr(>F)
Row  4  514.24  128.56  0.8822 0.50328
Col  4 1711.44  427.86  2.9360 0.06611 .
trt  4 1869.04  467.26  3.2064 0.05229 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.5.2 p408

(116) MODEL

```
v1p408 = read.table("C:/G/Rt/Kemp/v1p408.txt", head=TRUE)
v1p408 = af(v1p408,c("breed", "farm", "wclass", "dosage"))
ANOVA(response ~ breed + breed:farm + wclass + dosage + breed:dosage, v1p408) # OK
```

```
$ANOVA
Response : response
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           16 4470.2 279.391  140.87 2.039e-13 ***
RESIDUALS       15   29.7   1.983
CORRECTED TOTAL 31 4500.0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
             Df Sum Sq Mean Sq   F value    Pr(>F)
breed         1 3280.5  3280.5 1654.0336 < 2.2e-16 ***
breed:farm    6    9.0     1.5    0.7563    0.6146
wclass        3  466.8   155.6   78.4454 2.142e-09 ***
dosage        3  580.2   193.4   97.5210 4.596e-10 ***
breed:dosage  3  133.8    44.6   22.4790 8.366e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
             Df Sum Sq Mean Sq   F value    Pr(>F)
breed         1 3280.5  3280.5 1654.0336 < 2.2e-16 ***
breed:farm    6    9.0     1.5    0.7563    0.6146
wclass        3  466.7   155.6   78.4454 2.142e-09 ***
dosage        3  580.2   193.4   97.5210 4.596e-10 ***
breed:dosage  3  133.8    44.6   22.4790 8.366e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
             Df Sum Sq Mean Sq   F value    Pr(>F)
breed         1 3280.5  3280.5 1654.0336 < 2.2e-16 ***
breed:farm    6    9.0     1.5    0.7563    0.6146
wclass        3  466.8   155.6   78.4454 2.142e-09 ***
dosage        3  580.3   193.4   97.5210 4.596e-10 ***
breed:dosage  3  133.7    44.6   22.4790 8.366e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.5.3 p410

(117) MODEL

```
v1p410 = read.table("C:/G/Rt/Kemp/v1p410.txt", head=TRUE)
v1p410$carry = ifelse(v1p410$carry == 0, 3, v1p410$carry)
v1p410 = af(v1p410,c("period", "sequence", "steer", "trt", "carry"))
ANOVA(y ~ period + sequence + steer:sequence + trt + carry, v1p410) # OK
```

```
$ANOVA
Response : y
                 Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL            17 1302.51  76.618  8.7402 1.572e-05 ***
RESIDUALS        18  157.79   8.766
CORRECTED TOTAL  35 1460.31
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
               Df Sum Sq Mean Sq F value    Pr(>F)
period          2 292.06 146.028 16.6580 8.038e-05 ***
sequence        5 326.47  65.294  7.4484 0.0006072 ***
sequence:steer  6 118.50  19.750  2.2530 0.0849122 .
trt             2 549.06 274.528 31.3166 1.377e-06 ***
carry           2  16.43   8.215  0.9372 0.4100385
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
               Df Sum Sq Mean Sq F value    Pr(>F)
period          2 172.31  86.154  9.8279 0.0013030 **
sequence        5 318.69  63.738  7.2709 0.0006954 ***
sequence:steer  6 118.50  19.750  2.2530 0.0849122 .
trt             2 440.61 220.304 25.1311 6.164e-06 ***
carry           2  16.43   8.215  0.9372 0.4100385
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
               Df Sum Sq Mean Sq F value    Pr(>F)
period          2 172.31  86.154  9.8279 0.0013030 **
sequence        5 318.69  63.738  7.2709 0.0006954 ***
sequence:steer  6 118.50  19.750  2.2530 0.0849122 .
trt             2 440.61 220.304 25.1311 6.164e-06 ***
carry           2  16.43   8.215  0.9372 0.4100385
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(y ~ period + sequence + steer:sequence + trt + carry, v1p410), type=3,
      singular.ok=TRUE) # NOT OK for sequence
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: y
               Sum Sq Df F values    Pr(>F)
period         172.31  2   9.8279  0.001303 **
sequence         0.00  0
trt            440.61  2  25.1311 6.164e-06 ***
carry           16.43  2   0.9372  0.410038
sequence:steer 118.50  6   2.2530  0.084912 .
Residuals      157.79 18
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.6 Chapter 11

8.6.1 p432

(118) MODEL

```
v1p432 = read.table("C:/G/Rt/Kemp/v1p432.txt", head=TRUE)
v1p432 = af(v1p432,c("V", "Block", "A", "B", "C"))
ANOVA(Y ~ V + Block:V + A + B + A:B + V:A + V:B + V:A:B + Block:A:V + Block:B:V,
    v1p432) # OK
```

```
$ANOVA
Response : Y
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            94 261663 2783.65  30.584 2.065e-14 ***
RESIDUALS        25   2275   91.02
CORRECTED TOTAL 119 263939
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df Sum Sq Mean Sq  F value    Pr(>F)
V          4 102743   25686 282.2094 < 2.2e-16 ***
V:Block   25  50019    2001  21.9825 1.588e-11 ***
A          1  18451   18451 202.7233 1.692e-13 ***
B          1  78541   78541 862.9280 < 2.2e-16 ***
A:B        1    108     108   1.1899   0.28575
V:A        4   3751     938  10.3023 4.532e-05 ***
V:B        4    307      77   0.8421   0.51168
V:A:B      4   1495     374   4.1058   0.01081 *
V:Block:A 25   3416     137   1.5011   0.15818
V:Block:B 25   2833     113   1.2451   0.29390
---
```

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

$`Type II`
          Df Sum Sq Mean Sq  F value    Pr(>F)
V          4 102743   25686 282.2094 < 2.2e-16 ***
V:Block   25  50019    2001  21.9825 1.588e-11 ***
A          1  18451   18451 202.7233 1.692e-13 ***
B          1  78541   78541 862.9280 < 2.2e-16 ***
A:B        1    108     108   1.1899   0.28575
V:A        4   3751     938  10.3023 4.532e-05 ***
V:B        4    307      77   0.8421   0.51168
V:A:B      4   1495     374   4.1058   0.01081 *
V:Block:A 25   3416     137   1.5011   0.15818
V:Block:B 25   2833     113   1.2451   0.29390
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df Sum Sq Mean Sq  F value    Pr(>F)
V          4 102743   25686 282.2094 < 2.2e-16 ***
V:Block   25  50019    2001  21.9825 1.588e-11 ***
A          1  18451   18451 202.7233 1.692e-13 ***
B          1  78541   78541 862.9280 < 2.2e-16 ***
A:B        1    108     108   1.1899   0.28575
V:A        4   3751     938  10.3023 4.532e-05 ***
V:B        4    307      77   0.8421   0.51168
V:A:B      4   1495     374   4.1058   0.01081 *
V:Block:A 25   3416     137   1.5011   0.15818
V:Block:B 25   2833     113   1.2451   0.29390
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.6.2 p434

(119) MODEL

```
ANOVA(Y ~ V + Block:V + A + B + A:B + V:A + V:B + V:A:B, v1p432) # OK
```

```
$ANOVA
Response : Y
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            44 255415  5804.9  51.075 < 2.2e-16 ***
RESIDUALS        75   8524   113.7
CORRECTED TOTAL 119 263939
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
        Df Sum Sq Mean Sq  F value    Pr(>F)
```

```
V        4 102743   25686 225.9988 < 2.2e-16 ***
V:Block 25  50019    2001  17.6040 < 2.2e-16 ***
A        1  18451   18451 162.3447 < 2.2e-16 ***
B        1  78541   78541 691.0494 < 2.2e-16 ***
A:B      1    108     108   0.9529   0.33212
V:A      4   3751     938   8.2503 1.435e-05 ***
V:B      4    307      77   0.6744   0.61182
V:A:B    4   1495     374   3.2880   0.01541 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df Sum Sq Mean Sq  F value    Pr(>F)
V        4 102743   25686 225.9988 < 2.2e-16 ***
V:Block 25  50019    2001  17.6040 < 2.2e-16 ***
A        1  18451   18451 162.3447 < 2.2e-16 ***
B        1  78541   78541 691.0494 < 2.2e-16 ***
A:B      1    108     108   0.9529   0.33212
V:A      4   3751     938   8.2503 1.435e-05 ***
V:B      4    307      77   0.6744   0.61182
V:A:B    4   1495     374   3.2880   0.01541 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
        Df Sum Sq Mean Sq  F value    Pr(>F)
V        4 102743   25686 225.9988 < 2.2e-16 ***
V:Block 25  50019    2001  17.6040 < 2.2e-16 ***
A        1  18451   18451 162.3447 < 2.2e-16 ***
B        1  78541   78541 691.0494 < 2.2e-16 ***
A:B      1    108     108   0.9529   0.33212
V:A      4   3751     938   8.2503 1.435e-05 ***
V:B      4    307      77   0.6744   0.61182
V:A:B    4   1495     374   3.2880   0.01541 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.6.3 p438

(120) MODEL

```
ANOVA(Y ~ V + Block:V + C + V:C, v1p432) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           44 255415  5804.9  51.075 < 2.2e-16 ***
RESIDUALS       75   8524   113.7
CORRECTED TOTAL 119 263939
```

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

$`Type I`
        Df Sum Sq Mean Sq  F value    Pr(>F)
V        4 102743   25686 225.9988 < 2.2e-16 ***
V:Block 25  50019    2001  17.6040 < 2.2e-16 ***
C        3  97100   32367 284.7823 < 2.2e-16 ***
V:C     12   5552     463   4.0709  7.23e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df Sum Sq Mean Sq  F value    Pr(>F)
V        4 102743   25686 225.9988 < 2.2e-16 ***
V:Block 25  50019    2001  17.6040 < 2.2e-16 ***
C        3  97100   32367 284.7823 < 2.2e-16 ***
V:C     12   5552     463   4.0709  7.23e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
        Df Sum Sq Mean Sq  F value    Pr(>F)
V        4 102743   25686 225.9988 < 2.2e-16 ***
V:Block 25  50019    2001  17.6040 < 2.2e-16 ***
C        3  97100   32367 284.7823 < 2.2e-16 ***
V:C     12   5552     463   4.0709  7.23e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.6.4 p444

(121) MODEL

```
v1p444 = v1p432[v1p432$Block==5,]
ANOVA(Y ~ V + A + B + A:B + V:A, v1p444) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           11  39278  3570.8  59.787 1.897e-06 ***
RESIDUALS        8    478    59.7
CORRECTED TOTAL 19  39756
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
V    4 19287.7  4821.9  80.7355 1.674e-06 ***
```

```
A    1  3380.0  3380.0  56.5927 6.780e-05 ***
B    1 14045.0 14045.0 235.1612 3.247e-07 ***
A:B  1   115.2   115.2   1.9288  0.202326
V:A  4  2450.5   612.6  10.2574  0.003081 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
V    4 19287.7  4821.9  80.7355 1.674e-06 ***
A    1  3380.0  3380.0  56.5927 6.780e-05 ***
B    1 14045.0 14045.0 235.1612 3.247e-07 ***
A:B  1   115.2   115.2   1.9288  0.202326
V:A  4  2450.5   612.6  10.2574  0.003081 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
V    4 19287.7  4821.9  80.7355 1.674e-06 ***
A    1  3380.0  3380.0  56.5927 6.780e-05 ***
B    1 14045.0 14045.0 235.1612 3.247e-07 ***
A:B  1   115.2   115.2   1.9288  0.202326
V:A  4  2450.5   612.6  10.2574  0.003081 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.6.5 p482

(122) MODEL

```
v1p482 = read.table("C:/G/Rt/Kemp/v1p482.txt", head=TRUE)
v1p482 = af(v1p482,c("block", "A", "B"))
ANOVA(y ~ block + A + B + A:B, v1p482) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            8 156.88 19.6094  9.8871 9.377e-05 ***
RESIDUALS       15  29.75  1.9833
CORRECTED TOTAL 23 186.62
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
block  5 108.38  21.675 10.9286 0.0001415 ***
A      1   4.00   4.000  2.0168 0.1760166
B      1  42.25  42.250 21.3025 0.0003365 ***
```

```
A:B    1   2.25   2.250  1.1345 0.3036727
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
block  5 31.417   6.283  3.1681 0.0377804 *
A      1  4.000   4.000  2.0168 0.1760166
B      1 42.250  42.250 21.3025 0.0003365 ***
A:B    1  2.250   2.250  1.1345 0.3036727
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq F value    Pr(>F)
block  5 31.417   6.283  3.1681 0.0377804 *
A      1  4.000   4.000  2.0168 0.1760166
B      1 42.250  42.250 21.3025 0.0003365 ***
A:B    1  2.250   2.250  1.1345 0.3036727
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.7 Chapter 12

8.7.1 p525

(123) MODEL

```
v1p525 = read.table("C:/G/Rt/Kemp/v1p525.txt", head=TRUE)
REG(y ~ x1 + x2 + x3, v1p525)
```

```
            Estimate Std. Error Df  t value  Pr(>|t|)
(Intercept)  14.2125    0.10383 12 136.8787 < 2.2e-16 ***
x1            0.7875    0.10383 12   7.5843 6.465e-06 ***
x2            1.3875    0.10383 12  13.3628 1.446e-08 ***
x3            1.6625    0.10383 12  16.0113 1.839e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
ANOVA(y ~ x1 + x2 + x3, v1p525) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL            3 84.948 28.3158  164.15 5.26e-10 ***
RESIDUALS       12  2.070  0.1725
CORRECTED TOTAL 15 87.018
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
   Df Sum Sq Mean Sq F value    Pr(>F)
x1  1  9.923   9.923  57.522 6.465e-06 ***
x2  1 30.803  30.803 178.565 1.446e-08 ***
x3  1 44.223  44.223 256.362 1.839e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
   Df Sum Sq Mean Sq F value    Pr(>F)
x1  1  9.923   9.923  57.522 6.465e-06 ***
x2  1 30.803  30.803 178.565 1.446e-08 ***
x3  1 44.223  44.223 256.362 1.839e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
   Df Sum Sq Mean Sq F value    Pr(>F)
x1  1  9.923   9.923  57.522 6.465e-06 ***
x2  1 30.803  30.803 178.565 1.446e-08 ***
x3  1 44.223  44.223 256.362 1.839e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.7.2 p527

(124) MODEL

```
v1p527 = read.table("C:/G/Rt/Kemp/v1p527.txt", head=TRUE)
ANOVA(y ~ A + B, v1p527) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value  Pr(>F)
MODEL            2  22.99 11.4952  4.8917 0.04686 *
RESIDUALS        7  16.45  2.3499
CORRECTED TOTAL  9  39.44
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
  Df Sum Sq Mean Sq F value  Pr(>F)
A  1 10.364  10.364  4.4103 0.07386 .
B  1 12.626  12.626  5.3730 0.05355 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
  Df Sum Sq Mean Sq F value  Pr(>F)
```

```
A  1 10.364  10.364  4.4103 0.07386 .
B  1 12.626  12.626  5.3730 0.05355 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
  Df Sum Sq Mean Sq F value  Pr(>F)
A  1 10.364  10.364  4.4103 0.07386 .
B  1 12.626  12.626  5.3730 0.05355 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.7.3 p529

(125) MODEL

```
v1p529 = read.table("C:/G/Rt/Kemp/v1p529.txt", head=TRUE)
ANOVA(y ~ A + B + I(A*A) + I(B*B) + I(A*B), v1p529) # OK
```

```
$ANOVA
Response : y
               Df Sum Sq Mean Sq F value  Pr(>F)
MODEL           5 35.713  7.1427  6.7928 0.01857 *
RESIDUALS       6  6.309  1.0515
CORRECTED TOTAL 11 42.023
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
         Df  Sum Sq Mean Sq F value  Pr(>F)
A         1 11.6012 11.6012 11.0329 0.01597 *
B         1 12.6263 12.6263 12.0077 0.01338 *
I(A * A)  1  1.7167  1.7167  1.6326 0.24855
I(B * B)  1  5.3593  5.3593  5.0967 0.06476 .
I(A * B)  1  4.4100  4.4100  4.1940 0.08649 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
         Df  Sum Sq Mean Sq F value  Pr(>F)
A         1 11.6012 11.6012 11.0329 0.01597 *
B         1 12.6263 12.6263 12.0077 0.01338 *
I(A * A)  1  5.5468  5.5468  5.2750 0.06137 .
I(B * B)  1  5.3593  5.3593  5.0967 0.06476 .
I(A * B)  1  4.4100  4.4100  4.1940 0.08649 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
```

```
          Df  Sum Sq Mean Sq F value  Pr(>F)
A          1 11.6012 11.6012 11.0329 0.01597 *
B          1 12.6263 12.6263 12.0077 0.01338 *
I(A * A)   1  5.5468  5.5468  5.2750 0.06137 .
I(B * B)   1  5.3593  5.3593  5.0967 0.06476 .
I(A * B)   1  4.4100  4.4100  4.1940 0.08649 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.8 Chapter 13

8.8.1 p563

(126) MODEL

```
v1p563 = read.table("C:/G/Rt/Kemp/v1p563.txt", head=TRUE)
v1p563 = af(v1p563, c("rep", "A", "B"))
ANOVA(y ~ rep + A + rep:A + B + A:B, v1p563) # OK
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           14 2097.08 149.792  17.228 8.385e-05 ***
RESIDUALS        9   78.25   8.694
CORRECTED TOTAL 23 2175.33
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df  Sum Sq Mean Sq F value    Pr(>F)
rep    3 1241.00  413.67 47.5783 7.606e-06 ***
A      2  353.08  176.54 20.3051 0.0004613 ***
rep:A  6  192.25   32.04  3.6853 0.0393557 *
B      1  216.00  216.00 24.8435 0.0007550 ***
A:B    2   94.75   47.38  5.4489 0.0281496 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df  Sum Sq Mean Sq F value    Pr(>F)
rep    3 1241.00  413.67 47.5783 7.606e-06 ***
A      2  353.08  176.54 20.3051 0.0004613 ***
rep:A  6  192.25   32.04  3.6853 0.0393557 *
B      1  216.00  216.00 24.8435 0.0007550 ***
A:B    2   94.75   47.38  5.4489 0.0281496 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
```

```
      Df  Sum Sq Mean Sq F value    Pr(>F)
rep    3 1241.00  413.67 47.5783 7.606e-06 ***
A      2  353.08  176.54 20.3051 0.0004613 ***
rep:A  6  192.25   32.04  3.6853 0.0393557 *
B      1  216.00  216.00 24.8435 0.0007550 ***
A:B    2   94.75   47.38  5.4489 0.0281496 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.8.2 p566

(127) MODEL

```
v1p566 = read.table("C:/G/Rt/Kemp/v1p566.txt", head=TRUE)
v1p566 = af(v1p566, c("subject", "A", "B"))
ANOVA(y ~ A + B + A:B, v1p566) # OK
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL            5 1469.58  293.92    86.2 5.592e-09 ***
RESIDUALS       12   40.92    3.41
CORRECTED TOTAL 17 1510.50
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
A    2 1390.04  695.02 203.8350 5.466e-10 ***
B    1   76.06   76.06  22.3055 0.0004945 ***
A:B  2    3.49    1.74   0.5112 0.6122667
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
A    2 1390.04  695.02 203.8350 5.466e-10 ***
B    1   76.06   76.06  22.3055 0.0004945 ***
A:B  2    3.49    1.74   0.5112 0.6122667
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq  F value    Pr(>F)
A    2 1390.04  695.02 203.8350 5.466e-10 ***
B    1   79.00   79.00  23.1700 0.0004237 ***
A:B  2    3.49    1.74   0.5112 0.6122667
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

8.9 Chapter 14

8.9.1 p581

(128) MODEL

```
v1p581 = read.table("C:/G/Rt/Kemp/v1p581.txt", head=TRUE)
v1p581 = af(v1p581, c("drug", "person", "time"))
ANOVA(rate ~ drug + person:drug + time + drug:time, v1p581) # OK
```

```
$ANOVA
Response : rate
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           23 2449.5 106.500  12.733 3.469e-11 ***
RESIDUALS       36  301.1   8.364
CORRECTED TOTAL 59 2750.6
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
            Df  Sum Sq Mean Sq F value    Pr(>F)
drug         2  337.60 168.800 20.1820 1.323e-06 ***
drug:person 12 1498.50 124.875 14.9303 1.501e-10 ***
time         3  256.33  85.444 10.2159 5.230e-05 ***
drug:time    6  357.07  59.511  7.1152 4.707e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df  Sum Sq Mean Sq F value    Pr(>F)
drug         2  337.60 168.800 20.1820 1.323e-06 ***
drug:person 12 1498.50 124.875 14.9303 1.501e-10 ***
time         3  256.33  85.444 10.2159 5.230e-05 ***
drug:time    6  357.07  59.511  7.1152 4.707e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
            Df  Sum Sq Mean Sq F value    Pr(>F)
drug         2  337.60 168.800 20.1820 1.323e-06 ***
drug:person 12 1498.50 124.875 14.9303 1.501e-10 ***
time         3  256.33  85.444 10.2159 5.230e-05 ***
drug:time    6  357.07  59.511  7.1152 4.707e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9 Hinkelmann & Kempthorne - Volume 2

Reference - Hinkelmann K, Kempthorne O. Design and Analysis of Experiments Volume 2 Advanced Experimental Design. 2e. John Wiley & Sons Inc. 2008.

9.1 Chapter 1

9.1.1 p53

(129) MODEL

```
v2p53 = read.table("C:/G/Rt/Kemp/v2p53.txt", head=TRUE)
v2p53 = af(v2p53, c("TRT", "BLOCK"))
ANOVA(Y ~ BLOCK + TRT, v2p53) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            7 518.21  74.030  8.1408 0.1137
RESIDUALS        2  18.19   9.094
CORRECTED TOTAL  9 536.40

$`Type I`
      Df Sum Sq Mean Sq F value  Pr(>F)
BLOCK  4 261.40  65.350  7.1863 0.12587
TRT    3 256.81  85.604  9.4135 0.09755 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df  Sum Sq Mean Sq F value  Pr(>F)
BLOCK  4  79.146  19.786  2.1758 0.33880
TRT    3 256.812  85.604  9.4135 0.09755 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df  Sum Sq Mean Sq F value  Pr(>F)
BLOCK  4  79.146  19.786  2.1758 0.33880
TRT    3 256.813  85.604  9.4135 0.09755 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.1.2 p62

(130) MODEL

```
ANOVA(Y ~ TRT + BLOCK, v2p53) # OK
```

```
$ANOVA
```

```
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            7 518.21  74.030  8.1408 0.1137
RESIDUALS        2  18.19   9.094
CORRECTED TOTAL  9 536.40

$`Type I`
      Df Sum Sq Mean Sq F value  Pr(>F)
TRT    3 439.07 146.356 16.0941 0.05907 .
BLOCK  4  79.15  19.786  2.1758 0.33880
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df  Sum Sq Mean Sq F value  Pr(>F)
TRT    3 256.812  85.604  9.4135 0.09755 .
BLOCK  4  79.146  19.786  2.1758 0.33880
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df  Sum Sq Mean Sq F value  Pr(>F)
TRT    3 256.813  85.604  9.4135 0.09755 .
BLOCK  4  79.146  19.786  2.1758 0.33880
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.2 Chapter 2

9.2.1 p82

(131) MODEL

```
v2p82 = read.table("C:/G/Rt/Kemp/v2p82.txt", head=TRUE)
v2p82 = af(v2p82, c("B", "Tx"))
ANOVA(Y ~ B + Tx, v2p82) # OK
```

```
$ANOVA
Response : Y
                Df  Sum Sq Mean Sq F value   Pr(>F)
MODEL           14  889.11  63.508  6.3183 0.000518 ***
RESIDUALS       15  150.77  10.052
CORRECTED TOTAL 29 1039.89
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
   Df Sum Sq Mean Sq F value    Pr(>F)
B   9 730.39  81.154  8.0738 0.0002454 ***
```

```
Tx  5 158.73  31.745  3.1583 0.0381655 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
   Df Sum Sq Mean Sq F value    Pr(>F)
B   9 595.74  66.193  6.5854 0.0007602 ***
Tx  5 158.73  31.745  3.1583 0.0381655 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
   Df Sum Sq Mean Sq F value    Pr(>F)
B   9 595.74  66.193  6.5854 0.0007602 ***
Tx  5 158.73  31.745  3.1583 0.0381655 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.2.2 p87

(132) MODEL

```
v2p87 = read.table("C:/G/Rt/Kemp/v2p87.txt", head=TRUE)
ANOVA(y ~ x1 + x2 + x3 + x4 + x5 + x6, v2p87) # OK
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            5 1613.25  322.65  2.2332 0.2282
RESIDUALS        4  577.91  144.48
CORRECTED TOTAL  9 2191.16

$`Type I`
   Df  Sum Sq Mean Sq F value  Pr(>F)
x1  1 1044.48 1044.48  7.2293 0.05473 .
x2  1   89.79   89.79  0.6215 0.47459
x3  1   10.45   10.45  0.0724 0.80124
x4  1  407.08  407.08  2.8176 0.16854
x5  1   61.44   61.44  0.4253 0.54990
x6  0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
   Df Sum Sq Mean Sq F value Pr(>F)
x1  0
x2  0
x3  0
x4  0
```

```
x5  0
x6  0

$`Type III`
CAUTION: Singularity Exists !
   Df Sum Sq Mean Sq F value Pr(>F)
x1  0
x2  0
x3  0
x4  0
x5  0
x6  0
```

9.3 Chapter 6

9.3.1 p217

(133) MODEL

```
v2p217 = read.table("C:/G/Rt/Kemp/v2p217.txt", head=TRUE)
v2p217 = af(v2p217, c("R", "C", "Tx"))
ANOVA(Y ~ R + C + Tx, v2p217) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           22 4305.1 195.687  7.5094 0.0002682 ***
RESIDUALS       13  338.8  26.059
CORRECTED TOTAL 35 4643.9
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
   Df Sum Sq Mean Sq F value    Pr(>F)
R   3 3951.4 1317.15 50.5446 1.998e-07 ***
C   8  168.9   21.11  0.8101    0.6062
Tx 11  184.8   16.80  0.6446    0.7638
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
   Df Sum Sq Mean Sq F value   Pr(>F)
R   3 3403.5 1134.51 43.5360 4.83e-07 ***
C   8  112.4   14.05  0.5390   0.8077
Tx 11  184.8   16.80  0.6446   0.7638
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
```

```
   Df Sum Sq Mean Sq F value   Pr(>F)
R   3 3403.5 1134.51 43.5360 4.83e-07 ***
C   8  112.4   14.05  0.5390   0.8077
Tx 11  184.8   16.80  0.6446   0.7638
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.3.2 p234

(134) MODEL

```
v2p234 = read.table("C:/G/Rt/Kemp/v2p234.txt", head=TRUE)
v2p234 = af(v2p234, c("R", "C", "Tx"))
ANOVA(Y ~ C + R + Tx, v2p234) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           13 426.50  32.808  7.0936 0.1302
RESIDUALS        2   9.25   4.625
CORRECTED TOTAL 15 435.75

$`Type I`
   Df Sum Sq Mean Sq F value  Pr(>F)
C   3  16.25   5.417  1.1712 0.49129
R   3 357.25 119.083 25.7477 0.03762 *
Tx  7  53.00   7.571  1.6371 0.43052
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
   Df Sum Sq Mean Sq F value Pr(>F)
C   3  10.25   3.417  0.7387 0.6189
R   3 285.50  95.167 20.5766 0.0467 *
Tx  7  53.00   7.571  1.6371 0.4305
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
   Df Sum Sq Mean Sq F value Pr(>F)
C   3  10.25   3.417  0.7387 0.6189
R   3 285.50  95.167 20.5766 0.0467 *
Tx  7  53.00   7.571  1.6371 0.4305
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.4 Chapter 7

9.4.1 p268

(135) MODEL

```
v2p268 = read.table("C:/G/Rt/Kemp/v2p268.txt", head=TRUE)
v2p268 = af(v2p268, c("A", "B", "C"))
ANOVA(y ~ block + A*B*C, v2p268) # OK
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL            8 1026.00 128.250  24.981 0.0001765 ***
RESIDUALS        7   35.94   5.134
CORRECTED TOTAL 15 1061.94
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq  F value    Pr(>F)
block  1 715.56  715.56 139.3791 7.093e-06 ***
A      1  68.06   68.06  13.2574 0.0082753 **
B      1   0.06    0.06   0.0122 0.9152401
A:B    1   0.56    0.56   0.1096 0.7503276
C      1 232.56  232.56  45.2991 0.0002698 ***
A:C    1   0.06    0.06   0.0122 0.9152401
B:C    1   7.56    7.56   1.4730 0.2642229
A:B:C  1   1.56    1.56   0.3043 0.5983312
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq  F value    Pr(>F)
block  1 715.56  715.56 139.3791 7.093e-06 ***
A      1  68.06   68.06  13.2574 0.0082753 **
B      1   0.06    0.06   0.0122 0.9152401
A:B    1   0.56    0.56   0.1096 0.7503276
C      1 232.56  232.56  45.2991 0.0002698 ***
A:C    1   0.06    0.06   0.0122 0.9152401
B:C    1   7.56    7.56   1.4730 0.2642229
A:B:C  1   1.56    1.56   0.3043 0.5983312
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq  F value    Pr(>F)
block  1 715.56  715.56 139.3791 7.093e-06 ***
A      1  68.06   68.06  13.2574 0.0082753 **
```

```
B      1   0.06    0.06   0.0122 0.9152401
A:B    1   0.56    0.56   0.1096 0.7503276
C      1 232.56  232.56  45.2991 0.0002698 ***
A:C    1   0.06    0.06   0.0122 0.9152401
B:C    1   7.56    7.56   1.4730 0.2642229
A:B:C  1   1.56    1.56   0.3043 0.5983312
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.4.2 p273

(136) MODEL

```
v2p273 = read.table("C:/G/Rt/Kemp/v2p273.txt", head=TRUE)
v2p273 = af(v2p273, c("block", "A", "B", "C"))
ANOVA(y ~ block + A*B*C + block:A:B:C, v2p273) # OK
```

```
$ANOVA
Response : y
               Df Sum Sq Mean Sq F value    Pr(>F)
MODEL          15 2245.0 149.665  129.44 8.427e-14 ***
RESIDUALS      16   18.5   1.156
CORRECTED TOTAL 31 2263.5
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
            Df  Sum Sq Mean Sq   F value    Pr(>F)
block        1 1498.78 1498.78 1296.2432 < 2.2e-16 ***
A            1  132.03  132.03  114.1892 1.083e-08 ***
B            1    0.03    0.03    0.0270   0.87148
A:B          1    1.53    1.53    1.3243   0.26673
C            1  504.03  504.03  435.9189 4.926e-13 ***
A:C          1    0.78    0.78    0.6757   0.42316
B:C          1    3.78    3.78    3.2703   0.08938 .
A:B:C        1    2.53    2.53    2.1892   0.15840
block:A:B:C  7  101.47   14.50   12.5367 1.965e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
            Df  Sum Sq Mean Sq   F value    Pr(>F)
block        1 1498.78 1498.78 1296.2432 < 2.2e-16 ***
A            1  132.03  132.03  114.1892 1.083e-08 ***
B            1    0.03    0.03    0.0270   0.87148
A:B          1    1.53    1.53    1.3243   0.26673
C            1  504.03  504.03  435.9189 4.926e-13 ***
A:C          1    0.78    0.78    0.6757   0.42316
B:C          1    3.78    3.78    3.2703   0.08938 .
```

```
A:B:C        1    2.53    2.53    2.1892   0.15840
block:A:B:C  7  101.47   14.50   12.5367 1.965e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
            Df  Sum Sq Mean Sq   F value    Pr(>F)
block        1 1498.78 1498.78 1296.2432 < 2.2e-16 ***
A            1  132.03  132.03  114.1892 1.083e-08 ***
B            1    0.03    0.03    0.0270   0.87148
A:B          1    1.53    1.53    1.3243   0.26673
C            1  504.03  504.03  435.9189 4.926e-13 ***
A:C          1    0.78    0.78    0.6757   0.42316
B:C          1    3.78    3.78    3.2703   0.08938 .
A:B:C        1    2.53    2.53    2.1892   0.15840
block:A:B:C  7  101.47   14.50   12.5367 1.965e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.5 Chapter 8

9.5.1 p304

(137) MODEL

```
v2p304 = read.table("C:/G/Rt/Kemp/v2p304.txt", head=TRUE)
v2p304 = af(v2p304, c("rep", "block", "A", "B", "C"))
ANOVA(y ~ rep + block %in% rep + A*B*C - A:B:C, v2p304) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            9 699.06  77.674  248.56 5.096e-07 ***
RESIDUALS        6   1.88   0.312
CORRECTED TOTAL 15 700.94
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df Sum Sq Mean Sq F value    Pr(>F)
rep        1 390.06  390.06  1248.2 3.428e-08 ***
rep:block  2   8.12    4.06    13.0 0.0065918 **
A          1  18.06   18.06    57.8 0.0002696 ***
B          1 175.56  175.56   561.8 3.702e-07 ***
A:B        1   0.06    0.06     0.2 0.6704121
C          1  68.06   68.06   217.8 6.083e-06 ***
A:C        1   0.06    0.06     0.2 0.6704121
B:C        1  39.06   39.06   125.0 3.056e-05 ***
---
```

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

$`Type II`
          Df Sum Sq Mean Sq F value    Pr(>F)
rep        1 390.06  390.06  1248.2 3.428e-08 ***
rep:block  2   8.12    4.06    13.0 0.0065918 **
A          1  18.06   18.06    57.8 0.0002696 ***
B          1 175.56  175.56   561.8 3.702e-07 ***
A:B        1   0.06    0.06     0.2 0.6704121
C          1  68.06   68.06   217.8 6.083e-06 ***
A:C        1   0.06    0.06     0.2 0.6704121
B:C        1  39.06   39.06   125.0 3.056e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df Sum Sq Mean Sq F value    Pr(>F)
rep        1 390.06  390.06  1248.2 3.428e-08 ***
rep:block  2   8.12    4.06    13.0 0.0065918 **
A          1  18.06   18.06    57.8 0.0002696 ***
B          1 175.56  175.56   561.8 3.702e-07 ***
A:B        1   0.06    0.06     0.2 0.6704121
C          1  68.06   68.06   217.8 6.083e-06 ***
A:C        1   0.06    0.06     0.2 0.6704121
B:C        1  39.06   39.06   125.0 3.056e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.5.2 p309

(138) MODEL

```
ANOVA(y ~ rep*A*B*C, v2p304) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           15 700.94  46.729
RESIDUALS        0   0.00
CORRECTED TOTAL 15 700.94

$`Type I`
          Df Sum Sq Mean Sq F value Pr(>F)
rep        1 390.06  390.06
A          1  18.06   18.06
rep:A      1   0.06    0.06
B          1 175.56  175.56
rep:B      1   1.56    1.56
A:B        1   0.06    0.06
```

```
rep:A:B    1   0.06    0.06
C          1  68.06   68.06
rep:C      1   0.06    0.06
A:C        1   0.06    0.06
rep:A:C    1   0.06    0.06
B:C        1  39.06   39.06
rep:B:C    1   0.06    0.06
A:B:C      1   7.56    7.56
rep:A:B:C  1   0.56    0.56

$`Type II`
          Df Sum Sq Mean Sq F value Pr(>F)
rep        1 390.06  390.06
A          1  18.06   18.06
rep:A      1   0.06    0.06
B          1 175.56  175.56
rep:B      1   1.56    1.56
A:B        1   0.06    0.06
rep:A:B    1   0.06    0.06
C          1  68.06   68.06
rep:C      1   0.06    0.06
A:C        1   0.06    0.06
rep:A:C    1   0.06    0.06
B:C        1  39.06   39.06
rep:B:C    1   0.06    0.06
A:B:C      1   7.56    7.56
rep:A:B:C  1   0.56    0.56

$`Type III`
          Df Sum Sq Mean Sq F value Pr(>F)
rep        1 390.06  390.06
A          1  18.06   18.06
rep:A      1   0.06    0.06
B          1 175.56  175.56
rep:B      1   1.56    1.56
A:B        1   0.06    0.06
rep:A:B    1   0.06    0.06
C          1  68.06   68.06
rep:C      1   0.06    0.06
A:C        1   0.06    0.06
rep:A:C    1   0.06    0.06
B:C        1  39.06   39.06
rep:B:C    1   0.06    0.06
A:B:C      1   7.56    7.56
rep:A:B:C  1   0.56    0.56
```

9.6 Chapter 9

9.6.1 p343

(139) MODEL

```
v2p343 = read.table("C:/G/Rt/Kemp/v2p343.txt", head=TRUE)
v2p343 = af(v2p343, c("rep", "block", "A", "B", "C"))
ANOVA(y ~ rep + block %in% rep + A*B*C - A:B:C, v2p343) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL           17 1889.8 111.167  14.659 0.001608 **
RESIDUALS        6   45.5   7.583
CORRECTED TOTAL 23 1935.3
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df  Sum Sq Mean Sq  F value    Pr(>F)
rep        2 1537.33  768.67 101.3626 2.375e-05 ***
rep:block  9  127.00   14.11   1.8608   0.23163
A          1   36.00   36.00   4.7473   0.07218 .
B          1   36.00   36.00   4.7473   0.07218 .
A:B        1   12.25   12.25   1.6154   0.25079
C          1   56.25   56.25   7.4176   0.03448 *
A:C        1   81.00   81.00  10.6813   0.01707 *
B:C        1    4.00    4.00   0.5275   0.49502
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df  Sum Sq Mean Sq  F value    Pr(>F)
rep        2 1537.33  768.67 101.3626 2.375e-05 ***
rep:block  9  119.83   13.31   1.7558   0.25388
A          1   36.00   36.00   4.7473   0.07218 .
B          1   36.00   36.00   4.7473   0.07218 .
A:B        1   12.25   12.25   1.6154   0.25079
C          1   56.25   56.25   7.4176   0.03448 *
A:C        1   81.00   81.00  10.6813   0.01707 *
B:C        1    4.00    4.00   0.5275   0.49502
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df  Sum Sq Mean Sq  F value    Pr(>F)
rep        2 1537.33  768.67 101.3626 2.375e-05 ***
rep:block  9  119.83   13.31   1.7558   0.25388
```

```
A           1   36.00   36.00   4.7473   0.07218 .
B           1   36.00   36.00   4.7473   0.07218 .
A:B         1   12.25   12.25   1.6154   0.25079
C           1   56.25   56.25   7.4176   0.03448 *
A:C         1   81.00   81.00  10.6813   0.01707 *
B:C         1    4.00    4.00   0.5275   0.49502
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.6.2 p348

(140) MODEL

```
ANOVA(y ~ rep + A*B*C + block %in% rep, v2p343) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL           17 1889.8 111.167  14.659 0.001608 **
RESIDUALS        6   45.5   7.583
CORRECTED TOTAL 23 1935.3
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df  Sum Sq Mean Sq  F value    Pr(>F)
rep        2 1537.33  768.67 101.3626 2.375e-05 ***
A          1   88.17   88.17  11.6264   0.01432 *
B          1   37.50   37.50   4.9451   0.06785 .
A:B        1    2.67    2.67   0.3516   0.57484
C          1   66.67   66.67   8.7912   0.02512 *
A:C        1   37.50   37.50   4.9451   0.06785 .
B:C        1    0.17    0.17   0.0220   0.88700
A:B:C      1   24.00   24.00   3.1648   0.12555
rep:block  8   95.83   11.98   1.5797   0.29730
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df  Sum Sq Mean Sq  F value    Pr(>F)
rep        2 1537.33  768.67 101.3626 2.375e-05 ***
A          1   36.00   36.00   4.7473   0.07218 .
B          1   36.00   36.00   4.7473   0.07218 .
A:B        1   12.25   12.25   1.6154   0.25079
C          1   56.25   56.25   7.4176   0.03448 *
A:C        1   81.00   81.00  10.6813   0.01707 *
B:C        1    4.00    4.00   0.5275   0.49502
A:B:C      0
rep:block  8   95.83   11.98   1.5797   0.29730
```

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

$`Type III`
CAUTION: Singularity Exists !
          Df  Sum Sq Mean Sq  F value    Pr(>F)
rep        2 1537.33  768.67 101.3626 2.375e-05 ***
A          1   36.00   36.00   4.7473   0.07218 .
B          1   36.00   36.00   4.7473   0.07218 .
A:B        1   12.25   12.25   1.6154   0.25079
C          1   56.25   56.25   7.4176   0.03448 *
A:C        1   81.00   81.00  10.6813   0.01707 *
B:C        1    4.00    4.00   0.5275   0.49502
A:B:C      0
rep:block  8   95.83   11.98   1.5797   0.29730
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.6.3 p353

(141) MODEL

```
v2p353 = read.table("C:/G/Rt/Kemp/v2p353.txt", head=TRUE)
v2p353 = af(v2p353, c("rep", "block", "A", "B", "C", "D"))
ANOVA(y ~ rep + rep:block + A*B*C*D - A:B:C:D, v2p353) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           21 7132.2  339.63  56.022 9.795e-08 ***
RESIDUALS       10   60.6    6.06
CORRECTED TOTAL 31 7192.9
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df Sum Sq Mean Sq  F value    Pr(>F)
rep        1 5940.5  5940.5 979.8763 2.600e-11 ***
rep:block  6  777.4   129.6  21.3711 3.675e-05 ***
A          1  171.1   171.1  28.2268 0.0003412 ***
B          1   18.0    18.0   2.9691 0.1155937
A:B        1    1.6     1.6   0.2577 0.6226914
C          1  120.1   120.1  19.8144 0.0012326 **
A:C        1    0.6     0.6   0.0928 0.7669127
B:C        1    2.0     2.0   0.3299 0.5784103
A:B:C      1    4.5     4.5   0.7423 0.4091189
D          1    6.1     6.1   1.0103 0.3385304
A:D        1    1.1     1.1   0.1856 0.6757693
B:D        1    5.1     5.1   0.8351 0.3823203
```

```
A:B:D      1    0.5     0.5   0.0825 0.7798349
C:D        1    1.6     1.6   0.2577 0.6226914
A:C:D      1   10.1    10.1   1.6701 0.2253083
B:C:D      1   72.0    72.0  11.8763 0.0062660 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df Sum Sq Mean Sq  F value    Pr(>F)
rep        1 5940.5  5940.5 979.8763   2.6e-11 ***
rep:block  6  406.9    67.8  11.1856 0.0006129 ***
A          1  171.1   171.1  28.2268 0.0003412 ***
B          1   18.0    18.0   2.9691 0.1155937
A:B        1    1.6     1.6   0.2577 0.6226914
C          1  120.1   120.1  19.8144 0.0012326 **
A:C        1    0.6     0.6   0.0928 0.7669127
B:C        1    2.0     2.0   0.3299 0.5784103
A:B:C      1    4.5     4.5   0.7423 0.4091189
D          1    6.1     6.1   1.0103 0.3385304
A:D        1    1.1     1.1   0.1856 0.6757693
B:D        1    5.1     5.1   0.8351 0.3823203
A:B:D      1    0.5     0.5   0.0825 0.7798349
C:D        1    1.6     1.6   0.2577 0.6226914
A:C:D      1   10.1    10.1   1.6701 0.2253083
B:C:D      1   72.0    72.0  11.8763 0.0062660 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df Sum Sq Mean Sq  F value    Pr(>F)
rep        1 5940.5  5940.5 979.8763   2.6e-11 ***
rep:block  6  406.9    67.8  11.1856 0.0006129 ***
A          1  171.1   171.1  28.2268 0.0003412 ***
B          1   18.0    18.0   2.9691 0.1155937
A:B        1    1.6     1.6   0.2577 0.6226914
C          1  120.1   120.1  19.8144 0.0012326 **
A:C        1    0.6     0.6   0.0928 0.7669127
B:C        1    2.0     2.0   0.3299 0.5784103
A:B:C      1    4.5     4.5   0.7423 0.4091189
D          1    6.1     6.1   1.0103 0.3385304
A:D        1    1.1     1.1   0.1856 0.6757693
B:D        1    5.1     5.1   0.8351 0.3823203
A:B:D      1    0.5     0.5   0.0825 0.7798349
C:D        1    1.6     1.6   0.2577 0.6226914
A:C:D      1   10.1    10.1   1.6701 0.2253083
B:C:D      1   72.0    72.0  11.8763 0.0062660 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.7 Chapter 10

9.7.1 p388

(142) MODEL

```
v2p388 = read.table("C:/G/Rt/Kemp/v2p388.txt", head=TRUE)
v2p388 = af(v2p388, c("rep", "block", "A", "B"))
ANOVA(y ~ rep + A*B + rep:block, v2p388) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           11 1136.8 103.343  124.01 3.698e-06 ***
RESIDUALS        6    5.0   0.833
CORRECTED TOTAL 17 1141.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df Sum Sq Mean Sq  F value    Pr(>F)
rep        1 410.89  410.89 493.0667 5.455e-07 ***
A          2 228.11  114.06 136.8667 9.868e-06 ***
B          2   3.44    1.72   2.0667  0.207585
A:B        4 464.22  116.06 139.2667 4.801e-06 ***
rep:block  2  30.11   15.06  18.0667  0.002888 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df Sum Sq Mean Sq  F value    Pr(>F)
rep        1 410.89  410.89 493.0667 5.455e-07 ***
A          2 228.11  114.06 136.8667 9.868e-06 ***
B          2   3.44    1.72   2.0667  0.207585
A:B        2  18.78    9.39  11.2667  0.009298 **
rep:block  2  30.11   15.06  18.0667  0.002888 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
          Df Sum Sq Mean Sq  F value    Pr(>F)
rep        1 410.89  410.89 493.0667 5.455e-07 ***
A          2 228.11  114.06 136.8667 9.868e-06 ***
B          2   3.44    1.72   2.0667  0.207585
A:B        2  18.78    9.39  11.2667  0.009298 **
rep:block  2  30.11   15.06  18.0667  0.002888 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.8 Chapter 14

9.8.1 p570

(143) MODEL

```
v2p570 = read.table("C:/G/Rt/Kemp/v2p570.txt", head=TRUE)
v2p570 = af(v2p570, c("A", "B", "C", "D"))
ANOVA(Y ~ A + B + C + D + A:B + A:C + A:D + B:C + B:D + C:D, v2p570) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            8 22.222  2.7778
RESIDUALS        0  0.000
CORRECTED TOTAL  8 22.222

$`Type I`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    2  2.8889  1.4444
B    2  2.8889  1.4444
C    2  1.5556  0.7778
D    2 14.8889  7.4444
A:B  0
A:C  0
A:D  0
B:C  0
B:D  0
C:D  0

$`Type II`
    Df Sum Sq Mean Sq F value Pr(>F)
A    0
B    0
C    0
D    0
A:B  0
A:C  0
A:D  0
B:C  0
B:D  0
C:D  0

$`Type III`
CAUTION: Singularity Exists !
    Df Sum Sq Mean Sq F value Pr(>F)
A    0
B    0
C    0
```

```
D    0
A:B  0
A:C  0
A:D  0
B:C  0
B:D  0
C:D  0
```

9.8.2 p578

(144) MODEL

```
v2p578 = read.table("C:/G/Rt/Kemp/v2p578.txt", head=TRUE)
v2p578 = af(v2p578, 1:11)
ANOVA(Y ~ A + B + C + D + E + F + G + H + J + K + L, v2p578) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           11    575  52.273
RESIDUALS        0      0
CORRECTED TOTAL 11    575

$`Type I`
  Df  Sum Sq Mean Sq F value Pr(>F)
A  1   3.000   3.000
B  1  27.000  27.000
C  1  12.000  12.000
D  1  16.333  16.333
E  1 176.333 176.333
F  1 133.333 133.333
G  1   1.333   1.333
H  1  21.333  21.333
J  1 108.000 108.000
K  1   1.333   1.333
L  1  75.000  75.000

$`Type II`
  Df  Sum Sq Mean Sq F value Pr(>F)
A  1   3.000   3.000
B  1  27.000  27.000
C  1  12.000  12.000
D  1  16.333  16.333
E  1 176.333 176.333
F  1 133.333 133.333
G  1   1.333   1.333
H  1  21.333  21.333
J  1 108.000 108.000
K  1   1.333   1.333
```

```
L  1  75.000  75.000

$`Type III`
  Df  Sum Sq Mean Sq F value Pr(>F)
A  1   3.000   3.000
B  1  27.000  27.000
C  1  12.000  12.000
D  1  16.333  16.333
E  1 176.333 176.333
F  1 133.333 133.333
G  1   1.333   1.333
H  1  21.333  21.333
J  1 108.000 108.000
K  1   1.333   1.333
L  1  75.000  75.000
```

(145) MODEL

```
ANOVA(Y ~ E*F + E*J + F*J + E*L + F*L + J*L, v2p578) # OK
```

```
$ANOVA
Response : Y
               Df Sum Sq Mean Sq F value  Pr(>F)
MODEL          10  574.5   57.45   114.9 0.07249 .
RESIDUALS       1    0.5    0.50
CORRECTED TOTAL 11  575.0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df  Sum Sq Mean Sq  F value  Pr(>F)
E    1 176.333 176.333 352.6667 0.03387 *
F    1 133.333 133.333 266.6667 0.03894 *
E:F  1  65.333  65.333 130.6667 0.05555 .
J    1  66.667  66.667 133.3333 0.05500 .
E:J  1   2.667   2.667   5.3333 0.26015
F:J  1 112.667 112.667 225.3333 0.04235 *
L    1  10.800  10.800  21.6000 0.13492
E:L  1   5.486   5.486  10.9714 0.18666
F:L  1   0.176   0.176   0.3516 0.65925
J:L  1   1.038   1.038   2.0769 0.38618
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df Sum Sq Mean Sq  F value  Pr(>F)
E    1 61.633  61.633 123.2667 0.05719 .
F    1 75.208  75.208 150.4167 0.05179 .
E:F  1  9.346   9.346  18.6923 0.14470
```

```
J    1 54.675  54.675 109.3500 0.06069 .
E:J  1  0.115   0.115   0.2308 0.71490
F:J  1 72.115  72.115 144.2308 0.05289 .
L    1 10.800  10.800  21.6000 0.13492
E:L  1  5.654   5.654  11.3077 0.18402
F:L  1  0.115   0.115   0.2308 0.71490
J:L  1  1.038   1.038   2.0769 0.38618
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq  F value  Pr(>F)
E    1 61.038  61.038 122.0769 0.05746 .
F    1 61.038  61.038 122.0769 0.05746 .
E:F  1  9.346   9.346  18.6923 0.14470
J    1 61.038  61.038 122.0769 0.05746 .
E:J  1  0.115   0.115   0.2308 0.71490
F:J  1 72.115  72.115 144.2308 0.05289 .
L    1  9.346   9.346  18.6923 0.14470
E:L  1  5.654   5.654  11.3077 0.18402
F:L  1  0.115   0.115   0.2308 0.71490
J:L  1  1.038   1.038   2.0769 0.38618
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.9 Chapter 16

9.9.1 p619

(146) MODEL

```
v2p619 = read.table("C:/G/Rt/Kemp/v2p619.txt", head=TRUE)
v2p619 = af(v2p619, c("A", "B", "C"))
ANOVA(y ~ A + B + C + A:B, v2p619) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            4 31.429  7.8571
RESIDUALS        2  0.000  0.0000
CORRECTED TOTAL  6 31.429

$`Type I`
    Df  Sum Sq Mean Sq F value    Pr(>F)
A    1 13.7619 13.7619     Inf < 2.2e-16 ***
B    1  1.6667  1.6667     Inf < 2.2e-16 ***
C    1 10.0000 10.0000     Inf < 2.2e-16 ***
A:B  1  6.0000  6.0000     Inf < 2.2e-16 ***
---
```

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

$`Type II`
    Df Sum Sq Mean Sq F value    Pr(>F)
A    1   19.6    19.6     Inf < 2.2e-16 ***
B    1    3.6     3.6     Inf < 2.2e-16 ***
C    1   13.5    13.5     Inf < 2.2e-16 ***
A:B  1    6.0     6.0     Inf < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq F value    Pr(>F)
A    1   24.0    24.0     Inf < 2.2e-16 ***
B    1    6.0     6.0     Inf < 2.2e-16 ***
C    1   13.5    13.5     Inf < 2.2e-16 ***
A:B  1    6.0     6.0     Inf < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(147) MODEL

```
ANOVA(y ~ A + B + C + A:C, v2p619) # OK
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            4 26.0952  6.5238  2.4464 0.3106
RESIDUALS        2  5.3333  2.6667
CORRECTED TOTAL  6 31.4286

$`Type I`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 13.7619 13.7619  5.1607 0.1511
B    1  1.6667  1.6667  0.6250 0.5120
C    1 10.0000 10.0000  3.7500 0.1924
A:C  1  0.6667  0.6667  0.2500 0.6667

$`Type II`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 19.6000 19.6000    7.35 0.1134
B    1  2.6667  2.6667    1.00 0.4226
C    1 10.0000 10.0000    3.75 0.1924
A:C  1  0.6667  0.6667    0.25 0.6667

$`Type III`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 16.6667 16.6667  6.2500 0.1296
B    1  2.6667  2.6667  1.0000 0.4226
```

```
C    1  8.1667  8.1667  3.0625 0.2222
A:C  1  0.6667  0.6667  0.2500 0.6667
```

(148) MODEL

```
ANOVA(y ~ A + B + C + B:C, v2p619) # OK
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            4 26.0952  6.5238  2.4464 0.3106
RESIDUALS        2  5.3333  2.6667
CORRECTED TOTAL  6 31.4286

$`Type I`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 13.7619 13.7619  5.1607 0.1511
B    1  1.6667  1.6667  0.6250 0.5120
C    1 10.0000 10.0000  3.7500 0.1924
B:C  1  0.6667  0.6667  0.2500 0.6667

$`Type II`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 16.6667 16.6667    6.25 0.1296
B    1  3.6000  3.6000    1.35 0.3652
C    1 10.0000 10.0000    3.75 0.1924
B:C  1  0.6667  0.6667    0.25 0.6667

$`Type III`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 16.6667 16.6667  6.2500 0.1296
B    1  2.6667  2.6667  1.0000 0.4226
C    1  8.1667  8.1667  3.0625 0.2222
B:C  1  0.6667  0.6667  0.2500 0.6667
```

9.9.2 p626

(149) MODEL

```
v2p626 = read.table("C:/G/Rt/Kemp/v2p626.txt", head=TRUE)
v2p626 = af(v2p626, c("A", "B", "C"))
ANOVA(y ~ A + B + C + A:B, v2p626) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value  Pr(>F)
MODEL            4 42.092 10.5231  22.002 0.04395 *
RESIDUALS        2  0.957  0.4783
CORRECTED TOTAL  6 43.049
---
```

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

$`Type I`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 16.2088 16.2088  33.890 0.02826 *
B    1  4.8150  4.8150  10.068 0.08662 .
C    1 15.7339 15.7339  32.898 0.02908 *
A:B  1  5.3346  5.3346  11.154 0.07916 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 25.4131 25.4131  53.136 0.01830 *
B    1  8.6630  8.6630  18.113 0.05102 .
C    1 19.5193 19.5193  40.812 0.02364 *
A:B  1  5.3346  5.3346  11.154 0.07916 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 29.7950 29.7950  62.297 0.01568 *
B    1 11.7460 11.7460  24.559 0.03839 *
C    1 19.5193 19.5193  40.812 0.02364 *
A:B  1  5.3346  5.3346  11.154 0.07916 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(150) MODEL

```
ANOVA(y ~ A + B + C + A:C, v2p626) # OK

$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            4 39.229  9.8072  5.1346 0.1696
RESIDUALS        2  3.820  1.9100
CORRECTED TOTAL  6 43.049

$`Type I`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 16.2088 16.2088  8.4862 0.1004
B    1  4.8150  4.8150  2.5209 0.2533
C    1 15.7339 15.7339  8.2376 0.1030
A:C  1  2.4711  2.4711  1.2937 0.3733

$`Type II`
    Df  Sum Sq Mean Sq F value  Pr(>F)
```

```
A    1 25.4131 25.4131 13.3052 0.06762 .
B    1  6.0361  6.0361  3.1602 0.21743
C    1 15.7339 15.7339  8.2376 0.10298
A:C  1  2.4711  2.4711  1.2937 0.37327
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df  Sum Sq Mean Sq F value  Pr(>F)
A    1 20.1428 20.1428 10.5459 0.08317 .
B    1  6.0361  6.0361  3.1602 0.21743
C    1 11.8863 11.8863  6.2232 0.13007
A:C  1  2.4711  2.4711  1.2937 0.37327
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(151) MODEL

```
ANOVA(y ~ A + B + C + B:C, v2p626) # OK
```

```
$ANOVA
Response : y
               Df Sum Sq Mean Sq F value Pr(>F)
MODEL           4 37.340  9.3349  3.2701 0.2477
RESIDUALS       2  5.709  2.8546
CORRECTED TOTAL 6 43.049

$`Type I`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 16.2088 16.2088  5.6781 0.1400
B    1  4.8150  4.8150  1.6867 0.3236
C    1 15.7339 15.7339  5.5118 0.1434
B:C  1  0.5819  0.5819  0.2038 0.6959

$`Type II`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 21.9995 21.9995  7.7067 0.1090
B    1  8.6630  8.6630  3.0347 0.2236
C    1 15.7339 15.7339  5.5118 0.1434
B:C  1  0.5819  0.5819  0.2038 0.6959

$`Type III`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 21.9995 21.9995  7.7067 0.1090
B    1  7.0709  7.0709  2.4770 0.2562
C    1 13.3221 13.3221  4.6669 0.1633
B:C  1  0.5819  0.5819  0.2038 0.6959
```

9.10 Chapter 17

9.10.1 p642

(152) MODEL

```
v2p642 = read.table("C:/G/Rt/Kemp/v2p642.txt", head=TRUE)
v2p642 = af(v2p642, 2:11)
ANOVA(Y ~ A + B + C + D + E + F + G, v2p642) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            7   11.0 1.57143  1.6688 0.1646
RESIDUALS       24   22.6 0.94167
CORRECTED TOTAL 31   33.6

$`Type I`
  Df Sum Sq Mean Sq F value  Pr(>F)
A  1 5.7800  5.7800  6.1381 0.02066 *
B  1 0.1800  0.1800  0.1912 0.66587
C  1 0.1250  0.1250  0.1327 0.71879
D  1 2.5312  2.5312  2.6881 0.11415
E  1 0.6613  0.6613  0.7022 0.41031
F  1 0.0112  0.0112  0.0119 0.91387
G  1 1.7113  1.7113  1.8173 0.19023
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
  Df Sum Sq Mean Sq F value  Pr(>F)
A  1 5.7800  5.7800  6.1381 0.02066 *
B  1 0.1800  0.1800  0.1912 0.66587
C  1 0.1250  0.1250  0.1327 0.71879
D  1 2.5312  2.5312  2.6881 0.11415
E  1 0.6613  0.6613  0.7022 0.41031
F  1 0.0112  0.0112  0.0119 0.91387
G  1 1.7113  1.7113  1.8173 0.19023
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
  Df Sum Sq Mean Sq F value  Pr(>F)
A  1 5.7800  5.7800  6.1381 0.02066 *
B  1 0.1800  0.1800  0.1912 0.66587
C  1 0.1250  0.1250  0.1327 0.71879
D  1 2.5312  2.5312  2.6881 0.11415
E  1 0.6613  0.6613  0.7022 0.41031
F  1 0.0112  0.0112  0.0119 0.91387
```

```
G  1 1.7113  1.7113  1.8173 0.19023
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(153) MODEL

```
ANOVA(log(S) ~ A + B + C + D + E + F + G, v2p642) # OK
```

```
$ANOVA
Response : log(S)
               Df Sum Sq Mean Sq F value Pr(>F)
MODEL           7 266.43  38.062
RESIDUALS      24   0.00   0.000
CORRECTED TOTAL 31 266.43

$`Type I`
  Df  Sum Sq Mean Sq F value    Pr(>F)
A  1   1.511   1.511     Inf < 2.2e-16 ***
B  1   0.600   0.600     Inf < 2.2e-16 ***
C  1   0.284   0.284     Inf < 2.2e-16 ***
D  1   0.384   0.384     Inf < 2.2e-16 ***
E  1   0.741   0.741     Inf < 2.2e-16 ***
F  1 261.783 261.783     Inf < 2.2e-16 ***
G  1   1.127   1.127     Inf < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
  Df  Sum Sq Mean Sq F value    Pr(>F)
A  1   1.511   1.511     Inf < 2.2e-16 ***
B  1   0.600   0.600     Inf < 2.2e-16 ***
C  1   0.284   0.284     Inf < 2.2e-16 ***
D  1   0.384   0.384     Inf < 2.2e-16 ***
E  1   0.741   0.741     Inf < 2.2e-16 ***
F  1 261.783 261.783     Inf < 2.2e-16 ***
G  1   1.127   1.127     Inf < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
  Df  Sum Sq Mean Sq F value    Pr(>F)
A  1   1.511   1.511     Inf < 2.2e-16 ***
B  1   0.600   0.600     Inf < 2.2e-16 ***
C  1   0.284   0.284     Inf < 2.2e-16 ***
D  1   0.384   0.384     Inf < 2.2e-16 ***
E  1   0.741   0.741     Inf < 2.2e-16 ***
F  1 261.783 261.783     Inf < 2.2e-16 ***
G  1   1.127   1.127     Inf < 2.2e-16 ***
---
```

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

9.11 Chapter 19

9.11.1 p700

(154) MODEL

```
v2p700 = read.table("C:/G/Rt/Kemp/v2p700.txt", head=TRUE)
v2p700 = af(v2p700, 2:5)
ANOVA(Y ~ P + S + T + C, v2p700) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL           12 378.80 31.5670  57.256 0.003319 **
RESIDUALS        3   1.65  0.5513
CORRECTED TOTAL 15 380.46
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
  Df  Sum Sq Mean Sq F value   Pr(>F)
P  3  53.888  17.963  32.580 0.008646 **
S  3 154.508  51.503  93.414 0.001845 **
T  3 149.848  49.949  90.597 0.001930 **
C  3  20.561   6.854  12.431 0.033708 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
  Df  Sum Sq Mean Sq F value   Pr(>F)
P  2   2.220   1.110  2.0133 0.278974
S  3 111.966  37.322 67.6941 0.002969 **
T  3 161.828  53.943 97.8403 0.001722 **
C  3  20.561   6.854 12.4311 0.033708 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
  Df  Sum Sq Mean Sq F value   Pr(>F)
P  2   2.220   1.110  2.0133 0.278974
S  3 111.966  37.322 67.6941 0.002969 **
T  3 161.828  53.943 97.8403 0.001722 **
C  3  20.561   6.854 12.4311 0.033708 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.11.2 p703

(155) MODEL

```
v2p703 = read.table("C:/G/Rt/Kemp/v2p703.txt", head=TRUE)
v2p703$C = ifelse(v2p703$C == 0, 4, v2p703$C)
v2p703 = af(v2p703, 2:5)
ANOVA(Y ~ P + S + T + C, v2p703) # OK
```

```
$ANOVA
Response : Y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           13 385.18 29.6293  21.766 0.0005673 ***
RESIDUALS        6   8.17  1.3613
CORRECTED TOTAL 19 393.35
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
  Df  Sum Sq Mean Sq F value    Pr(>F)
P  4  56.408  14.102 10.3596 0.0073255 **
S  3 119.260  39.753 29.2036 0.0005620 ***
T  3 190.430  63.477 46.6312 0.0001498 ***
C  3  19.083   6.361  4.6728 0.0518237 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
  Df  Sum Sq Mean Sq F value    Pr(>F)
P  4  52.288  13.072  9.6028 0.0088641 **
S  3 167.414  55.805 40.9952 0.0002163 ***
T  3 190.430  63.477 46.6312 0.0001498 ***
C  3  19.083   6.361  4.6728 0.0518237 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
  Df  Sum Sq Mean Sq F value    Pr(>F)
P  4  52.287  13.072  9.6028 0.0088641 **
S  3 167.414  55.805 40.9952 0.0002163 ***
T  3 190.430  63.477 46.6312 0.0001498 ***
C  3  19.083   6.361  4.6728 0.0518237 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10 Lawson - DAE with SAS

Reference

- Lawson J. Design and Analysis of Experiments with SAS. Taylor and Francis Group. 2010.

```
require(daewr)
```

10.1 Chapter 2

10.1.1 p22

(156) MODEL

```
ANOVA(height ~ time, bread) # OK
```

```
$ANOVA
Response : height
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            2 21.573 10.7865  4.6022  0.042 *
RESIDUALS        9 21.094  2.3438
CORRECTED TOTAL 11 42.667
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
     Df Sum Sq Mean Sq F value Pr(>F)
time  2 21.573  10.787  4.6022  0.042 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
     Df Sum Sq Mean Sq F value Pr(>F)
time  2 21.573  10.787  4.6022  0.042 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
     Df Sum Sq Mean Sq F value Pr(>F)
time  2 21.573  10.787  4.6022  0.042 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.1.2 p32

(157) MODEL

```
ANOVA(height^(1 - 1.294869) ~ time, bread) # OK
```

```
$ANOVA
Response : height^(1 - 1.294869)
```

```
                Df    Sum Sq   Mean Sq F value  Pr(>F)
MODEL            2 0.0130560 0.0065280  5.9356 0.02271 *
RESIDUALS        9 0.0098983 0.0010998
CORRECTED TOTAL 11 0.0229544
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
     Df   Sum Sq  Mean Sq F value  Pr(>F)
time  2 0.013056 0.006528  5.9356 0.02271 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
     Df   Sum Sq  Mean Sq F value  Pr(>F)
time  2 0.013056 0.006528  5.9356 0.02271 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
     Df   Sum Sq  Mean Sq F value  Pr(>F)
time  2 0.013056 0.006528  5.9356 0.02271 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.1.3 p42

(158) MODEL

```
ANOVA(yield ~ treat, sugarbeet) # OK
```

```
$ANOVA
Response : yield
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            3 291.00  97.002    45.9 1.718e-07 ***
RESIDUALS       14  29.59   2.113
CORRECTED TOTAL 17 320.59
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
treat  3    291  97.002    45.9 1.718e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
treat  3    291  97.002    45.9 1.718e-07 ***
```

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

$`Type III`
      Df Sum Sq Mean Sq F value    Pr(>F)
treat  3    291  97.002    45.9 1.718e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.2 Chapter 3

10.2.1 p63

(159) MODEL

```
ANOVA(CO ~ Eth + Ratio + Eth:Ratio, COdata) # OK
```

```
$ANOVA
Response : CO
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            8 1654.0 206.750  40.016 3.861e-06 ***
RESIDUALS        9   46.5   5.167
CORRECTED TOTAL 17 1700.5
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df Sum Sq Mean Sq F value    Pr(>F)
Eth        2    324   162.0  31.355 8.790e-05 ***
Ratio      2    652   326.0  63.097 5.067e-06 ***
Eth:Ratio  4    678   169.5  32.806 2.240e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df Sum Sq Mean Sq F value    Pr(>F)
Eth        2    324   162.0  31.355 8.790e-05 ***
Ratio      2    652   326.0  63.097 5.067e-06 ***
Eth:Ratio  4    678   169.5  32.806 2.240e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df Sum Sq Mean Sq F value    Pr(>F)
Eth        2    324   162.0  31.355 8.790e-05 ***
Ratio      2    652   326.0  63.097 5.067e-06 ***
Eth:Ratio  4    678   169.5  32.806 2.240e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(160) MODEL

```
ANOVA(CO ~ Ratio + Eth + Ratio:Eth, COdata) # OK
```

```
$ANOVA
Response : CO
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            8 1654.0 206.750  40.016 3.861e-06 ***
RESIDUALS        9   46.5   5.167
CORRECTED TOTAL 17 1700.5
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df Sum Sq Mean Sq F value    Pr(>F)
Ratio      2    652   326.0  63.097 5.067e-06 ***
Eth        2    324   162.0  31.355 8.790e-05 ***
Ratio:Eth  4    678   169.5  32.806 2.240e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df Sum Sq Mean Sq F value    Pr(>F)
Ratio      2    652   326.0  63.097 5.067e-06 ***
Eth        2    324   162.0  31.355 8.790e-05 ***
Ratio:Eth  4    678   169.5  32.806 2.240e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df Sum Sq Mean Sq F value    Pr(>F)
Ratio      2    652   326.0  63.097 5.067e-06 ***
Eth        2    324   162.0  31.355 8.790e-05 ***
Ratio:Eth  4    678   169.5  32.806 2.240e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.2.2 p74

(161) MODEL

```
ANOVA(CO ~ Eth + Ratio + Eth:Ratio, COdata[-18,]) # OK
```

```
$ANOVA
Response : CO
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            8 1423.0 177.879  31.978 2.749e-05 ***
RESIDUALS        8   44.5   5.563
CORRECTED TOTAL 16 1467.5
```

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

$`Type I`
          Df Sum Sq Mean Sq F value    Pr(>F)
Eth        2 472.66  236.33  42.486 5.482e-05 ***
Ratio      2 395.33  197.66  35.535 0.0001048 ***
Eth:Ratio  4 555.04  138.76  24.945 0.0001427 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df Sum Sq Mean Sq F value    Pr(>F)
Eth        2 398.26  199.13  35.799 0.0001020 ***
Ratio      2 395.33  197.66  35.535 0.0001048 ***
Eth:Ratio  4 555.04  138.76  24.945 0.0001427 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df Sum Sq Mean Sq F value    Pr(>F)
Eth        2 319.45  159.73  28.715 0.0002235 ***
Ratio      2 511.45  255.73  45.973 4.105e-05 ***
Eth:Ratio  4 555.04  138.76  24.945 0.0001427 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.2.3 p91

(162) MODEL

```r
volt$XA = (as.numeric(as.character(volt$A)) - 27)/5
volt$XB = (as.numeric(as.character(volt$B)) - 2.75)/2.25
volt$XC = (as.numeric(as.character(volt$C)) - 2.75)/2.25
ANOVA(y ~ XA + XB + XC + XA:XB + XA:XC + XB:XC + XA:XB:XC, volt) # OK
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            7  8843.4 1263.35  3.8686 0.0385 *
RESIDUALS        8  2612.5  326.56
CORRECTED TOTAL 15 11455.9
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
         Df Sum Sq Mean Sq F value   Pr(>F)
XA        1 4522.6  4522.6 13.8490 0.005859 **
XB        1   14.1    14.1  0.0431 0.840793
```

```
XC        1  473.1   473.1  1.4486 0.263154
XA:XB     1  715.6   715.6  2.1912 0.177071
XA:XC     1 2525.1  2525.1  7.7322 0.023899 *
XB:XC     1   52.6    52.6  0.1610 0.698780
XA:XB:XC  1  540.6   540.6  1.6553 0.234218
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
         Df Sum Sq Mean Sq F value   Pr(>F)
XA        1 4522.6  4522.6 13.8490 0.005859 **
XB        1   14.1    14.1  0.0431 0.840793
XC        1  473.1   473.1  1.4486 0.263154
XA:XB     1  715.6   715.6  2.1912 0.177071
XA:XC     1 2525.1  2525.1  7.7322 0.023899 *
XB:XC     1   52.6    52.6  0.1610 0.698780
XA:XB:XC  1  540.6   540.6  1.6553 0.234218
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
         Df Sum Sq Mean Sq F value   Pr(>F)
XA        1 4522.6  4522.6 13.8490 0.005859 **
XB        1   14.1    14.1  0.0431 0.840793
XC        1  473.1   473.1  1.4486 0.263154
XA:XB     1  715.6   715.6  2.1912 0.177071
XA:XC     1 2525.1  2525.1  7.7322 0.023899 *
XB:XC     1   52.6    52.6  0.1610 0.698780
XA:XB:XC  1  540.6   540.6  1.6553 0.234218
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.2.4 p97

(163) MODEL

```
chem2 = af(chem, c("A","B","C","D"))
ANOVA(y ~ A*B*C*D, chem2) # OK
```

```
$ANOVA
Response : y
               Df Sum Sq Mean Sq F value Pr(>F)
MODEL          15 6369.4  424.63
RESIDUALS       0    0.0
CORRECTED TOTAL 15 6369.4

$`Type I`
        Df Sum Sq Mean Sq F value Pr(>F)
A        1  637.6   637.6
```

```
B         1 5076.6  5076.6
A:B       1  451.6   451.6
C         1    0.6     0.6
A:C       1   10.6    10.6
B:C       1    1.6     1.6
A:B:C     1    0.6     0.6
D         1    7.6     7.6
A:D       1   68.1    68.1
B:D       1    0.1     0.1
A:B:D     1    7.6     7.6
C:D       1    7.6     7.6
A:C:D     1   95.1    95.1
B:C:D     1    3.1     3.1
A:B:C:D   1    1.6     1.6

$`Type II`
         Df Sum Sq Mean Sq F value Pr(>F)
A         1  637.6   637.6
B         1 5076.6  5076.6
A:B       1  451.6   451.6
C         1    0.6     0.6
A:C       1   10.6    10.6
B:C       1    1.6     1.6
A:B:C     1    0.6     0.6
D         1    7.6     7.6
A:D       1   68.1    68.1
B:D       1    0.1     0.1
A:B:D     1    7.6     7.6
C:D       1    7.6     7.6
A:C:D     1   95.1    95.1
B:C:D     1    3.1     3.1
A:B:C:D   1    1.6     1.6

$`Type III`
         Df Sum Sq Mean Sq F value Pr(>F)
A         1  637.6   637.6
B         1 5076.6  5076.6
A:B       1  451.6   451.6
C         1    0.6     0.6
A:C       1   10.6    10.6
B:C       1    1.6     1.6
A:B:C     1    0.6     0.6
D         1    7.6     7.6
A:D       1   68.1    68.1
B:D       1    0.1     0.1
A:B:D     1    7.6     7.6
C:D       1    7.6     7.6
A:C:D     1   95.1    95.1
```

```
B:C:D    1    3.1     3.1
A:B:C:D  1    1.6     1.6
```

10.2.5 p104

(164) MODEL

```
ANOVA(y ~ A*B*C*D, BoxM) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           15  207.1  13.807
RESIDUALS        0    0.0
CORRECTED TOTAL 15  207.1

$`Type I`
        Df Sum Sq Mean Sq F value Pr(>F)
A        1  2.560   2.560
B        1 71.234  71.234
A:B      1  3.312   3.312
C        1 55.056  55.056
A:C      1 24.800  24.800
B:C      1  2.560   2.560
A:B:C    1  5.760   5.760
D        1  4.080   4.080
A:D      1  1.346   1.346
B:D      1  5.570   5.570
A:B:D    1  2.074   2.074
C:D      1  8.880   8.880
A:C:D    1  0.640   0.640
B:C:D    1  9.986   9.986
A:B:C:D  1  9.242   9.242

$`Type II`
        Df Sum Sq Mean Sq F value Pr(>F)
A        1  2.560   2.560
B        1 71.234  71.234
A:B      1  3.312   3.312
C        1 55.056  55.056
A:C      1 24.800  24.800
B:C      1  2.560   2.560
A:B:C    1  5.760   5.760
D        1  4.080   4.080
A:D      1  1.346   1.346
B:D      1  5.570   5.570
A:B:D    1  2.074   2.074
C:D      1  8.880   8.880
A:C:D    1  0.640   0.640
```

```
B:C:D    1  9.986   9.986
A:B:C:D  1  9.242   9.242

$`Type III`
        Df Sum Sq Mean Sq F value Pr(>F)
A        1  2.560   2.560
B        1 71.234  71.234
A:B      1  3.312   3.312
C        1 55.056  55.056
A:C      1 24.800  24.800
B:C      1  2.560   2.560
A:B:C    1  5.760   5.760
D        1  4.080   4.080
A:D      1  1.346   1.346
B:D      1  5.570   5.570
A:B:D    1  2.074   2.074
C:D      1  8.880   8.880
A:C:D    1  0.640   0.640
B:C:D    1  9.986   9.986
A:B:C:D  1  9.242   9.242
```

10.3 Chapter 4

10.3.1 p122

(165) MODEL

```
ANOVA(rate ~ rat + dose, drug) # OK
```

```
$ANOVA
Response : rate
                Df  Sum Sq  Mean Sq F value   Pr(>F)
MODEL           13 2.12867 0.163744  19.613 1.59e-12 ***
RESIDUALS       36 0.30055 0.008349
CORRECTED TOTAL 49 2.42922
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
     Df  Sum Sq Mean Sq F value    Pr(>F)
rat   9 1.66846 0.18538  22.205 3.749e-12 ***
dose  4 0.46021 0.11505  13.781 6.535e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
     Df  Sum Sq Mean Sq F value    Pr(>F)
rat   9 1.66846 0.18538  22.205 3.749e-12 ***
dose  4 0.46021 0.11505  13.781 6.535e-07 ***
```

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

$`Type III`
     Df  Sum Sq Mean Sq F value    Pr(>F)
rat   9 1.66846 0.18538  22.205 3.749e-12 ***
dose  4 0.46021 0.11505  13.781 6.535e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.3.2 p127

(166) MODEL

```
ANOVA(y ~ block + treat + strain + treat:strain, bha) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            8 543.22  67.902  26.203 0.0001507 ***
RESIDUALS        7  18.14   2.591
CORRECTED TOTAL 15 561.36
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
             Df Sum Sq Mean Sq  F value    Pr(>F)
block         1  47.61   47.61  18.3721  0.003627 **
treat         1 422.30  422.30 162.9613 4.194e-06 ***
strain        3  32.96   10.99   4.2399  0.052741 .
treat:strain  3  40.34   13.45   5.1892  0.033685 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
             Df Sum Sq Mean Sq  F value    Pr(>F)
block         1  47.61   47.61  18.3721  0.003627 **
treat         1 422.30  422.30 162.9613 4.194e-06 ***
strain        3  32.96   10.99   4.2399  0.052741 .
treat:strain  3  40.34   13.45   5.1892  0.033685 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
             Df Sum Sq Mean Sq  F value    Pr(>F)
block         1  47.61   47.61  18.3721  0.003627 **
treat         1 422.30  422.30 162.9613 4.194e-06 ***
strain        3  32.96   10.99   4.2399  0.052741 .
treat:strain  3  40.34   13.45   5.1892  0.033685 *
```

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

10.3.3 p129

(167) MODEL

```
ANOVA(cdistance ~ id + teehgt, rcb) # OK
```

```
$ANOVA
Response : cdistance
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            10 126465 12646.5  161.72 < 2.2e-16 ***
RESIDUALS       124   9697    78.2
CORRECTED TOTAL 134 136162
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
       Df Sum Sq Mean Sq F value    Pr(>F)
id      8 124741   15593 199.394 < 2.2e-16 ***
teehgt  2   1724     862  11.023 3.926e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
       Df Sum Sq Mean Sq F value    Pr(>F)
id      8 124741   15593 199.394 < 2.2e-16 ***
teehgt  2   1724     862  11.023 3.926e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
       Df Sum Sq Mean Sq F value    Pr(>F)
id      8 124741   15593 199.394 < 2.2e-16 ***
teehgt  2   1724     862  11.023 3.926e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.3.4 p136

(168) MODEL

```
ANOVA(AUC ~ Subject + Period + Treat, bioeqv) # OK
```

```
$ANOVA
Response : AUC
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            6 174461   29077  0.1315 0.9774
RESIDUALS        2 442158  221079
```

```
CORRECTED TOTAL  8 616618

$`Type I`
        Df Sum Sq Mean Sq F value Pr(>F)
Subject  2 114264   57132  0.2584 0.7946
Period   2  45196   22598  0.1022 0.9073
Treat    2  15000    7500  0.0339 0.9672

$`Type II`
        Df Sum Sq Mean Sq F value Pr(>F)
Subject  2 114264   57132  0.2584 0.7946
Period   2  45196   22598  0.1022 0.9073
Treat    2  15000    7500  0.0339 0.9672

$`Type III`
        Df Sum Sq Mean Sq F value Pr(>F)
Subject  2 114264   57132  0.2584 0.7946
Period   2  45196   22598  0.1022 0.9073
Treat    2  15000    7500  0.0339 0.9672
```

10.4 Chapter 5

10.4.1 p152

(169) MODEL

```
ANOVA(conc ~ lab, Apo) # OK
```

```
$ANOVA
Response : conc
               Df   Sum Sq   Mean Sq F value    Pr(>F)
MODEL           3 0.092233 0.0307444  42.107 4.009e-10 ***
RESIDUALS      26 0.018984 0.0007302
CORRECTED TOTAL 29 0.111217
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df   Sum Sq  Mean Sq F value    Pr(>F)
lab  3 0.092233 0.030744  42.107 4.009e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df   Sum Sq  Mean Sq F value    Pr(>F)
lab  3 0.092233 0.030744  42.107 4.009e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
    Df   Sum Sq  Mean Sq F value    Pr(>F)
lab  3 0.092233 0.030744  42.107 4.009e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.4.2 p181

(170) MODEL

```
ANOVA(residue ~ form + tech + form:tech + plot:form:tech, pesticide) # OK
```

```
$ANOVA
Response : residue
                Df   Sum Sq   Mean Sq F value   Pr(>F)
MODEL            7 0.036857 0.0052653  11.804 0.001187 **
RESIDUALS        8 0.003569 0.0004461
CORRECTED TOTAL 15 0.040426
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
               Df   Sum Sq  Mean Sq F value    Pr(>F)
form            1 0.000018 0.000018  0.0405   0.84554
tech            1 0.032310 0.032310 72.4339 2.789e-05 ***
form:tech       1 0.002186 0.002186  4.8997   0.05776 .
form:tech:plot  4 0.002344 0.000586  1.3136   0.34317
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
               Df   Sum Sq  Mean Sq F value    Pr(>F)
form            1 0.000018 0.000018  0.0405   0.84554
tech            1 0.032310 0.032310 72.4339 2.789e-05 ***
form:tech       1 0.002186 0.002186  4.8997   0.05776 .
form:tech:plot  4 0.002344 0.000586  1.3136   0.34317
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
               Df   Sum Sq  Mean Sq F value    Pr(>F)
form            1 0.000018 0.000018  0.0405   0.84554
tech            1 0.032310 0.032310 72.4339 2.789e-05 ***
form:tech       1 0.002186 0.002186  4.8997   0.05776 .
form:tech:plot  4 0.002344 0.000586  1.3136   0.34317
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.5 Chapter 7

10.5.1 p260

(171) MODEL

```
ANOVA(score ~ recipe + panelist, taste) # OK
```

```
$ANOVA
Response : score
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           14 28.458 2.03274   2.661 0.0719 .
RESIDUALS        9  6.875 0.76389
CORRECTED TOTAL 23 35.333
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
         Df  Sum Sq Mean Sq F value   Pr(>F)
recipe    3 21.0000   7.000  9.1636 0.004246 **
panelist 11  7.4583   0.678  0.8876 0.581099
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
         Df Sum Sq Mean Sq F value  Pr(>F)
recipe    3 9.1250 3.04167  3.9818 0.04649 *
panelist 11 7.4583 0.67803  0.8876 0.58110
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
         Df Sum Sq Mean Sq F value  Pr(>F)
recipe    3 9.1250 3.04167  3.9818 0.04649 *
panelist 11 7.4583 0.67803  0.8876 0.58110
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.5.2 p262

(172) MODEL

```
ANOVA(pressure ~ Block + Treatment, BPmonitor) # OK
```

```
$ANOVA
Response : pressure
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            8 321.00  40.125  4.4174 0.1245
RESIDUALS        3  27.25   9.083
CORRECTED TOTAL 11 348.25
```

```
$`Type I`
          Df Sum Sq Mean Sq F value  Pr(>F)
Block      5  73.75  14.750  1.6239 0.36606
Treatment  3 247.25  82.417  9.0734 0.05149 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df Sum Sq Mean Sq F value  Pr(>F)
Block      5  83.25  16.650  1.8330 0.32772
Treatment  3 247.25  82.417  9.0734 0.05149 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df Sum Sq Mean Sq F value  Pr(>F)
Block      5  83.25  16.650  1.8330 0.32772
Treatment  3 247.25  82.417  9.0734 0.05149 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.5.3 p276

(173) MODEL

```
ANOVA(weight ~ Blocks + A + B + C + D + E + F + G + H, Bff) # OK
```

```
$ANOVA
Response : weight
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           15 158.37  10.558
RESIDUALS        0   0.00
CORRECTED TOTAL 15 158.37

$`Type I`
       Df Sum Sq Mean Sq F value Pr(>F)
Blocks  7 30.567   4.367
A       1 21.879  21.879
B       1  8.338   8.338
C       1  6.213   6.213
D       1 12.870  12.870
E       1  0.098   0.098
F       1  1.260   1.260
G       1 71.868  71.868
H       1  5.279   5.279

$`Type II`
       Df Sum Sq Mean Sq F value Pr(>F)
```

```
Blocks  7 30.567   4.367
A       1 21.879  21.879
B       1  8.338   8.338
C       1  6.213   6.213
D       1 12.870  12.870
E       1  0.098   0.098
F       1  1.260   1.260
G       1 71.868  71.868
H       1  5.279   5.279

$`Type III`
       Df Sum Sq Mean Sq F value Pr(>F)
Blocks  7 30.567   4.367
A       1 21.879  21.879
B       1  8.338   8.338
C       1  6.213   6.213
D       1 12.870  12.870
E       1  0.098   0.098
F       1  1.260   1.260
G       1 71.868  71.868
H       1  5.279   5.279
```

10.6 Chapter 8

10.6.1 p315

(174) MODEL

```
ANOVA(ys ~ Block + A*B + Block:A:B + C*D + A:C + A:D + B:C + B:D + A:B:C + A:B:D +
         A:C:D + B:C:D + A:B:C:D, sausage) # OK
```

```
$ANOVA
Response : ys
                Df   Sum Sq   Mean Sq F value   Pr(>F)
MODEL           19 0.064059 0.0033715  14.134 1.74e-05 ***
RESIDUALS       12 0.002862 0.0002385
CORRECTED TOTAL 31 0.066922
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
          Df   Sum Sq  Mean Sq  F value    Pr(>F)
Block      1 0.000903 0.000903   3.7860  0.075482 .
A          1 0.045753 0.045753 191.8035 9.647e-09 ***
B          1 0.002628 0.002628  11.0175  0.006119 **
A:B        1 0.001128 0.001128   4.7293  0.050371 .
Block:A:B  3 0.005484 0.001828   7.6638  0.004007 **
C          1 0.003828 0.003828  16.0480  0.001743 **
D          1 0.000528 0.000528   2.2140  0.162566
```

```
C:D        1 0.000253 0.000253   1.0611  0.323272
A:C        1 0.000153 0.000153   0.6419  0.438593
A:D        1 0.000903 0.000903   3.7860  0.075482 .
B:C        1 0.000078 0.000078   0.3275  0.577693
B:D        1 0.000253 0.000253   1.0611  0.323272
A:B:C      1 0.001378 0.001378   5.7773  0.033299 *
A:B:D      1 0.000703 0.000703   2.9476  0.111680
A:C:D      1 0.000028 0.000028   0.1179  0.737260
B:C:D      1 0.000028 0.000028   0.1179  0.737260
A:B:C:D    1 0.000028 0.000028   0.1179  0.737260
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df   Sum Sq  Mean Sq  F value    Pr(>F)
Block      1 0.000903 0.000903   3.7860  0.075482 .
A          1 0.045753 0.045753 191.8035 9.647e-09 ***
B          1 0.002628 0.002628  11.0175  0.006119 **
A:B        1 0.001128 0.001128   4.7293  0.050371 .
Block:A:B  3 0.005484 0.001828   7.6638  0.004007 **
C          1 0.003828 0.003828  16.0480  0.001743 **
D          1 0.000528 0.000528   2.2140  0.162566
C:D        1 0.000253 0.000253   1.0611  0.323272
A:C        1 0.000153 0.000153   0.6419  0.438593
A:D        1 0.000903 0.000903   3.7860  0.075482 .
B:C        1 0.000078 0.000078   0.3275  0.577693
B:D        1 0.000253 0.000253   1.0611  0.323272
A:B:C      1 0.001378 0.001378   5.7773  0.033299 *
A:B:D      1 0.000703 0.000703   2.9476  0.111680
A:C:D      1 0.000028 0.000028   0.1179  0.737260
B:C:D      1 0.000028 0.000028   0.1179  0.737260
A:B:C:D    1 0.000028 0.000028   0.1179  0.737260
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df   Sum Sq  Mean Sq  F value    Pr(>F)
Block      1 0.000903 0.000903   3.7860  0.075482 .
A          1 0.045753 0.045753 191.8035 9.647e-09 ***
B          1 0.002628 0.002628  11.0175  0.006119 **
A:B        1 0.001128 0.001128   4.7293  0.050371 .
Block:A:B  3 0.005484 0.001828   7.6638  0.004007 **
C          1 0.003828 0.003828  16.0480  0.001743 **
D          1 0.000528 0.000528   2.2140  0.162566
C:D        1 0.000253 0.000253   1.0611  0.323272
A:C        1 0.000153 0.000153   0.6419  0.438593
A:D        1 0.000903 0.000903   3.7860  0.075482 .
B:C        1 0.000078 0.000078   0.3275  0.577693
```

```
B:D         1 0.000253 0.000253   1.0611  0.323272
A:B:C       1 0.001378 0.001378   5.7773  0.033299 *
A:B:D       1 0.000703 0.000703   2.9476  0.111680
A:C:D       1 0.000028 0.000028   0.1179  0.737260
B:C:D       1 0.000028 0.000028   0.1179  0.737260
A:B:C:D     1 0.000028 0.000028   0.1179  0.737260
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.6.2 p320

(175) MODEL

```
ANOVA(y ~ A*B*C*D*E, plasma) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           31 6672.9  215.26
RESIDUALS        0    0.0
CORRECTED TOTAL 31 6672.9

$`Type I`
          Df  Sum Sq Mean Sq F value Pr(>F)
A          1 1118.65 1118.65
B          1  142.81  142.81
A:B        1  141.96  141.96
C          1   91.80   91.80
A:C        1   70.81   70.81
B:C        1    5.78    5.78
A:B:C      1   65.55   65.55
D          1 1824.08 1824.08
A:D        1 2194.53 2194.53
B:D        1   87.78   87.78
A:B:D      1   87.12   87.12
C:D        1   22.45   22.45
A:C:D      1   42.78   42.78
B:C:D      1   12.25   12.25
A:B:C:D    1  375.38  375.38
E          1   78.75   78.75
A:E        1  278.48  278.48
B:E        1    0.72    0.72
A:B:E      1    0.10    0.10
C:E        1    0.15    0.15
A:C:E      1    0.24    0.24
B:C:E      1    6.48    6.48
A:B:C:E    1    1.53    1.53
D:E        1    8.40    8.40
A:D:E      1    5.28    5.28
```

```
B:D:E      1    0.28    0.28
A:B:D:E    1    0.60    0.60
C:D:E      1    0.85    0.85
A:C:D:E    1    0.55    0.55
B:C:D:E    1    6.30    6.30
A:B:C:D:E  1    0.50    0.50

$`Type II`
          Df  Sum Sq Mean Sq F value Pr(>F)
A          1 1118.65 1118.65
B          1  142.81  142.81
A:B        1  141.96  141.96
C          1   91.80   91.80
A:C        1   70.81   70.81
B:C        1    5.78    5.78
A:B:C      1   65.55   65.55
D          1 1824.08 1824.08
A:D        1 2194.53 2194.53
B:D        1   87.78   87.78
A:B:D      1   87.12   87.12
C:D        1   22.45   22.45
A:C:D      1   42.78   42.78
B:C:D      1   12.25   12.25
A:B:C:D    1  375.38  375.38
E          1   78.75   78.75
A:E        1  278.48  278.48
B:E        1    0.72    0.72
A:B:E      1    0.10    0.10
C:E        1    0.15    0.15
A:C:E      1    0.24    0.24
B:C:E      1    6.48    6.48
A:B:C:E    1    1.53    1.53
D:E        1    8.40    8.40
A:D:E      1    5.28    5.28
B:D:E      1    0.28    0.28
A:B:D:E    1    0.60    0.60
C:D:E      1    0.85    0.85
A:C:D:E    1    0.55    0.55
B:C:D:E    1    6.30    6.30
A:B:C:D:E  1    0.50    0.50

$`Type III`
          Df  Sum Sq Mean Sq F value Pr(>F)
A          1 1118.64 1118.64
B          1  142.80  142.80
A:B        1  141.96  141.96
C          1   91.80   91.80
A:C        1   70.81   70.81
```

```
B:C         1    5.78    5.78
A:B:C       1   65.55   65.55
D           1 1824.08 1824.08
A:D         1 2194.53 2194.53
B:D         1   87.78   87.78
A:B:D       1   87.12   87.12
C:D         1   22.45   22.45
A:C:D       1   42.78   42.78
B:C:D       1   12.25   12.25
A:B:C:D     1  375.38  375.38
E           1   78.75   78.75
A:E         1  278.48  278.48
B:E         1    0.72    0.72
A:B:E       1    0.10    0.10
C:E         1    0.15    0.15
A:C:E       1    0.24    0.24
B:C:E       1    6.48    6.48
A:B:C:E     1    1.53    1.53
D:E         1    8.40    8.40
A:D:E       1    5.28    5.28
B:D:E       1    0.28    0.28
A:B:D:E     1    0.60    0.60
C:D:E       1    0.85    0.85
A:C:D:E     1    0.55    0.55
B:C:D:E     1    6.30    6.30
A:B:C:D:E   1    0.50    0.50
```

10.6.3 p335

(176) MODEL

```
gear$A = as.numeric(as.character(gear$A))
gear$B = as.numeric(as.character(gear$B))
gear$C = as.numeric(as.character(gear$C))
gear$P = as.numeric(as.character(gear$P))
gear$Q = as.numeric(as.character(gear$Q))
REG(y ~ A*B*C + P + Q + A:P + A:Q + B:P + B:Q + C:P + C:Q, gear) # OK
```

```
            Estimate Std. Error Df t value Pr(>|t|)
(Intercept)  15.4062             0
A            -4.9062             0
B            -0.1562             0
A:B           0.5312             0
C             3.9688             0
A:C           2.9062             0
B:C           0.4062             0
A:B:C         0.5938             0
P            -2.3438             0
Q            -3.4062             0
```

```
A:P          -0.9062             0
A:Q          -0.3438             0
B:P           1.0938             0
B:Q           0.1562             0
C:P          -0.2812             0
C:Q           0.7812             0
```

10.7 Chapter 9

10.7.1 p349

(177) MODEL

```
ANOVA(pl ~ Subject + Period + Treat, antifungal) # OK
```

```
$ANOVA
Response : pl
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL           18 118.558  6.5866  1.4435 0.2388
RESIDUALS       15  68.444  4.5630
CORRECTED TOTAL 33 187.002

$`Type I`
        Df  Sum Sq Mean Sq F value Pr(>F)
Subject 16 114.642  7.1651  1.5703 0.1942
Period   1   0.922  0.9224  0.2021 0.6594
Treat    1   2.993  2.9932  0.6560 0.4306

$`Type II`
        Df  Sum Sq Mean Sq F value Pr(>F)
Subject 16 114.642  7.1651  1.5703 0.1942
Period   1   0.734  0.7344  0.1609 0.6939
Treat    1   2.993  2.9932  0.6560 0.4306

$`Type III`
        Df  Sum Sq Mean Sq F value Pr(>F)
Subject 16 114.642  7.1651  1.5703 0.1942
Period   1   0.734  0.7344  0.1609 0.6939
Treat    1   2.993  2.9932  0.6560 0.4306
```

10.7.2 p355

(178) MODEL

```
ANOVA(y ~ Group + Subject:Group + Period + Treat + Carry, bioequiv) # OK
```

```
$ANOVA
Response : y
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            39 417852 10714.1  20.367 < 2.2e-16 ***
```

```
RESIDUALS        68  35772   526.1
CORRECTED TOTAL 107 453624
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
             Df Sum Sq Mean Sq F value    Pr(>F)
Group         1  43335   43335 82.3763  2.46e-13 ***
Group:Subject 34 370970   10911 20.7406 < 2.2e-16 ***
Period        2    287     143  0.2723    0.7624
Treat         1   2209    2209  4.1993    0.0443 *
Carry         1   1051    1051  1.9970    0.1622
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
             Df Sum Sq Mean Sq F value    Pr(>F)
Group         1  32616   32616 61.9998 3.712e-11 ***
Group:Subject 34 370970   10911 20.7406 < 2.2e-16 ***
Period        1     38      38  0.0724    0.7888
Treat         1   2209    2209  4.1993    0.0443 *
Carry         1   1051    1051  1.9970    0.1622
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
             Df Sum Sq Mean Sq F value    Pr(>F)
Group         1  32616   32616 61.9998 3.712e-11 ***
Group:Subject 34 370970   10911 20.7406 < 2.2e-16 ***
Period        1     38      38  0.0724    0.7888
Treat         1   2209    2209  4.1993    0.0443 *
Carry         1   1051    1051  1.9970    0.1622
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

(179) MODEL

```
ANOVA(y ~ Subject + Period + Treat + Carry, bioequiv) # OK

$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL           39 417852 10714.1  20.367 < 2.2e-16 ***
RESIDUALS       68  35772   526.1
CORRECTED TOTAL 107 453624
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
        Df Sum Sq Mean Sq F value Pr(>F)
Subject 35 414306 11837.3 22.5016 <2e-16 ***
Period   2    287   143.3  0.2723 0.7624
Treat    1   2209  2209.1  4.1993 0.0443 *
Carry    1   1051  1050.6  1.9970 0.1622
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df Sum Sq Mean Sq F value Pr(>F)
Subject 35 403586 11531.0 21.9194 <2e-16 ***
Period   1     38    38.1  0.0724 0.7888
Treat    1   2209  2209.1  4.1993 0.0443 *
Carry    1   1051  1050.6  1.9970 0.1622
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
        Df Sum Sq Mean Sq F value Pr(>F)
Subject 35 403586 11531.0 21.9194 <2e-16 ***
Period   1     38    38.1  0.0724 0.7888
Treat    1   2209  2209.1  4.1993 0.0443 *
Carry    1   1051  1050.6  1.9970 0.1622
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.7.3 p361

(180) MODEL

```
ANOVA(Time ~ Subject + Period + Treat + Carry, chipman) # OK
```

```
$ANOVA
Response : Time
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           17 28.0757 1.65151  64.421 1.139e-12 ***
RESIDUALS       18  0.4615 0.02564
CORRECTED TOTAL 35 28.5372
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
        Df  Sum Sq Mean Sq F value    Pr(>F)
Subject 11 24.2084 2.20076 85.8462 3.157e-13 ***
Period   2  3.2065 1.60325 62.5388 7.894e-09 ***
Treat    2  0.4276 0.21382  8.3406  0.002733 **
Carry    2  0.2332 0.11660  4.5484  0.025188 *
```

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

$`Type II`
        Df  Sum Sq Mean Sq F value    Pr(>F)
Subject 11 24.2547 2.20497 86.0105 3.104e-13 ***
Period   1  0.0018 0.00184  0.0717 0.7919554
Treat    2  0.6392 0.31958 12.4661 0.0004003 ***
Carry    2  0.2332 0.11660  4.5484 0.0251881 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
        Df  Sum Sq Mean Sq F value    Pr(>F)
Subject 11 24.2547 2.20497 86.0105 3.104e-13 ***
Period   1  0.0018 0.00184  0.0717 0.7919554
Treat    2  0.6392 0.31958 12.4661 0.0004003 ***
Carry    2  0.2332 0.11660  4.5484 0.0251881 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.7.4 p372

(181) MODEL

```
residue$lc1 = log(residue$X1)
residue$lc2 = log(residue$X2)
residue$lc3 = log(residue$X3)
residue$lc4 = log(residue$X4)
residue$lc5 = log(residue$X5)
residue$sp = 7*residue$lc2+ 14*residue$lc3 + 30*residue$lc4 + 60*residue$lc5
residue$sm = residue$lc1 + residue$lc2+ residue$lc3 + residue$lc4 + residue$lc5
residue$num = 5*residue$sp - 111*residue$sm
residue$den = 5*4745 - 111^2
residue$k = residue$num/residue$den
residue$HL = -log(2)/residue$k
residue$logHL = log(residue$HL)
ANOVA(logHL ~ temp*moisture*soil, residue) # OK
```

```
$ANOVA
Response : logHL
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            7 7.5133 1.07332  13.543 0.0007329 ***
RESIDUALS        8 0.6340 0.07925
CORRECTED TOTAL 15 8.1473
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
                  Df Sum Sq Mean Sq F value    Pr(>F)
temp               1 6.0503  6.0503 76.3427 2.303e-05 ***
moisture           1 0.9521  0.9521 12.0134  0.008492 **
temp:moisture      1 0.0013  0.0013  0.0162  0.901779
soil               1 0.4098  0.4098  5.1712  0.052559 .
temp:soil          1 0.0086  0.0086  0.1081  0.750753
moisture:soil      1 0.0860  0.0860  1.0855  0.327921
temp:moisture:soil 1 0.0051  0.0051  0.0648  0.805427
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
                  Df Sum Sq Mean Sq F value    Pr(>F)
temp               1 6.0503  6.0503 76.3427 2.303e-05 ***
moisture           1 0.9521  0.9521 12.0134  0.008492 **
temp:moisture      1 0.0013  0.0013  0.0162  0.901779
soil               1 0.4098  0.4098  5.1712  0.052559 .
temp:soil          1 0.0086  0.0086  0.1081  0.750753
moisture:soil      1 0.0860  0.0860  1.0855  0.327921
temp:moisture:soil 1 0.0051  0.0051  0.0648  0.805427
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
                  Df Sum Sq Mean Sq F value    Pr(>F)
temp               1 6.0503  6.0503 76.3427 2.303e-05 ***
moisture           1 0.9521  0.9521 12.0134  0.008492 **
temp:moisture      1 0.0013  0.0013  0.0162  0.901779
soil               1 0.4098  0.4098  5.1712  0.052559 .
temp:soil          1 0.0086  0.0086  0.1081  0.750753
moisture:soil      1 0.0860  0.0860  1.0855  0.327921
temp:moisture:soil 1 0.0051  0.0051  0.0648  0.805427
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.8 Chapter 11

10.8.1 p461

(182) MODEL

```
ANOVA(y ~ x1 + x2 + x1:x2 + x1:x3 + x2:x3, pest) # OK
```

```
$ANOVA
Response : y
               Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           5 275.642  55.128  160.38 4.631e-07 ***
RESIDUALS       7   2.406   0.344
```

```
CORRECTED TOTAL 12 278.048
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df  Sum Sq Mean Sq  F value    Pr(>F)
x1     1  83.402  83.402 242.6351 1.086e-06 ***
x2     1 161.734 161.734 470.5191 1.116e-07 ***
x1:x2  1   0.246   0.246   0.7169 0.4251627
x1:x3  1  15.663  15.663  45.5660 0.0002649 ***
x2:x3  1  14.596  14.596  42.4614 0.0003291 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df  Sum Sq Mean Sq F value    Pr(>F)
x1     1 215.951 215.951 628.246 4.105e-08 ***
x2     1 175.256 175.256 509.855 8.458e-08 ***
x1:x2  1   0.025   0.025   0.072 0.7961658
x1:x3  1  14.539  14.539  42.298 0.0003330 ***
x2:x3  1  14.596  14.596  42.461 0.0003291 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df  Sum Sq Mean Sq F value    Pr(>F)
x1     1 178.372 178.372 518.922 7.958e-08 ***
x2     1 145.518 145.518 423.341 1.608e-07 ***
x1:x2  1   0.025   0.025   0.072 0.7961658
x1:x3  1  14.539  14.539  42.298 0.0003330 ***
x2:x3  1  14.596  14.596  42.461 0.0003291 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.8.2 p469

(183) MODEL

```
ANOVA(y ~ x1 + x2 + x1:x2 + x1:x3 + x2:x3 + x1:x2:x3, polvdat) # OK
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL            6 12.5313 2.08854  37.056 0.0005473 ***
RESIDUALS        5  0.2818 0.05636
CORRECTED TOTAL 11 12.8131
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 5.4668  5.4668 96.9942 0.0001839 ***
x2         1 0.3660  0.3660  6.4944 0.0513654 .
x1:x2      1 4.6897  4.6897 83.2068 0.0002652 ***
x1:x3      1 1.2450  1.2450 22.0887 0.0053378 **
x2:x3      1 0.4707  0.4707  8.3509 0.0341949 *
x1:x2:x3   1 0.2931  0.2931  5.2004 0.0714991 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
          Df Sum Sq Mean Sq F value    Pr(>F)
x1         1 0.0184  0.0184  0.3265 0.5924707
x2         1 0.2419  0.2419  4.2911 0.0930613 .
x1:x2      1 3.8824  3.8824 68.8834 0.0004147 ***
x1:x3      1 1.4383  1.4383 25.5196 0.0039276 **
x2:x3      1 0.4707  0.4707  8.3509 0.0341949 *
x1:x2:x3   1 0.2931  0.2931  5.2004 0.0714991 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
          Df  Sum Sq Mean Sq F value  Pr(>F)
x1         1 0.25744 0.25744  4.5677 0.08562 .
x2         1 0.12956 0.12956  2.2987 0.18992
x1:x2      1 0.65909 0.65909 11.6939 0.01885 *
x1:x3      1 0.26323 0.26323  4.6704 0.08307 .
x2:x3      1 0.12999 0.12999  2.3063 0.18931
x1:x2:x3   1 0.29310 0.29310  5.2004 0.07150 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.8.3 p482

(184) MODEL

```
REG(y ~ x1 + x2 + x3 + x1:x2 + x1:x3 + x2:x3 + x1:z1 + x2:z1 + x3:z1 +
       x1:x2:z1 + x1:x3:z1 + x2:x3:z1 + x1:z2 + x2:z2 + x3:z2 +
       x1:x2:z2 + x1:x3:z2 + x2:x3:z2 + x1:z1:z2 + x2:z1:z2 + x3:z1:z2 +
       x1:x2:z1:z2 + x1:x3:z1:z2 + x2:x3:z1:z2 - 1, MPV) # OK
```

```
            Estimate Std. Error Df t value  Pr(>|t|)
x1            346948     294197 11  1.1793 0.2631550
x2              8223        490 11 16.7869 3.467e-09 ***
x3              1656        459 11  3.6104 0.0040950 **
x1:x2         -414463     312262 11 -1.3273 0.2113017
x1:x3         -334747     311426 11 -1.0749 0.3054382
x2:x3           -6476       1199 11 -5.4032 0.0002156 ***
```

```
x1:z1         103044     328922 11  0.3133 0.7599297
x2:z1          -2241        548 11 -4.0924 0.0017824 **
x3:z1            823        513 11  1.6056 0.1366709
x1:x2:z1      -64013     349120 11 -0.1834 0.8578546
x1:x3:z1     -123730     348184 11 -0.3554 0.7290412
x2:x3:z1        4659       1340 11  3.4765 0.0051806 **
x1:z2         244320     328922 11  0.7428 0.4731733
x2:z2            886        548 11  1.6187 0.1338108
x3:z2             86        513 11  0.1670 0.8704301
x1:x2:z2     -266052     349120 11 -0.7621 0.4620497
x1:x3:z2     -253151     348184 11 -0.7271 0.4823761
x2:x3:z2       -1822       1340 11 -1.3593 0.2012686
x1:z1:z2      259038     328922 11  0.7875 0.4476062
x2:z1:z2        -137        548 11 -0.2500 0.8071853
x3:z1:z2         100        513 11  0.1955 0.8485983
x1:x2:z1:z2  -269527     349120 11 -0.7720 0.4563702
x1:x3:z1:z2  -269249     348184 11 -0.7733 0.4556454
x2:x3:z1:z2     -328       1340 11 -0.2448 0.8111141
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.9 Chapter 12

10.9.1 p513

(185) MODEL

```
ANOVA(ybar ~ A + B + C + D + E + F + G, tile) # OK
```

```
$ANOVA
Response : ybar
                Df  Sum Sq  Mean Sq F value Pr(>F)
MODEL            7 0.68737 0.098196
RESIDUALS        0 0.00000
CORRECTED TOTAL  7 0.68737

$`Type I`
  Df  Sum Sq Mean Sq F value Pr(>F)
A  1 0.04984 0.04984
B  1 0.01992 0.01992
C  1 0.51534 0.51534
D  1 0.01532 0.01532
E  1 0.05965 0.05965
F  1 0.00879 0.00879
G  1 0.01851 0.01851

$`Type II`
  Df  Sum Sq Mean Sq F value Pr(>F)
A  1 0.04984 0.04984
```

```
B  1 0.01992 0.01992
C  1 0.51534 0.51534
D  1 0.01532 0.01532
E  1 0.05965 0.05965
F  1 0.00879 0.00879
G  1 0.01851 0.01851

$`Type III`
  Df  Sum Sq Mean Sq F value Pr(>F)
A  1 0.04984 0.04984
B  1 0.01992 0.01992
C  1 0.51534 0.51534
D  1 0.01532 0.01532
E  1 0.05965 0.05965
F  1 0.00879 0.00879
G  1 0.01851 0.01851
```

(186) MODEL

```
ANOVA(lns2 ~ A + B + C + D + E + F + G, tile) # OK
```

```
$ANOVA
Response : lns2
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL            7 12.305  1.7578
RESIDUALS        0  0.000
CORRECTED TOTAL  7 12.305

$`Type I`
  Df Sum Sq Mean Sq F value Pr(>F)
A  1 1.6436  1.6436
B  1 0.3109  0.3109
C  1 7.1858  7.1858
D  1 2.3199  2.3199
E  1 0.0248  0.0248
F  1 0.7379  0.7379
G  1 0.0820  0.0820

$`Type II`
  Df Sum Sq Mean Sq F value Pr(>F)
A  1 1.6436  1.6436
B  1 0.3109  0.3109
C  1 7.1858  7.1858
D  1 2.3199  2.3199
E  1 0.0248  0.0248
F  1 0.7379  0.7379
G  1 0.0820  0.0820

$`Type III`
```

```
  Df Sum Sq Mean Sq F value Pr(>F)
A  1 1.6436  1.6436
B  1 0.3109  0.3109
C  1 7.1858  7.1858
D  1 2.3199  2.3199
E  1 0.0248  0.0248
F  1 0.7379  0.7379
G  1 0.0820  0.0820
```

10.9.2 p521

(187) MODEL

```
strng = reshape(tile,
        direction = "long",
        varying = list(c("y1", "y2")),
        v.names = "y",
        idvar = c("A", "B", "C", "D", "E", "F", "G"),
        timevar = "H",
        times = c(-1, 1))
ANOVA(y ~ A/H + B/H + C/H + D/H + E/H + F/H + G/H, strng) # OK
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL           14 1.65427 0.11816  0.1433 0.9807
RESIDUALS        1 0.82473 0.82473
CORRECTED TOTAL 15 2.47901

$`Type I`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 0.09968 0.09968  0.1209 0.7870
A:H  1 0.04015 0.04015  0.0487 0.8618
B    1 0.03984 0.03984  0.0483 0.8623
H:B  1 0.00043 0.00043  0.0005 0.9854
C    1 1.03069 1.03069  1.2497 0.4646
H:C  1 0.15307 0.15307  0.1856 0.7410
D    1 0.03064 0.03064  0.0372 0.8788
H:D  1 0.04690 0.04690  0.0569 0.8510
E    1 0.11929 0.11929  0.1446 0.7686
H:E  1 0.01883 0.01883  0.0228 0.9045
F    1 0.01758 0.01758  0.0213 0.9077
H:F  1 0.01384 0.01384  0.0168 0.9180
G    1 0.03702 0.03702  0.0449 0.8671
H:G  1 0.00632 0.00632  0.0077 0.9444

$`Type II`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 0.09968 0.09968  0.1209 0.7870
```

```
A:H  1 0.04015 0.04015  0.0487 0.8618
B    1 0.03984 0.03984  0.0483 0.8623
H:B  1 0.00043 0.00043  0.0005 0.9854
C    1 1.03069 1.03069  1.2497 0.4646
H:C  1 0.15307 0.15307  0.1856 0.7410
D    1 0.03064 0.03064  0.0372 0.8788
H:D  1 0.04690 0.04690  0.0569 0.8510
E    1 0.11929 0.11929  0.1446 0.7686
H:E  1 0.01883 0.01883  0.0228 0.9045
F    1 0.01758 0.01758  0.0213 0.9077
H:F  1 0.01384 0.01384  0.0168 0.9180
G    1 0.03702 0.03702  0.0449 0.8671
H:G  1 0.00632 0.00632  0.0077 0.9444

$`Type III`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 0.09968 0.09968  0.1209 0.7870
A:H  1 0.04015 0.04015  0.0487 0.8618
B    1 0.03984 0.03984  0.0483 0.8623
H:B  1 0.00043 0.00043  0.0005 0.9854
C    1 1.03069 1.03069  1.2497 0.4646
H:C  1 0.15307 0.15307  0.1856 0.7410
D    1 0.03064 0.03064  0.0372 0.8788
H:D  1 0.04690 0.04690  0.0569 0.8510
E    1 0.11929 0.11929  0.1446 0.7686
H:E  1 0.01883 0.01883  0.0228 0.9045
F    1 0.01758 0.01758  0.0213 0.9077
H:F  1 0.01384 0.01384  0.0168 0.9180
G    1 0.03702 0.03702  0.0449 0.8671
H:G  1 0.00632 0.00632  0.0077 0.9444
```

10.9.3 p525

(188) MODEL

```
prod2 = af(prodstd, 1:7)
ANOVA(Pof ~ A + B + C + D + E + F + G + A:G + A:E:F + B:E:G + C:E:G + C:E:G:F +
          D:E + D:F, prod2) # OK
```

```
$ANOVA
Response : Pof
               Df Sum Sq Mean Sq F value    Pr(>F)
MODEL          47 769.49 16.3721  5.1667 2.737e-05 ***
RESIDUALS      24  76.05  3.1688
CORRECTED TOTAL 71 845.54
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
```

```
        Df  Sum Sq Mean Sq F value    Pr(>F)
A        2  50.577  25.288  7.9806 0.0022023 **
B        2  13.384   6.692  2.1118 0.1429491
C        2  68.594  34.297 10.8234 0.0004463 ***
D        2  23.674  11.837  3.7355 0.0386914 *
E        1 275.733 275.733 87.0165 1.878e-09 ***
F        1 161.700 161.700 51.0296 2.204e-07 ***
G        1   1.051   1.051  0.3318 0.5699896
A:G      2  26.567  13.284  4.1921 0.0274494 *
A:E:F    7  28.404   4.058  1.2806 0.3013844
B:E:G    7  22.453   3.208  1.0123 0.4475160
C:E:G    6  35.546   5.924  1.8696 0.1277692
C:E:F:G 10  24.607   2.461  0.7766 0.6500534
D:E      2  21.745  10.873  3.4312 0.0489076 *
D:F      2  15.450   7.725  2.4379 0.1086730
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
        Df  Sum Sq Mean Sq F value    Pr(>F)
A        2  50.577  25.288  7.9806 0.0022023 **
B        2  13.384   6.692  2.1118 0.1429491
C        2  68.594  34.297 10.8234 0.0004463 ***
D        2  23.674  11.837  3.7355 0.0386914 *
E        1 275.733 275.733 87.0165 1.878e-09 ***
F        1 161.700 161.700 51.0296 2.204e-07 ***
G        1   1.051   1.051  0.3318 0.5699896
A:G      2  26.567  13.284  4.1921 0.0274494 *
A:E:F    6  24.623   4.104  1.2951 0.2970196
B:E:G    6  19.770   3.295  1.0398 0.4246194
C:E:G    6  35.546   5.924  1.8696 0.1277692
C:E:F:G 10  24.607   2.461  0.7766 0.6500534
D:E      2  21.745  10.873  3.4312 0.0489076 *
D:F      2  15.450   7.725  2.4379 0.1086730
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
CAUTION: Singularity Exists !
        Df  Sum Sq Mean Sq F value    Pr(>F)
A        2  50.577  25.288  7.9806 0.0022023 **
B        2  13.384   6.692  2.1118 0.1429491
C        2  68.594  34.297 10.8234 0.0004463 ***
D        2  23.674  11.837  3.7355 0.0386914 *
E        1 275.733 275.733 87.0165 1.878e-09 ***
F        1 161.700 161.700 51.0296 2.204e-07 ***
G        1   1.051   1.051  0.3318 0.5699896
A:G      2  26.567  13.284  4.1921 0.0274494 *
```

```
A:E:F    6  24.623   4.104  1.2951 0.2970196
B:E:G    6  19.770   3.295  1.0398 0.4246194
C:E:G    6  35.546   5.924  1.8696 0.1277692
C:E:F:G 10  24.607   2.461  0.7766 0.6500534
D:E      2  21.745  10.873  3.4312 0.0489076 *
D:F      2  15.450   7.725  2.4379 0.1086730
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.9.4 p532

(189) MODEL

```
ANOVA(torque ~ A + B + C + D + E + A:B + A:C + A:D + A:E, Smotor) # OK
```

```
$ANOVA
Response : torque
                Df    Sum Sq    Mean Sq F value   Pr(>F)
MODEL           15 0.0112217 0.00074811   102.2 0.009731 **
RESIDUALS        2 0.0000146 0.00000732
CORRECTED TOTAL 17 0.0112363
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df    Sum Sq   Mean Sq  F value   Pr(>F)
A    1 0.0039545 0.0039545 540.2187 0.001846 **
B    2 0.0003817 0.0001909  26.0732 0.036937 *
C    2 0.0057241 0.0028620 390.9837 0.002551 **
D    2 0.0000265 0.0000133   1.8104 0.355820
E    1 0.0000984 0.0000984  13.4406 0.067009 .
A:B  2 0.0010068 0.0005034  68.7668 0.014333 *
A:C  2 0.0000031 0.0000016   0.2134 0.824110
A:D  2 0.0000009 0.0000004   0.0599 0.943521
A:E  1 0.0000258 0.0000258   3.5198 0.201458
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
    Df    Sum Sq   Mean Sq  F value   Pr(>F)
A    1 0.0039545 0.0039545 540.2187 0.001846 **
B    2 0.0003817 0.0001909  26.0732 0.036937 *
C    2 0.0032014 0.0016007 218.6753 0.004552 **
D    2 0.0000268 0.0000134   1.8319 0.353123
E    1 0.0000423 0.0000423   5.7744 0.138172
A:B  2 0.0010068 0.0005034  68.7668 0.014333 *
A:C  2 0.0000031 0.0000016   0.2134 0.824110
A:D  2 0.0000052 0.0000026   0.3536 0.738760
A:E  1 0.0000258 0.0000258   3.5198 0.201458
```

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

$`Type III`
    Df    Sum Sq   Mean Sq  F value   Pr(>F)
A    1 0.0034241 0.0034241 467.7636 0.002131 **
B    2 0.0003817 0.0001909  26.0732 0.036937 *
C    2 0.0032014 0.0016007 218.6753 0.004552 **
D    2 0.0000268 0.0000134   1.8319 0.353123
E    1 0.0000423 0.0000423   5.7744 0.138172
A:B  2 0.0010068 0.0005034  68.7668 0.014333 *
A:C  2 0.0000031 0.0000016   0.2134 0.824110
A:D  2 0.0000052 0.0000026   0.3536 0.738760
A:E  1 0.0000258 0.0000258   3.5198 0.201458
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.9.5 p535

(190) MODEL

```
ANOVA(shrinkage ~ A + B + C + D + E + F + G + A:B + A:C + A:D + A:E + A:F + A:G +
                B:D, inject) # OK
```

```
$ANOVA
Response : shrinkage
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL           14 6659.4  475.67  129.08 1.97e-05 ***
RESIDUALS        5   18.4    3.68
CORRECTED TOTAL 19 6677.8
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
    Df Sum Sq Mean Sq   F value    Pr(>F)
A    1  770.1   770.1  208.9722 2.858e-05 ***
B    1 5076.6  5076.6 1377.6289 2.674e-07 ***
C    1    3.1     3.1    0.8311  0.403773
D    1    7.6     7.6    2.0522  0.211416
E    1    0.6     0.6    0.1526  0.712112
F    1    0.6     0.6    0.1526  0.712112
G    1   95.1    95.1   25.7972  0.003837 **
A:B  1  564.1   564.1  153.0699 6.112e-05 ***
A:C  1   10.6    10.6    2.8664  0.151230
A:D  1  115.6   115.6   31.3602  0.002508 **
A:E  1   14.1    14.1    3.8161  0.108185
A:F  1    1.6     1.6    0.4240  0.543677
A:G  1    0.1     0.1    0.0170  0.901459
B:D  1    0.1     0.1    0.0170  0.901459
```

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

$`Type II`
    Df Sum Sq Mean Sq   F value    Pr(>F)
A    1  770.1   770.1  208.9722 2.858e-05 ***
B    1 5076.6  5076.6 1377.6289 2.674e-07 ***
C    1    3.1     3.1    0.8311  0.403773
D    1    7.6     7.6    2.0522  0.211416
E    1    0.6     0.6    0.1526  0.712112
F    1    0.6     0.6    0.1526  0.712112
G    1   95.1    95.1   25.7972  0.003837 **
A:B  1  564.1   564.1  153.0699 6.112e-05 ***
A:C  1   10.6    10.6    2.8664  0.151230
A:D  1  115.6   115.6   31.3602  0.002508 **
A:E  1   14.1    14.1    3.8161  0.108185
A:F  1    1.6     1.6    0.4240  0.543677
A:G  1    0.1     0.1    0.0170  0.901459
B:D  1    0.1     0.1    0.0170  0.901459
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
    Df Sum Sq Mean Sq   F value    Pr(>F)
A    1  770.1   770.1  208.9722 2.858e-05 ***
B    1 5076.6  5076.6 1377.6289 2.674e-07 ***
C    1    3.1     3.1    0.8311  0.403773
D    1    7.6     7.6    2.0522  0.211416
E    1    0.6     0.6    0.1526  0.712112
F    1    0.6     0.6    0.1526  0.712112
G    1   95.1    95.1   25.7972  0.003837 **
A:B  1  564.1   564.1  153.0699 6.112e-05 ***
A:C  1   10.6    10.6    2.8664  0.151230
A:D  1  115.6   115.6   31.3602  0.002508 **
A:E  1   14.1    14.1    3.8161  0.108185
A:F  1    1.6     1.6    0.4240  0.543677
A:G  1    0.1     0.1    0.0170  0.901459
B:D  1    0.1     0.1    0.0170  0.901459
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10.9.6 p539

(191) MODEL

```
eptax = cbind(eptaxr[1:16,], y2=eptaxr[17:32,9], y3=eptaxr[33:48,9],
              y5=eptaxr[49:64,9])
eptax$ybar = (eptax$y + eptax$y2 + eptax$y3 + eptax$y5)/4
```

```
ANOVA(ybar ~ A + B + C + D + E + F + G + H + A:B + A:C + A:D + A:E + A:F + A:G +
          A:H, eptax) # OK
```

```
$ANOVA
Response : ybar
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           15 2.8452 0.18968
RESIDUALS        0 0.0000
CORRECTED TOTAL 15 2.8452

$`Type I`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 0.02686 0.02686
B    1 0.00042 0.00042
C    1 0.06306 0.06306
D    1 2.49443 2.49443
E    1 0.00304 0.00304
F    1 0.03209 0.03209
G    1 0.02954 0.02954
H    1 0.12879 0.12879
A:B  1 0.00047 0.00047
A:C  1 0.03218 0.03218
A:D  1 0.01185 0.01185
A:E  1 0.00380 0.00380
A:F  1 0.01674 0.01674
A:G  1 0.00186 0.00186
A:H  1 0.00012 0.00012

$`Type II`
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 0.02686 0.02686
B    1 0.00042 0.00042
C    1 0.06306 0.06306
D    1 2.49443 2.49443
E    1 0.00304 0.00304
F    1 0.03209 0.03209
G    1 0.02954 0.02954
H    1 0.12879 0.12879
A:B  1 0.00047 0.00047
A:C  1 0.03218 0.03218
A:D  1 0.01185 0.01185
A:E  1 0.00380 0.00380
A:F  1 0.01674 0.01674
A:G  1 0.00186 0.00186
A:H  1 0.00012 0.00012

$`Type III`
```

```
    Df  Sum Sq Mean Sq F value Pr(>F)
A    1 0.02686 0.02686
B    1 0.00042 0.00042
C    1 0.06306 0.06306
D    1 2.49443 2.49443
E    1 0.00304 0.00304
F    1 0.03209 0.03209
G    1 0.02954 0.02954
H    1 0.12879 0.12879
A:B  1 0.00047 0.00047
A:C  1 0.03218 0.03218
A:D  1 0.01185 0.01185
A:E  1 0.00380 0.00380
A:F  1 0.01674 0.01674
A:G  1 0.00186 0.00186
A:H  1 0.00012 0.00012
```

11 Searle - Linear Models 2e

Reference

- Searle SR, Gruber MHJ. Linear Models 2e, Kindle Edition. John Wiley & Sons Inc. 2016.

11.1 7.2 (p390, 59%)

(192) MODEL

```
weight = c(8,13,9,12,7,11,6,12,12,14,9,7,14,16,10,14,11,13)
treatment = c("ta","ta","ta","ta","ta","ta","tb","tb","tb","tb","tc","tc","tc",
              "tc","tc","tc","tc","tc")
variety = c("va","va","va","vc","vd","vd","va","va","vb","vb","vb","vb","vc",
            "vc","vd","vd","vd","vd")
d1 = data.frame(weight, treatment, variety)
ANOVA(weight ~ treatment*variety, d1)
```

```
$ANOVA
Response : weight
               Df Sum Sq Mean Sq F value Pr(>F)
MODEL           7     82  11.714  2.0918   0.14
RESIDUALS      10     56   5.600
CORRECTED TOTAL 17    138

$`Type I`
                 Df Sum Sq Mean Sq F value  Pr(>F)
treatment         2 10.500   5.250  0.9375 0.42348
variety           3 36.786  12.262  2.1896 0.15232
treatment:variety 2 34.714  17.357  3.0995 0.08965 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
                 Df Sum Sq Mean Sq F value  Pr(>F)
treatment         2  9.486  4.7429  0.8469 0.45731
variety           3 36.786 12.2619  2.1896 0.15232
treatment:variety 2 34.714 17.3571  3.0995 0.08965 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
                 Df Sum Sq Mean Sq F value  Pr(>F)
treatment         2 12.471  6.2353  1.1134 0.36595
variety           3 34.872 11.6240  2.0757 0.16719
treatment:variety 2 34.714 17.3571  3.0995 0.08965 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts = c("contr.sum", "contr.poly"))
Anova(lm(weight ~ treatment*variety, d1), type=3, singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison
Anova Table (Type III tests)

Response: weight
                  Sum Sq Df F values  Pr(>F)
treatment          0.000  0
variety            0.000  0
treatment:variety 34.714  2   3.0995 0.08965 .
Residuals         56.000 10
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

11.2 7.2 (p393, 60%)

(193) MODEL

```
percent = c(31,33,44,36,38,26,37,59,42,42,34,42,28,39,36,32,38,42,36,22,42,46,
            26,37,43)
refinery = c(rep("g",9),rep("n",8),rep("s",8))
process = as.factor(c(1,1,1,1,1,1,2,2,2,1,1,1,1,2,2,2,2,1,1,1,2,2,2,2,2))
source0 = c("t","t","t","t","o","m","t","t","o","m","i","i","i","t","o","m","m",
            "t","o","i","o","o","m","i","i")
d2 = data.frame(percent, refinery, process, source=source0)
ANOVA(percent ~ refinery*source, d2)
```

```
$ANOVA
Response : percent
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL           10  442.56  44.256  0.6361 0.7616
RESIDUALS       14  974.00  69.571
CORRECTED TOTAL 24 1416.56

$`Type I`
                Df  Sum Sq Mean Sq F value Pr(>F)
refinery         2  20.963  10.481  0.1507 0.8615
source           3 266.124  88.708  1.2751 0.3212
refinery:source  5 155.474  31.095  0.4469 0.8086

$`Type II`
                Df  Sum Sq Mean Sq F value Pr(>F)
refinery         2  25.535  12.767  0.1835 0.8343
source           3 266.124  88.708  1.2751 0.3212
refinery:source  5 155.474  31.095  0.4469 0.8086
```

```
$`Type III`
                Df  Sum Sq Mean Sq F value Pr(>F)
refinery         2  10.766   5.383  0.0774 0.9259
source           3 282.633  94.211  1.3542 0.2972
refinery:source  5 155.474  31.095  0.4469 0.8086
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(percent ~ refinery*source, d2), type=3, singular.ok=TRUE) # NOT OK
```

```
Note: model has aliased coefficients
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: percent
                Sum Sq Df F values Pr(>F)
refinery          2.52  1   0.0362 0.8518
source          268.19  2   1.9275 0.1822
refinery:source 155.47  5   0.4469 0.8086
Residuals       974.00 14
```

12 Test Summary

Package	Version	Total Count	Identical to SAS	Different from SAS
sasLM	0.5.2	193	193 (100%)	0 (0%)
car	3.0.10	193	< 174 (90%)	>= 20 (10%)

All of the results in sasLM 0.5.2 were identical, while type III SSs of Model (83) and (84) were different from those of SAS in sasLM 0.1.2 package.

Slight differences in the last digits between type II and type III SS (when they should be same) are resulted from the round-to-even number way of R rounding function.

If you are uncertain about the equivalence of the 'sasLM' to 'SAS,' you can use 'SAS University Edition' for free.

If you find any discrepancies, please mail to the author, Kyun-Seop Bae k@acr.kr.

13 Sesssion Information

```
R version 4.0.5 (2021-03-31)
Platform: x86_64-w64-mingw32/x64 (64-bit)
Running under: Windows 10 x64 (build 17763)

Matrix products: default

locale:
[1] LC_COLLATE=Korean_Korea.949  LC_CTYPE=Korean_Korea.949
[3] LC_MONETARY=Korean_Korea.949 LC_NUMERIC=C
[5] LC_TIME=Korean_Korea.949

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods   base

other attached packages:
[1] daewr_1.2-7   car_3.0-10    carData_3.0-4 sasLM_0.5.2   rmarkdown_2.7

loaded via a namespace (and not attached):
 [1] tinytex_0.28         zoo_1.8-9            xfun_0.20
 [4] partitions_1.10-2    haven_2.3.1          lattice_0.20-41
 [7] colorspace_2.0-0     vctrs_0.3.7          htmltools_0.5.1.1
[10] yaml_2.2.1           gmp_0.6-2            utf8_1.2.1
[13] rlang_0.4.10         pillar_1.5.1         foreign_0.8-81
[16] readxl_1.3.1         lifecycle_1.0.0      stringr_1.4.0
[19] combinat_0.0-8       cellranger_1.1.0     DoE.base_1.1-6
[22] zip_2.1.1            evaluate_0.14        knitr_1.31
[25] rio_0.5.26           forcats_0.5.1        lmtest_0.9-38
[28] curl_4.3             numbers_0.7-5        fansi_0.4.2
[31] vcd_1.4-8            conf.design_2.0.0    Rcpp_1.0.6
[34] polynom_1.4-0        scatterplot3d_0.3-41 abind_1.4-5
[37] FrF2_2.2-2           hms_1.0.0            digest_0.6.27
[40] stringi_1.5.3        openxlsx_4.2.3       grid_4.0.5
[43] mathjaxr_1.4-0       tools_4.0.5          magrittr_2.0.1
[46] tibble_3.1.0         crayon_1.4.1         pkgconfig_2.0.3
[49] MASS_7.3-53.1        ellipsis_0.3.1       data.table_1.14.0
[52] sfsmisc_1.1-10       igraph_1.2.6         compiler_4.0.5
```