Validation of 'sasLM' Package

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Contents

11 Searle - Linear Models 2e **215**

12 Web site examples **218**

13 Bioequivalence (BE) data example **220**

14 Test Summary **222**

15 Sesssion Information **223**

1 Tested Version and Books used for the Validation

1.1 Packages Used

- 'sasLM' version: 0.9.12
- 'SAS' version: 9.4 Licensed and University Edition
- 'car' version: 3.1.2
- R version: R version 4.3.1 (2023-06-16 ucrt)

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"))
GLM(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

$Fitness
 Root MSE Barrow Mean Coef Var  R-square   Adj R-sq
 2.097618    5.222222 40.16715 0.1440922 0.02997118

$`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"))
GLM(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


$Fitness
 Root MSE   Y Mean Coef Var  R-square  Adj R-sq
  2.00521 5.222222 38.39764 0.2699867 0.1135553


$`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
```

GLM(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


$Fitness
 Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 1.473846 5.222222 28.22258 0.6619597 0.5211095


$`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"))
GLM(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


$Fitness
  Root MSE Gain Mean Coef Var  R-square  Adj R-sq
 0.2255642  2.411385 9.354136 0.5055646 0.3407528


$`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
```

7

```
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

`GLM(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


$Fitness
  Root MSE Gain Mean Coef Var  R-square Adj R-sq
 0.2393787   2.411385 9.927022 0.4199453  0.25753


$`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"))
GLM(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
```

```
$Fitness
 Root MSE   Y Mean Coef Var R-square
       NA 8.736905      NA        1
```

```
$`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"))
GLM(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


$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 1.270954 5.4725 23.22438 0.6779647 0.4364382


$`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
```

`GLM(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


$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 1.270954 5.4725 23.22438 0.6779647 0.4364382


$`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
```

`GLM(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

$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 1.270954 5.4725 23.22438 0.6779647 0.4364382

$`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
```

`GLM(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

$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 1.270954 5.4725 23.22438 0.6779647 0.4364382

$`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

```
GLM(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


$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 1.270954 5.4725 23.22438 0.6779647 0.4364382


$`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

```
GLM(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


$Fitness
 Root MSE y Mean Coef Var  R-square   Adj R-sq
 1.270954 5.4725 23.22438 0.6779647 0.4364382


$`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

```
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 1.455507 5.342857 27.24211 0.6676471 0.3352941


$`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"))
GLM(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
```

```
$Fitness
  Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 0.9140295 6.159286 14.83986 0.8870405 0.7902181


$`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 3.2025  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"))
GLM(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


$Fitness
  Root MSE y Mean Coef Var  R-square  Adj R-sq
 0.6924594    9.34 7.413912 0.9780499 0.9597582


$`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

```
p33 = read.csv("C:/G/Rt/ANOVA/Goodnight-p33.csv")
p33 = af(p33, c("A", "B"))
GLM(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

$Fitness
 Root MSE y Mean Coef Var R-square
       NA  6.946        NA        1

$`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`
```

18

```
     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)
GLM(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

$Fitness
 Root MSE COST Mean Coef Var  R-square  Adj R-sq
 10.53198  35.29342 29.84119 0.7773107 0.7642113

$`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)
GLM(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

$Fitness

Root MSE	COST Mean	Coef Var	R-square	Adj R-sq
6.158842	35.29342	17.4504	0.9372871	0.9193691

$`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

```
GLM(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


$Fitness
 Root MSE COST Mean Coef Var  R-square  Adj R-sq
 6.555887  35.29342 18.57538 0.9238649 0.9086379


$`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
```

```
GLM(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


$Fitness
```

```
 Root MSE COST Mean Coef Var  R-square  Adj R-sq
 6.555887  35.29342 18.57538 0.9238649 0.9086379


$`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
```

```
GLM(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


$Fitness
 Root MSE COST Mean Coef Var R-square Adj R-sq
 5.950105  35.29342 16.85896 0.937285 0.924742


$`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)
```

```
$ANOVA
Response : COST
                  Df Sum Sq Mean Sq F value    Pr(>F)
MODEL              3  31586 10528.5  306.83 2.398e-14 ***
RESIDUALS         16    549    34.3
UNCORRECTED TOTAL 19  32135
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$Fitness
 Root MSE COST Mean Coef Var  R-square  Adj R-sq    PRESS    R2pred
 5.857788  35.29342 16.59739 0.9829151 0.9797116 1365.162 0.9575175


$Coefficients
                 Estimate Std. Error Df Lower CL Upper CL t value   Pr(>|t|)
CATTLE             3.3000    0.38314 16  2.48782   4.1123  8.6131 2.100e-07 ***
CALVES             1.9672    0.59108 16  0.71414   3.2202  3.3281  0.004259 **
I(HOGS + SHEEP)    0.8068    0.13800 16  0.51428   1.0994  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"))
GLM(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


$Fitness
 Root MSE fruitwt Mean Coef Var  R-square  Adj R-sq
 57.98607      267.075 21.71153 0.8254864 0.7569274


$`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"))
GLM(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

$Fitness
 Root MSE wtloss Mean Coef Var R-square Adj R-sq
 7.826238   239.5 3.26774 0.9506314 0.8765785

$`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
```

```
GLM(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


$Fitness
 Root MSE shrink Mean Coef Var  R-square  Adj R-sq
 1.732051       47.125 3.675439 0.9365639 0.8414097


$`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"))
GLM(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


$Fitness
 Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 4.432857 18.43778 24.04225 0.4760484 0.3782441


$`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

```
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"))
GLM(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

$Fitness
 Root MSE logct Mean Coef Var  R-square  Adj R-sq
 0.196156    3.049459 6.432487 0.9562528 0.9132347

$`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

```
GLM(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


$Fitness
 Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 4.432857 18.43778 24.04225 0.4760484 0.3782441


$`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"))
GLM(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


$Fitness
  Root MSE resista Mean Coef Var  R-square  Adj R-sq
 0.3333906      6.002917 5.553811 0.7775641 0.5643963


$`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")
GLM(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

$Fitness
  Root MSE drywt Mean Coef Var R-square Adj R-sq
 0.8398909   30.41667 2.761285 0.9489055 0.9020688

$`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"))
GLM(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

$Fitness
 Root MSE FLUSH Mean Coef Var  R-square   Adj R-sq
 17.39728   23.12697  75.2251 0.1441665 0.08389657

$`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
```

GLM(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

$Fitness
 Root MSE FLUSH Mean Coef Var  R-square   Adj R-sq
 17.71054   23.12697 76.57962 0.1630364 0.05060842

$`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)
GLM(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


$Fitness
 Root MSE score2 Mean Coef Var   R-square     Adj R-sq
  6.66532     73.54839 9.062496 0.03844533 -0.03023714


$`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"))
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 1.473846 5.111111 28.83612 0.7096535 0.5886757


$`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

```
GLM(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

$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 1.473846 5.352941 27.53339 0.6373704 0.5164939

$`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"))
```

```
GLM(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


$Fitness
 Root MSE yield Mean Coef Var  R-square   Adj R-sq
 3.136435    30.91667   10.1448 0.5340937 -0.3200677


$`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
```
GLM(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


$Fitness
 Root MSE yield Mean Coef Var  R-square   Adj R-sq
```

```
 3.136435    30.91667   10.1448 0.5340937 -0.3200677


$`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"))
GLM(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


$Fitness
  Root MSE final Mean Coef Var  R-square  Adj R-sq
 0.5491762      30.845 1.780438 0.9882278 0.9840235
```

```
$`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

```
GLM(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


$Fitness
 Root MSE final Mean Coef Var  R-square  Adj R-sq
 0.5323541      30.845 1.725901 0.9920985 0.9849872


$`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"))
GLM(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


$Fitness
 Root MSE  Q1 Mean Coef Var  R-square  Adj R-sq
 4.664374 10.21711 45.65257 0.6803814 0.5338895


$`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

```
GLM(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


$Fitness
 Root MSE  Q1 Mean Coef Var  R-square  Adj R-sq
 4.664374 10.21711 45.65257 0.6803814 0.5338895


$`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

```
$ANOVA
Response : Q1
                  Df Sum Sq Mean Sq F value    Pr(>F)
MODEL             12 4869.5  405.79  18.652 2.638e-09 ***
RESIDUALS         24  522.2   21.76
UNCORRECTED TOTAL 36 5391.7
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$Fitness
 Root MSE  Q1 Mean Coef Var R-square Adj R-sq   PRESS    R2pred
 4.664374 10.21711 45.65257 0.903156 0.854734 1431.83 0.7344377


$Coefficients
        Estimate Std. Error Df Lower CL Upper CL t value  Pr(>|t|)
DAY1      18.675    14.4110 24  -11.067   48.418  1.2959 0.2073286
DAY2      38.487    15.1094 24    7.303   69.671  2.5472 0.0176863 *
DAY3      45.330    26.1576 24   -8.657   99.316  1.7329 0.0959384 .
DAY4      49.149    16.6092 24   14.870   83.429  2.9592 0.0068366 **
DAY5      77.899    27.5007 24   21.140  134.658  2.8326 0.0092034 **
DAY6      73.273    13.4837 24   45.444  101.102  5.4341  1.39e-05 ***
DAY1:P1   -0.220     0.2915 24   -0.822    0.381 -0.7562 0.4568599
DAY2:P1   -0.624     0.2978 24   -1.238   -0.009 -2.0940 0.0470031 *
DAY3:P1   -0.611     0.5049 24   -1.653    0.431 -1.2102 0.2379998
DAY4:P1   -0.796     0.3193 24   -1.455   -0.137 -2.4914 0.0200350 *
DAY5:P1   -1.196     0.5049 24   -2.238   -0.154 -2.3683 0.0262648 *
DAY6:P1   -1.225     0.2652 24   -1.773   -0.678 -4.6199 0.0001092 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
 (41) MODEL
```

GLM(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


$Fitness
 Root MSE  Q1 Mean Coef Var  R-square  Adj R-sq
 4.664374 10.21711 45.65257 0.6803814 0.5338895
```

```
$`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

```
GLM(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

$Fitness
 Root MSE  Q1 Mean Coef Var  R-square  Adj R-sq
 4.213375 10.21711 41.23842 0.7500678 0.6196683

$`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"))
GLM(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


$Fitness
  Root MSE lint Mean Coef Var  R-square  Adj R-sq
 0.2196884    1.77551 12.37325 0.9416596 0.9299915


$`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

```
GLM(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

$Fitness
 Root MSE lint Mean Coef Var  R-square  Adj R-sq
0.2256406   1.77551 12.70849 0.9307624 0.9261466

$`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"))
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 4.102506 54.95833 7.464757 0.7638277 0.6378692


$`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
GLM(y ~ bloc + type + logdose + logd2 + type:logdose + type:logd2, p256)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL            8  816.50 102.062  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


$Fitness
 Root MSE    y Mean Coef Var  R-square  Adj R-sq
 4.102506 54.95833 7.464757 0.7638277 0.6378692


$`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

```
GLM(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


$Fitness
 Root MSE    y Mean Coef Var  R-square  Adj R-sq
 4.102506 54.95833 7.464757 0.7638277 0.6378692


$`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"))
GLM(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

$Fitness
  Root MSE fev1 Mean Coef Var  R-square  Adj R-sq
 0.2512505  3.087049 8.138859 0.9067963 0.8890432

$`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"))
GLM(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


$Fitness
  Root MSE   y Mean Coef Var  R-square  Adj R-sq
 0.4502714 2.37375 18.96878 0.9734438 0.9444733


$`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"))
GLM(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
```

```
$Fitness
 Root MSE  y Mean Coef Var R-square
       NA 2.68875        NA         1

$`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

GLM(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
```


$Fitness
```
 Root MSE  y Mean Coef Var R-square
       NA 2.68875        NA        1
```


$`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"))
GLM(y ~ trt + blk, p399)
```

```
$ANOVA
Response : y
                Df  Sum Sq Mean Sq F value   Pr(>F)
MODEL            8 281.128  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
```

```
$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 0.927811    9.75 9.516011 0.9908974 0.9666238


$`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  59.018  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
```

5.8.4 p403

(53) MODEL

```
p403 = read.table("C:/G/Rt/SAS4lm/p403.txt", header=TRUE)
p403 = af(p403, c("PATIENT", "VISIT"))
GLM(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


$Fitness
 Root MSE  HR Mean Coef Var  R-square Adj R-sq
 7.515988 80.80556 9.301326 0.7298134 0.543256


$`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  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
```
```r
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             343.9   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)
GLM(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

$Fitness
  Root MSE TS Mean Coef Var R-square Adj R-sq
 0.4429698 16.03333 2.762805 0.9932206 0.9894542

$`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)
GLM(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
```

$Fitness
```
 Root MSE ts Mean Coef Var  R-square  Adj R-sq
 0.380815  14.535 2.619986 0.9941306 0.9930301
```

$`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"))
GLM(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


$Fitness
  Root MSE loglivcu Mean Coef Var  R-square  Adj R-sq
 0.1059034       1.750172 6.051026 0.9588819 0.9527142


$`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"))
GLM(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


$Fitness
```

```
 Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 1.752288 15.42857 11.35742 0.8700388 0.8000596


$`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

```r
p431 = read.table("C:/G/Rt/SAS4lm/p431.txt", header=TRUE)
p431 = af(p431, c("line", "sire", "agedam", "steerno"))
GLM(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


$Fitness
  Root MSE avdlygn Mean Coef Var R-square Adj R-sq
 0.2241612    2.411385 9.295956 0.511696 0.348928


$`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

```
GLM(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

$Fitness

Root MSE	avdlygn Mean	Coef Var	R-square	Adj R-sq
0.2550961	2.411385	10.57882	0.2885747	0.1568292

$`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

```
GLM(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


$Fitness
  Root MSE avdlygn Mean Coef Var R-square Adj R-sq
 0.2241612     2.411385 9.295956 0.511696 0.348928


$`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")
GLM(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

$Fitness
 Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 1.832089 64.15625 2.855667 0.2887583 0.2405385

$`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"))
GLM(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


$Fitness
 Root MSE    Y Mean Coef Var  R-square  Adj R-sq
 0.160473 0.6279434 25.55532 0.5821469 0.5171475


$`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"))
GLM(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


$Fitness
 Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 1.995817 84.18936 2.370629 0.9498962 0.9341493


$`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"))
GLM(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


$Fitness
 Root MSE   Y Mean Coef Var R-square  Adj R-sq
 10.55946 192.1373 5.495791 0.340954 0.2990147


$`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"))
GLM(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

$Fitness
   Root MSE  pH Mean  Coef Var  R-square  Adj R-sq
 0.04973534 7.449813 0.6676053 0.4589074 0.3005388

$`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
```

```r
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"))
GLM(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


$Fitness
 Root MSE Residue Mean Coef Var  R-square  Adj R-sq
 0.100193    0.5023377 19.94535 0.9352456 0.776303


$`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
```

```
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
```

```
# 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"))
GLM(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


$Fitness
 Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 4.111227 66.14375 6.215594 0.8896527 0.8068923


$`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"))
GLM(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


$Fitness
 Root MSE   Y Mean Coef Var  R-square  Adj R-sq
  4.92196 25.30208 19.45279 0.9683464 0.9373523


$`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"))
GLM(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


$Fitness
 Root MSE    Y Mean Coef Var R-square  Adj R-sq
 1.140987 45.61667 2.501251 0.921413 0.7424093


$`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"))
GLM(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


$Fitness
 Root MSE   Y Mean Coef Var  R-square   Adj R-sq
 15.79971 1000.098 1.579816 0.4629279 -0.1077112


$`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
```

GLM(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


$Fitness
 Root MSE   Y Mean Coef Var R-square
      NA 1000.098      NA        1


$`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
```

```
GLM(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

$Fitness
 Root MSE   Y Mean Coef Var R-square
       NA 1000.098      NA        1

$`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"))
GLM(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

$Fitness
 Root MSE Yield Mean Coef Var  R-square Adj R-sq
 693.7877    8290.769 8.368195 0.9593218 0.918813

$`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"))
GLM(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			

$Fitness

Root MSE	height Mean	Coef Var	R-square
NA	93.965	NA	1

$`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	265.5	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	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	90.162		

```
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
```

$`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  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  195.0  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

```
GLM(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
```

$Fitness
```
 Root MSE height Mean Coef Var R-square
       NA     93.965          NA        1
```

$`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  253.13  253.13
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   10.49
```

```r
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
```

```r
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"))
GLM(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


$Fitness
 Root MSE yield Mean Coef Var  R-square  Adj R-sq
 13.30727    103.9722 12.79887 0.8467134 0.7581478


$`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
```

GLM(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


$Fitness
 Root MSE yield Mean Coef Var  R-square  Adj R-sq
 10.70513    103.9722 10.29615 0.9250491 0.8434848


$`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"))
GLM(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

$Fitness
 Root MSE height Mean Coef Var R-square
      NA        6.815       NA        1
```

85

```
$`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  28.12 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 21.8812
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  5.6087
```

 (79) MODEL

```
GLM(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


$Fitness
 Root MSE height Mean Coef Var R-square
       NA         6.815        NA         1


$`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  12.237
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


$`Type III`
          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  32.562
R:P        4  48.95  12.238
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
```

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"))
GLM(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


$Fitness
 Root MSE Y Mean Coef Var R-square  Adj R-sq
 1.013794     5.5 18.43261 0.926236 0.8278841


$`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
```

GLM(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

$Fitness
  Root MSE Y Mean Coef Var  R-square  Adj R-sq
 0.9937303    5.5 18.06782 0.9291268 0.8346292

$`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
```

```
GLM(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
```

```
$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
 1.077122     5.5 19.58405 0.9389372 0.8057093


$`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

```
GLM(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
```

```
$Fitness
  Root MSE Y Mean Coef Var  R-square  Adj R-sq
 0.8280787     5.5 15.05598 0.9770335 0.8851675


$`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"))
GLM(Y ~ R + G + R:G + F + F:G, ex7.1)
```

$ANOVA
Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
MODEL	95	577.82	6.0824	5.3082	1.068e-05	***
RESIDUALS	24	27.50	1.1458			
CORRECTED TOTAL	119	605.32				

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

$Fitness

Root MSE	Y Mean	Coef Var	R-square	Adj R-sq
1.070436	6.175	17.335	0.9545699	0.7747422

$`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	50.50	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"))
GLM(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


$Fitness
 Root MSE    Y Mean Coef Var R-square  Adj R-sq
 1.024017 6.032258 16.97569 0.955368 0.7712612


$`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"))
GLM(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

$Fitness
  Root MSE   Y Mean Coef Var R-square  Adj R-sq
 0.5610836 6.265625  8.95495  0.98302 0.9099118

$`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"))
GLM(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


$Fitness
 Root MSE  Y Mean Coef Var R-square
       NA 10.0381       NA        1


$`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"))
GLM(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


$Fitness
 Root MSE    Y Mean Coef Var  R-square  Adj R-sq
 4.147591 66.19839 6.265396 0.8937663 0.8094043


$`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

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

$Fitness
 Root MSE yield Mean Coef Var  R-square  Adj R-sq
 1.178511    45.77193 2.574747 0.9177062 0.7119716

$`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 *
```

101

```
---
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
```

```r
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
GLM(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

$Fitness

Root MSE	Yield Mean	Coef Var	R-square	Adj R-sq
56.32947	9967.354	0.5651396	0.9995357	0.9990734

$`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    23901387    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"))
GLM(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

$Fitness
 Root MSE Yield Mean  Coef Var  R-square  Adj R-sq
 50.94537    11083.06 0.4596687 0.9998974 0.9998049

$`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 ***
```

105

```
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"))
GLM(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

$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
  3.05505      7 43.64358 0.7454545 0.5121212

$`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
```

GLM(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


$Fitness
 Root MSE Z Mean Coef Var  R-square  Adj R-sq
 1.290994     2.5 51.63978 0.6969697 0.4191919


$`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
```

GLM(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

$Fitness
 Root MSE Y Mean Coef Var R-square Adj R-sq
 2.977949   7 42.54213 0.7782955 0.536436

$`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)
GLM(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  7 295.938
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$Fitness
 Root MSE  MY Mean Coef Var  R-square  Adj R-sq
 3.501377 20.06415 17.45091 0.7928678 0.7100149

$`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

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

```
$Fitness
 Root MSE  Y Mean Coef Var  R-square  Adj R-sq
 1.030776 14.1875 7.265384 0.9835881 0.9589702


$`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

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


$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
  3.05505      7 43.64358 0.7454545 0.5121212
```

```
$`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
```

```
GLM(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

$Fitness
    Root MSE Z Mean    Coef Var R-square Adj R-sq
 3.101924e-08     3.5 8.86264e-07        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
```

GLM(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


$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
  3.05505      7 43.64358 0.7454545 0.5121212


$`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"))
GLM(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


$Fitness
  Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 0.7071068 2.916667 24.24366 0.8487395 0.4201681
```

```
$`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

```
GLM(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


$Fitness
 Root MSE Z Mean Coef Var  R-square  Adj R-sq
```

```
 0.745356    1.75 42.59177 0.9033816 0.6296296


$`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
```

GLM(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


$Fitness
  Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 0.6311365 2.916667 21.63897 0.8995798 0.5380672
```

```
$`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"))
GLM(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


$Fitness
  Root MSE miles Mean Coef Var  R-square  Adj R-sq
 0.8683317      26.24 3.309191 0.9260842 0.8669516


$`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"))
GLM(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


$Fitness
  Root MSE miles Mean Coef Var  R-square  Adj R-sq
 0.4404543   26.16667 1.683265 0.9730418 0.9609106


$`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"))
```

```
GLM(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
```

$Fitness
```
  Root MSE yield Mean Coef Var  R-square  Adj R-sq
 0.7169379      15.94 4.497729 0.9583765 0.9250777
```

$`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"))
GLM(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


$Fitness
  Root MSE yield Mean Coef Var  R-square  Adj R-sq
 0.8266398       16.4 5.040486 0.9279488 0.8991284


$`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"))
GLM(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


$Fitness
  Root MSE y Mean Coef Var  R-square  Adj R-sq
 0.8750081      9 9.722312 0.9095378 0.8848663


$`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

```
GLM(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

$Fitness
  Root MSE y Mean Coef Var  R-square  Adj R-sq
 0.9060697      9 10.06744 0.9206374  0.876547

$`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

```
GLM(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

$Fitness
  Root MSE y Mean Coef Var  R-square Adj R-sq
 0.9060697      9 10.06744 0.9206374 0.876547

$`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"))
GLM(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


$Fitness
 Root MSE gain Mean Coef Var R-square  Adj R-sq
 5.927698  68.31333 8.677219 0.874919 0.8186325


$`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"))
GLM(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


$Fitness
 Root MSE diast Mean Coef Var  R-square  Adj R-sq
 1.966384    134.5333 1.461633 0.9637379 0.9298933


$`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"))
GLM(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


$Fitness
 Root MSE height Mean Coef Var  R-square  Adj R-sq
 4.694855     210.6667 2.228571 0.9871946 0.9749227


$`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"))
GLM(y ~ var + N + var:N, v1p357) # OK
```

```
$ANOVA
Response : y
                Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            9 4465.4  496.16  14.116 0.000142 ***
RESIDUALS       10  351.5   35.15
CORRECTED TOTAL 19 4816.9
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 5.928744 137.55 4.310246 0.9270285 0.8613542


$`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  848.43 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
```

8.4.5 p361

(114) MODEL

```
v1p361 = read.table("C:/G/Rt/Kemp/v1p361.txt", head=TRUE)
v1p361 = af(v1p361,c("block", "trt"))
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 1.224745 19.83333 6.175184 0.9938229 0.9691146


$`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"))
GLM(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

$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 12.07173  93.32 12.93584 0.7007379 0.4014758

$`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"))
GLM(response ~ breed + breed:farm + wclass + dosage + breed:dosage, v1p408) # OK

$ANOVA
Response : response
                Df Sum Sq Mean Sq F value   Pr(>F)
MODEL           16 4470.3 279.391  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


$Fitness
 Root MSE response Mean Coef Var  R-square  Adj R-sq
 1.408309          155.75 0.904211 0.9933889 0.986337


$`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  466.8   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 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   580.2    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
```

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"))
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 2.960778 52.36111 5.654535 0.8919461 0.7898953


$`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"))
GLM(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


$Fitness
```

```
 Root MSE Y Mean Coef Var R-square Adj R-sq
 9.540266  612.9 1.556578 0.991379 0.958964


$`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

```
GLM(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


$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
 10.66088  612.9 1.739417 0.9677043 0.9487575


$`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

`GLM(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


$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
 10.66088  612.9 1.739417 0.9677043 0.9487575


$`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,]
GLM(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
```

```
$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
 7.728195  630.7 1.225336 0.9879817 0.9714567
```

```
$`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"))
GLM(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

$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 1.408309  7.875 17.88328 0.8405894 0.7555704

$`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)
```

```
$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 87.017
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$Fitness
  Root MSE  y Mean Coef Var  R-square  Adj R-sq PRESS    R2pred
 0.4153312 14.2125 2.922295 0.9762117 0.9702646  3.68 0.9577097


$Coefficients
            Estimate Std. Error Df Lower CL Upper CL  t value  Pr(>|t|)
(Intercept)  14.2125    0.10383 12  13.9863  14.4387 136.8787 < 2.2e-16 ***
x1            0.7875    0.10383 12   0.5613   1.0137   7.5843 6.465e-06 ***
x2            1.3875    0.10383 12   1.1613   1.6137  13.3628 1.446e-08 ***
x3            1.6625    0.10383 12   1.4363   1.8887  16.0113 1.839e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
GLM(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 87.017
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$Fitness
  Root MSE  y Mean Coef Var  R-square  Adj R-sq
```

```
  0.4153312 14.2125 2.922295 0.9762117 0.9702646


$`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)
GLM(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


$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 1.532954    5.2 29.47989 0.5829197 0.4637539


$`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)
GLM(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


$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 1.025434  5.275  19.4395 0.8498641 0.7247508


$`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"))
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 2.948634 31.16667 9.460859 0.9640285 0.9080728


$`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"))
GLM(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

$Fitness
 Root MSE    y Mean Coef Var  R-square  Adj R-sq
 1.846543 35.83333 5.153144 0.9729118 0.9616251

$`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"))
GLM(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

$Fitness
 Root MSE rate Mean Coef Var R-square  Adj R-sq
 2.892039      77.7 3.722058 0.890533 0.8205957


$`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"))
GLM(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


$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
 3.015585    19.4 15.54425 0.9660934 0.8474203


$`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    3 256.812  85.604  9.4135 0.09755 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

9.1.2 p62

(130) MODEL

```
GLM(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
```

```
$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
 3.015585   19.4 15.54425 0.9660934 0.8474203
```

```
$`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    3 256.812  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
```

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"))
GLM(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


$Fitness
 Root MSE    Y Mean Coef Var  R-square  Adj R-sq
 3.170413 38.46667 8.241975 0.8550104 0.7196867


$`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)
GLM(y ~ x1 + x2 + x3 + x4 + x5 + x6, v2p87) # OK
```

```
Warning in min(abs(rx$coefficients[rx$coefficients != 0])): no non-missing
arguments to min; returning Inf

$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
```

```
$Fitness
 Root MSE y Mean Coef Var  R-square  Adj R-sq
 12.01991  115.4 10.41587 0.7362523 0.4065678


$`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"))
GLM(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

$Fitness
 Root MSE   Y Mean Coef Var  R-square Adj R-sq
 5.104813 27.05556 18.86789 0.9270507 0.803598


$`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"))
GLM(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


$Fitness
 Root MSE Y Mean Coef Var  R-square  Adj R-sq
```

```
   2.150581 29.625 7.259346 0.9787722 0.8407917
```

$`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

```r
v2p268 = read.table("C:/G/Rt/Kemp/v2p268.txt", head=TRUE)
v2p268 = af(v2p268, c("A", "B", "C"))
GLM(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
```

```
$Fitness
 Root MSE  y Mean Coef Var  R-square  Adj R-sq
 2.265817 25.5625 8.863833 0.9661586 0.9274826
```

```
$`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"))
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 1.075291 25.78125 4.170824 0.9918267 0.9841642


$`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"))
GLM(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


$Fitness
 Root MSE   y Mean Coef Var R-square  Adj R-sq
 0.559017 23.0625 2.423922 0.997325 0.9933125


$`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

```
GLM(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


$Fitness
 Root MSE  y Mean Coef Var R-square
       NA 23.0625       NA        1


$`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
```

154

```
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"))
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 2.753785 21.66667 12.70978 0.9764898 0.9098777


$`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

```
GLM(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
```

```
$Fitness
 Root MSE    y Mean Coef Var  R-square  Adj R-sq
 2.753785 21.66667 12.70978 0.9764898 0.9098777
```

```
$`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"))
GLM(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


$Fitness
 Root MSE  y Mean Coef Var  R-square  Adj R-sq
 2.462214 37.1875 6.621081 0.9915715 0.9738717


$`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"))
GLM(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


$Fitness
  Root MSE    y Mean Coef Var  R-square  Adj R-sq
 0.9128709 26.11111 3.496101 0.9956209 0.9875924


$`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"))
GLM(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

$Fitness
 Root MSE   Y Mean Coef Var R-square
       NA 6.555556      NA        1

$`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
```

161

```
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)
GLM(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
```

```
$Fitness
 Root MSE Y Mean Coef Var R-square
      NA   25.5      NA         1
```

```
$`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

```
GLM(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


$Fitness
```

```
   Root MSE Y Mean Coef Var  R-square  Adj R-sq
 0.7071068    25.5 2.772968 0.9991304 0.9904348


$`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"))
GLM(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

$Fitness
 Root MSE   y Mean Coef Var R-square Adj R-sq
        0 10.78571        0        1        1

$`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

```
GLM(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			

$Fitness

Root MSE	y Mean	Coef Var	R-square	Adj R-sq
1.632993	10.78571	15.14033	0.830303	0.4909091

$`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

```
GLM(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			

$Fitness

Root MSE	y Mean	Coef Var	R-square	Adj R-sq
1.632993	10.78571	15.14033	0.830303	0.4909091

```
$`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"))
GLM(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

$Fitness
  Root MSE   y Mean Coef Var  R-square  Adj R-sq
 0.6915708 11.12243 6.217804 0.9777801 0.9333402

$`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 .
---
```

167

```
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
```

```
GLM(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


$Fitness
 Root MSE    y Mean Coef Var  R-square Adj R-sq
 1.382033 11.12243 12.42564 0.9112627 0.733788


$`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

```
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 1.689558 11.12243 15.19055 0.8673781 0.6021342


$`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)
GLM(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


$Fitness
  Root MSE Y Mean Coef Var R-square  Adj R-sq
 0.9703951    2.25 43.12867 0.327381 0.1312004


$`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

```
GLM(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


$Fitness
 Root MSE log(S) Mean Coef Var R-square Adj R-sq
        0   -2.233358        0        1        1


$`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)
GLM(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

$Fitness
  Root MSE   Y Mean Coef Var  R-square  Adj R-sq
 0.7425182 19.6375 3.781124 0.9956526 0.978263

$`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)
GLM(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

$Fitness
 Root MSE Y Mean Coef Var R-square Adj R-sq
 1.166726 19.46 5.99551 0.9792359 0.9342472

$`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  52.288  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
```

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

```
GLM(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


$Fitness
 Root MSE height Mean Coef Var  R-square Adj R-sq
 1.530931    7.333333 20.87633 0.5056152 0.395752


$`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

```
GLM(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
```

$Fitness
```
  Root MSE height^(1 - 1.294869) Mean Coef Var  R-square  Adj R-sq
 0.03316344                  0.5629811 5.890685 0.5687825 0.4729564
```

$`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

```
GLM(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
```

```
$Fitness
 Root MSE yield Mean Coef Var  R-square  Adj R-sq
 1.453727    45.68333 3.182182 0.9077128 0.8879369


$`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

```
GLM(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


$Fitness
 Root MSE  CO Mean Coef Var  R-square  Adj R-sq
 2.27303 72.83333 3.120865 0.9726551 0.9483485


$`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

```
GLM(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


$Fitness
 Root MSE  CO Mean Coef Var  R-square  Adj R-sq
  2.27303 72.83333 3.120865 0.9726551 0.9483485


$`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

```
GLM(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


$Fitness
 Root MSE  CO Mean Coef Var  R-square  Adj R-sq
 2.358495 73.70588 3.199874 0.9696769 0.9393539


$`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

```
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
GLM(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


$Fitness
 Root MSE    y Mean Coef Var  R-square  Adj R-sq
 18.07104 668.5625 2.702969 0.7719523 0.5724106


$`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"))
GLM(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

$Fitness
 Root MSE  Y Mean Coef Var R-square
       NA 62.3125        NA        1

$`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

```
GLM(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
```

```
$Fitness
 Root MSE y Mean Coef Var R-square
       NA 48.245        NA        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

```
GLM(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


$Fitness
   Root MSE rate Mean Coef Var  R-square  Adj R-sq
 0.09137104    0.9142 9.994644 0.8762762 0.8315982


$`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

```
GLM(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

$Fitness
 Root MSE  y Mean Coef Var  R-square  Adj R-sq
 1.609791 12.9875 12.39493 0.9676855 0.9307546

$`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

```
GLM(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

$Fitness
 Root MSE cdistance Mean Coef Var  R-square  Adj R-sq
   8.8431        176.3778 5.013727 0.9287846 0.9230414

$`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

```
GLM(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
```

```
$Fitness
 Root MSE AUC Mean Coef Var  R-square  Adj R-sq
 470.1902 1141.556 41.18855 0.2829314 -1.868274
```

```
$`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

```
GLM(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
```

```
$Fitness
   Root MSE conc Mean Coef Var  R-square Adj R-sq
 0.02702142  1.141567 2.367047 0.8293064 0.809611
```

```
$`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

```
GLM(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

$Fitness
  Root MSE residue Mean Coef Var  R-square  Adj R-sq
 0.02112019    0.3165625 6.671729 0.9117275 0.834489

$`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

```
GLM(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

$Fitness
  Root MSE score Mean Coef Var  R-square  Adj R-sq
 0.8740074    5.833333 14.98298 0.8054245 0.5027516

$`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

```
GLM(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


$Fitness
 Root MSE pressure Mean Coef Var  R-square  Adj R-sq
 3.013857          77.75 3.876343 0.9217516 0.7130893


$`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

```
GLM(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


$Fitness
 Root MSE weight Mean Coef Var R-square
       NA   5.925625       NA        1


$`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

```
GLM(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


$Fitness
   Root MSE  ys Mean  Coef Var  R-square  Adj R-sq
 0.01544479 2.023438 0.7632948 0.9572262 0.8895011


$`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

```
GLM(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


$Fitness
 Root MSE   y Mean Coef Var R-square
       NA 40.98125        NA        1


$`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
```

```
Warning in qt(0.5 + conf.level/2, Res0[, "Df"]): NaNs produced

$ANOVA
Response : y
                Df Sum Sq Mean Sq F value Pr(>F)
MODEL           15 1104.6  73.641
RESIDUALS        0    0.0
CORRECTED TOTAL 15 1104.6


$Fitness
 Root MSE   y Mean Coef Var R-square PRESS R2pred
       NA 15.40625       NA        1   NaN    NaN


$Coefficients
            Estimate Std. Error Df Lower CL Upper CL 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

```
GLM(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

$Fitness
 Root MSE  pl Mean Coef Var  R-square  Adj R-sq
 2.136109 13.15882 16.23328 0.6339915 0.1947814

$`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

```
GLM(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

$Fitness
 Root MSE   y Mean Coef Var  R-square  Adj R-sq
 22.93611 101.3846 22.62287 0.9211408 0.8759128

$`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
```

```
GLM(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


$Fitness
 Root MSE   y Mean Coef Var  R-square   Adj R-sq
 22.93611 101.3846 22.62287 0.9211408 0.8759128


$`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

```
GLM(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


$Fitness
  Root MSE Time Mean Coef Var  R-square  Adj R-sq
 0.1601128  6.250556 2.561577 0.9838299 0.9685581


$`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)
GLM(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

$Fitness

Root MSE	logHL Mean	Coef Var	R-square	Adj R-sq
0.2815174	4.875155	5.774532	0.9221806	0.8540886

$`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

```
GLM(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


$Fitness
  Root MSE   y Mean Coef Var  R-square Adj R-sq
 0.5862902 52.63077 1.113968 0.9913463 0.985165


$`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

```
GLM(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

$Fitness
  Root MSE   y Mean Coef Var R-square Adj R-sq
 0.2374067 5.406667   4.391 0.9780061 0.9516133

$`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
```

```
$ANOVA
Response : y
                  Df     Sum Sq  Mean Sq F value    Pr(>F)
MODEL             24 535997257 22333219  96.728 1.142e-09 ***
RESIDUALS         11   2539743   230886
UNCORRECTED TOTAL 35 538537000
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$Fitness
 Root MSE    y Mean Coef Var R-square  Adj R-sq    PRESS    R2pred
 480.5057 3582.857 13.41124 0.995284 0.9849945 51495197 0.9043795


$Coefficients
           Estimate Std. Error Df Lower CL Upper CL t value  Pr(>|t|)
x1           346948     294197 11  -300575   994471  1.1793 0.2631550
x2             8223        490 11     7144     9301 16.7869 3.467e-09 ***
x3             1656        459 11      646     2665  3.6104 0.0040950 **
x1:x2       -414463     312262 11 -1101748   272822 -1.3273 0.2113017
x1:x3       -334747     311426 11 -1020190   350696 -1.0749 0.3054382
x2:x3         -6476       1199 11    -9114    -3838 -5.4032 0.0002156 ***
x1:z1        103044     328922 11  -620909   826997  0.3133 0.7599297
x2:z1         -2241        548 11    -3446    -1036 -4.0924 0.0017824 **
x3:z1           823        513 11     -305     1952  1.6056 0.1366709
x1:x2:z1     -64013     349120 11  -832421   704395 -0.1834 0.8578546
```

```
x1:x3:z1      -123730      348184 11  -890079      642618 -0.3554 0.7290412
x2:x3:z1         4659        1340 11     1709         7608  3.4765 0.0051806 **
x1:z2          244320      328922 11  -479632       968273  0.7428 0.4731733
x2:z2             886         548 11     -319         2092  1.6187 0.1338108
x3:z2              86         513 11    -1043         1214  0.1670 0.8704301
x1:x2:z2      -266052      349120 11 -1034460       502356 -0.7621 0.4620497
x1:x3:z2      -253151      348184 11 -1019500       513198 -0.7271 0.4823761
x2:x3:z2        -1822        1340 11    -4771         1128 -1.3593 0.2012686
x1:z1:z2       259038      328922 11  -464915       982990  0.7875 0.4476062
x2:z1:z2         -137         548 11    -1342         1068 -0.2500 0.8071853
x3:z1:z2          100         513 11    -1028         1229  0.1955 0.8485983
x1:x2:z1:z2   -269527      349120 11 -1037935       498881 -0.7720 0.4563702
x1:x3:z1:z2   -269249      348184 11 -1035597       497100 -0.7733 0.4556454
x2:x3:z1:z2      -328        1340 11    -3278         2621 -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

```
GLM(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

$Fitness
 Root MSE ybar Mean Coef Var R-square
       NA 0.7424626        NA        1

$`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

```
GLM(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


$Fitness
 Root MSE lns2 Mean Coef Var R-square
       NA -2.623421        NA        1


$`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))
GLM(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
```

```
$Fitness
  Root MSE     y Mean Coef Var R-square  Adj R-sq
 0.9081486 0.7424626 122.3157 0.667313 -3.990305
```

```
$`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)
GLM(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


$Fitness
 Root MSE Pof Mean Coef Var  R-square  Adj R-sq
 1.780098 19.73194 9.021403 0.9100571 0.7339189


$`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

```
GLM(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


$Fitness
   Root MSE torque Mean Coef Var  R-square Adj R-sq
 0.002705567    0.2572743 1.051627 0.9986971 0.988925


$`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

```
GLM(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
```

```
$Fitness
 Root MSE shrinkage Mean Coef Var  R-square  Adj R-sq
 1.919635           27.1 7.083525 0.9972409 0.9895153


$`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
GLM(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


$Fitness
 Root MSE ybar Mean Coef Var R-square
       NA  14.36122       NA        1


$`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)
GLM(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


$Fitness
 Root MSE weight Mean Coef Var  R-square  Adj R-sq
 2.366432           11 21.51302 0.5942029 0.3101449


$`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
```

215

```
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)
GLM(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


$Fitness
 Root MSE percent Mean Coef Var  R-square   Adj R-sq
 8.340949          37.24 22.39782 0.3124188 -0.1787106


$`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   Web site examples

12.1   https://github.com/djnavarro/psyr

(194) MODEL

```
d21 = read.csv("http://r.acr.kr/psyr/coffee.csv")
GLM(babble ~ sugar*milk - 1, d21)
```

```
$ANOVA
Response : babble
                  Df Sum Sq Mean Sq F value    Pr(>F)
MODEL              6 472.54  78.756  298.84 2.39e-12 ***
RESIDUALS         12   3.16   0.264
UNCORRECTED TOTAL 18 475.70
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$Fitness
  Root MSE babble Mean Coef Var  R-square  Adj R-sq
 0.5133631    5.066667 10.13217 0.9933519 0.9900279


$`Type I`
          Df Sum Sq Mean Sq  F value     Pr(>F)
sugar      3 465.64 155.213 588.9486 2.756e-13 ***
milk       1   0.96   0.956   3.6279  0.081061 .
sugar:milk 2   5.94   2.972  11.2769  0.001754 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$`Type II`
          Df Sum Sq Mean Sq F value    Pr(>F)
sugar      2 3.0696 1.53482  5.8238 0.017075 *
milk       1 0.9561 0.95611  3.6279 0.081061 .
sugar:milk 2 5.9439 2.97193 11.2769 0.001754 **
---
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)
sugar      2 2.1318  1.0659  4.0446 0.045426 *
milk       1 1.0041  1.0041  3.8102 0.074672 .
sugar:milk 2 5.9439  2.9719 11.2769 0.001754 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts=c("contr.sum", "contr.poly"))
r21 = lm(babble ~ sugar*milk - 1, d21)
```

```
anova(r21) # Type I SS OK
```

Analysis of Variance Table

Response: babble

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
sugar	3	465.64	155.213	588.9486	2.756e-13	***
milk	1	0.96	0.956	3.6279	0.081061	.
sugar:milk	2	5.94	2.972	11.2769	0.001754	**
Residuals	12	3.16	0.264			

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

```
Anova(r21, type=2) # NOT OK
```

Anova Table (Type II tests)

Response: babble

	Sum Sq	Df	F value	Pr(>F)	
sugar	453.76	3	573.9233	3.214e-13	***
milk	0.96	1	3.6279	0.081061	.
sugar:milk	5.94	2	11.2769	0.001754	**
Residuals	3.16	12			

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

```
Anova(r21, type=3) # NOT OK
```

Anova Table (Type III tests)

Response: babble

	Sum Sq	Df	F value	Pr(>F)	
sugar	454.77	3	575.1970	3.172e-13	***
milk	1.00	1	3.8102	0.074672	.
sugar:milk	5.94	2	11.2769	0.001754	**
Residuals	3.16	12			

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

13 Bioequivalence (BE) data example

(195) MODEL

```
GLM(log(CMAX) ~ SEQ/SUBJ + PRD + TRT, BEdata) # a BE dataset in sasLM package

$ANOVA
Response : log(CMAX)
                Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL           48 23.1924 0.48317  5.6278 4.395e-08 ***
RESIDUALS       42  3.6059 0.08585
CORRECTED TOTAL 90 26.7983
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$Fitness
  Root MSE log(CMAX) Mean Coef Var  R-square  Adj R-sq
 0.2930098        6.071036 4.826355 0.8654428 0.7116631


$`Type I`
         Df  Sum Sq Mean Sq F value    Pr(>F)
SEQ       1  0.6454 0.64544  7.5178  0.008938 **
SEQ:SUBJ 45 22.4395 0.49866  5.8081 3.359e-08 ***
PRD       1  0.0969 0.09686  1.1281  0.294242
TRT       1  0.0106 0.01057  0.1231  0.727410
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$`Type II`
         Df  Sum Sq Mean Sq F value    Pr(>F)
SEQ       1  0.6440 0.64395  7.5005  0.009011 **
SEQ:SUBJ 45 22.5232 0.50052  5.8298 3.173e-08 ***
PRD       1  0.0996 0.09958  1.1599  0.287632
TRT       1  0.0106 0.01057  0.1231  0.727410
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$`Type III`
         Df  Sum Sq Mean Sq F value    Pr(>F)
SEQ       1  0.3368 0.33679  3.9228   0.05421 .
SEQ:SUBJ 45 22.5232 0.50052  5.8298 3.173e-08 ***
PRD       1  0.0996 0.09958  1.1599   0.28763
TRT       1  0.0106 0.01057  0.1231   0.72741
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(log(CMAX) ~ SEQ/SUBJ + PRD + TRT, BEdata), type=3, singular.ok=TRUE)
```

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

Anova Table (Type III tests)

Response: log(CMAX)
          Sum Sq Df F values     Pr(>F)
SEQ       0.0000  0
PRD       0.0996  1   1.1599     0.2876
TRT       0.0106  1   0.1231     0.7274
SEQ:SUBJ  22.5232 45   5.8298 3.173e-08 ***
Residuals 3.6059 42
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

14   Test Summary

Package	Version	Total Count	Identical to SAS	Different from SAS
sasLM	0.9.12	195	195 (100%)	0 (0%)
car	3.1.2	195	173 (89%)	22 (11%)

All of the results by sasLM 0.9.12 were practically identical to those of SAS.

Last digit difference by 1 is 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 check these examples using 'SAS onDemand' for free.

If you have any question, please mail to the author, Kyun-Seop Bae k@acr.kr.

15 Sesssion Information

```
R version 4.3.1 (2023-06-16 ucrt)
Platform: x86_64-w64-mingw32/x64 (64-bit)
Running under: Windows 10 x64 (build 19044)

Matrix products: default


locale:
[1] LC_COLLATE=Korean_Korea.utf8  LC_CTYPE=Korean_Korea.utf8
[3] LC_MONETARY=Korean_Korea.utf8 LC_NUMERIC=C
[5] LC_TIME=Korean_Korea.utf8

time zone: Asia/Seoul
tzcode source: internal

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods   base

other attached packages:
[1] daewr_1.2-10   car_3.1-2       carData_3.0-5  sasLM_0.9.12   mvtnorm_1.2-3
[6] rmarkdown_2.24

loaded via a namespace (and not attached):
 [1] digest_0.6.33   fastmap_1.1.1   xfun_0.40       abind_1.4-5
 [5] knitr_1.43      htmltools_0.5.6 tinytex_0.46    cli_3.6.1
 [9] compiler_4.3.1  tools_4.3.1     evaluate_0.21   yaml_2.3.7
[13] rlang_1.1.1     MASS_7.3-60
```