

Validation of 'sasLM' Package

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1 Tested Version and Books used for the Validation

1.1 Packages Used

- 'sasLM' version: 0.9.2
- 'SAS' version: 9.4 Licensed and University Edition
- 'car' version: 3.1.0
- R version: R version 4.2.1 (2022-06-23 ucrt)

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

If you see any difference between '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 | | | | |
| 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 | 3.2026 | 1.6013 | 1.9167 | 0.2169 |

4.3 Type III SS

4.3.1 p27

(15) MODEL

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

| | 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 | | |

```
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)
```

| | Estimate | Std. Error | Df | t value | Pr(> t) |
|-----------------|----------|------------|----|---------|---------------|
| CATTLE | 3.3000 | 0.38314 | 16 | 8.6131 | 2.100e-07 *** |
| CALVES | 1.9672 | 0.59108 | 16 | 3.3281 | 0.004259 ** |
| I(HOGS + SHEEP) | 0.8068 | 0.13800 | 16 | 5.8466 | 2.479e-05 *** |

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

5.2 Chapter 3

5.2.1 p63

(23) MODEL

```

p63w = read.table("C:/G/Rt/SAS4lm/p63.txt", header=TRUE)
p63l = reshape(p63w,
               direction = "long",
               varying = list(names(p63w)[2:9]),
               v.names = "fruitwt",
               idvar = c("irrig"),
               timevar = "bloc",
               times = 1:8)
p63l = af(p63l, c("bloc"))
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) # Output 7.10
```

| | Estimate | Std. Error | Df | t value | Pr(> t) |
|---------|----------|------------|----|---------|---------------|
| DAY1 | 18.675 | 14.4110 | 24 | 1.2959 | 0.2073286 |
| DAY2 | 38.487 | 15.1094 | 24 | 2.5472 | 0.0176863 * |
| DAY3 | 45.330 | 26.1576 | 24 | 1.7329 | 0.0959384 . |
| DAY4 | 49.149 | 16.6092 | 24 | 2.9592 | 0.0068366 ** |
| DAY5 | 77.899 | 27.5007 | 24 | 2.8326 | 0.0092034 ** |
| DAY6 | 73.273 | 13.4837 | 24 | 5.4341 | 1.39e-05 *** |
| DAY1:P1 | -0.220 | 0.2915 | 24 | -0.7562 | 0.4568599 |
| DAY2:P1 | -0.624 | 0.2978 | 24 | -2.0940 | 0.0470031 * |
| DAY3:P1 | -0.611 | 0.5049 | 24 | -1.2102 | 0.2379998 |
| DAY4:P1 | -0.796 | 0.3193 | 24 | -2.4914 | 0.0200350 * |
| DAY5:P1 | -1.196 | 0.5049 | 24 | -2.3683 | 0.0262648 * |
| DAY6:P1 | -1.225 | 0.2652 | 24 | -4.6199 | 0.0001092 *** |

```
---
```

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

(41) MODEL

```
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) |
|---------|----|---------|---------|----------|---------------|
| bolllwt | 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) |
|---------|----|---------|---------|----------|---------------|
| bolllwt | 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 | 102.063 | 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 | 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 | 281.127 | 35.141 | 40.822 | 0.005606 ** |
| RESIDUALS | 3 | 2.583 | 0.861 | | |
| CORRECTED TOTAL | 11 | 283.710 | | | |

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

\$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 | 59.017 | 19.672 | 22.853 | 0.014388 * |
| blk | 5 | 178.871 | 35.774 | 41.558 | 0.005691 ** |

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

5.8.4 p403

(53) MODEL

```
p403 = read.table("C:/G/Rt/SAS4lm/p403.txt", header=TRUE)
p403 = af(p403, c("PATIENT", "VISIT"))
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  343.9 171.975  3.0443  0.05826 .
RESIDS         1  309.2 309.174  5.4731  0.02414 *
RESIDT         1    0.8   0.840  0.0149  0.90351
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

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

```

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

Anova Table (Type III tests)

Response: HR

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

```

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

```

5.8.5 p409 11.5

(54) MODEL

```

p409 = read.table("C:/G/Rt/SAS4lm/p409.txt", header=TRUE)
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

```

```

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

```

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

Anova Table (Type III tests)

```

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

```

5.8.9 p431

(58) MODEL

```

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

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

\$`Type II`

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

\$`Type III`

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

(75) MODEL

```
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 | 253.12 | 253.12 | | |
| S | 3 | 16.38 | 5.46 | | |
| R:S | 12 | 195.05 | 16.25 | | |
| row:P | 4 | 167.25 | 41.81 | | |
| R:P | 4 | 504.95 | 126.24 | | |
| row:R:P | 32 | 2933.52 | 91.67 | | |
| P:S | 3 | 14.30 | 4.77 | | |
| row:P:S | 24 | 234.68 | 9.78 | | |
| R:P:S | 12 | 100.33 | 8.36 | | |
| row:R:P:S | 96 | 1007.52 | 10.50 | | |

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

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

Model :

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

(76) MODEL

- p94 Appendix 3.1

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

```

\$`Type I`

```

      Df Sum Sq Mean Sq F value Pr(>F)
P          1  28.12  28.1250
column      4  34.33   8.5825
P:column     4  91.45  22.8625
R          4  31.03   7.7575
P:R          4  48.95  12.2375
column:R     16 467.92  29.2450
P:column:R   16 350.10  21.8813
S           3   3.77   1.2583
P:S          3   3.29   1.0983
column:S     12  74.55   6.2125

```

| | | | |
|--------------|----|--------|--------|
| P:column:S | 12 | 47.03 | 3.9192 |
| R:S | 12 | 36.65 | 3.0542 |
| column:R:S | 48 | 197.40 | 4.1125 |
| P:R:S | 12 | 26.33 | 2.1942 |
| P:column:R:S | 48 | 269.22 | 5.6087 |

\$`Type II`

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

\$`Type III`

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|--------------|----|--------|---------|---------|--------|
| P | 1 | 28.12 | 28.1250 | | |
| column | 4 | 34.33 | 8.5825 | | |
| P:column | 4 | 91.45 | 22.8625 | | |
| R | 4 | 31.03 | 7.7575 | | |
| P:R | 4 | 48.95 | 12.2375 | | |
| column:R | 16 | 467.92 | 29.2450 | | |
| P:column:R | 16 | 350.10 | 21.8813 | | |
| S | 3 | 3.77 | 1.2583 | | |
| P:S | 3 | 3.29 | 1.0983 | | |
| column:S | 12 | 74.55 | 6.2125 | | |
| P:column:S | 12 | 47.03 | 3.9192 | | |
| R:S | 12 | 36.65 | 3.0542 | | |
| column:R:S | 48 | 197.40 | 4.1125 | | |
| P:R:S | 12 | 26.33 | 2.1942 | | |
| P:column:R:S | 48 | 269.22 | 5.6088 | | |

(79) MODEL

```
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 | 12.238 | | |
| row:R:P | 32 | 504.12 | 15.754 | | |
| P:S | 3 | 3.30 | 1.098 | | |
| row:P:S | 24 | 171.28 | 7.137 | | |
| R:P:S | 12 | 26.33 | 2.194 | | |
| row:R:P:S | 96 | 416.92 | 4.343 | | |

\$`Type III`

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|-------|----|--------|---------|---------|--------|
| row | 4 | 309.43 | 77.358 | | |
| R | 4 | 31.03 | 7.757 | | |
| P | 1 | 28.13 | 28.125 | | |
| S | 3 | 3.78 | 1.258 | | |
| R:S | 12 | 36.65 | 3.054 | | |
| row:P | 4 | 130.25 | 32.563 | | |

| | | | |
|-----------|----|--------|--------|
| R:P | 4 | 48.95 | 12.237 |
| row:R:P | 32 | 504.12 | 15.754 |
| P:S | 3 | 3.30 | 1.098 |
| row:P:S | 24 | 171.28 | 7.137 |
| R:P:S | 12 | 26.33 | 2.194 |
| row:R:P:S | 96 | 416.92 | 4.343 |

7.7 Example 5.1

(80) MODEL

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

$Y \sim R + A + A:R + C + B + B:C + Tx + A:Tx + B:Tx$

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
      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 :

$Y \sim R + A + A:R + C + B + C:B + Tx + A:Tx + B:Tx + A:B:Tx$

Complete :

| | (Intercept) | R1 | R2 | A1 | C1 | C2 | B1 | Tx1 | Tx2 | Tx3 | Tx4 | Tx5 |
|-----------|-------------|--------|--------|-----------|-----------|-----------|-----------|--------|--------|--------|------|------|
| B1:Tx5 | 0 | | 0 | -1/5 | 0 | 0 | -1/5 | 0 | 0 | 0 | 0 | 0 |
| A1:B1:Tx5 | -1/6 | | 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 |
| | 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 | | 0 | | | |
| A1:B1:Tx5 | 0 | 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 | 577.83 | 6.0824 | 5.3082 | 1.068e-05 *** |
| RESIDUALS | 24 | 27.50 | 1.1458 | | |
| CORRECTED TOTAL | 119 | 605.33 | | | |

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

\$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 | 50.51 | 25.2525 | 22.0385 | 3.686e-06 *** |

```
G:F 54 77.98 1.4441 1.2603 0.2718
```

```
---
```

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

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

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

Anova Table (Type III tests)

Response: Y

| | Sum Sq | Df | F values | Pr(>F) |
|-----------|---------|----|----------|---------------|
| R | 0.000 | 0 | | |
| G | 202.417 | 3 | 58.8848 | 3.258e-11 *** |
| F | 50.505 | 2 | 22.0385 | 3.686e-06 *** |
| R:G | 11.750 | 9 | 1.1394 | 0.3749 |
| G:F | 77.983 | 54 | 1.2603 | 0.2718 |
| Residuals | 27.500 | 24 | | |

```
---
```

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

7.9 Example 7.2

(85) MODEL

```
ex7.2 = read.table("C:/G/Rt/Split/aspectt.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

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

```

```

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

```

```

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

```

```

options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(yield ~ rep + hyb + rep:hyb + gen + gen:rep + gen:hyb, ex9.2), type=3,

```

```
singular.ok=TRUE) # NOT OK
```

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

Anova Table (Type III tests)

Response: yield

| | Sum Sq | Df | F values | Pr(>F) |
|-----------|--------|----|----------|---------------|
| rep | 0.000 | 0 | | |
| hyb | 66.704 | 8 | 6.0033 | 0.0011847 ** |
| gen | 30.671 | 2 | 11.0416 | 0.0009707 *** |
| rep:hyb | 67.000 | 8 | 6.0300 | 0.0011569 ** |
| rep:gen | 12.111 | 2 | 4.3600 | 0.0308015 * |
| hyb:gen | 60.504 | 18 | 2.4201 | 0.0408545 * |
| Residuals | 22.222 | 16 | | |

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

7.14 Example 10.1

(90) MODEL

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

```

```

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 *** |
| 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 7 295.937

```

```
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

```
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

```

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, vip265) # 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 | 4465.5 | 496.16 | 14.116 | 0.000142 *** |
| RESIDUALS | 10 | 351.5 | 35.15 | | |
| CORRECTED TOTAL | 19 | 4817.0 | | | |

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

\$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   848.42  24.1373 4.027e-05 ***
var:N   4   931.3   232.83   6.6238  0.007152 **
```

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

8.4.5 p361

(114) MODEL

```
v1p361 = read.table("C:/G/Rt/Kemp/v1p361.txt", head=TRUE)
v1p361 = af(v1p361,c("block", "trt"))
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 4470.2  279.391  140.87 2.039e-13 ***

```



```
RESIDUALS      15   29.7   1.983
CORRECTED TOTAL 31 4500.0
```

```
---
```

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

```
$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 | 466.7 | 155.6 | 78.4454 | 2.142e-09 *** |
| dosage | 3 | 580.2 | 193.4 | 97.5210 | 4.596e-10 *** |
| breed:dosage | 3 | 133.8 | 44.6 | 22.4790 | 8.366e-06 *** |

```
---
```

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

```
$`Type III`
```

| | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|--------------|----|--------|---------|-----------|---------------|
| breed | 1 | 3280.5 | 3280.5 | 1654.0336 | < 2.2e-16 *** |
| breed:farm | 6 | 9.0 | 1.5 | 0.7563 | 0.6146 |
| wclass | 3 | 466.8 | 155.6 | 78.4454 | 2.142e-09 *** |
| dosage | 3 | 580.3 | 193.4 | 97.5210 | 4.596e-10 *** |
| breed:dosage | 3 | 133.7 | 44.6 | 22.4790 | 8.366e-06 *** |

```
---
```

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

8.5.3 p410

```
(117) MODEL
```

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

```

```

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

```

```

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 87.018
---

```

```

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 | 256.813 | 85.604 | 9.4135 | 0.09755 . |

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

9.1.2 p62

(130) MODEL

```
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 | 256.813 | 85.604 | 9.4135 | 0.09755 . |
| BLOCK | 4 | 79.146 | 19.786 | 2.1758 | 0.33880 |

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

9.2 Chapter 2

9.2.1 p82

(131) MODEL

```
v2p82 = read.table("C:/G/Rt/Kemp/v2p82.txt", head=TRUE)
v2p82 = af(v2p82, c("B", "Tx"))
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
```

\$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

```
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 | | |
| 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 | | | | |
| 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 .
---
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 | -2.23358 | | 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 | 52.287 | 13.072 | 9.6028 | 0.0088641 ** |
| S | 3 | 167.414 | 55.805 | 40.9952 | 0.0002163 *** |
| T | 3 | 190.430 | 63.477 | 46.6312 | 0.0001498 *** |
| C | 3 | 19.083 | 6.361 | 4.6728 | 0.0518237 . |

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

10 Lawson - DAE with SAS

Reference

- Lawson J. Design and Analysis of Experiments with SAS. Taylor and Francis Group. 2010.

```
require(daewr)
```

10.1 Chapter 2

10.1.1 p22

(156) MODEL

```
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 0.0307444  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 0.0307444  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

```

| | Estimate | Std. Error | Df | t value | Pr(> t) |
|-------------|----------|------------|----|---------|----------|
| (Intercept) | 15.4062 | | 0 | | |
| A | -4.9062 | | 0 | | |
| B | -0.1562 | | 0 | | |
| A:B | 0.5312 | | 0 | | |
| C | 3.9688 | | 0 | | |
| A:C | 2.9062 | | 0 | | |
| B:C | 0.4062 | | 0 | | |
| A:B:C | 0.5938 | | 0 | | |
| P | -2.3438 | | 0 | | |
| Q | -3.4062 | | 0 | | |
| A:P | -0.9062 | | 0 | | |
| A:Q | -0.3438 | | 0 | | |
| B:P | 1.0938 | | 0 | | |
| B:Q | 0.1562 | | 0 | | |

| | | |
|-----|---------|---|
| C:P | -0.2812 | 0 |
| C:Q | 0.7812 | 0 |

10.7 Chapter 9

10.7.1 p349

(177) MODEL

```
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

```

```

      Estimate Std. Error Df t value    Pr(>|t|)
x1      346948     294197 11   1.1793 0.2631550
x2       8223         490 11  16.7869 3.467e-09 ***
x3       1656         459 11   3.6104 0.0040950 **
x1:x2   -414463     312262 11  -1.3273 0.2113017
x1:x3   -334747     311426 11  -1.0749 0.3054382
x2:x3    -6476        1199 11  -5.4032 0.0002156 ***
x1:z1    103044     328922 11   0.3133 0.7599297
x2:z1    -2241         548 11  -4.0924 0.0017824 **
x3:z1      823         513 11   1.6056 0.1366709

```

```

x1:x2:z1      -64013      349120 11 -0.1834 0.8578546
x1:x3:z1     -123730      348184 11 -0.3554 0.7290412
x2:x3:z1        4659        1340 11  3.4765 0.0051806 **
x1:z2          244320      328922 11  0.7428 0.4731733
x2:z2           886         548 11  1.6187 0.1338108
x3:z2           86         513 11  0.1670 0.8704301
x1:x2:z2     -266052      349120 11 -0.7621 0.4620497
x1:x3:z2     -253151      348184 11 -0.7271 0.4823761
x2:x3:z2      -1822        1340 11 -1.3593 0.2012686
x1:z1:z2      259038      328922 11  0.7875 0.4476062
x2:z1:z2      -137         548 11 -0.2500 0.8071853
x3:z1:z2       100         513 11  0.1955 0.8485983
x1:x2:z1:z2  -269527      349120 11 -0.7720 0.4563702
x1:x3:z1:z2  -269249      348184 11 -0.7733 0.4556454
x2:x3:z1:z2   -328         1340 11 -0.2448 0.8111141
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

10.9 Chapter 12

10.9.1 p513

(185) MODEL

```
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","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 |
| 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))
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

```
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 | 0.9.2 | 195 | 195 (100%) | 0 (0%) |
| car | 3.1.0 | 195 | 173 (89%) | 22 (11%) |

All of the results by sasLM 0.9.2 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 4.2.1 (2022-06-23 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

attached base packages:

[1] stats graphics grDevices utils datasets methods base

other attached packages:

[1] daewr_1.2-7 car_3.1-0 carData_3.0-5 sasLM_0.9.2 mvtnorm_1.1-3
[6] rmarkdown_2.16

loaded via a namespace (and not attached):

| | | |
|----------------------|----------------------|-------------------|
| [1] gmp_0.6-6 | compiler_4.2.1 | mathjaxr_1.6-0 |
| [4] numbers_0.8-2 | tools_4.2.1 | partitions_1.10-7 |
| [7] digest_0.6.29 | evaluate_0.16 | lattice_0.20-45 |
| [10] pkgconfig_2.0.3 | rlang_1.0.5 | igraph_1.3.4 |
| [13] cli_3.3.0 | yaml_2.3.5 | polynom_1.4-1 |
| [16] xfun_0.32 | fastmap_1.1.0 | stringr_1.4.1 |
| [19] knitr_1.40 | scatterplot3d_0.3-41 | combinat_0.0-8 |
| [22] lmtest_0.9-40 | vcd_1.4-10 | grid_4.2.1 |
| [25] DoE.base_1.2-1 | Rdpack_2.4 | conf.design_2.0.0 |
| [28] FrF2_2.2-3 | magrittr_2.0.3 | sfsmisc_1.1-13 |
| [31] htmltools_0.5.3 | rbibutils_2.2.9 | MASS_7.3-58.1 |
| [34] abind_1.4-5 | colorspace_2.0-3 | tinytex_0.41 |
| [37] stringi_1.7.8 | zoo_1.8-10 | |