

# Validation of 'sasLM' Package

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# 1 Tested Version and Books used for the Validation

## 1.1 Packages Used

- 'sasLM' version: 0.6.6
- 'SAS' version: 9.4 Licensed and University Edition
- 'car' version: 3.0.12
- R version: R version 4.1.2 (2021-11-01)

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"))
ANOVA(Barrow ~ Ration, p8)
```

\$ANOVA

Response : Barrow

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

\$`Type I`

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

\$`Type II`

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

\$`Type III`

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

### 2.2 p42

(2) MODEL

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

\$ANOVA

Response : Y

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

\$`Type I`

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

\$`Type II`

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

\$`Type III`

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

(3) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	5	51.044	10.2089	4.6997	0.01311 *
RESIDUALS	12	26.067	2.1722		
CORRECTED TOTAL	17	77.111			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Sire	2	11.1111	5.5556	2.5575	0.118799
Ration	1	9.7079	9.7079	4.4691	0.056129 .
Sire:Ration	2	30.2255	15.1127	6.9573	0.009859 **

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Sire	2	15.6829	7.8414	3.6099	0.059238 .
Ration	1	9.7079	9.7079	4.4691	0.056129 .
Sire:Ration	2	30.2255	15.1127	6.9573	0.009859 **

---

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

```
$`Type III`
```

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

```
---
```

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

## 2.3 p101

(4) MODEL

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

```
$ANOVA
```

```
Response : Gain
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	16	2.4972	0.156073	3.0675	0.001364 **
RESIDUALS	48	2.4422	0.050879		
CORRECTED TOTAL	64	4.9394			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Line	2	0.38009	0.190046	3.7352	0.03107 *
Sire	6	0.92634	0.154391	3.0345	0.01347 *
Dam	2	0.11894	0.059471	1.1689	0.31940
Line:Dam	4	0.64889	0.162222	3.1884	0.02113 *
Age	1	0.16462	0.164622	3.2356	0.07835 .
Weight	1	0.25828	0.258283	5.0764	0.02886 *

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Line	0				
Sire	6	0.95299	0.15883	3.1217	0.01155 *
Dam	2	0.32039	0.16019	3.1485	0.05190 .
Line:Dam	4	0.46516	0.11629	2.2856	0.07373 .
Age	1	0.34830	0.34830	6.8456	0.01185 *
Weight	1	0.25828	0.25828	5.0764	0.02886 *

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

```
$`Type III`
```

```
CAUTION: Singularity Exists !
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Line	0				
Sire	6	0.95299	0.15883	3.1217	0.01155 *
Dam	2	0.12469	0.06234	1.2253	0.30268
Line:Dam	4	0.46516	0.11629	2.2856	0.07373 .
Age	1	0.34830	0.34830	6.8456	0.01185 *
Weight	1	0.25828	0.25828	5.0764	0.02886 *

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

## (5) MODEL

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

```
$ANOVA
```

```
Response : Gain
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	2.0743	0.148162	2.5856	0.006996 **
RESIDUALS	50	2.8651	0.057302		
CORRECTED TOTAL	64	4.9394			

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Sire	8	1.30644	0.163305	2.8499	0.01089 *
Dam	2	0.11894	0.059471	1.0379	0.36172
Dam:Line	4	0.64889	0.162222	2.8310	0.03412 *

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Sire	6	1.06000	0.176667	3.0831	0.01202 *
Dam	2	0.11894	0.059471	1.0379	0.36172
Dam:Line	4	0.64889	0.162222	2.8310	0.03412 *

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

```
$`Type III`
```

```
CAUTION: Singularity Exists !
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------



Sire	6	1.06000	0.176667	3.0831	0.01202	*
Dam	2	0.02569	0.012844	0.2242	0.79999	
Dam:Line	4	0.64889	0.162222	2.8310	0.03412	*

---

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

### 3 Snee EMS ANOVA 1974

#### Reference

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

#### (6) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	167	751.27	4.4986		
RESIDUALS	0	0.00			
CORRECTED TOTAL	167	751.27			

\$`Type I`

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

\$`Type II`

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

\$`Type III`

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

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

## 4 Goodnight

### Reference

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

### 4.1 Type I SS

#### 4.1.1 p7

(7) MODEL

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

\$ANOVA

Response : y

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

\$`Type I`

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

---

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

\$`Type II`

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

---

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

\$`Type III`

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

---

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

## (8) MODEL

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

```
$ANOVA
```

```
Response : y
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	10.8113	10.8113	6.6929	0.06087 .
A:B	2	2.7914	1.3957	0.8640	0.48764
B	0				

```
---
```

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

```
$`Type II`
```

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

```
---
```

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

```
$`Type III`
```

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

```
---
```

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

## (9) MODEL

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

```
$ANOVA
```

```
Response : y
```

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

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

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

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

#### (10) MODEL

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

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

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

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

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

\$`Type III`

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

---

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

(11) MODEL

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

\$ANOVA

Response : y

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

\$`Type I`

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

\$`Type II`

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

---

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

\$`Type III`

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

---

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

(12) MODEL

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

```
$ANOVA
```

```
Response : y
```

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

```
$`Type I`
```

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

```
$`Type II`
```

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

```
---
```

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

```
$`Type III`
```

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

```
---
```

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

## 4.2 Type II SS

### 4.2.1 p14

```
(13) MODEL
```

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

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	3	12.7672	4.2557	2.0088	0.2906
RESIDUALS	3	6.3555	2.1185		
CORRECTED TOTAL	6	19.1227			

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

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

```
$`Type III`
      Df Sum Sq Mean Sq F value Pr(>F)
A      1  9.5258   9.5258   4.4965 0.1241
B      1  1.3690   1.3690   0.6462 0.4803
A:B    1  0.8880   0.8880   0.4192 0.5635
```

#### 4.2.2 p24

(14) MODEL

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

```
$ANOVA
Response : Y

      Df Sum Sq Mean Sq F value Pr(>F)
MODEL      6 45.924   7.6540   9.1615 0.00499 **
RESIDUALS   7  5.848   0.8354
CORRECTED TOTAL 13 51.772

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

```
$`Type I`
      Df Sum Sq Mean Sq F value Pr(>F)
A      1  4.724   4.7235   5.6538 0.04904 *
B      3 37.998  12.6660  15.1606 0.00191 **
C      2  3.203   1.6013   1.9167 0.21686

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

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



```
A 0
B 2 0.4424 0.2212 0.2648 0.7747
C 2 3.2025 1.6013 1.9167 0.2169
```

\$`Type III`

CAUTION: Singularity Exists !

```
  Df Sum Sq Mean Sq F value Pr(>F)
A 0
B 2 0.4424 0.2212 0.2648 0.7747
C 2 3.2026 1.6013 1.9167 0.2169
```

### 4.3 Type III SS

#### 4.3.1 p27

(15) MODEL

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

\$ANOVA

Response : y

```
      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      5 128.193  25.6386   53.469 6.77e-05 ***
RESIDUALS    6   2.877   0.4795
CORRECTED TOTAL 11 131.070
```

---

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

\$`Type I`

```
      Df Sum Sq Mean Sq F value    Pr(>F)
A      2 89.580  44.790 93.4102 3.013e-05 ***
B      2 38.542  19.271 40.1901 0.0003351 ***
A:B    1  0.071   0.071  0.1471 0.7145464
```

---

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

\$`Type II`

```
      Df Sum Sq Mean Sq F value    Pr(>F)
A      2 126.778  63.389 132.1977 1.093e-05 ***
B      2  38.542  19.271  40.1901 0.0003351 ***
A:B    1  0.071   0.071   0.1471 0.7145464
```

---

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

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

#### 4.3.2 p33

(16) MODEL

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

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

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

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

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

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

## 5 SAS for Linear Models 4e

### Reference

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

### 5.1 Chapter 2

#### 5.1.1 p5

(17) MODEL

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

\$ANOVA

Response : COST

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	1	6582.1	6582.1	59.34	6.083e-07 ***
RESIDUALS	17	1885.7	110.9		
CORRECTED TOTAL	18	8467.8			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	6582.1	6582.1	59.34	6.083e-07 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	6582.1	6582.1	59.34	6.083e-07 ***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	6582.1	6582.1	59.34	6.083e-07 ***

---

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

#### 5.1.2 p12

(18) MODEL

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

\$ANOVA

Response : COST

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	7936.7	1984.18	52.31	2.885e-08 ***
RESIDUALS	14	531.0	37.93		
CORRECTED TOTAL	18	8467.8			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	6582.1	6582.1	173.5265	2.801e-09 ***
CALVES	1	186.7	186.7	4.9213	0.0435698 *
HOGS	1	489.9	489.9	12.9145	0.0029351 **
SHEEP	1	678.1	678.1	17.8773	0.0008431 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	2200.71	2200.71	58.0183	2.413e-06 ***
CALVES	1	136.08	136.08	3.5876	0.0790616 .
HOGS	1	113.66	113.66	2.9964	0.1054198
SHEEP	1	678.11	678.11	17.8773	0.0008431 ***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	2200.71	2200.71	58.0183	2.413e-06 ***
CALVES	1	136.08	136.08	3.5876	0.0790616 .
HOGS	1	113.66	113.66	2.9964	0.1054198
SHEEP	1	678.11	678.11	17.8773	0.0008431 ***

---

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

(19) MODEL

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

\$ANOVA

Response : COST

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

```

MODEL          3 7823.1 2607.69  60.673 1.281e-08 ***
RESIDUALS      15  644.7   42.98
CORRECTED TOTAL 18 8467.8

```

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	6582.1	6582.1	153.1443	2.835e-09 ***
CALVES	1	186.7	186.7	4.3432	0.0546701 .
SHEEP	1	1054.3	1054.3	24.5306	0.0001735 ***

---

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

\$`Type II`

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

---

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

\$`Type III`

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

---

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

(20) MODEL

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

\$ANOVA

Response : COST

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	3	7823.1	2607.69	60.673	1.281e-08 ***
RESIDUALS	15	644.7	42.98		
CORRECTED TOTAL	18	8467.8			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	6582.1	6582.1	153.1443	2.835e-09 ***
CALVES	1	186.7	186.7	4.3432	0.0546701 .

```
SHEEP    1 1054.3  1054.3  24.5306 0.0001735 ***
```

```
---
```

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

```
$`Type II`
```

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

```
---
```

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

```
$`Type III`
```

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

```
---
```

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

(21) MODEL

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

```
$ANOVA
```

```
Response : COST
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	3	7936.7	2645.6	74.726	3.011e-09 ***
RESIDUALS	15	531.1	35.4		
CORRECTED TOTAL	18	8467.8			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	6582.1	6582.1	185.9151	7.406e-10 ***
CALVES	1	186.7	186.7	5.2726	0.03649 *
I(HOGS + SHEEP)	1	1168.0	1168.0	32.9896	3.883e-05 ***

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	2215.48	2215.48	62.5775	9.887e-07 ***
CALVES	1	155.03	155.03	4.3788	0.0538 .
I(HOGS + SHEEP)	1	1167.96	1167.96	32.9896	3.883e-05 ***

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
CATTLE	1	2215.48	2215.48	62.5775	9.887e-07 ***
CALVES	1	155.03	155.03	4.3788	0.0538 .
I(HOGS + SHEEP)	1	1167.96	1167.96	32.9896	3.883e-05 ***

```
---
```

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

```
(22) MODEL
```

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

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

```
---
```

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

## 5.2 Chapter 3

### 5.2.1 p63

```
(23) MODEL
```

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

```
$ANOVA
```

```
Response : fruitwt
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	445334	40485	12.04	6.643e-08 ***
RESIDUALS	28	94147	3362		
CORRECTED TOTAL	39	539481			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	7	401308	57330	17.0503	1.452e-08 ***
irrig	4	44026	11006	3.2734	0.02539 *

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	7	401308	57330	17.0503	1.452e-08 ***
irrig	4	44026	11006	3.2734	0.02539 *

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	7	401308	57330	17.0503	1.452e-08 ***
irrig	4	44026	11006	3.2734	0.02539 *

```
---
```

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

## 5.2.2 p72

(24) MODEL

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

```
$ANOVA
```

```
Response : wtloss
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	9	7076.5	786.28	12.837	0.002828 **
RESIDUALS	6	367.5	61.25		
CORRECTED TOTAL	15	7444.0			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
run	3	986.5	328.83	5.3687	0.0390130 *
pos	3	1468.5	489.50	7.9918	0.0161685 *
mat	3	4621.5	1540.50	25.1510	0.0008498 ***

```
---
```



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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
run	3	986.5	328.83	5.3687	0.0390130 *
pos	3	1468.5	489.50	7.9918	0.0161685 *
mat	3	4621.5	1540.50	25.1510	0.0008498 ***

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
run	3	986.5	328.83	5.3687	0.0390130 *
pos	3	1468.5	489.50	7.9918	0.0161685 *
mat	3	4621.5	1540.50	25.1510	0.0008498 ***

```
---
```

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

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

```
$ANOVA
```

```
Response : shrink
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	9	265.75	29.528	9.8426	0.005775 **
RESIDUALS	6	18.00	3.000		
CORRECTED TOTAL	15	283.75			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
run	3	33.25	11.083	3.6944	0.081254 .
pos	3	60.25	20.083	6.6944	0.024212 *
mat	3	172.25	57.417	19.1389	0.001786 **

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
run	3	33.25	11.083	3.6944	0.081254 .
pos	3	60.25	20.083	6.6944	0.024212 *
mat	3	172.25	57.417	19.1389	0.001786 **

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

```
run 3 33.25 11.083 3.6944 0.081254 .
pos 3 60.25 20.083 6.6944 0.024212 *
mat 3 172.25 57.417 19.1389 0.001786 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

### 5.2.3 p75

(25) MODEL

```
p75w = read.table("C:/G/Rt/SAS4lm/p75.txt", header=TRUE)
p75l = reshape(p75w,
               direction = "long",
               varying = list(names(p75w)[4:9]),
               v.names = "Y",
               idvar = c("method", "variety", "trt"),
               timevar = "yield",
               times = 1:6)
p75l = af(p75l, c("variety", "yield"))
ANOVA(Y ~ method*variety, p75l) # p78
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	1339.0	95.645	4.8674	2.723e-06 ***
RESIDUALS	75	1473.8	19.650		
CORRECTED TOTAL	89	2812.8			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
method	2	953.16	476.58	24.2531	7.525e-09 ***
variety	4	11.38	2.85	0.1448	0.96476
method:variety	8	374.49	46.81	2.3822	0.02409 *

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
method	2	953.16	476.58	24.2531	7.525e-09 ***
variety	4	11.38	2.85	0.1448	0.96476
method:variety	8	374.49	46.81	2.3822	0.02409 *

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

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

## 5.3 Chapter 4

### 5.3.1 p94

(26) MODEL

```
p94w = read.table("C:/G/Rt/SAS4lm/p94.txt", head=TRUE)
p94l = reshape(p94w,
               direction = "long",
               varying = list(names(p94w)[3:8]),
               v.names = "ct",
               idvar = c("package"),
               timevar = "sample",
               times = 1:6)
p94l$sampleA = floor((p94l$sample + 1)/2)
p94l$sampleB = 2 - (p94l$sample) %% 2
p94l$logct = log10(p94l$ct)
p94l = af(p94l, c("sample", "sampleA", "sampleB", "package"))
ANOVA(logct ~ package + sampleA %in% package, p94l) # p97
```

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

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

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

```

package          19 30.529 1.60680 41.760 < 2.2e-16 ***
package:sampleA  40 19.934 0.49836 12.952 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type III`

```

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

```

### 5.3.2 p116

(27) MODEL

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

\$ANOVA

Response : Y

```

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

```

\$`Type I`

```

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

```

\$`Type II`

```

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

```

\$`Type III`

```

          Df Sum Sq Mean Sq F value    Pr(>F)
method        2  953.16  476.58 24.2531 7.525e-09 ***

```

```

variety          4  11.38    2.85  0.1448   0.96476
method:variety   8 374.49   46.81  2.3822   0.02409 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

### 5.3.3 p122

(28) MODEL

```

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

```

```

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

```

```

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

```

```

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

```

```

$`Type III`
          Df Sum Sq Mean Sq F value    Pr(>F)
et           3  3.1122   1.03739   9.3333 0.0002851 ***
et:wafer     8  4.2745   0.53431   4.8071 0.0012742 **
pos          3  1.1289   0.37630   3.3855 0.0345139 *
et:pos       9  0.8095   0.08994   0.8092 0.6125279

```

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

### 5.3.4 p136

(29) MODEL

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

\$ANOVA

Response : drywt

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	157.208	14.2917	20.26	4.594e-06 ***
RESIDUALS	12	8.465	0.7054		
CORRECTED TOTAL	23	165.673			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	3	25.320	8.440	11.9646	0.0006428 ***
cult	1	2.407	2.407	3.4117	0.0895283 .
rep:cult	3	9.480	3.160	4.4796	0.0249095 *
inoc	2	118.176	59.088	83.7631	8.919e-08 ***
cult:inoc	2	1.826	0.913	1.2942	0.3097837

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	3	25.320	8.440	11.9646	0.0006428 ***
cult	1	2.407	2.407	3.4117	0.0895283 .
rep:cult	3	9.480	3.160	4.4796	0.0249095 *
inoc	2	118.176	59.088	83.7631	8.919e-08 ***
cult:inoc	2	1.826	0.913	1.2942	0.3097837

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	3	25.320	8.440	11.9646	0.0006428 ***
cult	1	2.407	2.407	3.4117	0.0895283 .
rep:cult	3	9.480	3.160	4.4796	0.0249095 *
inoc	2	118.176	59.088	83.7631	8.919e-08 ***

```
cult:inoc 2 1.826 0.913 1.2942 0.3097837
```

```
---
```

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

## 5.4 Chapter 5

### 5.4.1 p142

(30) MODEL

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

```
$ANOVA
```

```
Response : FLUSH
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	5	3619.9	723.98	2.392	0.04607 *
RESIDUALS	71	21489.2	302.67		
CORRECTED TOTAL	76	25109.1			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
STUDY	4	3553.9	888.46	2.9355	0.02638 *
TRT	1	66.0	66.04	0.2182	0.64185

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
STUDY	4	3599.4	899.85	2.9731	0.02496 *
TRT	1	66.0	66.04	0.2182	0.64185

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
STUDY	4	3599.4	899.85	2.9731	0.02496 *
TRT	1	66.0	66.04	0.2182	0.64185

```
---
```

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

(31) MODEL

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

```
$ANOVA
```

```
Response : FLUSH
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	1	20.5	20.49	0.0653	0.79906
STUDY	4	3599.4	899.85	2.8688	0.02956 *
TRT:STUDY	4	473.8	118.45	0.3776	0.82383

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	1	66.0	66.04	0.2105	0.64783
STUDY	4	3599.4	899.85	2.8688	0.02956 *
TRT:STUDY	4	473.8	118.45	0.3776	0.82383

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	1	1.9	1.93	0.0062	0.9377
STUDY	4	3339.4	834.85	2.6616	0.0400 *
TRT:STUDY	4	473.8	118.45	0.3776	0.8238

```
---
```

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

## 5.5 Chapter 6

### 5.5.1 p171

```
(32) MODEL
```

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

```
$ANOVA
```

```
Response : score2
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------



```
MODEL          2   49.74  24.868  0.5598 0.5776
RESIDUALS      28 1243.94  44.426
CORRECTED TOTAL 30 1293.68
```

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

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

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

## 5.5.2 p188

(33) MODEL

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

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

```
$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
a       1  7.803   7.8028   3.5921 0.082395 .
b       2 20.492  10.2459   4.7168 0.030798 *
a:b     2 35.416  17.7082   8.1521 0.005807 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
a       1 15.850  15.850   7.2968 0.019265 *
b       2 20.492  10.246   4.7168 0.030798 *
a:b     2 35.416  17.708   8.1521 0.005807 **
```

```

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

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

```

### 5.5.3 p203

(34) MODEL

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

```

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

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

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

$`Type III`
      Df Sum Sq Mean Sq F value    Pr(>F)
a      1  0.3507   0.3507   0.1615 0.694881
b      2 16.0733   8.0367   3.6997 0.056021 .

```

```
a:b  1 29.5681 29.5681 13.6119 0.003095 **
```

```
---
```

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

#### 5.5.4 p215

(35) MODEL

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

\$ANOVA

Response : yield

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

\$`Type I`

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

\$`Type II`

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

\$`Type III`

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

```
# Compare with SAS output
```

(36) MODEL

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

```
$ANOVA
```

```
Response : yield
```

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

```
$`Type I`
```

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

```
$`Type II`
```

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

```
$`Type III`
```

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

## 5.6 Chapter 7

### 5.6.1 p232

(37) MODEL

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

```
$ANOVA
```

```
Response : final
```

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

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	4	198.41	49.602	164.47	1.340e-11 ***
initial	1	156.04	156.040	517.38	1.867e-12 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	4	12.089	3.022	10.021	0.0004819 ***
initial	1	156.040	156.040	517.384	1.867e-12 ***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	4	12.089	3.022	10.021	0.0004819 ***
initial	1	156.040	156.040	517.384	1.867e-12 ***

---

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

## 5.6.2 p240

(38) MODEL

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

\$ANOVA

Response : final

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	9	355.84	39.537	139.51	2.572e-09 ***
RESIDUALS	10	2.83	0.283		
CORRECTED TOTAL	19	358.67			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
initial	1	342.36	342.36	1208.0336	9.211e-12 ***

```

trt          4  12.09    3.02   10.6645  0.001247 **
initial:trt  4   1.39    0.35    1.2247  0.360175
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type II`

```

      Df Sum Sq Mean Sq F value    Pr(>F)
initial  1 156.040 156.040 550.5987 4.478e-10 ***
trt      4  12.089   3.022  10.6645  0.001247 **
initial:trt 4   1.388   0.347   1.2247  0.360175
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type III`

```

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

```

### 5.6.3 p241

(39) MODEL

```

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

```

\$ANOVA

Response : Q1

```

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

```

\$`Type I`

```

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

```

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

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

#### 5.6.4 p243

(40) MODEL

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

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

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

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
DAY	5	201.17	40.234	1.8493	0.1411648
DAY:P1	6	861.13	143.521	6.5967	0.0003239 ***

---

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

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

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

\$ANOVA

Response : Q1

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	1111.52	101.048	4.6445	0.0008119 ***
RESIDUALS	24	522.15	21.756		
CORRECTED TOTAL	35	1633.68			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P1	1	516.59	516.59	23.7444	5.739e-05 ***
DAY	5	430.54	86.11	3.9578	0.009275 **
P1:DAY	5	164.39	32.88	1.5112	0.223566

---

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

\$`Type II`



	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P1	1	696.73	696.73	32.0243	7.925e-06 ***
DAY	5	430.54	86.11	3.9578	0.009275 **
P1:DAY	5	164.39	32.88	1.5112	0.223566

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P1	1	554.79	554.79	25.4999	3.665e-05 ***
DAY	5	201.17	40.23	1.8493	0.1412
P1:DAY	5	164.39	32.88	1.5112	0.2236

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

#### (42) MODEL

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

\$ANOVA  
Response : Q1

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	12	1225.37	102.114	5.7521	0.0001688 ***
RESIDUALS	23	408.31	17.753		
CORRECTED TOTAL	35	1633.68			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
STORE	5	313.42	62.68	3.5310	0.01629 *
DAY	5	250.40	50.08	2.8210	0.03957 *
P1	1	622.01	622.01	35.0377	4.924e-06 ***
P2	1	39.54	39.54	2.2274	0.14917

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
STORE	5	223.83	44.77	2.5217	0.058346 .
DAY	5	433.10	86.62	4.8793	0.003456 **
P1	1	538.17	538.17	30.3150	1.342e-05 ***
P2	1	39.54	39.54	2.2274	0.149171

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
STORE	5	223.83	44.77	2.5217	0.058346 .
DAY	5	433.10	86.62	4.8793	0.003456 **
P1	1	538.17	538.17	30.3150	1.342e-05 ***
P2	1	39.54	39.54	2.2274	0.149171

---

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

### 5.6.5 p250

(43) MODEL

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

\$ANOVA

Response : lint

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	31.160	3.8950	80.704	< 2.2e-16 ***
RESIDUALS	40	1.931	0.0483		
CORRECTED TOTAL	48	33.091			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bollwt	1	29.0693	29.0693	602.3107	< 2.2e-16 ***
variety	1	1.2635	1.2635	26.1802	8.158e-06 ***
spacing	1	0.4666	0.4666	9.6689	0.003447 **
variety:spacing	1	0.0933	0.0933	1.9325	0.172169
variety:spacing:plant	4	0.2673	0.0668	1.3847	0.256548

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bollwt	1	11.1186	11.1186	230.3745	< 2.2e-16 ***
variety	1	1.1973	1.1973	24.8084	1.259e-05 ***
spacing	1	0.4666	0.4666	9.6689	0.003447 **
variety:spacing	1	0.0933	0.0933	1.9325	0.172169
variety:spacing:plant	4	0.2673	0.0668	1.3847	0.256548

---

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

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

## 5.6.6 p254 Output 7.20

(44) MODEL

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

```
$ANOVA
Response : lint
              Df Sum Sq Mean Sq F value    Pr(>F)
MODEL          3 30.799  10.2665  201.65 < 2.2e-16 ***
RESIDUALS      45  2.291   0.0509
CORRECTED TOTAL 48 33.091
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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

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

```
$`Type III`
              Df Sum Sq Mean Sq F value    Pr(>F)
bollwt        1 11.5717  11.5717 227.2815 < 2.2e-16 ***
variety        1  1.1973   1.1973  23.5168 1.516e-05 ***
spacing        1  0.4666   0.4666   9.1655 0.004072 **
```

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

### 5.6.7 p256

(45) MODEL

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

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	816.50	102.063	6.0641	0.0014 **
RESIDUALS	15	252.46	16.831		
CORRECTED TOTAL	23	1068.96			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	3	538.79	179.597	10.6709	0.0005223 ***
type	1	12.04	12.042	0.7155	0.4109264
logdose	2	121.58	60.792	3.6120	0.0524231 .
type:logdose	2	144.08	72.042	4.2804	0.0338265 *

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	3	538.79	179.597	10.6709	0.0005223 ***
type	1	12.04	12.042	0.7155	0.4109264
logdose	2	121.58	60.792	3.6120	0.0524231 .
type:logdose	2	144.08	72.042	4.2804	0.0338265 *

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	3	538.79	179.597	10.6709	0.0005223 ***
type	1	12.04	12.042	0.7155	0.4109264
logdose	2	121.58	60.792	3.6120	0.0524231 .
type:logdose	2	144.08	72.042	4.2804	0.0338265 *

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

### 5.6.8 p261 Output 7.27

(46) MODEL

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

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	816.50	102.063	6.0641	0.0014 **
RESIDUALS	15	252.46	16.831		
CORRECTED TOTAL	23	1068.96			

---

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

\$`Type I`

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

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	3	538.79	179.597	10.6709	0.0005223 ***
type	1	12.04	12.042	0.7155	0.4109264
logdose	1	0.39	0.389	0.0231	0.8811262
logd2	1	6.02	6.021	0.3577	0.5586917
type:logdose	1	0.81	0.812	0.0483	0.8290541
type:logd2	1	6.02	6.021	0.3577	0.5586917

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	3	538.79	179.597	10.6709	0.0005223 ***
type	1	28.12	28.125	1.6711	0.2156736
logdose	1	0.39	0.389	0.0231	0.8811262
logd2	1	6.02	6.021	0.3577	0.5586917
type:logdose	1	0.81	0.812	0.0483	0.8290541
type:logd2	1	6.02	6.021	0.3577	0.5586917

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

## 5.6.9 p262 Output 7.28

(47) MODEL

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

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	816.50	102.063	6.0641	0.0014 **
RESIDUALS	15	252.46	16.831		
CORRECTED TOTAL	23	1068.96			

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	3	538.79	179.597	10.6709	0.0005223 ***
type	1	12.04	12.042	0.7155	0.4109264
type:logdose	4	265.67	66.417	3.9462	0.0220552 *

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	3	538.79	179.597	10.6709	0.0005223 ***
type	1	12.04	12.042	0.7155	0.4109264
type:logdose	4	265.67	66.417	3.9462	0.0220552 *

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
bloc	3	538.79	179.597	10.6709	0.0005223 ***
type	1	12.04	12.042	0.7155	0.4109264
type:logdose	4	265.67	66.417	3.9462	0.0220552 *

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

## 5.7 Chapter 8

### 5.7.1 p269

(48) MODEL

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

\$ANOVA

Response : fev1

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	92	296.65	3.2244	51.078	< 2.2e-16 ***
RESIDUALS	483	30.49	0.0631		
CORRECTED TOTAL	575	327.14			

---

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

\$`Type I`

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

---

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

\$`Type II`

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

---

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

\$`Type III`

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

---

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

## 5.8 Chapter 11

### 5.8.1 p390

(49) MODEL

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

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	12	81.75	6.8125	33.601	6.618e-07 ***
RESIDUALS	11	2.23	0.2027		
CORRECTED TOTAL	23	83.98			

---

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

\$`Type I`

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

---

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

\$`Type II`

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

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	0.051	0.025	0.1256	0.883224



```

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

```

## 5.8.2 p394

(50) MODEL

```

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

```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	6.3559	0.90798		
RESIDUALS	0	0.0000			
CORRECTED TOTAL	7	6.3559			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
ca	1	2.07061	2.07061		
cb	1	0.59951	0.59951		
ca:cb	1	0.00031	0.00031		
cc	1	0.00551	0.00551		
ca:cc	1	0.80011	0.80011		
cb:cc	1	2.82031	2.82031		
ca:cb:cc	1	0.05951	0.05951		
cd	0				
ca:cd	0				
cb:cd	0				
ca:cb:cd	0				
cc:cd	0				
ca:cc:cd	0				
cb:cc:cd	0				
ca:cb:cc:cd	0				

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

ca	0
cb	0
ca:cb	0
cc	0
ca:cc	0
cb:cc	0
ca:cb:cc	0
cd	0
ca:cd	0
cb:cd	0
ca:cb:cd	0
cc:cd	0
ca:cc:cd	0
cb:cc:cd	0
ca:cb:cc:cd	0

\$`Type III`

CAUTION: Singularity Exists !

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

(51) MODEL

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

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	6.3559	0.90798		
RESIDUALS	0	0.0000			
CORRECTED TOTAL	7	6.3559			

\$`Type I`

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

\$`Type II`

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

\$`Type III`

CAUTION: Singularity Exists !

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

```

a:b:d    0
c:d      0
a:c:d    0
b:c:d    0
a:b:c:d  0

```

### 5.8.3 p399

(52) MODEL

```

p399 = read.table("C:/G/Rt/SAS41m/p399.txt", header=TRUE)
p399 = af(p399, c("blk", "trt"))
ANOVA(y ~ trt + blk, p399)

```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	281.127	35.141	40.822	0.005606 **
RESIDUALS	3	2.583	0.861		
CORRECTED TOTAL	11	283.710			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	3	102.26	34.086	39.596	0.006515 **
blk	5	178.87	35.774	41.558	0.005691 **

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	3	59.018	19.673	22.853	0.014388 *
blk	5	178.871	35.774	41.558	0.005691 **

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	3	59.017	19.672	22.853	0.014388 *
blk	5	178.871	35.774	41.558	0.005691 **

---

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

### 5.8.4 p403

(53) MODEL

```
p403 = read.table("C:/G/Rt/SAS41m/p403.txt", header=TRUE)
p403 = af(p403, c("PATIENT", "VISIT"))
ANOVA(HR ~ SEQUENCE + PATIENT %in% SEQUENCE + VISIT + DRUG + RESIDS + RESIDT, p403)
```

\$ANOVA

Response : HR

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	29	6408.7	220.99	3.912	3.127e-05 ***
RESIDUALS	42	2372.6	56.49		
CORRECTED TOTAL	71	8781.3			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
SEQUENCE	5	508.9	101.79	1.8019	0.133346
SEQUENCE:PATIENT	18	4692.3	260.69	4.6147	2.21e-05 ***
VISIT	2	146.8	73.39	1.2991	0.283499
DRUG	2	668.8	334.39	5.9194	0.005435 **
RESIDS	1	391.0	391.02	6.9219	0.011854 *
RESIDT	1	0.8	0.84	0.0149	0.903511

---

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

\$`Type II`

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

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
SEQUENCE	5	701.2	140.237	2.4825	0.04665 *
SEQUENCE:PATIENT	18	4692.3	260.685	4.6147	2.21e-05 ***
VISIT	2	146.8	73.389	1.2991	0.28350
DRUG	2	343.9	171.975	3.0443	0.05826 .
RESIDS	1	309.2	309.174	5.4731	0.02414 *
RESIDT	1	0.8	0.840	0.0149	0.90351

---

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

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

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

Anova Table (Type III tests)

Response: HR

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

---

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

### 5.8.5 p409 11.5

(54) MODEL

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

\$ANOVA

Response : TS

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	5	258.727	51.745	263.71	1.785e-09 ***
RESIDUALS	9	1.766	0.196		
CORRECTED TOTAL	14	260.493			

---

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

\$`Type I`

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

---

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

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

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

## 5.8.6 p412

(55) MODEL

```
p412 = read.table("C:/G/Rt/SAS41m/p412.txt", header=TRUE)
ANOVA(ts ~ source:amt, p412) # p413 Output 11.24
```

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

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

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

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

```
source:amt 3 393.01      131  903.34 < 2.2e-16 ***
```

```
---
```

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

### 5.8.7 p414

(56) MODEL

```
p414 = read.table("C:/G/Rt/SAS41m/p414.txt", header=TRUE)
p414 = af(p414, c("lackofit"))
ANOVA(loglivcu ~ level + lackofit, p414) # p415 Output 11.26
```

```
$ANOVA
```

```
Response : loglivcu
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	3	5.2310	1.74365	155.47	5.018e-14 ***
RESIDUALS	20	0.2243	0.01122		
CORRECTED TOTAL	23	5.4553			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
level	1	4.9859	4.9859	444.555	3.997e-15 ***
lackofit	2	0.2450	0.1225	10.924	0.0006216 ***

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
level	0				
lackofit	2	0.24504	0.12252	10.924	0.0006216 ***

```
---
```

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

```
$`Type III`
```

```
CAUTION: Singularity Exists !
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
level	0				
lackofit	2	0.24504	0.12252	10.924	0.0006216 ***

```
---
```

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

### 5.8.8 p417

(57) MODEL



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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	267.226	38.175	12.433	7.522e-05 ***
RESIDUALS	13	39.917	3.071		
CORRECTED TOTAL	20	307.143			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	2	236.921	118.460	38.580	3.412e-06 ***
TRT:POT	5	30.306	6.061	1.974	0.1499

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	2	236.921	118.460	38.580	3.412e-06 ***
TRT:POT	5	30.306	6.061	1.974	0.1499

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	2	200.111	100.055	32.586	8.626e-06 ***
TRT:POT	5	30.306	6.061	1.974	0.1499

---

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

```
options(contrasts=c("contr.sum", "contr.poly"))
```

```
Anova(lm(Y ~ TRT + POT %in% TRT, p417), type=3, singular.ok=TRUE) # NOT OK
```

Note: model has aliased coefficients

sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Y

	Sum Sq	Df	F values	Pr(>F)
TRT	22.310	1	7.266	0.01835 *
TRT:POT	30.306	5	1.974	0.14991

Residuals 39.917 13

---

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

### 5.8.9 p431

(58) MODEL

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

\$ANOVA

Response : avdlygn

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	16	2.5275	0.157966	3.1437	0.001091 **
RESIDUALS	48	2.4119	0.050248		
CORRECTED TOTAL	64	4.9394			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
line	2	0.38009	0.190046	3.7821	0.02983 *
line:sire	6	0.92634	0.154391	3.0726	0.01260 *
agedam	2	0.11894	0.059471	1.1835	0.31497
line:agedam	4	0.64889	0.162222	3.2284	0.02000 *
age	1	0.18349	0.183487	3.6516	0.06200 .
intlwt	1	0.26970	0.269704	5.3674	0.02483 *

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
line	2	0.05526	0.02763	0.5498	0.580636
line:sire	6	0.97389	0.16231	3.2303	0.009543 **
agedam	2	0.33106	0.16553	3.2943	0.045640 *
line:agedam	4	0.45343	0.11336	2.2560	0.076821 .
age	1	0.38128	0.38128	7.5878	0.008277 **
intlwt	1	0.26970	0.26970	5.3674	0.024830 *

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
line	2	0.13620	0.06810	1.3553	0.267560

```

line:sire      6 0.97389 0.16231  3.2303 0.009543 **
agedam        2 0.13011 0.06505  1.2946 0.283392
line:agedam    4 0.45343 0.11336  2.2560 0.076821 .
age           1 0.38128 0.38128  7.5878 0.008277 **
intlwt        1 0.26970 0.26970  5.3674 0.024830 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

*# p433 Output 11.40*

```

options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(amdlygn ~ 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: amdlygn
      Sum Sq Df F values    Pr(>F)
line      0.00000  0
agedam    0.13011  2   1.2946 0.283392
age       0.38128  1   7.5878 0.008277 **
intlwt    0.26970  1   5.3674 0.024830 *
line:sire  0.97389  6   3.2303 0.009543 **
line:agedam 0.45343  4   2.2560 0.076821 .
Residuals  2.41192 48
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

(59) MODEL

*ANOVA(amdlygn ~ sire + agedam, p431) # # p434 Output 11.41*

```

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

```

\$`Type I`

```

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

```

```

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

```

```

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

```

### 5.8.10 p437 ABSORB option in SAS

(60) MODEL

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

```

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

```

```

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

```

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
line	0				
sire	6	0.97389	0.16231	3.2303	0.009543 **
agedam	2	0.33106	0.16553	3.2943	0.045640 *
line:agedam	4	0.45343	0.11336	2.2560	0.076821 .
age	1	0.38128	0.38128	7.5878	0.008277 **
intlwt	1	0.26970	0.26970	5.3674	0.024830 *

---

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
line	0				
sire	6	0.97389	0.16231	3.2303	0.009543 **
agedam	2	0.13011	0.06505	1.2946	0.283392
line:agedam	4	0.45343	0.11336	2.2560	0.076821 .
age	1	0.38128	0.38128	7.5878	0.008277 **
intlwt	1	0.26970	0.26970	5.3674	0.024830 *

---

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

# p437 Output 11.43

## 6 Sahai - Unbalanced

### Reference

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

### 6.1 Table 11.2

(61) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	80.401	20.1003	5.9884	0.0004103 ***
RESIDUALS	59	198.036	3.3565		
CORRECTED TOTAL	63	278.438			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Group	4	80.401	20.1	5.9884	0.0004103 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Group	4	80.401	20.1	5.9884	0.0004103 ***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Group	4	80.401	20.1	5.9884	0.0004103 ***

---

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

### 6.2 Table 12.6

(62) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	1.6144	0.230636	8.9562	7.223e-07 ***
RESIDUALS	45	1.1588	0.025752		
CORRECTED TOTAL	52	2.7733			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Location	3	0.74036	0.24679	9.5833	5.219e-05 ***
Family	4	0.87410	0.21852	8.4859	3.436e-05 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Location	3	0.83765	0.27921	10.8426	1.753e-05 ***
Family	4	0.87410	0.21852	8.4859	3.436e-05 ***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Location	3	0.83765	0.27921	10.8426	1.753e-05 ***
Family	4	0.87410	0.21852	8.4859	3.436e-05 ***

---

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

### 6.3 Table 13.6

(63) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	2643.11	240.283	60.323	< 2.2e-16 ***
RESIDUALS	35	139.42	3.983		
CORRECTED TOTAL	46	2782.52			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Site	2	1281.55	640.77	160.866	< 2.2e-16 ***
Worker	3	399.27	133.09	33.412	2.234e-10 ***
Site:Worker	6	962.29	160.38	40.264	2.720e-14 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Site	2	1322.24	661.12	165.973	< 2.2e-16 ***
Worker	3	399.27	133.09	33.412	2.234e-10 ***
Site:Worker	6	962.29	160.38	40.264	2.720e-14 ***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Site	2	804.83	402.42	101.026	2.887e-15 ***
Worker	3	430.88	143.63	36.058	8.310e-11 ***
Site:Worker	6	962.29	160.38	40.264	2.720e-14 ***

---

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

## 6.4 Table 14.2

(64) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	6345.4	906.48	8.1297	5.931e-08 ***
RESIDUALS	110	12265.3	111.50		



```
CORRECTED TOTAL 117 18610.6
```

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Day	2	3737.8	1868.90	16.7611	4.426e-07 ***
Machine	2	2440.7	1220.33	10.9445	4.625e-05 ***
Operator	3	166.9	55.63	0.4989	0.6838

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Day	2	3795.1	1897.56	17.0181	3.636e-07 ***
Machine	2	2464.8	1232.39	11.0526	4.227e-05 ***
Operator	3	166.9	55.63	0.4989	0.6838

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Day	2	3795.1	1897.56	17.0181	3.636e-07 ***
Machine	2	2464.8	1232.39	11.0526	4.227e-05 ***
Operator	3	166.9	55.63	0.4989	0.6838

```
---
```

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

## 6.5 Table 15.3

(65) MODEL

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

```
$ANOVA
```

```
Response : pH
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	36	0.25804	0.0071678	2.8977	7.2e-06 ***
RESIDUALS	123	0.30425	0.0024736		
CORRECTED TOTAL	159	0.56229			

```
---
```

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

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

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

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

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

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

Anova Table (Type III tests)

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

## 6.6 Table 16.3

(66) MODEL

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

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

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

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

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

```
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"))
ANOVA(Y ~ R + A + R:A + B + A:B, ex1.1)
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	27	4905.7	181.694	10.75	1.994e-10 ***
RESIDUALS	36	608.5	16.902		
CORRECTED TOTAL	63	5514.2			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	223.8	74.60	4.4138	0.00963 **
A	3	194.6	64.85	3.8370	0.01756 *
R:A	9	158.2	17.58	1.0402	0.42842
B	3	4107.4	1369.13	81.0030	4.441e-16 ***
A:B	9	221.7	24.64	1.4577	0.20117

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	223.8	74.60	4.4138	0.00963 **
A	3	194.6	64.85	3.8370	0.01756 *
R:A	9	158.2	17.58	1.0402	0.42842
B	3	4107.4	1369.13	81.0030	4.441e-16 ***
A:B	9	221.7	24.64	1.4577	0.20117

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

```

R      3  223.8   74.60  4.4138   0.00963 **
A      3  194.6   64.85  3.8370   0.01756 *
R:A    9  158.2   17.58  1.0402   0.42842
B      3 4107.4 1369.13 81.0030 4.441e-16 ***
A:B    9  221.7   24.64  1.4577   0.20117
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 7.2 Example 1.2

(68) MODEL

```

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

```

```

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

```

```

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

```

```

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

```

```

$`Type III`

```

```

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

```

### 7.3 Example 2.1

(69) MODEL

```

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

```

\$ANOVA

Response : Y

```

      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      41 274.750   6.7012    5.1475 0.0002305 ***
RESIDUALS   18  23.433   1.3019
CORRECTED TOTAL 59 298.183

```

```

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

```

\$`Type I`

```

      Df Sum Sq Mean Sq F value    Pr(>F)
R      1   2.817   2.8167   2.1636 0.1585807
A      9  77.683   8.6315   6.6302 0.0003456 ***
R:A    9  81.017   9.0019   6.9147 0.0002658 ***
B      2  35.433  17.7167  13.6088 0.0002510 ***
R:B    2  16.233   8.1167   6.2347 0.0087635 **
A:B   18  61.567   3.4204   2.6273 0.0236253 *

```

```

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

```

\$`Type II`

```

      Df Sum Sq Mean Sq F value    Pr(>F)
R      1   2.817   2.8167   2.1636 0.1585807
A      9  77.683   8.6315   6.6302 0.0003456 ***
R:A    9  81.017   9.0019   6.9147 0.0002658 ***
B      2  35.433  17.7167  13.6088 0.0002510 ***
R:B    2  16.233   8.1167   6.2347 0.0087635 **
A:B   18  61.567   3.4204   2.6273 0.0236253 *

```

```

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

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

```

## 7.4 Example 2.2

(70) MODEL

```

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

```

```

$ANOVA
Response : Y

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

```

```

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

```

```

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

```



\$`Type III`

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

(71) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	99	22310	225.36		
RESIDUALS	0	0			
CORRECTED TOTAL	99	22310			

\$`Type I`

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

\$`Type II`

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Row	0				
R	4	1159.8	289.94		
Row:R	0				

S	3	351.9	117.29
S:Column	12	3863.3	321.94
R:S	12	826.0	68.83
R:S:Column	48	11982.3	249.63

(72) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	99	22310	225.36		
RESIDUALS	0	0			
CORRECTED TOTAL	99	22310			

\$`Type I`

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

\$`Type II`

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

\$`Type III`

CAUTION: Singularity Exists !

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

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

## 7.5 Example 3.1

(73) MODEL

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

\$ANOVA

Response : Yield

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	239	2724374186	11399055	23.682	< 2.2e-16 ***
RESIDUALS	240	115521933	481341		
CORRECTED TOTAL	479	2839896119			

---

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

\$`Type I`

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

---

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

\$`Type II`

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

---

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

\$`Type III`

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

---

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

(74) MODEL

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

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

```
$ANOVA
```

```
Response : height
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	199	7534.8	37.863		
RESIDUALS	0	0.0			
CORRECTED TOTAL	199	7534.8			

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	1	253.1	253.125		
column	4	109.4	27.357		
P:column	4	207.9	51.987		
R	4	90.6	22.657		
P:R	4	505.0	126.238		
column:R	16	3357.8	209.864		
P:column:R	16	1442.6	90.163		
S	3	16.4	5.458		
P:S	3	14.3	4.765		
column:S	12	265.4	22.121		
P:column:S	12	96.5	8.044		
R:S	12	195.1	16.254		
column:R:S	48	365.5	7.615		
P:R:S	12	100.3	8.361		
P:column:R:S	48	514.7	10.723		

```
$`Type II`
```

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

```
$`Type III`
```

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

(75) MODEL

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

\$ANOVA

Response : height

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	199	7534.8	37.863		
RESIDUALS	0	0.0			
CORRECTED TOTAL	199	7534.8			

\$`Type I`

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
row	4	2017.03	504.26		

R	4	90.63	22.66
P	1	253.12	253.12
S	3	16.38	5.46
R:S	12	195.05	16.25
row:P	4	167.25	41.81
R:P	4	504.95	126.24
row:R:P	32	2933.52	91.67
P:S	3	14.29	4.76
row:P:S	24	234.68	9.78
R:P:S	12	100.33	8.36
row:R:P:S	96	1007.52	10.49

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
row	4	2017.03	504.26		
R	4	90.63	22.66		
P	1	253.12	253.12		
S	3	16.38	5.46		
R:S	12	195.05	16.25		
row:P	4	167.25	41.81		
R:P	4	504.95	126.24		
row:R:P	32	2933.52	91.67		
P:S	3	14.30	4.77		
row:P:S	24	234.68	9.78		
R:P:S	12	100.33	8.36		
row:R:P:S	96	1007.52	10.50		

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

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

Model :

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

(76) MODEL

- p94 Appendix 3.1

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

```

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

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

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

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

```

(77) MODEL

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

```

$ANOVA
Response : yield
              Df Sum Sq Mean Sq F value    Pr(>F)
MODEL          37  48090  1299.7   11.341 6.734e-11 ***

```



```
RESIDUALS      34   3896   114.6
CORRECTED TOTAL 71  51986
```

```
---
```

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

```
$`Type I`
```

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

```
---
```

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

```
$`Type II`
```

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

```
---
```

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

```
$`Type III`
```

```
CAUTION: Singularity Exists !
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	5942.5	2971.3	25.9273	1.449e-07 ***
var	2	2799.8	1399.9	12.2155	0.0001005 ***
rep:var	4	997.8	249.4	2.1767	0.0926008 .
nit	3	11977.9	3992.6	34.8397	1.775e-10 ***
var:nit	6	477.8	79.6	0.6949	0.6553307
row	9	945.0	105.0	0.9162	0.5230151
col	2	3171.5	1585.7	13.8373	4.012e-05 ***

```
---
```

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

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

Note: model has aliased coefficients

sums of squares computed by model comparison

Anova Table (Type III tests)

Response: yield

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

---

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

## 7.6 Example 4.1

(78) MODEL

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

\$ANOVA

Response : height

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	199	1710.2	8.5937		
RESIDUALS	0	0.0			
CORRECTED TOTAL	199	1710.2			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	1	28.12	28.1250		
column	4	34.33	8.5825		
P:column	4	91.45	22.8625		
R	4	31.03	7.7575		
P:R	4	48.95	12.2375		
column:R	16	467.92	29.2450		
P:column:R	16	350.10	21.8813		
S	3	3.77	1.2583		
P:S	3	3.29	1.0983		
column:S	12	74.55	6.2125		
P:column:S	12	47.03	3.9192		

R:S	12	36.65	3.0542
column:R:S	48	197.40	4.1125
P:R:S	12	26.33	2.1942
P:column:R:S	48	269.22	5.6087

\$`Type II`

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

\$`Type III`

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

(79) MODEL

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

\$ANOVA

Response : height

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	199	1710.2	8.5937		
RESIDUALS	0	0.0			
CORRECTED TOTAL	199	1710.2			

\$`Type I`

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

\$`Type II`

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

\$`Type III`

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

```
R:P:S      12  26.33   2.194
row:R:P:S  96 416.92   4.343
```

## 7.7 Example 5.1

(80) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	20	193.583	9.6792	9.4176	2.969e-05 ***
RESIDUALS	15	15.417	1.0278		
CORRECTED TOTAL	35	209.000			

---

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

\$`Type I`

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

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	2	23.047	11.5236	11.2122	0.0010520 **
A	1	12.375	12.3751	12.0406	0.0034285 **
R:A	2	27.164	13.5819	13.2148	0.0004907 ***
C	2	0.500	0.2500	0.2432	0.7871141
B	1	1.778	1.7778	1.7297	0.2081966
C:B	2	0.389	0.1944	0.1892	0.8295745
Tx	5	103.333	20.6667	20.1081	3.63e-06 ***
B:Tx	5	5.917	1.1833	1.1514	0.3770453

---

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

\$`Type III`

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

---

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

(81) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	20	194.188	9.7094	9.8323	2.254e-05 ***
RESIDUALS	15	14.813	0.9875		
CORRECTED TOTAL	35	209.000			

---

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

\$`Type I`

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

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	2	33.500	16.7500	16.9620	0.0001410 ***
A	1	16.000	16.0000	16.2025	0.0011013 **
R:A	2	32.167	16.0833	16.2869	0.0001739 ***
C	2	0.807	0.4037	0.4088	0.6716130
B	1	1.757	1.7574	1.7797	0.2020905
C:B	2	0.030	0.0150	0.0152	0.9849064

```
Tx      5 103.333 20.6667 20.9283 2.813e-06 ***
A:Tx    5   6.521  1.3042  1.3207 0.3078554
```

```
---
```

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

```
$`Type III`
```

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

```
---
```

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

(82) MODEL

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

```
$ANOVA
```

```
Response : Y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	24	196.238	8.1766	7.0476	0.0008758 ***
RESIDUALS	11	12.762	1.1602		
CORRECTED TOTAL	35	209.000			

```
---
```

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

```
$`Type I`
```

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

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

```

R      2  23.116 11.5581  9.9622  0.003396 **
A      1  12.375 12.3751 10.6664  0.007519 **
R:A    2  27.426 13.7132 11.8197  0.001820 **
C      2   0.970  0.4850  0.4180  0.668392
B      1   1.757  1.7574  1.5148  0.244080
C:B    2   0.085  0.0424  0.0366  0.964202
Tx     5 103.333 20.6667 17.8131 6.055e-05 ***
A:Tx   4   2.655  0.6636  0.5720  0.688652
B:Tx   4   2.050  0.5126  0.4418  0.776173

```

---

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	2	22.186	11.0928	9.5611	0.003924 **
A	1	15.185	15.1853	13.0886	0.004042 **
R:A	2	27.426	13.7132	11.8197	0.001820 **
C	2	1.010	0.5049	0.4352	0.657839
B	1	1.792	1.7922	1.5448	0.239751
C:B	2	0.085	0.0424	0.0366	0.964202
Tx	5	103.333	20.6667	17.8131	6.055e-05 ***
A:Tx	4	2.655	0.6636	0.5720	0.688652
B:Tx	4	2.050	0.5126	0.4418	0.776173

---

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

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

Model :

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

Complete :

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

```

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

```

Note: model has aliased coefficients

sums of squares computed by model comparison



# Anova Table (Type III tests)

Response: Y

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

---

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

(83) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	28	204.2	7.2929	10.635	0.001719 **
RESIDUALS	7	4.8	0.6857		
CORRECTED TOTAL	35	209.0			

---

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

\$`Type I`

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

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

```

R      2  31.838 15.9191 23.2153 0.0008139 ***
A      1  12.375 12.3751 18.0470 0.0038017 **
R:A    1   2.017  2.0174  2.9420 0.1300172
C      2   0.500  0.2500  0.3645 0.7069558
B      1   1.757  1.7574  2.5629 0.1534298
C:B    1   0.644  0.6445  0.9399 0.3646045
Tx     5 103.333 20.6667 30.1389 0.0001357 ***
A:Tx   4   2.655  0.6636  0.9678 0.4812226
B:Tx   4   2.050  0.5126  0.7475 0.5896365
A:B:Tx 4   7.962  1.9905  2.9029 0.1038803

```

---

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	2	28.112	14.0562	20.4986	0.0011846 **
A	1	14.655	14.6551	21.3720	0.0024176 **
R:A	1	2.017	2.0174	2.9420	0.1300172
C	2	0.471	0.2356	0.3436	0.7205632
B	1	1.769	1.7694	2.5804	0.1522328
C:B	1	0.644	0.6445	0.9399	0.3646045
Tx	5	103.815	20.7630	30.2793	0.0001336 ***
A:Tx	4	2.951	0.7378	1.0760	0.4358837
B:Tx	4	3.553	0.8882	1.2954	0.3579988
A:B:Tx	4	7.962	1.9905	2.9029	0.1038803

---

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

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

Model :

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

Complete :

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

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

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

Anova Table (Type III tests)

Response: Y

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

---

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

## 7.8 Example 7.1

(84) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	95	577.83	6.0824	5.3082	1.068e-05 ***
RESIDUALS	24	27.50	1.1458		
CORRECTED TOTAL	119	605.33			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	84.76	28.2528	24.6570	1.655e-07 ***

```
G    27 343.48 12.7216 11.1025 4.286e-08 ***
R:G   9  11.75  1.3056  1.1394    0.3749
F     2  59.85 29.9250 26.1164 9.481e-07 ***
G:F  54  77.98  1.4441  1.2603    0.2718
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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

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

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

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

Anova Table (Type III tests)

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

## 7.9 Example 7.2

(85) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	99	538.70	5.4415	5.1892	1.286e-05 ***
RESIDUALS	24	25.17	1.0486		
CORRECTED TOTAL	123	563.87			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	73.255	24.4183	23.2863	2.752e-07 ***
T	3	32.000	10.6667	10.1722	0.0001645 ***
R:T	9	28.402	3.1558	3.0095	0.0149568 *
G	21	309.908	14.7575	14.0734	7.158e-09 ***
T:G	63	95.140	1.5102	1.4401	0.1617931

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	4.229	1.4097	1.3444	0.2834998
T	3	32.000	10.6667	10.1722	0.0001645 ***
R:T	9	10.854	1.2060	1.1501	0.3684706
G	21	309.908	14.7575	14.0734	7.158e-09 ***
T:G	63	95.140	1.5102	1.4401	0.1617931

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	4.229	1.4097	1.3444	0.283500
T	3	22.668	7.5559	7.2056	0.001299 **
R:T	9	10.854	1.2060	1.1501	0.368471
G	21	309.908	14.7575	14.0734	7.158e-09 ***
T:G	63	95.140	1.5102	1.4401	0.161793

---

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

## 7.10 Example 7.3

(86) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	155	656.12	4.2330	13.446	3.997e-14 ***
RESIDUALS	36	11.33	0.3148		
CORRECTED TOTAL	191	667.45			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	27.06	9.019	28.6489	1.203e-09 ***
T	1	10.55	10.547	33.5018	1.334e-06 ***
R:T	3	2.97	0.991	3.1489	0.036705 *
G	22	389.01	17.682	56.1668	< 2.2e-16 ***
T:G	22	18.42	0.837	2.6601	0.004445 **
R:T:G	12	8.78	0.731	2.3235	0.025315 *
F	2	164.28	82.141	260.9173	< 2.2e-16 ***
T:F	2	0.84	0.422	1.3401	0.274574
G:F	44	23.47	0.533	1.6943	0.053191 .
T:G:F	44	10.74	0.244	0.7753	0.790640

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	12.49	4.162	13.2206	5.655e-06 ***
T	1	10.55	10.547	33.5018	1.334e-06 ***
R:T	3	1.15	0.384	1.2206	0.316281
G	22	389.01	17.682	56.1668	< 2.2e-16 ***
T:G	22	18.42	0.837	2.6601	0.004445 **
R:T:G	12	8.78	0.731	2.3235	0.025315 *
F	2	164.28	82.141	260.9173	< 2.2e-16 ***
T:F	2	0.84	0.422	1.3401	0.274574
G:F	44	23.47	0.533	1.6943	0.053191 .
T:G:F	44	10.74	0.244	0.7753	0.790640

---

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

```
$`Type III`
      Df Sum Sq Mean Sq  F value    Pr(>F)
R        3   12.49    4.162   13.2206 5.655e-06 ***
T        1   11.16   11.158   35.4430 8.021e-07 ***
R:T       3    1.15    0.384    1.2206 0.316281
G       22 389.01   17.682   56.1668 < 2.2e-16 ***
T:G      22   18.42    0.837    2.6601 0.004445 **
R:T:G    12    8.78    0.731    2.3235 0.025315 *
F        2 120.56   60.282  191.4828 < 2.2e-16 ***
T:F       2    0.82    0.411    1.3060 0.283432
G:F      44   23.47    0.533    1.6943 0.053191 .
T:G:F    44   10.74    0.244    0.7753 0.790640
---
```

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

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

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

Anova Table (Type III tests)

```
Response: Y
      Sum Sq Df F values    Pr(>F)
R          0 0
T          0 0
G       73.444 2 116.6471 < 2.2e-16 ***
F      120.563 2 191.4828 < 2.2e-16 ***
R:T        0 0
T:G       5.778 2   9.1765 0.0006018 ***
T:F       0.822 2   1.3060 0.2834316
G:F      23.469 44   1.6943 0.0531910 .
R:T:G      8.778 12   2.3235 0.0253153 *
T:G:F     10.740 44   0.7753 0.7906401
Residuals 11.333 36
---
```

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

## 7.11 Example 8.1

(87) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	104	3951.8	37.999		
RESIDUALS	0	0.0			
CORRECTED TOTAL	104	3951.8			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	2	1787.68	893.84		
A	12	601.24	50.10		
R:A	6	24.93	4.16		
B	8	156.87	19.61		
R:B	4	319.87	79.97		
A:B	60	1012.26	16.87		
R:A:B	12	49.00	4.08		

\$`Type II`

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

\$`Type III`

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

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



## 7.12 Example 9.1

(88) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	27	4920.8	182.251	10.594	5.927e-10 ***
RESIDUALS	34	584.9	17.203		
CORRECTED TOTAL	61	5505.6			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	218.7	72.89	4.2369	0.01199 *
A	3	194.9	64.96	3.7760	0.01930 *
R:A	9	186.9	20.76	1.2070	0.32287
B	3	4087.4	1362.47	79.2018	1.998e-15 ***
A:B	9	233.0	25.88	1.5047	0.18602

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	157.8	52.61	3.0583	0.04134 *
A	3	227.2	75.73	4.4020	0.01014 *
R:A	9	94.5	10.50	0.6106	0.77932
B	3	4087.4	1362.47	79.2018	1.998e-15 ***
A:B	9	233.0	25.88	1.5047	0.18602

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	171.0	57.01	3.3138	0.03143 *
A	3	209.7	69.92	4.0643	0.01431 *
R:A	9	94.5	10.50	0.6106	0.77932
B	3	4089.9	1363.29	79.2493	1.998e-15 ***
A:B	9	233.0	25.88	1.5047	0.18602

---

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

### 7.13 Example 9.2

(89) MODEL

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

\$ANOVA

Response : yield

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	40	247.813	6.1953	4.4606	0.001119 **
RESIDUALS	16	22.222	1.3889		
CORRECTED TOTAL	56	270.035			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	0.239	0.2388	0.1719	0.6839085
hyb	9	66.796	7.4218	5.3437	0.0018370 **
rep:hyb	8	67.000	8.3750	6.0300	0.0011569 **
gen	2	36.351	18.1754	13.0863	0.0004293 ***
rep:gen	2	16.923	8.4616	6.0924	0.0107858 *
hyb:gen	18	60.504	3.3613	2.4201	0.0408545 *

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	0.167	0.1667	0.1200	0.7335481
hyb	9	66.796	7.4218	5.3437	0.0018370 **
rep:hyb	8	67.000	8.3750	6.0300	0.0011569 **
gen	2	36.351	18.1754	13.0863	0.0004293 ***
rep:gen	2	12.111	6.0556	4.3600	0.0308015 *
hyb:gen	18	60.504	3.3613	2.4201	0.0408545 *

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	0.167	0.1667	0.1200	0.7335481
hyb	9	66.796	7.4218	5.3437	0.0018370 **
rep:hyb	8	67.000	8.3750	6.0300	0.0011569 **
gen	2	30.671	15.3356	11.0416	0.0009707 ***
rep:gen	2	12.111	6.0556	4.3600	0.0308015 *
hyb:gen	18	60.504	3.3613	2.4201	0.0408545 *

---

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

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

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

Anova Table (Type III tests)

Response: yield

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

---

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

## 7.14 Example 10.1

(90) MODEL

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

\$ANOVA

Response : Yield

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	239	1639561484	6860090	2162	< 2.2e-16 ***
RESIDUALS	240	761522	3173		
CORRECTED TOTAL	479	1640323006			

---

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

\$`Type I`

Df	Sum Sq	Mean Sq	F value	Pr(>F)
----	--------	---------	---------	--------

Site	3	552717	184239	5.8064e+01	< 2e-16	***
Site:Block	8	7062320	882790	2.7822e+02	< 2e-16	***
A	4	1387680917	346920229	1.0933e+05	< 2e-16	***
Site:A	12	34068	2839	8.9470e-01	0.55301	
B	1	100939695	100939695	3.1812e+04	< 2e-16	***
Site:B	3	1618	539	1.6990e-01	0.91662	
A:B	4	31444008	7861002	2.4775e+03	< 2e-16	***
Site:A:B	12	33737	2811	8.8600e-01	0.56185	
Site:Block:A:B	72	186911	2596	8.1810e-01	0.84155	
C	3	19356264	6452088	2.0334e+03	< 2e-16	***
A:C	12	26075792	2172983	6.8483e+02	< 2e-16	***
B:C	3	23901388	7967129	2.5109e+03	< 2e-16	***
A:B:C	12	41996729	3499727	1.1030e+03	< 2e-16	***
Site:C	9	47625	5292	1.6677e+00	0.09747	.
Site:A:C	36	104110	2892	9.1140e-01	0.61768	
Site:B:C	9	61111	6790	2.1400e+00	0.02701	*
Site:A:B:C	36	82475	2291	7.2200e-01	0.87941	

---

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

\$`Type II`

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

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Site	3	552717	184239	5.8064e+01	< 2e-16 ***
Site:Block	8	7062320	882790	2.7822e+02	< 2e-16 ***
A	4	1387680917	346920229	1.0933e+05	< 2e-16 ***
Site:A	12	34068	2839	8.9470e-01	0.55301

```

B          1  100939695 100939695 3.1812e+04 < 2e-16 ***
Site:B      3      1618      539 1.6990e-01 0.91662
A:B         4  31444008   7861002 2.4775e+03 < 2e-16 ***
Site:A:B    12     33737     2811 8.8600e-01 0.56185
Site:Block:A:B 72    186911     2596 8.1810e-01 0.84155
C           3  19356264   6452088 2.0334e+03 < 2e-16 ***
A:C         12  26075792   2172983 6.8483e+02 < 2e-16 ***
B:C         3  23901388   7967129 2.5109e+03 < 2e-16 ***
A:B:C       12  41996729   3499727 1.1030e+03 < 2e-16 ***
Site:C      9      47625     5292 1.6677e+00 0.09747 .
Site:A:C    36     104110     2892 9.1140e-01 0.61768
Site:B:C     9      61111     6790 2.1400e+00 0.02701 *
Site:A:B:C  36     82475     2291 7.2200e-01 0.87941
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

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

```

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

Anova Table (Type III tests)

Response: Yield

	Sum Sq	Df	F values	Pr(>F)
Site	552717	3	5.8064e+01	< 2e-16 ***
A	1387680917	4	1.0933e+05	< 2e-16 ***
B	100939695	1	3.1812e+04	< 2e-16 ***
C	19356264	3	2.0334e+03	< 2e-16 ***
Site:Block	0	0		
Site:A	34068	12	8.9470e-01	0.55301
Site:B	1618	3	1.6990e-01	0.91662
A:B	31444008	4	2.4775e+03	< 2e-16 ***
A:C	26075792	12	6.8483e+02	< 2e-16 ***
B:C	23901388	3	2.5109e+03	< 2e-16 ***
Site:C	47625	9	1.6677e+00	0.09747 .
Site:A:B	33737	12	8.8600e-01	0.56185
A:B:C	41996729	12	1.1030e+03	< 2e-16 ***
Site:A:C	104110	36	9.1140e-01	0.61768
Site:B:C	61111	9	2.1400e+00	0.02701 *
Site:Block:A:B	186911	72	8.1810e-01	0.84155
Site:A:B:C	82475	36	7.2200e-01	0.87941
Residuals	761522	240		

```

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

```

## 7.15 Example 10.2

(91) MODEL

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

\$ANOVA

Response : Yield

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	227	6370995084	28066058	10814	< 2.2e-16 ***
RESIDUALS	252	654049	2595		
CORRECTED TOTAL	479	6371649132			

---

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

\$`Type I`

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

---

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

\$`Type II`

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

---

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

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

## 7.16 Example 11.1

(92) MODEL

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

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

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

```
$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
R        2    48     24  2.5714 0.11765
```

```

T      1      24      24  2.5714 0.13479
R:T    2      16       8  0.8571 0.44880
S      3     156      52  5.5714 0.01251 *
T:S    3      84      28  3.0000 0.07277 .
---

```

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

\$`Type III`

```

      Df Sum Sq Mean Sq F value Pr(>F)
R      2      48      24  2.5714 0.11765
T      1      24      24  2.5714 0.13479
R:T    2      16       8  0.8571 0.44880
S      3     156      52  5.5714 0.01251 *
T:S    3      84      28  3.0000 0.07277 .
---

```

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

(93) MODEL

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

\$ANOVA

Response : Z

```

      Df Sum Sq Mean Sq F value Pr(>F)
MODEL      11      46  4.1818  2.5091 0.06452 .
RESIDUALS    12      20  1.6667
CORRECTED TOTAL 23      66
---

```

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

\$`Type I`

```

      Df Sum Sq Mean Sq F value Pr(>F)
R      2       9      4.5      2.7 0.1076
T      1       6      6.0      3.6 0.0821 .
R:T    2       1      0.5      0.3 0.7462
S      3       9      3.0      1.8 0.2008
T:S    3      21      7.0      4.2 0.0301 *
---

```

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

\$`Type II`

```

      Df Sum Sq Mean Sq F value Pr(>F)
R      2       9      4.5      2.7 0.1076
T      1       6      6.0      3.6 0.0821 .
R:T    2       1      0.5      0.3 0.7462
S      3       9      3.0      1.8 0.2008
T:S    3      21      7.0      4.2 0.0301 *

```



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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	2	9	4.5	2.7	0.1076
T	1	6	6.0	3.6	0.0821 .
R:T	2	1	0.5	0.3	0.7462
S	3	9	3.0	1.8	0.2008
T:S	3	21	7.0	4.2	0.0301 *

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

(94) MODEL

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

```
$ANOVA
```

```
Response : Y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	12	342.45	28.5375	3.218	0.03116 *
RESIDUALS	11	97.55	8.8682		
CORRECTED TOTAL	23	440.00			

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	2	48.00	24.00	2.7063	0.11071
T	1	24.00	24.00	2.7063	0.12820
R:T	2	16.00	8.00	0.9021	0.43373
S	3	156.00	52.00	5.8637	0.01211 *
T:S	3	84.00	28.00	3.1574	0.06828 .
Z	1	14.45	14.45	1.6294	0.22807

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	2	18.300	9.1500	1.0318	0.38844
T	1	2.679	2.6786	0.3020	0.59359
R:T	2	9.450	4.7250	0.5328	0.60137
S	3	79.196	26.3985	2.9768	0.07822 .
T:S	3	37.474	12.4915	1.4086	0.29234
Z	1	14.450	14.4500	1.6294	0.22807

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

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

## 7.17 Example 11.2

(95) MODEL

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

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

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

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

```
$`Type III`
```

```

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

```

(96) MODEL

```

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

```

```

$ANOVA
Response : Y

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

```

```

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

```

```

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

```

```

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

```

(97) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	328	29.8182	3.1948	0.02875 *
RESIDUALS	12	112	9.3333		
CORRECTED TOTAL	23	440			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	48	24	2.5714	0.11765
whole	1	24	24	2.5714	0.13479
block:whole	2	16	8	0.8571	0.44880
split	3	156	52	5.5714	0.01251 *
whole:split	3	84	28	3.0000	0.07277 .

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	48	24	2.5714	0.11765
whole	1	24	24	2.5714	0.13479
block:whole	2	16	8	0.8571	0.44880
split	3	156	52	5.5714	0.01251 *
whole:split	3	84	28	3.0000	0.07277 .

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	48	24	2.5714	0.11765
whole	1	24	24	2.5714	0.13479
block:whole	2	16	8	0.8571	0.44880
split	3	156	52	5.5714	0.01251 *
whole:split	3	84	28	3.0000	0.07277 .

---

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

(98) MODEL

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

```
$ANOVA
```

```
Response : Z
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	38	3.4545	3.5903e+15	< 2.2e-16 ***
RESIDUALS	12	0	0.0000		
CORRECTED TOTAL	23	38			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	36.000	18.0000	1.8707e+16	<2e-16 ***
whole	1	0.667	0.6667	6.9286e+14	<2e-16 ***
block:whole	2	1.333	0.6667	6.9286e+14	<2e-16 ***
split	3	0.000	0.0000	0.0000e+00	1
whole:split	3	0.000	0.0000	0.0000e+00	1

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	36.000	18.0000	1.8707e+16	<2e-16 ***
whole	1	0.667	0.6667	6.9286e+14	<2e-16 ***
block:whole	2	1.333	0.6667	6.9286e+14	<2e-16 ***
split	3	0.000	0.0000	0.0000e+00	1
whole:split	3	0.000	0.0000	0.0000e+00	1

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	36.000	18.0000	1.8707e+16	<2e-16 ***
whole	1	0.667	0.6667	6.9286e+14	<2e-16 ***
block:whole	2	1.333	0.6667	6.9286e+14	<2e-16 ***
split	3	0.000	0.0000	0.0000e+00	1
whole:split	3	0.000	0.0000	0.0000e+00	1

```
---
```

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

```
(99) MODEL
```

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

```
$ANOVA
```

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	328	29.8182	3.1948	0.02875 *
RESIDUALS	12	112	9.3333		
CORRECTED TOTAL	23	440			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	48	24	2.5714	0.11765
whole	1	24	24	2.5714	0.13479
block:whole	2	16	8	0.8571	0.44880
split	3	156	52	5.5714	0.01251 *
whole:split	3	84	28	3.0000	0.07277 .
Z	0				

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	13.286	6.643	0.7117	0.51039
whole	1	16.000	16.000	1.7143	0.21495
block:whole	1	16.000	16.000	1.7143	0.21495
split	3	156.000	52.000	5.5714	0.01251 *
whole:split	3	84.000	28.000	3.0000	0.07277 .
Z	0				

---

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	13.286	6.643	0.7117	0.51039
whole	1	16.000	16.000	1.7143	0.21495
block:whole	1	16.000	16.000	1.7143	0.21495
split	3	156.000	52.000	5.5714	0.01251 *
whole:split	3	84.000	28.000	3.0000	0.07277 .
Z	0				

---

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

## 7.18 Example 11.3

(100) MODEL

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

\$ANOVA

Response : Y

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	4.5000	1.5000	3.0000	0.11696
A	1	1.5000	1.5000	3.0000	0.13397
block:A	3	0.5000	0.1667	0.3333	0.80220
B	2	8.3333	4.1667	8.3333	0.01855 *
block:B	6	1.0000	0.1667	0.3333	0.89648
A:B	2	1.0000	0.5000	1.0000	0.42188

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	4.5000	1.5000	3.0000	0.11696
A	1	1.5000	1.5000	3.0000	0.13397
block:A	3	0.5000	0.1667	0.3333	0.80220
B	2	8.3333	4.1667	8.3333	0.01855 *
block:B	6	1.0000	0.1667	0.3333	0.89648
A:B	2	1.0000	0.5000	1.0000	0.42188

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	4.5000	1.5000	3.0000	0.11696
A	1	1.5000	1.5000	3.0000	0.13397
block:A	3	0.5000	0.1667	0.3333	0.80220
B	2	8.3333	4.1667	8.3333	0.01855 *
block:B	6	1.0000	0.1667	0.3333	0.89648
A:B	2	1.0000	0.5000	1.0000	0.42188

---

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

(101) MODEL

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

```
$ANOVA
```

```
Response : Z
```

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

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	6.8333	2.2778	4.1	0.06689 .
A	1	6.0000	6.0000	10.8	0.01669 *
block:A	3	1.6667	0.5556	1.0	0.45472
B	2	13.0000	6.5000	11.7	0.00850 **
block:B	6	3.6667	0.6111	1.1	0.45542
A:B	2	0.0000	0.0000	0.0	1.00000

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	6.8333	2.2778	4.1	0.06689 .
A	1	6.0000	6.0000	10.8	0.01669 *
block:A	3	1.6667	0.5556	1.0	0.45472
B	2	13.0000	6.5000	11.7	0.00850 **
block:B	6	3.6667	0.6111	1.1	0.45542
A:B	2	0.0000	0.0000	0.0	1.00000

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	6.8333	2.2778	4.1	0.06689 .
A	1	6.0000	6.0000	10.8	0.01669 *
block:A	3	1.6667	0.5556	1.0	0.45472
B	2	13.0000	6.5000	11.7	0.00850 **
block:B	6	3.6667	0.6111	1.1	0.45542
A:B	2	0.0000	0.0000	0.0	1.00000

```
---
```

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

```
(102) MODEL
```



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

```
$ANOVA
```

```
Response : Y
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	4.5000	1.5000	3.7657	0.09378 .
A	1	1.5000	1.5000	3.7657	0.10999
block:A	3	0.5000	0.1667	0.4184	0.74788
B	2	8.3333	4.1667	10.4603	0.01634 *
block:B	6	1.0000	0.1667	0.4184	0.84059
A:B	2	1.0000	0.5000	1.2552	0.36163
Z	1	1.0083	1.0083	2.5314	0.17248

```
---
```

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

```
$`Type II`
```

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

```
$`Type III`
```

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

## 8 Hinkelmann & Kempthorne - Volume 1

### Reference

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

### 8.1 Chapter 6

#### 8.1.1 p202

(103) MODEL

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

\$ANOVA

Response : miles

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	47.234	11.809	15.661	0.004924 **
RESIDUALS	5	3.770	0.754		
CORRECTED TOTAL	9	51.004			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	47.234	11.809	15.661	0.004924 **

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	47.234	11.809	15.661	0.004924 **

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	47.234	11.809	15.661	0.004924 **

---

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

### 8.1.2 p205

(104) MODEL

```
v1p205 = read.table("C:/G/Rt/Kemp/v1p205.txt", head=TRUE)
v1p205 = af(v1p205,c("brand", "car"))
ANOVA(miles ~ brand + car %in% brand, v1p205) # OK
```

\$ANOVA

Response : miles

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	9	140.05	15.561	80.21	1.017e-13 ***
RESIDUALS	20	3.88	0.194		
CORRECTED TOTAL	29	143.93			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	133.243	33.311	171.7053	3.553e-15 ***
brand:car	5	6.803	1.361	7.0137	0.0006214 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	133.243	33.311	171.7053	3.553e-15 ***
brand:car	5	6.803	1.361	7.0137	0.0006214 ***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	133.243	33.311	171.7053	3.553e-15 ***
brand:car	5	6.803	1.361	7.0137	0.0006214 ***

---

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

## 8.2 Chapter 7

### 8.2.1 p232

(105) MODEL

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

\$ANOVA

Response : yield

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	59.174	14.793	28.781	0.0012 **
RESIDUALS	5	2.570	0.514		
CORRECTED TOTAL	9	61.744			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	4	59.174	14.793	28.781	0.0012 **

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	4	59.174	14.793	28.781	0.0012 **

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	4	59.174	14.793	28.781	0.0012 **

---

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

## 8.2.2 p235

(106) MODEL

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

\$ANOVA

Response : yield

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	88.007	22.0017	32.198	1.095e-05 ***
RESIDUALS	10	6.833	0.6833		
CORRECTED TOTAL	14	94.840			

```

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

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

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

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

```

## 8.3 Chapter 8

### 8.3.1 p265

(107) MODEL

```

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

```

```

$ANOVA
Response : y

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

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

```

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

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

### 8.3.2 p272

(108) MODEL

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

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

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

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

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

```

trt      2  6.1392  3.0696  3.7390 0.065769 .
trt:x    3 18.8433  6.2811  7.6509 0.007578 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

### 8.3.3 p273

(109) MODEL

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

```

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

```

```

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

```

```

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

```

```

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

```

## 8.4 Chapter 9

### 8.4.1 p344

(110) MODEL

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

\$ANOVA

Response : gain

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	9	4915.6	546.18	15.544	3.363e-07 ***
RESIDUALS	20	702.8	35.14		
CORRECTED TOTAL	29	5618.4			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
litter	5	4438.0	887.6	25.2608	5.298e-08 ***
diet	4	477.6	119.4	3.3981	0.02824 *

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
litter	5	4438.0	887.6	25.2608	5.298e-08 ***
diet	4	477.6	119.4	3.3981	0.02824 *

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
litter	5	4438.0	887.6	25.2608	5.298e-08 ***
diet	4	477.6	119.4	3.3981	0.02824 *

---

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

### 8.4.2 p349

(111) MODEL



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

\$ANOVA

Response : diast

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	1541.5	110.105	28.475	2.953e-08 ***
RESIDUALS	15	58.0	3.867		
CORRECTED TOTAL	29	1599.5			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
subject	4	905.13	226.283	58.5216	5.672e-09 ***
exercise	2	591.27	295.633	76.4569	1.357e-08 ***
subject:exercise	8	45.07	5.633	1.4569	0.2522

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
subject	4	905.13	226.283	58.5216	5.672e-09 ***
exercise	2	591.27	295.633	76.4569	1.357e-08 ***
subject:exercise	8	45.07	5.633	1.4569	0.2522

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
subject	4	905.13	226.283	58.5216	5.672e-09 ***
exercise	2	591.27	295.633	76.4569	1.357e-08 ***
subject:exercise	8	45.07	5.633	1.4569	0.2522

---

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

### 8.4.3 p354

(112) MODEL

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

\$ANOVA

Response : height

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	23	40782	1773.12	80.444	< 2.2e-16 ***
RESIDUALS	24	529	22.04		
CORRECTED TOTAL	47	41311			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
loc	1	20336.3	20336.3	922.6314	< 2.2e-16 ***
loc:block	6	1462.3	243.7	11.0573	6.408e-06 ***
HSF	2	12170.7	6085.3	276.0832	< 2.2e-16 ***
loc:HSF	2	6511.2	3255.6	147.7013	3.242e-14 ***
loc:block:HSF	12	301.2	25.1	1.1386	0.3769

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
loc	1	20336.3	20336.3	922.6314	< 2.2e-16 ***
loc:block	6	1462.3	243.7	11.0573	6.408e-06 ***
HSF	2	12170.7	6085.3	276.0832	< 2.2e-16 ***
loc:HSF	2	6511.2	3255.6	147.7013	3.242e-14 ***
loc:block:HSF	12	301.2	25.1	1.1386	0.3769

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
loc	1	20336.3	20336.3	922.6314	< 2.2e-16 ***
loc:block	6	1462.3	243.7	11.0573	6.408e-06 ***
HSF	2	12170.7	6085.3	276.0832	< 2.2e-16 ***
loc:HSF	2	6511.2	3255.6	147.7013	3.242e-14 ***
loc:block:HSF	12	301.2	25.1	1.1386	0.3769

---

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

#### 8.4.4 p357

(113) MODEL

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

\$ANOVA

```

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

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

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

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

```

#### 8.4.5 p361

(114) MODEL

```

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

```

```

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

```

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

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

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

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

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

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

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

## 8.5 Chapter 10

### 8.5.1 p405

(115) MODEL

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

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	12	4094.7	341.23	2.3416	0.07739 .
RESIDUALS	12	1748.7	145.73		
CORRECTED TOTAL	24	5843.4			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Row	4	514.24	128.56	0.8822	0.50328
Col	4	1711.44	427.86	2.9360	0.06611 .
trt	4	1869.04	467.26	3.2064	0.05229 .

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Row	4	514.24	128.56	0.8822	0.50328
Col	4	1711.44	427.86	2.9360	0.06611 .
trt	4	1869.04	467.26	3.2064	0.05229 .

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Row	4	514.24	128.56	0.8822	0.50328
Col	4	1711.44	427.86	2.9360	0.06611 .
trt	4	1869.04	467.26	3.2064	0.05229 .

---

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

## 8.5.2 p408

(116) MODEL

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

\$ANOVA

Response : response

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	16	4470.2	279.391	140.87	2.039e-13 ***
RESIDUALS	15	29.7	1.983		
CORRECTED TOTAL	31	4500.0			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
breed	1	3280.5	3280.5	1654.0336	< 2.2e-16 ***
breed:farm	6	9.0	1.5	0.7563	0.6146
wclass	3	466.8	155.6	78.4454	2.142e-09 ***
dosage	3	580.2	193.4	97.5210	4.596e-10 ***
breed:dosage	3	133.8	44.6	22.4790	8.366e-06 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
breed	1	3280.5	3280.5	1654.0336	< 2.2e-16 ***
breed:farm	6	9.0	1.5	0.7563	0.6146
wclass	3	466.7	155.6	78.4454	2.142e-09 ***
dosage	3	580.2	193.4	97.5210	4.596e-10 ***
breed:dosage	3	133.8	44.6	22.4790	8.366e-06 ***

---

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

\$`Type III`

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

---

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

### 8.5.3 p410

(117) MODEL

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

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	17	1302.51	76.618	8.7402	1.572e-05 ***
RESIDUALS	18	157.79	8.766		
CORRECTED TOTAL	35	1460.31			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
period	2	292.06	146.028	16.6580	8.038e-05 ***
sequence	5	326.47	65.294	7.4484	0.0006072 ***
sequence:steer	6	118.50	19.750	2.2530	0.0849122 .
trt	2	549.06	274.528	31.3166	1.377e-06 ***
carry	2	16.43	8.215	0.9372	0.4100385

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
period	2	172.31	86.154	9.8279	0.0013030 **
sequence	5	318.69	63.738	7.2709	0.0006954 ***
sequence:steer	6	118.50	19.750	2.2530	0.0849122 .
trt	2	440.61	220.304	25.1311	6.164e-06 ***
carry	2	16.43	8.215	0.9372	0.4100385

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
period	2	172.31	86.154	9.8279	0.0013030 **
sequence	5	318.69	63.738	7.2709	0.0006954 ***
sequence:steer	6	118.50	19.750	2.2530	0.0849122 .
trt	2	440.61	220.304	25.1311	6.164e-06 ***
carry	2	16.43	8.215	0.9372	0.4100385

---

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

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

Note: model has aliased coefficients

sums of squares computed by model comparison

Anova Table (Type III tests)

Response: y

	Sum Sq	Df	F values	Pr(>F)
period	172.31	2	9.8279	0.001303 **
sequence	0.00	0		
trt	440.61	2	25.1311	6.164e-06 ***
carry	16.43	2	0.9372	0.410038
sequence:steer	118.50	6	2.2530	0.084912 .
Residuals	157.79	18		

---

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

## 8.6 Chapter 11

### 8.6.1 p432

(118) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	94	261663	2783.65	30.584	2.065e-14 ***
RESIDUALS	25	2275	91.02		
CORRECTED TOTAL	119	263939			

---

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

\$`Type I`

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

---

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



\$`Type II`

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

---

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

\$`Type III`

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

---

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

## 8.6.2 p434

(119) MODEL

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

\$ANOVA

Response : Y

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

---

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

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

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

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

### 8.6.3 p438

(120) MODEL

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

```
$ANOVA
```

Response : Y

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

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
V	4	102743	25686	225.9988	< 2.2e-16 ***
V:Block	25	50019	2001	17.6040	< 2.2e-16 ***
C	3	97100	32367	284.7823	< 2.2e-16 ***
V:C	12	5552	463	4.0709	7.23e-05 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
V	4	102743	25686	225.9988	< 2.2e-16 ***
V:Block	25	50019	2001	17.6040	< 2.2e-16 ***
C	3	97100	32367	284.7823	< 2.2e-16 ***
V:C	12	5552	463	4.0709	7.23e-05 ***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
V	4	102743	25686	225.9988	< 2.2e-16 ***
V:Block	25	50019	2001	17.6040	< 2.2e-16 ***
C	3	97100	32367	284.7823	< 2.2e-16 ***
V:C	12	5552	463	4.0709	7.23e-05 ***

---

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

#### 8.6.4 p444

(121) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	39278	3570.8	59.787	1.897e-06 ***

```
RESIDUALS      8    478    59.7
CORRECTED TOTAL 19 39756
```

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
V	4	19287.7	4821.9	80.7355	1.674e-06 ***
A	1	3380.0	3380.0	56.5927	6.780e-05 ***
B	1	14045.0	14045.0	235.1612	3.247e-07 ***
A:B	1	115.2	115.2	1.9288	0.202326
V:A	4	2450.5	612.6	10.2574	0.003081 **

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
V	4	19287.7	4821.9	80.7355	1.674e-06 ***
A	1	3380.0	3380.0	56.5927	6.780e-05 ***
B	1	14045.0	14045.0	235.1612	3.247e-07 ***
A:B	1	115.2	115.2	1.9288	0.202326
V:A	4	2450.5	612.6	10.2574	0.003081 **

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
V	4	19287.7	4821.9	80.7355	1.674e-06 ***
A	1	3380.0	3380.0	56.5927	6.780e-05 ***
B	1	14045.0	14045.0	235.1612	3.247e-07 ***
A:B	1	115.2	115.2	1.9288	0.202326
V:A	4	2450.5	612.6	10.2574	0.003081 **

```
---
```

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

## 8.6.5 p482

(122) MODEL

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

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

```

MODEL          8 156.88 19.6094  9.8871 9.377e-05 ***
RESIDUALS      15  29.75  1.9833
CORRECTED TOTAL 23 186.62

```

---

```

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

```

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	5	108.38	21.675	10.9286	0.0001415 ***
A	1	4.00	4.000	2.0168	0.1760166
B	1	42.25	42.250	21.3025	0.0003365 ***
A:B	1	2.25	2.250	1.1345	0.3036727

---

```

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

```

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	5	31.417	6.283	3.1681	0.0377804 *
A	1	4.000	4.000	2.0168	0.1760166
B	1	42.250	42.250	21.3025	0.0003365 ***
A:B	1	2.250	2.250	1.1345	0.3036727

---

```

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

```

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	5	31.417	6.283	3.1681	0.0377804 *
A	1	4.000	4.000	2.0168	0.1760166
B	1	42.250	42.250	21.3025	0.0003365 ***
A:B	1	2.250	2.250	1.1345	0.3036727

---

```

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

```

## 8.7 Chapter 12

### 8.7.1 p525

(123) MODEL

```

vip525 = read.table("C:/G/Rt/Kemp/vip525.txt", head=TRUE)
REG(y ~ x1 + x2 + x3, vip525)

```

	Estimate	Std. Error	Df	t value	Pr(> t )
(Intercept)	14.2125	0.10383	12	136.8787	< 2.2e-16 ***
x1	0.7875	0.10383	12	7.5843	6.465e-06 ***
x2	1.3875	0.10383	12	13.3628	1.446e-08 ***

```

x3          1.6625    0.10383 12  16.0113 1.839e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

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

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	3	84.948	28.3158	164.15	5.26e-10 ***
RESIDUALS	12	2.070	0.1725		
CORRECTED TOTAL	15	87.018			

```

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

```

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
x1	1	9.923	9.923	57.522	6.465e-06 ***
x2	1	30.803	30.803	178.565	1.446e-08 ***
x3	1	44.223	44.223	256.362	1.839e-09 ***

```

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

```

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
x1	1	9.923	9.923	57.522	6.465e-06 ***
x2	1	30.803	30.803	178.565	1.446e-08 ***
x3	1	44.223	44.223	256.362	1.839e-09 ***

```

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

```

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
x1	1	9.923	9.923	57.522	6.465e-06 ***
x2	1	30.803	30.803	178.565	1.446e-08 ***
x3	1	44.223	44.223	256.362	1.839e-09 ***

```

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

```

## 8.7.2 p527

(124) MODEL

```

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

```

```

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

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

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

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

```

### 8.7.3 p529

(125) MODEL

```

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

```

```

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

```

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

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

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

## 8.8 Chapter 13

### 8.8.1 p563

(126) MODEL

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

```
$ANOVA
Response : y
      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL    14 2097.08 149.792  17.228 8.385e-05 ***
RESIDUALS    9   78.25   8.694
CORRECTED TOTAL 23 2175.33
```



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

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

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

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

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

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

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

## 8.8.2 p566

(127) MODEL

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

```
$ANOVA
Response : y
      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL     5 1469.58  293.92   86.2 5.592e-09 ***
RESIDUALS 12   40.92    3.41
```

```
CORRECTED TOTAL 17 1510.50
```

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	2	1390.04	695.02	203.8350	5.466e-10 ***
B	1	76.06	76.06	22.3055	0.0004945 ***
A:B	2	3.49	1.74	0.5112	0.6122667

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	2	1390.04	695.02	203.8350	5.466e-10 ***
B	1	76.06	76.06	22.3055	0.0004945 ***
A:B	2	3.49	1.74	0.5112	0.6122667

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	2	1390.04	695.02	203.8350	5.466e-10 ***
B	1	79.00	79.00	23.1700	0.0004237 ***
A:B	2	3.49	1.74	0.5112	0.6122667

```
---
```

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

## 8.9 Chapter 14

### 8.9.1 p581

(128) MODEL

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

```
$ANOVA
```

```
Response : rate
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	23	2449.5	106.500	12.733	3.469e-11 ***
RESIDUALS	36	301.1	8.364		
CORRECTED TOTAL	59	2750.6			

```
---
```

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
drug	2	337.60	168.800	20.1820	1.323e-06	***
drug:person	12	1498.50	124.875	14.9303	1.501e-10	***
time	3	256.33	85.444	10.2159	5.230e-05	***
drug:time	6	357.07	59.511	7.1152	4.707e-05	***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
drug	2	337.60	168.800	20.1820	1.323e-06	***
drug:person	12	1498.50	124.875	14.9303	1.501e-10	***
time	3	256.33	85.444	10.2159	5.230e-05	***
drug:time	6	357.07	59.511	7.1152	4.707e-05	***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
drug	2	337.60	168.800	20.1820	1.323e-06	***
drug:person	12	1498.50	124.875	14.9303	1.501e-10	***
time	3	256.33	85.444	10.2159	5.230e-05	***
drug:time	6	357.07	59.511	7.1152	4.707e-05	***

---

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

## 9 Hinkelmann & Kempthorne - Volume 2

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

### 9.1 Chapter 1

#### 9.1.1 p53

(129) MODEL

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

\$ANOVA

Response : Y

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
BLOCK	4	261.40	65.350	7.1863	0.12587
TRT	3	256.81	85.604	9.4135	0.09755 .

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
BLOCK	4	79.146	19.786	2.1758	0.33880
TRT	3	256.812	85.604	9.4135	0.09755 .

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
BLOCK	4	79.146	19.786	2.1758	0.33880
TRT	3	256.813	85.604	9.4135	0.09755 .

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

#### 9.1.2 p62

(130) MODEL

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

```
$ANOVA
```

```
Response : Y
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	3	439.07	146.356	16.0941	0.05907 .
BLOCK	4	79.15	19.786	2.1758	0.33880

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	3	256.812	85.604	9.4135	0.09755 .
BLOCK	4	79.146	19.786	2.1758	0.33880

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	3	256.813	85.604	9.4135	0.09755 .
BLOCK	4	79.146	19.786	2.1758	0.33880

```
---
```

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

## 9.2 Chapter 2

### 9.2.1 p82

```
(131) MODEL
```

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

```
$ANOVA
```

```
Response : Y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	889.11	63.508	6.3183	0.000518 ***
RESIDUALS	15	150.77	10.052		

CORRECTED TOTAL 29 1039.89

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
B	9	730.39	81.154	8.0738	0.0002454 ***
Tx	5	158.73	31.745	3.1583	0.0381655 *

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
B	9	595.74	66.193	6.5854	0.0007602 ***
Tx	5	158.73	31.745	3.1583	0.0381655 *

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
B	9	595.74	66.193	6.5854	0.0007602 ***
Tx	5	158.73	31.745	3.1583	0.0381655 *

---

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

## 9.2.2 p87

(132) MODEL

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

\$ANOVA

Response : y

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
x1	1	1044.48	1044.48	7.2293	0.05473 .
x2	1	89.79	89.79	0.6215	0.47459
x3	1	10.45	10.45	0.0724	0.80124
x4	1	407.08	407.08	2.8176	0.16854
x5	1	61.44	61.44	0.4253	0.54990

```
x6  0
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
      Df Sum Sq Mean Sq F value Pr(>F)
x1     0
x2     0
x3     0
x4     0
x5     0
x6     0
```

```
$`Type III`
CAUTION: Singularity Exists !
      Df Sum Sq Mean Sq F value Pr(>F)
x1     0
x2     0
x3     0
x4     0
x5     0
x6     0
```

## 9.3 Chapter 6

### 9.3.1 p217

(133) MODEL

```
v2p217 = read.table("C:/G/Rt/Kemp/v2p217.txt", head=TRUE)
v2p217 = af(v2p217, c("R", "C", "Tx"))
ANOVA(Y ~ R + C + Tx, v2p217) # OK
```

```
$ANOVA
Response : Y
      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      22 4305.1  195.687   7.5094 0.0002682 ***
RESIDUALS   13   338.8   26.059
CORRECTED TOTAL 35 4643.9
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
R       3 3951.4 1317.15 50.5446 1.998e-07 ***
C       8  168.9   21.11  0.8101  0.6062
```

```

Tx 11  184.8   16.80  0.6446   0.7638
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
R      3 3403.5  1134.51  43.5360 4.83e-07 ***
C      8  112.4    14.05   0.5390  0.8077
Tx 11   184.8    16.80   0.6446   0.7638
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq F value    Pr(>F)
R      3 3403.5  1134.51  43.5360 4.83e-07 ***
C      8  112.4    14.05   0.5390  0.8077
Tx 11   184.8    16.80   0.6446   0.7638
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

### 9.3.2 p234

(134) MODEL

```

v2p234 = read.table("C:/G/Rt/Kemp/v2p234.txt", head=TRUE)
v2p234 = af(v2p234, c("R", "C", "Tx"))
ANOVA(Y ~ C + R + Tx, v2p234) # OK

```

\$ANOVA

Response : Y

```

              Df Sum Sq Mean Sq F value Pr(>F)
MODEL              13 426.50   32.808   7.0936 0.1302
RESIDUALS           2   9.25    4.625
CORRECTED TOTAL  15 435.75

```

```

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
C      3  16.25    5.417   1.1712 0.49129
R      3 357.25  119.083  25.7477 0.03762 *
Tx     7  53.00    7.571   1.6371 0.43052
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
C      3  10.25    3.417   0.7387 0.6189

```



```

R    3 285.50  95.167 20.5766 0.0467 *
Tx   7  53.00   7.571  1.6371 0.4305
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df Sum Sq Mean Sq F value Pr(>F)
C       3  10.25   3.417  0.7387 0.6189
R       3 285.50  95.167 20.5766 0.0467 *
Tx      7  53.00   7.571  1.6371 0.4305
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 9.4 Chapter 7

### 9.4.1 p268

(135) MODEL

```

v2p268 = read.table("C:/G/Rt/Kemp/v2p268.txt", head=TRUE)
v2p268 = af(v2p268, c("A", "B", "C"))
ANOVA(y ~ block + A*B*C, v2p268) # OK

```

```

$ANOVA
Response : y
      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      8 1026.00  128.250   24.981 0.0001765 ***
RESIDUALS    7   35.94    5.134
CORRECTED TOTAL 15 1061.94
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
block  1 715.56  715.56  139.3791 7.093e-06 ***
A       1  68.06   68.06   13.2574 0.0082753 **
B       1   0.06    0.06    0.0122 0.9152401
A:B     1   0.56    0.56    0.1096 0.7503276
C       1 232.56  232.56   45.2991 0.0002698 ***
A:C     1   0.06    0.06    0.0122 0.9152401
B:C     1   7.56    7.56    1.4730 0.2642229
A:B:C   1   1.56    1.56    0.3043 0.5983312
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

$`Type II`

```

```

      Df Sum Sq Mean Sq  F value    Pr(>F)
block  1 715.56   715.56 139.3791 7.093e-06 ***
A       1  68.06    68.06  13.2574 0.0082753 **
B       1   0.06     0.06   0.0122 0.9152401
A:B     1   0.56     0.56   0.1096 0.7503276
C       1 232.56   232.56  45.2991 0.0002698 ***
A:C     1   0.06     0.06   0.0122 0.9152401
B:C     1   7.56     7.56   1.4730 0.2642229
A:B:C   1   1.56     1.56   0.3043 0.5983312
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type III`

```

      Df Sum Sq Mean Sq  F value    Pr(>F)
block  1 715.56   715.56 139.3791 7.093e-06 ***
A       1  68.06    68.06  13.2574 0.0082753 **
B       1   0.06     0.06   0.0122 0.9152401
A:B     1   0.56     0.56   0.1096 0.7503276
C       1 232.56   232.56  45.2991 0.0002698 ***
A:C     1   0.06     0.06   0.0122 0.9152401
B:C     1   7.56     7.56   1.4730 0.2642229
A:B:C   1   1.56     1.56   0.3043 0.5983312
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 9.4.2 p273

(136) MODEL

```

v2p273 = read.table("C:/G/Rt/Kemp/v2p273.txt", head=TRUE)
v2p273 = af(v2p273, c("block", "A", "B", "C"))
ANOVA(y ~ block + A*B*C + block:A:B:C, v2p273) # OK

```

\$ANOVA

Response : y

```

      Df Sum Sq Mean Sq  F value    Pr(>F)
MODEL    15 2245.0  149.665  129.44 8.427e-14 ***
RESIDUALS  16   18.5    1.156
CORRECTED TOTAL 31 2263.5
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type I`

```

      Df Sum Sq Mean Sq  F value    Pr(>F)
block    1 1498.78 1498.78 1296.2432 < 2.2e-16 ***
A         1  132.03  132.03  114.1892 1.083e-08 ***

```

```

B          1      0.03      0.03      0.0270      0.87148
A:B        1      1.53      1.53      1.3243      0.26673
C          1  504.03  504.03  435.9189  4.926e-13 ***
A:C        1      0.78      0.78      0.6757      0.42316
B:C        1      3.78      3.78      3.2703      0.08938 .
A:B:C      1      2.53      2.53      2.1892      0.15840
block:A:B:C 7  101.47   14.50   12.5367  1.965e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type II`

```

      Df Sum Sq Mean Sq  F value    Pr(>F)
block    1 1498.78 1498.78 1296.2432 < 2.2e-16 ***
A         1  132.03  132.03  114.1892 1.083e-08 ***
B         1    0.03    0.03   0.0270  0.87148
A:B       1    1.53    1.53   1.3243  0.26673
C         1  504.03  504.03  435.9189 4.926e-13 ***
A:C       1    0.78    0.78   0.6757  0.42316
B:C       1    3.78    3.78   3.2703  0.08938 .
A:B:C     1    2.53    2.53   2.1892  0.15840
block:A:B:C 7  101.47   14.50   12.5367 1.965e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type III`

```

      Df Sum Sq Mean Sq  F value    Pr(>F)
block    1 1498.78 1498.78 1296.2432 < 2.2e-16 ***
A         1  132.03  132.03  114.1892 1.083e-08 ***
B         1    0.03    0.03   0.0270  0.87148
A:B       1    1.53    1.53   1.3243  0.26673
C         1  504.03  504.03  435.9189 4.926e-13 ***
A:C       1    0.78    0.78   0.6757  0.42316
B:C       1    3.78    3.78   3.2703  0.08938 .
A:B:C     1    2.53    2.53   2.1892  0.15840
block:A:B:C 7  101.47   14.50   12.5367 1.965e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 9.5 Chapter 8

### 9.5.1 p304

(137) MODEL

```

v2p304 = read.table("C:/G/Rt/Kemp/v2p304.txt", head=TRUE)
v2p304 = af(v2p304, c("rep", "block", "A", "B", "C"))
ANOVA(y ~ rep + block %in% rep + A*B*C - A:B:C, v2p304) # OK

```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	9	699.06	77.674	248.56	5.096e-07 ***
RESIDUALS	6	1.88	0.312		
CORRECTED TOTAL	15	700.94			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06	1248.2	3.428e-08 ***
rep:block	2	8.12	4.06	13.0	0.0065918 **
A	1	18.06	18.06	57.8	0.0002696 ***
B	1	175.56	175.56	561.8	3.702e-07 ***
A:B	1	0.06	0.06	0.2	0.6704121
C	1	68.06	68.06	217.8	6.083e-06 ***
A:C	1	0.06	0.06	0.2	0.6704121
B:C	1	39.06	39.06	125.0	3.056e-05 ***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06	1248.2	3.428e-08 ***
rep:block	2	8.12	4.06	13.0	0.0065918 **
A	1	18.06	18.06	57.8	0.0002696 ***
B	1	175.56	175.56	561.8	3.702e-07 ***
A:B	1	0.06	0.06	0.2	0.6704121
C	1	68.06	68.06	217.8	6.083e-06 ***
A:C	1	0.06	0.06	0.2	0.6704121
B:C	1	39.06	39.06	125.0	3.056e-05 ***

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06	1248.2	3.428e-08 ***
rep:block	2	8.12	4.06	13.0	0.0065918 **
A	1	18.06	18.06	57.8	0.0002696 ***
B	1	175.56	175.56	561.8	3.702e-07 ***
A:B	1	0.06	0.06	0.2	0.6704121
C	1	68.06	68.06	217.8	6.083e-06 ***
A:C	1	0.06	0.06	0.2	0.6704121
B:C	1	39.06	39.06	125.0	3.056e-05 ***

---

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

## 9.5.2 p309

(138) MODEL

```
ANOVA(y ~ rep*A*B*C, v2p304) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	15	700.94	46.729		
RESIDUALS	0	0.00			
CORRECTED TOTAL	15	700.94			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06		
A	1	18.06	18.06		
rep:A	1	0.06	0.06		
B	1	175.56	175.56		
rep:B	1	1.56	1.56		
A:B	1	0.06	0.06		
rep:A:B	1	0.06	0.06		
C	1	68.06	68.06		
rep:C	1	0.06	0.06		
A:C	1	0.06	0.06		
rep:A:C	1	0.06	0.06		
B:C	1	39.06	39.06		
rep:B:C	1	0.06	0.06		
A:B:C	1	7.56	7.56		
rep:A:B:C	1	0.56	0.56		

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06		
A	1	18.06	18.06		
rep:A	1	0.06	0.06		
B	1	175.56	175.56		
rep:B	1	1.56	1.56		
A:B	1	0.06	0.06		
rep:A:B	1	0.06	0.06		
C	1	68.06	68.06		
rep:C	1	0.06	0.06		
A:C	1	0.06	0.06		
rep:A:C	1	0.06	0.06		
B:C	1	39.06	39.06		
rep:B:C	1	0.06	0.06		
A:B:C	1	7.56	7.56		

```
rep:A:B:C 1 0.56 0.56
```

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06		
A	1	18.06	18.06		
rep:A	1	0.06	0.06		
B	1	175.56	175.56		
rep:B	1	1.56	1.56		
A:B	1	0.06	0.06		
rep:A:B	1	0.06	0.06		
C	1	68.06	68.06		
rep:C	1	0.06	0.06		
A:C	1	0.06	0.06		
rep:A:C	1	0.06	0.06		
B:C	1	39.06	39.06		
rep:B:C	1	0.06	0.06		
A:B:C	1	7.56	7.56		
rep:A:B:C	1	0.56	0.56		

## 9.6 Chapter 9

### 9.6.1 p343

(139) MODEL

```
v2p343 = read.table("C:/G/Rt/Kemp/v2p343.txt", head=TRUE)
v2p343 = af(v2p343, c("rep", "block", "A", "B", "C"))
ANOVA(y ~ rep + block %in% rep + A*B*C - A:B:C, v2p343) # OK
```

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	17	1889.8	111.167	14.659	0.001608 **
RESIDUALS	6	45.5	7.583		
CORRECTED TOTAL	23	1935.3			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
rep:block	9	127.00	14.11	1.8608	0.23163
A	1	36.00	36.00	4.7473	0.07218 .
B	1	36.00	36.00	4.7473	0.07218 .
A:B	1	12.25	12.25	1.6154	0.25079

C	1	56.25	56.25	7.4176	0.03448 *
A:C	1	81.00	81.00	10.6813	0.01707 *
B:C	1	4.00	4.00	0.5275	0.49502

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
rep:block	9	119.83	13.31	1.7558	0.25388
A	1	36.00	36.00	4.7473	0.07218 .
B	1	36.00	36.00	4.7473	0.07218 .
A:B	1	12.25	12.25	1.6154	0.25079
C	1	56.25	56.25	7.4176	0.03448 *
A:C	1	81.00	81.00	10.6813	0.01707 *
B:C	1	4.00	4.00	0.5275	0.49502

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
rep:block	9	119.83	13.31	1.7558	0.25388
A	1	36.00	36.00	4.7473	0.07218 .
B	1	36.00	36.00	4.7473	0.07218 .
A:B	1	12.25	12.25	1.6154	0.25079
C	1	56.25	56.25	7.4176	0.03448 *
A:C	1	81.00	81.00	10.6813	0.01707 *
B:C	1	4.00	4.00	0.5275	0.49502

---

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

## 9.6.2 p348

(140) MODEL

```
ANOVA(y ~ rep + A*B*C + block %in% rep, v2p343) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	17	1889.8	111.167	14.659	0.001608 **
RESIDUALS	6	45.5	7.583		
CORRECTED TOTAL	23	1935.3			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
A	1	88.17	88.17	11.6264	0.01432 *
B	1	37.50	37.50	4.9451	0.06785 .
A:B	1	2.67	2.67	0.3516	0.57484
C	1	66.67	66.67	8.7912	0.02512 *
A:C	1	37.50	37.50	4.9451	0.06785 .
B:C	1	0.17	0.17	0.0220	0.88700
A:B:C	1	24.00	24.00	3.1648	0.12555
rep:block	8	95.83	11.98	1.5797	0.29730

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
A	1	36.00	36.00	4.7473	0.07218 .
B	1	36.00	36.00	4.7473	0.07218 .
A:B	1	12.25	12.25	1.6154	0.25079
C	1	56.25	56.25	7.4176	0.03448 *
A:C	1	81.00	81.00	10.6813	0.01707 *
B:C	1	4.00	4.00	0.5275	0.49502
A:B:C	0				
rep:block	8	95.83	11.98	1.5797	0.29730

---

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
A	1	36.00	36.00	4.7473	0.07218 .
B	1	36.00	36.00	4.7473	0.07218 .
A:B	1	12.25	12.25	1.6154	0.25079
C	1	56.25	56.25	7.4176	0.03448 *
A:C	1	81.00	81.00	10.6813	0.01707 *
B:C	1	4.00	4.00	0.5275	0.49502
A:B:C	0				
rep:block	8	95.83	11.98	1.5797	0.29730

---

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

### 9.6.3 p353

(141) MODEL



```
v2p353 = read.table("C:/G/Rt/Kemp/v2p353.txt", head=TRUE)
v2p353 = af(v2p353, c("rep", "block", "A", "B", "C", "D"))
ANOVA(y ~ rep + rep:block + A*B*C*D - A:B:C:D, v2p353) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	21	7132.2	339.63	56.022	9.795e-08 ***
RESIDUALS	10	60.6	6.06		
CORRECTED TOTAL	31	7192.9			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	5940.5	5940.5	979.8763	2.600e-11 ***
rep:block	6	777.4	129.6	21.3711	3.675e-05 ***
A	1	171.1	171.1	28.2268	0.0003412 ***
B	1	18.0	18.0	2.9691	0.1155937
A:B	1	1.6	1.6	0.2577	0.6226914
C	1	120.1	120.1	19.8144	0.0012326 **
A:C	1	0.6	0.6	0.0928	0.7669127
B:C	1	2.0	2.0	0.3299	0.5784103
A:B:C	1	4.5	4.5	0.7423	0.4091189
D	1	6.1	6.1	1.0103	0.3385304
A:D	1	1.1	1.1	0.1856	0.6757693
B:D	1	5.1	5.1	0.8351	0.3823203
A:B:D	1	0.5	0.5	0.0825	0.7798349
C:D	1	1.6	1.6	0.2577	0.6226914
A:C:D	1	10.1	10.1	1.6701	0.2253083
B:C:D	1	72.0	72.0	11.8763	0.0062660 **

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	5940.5	5940.5	979.8763	2.6e-11 ***
rep:block	6	406.9	67.8	11.1856	0.0006129 ***
A	1	171.1	171.1	28.2268	0.0003412 ***
B	1	18.0	18.0	2.9691	0.1155937
A:B	1	1.6	1.6	0.2577	0.6226914
C	1	120.1	120.1	19.8144	0.0012326 **
A:C	1	0.6	0.6	0.0928	0.7669127
B:C	1	2.0	2.0	0.3299	0.5784103
A:B:C	1	4.5	4.5	0.7423	0.4091189
D	1	6.1	6.1	1.0103	0.3385304
A:D	1	1.1	1.1	0.1856	0.6757693

```

B:D      1      5.1      5.1      0.8351 0.3823203
A:B:D    1      0.5      0.5      0.0825 0.7798349
C:D      1      1.6      1.6      0.2577 0.6226914
A:C:D    1     10.1     10.1      1.6701 0.2253083
B:C:D    1     72.0     72.0     11.8763 0.0062660 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type III`

```

      Df Sum Sq Mean Sq  F value    Pr(>F)
rep      1 5940.5   5940.5  979.8763   2.6e-11 ***
rep:block 6  406.9     67.8   11.1856 0.0006129 ***
A         1  171.1   171.1   28.2268 0.0003412 ***
B         1   18.0    18.0    2.9691 0.1155937
A:B       1    1.6     1.6    0.2577 0.6226914
C         1  120.1   120.1   19.8144 0.0012326 **
A:C       1    0.6     0.6    0.0928 0.7669127
B:C       1    2.0     2.0    0.3299 0.5784103
A:B:C     1    4.5     4.5    0.7423 0.4091189
D         1    6.1     6.1    1.0103 0.3385304
A:D       1    1.1     1.1    0.1856 0.6757693
B:D       1    5.1     5.1    0.8351 0.3823203
A:B:D     1    0.5     0.5    0.0825 0.7798349
C:D       1    1.6     1.6    0.2577 0.6226914
A:C:D     1   10.1    10.1    1.6701 0.2253083
B:C:D     1   72.0    72.0   11.8763 0.0062660 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 9.7 Chapter 10

### 9.7.1 p388

(142) MODEL

```

v2p388 = read.table("C:/G/Rt/Kemp/v2p388.txt", head=TRUE)
v2p388 = af(v2p388, c("rep", "block", "A", "B"))
ANOVA(y ~ rep + A*B + rep:block, v2p388) # OK

```

\$ANOVA

Response : y

```

      Df Sum Sq Mean Sq  F value    Pr(>F)
MODEL    11 1136.8   103.343   124.01 3.698e-06 ***
RESIDUALS    6    5.0    0.833
CORRECTED TOTAL 17 1141.8
---

```

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	410.89	410.89	493.0667	5.455e-07 ***
A	2	228.11	114.06	136.8667	9.868e-06 ***
B	2	3.44	1.72	2.0667	0.207585
A:B	4	464.22	116.06	139.2667	4.801e-06 ***
rep:block	2	30.11	15.06	18.0667	0.002888 **

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	410.89	410.89	493.0667	5.455e-07 ***
A	2	228.11	114.06	136.8667	9.868e-06 ***
B	2	3.44	1.72	2.0667	0.207585
A:B	2	18.78	9.39	11.2667	0.009298 **
rep:block	2	30.11	15.06	18.0667	0.002888 **

---

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	410.89	410.89	493.0667	5.455e-07 ***
A	2	228.11	114.06	136.8667	9.868e-06 ***
B	2	3.44	1.72	2.0667	0.207585
A:B	2	18.78	9.39	11.2667	0.009298 **
rep:block	2	30.11	15.06	18.0667	0.002888 **

---

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

## 9.8 Chapter 14

### 9.8.1 p570

(143) MODEL

```
v2p570 = read.table("C:/G/Rt/Kemp/v2p570.txt", head=TRUE)
v2p570 = af(v2p570, c("A", "B", "C", "D"))
ANOVA(Y ~ A + B + C + D + A:B + A:C + A:D + B:C + B:D + C:D, v2p570) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

MODEL	8	22.222	2.7778
RESIDUALS	0	0.000	
CORRECTED TOTAL	8	22.222	

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	2	2.8889	1.4444		
B	2	2.8889	1.4444		
C	2	1.5556	0.7778		
D	2	14.8889	7.4444		
A:B	0				
A:C	0				
A:D	0				
B:C	0				
B:D	0				
C:D	0				

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	0				
B	0				
C	0				
D	0				
A:B	0				
A:C	0				
A:D	0				
B:C	0				
B:D	0				
C:D	0				

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	0				
B	0				
C	0				
D	0				
A:B	0				
A:C	0				
A:D	0				
B:C	0				
B:D	0				
C:D	0				

## 9.8.2 p578

(144) MODEL

```
v2p578 = read.table("C:/G/Rt/Kemp/v2p578.txt", head=TRUE)
v2p578 = af(v2p578, 1:11)
ANOVA(Y ~ A + B + C + D + E + F + G + H + J + K + L, v2p578) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	575	52.273		
RESIDUALS	0	0			
CORRECTED TOTAL	11	575			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	3.000	3.000		
B	1	27.000	27.000		
C	1	12.000	12.000		
D	1	16.333	16.333		
E	1	176.333	176.333		
F	1	133.333	133.333		
G	1	1.333	1.333		
H	1	21.333	21.333		
J	1	108.000	108.000		
K	1	1.333	1.333		
L	1	75.000	75.000		

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	3.000	3.000		
B	1	27.000	27.000		
C	1	12.000	12.000		
D	1	16.333	16.333		
E	1	176.333	176.333		
F	1	133.333	133.333		
G	1	1.333	1.333		
H	1	21.333	21.333		
J	1	108.000	108.000		
K	1	1.333	1.333		
L	1	75.000	75.000		

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	3.000	3.000		
B	1	27.000	27.000		
C	1	12.000	12.000		
D	1	16.333	16.333		
E	1	176.333	176.333		
F	1	133.333	133.333		

```
G 1 1.333 1.333
H 1 21.333 21.333
J 1 108.000 108.000
K 1 1.333 1.333
L 1 75.000 75.000
```

(145) MODEL

```
ANOVA(Y ~ E*F + E*J + F*J + E*L + F*L + J*L, v2p578) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	10	574.5	57.45	114.9	0.07249 .
RESIDUALS	1	0.5	0.50		
CORRECTED TOTAL	11	575.0			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
E	1	176.333	176.333	352.6667	0.03387 *
F	1	133.333	133.333	266.6667	0.03894 *
E:F	1	65.333	65.333	130.6667	0.05555 .
J	1	66.667	66.667	133.3333	0.05500 .
E:J	1	2.667	2.667	5.3333	0.26015
F:J	1	112.667	112.667	225.3333	0.04235 *
L	1	10.800	10.800	21.6000	0.13492
E:L	1	5.486	5.486	10.9714	0.18666
F:L	1	0.176	0.176	0.3516	0.65925
J:L	1	1.038	1.038	2.0769	0.38618

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
E	1	61.633	61.633	123.2667	0.05719 .
F	1	75.208	75.208	150.4167	0.05179 .
E:F	1	9.346	9.346	18.6923	0.14470
J	1	54.675	54.675	109.3500	0.06069 .
E:J	1	0.115	0.115	0.2308	0.71490
F:J	1	72.115	72.115	144.2308	0.05289 .
L	1	10.800	10.800	21.6000	0.13492
E:L	1	5.654	5.654	11.3077	0.18402
F:L	1	0.115	0.115	0.2308	0.71490
J:L	1	1.038	1.038	2.0769	0.38618

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
E	1	61.038	61.038	122.0769	0.05746 .
F	1	61.038	61.038	122.0769	0.05746 .
E:F	1	9.346	9.346	18.6923	0.14470
J	1	61.038	61.038	122.0769	0.05746 .
E:J	1	0.115	0.115	0.2308	0.71490
F:J	1	72.115	72.115	144.2308	0.05289 .
L	1	9.346	9.346	18.6923	0.14470
E:L	1	5.654	5.654	11.3077	0.18402
F:L	1	0.115	0.115	0.2308	0.71490
J:L	1	1.038	1.038	2.0769	0.38618

---

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

## 9.9 Chapter 16

### 9.9.1 p619

(146) MODEL

```
v2p619 = read.table("C:/G/Rt/Kemp/v2p619.txt", head=TRUE)
v2p619 = af(v2p619, c("A", "B", "C"))
ANOVA(y ~ A + B + C + A:B, v2p619) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	31.429	7.8571		
RESIDUALS	2	0.000	0.0000		
CORRECTED TOTAL	6	31.429			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	13.7619	13.7619	Inf < 2.2e-16 ***	
B	1	1.6667	1.6667	Inf < 2.2e-16 ***	
C	1	10.0000	10.0000	Inf < 2.2e-16 ***	
A:B	1	6.0000	6.0000	Inf < 2.2e-16 ***	

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	19.6	19.6	Inf < 2.2e-16 ***	

```

B      1      3.6      3.6      Inf < 2.2e-16 ***
C      1     13.5     13.5      Inf < 2.2e-16 ***
A:B    1      6.0      6.0      Inf < 2.2e-16 ***
---

```

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

\$`Type III`

```

      Df Sum Sq Mean Sq F value    Pr(>F)
A      1    24.0    24.0      Inf < 2.2e-16 ***
B      1     6.0     6.0      Inf < 2.2e-16 ***
C      1    13.5    13.5      Inf < 2.2e-16 ***
A:B    1     6.0     6.0      Inf < 2.2e-16 ***
---

```

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

(147) MODEL

```
ANOVA(y ~ A + B + C + A:C, v2p619) # OK
```

\$ANOVA

Response : y

```

      Df Sum Sq Mean Sq F value Pr(>F)
MODEL      4 26.0952   6.5238   2.4464 0.3106
RESIDUALS   2  5.3333   2.6667
CORRECTED TOTAL 6 31.4286

```

\$`Type I`

```

      Df Sum Sq Mean Sq F value Pr(>F)
A      1 13.7619 13.7619   5.1607 0.1511
B      1  1.6667  1.6667   0.6250 0.5120
C      1 10.0000 10.0000   3.7500 0.1924
A:C    1  0.6667  0.6667   0.2500 0.6667

```

\$`Type II`

```

      Df Sum Sq Mean Sq F value Pr(>F)
A      1 19.6000 19.6000   7.35 0.1134
B      1  2.6667  2.6667   1.00 0.4226
C      1 10.0000 10.0000   3.75 0.1924
A:C    1  0.6667  0.6667   0.25 0.6667

```

\$`Type III`

```

      Df Sum Sq Mean Sq F value Pr(>F)
A      1 16.6667 16.6667   6.2500 0.1296
B      1  2.6667  2.6667   1.0000 0.4226
C      1  8.1667  8.1667   3.0625 0.2222
A:C    1  0.6667  0.6667   0.2500 0.6667

```



(148) MODEL

```
ANOVA(y ~ A + B + C + B:C, v2p619) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	26.0952	6.5238	2.4464	0.3106
RESIDUALS	2	5.3333	2.6667		
CORRECTED TOTAL	6	31.4286			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	13.7619	13.7619	5.1607	0.1511
B	1	1.6667	1.6667	0.6250	0.5120
C	1	10.0000	10.0000	3.7500	0.1924
B:C	1	0.6667	0.6667	0.2500	0.6667

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.6667	16.6667	6.25	0.1296
B	1	3.6000	3.6000	1.35	0.3652
C	1	10.0000	10.0000	3.75	0.1924
B:C	1	0.6667	0.6667	0.25	0.6667

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.6667	16.6667	6.2500	0.1296
B	1	2.6667	2.6667	1.0000	0.4226
C	1	8.1667	8.1667	3.0625	0.2222
B:C	1	0.6667	0.6667	0.2500	0.6667

## 9.9.2 p626

(149) MODEL

```
v2p626 = read.table("C:/G/Rt/Kemp/v2p626.txt", head=TRUE)
v2p626 = af(v2p626, c("A", "B", "C"))
ANOVA(y ~ A + B + C + A:B, v2p626) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	42.092	10.5231	22.002	0.04395 *
RESIDUALS	2	0.957	0.4783		

CORRECTED TOTAL 6 43.049

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.2088	16.2088	33.890	0.02826 *
B	1	4.8150	4.8150	10.068	0.08662 .
C	1	15.7339	15.7339	32.898	0.02908 *
A:B	1	5.3346	5.3346	11.154	0.07916 .

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	25.4131	25.4131	53.136	0.01830 *
B	1	8.6630	8.6630	18.113	0.05102 .
C	1	19.5193	19.5193	40.812	0.02364 *
A:B	1	5.3346	5.3346	11.154	0.07916 .

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	29.7950	29.7950	62.297	0.01568 *
B	1	11.7460	11.7460	24.559	0.03839 *
C	1	19.5193	19.5193	40.812	0.02364 *
A:B	1	5.3346	5.3346	11.154	0.07916 .

---

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

(150) MODEL

```
ANOVA(y ~ A + B + C + A:C, v2p626) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	39.229	9.8072	5.1346	0.1696
RESIDUALS	2	3.820	1.9100		
CORRECTED TOTAL	6	43.049			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.2088	16.2088	8.4862	0.1004
B	1	4.8150	4.8150	2.5209	0.2533
C	1	15.7339	15.7339	8.2376	0.1030

```
A:C  1  2.4711  2.4711  1.2937 0.3733
```

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	25.4131	25.4131	13.3052	0.06762 .
B	1	6.0361	6.0361	3.1602	0.21743
C	1	15.7339	15.7339	8.2376	0.10298
A:C	1	2.4711	2.4711	1.2937	0.37327

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	20.1428	20.1428	10.5459	0.08317 .
B	1	6.0361	6.0361	3.1602	0.21743
C	1	11.8863	11.8863	6.2232	0.13007
A:C	1	2.4711	2.4711	1.2937	0.37327

```
---
```

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

(151) MODEL

```
ANOVA(y ~ A + B + C + B:C, v2p626) # OK
```

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	37.340	9.3349	3.2701	0.2477
RESIDUALS	2	5.709	2.8546		
CORRECTED TOTAL	6	43.049			

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.2088	16.2088	5.6781	0.1400
B	1	4.8150	4.8150	1.6867	0.3236
C	1	15.7339	15.7339	5.5118	0.1434
B:C	1	0.5819	0.5819	0.2038	0.6959

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	21.9995	21.9995	7.7067	0.1090
B	1	8.6630	8.6630	3.0347	0.2236
C	1	15.7339	15.7339	5.5118	0.1434
B:C	1	0.5819	0.5819	0.2038	0.6959

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

```

A    1 21.9995 21.9995  7.7067 0.1090
B    1  7.0709  7.0709  2.4770 0.2562
C    1 13.3221 13.3221  4.6669 0.1633
B:C  1  0.5819  0.5819  0.2038 0.6959

```

## 9.10 Chapter 17

### 9.10.1 p642

(152) MODEL

```

v2p642 = read.table("C:/G/Rt/Kemp/v2p642.txt", head=TRUE)
v2p642 = af(v2p642, 2:11)
ANOVA(Y ~ A + B + C + D + E + F + G, v2p642) # OK

```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	11.0	1.57143	1.6688	0.1646
RESIDUALS	24	22.6	0.94167		
CORRECTED TOTAL	31	33.6			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	5.7800	5.7800	6.1381	0.02066 *
B	1	0.1800	0.1800	0.1912	0.66587
C	1	0.1250	0.1250	0.1327	0.71879
D	1	2.5312	2.5312	2.6881	0.11415
E	1	0.6613	0.6613	0.7022	0.41031
F	1	0.0112	0.0112	0.0119	0.91387
G	1	1.7113	1.7113	1.8173	0.19023

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	5.7800	5.7800	6.1381	0.02066 *
B	1	0.1800	0.1800	0.1912	0.66587
C	1	0.1250	0.1250	0.1327	0.71879
D	1	2.5312	2.5312	2.6881	0.11415
E	1	0.6613	0.6613	0.7022	0.41031
F	1	0.0112	0.0112	0.0119	0.91387
G	1	1.7113	1.7113	1.8173	0.19023

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	5.7800	5.7800	6.1381	0.02066 *
B	1	0.1800	0.1800	0.1912	0.66587
C	1	0.1250	0.1250	0.1327	0.71879
D	1	2.5312	2.5312	2.6881	0.11415
E	1	0.6613	0.6613	0.7022	0.41031
F	1	0.0112	0.0112	0.0119	0.91387
G	1	1.7113	1.7113	1.8173	0.19023

---

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

(153) MODEL

```
ANOVA(log(S) ~ A + B + C + D + E + F + G, v2p642) # OK
```

\$ANOVA

Response : log(S)

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	266.43	38.062		
RESIDUALS	24	0.00	0.000		
CORRECTED TOTAL	31	266.43			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.511	1.511	Inf < 2.2e-16	***
B	1	0.600	0.600	Inf < 2.2e-16	***
C	1	0.284	0.284	Inf < 2.2e-16	***
D	1	0.384	0.384	Inf < 2.2e-16	***
E	1	0.741	0.741	Inf < 2.2e-16	***
F	1	261.783	261.783	Inf < 2.2e-16	***
G	1	1.127	1.127	Inf < 2.2e-16	***

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.511	1.511	Inf < 2.2e-16	***
B	1	0.600	0.600	Inf < 2.2e-16	***
C	1	0.284	0.284	Inf < 2.2e-16	***
D	1	0.384	0.384	Inf < 2.2e-16	***
E	1	0.741	0.741	Inf < 2.2e-16	***
F	1	261.783	261.783	Inf < 2.2e-16	***
G	1	1.127	1.127	Inf < 2.2e-16	***

---

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

```
$`Type III`
  Df Sum Sq Mean Sq F value    Pr(>F)
A  1   1.511   1.511      Inf < 2.2e-16 ***
B  1   0.600   0.600      Inf < 2.2e-16 ***
C  1   0.284   0.284      Inf < 2.2e-16 ***
D  1   0.384   0.384      Inf < 2.2e-16 ***
E  1   0.741   0.741      Inf < 2.2e-16 ***
F  1 261.783 261.783      Inf < 2.2e-16 ***
G  1   1.127   1.127      Inf < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

## 9.11 Chapter 19

### 9.11.1 p700

(154) MODEL

```
v2p700 = read.table("C:/G/Rt/Kemp/v2p700.txt", head=TRUE)
v2p700 = af(v2p700, 2:5)
ANOVA(Y ~ P + S + T + C, v2p700) # OK
```

```
$ANOVA
Response : Y

          Df Sum Sq Mean Sq F value    Pr(>F)
MODEL          12 378.80 31.5670  57.256 0.003319 **
RESIDUALS         3   1.65  0.5513
CORRECTED TOTAL  15 380.46
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
  Df Sum Sq Mean Sq F value    Pr(>F)
P  3  53.888  17.963  32.580 0.008646 **
S  3 154.508  51.503  93.414 0.001845 **
T  3 149.848  49.949  90.597 0.001930 **
C  3  20.561   6.854  12.431 0.033708 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
  Df Sum Sq Mean Sq F value    Pr(>F)
P  2   2.220   1.110   2.0133 0.278974
S  3 111.966  37.322 67.6941 0.002969 **
T  3 161.828  53.943 97.8403 0.001722 **
C  3  20.561   6.854 12.4311 0.033708 *
```

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	2	2.220	1.110	2.0133	0.278974
S	3	111.966	37.322	67.6941	0.002969 **
T	3	161.828	53.943	97.8403	0.001722 **
C	3	20.561	6.854	12.4311	0.033708 *

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

### 9.11.2 p703

(155) MODEL

```
v2p703 = read.table("C:/G/Rt/Kemp/v2p703.txt", head=TRUE)
v2p703$C = ifelse(v2p703$C == 0, 4, v2p703$C)
v2p703 = af(v2p703, 2:5)
ANOVA(Y ~ P + S + T + C, v2p703) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	13	385.18	29.6293	21.766	0.0005673 ***
RESIDUALS	6	8.17	1.3613		
CORRECTED TOTAL	19	393.35			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	4	56.408	14.102	10.3596	0.0073255 **
S	3	119.260	39.753	29.2036	0.0005620 ***
T	3	190.430	63.477	46.6312	0.0001498 ***
C	3	19.083	6.361	4.6728	0.0518237 .

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	4	52.288	13.072	9.6028	0.0088641 **
S	3	167.414	55.805	40.9952	0.0002163 ***
T	3	190.430	63.477	46.6312	0.0001498 ***
C	3	19.083	6.361	4.6728	0.0518237 .

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	4	52.287	13.072	9.6028	0.0088641 **
S	3	167.414	55.805	40.9952	0.0002163 ***
T	3	190.430	63.477	46.6312	0.0001498 ***
C	3	19.083	6.361	4.6728	0.0518237 .

---

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



## 10 Lawson - DAE with SAS

### Reference

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

```
require(daewr)
```

### 10.1 Chapter 2

#### 10.1.1 p22

(156) MODEL

```
ANOVA(height ~ time, bread) # OK
```

\$ANOVA

Response : height

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	2	21.573	10.7865	4.6022	0.042 *
RESIDUALS	9	21.094	2.3438		
CORRECTED TOTAL	11	42.667			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
time	2	21.573	10.787	4.6022	0.042 *

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
time	2	21.573	10.787	4.6022	0.042 *

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
time	2	21.573	10.787	4.6022	0.042 *

---

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

### 10.1.2 p32

(157) MODEL

```
ANOVA(height^(1 - 1.294869) ~ time, bread) # OK
```

\$ANOVA

Response : height^(1 - 1.294869)

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	2	0.0130560	0.0065280	5.9356	0.02271 *
RESIDUALS	9	0.0098983	0.0010998		
CORRECTED TOTAL	11	0.0229544			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
time	2	0.013056	0.006528	5.9356	0.02271 *

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
time	2	0.013056	0.006528	5.9356	0.02271 *

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
time	2	0.013056	0.006528	5.9356	0.02271 *

---

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

### 10.1.3 p42

(158) MODEL

```
ANOVA(yield ~ treat, sugarbeet) # OK
```

\$ANOVA

Response : yield

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	3	291.00	97.002	45.9	1.718e-07 ***
RESIDUALS	14	29.59	2.113		
CORRECTED TOTAL	17	320.59			

---

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treat	3	291	97.002	45.9	1.718e-07 ***

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treat	3	291	97.002	45.9	1.718e-07 ***

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treat	3	291	97.002	45.9	1.718e-07 ***

```
---
```

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

## 10.2 Chapter 3

### 10.2.1 p63

(159) MODEL

```
ANOVA(CO ~ Eth + Ratio + Eth:Ratio, COdata) # OK
```

```
$ANOVA
```

```
Response : CO
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	1654.0	206.750	40.016	3.861e-06 ***
RESIDUALS	9	46.5	5.167		
CORRECTED TOTAL	17	1700.5			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth:Ratio	4	678	169.5	32.806	2.240e-05 ***

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth:Ratio	4	678	169.5	32.806	2.240e-05 ***

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth:Ratio	4	678	169.5	32.806	2.240e-05 ***

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

(160) MODEL

```
ANOVA(CO ~ Ratio + Eth + Ratio:Eth, COdata) # OK
```

\$ANOVA

Response : CO

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	1654.0	206.750	40.016	3.861e-06 ***
RESIDUALS	9	46.5	5.167		
CORRECTED TOTAL	17	1700.5			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio:Eth	4	678	169.5	32.806	2.240e-05 ***

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio:Eth	4	678	169.5	32.806	2.240e-05 ***

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Ratio	2	652	326.0	63.097	5.067e-06 ***

```
Eth      2    324    162.0    31.355 8.790e-05 ***
Ratio:Eth 4    678    169.5    32.806 2.240e-05 ***
```

```
---
```

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

### 10.2.2 p74

(161) MODEL

```
ANOVA(CO ~ Eth + Ratio + Eth:Ratio, COdata[-18,]) # OK
```

```
$ANOVA
```

```
Response : CO
```

```
      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      8 1423.0  177.879   31.978 2.749e-05 ***
RESIDUALS   8   44.5    5.563
CORRECTED TOTAL 16 1467.5
```

```
---
```

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

```
$`Type I`
```

```
      Df Sum Sq Mean Sq F value    Pr(>F)
Eth      2 472.66   236.33   42.486 5.482e-05 ***
Ratio     2 395.33   197.66   35.535 0.0001048 ***
Eth:Ratio 4 555.04   138.76   24.945 0.0001427 ***
```

```
---
```

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

```
$`Type II`
```

```
      Df Sum Sq Mean Sq F value    Pr(>F)
Eth      2 398.26   199.13   35.799 0.0001020 ***
Ratio     2 395.33   197.66   35.535 0.0001048 ***
Eth:Ratio 4 555.04   138.76   24.945 0.0001427 ***
```

```
---
```

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

```
$`Type III`
```

```
      Df Sum Sq Mean Sq F value    Pr(>F)
Eth      2 319.45   159.73   28.715 0.0002235 ***
Ratio     2 511.45   255.73   45.973 4.105e-05 ***
Eth:Ratio 4 555.04   138.76   24.945 0.0001427 ***
```

```
---
```

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

### 10.2.3 p91

(162) MODEL

```
volt$XA = (as.numeric(as.character(volt$A)) - 27)/5
volt$XB = (as.numeric(as.character(volt$B)) - 2.75)/2.25
volt$XC = (as.numeric(as.character(volt$C)) - 2.75)/2.25
ANOVA(y ~ XA + XB + XC + XA:XB + XA:XC + XB:XC + XA:XB:XC, volt) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	8843.4	1263.35	3.8686	0.0385 *
RESIDUALS	8	2612.5	326.56		
CORRECTED TOTAL	15	11455.9			

---

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
XA	1	4522.6	4522.6	13.8490	0.005859 **
XB	1	14.1	14.1	0.0431	0.840793
XC	1	473.1	473.1	1.4486	0.263154
XA:XB	1	715.6	715.6	2.1912	0.177071
XA:XC	1	2525.1	2525.1	7.7322	0.023899 *
XB:XC	1	52.6	52.6	0.1610	0.698780
XA:XB:XC	1	540.6	540.6	1.6553	0.234218

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
XA	1	4522.6	4522.6	13.8490	0.005859 **
XB	1	14.1	14.1	0.0431	0.840793
XC	1	473.1	473.1	1.4486	0.263154
XA:XB	1	715.6	715.6	2.1912	0.177071
XA:XC	1	2525.1	2525.1	7.7322	0.023899 *
XB:XC	1	52.6	52.6	0.1610	0.698780
XA:XB:XC	1	540.6	540.6	1.6553	0.234218

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
XA	1	4522.6	4522.6	13.8490	0.005859 **
XB	1	14.1	14.1	0.0431	0.840793
XC	1	473.1	473.1	1.4486	0.263154
XA:XB	1	715.6	715.6	2.1912	0.177071
XA:XC	1	2525.1	2525.1	7.7322	0.023899 *
XB:XC	1	52.6	52.6	0.1610	0.698780
XA:XB:XC	1	540.6	540.6	1.6553	0.234218

---

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

#### 10.2.4 p97

(163) MODEL

```
chem2 = af(chem, c("A","B","C","D"))
ANOVA(y ~ A*B*C*D, chem2) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	15	6369.4	424.63		
RESIDUALS	0	0.0			
CORRECTED TOTAL	15	6369.4			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	637.6	637.6		
B	1	5076.6	5076.6		
A:B	1	451.6	451.6		
C	1	0.6	0.6		
A:C	1	10.6	10.6		
B:C	1	1.6	1.6		
A:B:C	1	0.6	0.6		
D	1	7.6	7.6		
A:D	1	68.1	68.1		
B:D	1	0.1	0.1		
A:B:D	1	7.6	7.6		
C:D	1	7.6	7.6		
A:C:D	1	95.1	95.1		
B:C:D	1	3.1	3.1		
A:B:C:D	1	1.6	1.6		

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	637.6	637.6		
B	1	5076.6	5076.6		
A:B	1	451.6	451.6		
C	1	0.6	0.6		
A:C	1	10.6	10.6		
B:C	1	1.6	1.6		
A:B:C	1	0.6	0.6		
D	1	7.6	7.6		
A:D	1	68.1	68.1		

B:D	1	0.1	0.1
A:B:D	1	7.6	7.6
C:D	1	7.6	7.6
A:C:D	1	95.1	95.1
B:C:D	1	3.1	3.1
A:B:C:D	1	1.6	1.6

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	637.6	637.6		
B	1	5076.6	5076.6		
A:B	1	451.6	451.6		
C	1	0.6	0.6		
A:C	1	10.6	10.6		
B:C	1	1.6	1.6		
A:B:C	1	0.6	0.6		
D	1	7.6	7.6		
A:D	1	68.1	68.1		
B:D	1	0.1	0.1		
A:B:D	1	7.6	7.6		
C:D	1	7.6	7.6		
A:C:D	1	95.1	95.1		
B:C:D	1	3.1	3.1		
A:B:C:D	1	1.6	1.6		

### 10.2.5 p104

(164) MODEL

```
ANOVA(y ~ A*B*C*D, BoxM) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	15	207.1	13.807		
RESIDUALS	0	0.0			
CORRECTED TOTAL	15	207.1			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	2.560	2.560		
B	1	71.234	71.234		
A:B	1	3.312	3.312		
C	1	55.056	55.056		
A:C	1	24.800	24.800		
B:C	1	2.560	2.560		



A:B:C	1	5.760	5.760
D	1	4.080	4.080
A:D	1	1.346	1.346
B:D	1	5.570	5.570
A:B:D	1	2.074	2.074
C:D	1	8.880	8.880
A:C:D	1	0.640	0.640
B:C:D	1	9.986	9.986
A:B:C:D	1	9.242	9.242

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	2.560	2.560		
B	1	71.234	71.234		
A:B	1	3.312	3.312		
C	1	55.056	55.056		
A:C	1	24.800	24.800		
B:C	1	2.560	2.560		
A:B:C	1	5.760	5.760		
D	1	4.080	4.080		
A:D	1	1.346	1.346		
B:D	1	5.570	5.570		
A:B:D	1	2.074	2.074		
C:D	1	8.880	8.880		
A:C:D	1	0.640	0.640		
B:C:D	1	9.986	9.986		
A:B:C:D	1	9.242	9.242		

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	2.560	2.560		
B	1	71.234	71.234		
A:B	1	3.312	3.312		
C	1	55.056	55.056		
A:C	1	24.800	24.800		
B:C	1	2.560	2.560		
A:B:C	1	5.760	5.760		
D	1	4.080	4.080		
A:D	1	1.346	1.346		
B:D	1	5.570	5.570		
A:B:D	1	2.074	2.074		
C:D	1	8.880	8.880		
A:C:D	1	0.640	0.640		
B:C:D	1	9.986	9.986		
A:B:C:D	1	9.242	9.242		

## 10.3 Chapter 4

### 10.3.1 p122

(165) MODEL

```
ANOVA(rate ~ rat + dose, drug) # OK
```

```
$ANOVA
```

```
Response : rate
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	13	2.12867	0.163744	19.613	1.59e-12 ***
RESIDUALS	36	0.30055	0.008349		
CORRECTED TOTAL	49	2.42922			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rat	9	1.66846	0.18538	22.205	3.749e-12 ***
dose	4	0.46021	0.11505	13.781	6.535e-07 ***

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rat	9	1.66846	0.18538	22.205	3.749e-12 ***
dose	4	0.46021	0.11505	13.781	6.535e-07 ***

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rat	9	1.66846	0.18538	22.205	3.749e-12 ***
dose	4	0.46021	0.11505	13.781	6.535e-07 ***

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

### 10.3.2 p127

(166) MODEL

```
ANOVA(y ~ block + treat + strain + treat:strain, bha) # OK
```

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	543.22	67.902	26.203	0.0001507 ***
RESIDUALS	7	18.14	2.591		
CORRECTED TOTAL	15	561.36			

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	1	47.61	47.61	18.3721	0.003627 **
treat	1	422.30	422.30	162.9613	4.194e-06 ***
strain	3	32.96	10.99	4.2399	0.052741 .
treat:strain	3	40.34	13.45	5.1892	0.033685 *

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	1	47.61	47.61	18.3721	0.003627 **
treat	1	422.30	422.30	162.9613	4.194e-06 ***
strain	3	32.96	10.99	4.2399	0.052741 .
treat:strain	3	40.34	13.45	5.1892	0.033685 *

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	1	47.61	47.61	18.3721	0.003627 **
treat	1	422.30	422.30	162.9613	4.194e-06 ***
strain	3	32.96	10.99	4.2399	0.052741 .
treat:strain	3	40.34	13.45	5.1892	0.033685 *

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### 10.3.3 p129

(167) MODEL

```
ANOVA(cdistance ~ id + teehgt, rcb) # OK
```

\$ANOVA

Response : cdistance

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	10	126465	12646.5	161.72	< 2.2e-16 ***
RESIDUALS	124	9697	78.2		
CORRECTED TOTAL	134	136162			

```

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
id      8 124741   15593 199.394 < 2.2e-16 ***
teehtg  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 ***
teehtg  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 ***
teehtg  2   1724     862  11.023 3.926e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

#### 10.3.4 p136

(168) MODEL

```
ANOVA(AUC ~ Subject + Period + Treat, bioeqv) # OK
```

```

$ANOVA
Response : AUC

      Df Sum Sq Mean Sq F value Pr(>F)
MODEL      6 174461   29077  0.1315 0.9774
RESIDUALS   2 442158   221079
CORRECTED TOTAL 8 616618

```

```

$`Type I`
      Df Sum Sq Mean Sq F value Pr(>F)
Subject  2 114264   57132  0.2584 0.7946
Period   2  45196   22598  0.1022 0.9073
Treat    2  15000    7500  0.0339 0.9672

```

```

$`Type II`
      Df Sum Sq Mean Sq F value Pr(>F)
Subject  2 114264   57132  0.2584 0.7946

```

Period	2	45196	22598	0.1022	0.9073
Treat	2	15000	7500	0.0339	0.9672

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subject	2	114264	57132	0.2584	0.7946
Period	2	45196	22598	0.1022	0.9073
Treat	2	15000	7500	0.0339	0.9672

## 10.4 Chapter 5

### 10.4.1 p152

(169) MODEL

```
ANOVA(conc ~ lab, Apo) # OK
```

\$ANOVA

Response : conc

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	3	0.092233	0.0307444	42.107	4.009e-10 ***
RESIDUALS	26	0.018984	0.0007302		
CORRECTED TOTAL	29	0.111217			

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
lab	3	0.092233	0.030744	42.107	4.009e-10 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
lab	3	0.092233	0.030744	42.107	4.009e-10 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
lab	3	0.092233	0.030744	42.107	4.009e-10 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### 10.4.2 p181

(170) MODEL

```
ANOVA(residue ~ form + tech + form:tech + plot:form:tech, pesticide) # OK
```

```
$ANOVA
```

```
Response : residue
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	0.036857	0.0052653	11.804	0.001187 **
RESIDUALS	8	0.003569	0.0004461		
CORRECTED TOTAL	15	0.040426			

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
form	1	0.000018	0.000018	0.0405	0.84554
tech	1	0.032310	0.032310	72.4339	2.789e-05 ***
form:tech	1	0.002186	0.002186	4.8997	0.05776 .
form:tech:plot	4	0.002344	0.000586	1.3136	0.34317

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
form	1	0.000018	0.000018	0.0405	0.84554
tech	1	0.032310	0.032310	72.4339	2.789e-05 ***
form:tech	1	0.002186	0.002186	4.8997	0.05776 .
form:tech:plot	4	0.002344	0.000586	1.3136	0.34317

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
form	1	0.000018	0.000018	0.0405	0.84554
tech	1	0.032310	0.032310	72.4339	2.789e-05 ***
form:tech	1	0.002186	0.002186	4.8997	0.05776 .
form:tech:plot	4	0.002344	0.000586	1.3136	0.34317

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

## 10.5 Chapter 7

### 10.5.1 p260

(171) MODEL

```
ANOVA(score ~ recipe + panelist, taste) # OK
```

```
$ANOVA
```

```
Response : score
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	28.458	2.03274	2.661	0.0719 .
RESIDUALS	9	6.875	0.76389		
CORRECTED TOTAL	23	35.333			

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
recipe	3	21.0000	7.000	9.1636	0.004246 **
panelist	11	7.4583	0.678	0.8876	0.581099

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
recipe	3	9.1250	3.04167	3.9818	0.04649 *
panelist	11	7.4583	0.67803	0.8876	0.58110

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
recipe	3	9.1250	3.04167	3.9818	0.04649 *
panelist	11	7.4583	0.67803	0.8876	0.58110

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

### 10.5.2 p262

(172) MODEL

```
ANOVA(pressure ~ Block + Treatment, BPmonitor) # OK
```

```
$ANOVA
```

```
Response : pressure
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	321.00	40.125	4.4174	0.1245
RESIDUALS	3	27.25	9.083		
CORRECTED TOTAL	11	348.25			

```
$`Type I`
      Df Sum Sq Mean Sq F value Pr(>F)
Block    5  73.75   14.750   1.6239 0.36606
Treatment 3 247.25   82.417   9.0734 0.05149 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
      Df Sum Sq Mean Sq F value Pr(>F)
Block    5  83.25   16.650   1.8330 0.32772
Treatment 3 247.25   82.417   9.0734 0.05149 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
      Df Sum Sq Mean Sq F value Pr(>F)
Block    5  83.25   16.650   1.8330 0.32772
Treatment 3 247.25   82.417   9.0734 0.05149 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

### 10.5.3 p276

(173) MODEL

```
ANOVA(weight ~ Blocks + A + B + C + D + E + F + G + H, Bff) # OK
```

```
$ANOVA
Response : weight
      Df Sum Sq Mean Sq F value Pr(>F)
MODEL      15 158.37   10.558
RESIDUALS    0    0.00
CORRECTED TOTAL 15 158.37
```

```
$`Type I`
      Df Sum Sq Mean Sq F value Pr(>F)
Blocks  7 30.567    4.367
A        1 21.879   21.879
B        1  8.338    8.338
C        1  6.213    6.213
D        1 12.870   12.870
E        1  0.098    0.098
F        1  1.260    1.260
G        1 71.868   71.868
H        1  5.279    5.279
```



```
$`Type II`
      Df Sum Sq Mean Sq F value Pr(>F)
Blocks  7 30.567    4.367
A         1 21.879   21.879
B         1  8.338    8.338
C         1  6.213    6.213
D         1 12.870   12.870
E         1  0.098    0.098
F         1  1.260    1.260
G         1 71.868   71.868
H         1  5.279    5.279
```

```
$`Type III`
      Df Sum Sq Mean Sq F value Pr(>F)
Blocks  7 30.567    4.367
A         1 21.879   21.879
B         1  8.338    8.338
C         1  6.213    6.213
D         1 12.870   12.870
E         1  0.098    0.098
F         1  1.260    1.260
G         1 71.868   71.868
H         1  5.279    5.279
```

## 10.6 Chapter 8

### 10.6.1 p315

(174) MODEL

```
ANOVA(ys ~ Block + A*B + Block:A*B + C*D + A:C + A:D + B:C + B:D + A:B:C + A:B:D +
      A:C:D + B:C:D + A:B:C:D, sausage) # OK
```

```
$ANOVA
```

```
Response : ys
```

```
      Df Sum Sq Mean Sq F value Pr(>F)
MODEL      19 0.064059 0.0033715  14.134 1.74e-05 ***
RESIDUALS   12 0.002862 0.0002385
CORRECTED TOTAL 31 0.066922
```

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
```

```
      Df Sum Sq Mean Sq F value Pr(>F)
Block      1 0.000903 0.000903   3.7860 0.075482 .
A           1 0.045753 0.045753 191.8035 9.647e-09 ***
```

B	1	0.002628	0.002628	11.0175	0.006119	**
A:B	1	0.001128	0.001128	4.7293	0.050371	.
Block:A:B	3	0.005484	0.001828	7.6638	0.004007	**
C	1	0.003828	0.003828	16.0480	0.001743	**
D	1	0.000528	0.000528	2.2140	0.162566	
C:D	1	0.000253	0.000253	1.0611	0.323272	
A:C	1	0.000153	0.000153	0.6419	0.438593	
A:D	1	0.000903	0.000903	3.7860	0.075482	.
B:C	1	0.000078	0.000078	0.3275	0.577693	
B:D	1	0.000253	0.000253	1.0611	0.323272	
A:B:C	1	0.001378	0.001378	5.7773	0.033299	*
A:B:D	1	0.000703	0.000703	2.9476	0.111680	
A:C:D	1	0.000028	0.000028	0.1179	0.737260	
B:C:D	1	0.000028	0.000028	0.1179	0.737260	
A:B:C:D	1	0.000028	0.000028	0.1179	0.737260	

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Block	1	0.000903	0.000903	3.7860	0.075482	.
A	1	0.045753	0.045753	191.8035	9.647e-09	***
B	1	0.002628	0.002628	11.0175	0.006119	**
A:B	1	0.001128	0.001128	4.7293	0.050371	.
Block:A:B	3	0.005484	0.001828	7.6638	0.004007	**
C	1	0.003828	0.003828	16.0480	0.001743	**
D	1	0.000528	0.000528	2.2140	0.162566	
C:D	1	0.000253	0.000253	1.0611	0.323272	
A:C	1	0.000153	0.000153	0.6419	0.438593	
A:D	1	0.000903	0.000903	3.7860	0.075482	.
B:C	1	0.000078	0.000078	0.3275	0.577693	
B:D	1	0.000253	0.000253	1.0611	0.323272	
A:B:C	1	0.001378	0.001378	5.7773	0.033299	*
A:B:D	1	0.000703	0.000703	2.9476	0.111680	
A:C:D	1	0.000028	0.000028	0.1179	0.737260	
B:C:D	1	0.000028	0.000028	0.1179	0.737260	
A:B:C:D	1	0.000028	0.000028	0.1179	0.737260	

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
Block	1	0.000903	0.000903	3.7860	0.075482	.
A	1	0.045753	0.045753	191.8035	9.647e-09	***
B	1	0.002628	0.002628	11.0175	0.006119	**
A:B	1	0.001128	0.001128	4.7293	0.050371	.
Block:A:B	3	0.005484	0.001828	7.6638	0.004007	**
C	1	0.003828	0.003828	16.0480	0.001743	**

D	1	0.000528	0.000528	2.2140	0.162566
C:D	1	0.000253	0.000253	1.0611	0.323272
A:C	1	0.000153	0.000153	0.6419	0.438593
A:D	1	0.000903	0.000903	3.7860	0.075482 .
B:C	1	0.000078	0.000078	0.3275	0.577693
B:D	1	0.000253	0.000253	1.0611	0.323272
A:B:C	1	0.001378	0.001378	5.7773	0.033299 *
A:B:D	1	0.000703	0.000703	2.9476	0.111680
A:C:D	1	0.000028	0.000028	0.1179	0.737260
B:C:D	1	0.000028	0.000028	0.1179	0.737260
A:B:C:D	1	0.000028	0.000028	0.1179	0.737260

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## 10.6.2 p320

(175) MODEL

```
ANOVA(y ~ A*B*C*D*E, plasma) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	31	6672.9	215.26		
RESIDUALS	0	0.0			
CORRECTED TOTAL	31	6672.9			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1118.65	1118.65		
B	1	142.81	142.81		
A:B	1	141.96	141.96		
C	1	91.80	91.80		
A:C	1	70.81	70.81		
B:C	1	5.78	5.78		
A:B:C	1	65.55	65.55		
D	1	1824.08	1824.08		
A:D	1	2194.53	2194.53		
B:D	1	87.78	87.78		
A:B:D	1	87.12	87.12		
C:D	1	22.45	22.45		
A:C:D	1	42.78	42.78		
B:C:D	1	12.25	12.25		
A:B:C:D	1	375.38	375.38		
E	1	78.75	78.75		
A:E	1	278.48	278.48		

B:E	1	0.72	0.72
A:B:E	1	0.10	0.10
C:E	1	0.15	0.15
A:C:E	1	0.24	0.24
B:C:E	1	6.48	6.48
A:B:C:E	1	1.53	1.53
D:E	1	8.40	8.40
A:D:E	1	5.28	5.28
B:D:E	1	0.28	0.28
A:B:D:E	1	0.60	0.60
C:D:E	1	0.85	0.85
A:C:D:E	1	0.55	0.55
B:C:D:E	1	6.30	6.30
A:B:C:D:E	1	0.50	0.50

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1118.65	1118.65		
B	1	142.81	142.81		
A:B	1	141.96	141.96		
C	1	91.80	91.80		
A:C	1	70.81	70.81		
B:C	1	5.78	5.78		
A:B:C	1	65.55	65.55		
D	1	1824.08	1824.08		
A:D	1	2194.53	2194.53		
B:D	1	87.78	87.78		
A:B:D	1	87.12	87.12		
C:D	1	22.45	22.45		
A:C:D	1	42.78	42.78		
B:C:D	1	12.25	12.25		
A:B:C:D	1	375.38	375.38		
E	1	78.75	78.75		
A:E	1	278.48	278.48		
B:E	1	0.72	0.72		
A:B:E	1	0.10	0.10		
C:E	1	0.15	0.15		
A:C:E	1	0.24	0.24		
B:C:E	1	6.48	6.48		
A:B:C:E	1	1.53	1.53		
D:E	1	8.40	8.40		
A:D:E	1	5.28	5.28		
B:D:E	1	0.28	0.28		
A:B:D:E	1	0.60	0.60		
C:D:E	1	0.85	0.85		
A:C:D:E	1	0.55	0.55		
B:C:D:E	1	6.30	6.30		
A:B:C:D:E	1	0.50	0.50		

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1118.64	1118.64		
B	1	142.80	142.80		
A:B	1	141.96	141.96		
C	1	91.80	91.80		
A:C	1	70.81	70.81		
B:C	1	5.78	5.78		
A:B:C	1	65.55	65.55		
D	1	1824.08	1824.08		
A:D	1	2194.53	2194.53		
B:D	1	87.78	87.78		
A:B:D	1	87.12	87.12		
C:D	1	22.45	22.45		
A:C:D	1	42.78	42.78		
B:C:D	1	12.25	12.25		
A:B:C:D	1	375.38	375.38		
E	1	78.75	78.75		
A:E	1	278.48	278.48		
B:E	1	0.72	0.72		
A:B:E	1	0.10	0.10		
C:E	1	0.15	0.15		
A:C:E	1	0.24	0.24		
B:C:E	1	6.48	6.48		
A:B:C:E	1	1.53	1.53		
D:E	1	8.40	8.40		
A:D:E	1	5.28	5.28		
B:D:E	1	0.28	0.28		
A:B:D:E	1	0.60	0.60		
C:D:E	1	0.85	0.85		
A:C:D:E	1	0.55	0.55		
B:C:D:E	1	6.30	6.30		
A:B:C:D:E	1	0.50	0.50		

### 10.6.3 p335

(176) MODEL

```
gear$A = as.numeric(as.character(gear$A))
gear$B = as.numeric(as.character(gear$B))
gear$C = as.numeric(as.character(gear$C))
gear$P = as.numeric(as.character(gear$P))
gear$Q = as.numeric(as.character(gear$Q))
REG(y ~ A*B*C + P + Q + A:P + A:Q + B:P + B:Q + C:P + C:Q, gear) # OK
```

Estimate Std. Error Df t value Pr(>|t|)

(Intercept)	15.4062	0
A	-4.9062	0
B	-0.1562	0
A:B	0.5312	0
C	3.9688	0
A:C	2.9062	0
B:C	0.4062	0
A:B:C	0.5938	0
P	-2.3438	0
Q	-3.4062	0
A:P	-0.9062	0
A:Q	-0.3438	0
B:P	1.0938	0
B:Q	0.1562	0
C:P	-0.2812	0
C:Q	0.7812	0

## 10.7 Chapter 9

### 10.7.1 p349

(177) MODEL

```
ANOVA(pl ~ Subject + Period + Treat, antifungal) # OK
```

\$ANOVA

Response : pl

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	18	118.558	6.5866	1.4435	0.2388
RESIDUALS	15	68.444	4.5630		
CORRECTED TOTAL	33	187.002			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subject	16	114.642	7.1651	1.5703	0.1942
Period	1	0.922	0.9224	0.2021	0.6594
Treat	1	2.993	2.9932	0.6560	0.4306

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subject	16	114.642	7.1651	1.5703	0.1942
Period	1	0.734	0.7344	0.1609	0.6939
Treat	1	2.993	2.9932	0.6560	0.4306

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
--	----	--------	---------	---------	--------

Subject	16	114.642	7.1651	1.5703	0.1942
Period	1	0.734	0.7344	0.1609	0.6939
Treat	1	2.993	2.9932	0.6560	0.4306

## 10.7.2 p355

(178) MODEL

```
ANOVA(y ~ Group + Subject:Group + Period + Treat + Carry, bioequiv) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	39	417852	10714.1	20.367	< 2.2e-16 ***
RESIDUALS	68	35772	526.1		
CORRECTED TOTAL	107	453624			

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Group	1	43335	43335	82.3763	2.46e-13 ***
Group:Subject	34	370970	10911	20.7406	< 2.2e-16 ***
Period	2	287	143	0.2723	0.7624
Treat	1	2209	2209	4.1993	0.0443 *
Carry	1	1051	1051	1.9970	0.1622

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Group	1	32616	32616	61.9998	3.712e-11 ***
Group:Subject	34	370970	10911	20.7406	< 2.2e-16 ***
Period	1	38	38	0.0724	0.7888
Treat	1	2209	2209	4.1993	0.0443 *
Carry	1	1051	1051	1.9970	0.1622

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Group	1	32616	32616	61.9998	3.712e-11 ***
Group:Subject	34	370970	10911	20.7406	< 2.2e-16 ***
Period	1	38	38	0.0724	0.7888
Treat	1	2209	2209	4.1993	0.0443 *

```
Carry          1    1051    1051  1.9970    0.1622
```

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
(179) MODEL
```

```
ANOVA(y ~ Subject + Period + Treat + Carry, bioequiv) # OK
```

```
$ANOVA
```

```
Response : y
```

		Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL		39	417852	10714.1	20.367	< 2.2e-16 ***
RESIDUALS		68	35772	526.1		
CORRECTED TOTAL		107	453624			

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
```

		Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subject		35	414306	11837.3	22.5016	<2e-16 ***
Period		2	287	143.3	0.2723	0.7624
Treat		1	2209	2209.1	4.1993	0.0443 *
Carry		1	1051	1050.6	1.9970	0.1622

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
```

		Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subject		35	403586	11531.0	21.9194	<2e-16 ***
Period		1	38	38.1	0.0724	0.7888
Treat		1	2209	2209.1	4.1993	0.0443 *
Carry		1	1051	1050.6	1.9970	0.1622

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
```

```
CAUTION: Singularity Exists !
```

		Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subject		35	403586	11531.0	21.9194	<2e-16 ***
Period		1	38	38.1	0.0724	0.7888
Treat		1	2209	2209.1	4.1993	0.0443 *
Carry		1	1051	1050.6	1.9970	0.1622

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```



### 10.7.3 p361

(180) MODEL

```
ANOVA(Time ~ Subject + Period + Treat + Carry, chipman) # OK
```

\$ANOVA

Response : Time

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	17	28.0757	1.65151	64.421	1.139e-12 ***
RESIDUALS	18	0.4615	0.02564		
CORRECTED TOTAL	35	28.5372			

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subject	11	24.2084	2.20076	85.8462	3.157e-13 ***
Period	2	3.2065	1.60325	62.5388	7.894e-09 ***
Treat	2	0.4276	0.21382	8.3406	0.002733 **
Carry	2	0.2332	0.11660	4.5484	0.025188 *

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subject	11	24.2547	2.20497	86.0105	3.104e-13 ***
Period	1	0.0018	0.00184	0.0717	0.7919554
Treat	2	0.6392	0.31958	12.4661	0.0004003 ***
Carry	2	0.2332	0.11660	4.5484	0.0251881 *

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Subject	11	24.2547	2.20497	86.0105	3.104e-13 ***
Period	1	0.0018	0.00184	0.0717	0.7919554
Treat	2	0.6392	0.31958	12.4661	0.0004003 ***
Carry	2	0.2332	0.11660	4.5484	0.0251881 *

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### 10.7.4 p372

(181) MODEL

```

residue$lc1 = log(residue$X1)
residue$lc2 = log(residue$X2)
residue$lc3 = log(residue$X3)
residue$lc4 = log(residue$X4)
residue$lc5 = log(residue$X5)
residue$sp = 7*residue$lc2+ 14*residue$lc3 + 30*residue$lc4 + 60*residue$lc5
residue$sm = residue$lc1 + residue$lc2+ residue$lc3 + residue$lc4 + residue$lc5
residue$num = 5*residue$sp - 111*residue$sm
residue$den = 5*4745 - 111^2
residue$k = residue$num/residue$den
residue$HL = -log(2)/residue$k
residue$logHL = log(residue$HL)
ANOVA(logHL ~ temp*moisture*soil, residue) # OK

```

\$ANOVA

Response : logHL

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	7.5133	1.07332	13.543	0.0007329 ***
RESIDUALS	8	0.6340	0.07925		
CORRECTED TOTAL	15	8.1473			

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
temp	1	6.0503	6.0503	76.3427	2.303e-05 ***
moisture	1	0.9521	0.9521	12.0134	0.008492 **
temp:moisture	1	0.0013	0.0013	0.0162	0.901779
soil	1	0.4098	0.4098	5.1712	0.052559 .
temp:soil	1	0.0086	0.0086	0.1081	0.750753
moisture:soil	1	0.0860	0.0860	1.0855	0.327921
temp:moisture:soil	1	0.0051	0.0051	0.0648	0.805427

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
temp	1	6.0503	6.0503	76.3427	2.303e-05 ***
moisture	1	0.9521	0.9521	12.0134	0.008492 **
temp:moisture	1	0.0013	0.0013	0.0162	0.901779
soil	1	0.4098	0.4098	5.1712	0.052559 .
temp:soil	1	0.0086	0.0086	0.1081	0.750753
moisture:soil	1	0.0860	0.0860	1.0855	0.327921
temp:moisture:soil	1	0.0051	0.0051	0.0648	0.805427

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
temp	1	6.0503	6.0503	76.3427	2.303e-05 ***
moisture	1	0.9521	0.9521	12.0134	0.008492 **
temp:moisture	1	0.0013	0.0013	0.0162	0.901779
soil	1	0.4098	0.4098	5.1712	0.052559 .
temp:soil	1	0.0086	0.0086	0.1081	0.750753
moisture:soil	1	0.0860	0.0860	1.0855	0.327921
temp:moisture:soil	1	0.0051	0.0051	0.0648	0.805427

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## 10.8 Chapter 11

### 10.8.1 p461

(182) MODEL

```
ANOVA(y ~ x1 + x2 + x1:x2 + x1:x3 + x2:x3, pest) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	5	275.642	55.128	160.38	4.631e-07 ***
RESIDUALS	7	2.406	0.344		
CORRECTED TOTAL	12	278.048			

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
x1	1	83.402	83.402	242.6351	1.086e-06 ***
x2	1	161.734	161.734	470.5191	1.116e-07 ***
x1:x2	1	0.246	0.246	0.7169	0.4251627
x1:x3	1	15.663	15.663	45.5660	0.0002649 ***
x2:x3	1	14.596	14.596	42.4614	0.0003291 ***

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
x1	1	215.951	215.951	628.246	4.105e-08 ***
x2	1	175.256	175.256	509.855	8.458e-08 ***
x1:x2	1	0.025	0.025	0.072	0.7961658
x1:x3	1	14.539	14.539	42.298	0.0003330 ***
x2:x3	1	14.596	14.596	42.461	0.0003291 ***

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
      Df Sum Sq Mean Sq F value    Pr(>F)
x1      1 178.372 178.372 518.922 7.958e-08 ***
x2      1 145.518 145.518 423.341 1.608e-07 ***
x1:x2    1   0.025   0.025   0.072 0.7961658
x1:x3    1  14.539  14.539  42.298 0.0003330 ***
x2:x3    1  14.596  14.596  42.461 0.0003291 ***
```

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

## 10.8.2 p469

(183) MODEL

```
ANOVA(y ~ x1 + x2 + x1:x2 + x1:x3 + x2:x3 + x1:x2:x3, polvdat) # OK
```

```
$ANOVA
Response : y
      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      6 12.5313  2.08854   37.056 0.0005473 ***
RESIDUALS    5  0.2818  0.05636
CORRECTED TOTAL 11 12.8131
```

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
x1      1 5.4668   5.4668 96.9942 0.0001839 ***
x2      1 0.3660   0.3660   6.4944 0.0513654 .
x1:x2    1 4.6897   4.6897 83.2068 0.0002652 ***
x1:x3    1 1.2450   1.2450 22.0887 0.0053378 **
x2:x3    1 0.4707   0.4707   8.3509 0.0341949 *
x1:x2:x3 1 0.2931   0.2931   5.2004 0.0714991 .
```

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
x1      1 0.0184   0.0184   0.3265 0.5924707
x2      1 0.2419   0.2419   4.2911 0.0930613 .
x1:x2    1 3.8824   3.8824 68.8834 0.0004147 ***
x1:x3    1 1.4383   1.4383 25.5196 0.0039276 **
x2:x3    1 0.4707   0.4707   8.3509 0.0341949 *
```

```
x1:x2:x3  1 0.2931  0.2931  5.2004 0.0714991 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

\$`Type III`

```
      Df Sum Sq Mean Sq F value Pr(>F)
x1      1 0.25744 0.25744  4.5677 0.08562 .
x2      1 0.12956 0.12956  2.2987 0.18992
x1:x2    1 0.65909 0.65909 11.6939 0.01885 *
x1:x3    1 0.26323 0.26323  4.6704 0.08307 .
x2:x3    1 0.12999 0.12999  2.3063 0.18931
x1:x2:x3 1 0.29310 0.29310  5.2004 0.07150 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

### 10.8.3 p482

(184) MODEL

```
REG(y ~ x1 + x2 + x3 + x1:x2 + x1:x3 + x2:x3 + x1:z1 + x2:z1 + x3:z1 +
      x1:x2:z1 + x1:x3:z1 + x2:x3:z1 + x1:z2 + x2:z2 + x3:z2 +
      x1:x2:z2 + x1:x3:z2 + x2:x3:z2 + x1:z1:z2 + x2:z1:z2 + x3:z1:z2 +
      x1:x2:z1:z2 + x1:x3:z1:z2 + x2:x3:z1:z2 - 1, MPV) # OK
```

	Estimate	Std. Error	Df	t value	Pr(> t )
x1	346948	294197	11	1.1793	0.2631550
x2	8223	490	11	16.7869	3.467e-09 ***
x3	1656	459	11	3.6104	0.0040950 **
x1:x2	-414463	312262	11	-1.3273	0.2113017
x1:x3	-334747	311426	11	-1.0749	0.3054382
x2:x3	-6476	1199	11	-5.4032	0.0002156 ***
x1:z1	103044	328922	11	0.3133	0.7599297
x2:z1	-2241	548	11	-4.0924	0.0017824 **
x3:z1	823	513	11	1.6056	0.1366709
x1:x2:z1	-64013	349120	11	-0.1834	0.8578546
x1:x3:z1	-123730	348184	11	-0.3554	0.7290412
x2:x3:z1	4659	1340	11	3.4765	0.0051806 **
x1:z2	244320	328922	11	0.7428	0.4731733
x2:z2	886	548	11	1.6187	0.1338108
x3:z2	86	513	11	0.1670	0.8704301
x1:x2:z2	-266052	349120	11	-0.7621	0.4620497
x1:x3:z2	-253151	348184	11	-0.7271	0.4823761
x2:x3:z2	-1822	1340	11	-1.3593	0.2012686
x1:z1:z2	259038	328922	11	0.7875	0.4476062
x2:z1:z2	-137	548	11	-0.2500	0.8071853
x3:z1:z2	100	513	11	0.1955	0.8485983

```

x1:x2:z1:z2  -269527      349120 11 -0.7720 0.4563702
x1:x3:z1:z2  -269249      348184 11 -0.7733 0.4556454
x2:x3:z1:z2    -328        1340 11 -0.2448 0.8111141
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 10.9 Chapter 12

### 10.9.1 p513

(185) MODEL

```
ANOVA(ybar ~ A + B + C + D + E + F + G, tile) # OK
```

\$ANOVA

Response : ybar

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	0.68737	0.098196		
RESIDUALS	0	0.00000			
CORRECTED TOTAL	7	0.68737			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.04984	0.04984		
B	1	0.01992	0.01992		
C	1	0.51534	0.51534		
D	1	0.01532	0.01532		
E	1	0.05965	0.05965		
F	1	0.00879	0.00879		
G	1	0.01851	0.01851		

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.04984	0.04984		
B	1	0.01992	0.01992		
C	1	0.51534	0.51534		
D	1	0.01532	0.01532		
E	1	0.05965	0.05965		
F	1	0.00879	0.00879		
G	1	0.01851	0.01851		

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.04984	0.04984		
B	1	0.01992	0.01992		
C	1	0.51534	0.51534		

D	1	0.01532	0.01532
E	1	0.05965	0.05965
F	1	0.00879	0.00879
G	1	0.01851	0.01851

(186) MODEL

```
ANOVA(lns2 ~ A + B + C + D + E + F + G, tile) # OK
```

\$ANOVA

Response : lns2

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	12.305	1.7578		
RESIDUALS	0	0.000			
CORRECTED TOTAL	7	12.305			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.6436	1.6436		
B	1	0.3109	0.3109		
C	1	7.1858	7.1858		
D	1	2.3199	2.3199		
E	1	0.0248	0.0248		
F	1	0.7379	0.7379		
G	1	0.0820	0.0820		

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.6436	1.6436		
B	1	0.3109	0.3109		
C	1	7.1858	7.1858		
D	1	2.3199	2.3199		
E	1	0.0248	0.0248		
F	1	0.7379	0.7379		
G	1	0.0820	0.0820		

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.6436	1.6436		
B	1	0.3109	0.3109		
C	1	7.1858	7.1858		
D	1	2.3199	2.3199		
E	1	0.0248	0.0248		
F	1	0.7379	0.7379		
G	1	0.0820	0.0820		

## 10.9.2 p521

(187) MODEL

```
strng = reshape(tile,
  direction = "long",
  varying = list(c("y1", "y2")),
  v.names = "y",
  idvar = c("A", "B", "C", "D", "E", "F", "G"),
  timevar = "H",
  times = c(-1, 1))
ANOVA(y ~ A/H + B/H + C/H + D/H + E/H + F/H + G/H, strng) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	1.65427	0.11816	0.1433	0.9807
RESIDUALS	1	0.82473	0.82473		
CORRECTED TOTAL	15	2.47901			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.09968	0.09968	0.1209	0.7870
A:H	1	0.04015	0.04015	0.0487	0.8618
B	1	0.03984	0.03984	0.0483	0.8623
H:B	1	0.00043	0.00043	0.0005	0.9854
C	1	1.03069	1.03069	1.2497	0.4646
H:C	1	0.15307	0.15307	0.1856	0.7410
D	1	0.03064	0.03064	0.0372	0.8788
H:D	1	0.04690	0.04690	0.0569	0.8510
E	1	0.11929	0.11929	0.1446	0.7686
H:E	1	0.01883	0.01883	0.0228	0.9045
F	1	0.01758	0.01758	0.0213	0.9077
H:F	1	0.01384	0.01384	0.0168	0.9180
G	1	0.03702	0.03702	0.0449	0.8671
H:G	1	0.00632	0.00632	0.0077	0.9444

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.09968	0.09968	0.1209	0.7870
A:H	1	0.04015	0.04015	0.0487	0.8618
B	1	0.03984	0.03984	0.0483	0.8623
H:B	1	0.00043	0.00043	0.0005	0.9854
C	1	1.03069	1.03069	1.2497	0.4646
H:C	1	0.15307	0.15307	0.1856	0.7410
D	1	0.03064	0.03064	0.0372	0.8788
H:D	1	0.04690	0.04690	0.0569	0.8510



E	1	0.11929	0.11929	0.1446	0.7686
H:E	1	0.01883	0.01883	0.0228	0.9045
F	1	0.01758	0.01758	0.0213	0.9077
H:F	1	0.01384	0.01384	0.0168	0.9180
G	1	0.03702	0.03702	0.0449	0.8671
H:G	1	0.00632	0.00632	0.0077	0.9444

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.09968	0.09968	0.1209	0.7870
A:H	1	0.04015	0.04015	0.0487	0.8618
B	1	0.03984	0.03984	0.0483	0.8623
H:B	1	0.00043	0.00043	0.0005	0.9854
C	1	1.03069	1.03069	1.2497	0.4646
H:C	1	0.15307	0.15307	0.1856	0.7410
D	1	0.03064	0.03064	0.0372	0.8788
H:D	1	0.04690	0.04690	0.0569	0.8510
E	1	0.11929	0.11929	0.1446	0.7686
H:E	1	0.01883	0.01883	0.0228	0.9045
F	1	0.01758	0.01758	0.0213	0.9077
H:F	1	0.01384	0.01384	0.0168	0.9180
G	1	0.03702	0.03702	0.0449	0.8671
H:G	1	0.00632	0.00632	0.0077	0.9444

### 10.9.3 p525

(188) MODEL

```
prod2 = af(prodstd, 1:7)
ANOVA(Pof ~ A + B + C + D + E + F + G + A:G + A:E:F + B:E:G + C:E:G + C:E:G:F +
      D:E + D:F, prod2) # OK
```

\$ANOVA

Response : Pof

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	47	769.49	16.3721	5.1667	2.737e-05 ***
RESIDUALS	24	76.05	3.1688		
CORRECTED TOTAL	71	845.54			

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	2	50.577	25.288	7.9806	0.0022023 **
B	2	13.384	6.692	2.1118	0.1429491
C	2	68.594	34.297	10.8234	0.0004463 ***

D	2	23.674	11.837	3.7355	0.0386914	*
E	1	275.733	275.733	87.0165	1.878e-09	***
F	1	161.700	161.700	51.0296	2.204e-07	***
G	1	1.051	1.051	0.3318	0.5699896	
A:G	2	26.567	13.284	4.1921	0.0274494	*
A:E:F	7	28.404	4.058	1.2806	0.3013844	
B:E:G	7	22.453	3.208	1.0123	0.4475160	
C:E:G	6	35.546	5.924	1.8696	0.1277692	
C:E:F:G	10	24.607	2.461	0.7766	0.6500534	
D:E	2	21.745	10.873	3.4312	0.0489076	*
D:F	2	15.450	7.725	2.4379	0.1086730	

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	2	50.577	25.288	7.9806	0.0022023	**
B	2	13.384	6.692	2.1118	0.1429491	
C	2	68.594	34.297	10.8234	0.0004463	***
D	2	23.674	11.837	3.7355	0.0386914	*
E	1	275.733	275.733	87.0165	1.878e-09	***
F	1	161.700	161.700	51.0296	2.204e-07	***
G	1	1.051	1.051	0.3318	0.5699896	
A:G	2	26.567	13.284	4.1921	0.0274494	*
A:E:F	6	24.623	4.104	1.2951	0.2970196	
B:E:G	6	19.770	3.295	1.0398	0.4246194	
C:E:G	6	35.546	5.924	1.8696	0.1277692	
C:E:F:G	10	24.607	2.461	0.7766	0.6500534	
D:E	2	21.745	10.873	3.4312	0.0489076	*
D:F	2	15.450	7.725	2.4379	0.1086730	

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	2	50.577	25.288	7.9806	0.0022023	**
B	2	13.384	6.692	2.1118	0.1429491	
C	2	68.594	34.297	10.8234	0.0004463	***
D	2	23.674	11.837	3.7355	0.0386914	*
E	1	275.733	275.733	87.0165	1.878e-09	***
F	1	161.700	161.700	51.0296	2.204e-07	***
G	1	1.051	1.051	0.3318	0.5699896	
A:G	2	26.567	13.284	4.1921	0.0274494	*
A:E:F	6	24.623	4.104	1.2951	0.2970196	
B:E:G	6	19.770	3.295	1.0398	0.4246194	
C:E:G	6	35.546	5.924	1.8696	0.1277692	
C:E:F:G	10	24.607	2.461	0.7766	0.6500534	

```
D:E      2  21.745  10.873  3.4312 0.0489076 *
D:F      2  15.450   7.725  2.4379 0.1086730
```

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

#### 10.9.4 p532

(189) MODEL

```
ANOVA(torque ~ A + B + C + D + E + A:B + A:C + A:D + A:E, Smotor) # OK
```

```
$ANOVA
```

```
Response : torque
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	15	0.0112217	0.00074811	102.2	0.009731 **
RESIDUALS	2	0.0000146	0.00000732		
CORRECTED TOTAL	17	0.0112363			

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.0039545	0.0039545	540.2187	0.001846 **
B	2	0.0003817	0.0001909	26.0732	0.036937 *
C	2	0.0057241	0.0028620	390.9837	0.002551 **
D	2	0.0000265	0.0000133	1.8104	0.355820
E	1	0.0000984	0.0000984	13.4406	0.067009 .
A:B	2	0.0010068	0.0005034	68.7668	0.014333 *
A:C	2	0.0000031	0.0000016	0.2134	0.824110
A:D	2	0.0000009	0.0000004	0.0599	0.943521
A:E	1	0.0000258	0.0000258	3.5198	0.201458

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.0039545	0.0039545	540.2187	0.001846 **
B	2	0.0003817	0.0001909	26.0732	0.036937 *
C	2	0.0032014	0.0016007	218.6753	0.004552 **
D	2	0.0000268	0.0000134	1.8319	0.353123
E	1	0.0000423	0.0000423	5.7744	0.138172
A:B	2	0.0010068	0.0005034	68.7668	0.014333 *
A:C	2	0.0000031	0.0000016	0.2134	0.824110
A:D	2	0.0000052	0.0000026	0.3536	0.738760
A:E	1	0.0000258	0.0000258	3.5198	0.201458

```
---
```

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	1	0.0034241	0.0034241	467.7636	0.002131	**
B	2	0.0003817	0.0001909	26.0732	0.036937	*
C	2	0.0032014	0.0016007	218.6753	0.004552	**
D	2	0.0000268	0.0000134	1.8319	0.353123	
E	1	0.0000423	0.0000423	5.7744	0.138172	
A:B	2	0.0010068	0.0005034	68.7668	0.014333	*
A:C	2	0.0000031	0.0000016	0.2134	0.824110	
A:D	2	0.0000052	0.0000026	0.3536	0.738760	
A:E	1	0.0000258	0.0000258	3.5198	0.201458	

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

### 10.9.5 p535

(190) MODEL

```
ANOVA(shrinkage ~ A + B + C + D + E + F + G + A:B + A:C + A:D + A:E + A:F + A:G +
      B:D, inject) # OK
```

\$ANOVA

Response : shrinkage

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	6659.4	475.67	129.08	1.97e-05 ***
RESIDUALS	5	18.4	3.68		
CORRECTED TOTAL	19	6677.8			

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	770.1	770.1	208.9722	2.858e-05 ***
B	1	5076.6	5076.6	1377.6289	2.674e-07 ***
C	1	3.1	3.1	0.8311	0.403773
D	1	7.6	7.6	2.0522	0.211416
E	1	0.6	0.6	0.1526	0.712112
F	1	0.6	0.6	0.1526	0.712112
G	1	95.1	95.1	25.7972	0.003837 **
A:B	1	564.1	564.1	153.0699	6.112e-05 ***
A:C	1	10.6	10.6	2.8664	0.151230
A:D	1	115.6	115.6	31.3602	0.002508 **
A:E	1	14.1	14.1	3.8161	0.108185
A:F	1	1.6	1.6	0.4240	0.543677

```
A:G 1 0.1 0.1 0.0170 0.901459
B:D 1 0.1 0.1 0.0170 0.901459
```

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	1	770.1	770.1	208.9722	2.858e-05	***
B	1	5076.6	5076.6	1377.6289	2.674e-07	***
C	1	3.1	3.1	0.8311	0.403773	
D	1	7.6	7.6	2.0522	0.211416	
E	1	0.6	0.6	0.1526	0.712112	
F	1	0.6	0.6	0.1526	0.712112	
G	1	95.1	95.1	25.7972	0.003837	**
A:B	1	564.1	564.1	153.0699	6.112e-05	***
A:C	1	10.6	10.6	2.8664	0.151230	
A:D	1	115.6	115.6	31.3602	0.002508	**
A:E	1	14.1	14.1	3.8161	0.108185	
A:F	1	1.6	1.6	0.4240	0.543677	
A:G	1	0.1	0.1	0.0170	0.901459	
B:D	1	0.1	0.1	0.0170	0.901459	

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	1	770.1	770.1	208.9722	2.858e-05	***
B	1	5076.6	5076.6	1377.6289	2.674e-07	***
C	1	3.1	3.1	0.8311	0.403773	
D	1	7.6	7.6	2.0522	0.211416	
E	1	0.6	0.6	0.1526	0.712112	
F	1	0.6	0.6	0.1526	0.712112	
G	1	95.1	95.1	25.7972	0.003837	**
A:B	1	564.1	564.1	153.0699	6.112e-05	***
A:C	1	10.6	10.6	2.8664	0.151230	
A:D	1	115.6	115.6	31.3602	0.002508	**
A:E	1	14.1	14.1	3.8161	0.108185	
A:F	1	1.6	1.6	0.4240	0.543677	
A:G	1	0.1	0.1	0.0170	0.901459	
B:D	1	0.1	0.1	0.0170	0.901459	

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

## 10.9.6 p539

(191) MODEL

```
eptax = cbind(eptaxr[1:16,], y2=eptaxr[17:32,9], y3=eptaxr[33:48,9],
              y5=eptaxr[49:64,9])
eptax$ybar = (eptax$y + eptax$y2 + eptax$y3 + eptax$y5)/4
ANOVA(ybar ~ A + B + C + D + E + F + G + H + A:B + A:C + A:D + A:E + A:F + A:G +
      A:H, eptax) # OK
```

\$ANOVA

Response : ybar

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	15	2.8452	0.18968		
RESIDUALS	0	0.0000			
CORRECTED TOTAL	15	2.8452			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.02686	0.02686		
B	1	0.00042	0.00042		
C	1	0.06306	0.06306		
D	1	2.49443	2.49443		
E	1	0.00304	0.00304		
F	1	0.03209	0.03209		
G	1	0.02954	0.02954		
H	1	0.12879	0.12879		
A:B	1	0.00047	0.00047		
A:C	1	0.03218	0.03218		
A:D	1	0.01185	0.01185		
A:E	1	0.00380	0.00380		
A:F	1	0.01674	0.01674		
A:G	1	0.00186	0.00186		
A:H	1	0.00012	0.00012		

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.02686	0.02686		
B	1	0.00042	0.00042		
C	1	0.06306	0.06306		
D	1	2.49443	2.49443		
E	1	0.00304	0.00304		
F	1	0.03209	0.03209		
G	1	0.02954	0.02954		
H	1	0.12879	0.12879		
A:B	1	0.00047	0.00047		
A:C	1	0.03218	0.03218		
A:D	1	0.01185	0.01185		
A:E	1	0.00380	0.00380		
A:F	1	0.01674	0.01674		
A:G	1	0.00186	0.00186		

A:H 1 0.00012 0.00012

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.02686	0.02686		
B	1	0.00042	0.00042		
C	1	0.06306	0.06306		
D	1	2.49443	2.49443		
E	1	0.00304	0.00304		
F	1	0.03209	0.03209		
G	1	0.02954	0.02954		
H	1	0.12879	0.12879		
A:B	1	0.00047	0.00047		
A:C	1	0.03218	0.03218		
A:D	1	0.01185	0.01185		
A:E	1	0.00380	0.00380		
A:F	1	0.01674	0.01674		
A:G	1	0.00186	0.00186		
A:H	1	0.00012	0.00012		

## 11 Searle - Linear Models 2e

### Reference

- Searle SR, Gruber MHJ. Linear Models 2e, Kindle Edition. John Wiley & Sons Inc. 2016.

### 11.1 7.2 (p390, 59%)

(192) MODEL

```
weight = c(8,13,9,12,7,11,6,12,12,14,9,7,14,16,10,14,11,13)
treatment = c("ta","ta","ta","ta","ta","ta","tb","tb","tb","tb","tc","tc","tc",
              "tc","tc","tc","tc","tc")
variety = c("va","va","va","vc","vd","vd","va","va","vb","vb","vb","vb","vb","vc",
            "vc","vd","vd","vd","vd")
d1 = data.frame(weight, treatment, variety)
ANOVA(weight ~ treatment*variety, d1)
```

\$ANOVA

Response : weight

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	82	11.714	2.0918	0.14
RESIDUALS	10	56	5.600		
CORRECTED TOTAL	17	138			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	2	10.500	5.250	0.9375	0.42348
variety	3	36.786	12.262	2.1896	0.15232
treatment:variety	2	34.714	17.357	3.0995	0.08965 .

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	2	9.486	4.7429	0.8469	0.45731
variety	3	36.786	12.2619	2.1896	0.15232
treatment:variety	2	34.714	17.3571	3.0995	0.08965 .

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	2	12.471	6.2353	1.1134	0.36595
variety	3	34.872	11.6240	2.0757	0.16719
treatment:variety	2	34.714	17.3571	3.0995	0.08965 .



---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
options(contrasts = c("contr.sum", "contr.poly"))
Anova(lm(weight ~ treatment*variety, d1), type=3, singular.ok=TRUE) # NOT OK
```

Note: model has aliased coefficients  
sums of squares computed by model comparison

Anova Table (Type III tests)

Response: weight

	Sum Sq	Df	F values	Pr(>F)
treatment	0.000	0		
variety	0.000	0		
treatment:variety	34.714	2	3.0995	0.08965 .
Residuals	56.000	10		

---

Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

## 11.2 7.2 (p393, 60%)

(193) MODEL

```
percent = c(31,33,44,36,38,26,37,59,42,42,34,42,28,39,36,32,38,42,36,22,42,46,
            26,37,43)
refinery = c(rep("g",9),rep("n",8),rep("s",8))
process = as.factor(c(1,1,1,1,1,1,2,2,2,1,1,1,1,2,2,2,2,1,1,1,2,2,2,2))
source0 = c("t","t","t","t","o","m","t","t","o","m","i","i","i","t","o","m","m",
            "t","o","i","o","o","m","i","i")
d2 = data.frame(percent, refinery, process, source=source0)
ANOVA(percent ~ refinery*source, d2)
```

\$ANOVA

Response : percent

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	10	442.56	44.256	0.6361	0.7616
RESIDUALS	14	974.00	69.571		
CORRECTED TOTAL	24	1416.56			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
refinery	2	20.963	10.481	0.1507	0.8615
source	3	266.124	88.708	1.2751	0.3212
refinery:source	5	155.474	31.095	0.4469	0.8086

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
refinery	2	25.535	12.767	0.1835	0.8343
source	3	266.124	88.708	1.2751	0.3212
refinery:source	5	155.474	31.095	0.4469	0.8086

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
refinery	2	10.766	5.383	0.0774	0.9259
source	3	282.633	94.211	1.3542	0.2972
refinery:source	5	155.474	31.095	0.4469	0.8086

```
options(contrasts=c("contr.sum", "contr.poly"))  
Anova(lm(percent ~ refinery*source, d2), type=3, singular.ok=TRUE) # NOT OK
```

Note: model has aliased coefficients  
      sums of squares computed by model comparison

Anova Table (Type III tests)

Response: percent

	Sum Sq	Df	F values	Pr(>F)
refinery	2.52	1	0.0362	0.8518
source	268.19	2	1.9275	0.1822
refinery:source	155.47	5	0.4469	0.8086
Residuals	974.00	14		

## 12 Test Summary

Package	Version	Total Count	Identical to SAS	Different from SAS
sasLM	0.6.6	193	193 (100%)	0 (0%)
car	3.0.12	193	< 174 (90%)	>= 20 (10%)

All of the results in sasLM 0.6.6 were identical, while type III SSs of Model (83) and (84) were different from those of SAS in sasLM 0.1.2 package.

Slight differences in the last digits between type II and type III SS (when they should be same) are resulted from the round-to-even number way of R rounding function.

If you are uncertain about the equivalence of the 'sasLM' to 'SAS,' you can use 'SAS University Edition' for free.

If you find any discrepancies, please mail to the author, Kyun-Seop Bae [k@acr.kr](mailto:k@acr.kr).

## 13 Session Information

R version 4.1.2 (2021-11-01)

Platform: x86\_64-w64-mingw32/x64 (64-bit)

Running under: Windows 10 x64 (build 17763)

Matrix products: default

locale:

[1] LC\_COLLATE=Korean\_Korea.949 LC\_CTYPE=Korean\_Korea.949

[3] LC\_MONETARY=Korean\_Korea.949 LC\_NUMERIC=C

[5] LC\_TIME=Korean\_Korea.949

attached base packages:

[1] stats graphics grDevices utils datasets methods base

other attached packages:

[1] daewr\_1.2-7 car\_3.0-12 carData\_3.0-5 sasLM\_0.6.6 mvtnorm\_1.1-3

[6] rmarkdown\_2.11

loaded via a namespace (and not attached):

[1] gmp_0.6-2.1	compiler_4.1.2	mathjaxr_1.4-0
[4] numbers_0.8-2	tools_4.1.2	partitions_1.10-4
[7] digest_0.6.29	evaluate_0.15	lattice_0.20-45
[10] pkgconfig_2.0.3	rlang_1.0.1	igraph_1.2.11
[13] cli_3.2.0	yaml_2.3.4	polynom_1.4-0
[16] xfun_0.29	fastmap_1.1.0	stringr_1.4.0
[19] knitr_1.37	combinat_0.0-8	lmtest_0.9-39
[22] vcd_1.4-9	grid_4.1.2	scatterplot3d_0.3-41
[25] DoE.base_1.2	conf.design_2.0.0	FrF2_2.2-2
[28] magrittr_2.0.2	htmltools_0.5.2	MASS_7.3-55
[31] sfsmisc_1.1-12	abind_1.4-5	colorspace_2.0-2
[34] tinytex_0.37	stringi_1.7.6	zoo_1.8-9