

Validation of 'sasLM' Package

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1 Tested Version and Books used for the Validation

1.1 Packages Used

- 'sasLM' version: 0.6.0
- 'SAS' version: 9.4 Licensed and University Edition
- 'car' version: 3.0.10
- R version: R version 4.1.0 (2021-05-18)

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/SAS41m/p256.txt", header=TRUE)
p256b = af(p256, c("bloc", "type", "logdose"))
ANOVA(y ~ bloc + type + logdose + type:logdose, p256b) # p258 Output 7.22
```

\$ANOVA

Response : y

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

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

\$`Type I`

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

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

\$`Type II`

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

\$`Type III`

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

5.6.8 p261 Output 7.27

(46) MODEL

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

\$ANOVA

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

\$`Type I`

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

```

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

\$`Type II`

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

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

\$`Type III`

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

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

5.6.9 p262 Output 7.28

(47) MODEL

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

\$ANOVA

Response : y

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

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

\$`Type I`

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

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

\$`Type II`

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

```

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

```

\$`Type III`

```

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

```

5.7 Chapter 8

5.7.1 p269

(48) MODEL

```

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

```

\$ANOVA

Response : fev1

```

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

```

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

\$`Type I`

```

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

```

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

\$`Type II`

```

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

```

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

\$`Type III`

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

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

5.8 Chapter 11

5.8.1 p390

(49) MODEL

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

\$ANOVA

Response : y

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

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

\$`Type I`

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

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

\$`Type II`

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

```

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

```

\$`Type III`

```

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

```

5.8.2 p394

(50) MODEL

```

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

```

\$ANOVA

Response : y

```

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

```

\$`Type I`

```

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

```

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

\$`Type II`

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

\$`Type III`

CAUTION: Singularity Exists !

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

(51) MODEL

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

```
$ANOVA
```

```
Response : y
```

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

```
$`Type I`
```

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

```
$`Type II`
```

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

```
$`Type III`
```

```
CAUTION: Singularity Exists !
```


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

5.8.3 p399

(52) MODEL

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

\$ANOVA

Response : y

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

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

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

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

5.8.4 p403

(53) MODEL

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

\$ANOVA

Response : HR

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

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

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

```
VISIT          2  146.8  73.389  1.2991  0.28350
DRUG           2  343.9 171.975  3.0443  0.05826 .
RESIDS         1  309.2 309.174  5.4731  0.02414 *
RESIDT         1    0.8   0.840  0.0149  0.90351
```

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

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

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

Anova Table (Type III tests)

Response: HR

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

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

5.8.5 p409 11.5

(54) MODEL

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

\$ANOVA

Response : TS

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

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
SOURCE	2	0.070	0.035	0.179	0.839
AMT	1	138.245	138.245	704.534	7.392e-10 ***
SOURCE:AMT	2	22.481	11.240	57.284	7.595e-06 ***

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

5.8.6 p412

(55) MODEL

```
p412 = read.table("C:/G/Rt/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/SAS4lm/p414.txt", header=TRUE)
p414 = af(p414, c("lackofit"))
ANOVA(loglivcu ~ level + lackofit, p414) # p415 Output 11.26
```

\$ANOVA

Response : loglivcu

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

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

CAUTION: Singularity Exists !

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

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

5.8.8 p417

(57) MODEL

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

```
$ANOVA
```

```
Response : Y
```

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

```
---
```

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

```
$`Type I`
```

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

```
---
```

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

```
$`Type II`
```

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

```
---
```

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

```
$`Type III`
```

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

```
---
```

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

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

```
Note: model has aliased coefficients
```

```
      sums of squares computed by model comparison
```

```
Anova Table (Type III tests)
```

```
Response: Y
```

	Sum Sq	Df	F values	Pr(>F)
TRT	22.310	1	7.266	0.01835 *
TRT:POT	30.306	5	1.974	0.14991
Residuals	39.917	13		

```
---
```

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

5.8.9 p431

```
(58) MODEL
```

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

\$ANOVA

Response : avdlygn

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

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
line	2	0.13620	0.06810	1.3553	0.267560
line:sire	6	0.97389	0.16231	3.2303	0.009543 **
agedam	2	0.13011	0.06505	1.2946	0.283392
line:agedam	4	0.45343	0.11336	2.2560	0.076821 .
age	1	0.38128	0.38128	7.5878	0.008277 **
intlwt	1	0.26970	0.26970	5.3674	0.024830 *

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

p433 Output 11.40

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

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

Anova Table (Type III tests)

Response: avdlygn

	Sum Sq	Df	F values	Pr(>F)
line	0.00000	0		
agedam	0.13011	2	1.2946	0.283392
age	0.38128	1	7.5878	0.008277 **
intlwt	0.26970	1	5.3674	0.024830 *
line:sire	0.97389	6	3.2303	0.009543 **
line:agedam	0.45343	4	2.2560	0.076821 .
Residuals	2.41192	48		

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

(59) MODEL

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

\$ANOVA

Response : avdlygn

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	10	1.4254	0.142538	2.1904	0.03237 *
RESIDUALS	54	3.5140	0.065074		
CORRECTED TOTAL	64	4.9394			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
sire	8	1.30644	0.163305	2.5095	0.02138 *
agedam	2	0.11894	0.059471	0.9139	0.40707

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
sire	8	1.33017	0.166271	2.5551	0.01937 *
agedam	2	0.11894	0.059471	0.9139	0.40707

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
sire	8	1.33017	0.166271	2.5551	0.01937 *
agedam	2	0.11894	0.059471	0.9139	0.40707

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

5.8.10 p437 ABSORB option in SAS

(60) MODEL

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

```
$ANOVA
Response : avdlygn
```

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

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

```
$`Type I`
```

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

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

```
$`Type II`
```

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

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

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

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
line	0				
sire	6	0.97389	0.16231	3.2303	0.009543 **
agedam	2	0.13011	0.06505	1.2946	0.283392

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

```
# p437 Output 11.43
```

6 Sahai - Unbalanced

Reference

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

6.1 Table 11.2

(61) MODEL

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

\$ANOVA

Response : Y

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

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

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

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

6.2 Table 12.6

(62) MODEL

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

```
$ANOVA
Response : Y
```

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

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

```
$`Type I`
```

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

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

```
$`Type II`
```

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

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

```
$`Type III`
```

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

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

6.3 Table 13.6

(63) MODEL

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

```
$ANOVA
Response : Y
```

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

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

```
$`Type I`
```

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

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

\$`Type II`

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

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

\$`Type III`

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

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

6.4 Table 14.2

(64) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	6345.4	906.48	8.1297	5.931e-08 ***
RESIDUALS	110	12265.3	111.50		
CORRECTED TOTAL	117	18610.6			

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

\$`Type I`

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

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

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

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

6.5 Table 15.3

(65) MODEL

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

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

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

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

```
$`Type III`
```

```

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

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

```

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

Anova Table (Type III tests)

Response: pH

```

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

```

6.6 Table 16.3

(66) MODEL

```

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

```

\$ANOVA

Response : Residue

```

      Df Sum Sq   Mean Sq F value    Pr(>F)
MODEL      54 3.1897 0.059069  5.8842 1.476e-05 ***
RESIDUALS   22 0.2208 0.010039
CORRECTED TOTAL 76 3.4106
---

```

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

\$`Type I`

```

      Df    Sum Sq   Mean Sq F value    Pr(>F)
Plot      10 1.84041 0.184041 18.3332 1.929e-08 ***
Plot:Sample 22 0.99175 0.045079  4.4906 0.0004209 ***
Plot:Sample:Subsample 22 0.35757 0.016253  1.6191 0.1330632
---

```

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

\$`Type II`

```

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

```

```

Plot                10 1.84041 0.184041 18.3332 1.929e-08 ***
Plot:Sample         22 0.99175 0.045079  4.4906 0.0004209 ***
Plot:Sample:Subsample 22 0.35757 0.016253  1.6191 0.1330632

```

```
---
```

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

```
$`Type III`
```

```

              Df Sum Sq Mean Sq F value    Pr(>F)
Plot                10 1.78686 0.178686 17.7998 2.547e-08 ***
Plot:Sample         22 0.99175 0.045079  4.4906 0.0004209 ***
Plot:Sample:Subsample 22 0.35757 0.016253  1.6191 0.1330632

```

```
---
```

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

```

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

\$ANOVA

Response : Y

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

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

\$`Type I`

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

```

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

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

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

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

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

Anova Table (Type III tests)

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

```

7.9 Example 7.2

(85) MODEL

```

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

```

```
$ANOVA
Response : Y
```

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

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

```
$`Type I`
```

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

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

```
$`Type II`
```

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

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

```
$`Type III`
```

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

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

7.10 Example 7.3

(86) MODEL

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

```
$ANOVA
Response : Y
```


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

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

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

```
T:G:F 44 10.74 0.244 0.7753 0.790640
```

```
---
```

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

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

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

Anova Table (Type III tests)

Response: Y

	Sum Sq	Df	F values	Pr(>F)
R	0.000	0		
T	0.000	0		
G	73.444	2	116.6471	< 2.2e-16 ***
F	120.563	2	191.4828	< 2.2e-16 ***
R:T	0.000	0		
T:G	5.778	2	9.1765	0.0006018 ***
T:F	0.822	2	1.3060	0.2834316
G:F	23.469	44	1.6943	0.0531910 .
R:T:G	8.778	12	2.3235	0.0253153 *
T:G:F	10.740	44	0.7753	0.7906401
Residuals	11.333	36		

```
---
```

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

7.11 Example 8.1

(87) MODEL

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

\$ANOVA

Response : Y

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

\$`Type I`

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

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

\$`Type II`

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

\$`Type III`

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

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

7.12 Example 9.1

(88) MODEL

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

\$ANOVA

Response : Y

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

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

\$`Type I`

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

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

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

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

7.13 Example 9.2

(89) MODEL

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

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

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

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

\$`Type II`

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

\$`Type III`

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

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

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

Anova Table (Type III tests)

Response: yield

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

7.14 Example 10.1

(90) MODEL

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

\$ANOVA

Response : Yield

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

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

\$`Type I`

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

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

\$`Type II`

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

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

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

\$`Type III`

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

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

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

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

Anova Table (Type III tests)

Response: Yield

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

```

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

```

7.15 Example 10.2

(91) MODEL

```

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

```

\$ANOVA

Response : Yield

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

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

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

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

7.16 Example 11.1

(92) MODEL

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

\$ANOVA

Response : Y

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

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

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

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

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

(93) MODEL

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

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

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

```
T:S 3      21      7.0      4.2 0.0301 *
```

```
---
```

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

```
$`Type II`
```

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

```
---
```

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

```
$`Type III`
```

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

```
---
```

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

```
(94) MODEL
```

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

```
$ANOVA
```

```
Response : Y
```

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

```
---
```

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

```
$`Type I`
```

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

```
---
```

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

```
$`Type II`
```

```

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

```

\$`Type III`

```

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

```

7.17 Example 11.2

(95) MODEL

```

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

```

\$ANOVA

Response : MY

```

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

```

\$`Type I`

```

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

```

\$`Type II`

```

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

```

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

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

(96) MODEL

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

```
$ANOVA
Response : Y

      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      9 382.06   42.451   39.954 0.0001135 ***
RESIDUALS    6   6.38    1.062
CORRECTED TOTAL 15 388.44
```

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

```
$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
A        1  68.062   68.062  64.0588 0.0002029 ***
A:sub     6 227.875   37.979  35.7451 0.0001934 ***
B         1  85.562   85.562  80.5294 0.0001070 ***
A:B       1   0.562    0.562   0.5294 0.4942562
```

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

```
$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
A        1  68.062   68.062  64.0588 0.0002029 ***
A:sub     6 227.875   37.979  35.7451 0.0001934 ***
B         1  85.562   85.562  80.5294 0.0001070 ***
A:B       1   0.562    0.562   0.5294 0.4942562
```

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

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

```
B      1  85.562  85.562 80.5294 0.0001070 ***
A:B    1   0.562   0.562  0.5294 0.4942562
```

```
---
```

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

```
(97) MODEL
```

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

```
$ANOVA
```

```
Response : Y
```

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

```
---
```

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

```
$`Type I`
```

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

```
---
```

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

```
$`Type II`
```

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

```
---
```

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

```
$`Type III`
```

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

```
---
```

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

(98) MODEL

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

\$ANOVA

Response : Z

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

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

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

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

(99) MODEL

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

\$ANOVA

Response : Y

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

```

MODEL          11    328 29.8182  3.1948 0.02875 *
RESIDUALS      12    112  9.3333
CORRECTED TOTAL 23    440

```

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	48	24	2.5714	0.11765
whole	1	24	24	2.5714	0.13479
block:whole	2	16	8	0.8571	0.44880
split	3	156	52	5.5714	0.01251 *
whole:split	3	84	28	3.0000	0.07277 .
Z	0				

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	13.286	6.643	0.7117	0.51039
whole	1	16.000	16.000	1.7143	0.21495
block:whole	1	16.000	16.000	1.7143	0.21495
split	3	156.000	52.000	5.5714	0.01251 *
whole:split	3	84.000	28.000	3.0000	0.07277 .
Z	0				

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	13.286	6.643	0.7117	0.51039
whole	1	16.000	16.000	1.7143	0.21495
block:whole	1	16.000	16.000	1.7143	0.21495
split	3	156.000	52.000	5.5714	0.01251 *
whole:split	3	84.000	28.000	3.0000	0.07277 .
Z	0				

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

7.18 Example 11.3

(100) MODEL

```

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

```

\$ANOVA

Response : Y

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	4.5000	1.5000	3.0000	0.11696
A	1	1.5000	1.5000	3.0000	0.13397
block:A	3	0.5000	0.1667	0.3333	0.80220
B	2	8.3333	4.1667	8.3333	0.01855 *
block:B	6	1.0000	0.1667	0.3333	0.89648
A:B	2	1.0000	0.5000	1.0000	0.42188

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	4.5000	1.5000	3.0000	0.11696
A	1	1.5000	1.5000	3.0000	0.13397
block:A	3	0.5000	0.1667	0.3333	0.80220
B	2	8.3333	4.1667	8.3333	0.01855 *
block:B	6	1.0000	0.1667	0.3333	0.89648
A:B	2	1.0000	0.5000	1.0000	0.42188

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	4.5000	1.5000	3.0000	0.11696
A	1	1.5000	1.5000	3.0000	0.13397
block:A	3	0.5000	0.1667	0.3333	0.80220
B	2	8.3333	4.1667	8.3333	0.01855 *
block:B	6	1.0000	0.1667	0.3333	0.89648
A:B	2	1.0000	0.5000	1.0000	0.42188

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

(101) MODEL

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

\$ANOVA

Response : Z

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

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	6.8333	2.2778	4.1	0.06689 .
A	1	6.0000	6.0000	10.8	0.01669 *
block:A	3	1.6667	0.5556	1.0	0.45472
B	2	13.0000	6.5000	11.7	0.00850 **
block:B	6	3.6667	0.6111	1.1	0.45542
A:B	2	0.0000	0.0000	0.0	1.00000

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	6.8333	2.2778	4.1	0.06689 .
A	1	6.0000	6.0000	10.8	0.01669 *
block:A	3	1.6667	0.5556	1.0	0.45472
B	2	13.0000	6.5000	11.7	0.00850 **
block:B	6	3.6667	0.6111	1.1	0.45542
A:B	2	0.0000	0.0000	0.0	1.00000

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	3	6.8333	2.2778	4.1	0.06689 .
A	1	6.0000	6.0000	10.8	0.01669 *
block:A	3	1.6667	0.5556	1.0	0.45472
B	2	13.0000	6.5000	11.7	0.00850 **
block:B	6	3.6667	0.6111	1.1	0.45542
A:B	2	0.0000	0.0000	0.0	1.00000

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

```
(102) MODEL
```

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

```
$ANOVA
```

```
Response : Y
```

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

```
$`Type I`
```

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

block	3	4.5000	1.5000	3.7657	0.09378	.
A	1	1.5000	1.5000	3.7657	0.10999	
block:A	3	0.5000	0.1667	0.4184	0.74788	
B	2	8.3333	4.1667	10.4603	0.01634	*
block:B	6	1.0000	0.1667	0.4184	0.84059	
A:B	2	1.0000	0.5000	1.2552	0.36163	
Z	1	1.0083	1.0083	2.5314	0.17248	

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

\$`Type II`

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

\$`Type III`

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

8 Hinkelmann & Kempthorne - Volume 1

Reference

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

8.1 Chapter 6

8.1.1 p202

(103) MODEL

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

\$ANOVA

Response : miles

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	47.234	11.809	15.661	0.004924 **
RESIDUALS	5	3.770	0.754		
CORRECTED TOTAL	9	51.004			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	47.234	11.809	15.661	0.004924 **

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	47.234	11.809	15.661	0.004924 **

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	47.234	11.809	15.661	0.004924 **

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

8.1.2 p205

(104) MODEL

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

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

```
$ANOVA
```

```
Response : miles
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	9	140.05	15.561	80.21	1.017e-13 ***
RESIDUALS	20	3.88	0.194		
CORRECTED TOTAL	29	143.93			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	133.243	33.311	171.7053	3.553e-15 ***
brand:car	5	6.803	1.361	7.0137	0.0006214 ***

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	133.243	33.311	171.7053	3.553e-15 ***
brand:car	5	6.803	1.361	7.0137	0.0006214 ***

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
brand	4	133.243	33.311	171.7053	3.553e-15 ***
brand:car	5	6.803	1.361	7.0137	0.0006214 ***

```
---
```

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

8.2 Chapter 7

8.2.1 p232

```
(105) MODEL
```

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

```
$ANOVA
```

```
Response : yield
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	59.174	14.793	28.781	0.0012 **
RESIDUALS	5	2.570	0.514		
CORRECTED TOTAL	9	61.744			

```
---
```

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

```
$`Type I`
```

```
      Df Sum Sq Mean Sq F value Pr(>F)
trt    4 59.174   14.793   28.781 0.0012 **
```

```
---
```

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

```
$`Type II`
```

```
      Df Sum Sq Mean Sq F value Pr(>F)
trt    4 59.174   14.793   28.781 0.0012 **
```

```
---
```

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

```
$`Type III`
```

```
      Df Sum Sq Mean Sq F value Pr(>F)
trt    4 59.174   14.793   28.781 0.0012 **
```

```
---
```

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

8.2.2 p235

(106) MODEL

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

```
$ANOVA
```

```
Response : yield
```

```
      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL          4 88.007  22.0017   32.198 1.095e-05 ***
RESIDUALS       10  6.833   0.6833
CORRECTED TOTAL 14 94.840
```

```
---
```

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

```
$`Type I`
```

```
      Df Sum Sq Mean Sq F value    Pr(>F)
density  4 88.007   22.002   32.198 1.095e-05 ***
```

```
---
```

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

```
$`Type II`
```

```
      Df Sum Sq Mean Sq F value    Pr(>F)
density  4 88.007   22.002   32.198 1.095e-05 ***
```

```
---
```

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

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

8.3 Chapter 8

8.3.1 p265

(107) MODEL

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

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

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

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

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

8.3.2 p272

(108) MODEL

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

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	5	85.711	17.142	20.881	0.0001046 ***
RESIDUALS	9	7.389	0.821		
CORRECTED TOTAL	14	93.100			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	2	66.868	33.434	40.7254	3.092e-05 ***
trt:x	3	18.843	6.281	7.6509	0.007578 **

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	2	66.868	33.434	40.7254	3.092e-05 ***
trt:x	3	18.843	6.281	7.6509	0.007578 **

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
trt	2	6.1392	3.0696	3.7390	0.065769 .
trt:x	3	18.8433	6.2811	7.6509	0.007578 **

```
---
```

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

8.3.3 p273

```
(109) MODEL
```

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

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	5	85.711	17.142	20.881	0.0001046 ***
RESIDUALS	9	7.389	0.821		
CORRECTED TOTAL	14	93.100			

```
---
```

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

```
$`Type I`
```



```

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

```

\$`Type II`

```

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

```

\$`Type III`

```

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

```

8.4 Chapter 9

8.4.1 p344

(110) MODEL

```

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

```

\$ANOVA

Response : gain

```

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

```

\$`Type I`

```

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

```

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

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

8.4.2 p349

(111) MODEL

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

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

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

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

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

```

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

```

8.4.3 p354

(112) MODEL

```

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

```

\$ANOVA

Response : height

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	23	40782	1773.12	80.444	< 2.2e-16 ***
RESIDUALS	24	529	22.04		
CORRECTED TOTAL	47	41311			

```

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

```

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
loc	1	20336.3	20336.3	922.6314	< 2.2e-16 ***
loc:block	6	1462.3	243.7	11.0573	6.408e-06 ***
HSF	2	12170.7	6085.3	276.0832	< 2.2e-16 ***
loc:HSF	2	6511.2	3255.6	147.7013	3.242e-14 ***
loc:block:HSF	12	301.2	25.1	1.1386	0.3769

```

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

```

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
loc	1	20336.3	20336.3	922.6314	< 2.2e-16 ***
loc:block	6	1462.3	243.7	11.0573	6.408e-06 ***
HSF	2	12170.7	6085.3	276.0832	< 2.2e-16 ***
loc:HSF	2	6511.2	3255.6	147.7013	3.242e-14 ***
loc:block:HSF	12	301.2	25.1	1.1386	0.3769

```

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

```

\$`Type III`

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

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

8.4.4 p357

(113) MODEL

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

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	9	4465.5	496.16	14.116	0.000142 ***
RESIDUALS	10	351.5	35.15		
CORRECTED TOTAL	19	4817.0			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
var	1	140.5	140.45	3.9957	0.073519 .
N	4	3393.7	848.42	24.1373	4.027e-05 ***
var:N	4	931.3	232.82	6.6238	0.007152 **

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
var	1	140.5	140.45	3.9957	0.073519 .
N	4	3393.7	848.43	24.1373	4.027e-05 ***
var:N	4	931.3	232.82	6.6238	0.007152 **

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
var	1	140.5	140.45	3.9957	0.073519 .
N	4	3393.7	848.42	24.1373	4.027e-05 ***
var:N	4	931.3	232.83	6.6238	0.007152 **

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

8.4.5 p361

(114) MODEL

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

\$ANOVA

Response : y

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	24.333	12.167	8.1111	0.24097
trt	2	217.000	108.500	72.3333	0.08286 .

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	108	54.0	36.000	0.11704
trt	2	217	108.5	72.333	0.08286 .

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	2	108	54.0	36.000	0.11704
trt	2	217	108.5	72.333	0.08286 .

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

```
y = model.frame(y ~ block + trt, v1p361)[,1]
```

```
x = ModelMatrix(y ~ block + trt, v1p361)
```

```
rx = lfit(x, y)
```

```
K = cbind(rep(1, 3), matrix(1/3, nrow=3, ncol=3), diag(3)) ; K
```

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

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

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

attr("Estimability")

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

8.5 Chapter 10

8.5.1 p405

```
(115) MODEL
```

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

```
$ANOVA
```

```
Response : y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	12	4094.7	341.23	2.3416	0.07739 .
RESIDUALS	12	1748.7	145.73		
CORRECTED TOTAL	24	5843.4			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Row	4	514.24	128.56	0.8822	0.50328
Col	4	1711.44	427.86	2.9360	0.06611 .
trt	4	1869.04	467.26	3.2064	0.05229 .

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Row	4	514.24	128.56	0.8822	0.50328
Col	4	1711.44	427.86	2.9360	0.06611 .
trt	4	1869.04	467.26	3.2064	0.05229 .

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Row	4	514.24	128.56	0.8822	0.50328
Col	4	1711.44	427.86	2.9360	0.06611 .
trt	4	1869.04	467.26	3.2064	0.05229 .

```
---
```

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

8.5.2 p408

```
(116) MODEL
```

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

\$ANOVA

Response : response

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	16	4470.2	279.391	140.87	2.039e-13 ***
RESIDUALS	15	29.7	1.983		
CORRECTED TOTAL	31	4500.0			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
breed	1	3280.5	3280.5	1654.0336	< 2.2e-16 ***
breed:farm	6	9.0	1.5	0.7563	0.6146
wclass	3	466.8	155.6	78.4454	2.142e-09 ***
dosage	3	580.2	193.4	97.5210	4.596e-10 ***
breed:dosage	3	133.8	44.6	22.4790	8.366e-06 ***

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
breed	1	3280.5	3280.5	1654.0336	< 2.2e-16 ***
breed:farm	6	9.0	1.5	0.7563	0.6146
wclass	3	466.7	155.6	78.4454	2.142e-09 ***
dosage	3	580.2	193.4	97.5210	4.596e-10 ***
breed:dosage	3	133.8	44.6	22.4790	8.366e-06 ***

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

\$`Type III`

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

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

8.5.3 p410

(117) MODEL

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

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	17	1302.51	76.618	8.7402	1.572e-05 ***
RESIDUALS	18	157.79	8.766		
CORRECTED TOTAL	35	1460.31			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
period	2	292.06	146.028	16.6580	8.038e-05 ***
sequence	5	326.47	65.294	7.4484	0.0006072 ***
sequence:steer	6	118.50	19.750	2.2530	0.0849122 .
trt	2	549.06	274.528	31.3166	1.377e-06 ***
carry	2	16.43	8.215	0.9372	0.4100385

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
period	2	172.31	86.154	9.8279	0.0013030 **
sequence	5	318.69	63.738	7.2709	0.0006954 ***
sequence:steer	6	118.50	19.750	2.2530	0.0849122 .
trt	2	440.61	220.304	25.1311	6.164e-06 ***
carry	2	16.43	8.215	0.9372	0.4100385

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
period	2	172.31	86.154	9.8279	0.0013030 **
sequence	5	318.69	63.738	7.2709	0.0006954 ***
sequence:steer	6	118.50	19.750	2.2530	0.0849122 .
trt	2	440.61	220.304	25.1311	6.164e-06 ***
carry	2	16.43	8.215	0.9372	0.4100385

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

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


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

Anova Table (Type III tests)

Response: y

	Sum Sq	Df	F values	Pr(>F)
period	172.31	2	9.8279	0.001303 **
sequence	0.00	0		
trt	440.61	2	25.1311	6.164e-06 ***
carry	16.43	2	0.9372	0.410038
sequence:steer	118.50	6	2.2530	0.084912 .
Residuals	157.79	18		

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

8.6 Chapter 11

8.6.1 p432

(118) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	94	261663	2783.65	30.584	2.065e-14 ***
RESIDUALS	25	2275	91.02		
CORRECTED TOTAL	119	263939			

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

\$`Type I`

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

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

\$`Type II`

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

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

\$`Type III`

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

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

8.6.2 p434

(119) MODEL

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

\$ANOVA

Response : Y

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

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

\$`Type I`

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

```

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

```

```

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

```

```

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

```

8.6.3 p438

(120) MODEL

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

\$ANOVA

Response : Y

```

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

```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
V	4	102743	25686	225.9988	< 2.2e-16 ***
V:Block	25	50019	2001	17.6040	< 2.2e-16 ***
C	3	97100	32367	284.7823	< 2.2e-16 ***
V:C	12	5552	463	4.0709	7.23e-05 ***

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
V	4	102743	25686	225.9988	< 2.2e-16 ***
V:Block	25	50019	2001	17.6040	< 2.2e-16 ***
C	3	97100	32367	284.7823	< 2.2e-16 ***
V:C	12	5552	463	4.0709	7.23e-05 ***

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
V	4	102743	25686	225.9988	< 2.2e-16 ***
V:Block	25	50019	2001	17.6040	< 2.2e-16 ***
C	3	97100	32367	284.7823	< 2.2e-16 ***
V:C	12	5552	463	4.0709	7.23e-05 ***

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

8.6.4 p444

```
(121) MODEL
```

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

```
$ANOVA
```

```
Response : Y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	39278	3570.8	59.787	1.897e-06 ***
RESIDUALS	8	478	59.7		
CORRECTED TOTAL	19	39756			

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

```
$`Type I`
```

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

```

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

```

```

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

```

```

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

```

8.6.5 p482

(122) MODEL

```

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

```

```

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

```

```

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

```

```

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

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

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

```

8.7 Chapter 12

8.7.1 p525

(123) MODEL

```

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

```

```

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

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

```

\$ANOVA

Response : y

```

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

```

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

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

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

8.7.2 p527

(124) MODEL

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

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

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

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

```

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

```

```

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

```

8.7.3 p529

(125) MODEL

```

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

```

```

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

```

```

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

```

```

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

```

```

$`Type III`

```



```

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

```

8.8 Chapter 13

8.8.1 p563

(126) MODEL

```

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

```

\$ANOVA

Response : y

```

      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      14 2097.08 149.792   17.228 8.385e-05 ***
RESIDUALS      9   78.25   8.694
CORRECTED TOTAL 23 2175.33
---

```

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

\$`Type I`

```

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

```

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

\$`Type II`

```

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

```

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

\$`Type III`

```

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

```

8.8.2 p566

(127) MODEL

```

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

```

\$ANOVA

Response : y

```

      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      5 1469.58  293.92   86.2 5.592e-09 ***
RESIDUALS  12   40.92    3.41
CORRECTED TOTAL 17 1510.50
---

```

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

\$`Type I`

```

      Df Sum Sq Mean Sq F value    Pr(>F)
A      2 1390.04  695.02  203.8350 5.466e-10 ***
B      1   76.06   76.06   22.3055 0.0004945 ***
A:B    2    3.49    1.74    0.5112 0.6122667
---

```

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

\$`Type II`

```

      Df Sum Sq Mean Sq F value    Pr(>F)
A      2 1390.04  695.02  203.8350 5.466e-10 ***
B      1   76.06   76.06   22.3055 0.0004945 ***
A:B    2    3.49    1.74    0.5112 0.6122667
---

```

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

\$`Type III`

```

      Df Sum Sq Mean Sq F value    Pr(>F)
A      2 1390.04  695.02  203.8350 5.466e-10 ***
B      1   79.00   79.00   23.1700 0.0004237 ***
A:B    2    3.49    1.74    0.5112 0.6122667
---

```

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

8.9 Chapter 14

8.9.1 p581

(128) MODEL

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

\$ANOVA

Response : rate

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	23	2449.5	106.500	12.733	3.469e-11 ***
RESIDUALS	36	301.1	8.364		
CORRECTED TOTAL	59	2750.6			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
drug	2	337.60	168.800	20.1820	1.323e-06 ***
drug:person	12	1498.50	124.875	14.9303	1.501e-10 ***
time	3	256.33	85.444	10.2159	5.230e-05 ***
drug:time	6	357.07	59.511	7.1152	4.707e-05 ***

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
drug	2	337.60	168.800	20.1820	1.323e-06 ***
drug:person	12	1498.50	124.875	14.9303	1.501e-10 ***
time	3	256.33	85.444	10.2159	5.230e-05 ***
drug:time	6	357.07	59.511	7.1152	4.707e-05 ***

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
drug	2	337.60	168.800	20.1820	1.323e-06 ***
drug:person	12	1498.50	124.875	14.9303	1.501e-10 ***
time	3	256.33	85.444	10.2159	5.230e-05 ***
drug:time	6	357.07	59.511	7.1152	4.707e-05 ***

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

9 Hinkelmann & Kempthorne - Volume 2

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

9.1 Chapter 1

9.1.1 p53

(129) MODEL

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

\$ANOVA

Response : Y

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
BLOCK	4	261.40	65.350	7.1863	0.12587
TRT	3	256.81	85.604	9.4135	0.09755 .

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
BLOCK	4	79.146	19.786	2.1758	0.33880
TRT	3	256.812	85.604	9.4135	0.09755 .

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
BLOCK	4	79.146	19.786	2.1758	0.33880
TRT	3	256.813	85.604	9.4135	0.09755 .

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

9.1.2 p62

(130) MODEL

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

\$ANOVA

Response : Y

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	3	439.07	146.356	16.0941	0.05907 .
BLOCK	4	79.15	19.786	2.1758	0.33880

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	3	256.812	85.604	9.4135	0.09755 .
BLOCK	4	79.146	19.786	2.1758	0.33880

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
TRT	3	256.813	85.604	9.4135	0.09755 .
BLOCK	4	79.146	19.786	2.1758	0.33880

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

9.2 Chapter 2

9.2.1 p82

(131) MODEL

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

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	889.11	63.508	6.3183	0.000518 ***
RESIDUALS	15	150.77	10.052		
CORRECTED TOTAL	29	1039.89			

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

\$`Type I`

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

```

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

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

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

```

9.2.2 p87

(132) MODEL

```

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

```

\$ANOVA

Response : y

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
x1	1	1044.48	1044.48	7.2293	0.05473 .
x2	1	89.79	89.79	0.6215	0.47459
x3	1	10.45	10.45	0.0724	0.80124
x4	1	407.08	407.08	2.8176	0.16854
x5	1	61.44	61.44	0.4253	0.54990
x6	0				

```

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

```

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
x1	0				
x2	0				
x3	0				
x4	0				

```
x5 0
x6 0
```

```
$`Type III`
```

```
CAUTION: Singularity Exists !
```

```
      Df Sum Sq Mean Sq F value Pr(>F)
x1  0
x2  0
x3  0
x4  0
x5  0
x6  0
```

9.3 Chapter 6

9.3.1 p217

```
(133) MODEL
```

```
v2p217 = read.table("C:/G/Rt/Kemp/v2p217.txt", head=TRUE)
v2p217 = af(v2p217, c("R", "C", "Tx"))
ANOVA(Y ~ R + C + Tx, v2p217) # OK
```

```
$ANOVA
```

```
Response : Y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	22	4305.1	195.687	7.5094	0.0002682 ***
RESIDUALS	13	338.8	26.059		
CORRECTED TOTAL	35	4643.9			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	3951.4	1317.15	50.5446	1.998e-07 ***
C	8	168.9	21.11	0.8101	0.6062
Tx	11	184.8	16.80	0.6446	0.7638

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	3403.5	1134.51	43.5360	4.83e-07 ***
C	8	112.4	14.05	0.5390	0.8077
Tx	11	184.8	16.80	0.6446	0.7638

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	3403.5	1134.51	43.5360	4.83e-07 ***
C	8	112.4	14.05	0.5390	0.8077
Tx	11	184.8	16.80	0.6446	0.7638

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

9.3.2 p234

(134) MODEL

```
v2p234 = read.table("C:/G/Rt/Kemp/v2p234.txt", head=TRUE)
v2p234 = af(v2p234, c("R", "C", "Tx"))
ANOVA(Y ~ C + R + Tx, v2p234) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	13	426.50	32.808	7.0936	0.1302
RESIDUALS	2	9.25	4.625		
CORRECTED TOTAL	15	435.75			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
C	3	16.25	5.417	1.1712	0.49129
R	3	357.25	119.083	25.7477	0.03762 *
Tx	7	53.00	7.571	1.6371	0.43052

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
C	3	10.25	3.417	0.7387	0.6189
R	3	285.50	95.167	20.5766	0.0467 *
Tx	7	53.00	7.571	1.6371	0.4305

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
C	3	10.25	3.417	0.7387	0.6189
R	3	285.50	95.167	20.5766	0.0467 *
Tx	7	53.00	7.571	1.6371	0.4305

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

9.4 Chapter 7

9.4.1 p268

(135) MODEL

```
v2p268 = read.table("C:/G/Rt/Kemp/v2p268.txt", head=TRUE)
v2p268 = af(v2p268, c("A", "B", "C"))
ANOVA(y ~ block + A*B*C, v2p268) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	1026.00	128.250	24.981	0.0001765 ***
RESIDUALS	7	35.94	5.134		
CORRECTED TOTAL	15	1061.94			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	1	715.56	715.56	139.3791	7.093e-06 ***
A	1	68.06	68.06	13.2574	0.0082753 **
B	1	0.06	0.06	0.0122	0.9152401
A:B	1	0.56	0.56	0.1096	0.7503276
C	1	232.56	232.56	45.2991	0.0002698 ***
A:C	1	0.06	0.06	0.0122	0.9152401
B:C	1	7.56	7.56	1.4730	0.2642229
A:B:C	1	1.56	1.56	0.3043	0.5983312

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	1	715.56	715.56	139.3791	7.093e-06 ***
A	1	68.06	68.06	13.2574	0.0082753 **
B	1	0.06	0.06	0.0122	0.9152401
A:B	1	0.56	0.56	0.1096	0.7503276
C	1	232.56	232.56	45.2991	0.0002698 ***
A:C	1	0.06	0.06	0.0122	0.9152401
B:C	1	7.56	7.56	1.4730	0.2642229
A:B:C	1	1.56	1.56	0.3043	0.5983312

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	1	715.56	715.56	139.3791	7.093e-06 ***
A	1	68.06	68.06	13.2574	0.0082753 **

```

B      1    0.06    0.06    0.0122 0.9152401
A:B    1    0.56    0.56    0.1096 0.7503276
C      1 232.56  232.56  45.2991 0.0002698 ***
A:C    1    0.06    0.06    0.0122 0.9152401
B:C    1    7.56    7.56    1.4730 0.2642229
A:B:C  1    1.56    1.56    0.3043 0.5983312

```

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

9.4.2 p273

(136) MODEL

```

v2p273 = read.table("C:/G/Rt/Kemp/v2p273.txt", head=TRUE)
v2p273 = af(v2p273, c("block", "A", "B", "C"))
ANOVA(y ~ block + A*B*C + block:A:B:C, v2p273) # OK

```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	15	2245.0	149.665	129.44	8.427e-14 ***
RESIDUALS	16	18.5	1.156		
CORRECTED TOTAL	31	2263.5			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	1	1498.78	1498.78	1296.2432	< 2.2e-16 ***
A	1	132.03	132.03	114.1892	1.083e-08 ***
B	1	0.03	0.03	0.0270	0.87148
A:B	1	1.53	1.53	1.3243	0.26673
C	1	504.03	504.03	435.9189	4.926e-13 ***
A:C	1	0.78	0.78	0.6757	0.42316
B:C	1	3.78	3.78	3.2703	0.08938 .
A:B:C	1	2.53	2.53	2.1892	0.15840
block:A:B:C	7	101.47	14.50	12.5367	1.965e-05 ***

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	1	1498.78	1498.78	1296.2432	< 2.2e-16 ***
A	1	132.03	132.03	114.1892	1.083e-08 ***
B	1	0.03	0.03	0.0270	0.87148
A:B	1	1.53	1.53	1.3243	0.26673
C	1	504.03	504.03	435.9189	4.926e-13 ***
A:C	1	0.78	0.78	0.6757	0.42316
B:C	1	3.78	3.78	3.2703	0.08938 .

```

A:B:C          1    2.53    2.53    2.1892    0.15840
block:A:B:C    7   101.47   14.50   12.5367  1.965e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
block	1	1498.78	1498.78	1296.2432	< 2.2e-16 ***
A	1	132.03	132.03	114.1892	1.083e-08 ***
B	1	0.03	0.03	0.0270	0.87148
A:B	1	1.53	1.53	1.3243	0.26673
C	1	504.03	504.03	435.9189	4.926e-13 ***
A:C	1	0.78	0.78	0.6757	0.42316
B:C	1	3.78	3.78	3.2703	0.08938 .
A:B:C	1	2.53	2.53	2.1892	0.15840
block:A:B:C	7	101.47	14.50	12.5367	1.965e-05 ***

```

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

```

9.5 Chapter 8

9.5.1 p304

(137) MODEL

```

v2p304 = read.table("C:/G/Rt/Kemp/v2p304.txt", head=TRUE)
v2p304 = af(v2p304, c("rep", "block", "A", "B", "C"))
ANOVA(y ~ rep + block %in% rep + A*B*C - A:B:C, v2p304) # OK

```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	9	699.06	77.674	248.56	5.096e-07 ***
RESIDUALS	6	1.88	0.312		
CORRECTED TOTAL	15	700.94			

```

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

```

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06	1248.2	3.428e-08 ***
rep:block	2	8.12	4.06	13.0	0.0065918 **
A	1	18.06	18.06	57.8	0.0002696 ***
B	1	175.56	175.56	561.8	3.702e-07 ***
A:B	1	0.06	0.06	0.2	0.6704121
C	1	68.06	68.06	217.8	6.083e-06 ***
A:C	1	0.06	0.06	0.2	0.6704121
B:C	1	39.06	39.06	125.0	3.056e-05 ***

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06	1248.2	3.428e-08 ***
rep:block	2	8.12	4.06	13.0	0.0065918 **
A	1	18.06	18.06	57.8	0.0002696 ***
B	1	175.56	175.56	561.8	3.702e-07 ***
A:B	1	0.06	0.06	0.2	0.6704121
C	1	68.06	68.06	217.8	6.083e-06 ***
A:C	1	0.06	0.06	0.2	0.6704121
B:C	1	39.06	39.06	125.0	3.056e-05 ***

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06	1248.2	3.428e-08 ***
rep:block	2	8.12	4.06	13.0	0.0065918 **
A	1	18.06	18.06	57.8	0.0002696 ***
B	1	175.56	175.56	561.8	3.702e-07 ***
A:B	1	0.06	0.06	0.2	0.6704121
C	1	68.06	68.06	217.8	6.083e-06 ***
A:C	1	0.06	0.06	0.2	0.6704121
B:C	1	39.06	39.06	125.0	3.056e-05 ***

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

9.5.2 p309

(138) MODEL

```
ANOVA(y ~ rep*A*B*C, v2p304) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	15	700.94	46.729		
RESIDUALS	0	0.00			
CORRECTED TOTAL	15	700.94			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06		
A	1	18.06	18.06		
rep:A	1	0.06	0.06		
B	1	175.56	175.56		
rep:B	1	1.56	1.56		
A:B	1	0.06	0.06		

rep:A:B	1	0.06	0.06
C	1	68.06	68.06
rep:C	1	0.06	0.06
A:C	1	0.06	0.06
rep:A:C	1	0.06	0.06
B:C	1	39.06	39.06
rep:B:C	1	0.06	0.06
A:B:C	1	7.56	7.56
rep:A:B:C	1	0.56	0.56

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06		
A	1	18.06	18.06		
rep:A	1	0.06	0.06		
B	1	175.56	175.56		
rep:B	1	1.56	1.56		
A:B	1	0.06	0.06		
rep:A:B	1	0.06	0.06		
C	1	68.06	68.06		
rep:C	1	0.06	0.06		
A:C	1	0.06	0.06		
rep:A:C	1	0.06	0.06		
B:C	1	39.06	39.06		
rep:B:C	1	0.06	0.06		
A:B:C	1	7.56	7.56		
rep:A:B:C	1	0.56	0.56		

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	390.06	390.06		
A	1	18.06	18.06		
rep:A	1	0.06	0.06		
B	1	175.56	175.56		
rep:B	1	1.56	1.56		
A:B	1	0.06	0.06		
rep:A:B	1	0.06	0.06		
C	1	68.06	68.06		
rep:C	1	0.06	0.06		
A:C	1	0.06	0.06		
rep:A:C	1	0.06	0.06		
B:C	1	39.06	39.06		
rep:B:C	1	0.06	0.06		
A:B:C	1	7.56	7.56		
rep:A:B:C	1	0.56	0.56		

9.6 Chapter 9

9.6.1 p343

(139) MODEL

```
v2p343 = read.table("C:/G/Rt/Kemp/v2p343.txt", head=TRUE)
v2p343 = af(v2p343, c("rep", "block", "A", "B", "C"))
ANOVA(y ~ rep + block %in% rep + A*B*C - A:B:C, v2p343) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	17	1889.8	111.167	14.659	0.001608 **
RESIDUALS	6	45.5	7.583		
CORRECTED TOTAL	23	1935.3			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
rep:block	9	127.00	14.11	1.8608	0.23163
A	1	36.00	36.00	4.7473	0.07218 .
B	1	36.00	36.00	4.7473	0.07218 .
A:B	1	12.25	12.25	1.6154	0.25079
C	1	56.25	56.25	7.4176	0.03448 *
A:C	1	81.00	81.00	10.6813	0.01707 *
B:C	1	4.00	4.00	0.5275	0.49502

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
rep:block	9	119.83	13.31	1.7558	0.25388
A	1	36.00	36.00	4.7473	0.07218 .
B	1	36.00	36.00	4.7473	0.07218 .
A:B	1	12.25	12.25	1.6154	0.25079
C	1	56.25	56.25	7.4176	0.03448 *
A:C	1	81.00	81.00	10.6813	0.01707 *
B:C	1	4.00	4.00	0.5275	0.49502

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
rep:block	9	119.83	13.31	1.7558	0.25388

A	1	36.00	36.00	4.7473	0.07218	.
B	1	36.00	36.00	4.7473	0.07218	.
A:B	1	12.25	12.25	1.6154	0.25079	
C	1	56.25	56.25	7.4176	0.03448	*
A:C	1	81.00	81.00	10.6813	0.01707	*
B:C	1	4.00	4.00	0.5275	0.49502	

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

9.6.2 p348

(140) MODEL

```
ANOVA(y ~ rep + A*B*C + block %in% rep, v2p343) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	17	1889.8	111.167	14.659	0.001608 **
RESIDUALS	6	45.5	7.583		
CORRECTED TOTAL	23	1935.3			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
A	1	88.17	88.17	11.6264	0.01432 *
B	1	37.50	37.50	4.9451	0.06785 .
A:B	1	2.67	2.67	0.3516	0.57484
C	1	66.67	66.67	8.7912	0.02512 *
A:C	1	37.50	37.50	4.9451	0.06785 .
B:C	1	0.17	0.17	0.0220	0.88700
A:B:C	1	24.00	24.00	3.1648	0.12555
rep:block	8	95.83	11.98	1.5797	0.29730

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
A	1	36.00	36.00	4.7473	0.07218 .
B	1	36.00	36.00	4.7473	0.07218 .
A:B	1	12.25	12.25	1.6154	0.25079
C	1	56.25	56.25	7.4176	0.03448 *
A:C	1	81.00	81.00	10.6813	0.01707 *
B:C	1	4.00	4.00	0.5275	0.49502
A:B:C	0				
rep:block	8	95.83	11.98	1.5797	0.29730

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	2	1537.33	768.67	101.3626	2.375e-05 ***
A	1	36.00	36.00	4.7473	0.07218 .
B	1	36.00	36.00	4.7473	0.07218 .
A:B	1	12.25	12.25	1.6154	0.25079
C	1	56.25	56.25	7.4176	0.03448 *
A:C	1	81.00	81.00	10.6813	0.01707 *
B:C	1	4.00	4.00	0.5275	0.49502
A:B:C	0				
rep:block	8	95.83	11.98	1.5797	0.29730

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

9.6.3 p353

(141) MODEL

```
v2p353 = read.table("C:/G/Rt/Kemp/v2p353.txt", head=TRUE)
v2p353 = af(v2p353, c("rep", "block", "A", "B", "C", "D"))
ANOVA(y ~ rep + rep:block + A*B*C*D - A:B:C:D, v2p353) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	21	7132.2	339.63	56.022	9.795e-08 ***
RESIDUALS	10	60.6	6.06		
CORRECTED TOTAL	31	7192.9			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	5940.5	5940.5	979.8763	2.600e-11 ***
rep:block	6	777.4	129.6	21.3711	3.675e-05 ***
A	1	171.1	171.1	28.2268	0.0003412 ***
B	1	18.0	18.0	2.9691	0.1155937
A:B	1	1.6	1.6	0.2577	0.6226914
C	1	120.1	120.1	19.8144	0.0012326 **
A:C	1	0.6	0.6	0.0928	0.7669127
B:C	1	2.0	2.0	0.3299	0.5784103
A:B:C	1	4.5	4.5	0.7423	0.4091189
D	1	6.1	6.1	1.0103	0.3385304
A:D	1	1.1	1.1	0.1856	0.6757693
B:D	1	5.1	5.1	0.8351	0.3823203

A:B:D	1	0.5	0.5	0.0825	0.7798349
C:D	1	1.6	1.6	0.2577	0.6226914
A:C:D	1	10.1	10.1	1.6701	0.2253083
B:C:D	1	72.0	72.0	11.8763	0.0062660 **

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
rep	1	5940.5	5940.5	979.8763	2.6e-11	***
rep:block	6	406.9	67.8	11.1856	0.0006129	***
A	1	171.1	171.1	28.2268	0.0003412	***
B	1	18.0	18.0	2.9691	0.1155937	
A:B	1	1.6	1.6	0.2577	0.6226914	
C	1	120.1	120.1	19.8144	0.0012326	**
A:C	1	0.6	0.6	0.0928	0.7669127	
B:C	1	2.0	2.0	0.3299	0.5784103	
A:B:C	1	4.5	4.5	0.7423	0.4091189	
D	1	6.1	6.1	1.0103	0.3385304	
A:D	1	1.1	1.1	0.1856	0.6757693	
B:D	1	5.1	5.1	0.8351	0.3823203	
A:B:D	1	0.5	0.5	0.0825	0.7798349	
C:D	1	1.6	1.6	0.2577	0.6226914	
A:C:D	1	10.1	10.1	1.6701	0.2253083	
B:C:D	1	72.0	72.0	11.8763	0.0062660	**

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
rep	1	5940.5	5940.5	979.8763	2.6e-11	***
rep:block	6	406.9	67.8	11.1856	0.0006129	***
A	1	171.1	171.1	28.2268	0.0003412	***
B	1	18.0	18.0	2.9691	0.1155937	
A:B	1	1.6	1.6	0.2577	0.6226914	
C	1	120.1	120.1	19.8144	0.0012326	**
A:C	1	0.6	0.6	0.0928	0.7669127	
B:C	1	2.0	2.0	0.3299	0.5784103	
A:B:C	1	4.5	4.5	0.7423	0.4091189	
D	1	6.1	6.1	1.0103	0.3385304	
A:D	1	1.1	1.1	0.1856	0.6757693	
B:D	1	5.1	5.1	0.8351	0.3823203	
A:B:D	1	0.5	0.5	0.0825	0.7798349	
C:D	1	1.6	1.6	0.2577	0.6226914	
A:C:D	1	10.1	10.1	1.6701	0.2253083	
B:C:D	1	72.0	72.0	11.8763	0.0062660	**

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

9.7 Chapter 10

9.7.1 p388

(142) MODEL

```
v2p388 = read.table("C:/G/Rt/Kemp/v2p388.txt", head=TRUE)
v2p388 = af(v2p388, c("rep", "block", "A", "B"))
ANOVA(y ~ rep + A*B + rep:block, v2p388) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	1136.8	103.343	124.01	3.698e-06 ***
RESIDUALS	6	5.0	0.833		
CORRECTED TOTAL	17	1141.8			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	410.89	410.89	493.0667	5.455e-07 ***
A	2	228.11	114.06	136.8667	9.868e-06 ***
B	2	3.44	1.72	2.0667	0.207585
A:B	4	464.22	116.06	139.2667	4.801e-06 ***
rep:block	2	30.11	15.06	18.0667	0.002888 **

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	410.89	410.89	493.0667	5.455e-07 ***
A	2	228.11	114.06	136.8667	9.868e-06 ***
B	2	3.44	1.72	2.0667	0.207585
A:B	2	18.78	9.39	11.2667	0.009298 **
rep:block	2	30.11	15.06	18.0667	0.002888 **

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
rep	1	410.89	410.89	493.0667	5.455e-07 ***
A	2	228.11	114.06	136.8667	9.868e-06 ***
B	2	3.44	1.72	2.0667	0.207585
A:B	2	18.78	9.39	11.2667	0.009298 **
rep:block	2	30.11	15.06	18.0667	0.002888 **

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

9.8 Chapter 14

9.8.1 p570

(143) MODEL

```
v2p570 = read.table("C:/G/Rt/Kemp/v2p570.txt", head=TRUE)
v2p570 = af(v2p570, c("A", "B", "C", "D"))
ANOVA(Y ~ A + B + C + D + A:B + A:C + A:D + B:C + B:D + C:D, v2p570) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	22.222	2.7778		
RESIDUALS	0	0.000			
CORRECTED TOTAL	8	22.222			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	2	2.8889	1.4444		
B	2	2.8889	1.4444		
C	2	1.5556	0.7778		
D	2	14.8889	7.4444		
A:B	0				
A:C	0				
A:D	0				
B:C	0				
B:D	0				
C:D	0				

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	0				
B	0				
C	0				
D	0				
A:B	0				
A:C	0				
A:D	0				
B:C	0				
B:D	0				
C:D	0				

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	0				
B	0				
C	0				

```
D      0
A:B    0
A:C    0
A:D    0
B:C    0
B:D    0
C:D    0
```

9.8.2 p578

(144) MODEL

```
v2p578 = read.table("C:/G/Rt/Kemp/v2p578.txt", head=TRUE)
v2p578 = af(v2p578, 1:11)
ANOVA(Y ~ A + B + C + D + E + F + G + H + J + K + L, v2p578) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	11	575	52.273		
RESIDUALS	0	0			
CORRECTED TOTAL	11	575			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	3.000	3.000		
B	1	27.000	27.000		
C	1	12.000	12.000		
D	1	16.333	16.333		
E	1	176.333	176.333		
F	1	133.333	133.333		
G	1	1.333	1.333		
H	1	21.333	21.333		
J	1	108.000	108.000		
K	1	1.333	1.333		
L	1	75.000	75.000		

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	3.000	3.000		
B	1	27.000	27.000		
C	1	12.000	12.000		
D	1	16.333	16.333		
E	1	176.333	176.333		
F	1	133.333	133.333		
G	1	1.333	1.333		
H	1	21.333	21.333		
J	1	108.000	108.000		
K	1	1.333	1.333		

```
L 1 75.000 75.000
```

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	3.000	3.000		
B	1	27.000	27.000		
C	1	12.000	12.000		
D	1	16.333	16.333		
E	1	176.333	176.333		
F	1	133.333	133.333		
G	1	1.333	1.333		
H	1	21.333	21.333		
J	1	108.000	108.000		
K	1	1.333	1.333		
L	1	75.000	75.000		

```
(145) MODEL
```

```
ANOVA(Y ~ E*F + E*J + F*J + E*L + F*L + J*L, v2p578) # OK
```

```
$ANOVA
```

```
Response : Y
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	10	574.5	57.45	114.9	0.07249 .
RESIDUALS	1	0.5	0.50		
CORRECTED TOTAL	11	575.0			

```
---
```

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
E	1	176.333	176.333	352.6667	0.03387 *
F	1	133.333	133.333	266.6667	0.03894 *
E:F	1	65.333	65.333	130.6667	0.05555 .
J	1	66.667	66.667	133.3333	0.05500 .
E:J	1	2.667	2.667	5.3333	0.26015
F:J	1	112.667	112.667	225.3333	0.04235 *
L	1	10.800	10.800	21.6000	0.13492
E:L	1	5.486	5.486	10.9714	0.18666
F:L	1	0.176	0.176	0.3516	0.65925
J:L	1	1.038	1.038	2.0769	0.38618

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
E	1	61.633	61.633	123.2667	0.05719 .
F	1	75.208	75.208	150.4167	0.05179 .
E:F	1	9.346	9.346	18.6923	0.14470

```

J      1 54.675  54.675 109.3500 0.06069 .
E:J    1  0.115   0.115   0.2308 0.71490
F:J    1 72.115  72.115 144.2308 0.05289 .
L      1 10.800  10.800  21.6000 0.13492
E:L    1  5.654   5.654  11.3077 0.18402
F:L    1  0.115   0.115   0.2308 0.71490
J:L    1  1.038   1.038   2.0769 0.38618
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

$`Type III`
      Df Sum Sq Mean Sq F value Pr(>F)
E      1 61.038  61.038 122.0769 0.05746 .
F      1 61.038  61.038 122.0769 0.05746 .
E:F    1  9.346   9.346  18.6923 0.14470
J      1 61.038  61.038 122.0769 0.05746 .
E:J    1  0.115   0.115   0.2308 0.71490
F:J    1 72.115  72.115 144.2308 0.05289 .
L      1  9.346   9.346  18.6923 0.14470
E:L    1  5.654   5.654  11.3077 0.18402
F:L    1  0.115   0.115   0.2308 0.71490
J:L    1  1.038   1.038   2.0769 0.38618
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

9.9 Chapter 16

9.9.1 p619

(146) MODEL

```

v2p619 = read.table("C:/G/Rt/Kemp/v2p619.txt", head=TRUE)
v2p619 = af(v2p619, c("A", "B", "C"))
ANOVA(y ~ A + B + C + A:B, v2p619) # OK

```

```

$ANOVA
Response : y
      Df Sum Sq Mean Sq F value Pr(>F)
MODEL      4 31.429   7.8571
RESIDUALS  2  0.000   0.0000
CORRECTED TOTAL 6 31.429

```

```

$`Type I`
      Df Sum Sq Mean Sq F value Pr(>F)
A      1 13.7619 13.7619      Inf < 2.2e-16 ***
B      1  1.6667  1.6667      Inf < 2.2e-16 ***
C      1 10.0000 10.0000      Inf < 2.2e-16 ***
A:B    1  6.0000  6.0000      Inf < 2.2e-16 ***
---

```

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	19.6	19.6	Inf	< 2.2e-16 ***
B	1	3.6	3.6	Inf	< 2.2e-16 ***
C	1	13.5	13.5	Inf	< 2.2e-16 ***
A:B	1	6.0	6.0	Inf	< 2.2e-16 ***

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	24.0	24.0	Inf	< 2.2e-16 ***
B	1	6.0	6.0	Inf	< 2.2e-16 ***
C	1	13.5	13.5	Inf	< 2.2e-16 ***
A:B	1	6.0	6.0	Inf	< 2.2e-16 ***

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

(147) MODEL

```
ANOVA(y ~ A + B + C + A:C, v2p619) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	26.0952	6.5238	2.4464	0.3106
RESIDUALS	2	5.3333	2.6667		
CORRECTED TOTAL	6	31.4286			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	13.7619	13.7619	5.1607	0.1511
B	1	1.6667	1.6667	0.6250	0.5120
C	1	10.0000	10.0000	3.7500	0.1924
A:C	1	0.6667	0.6667	0.2500	0.6667

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	19.6000	19.6000	7.35	0.1134
B	1	2.6667	2.6667	1.00	0.4226
C	1	10.0000	10.0000	3.75	0.1924
A:C	1	0.6667	0.6667	0.25	0.6667

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.6667	16.6667	6.2500	0.1296
B	1	2.6667	2.6667	1.0000	0.4226

```
C      1  8.1667  8.1667  3.0625 0.2222
A:C    1  0.6667  0.6667  0.2500 0.6667
```

(148) MODEL

```
ANOVA(y ~ A + B + C + B:C, v2p619) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	26.0952	6.5238	2.4464	0.3106
RESIDUALS	2	5.3333	2.6667		
CORRECTED TOTAL	6	31.4286			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	13.7619	13.7619	5.1607	0.1511
B	1	1.6667	1.6667	0.6250	0.5120
C	1	10.0000	10.0000	3.7500	0.1924
B:C	1	0.6667	0.6667	0.2500	0.6667

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.6667	16.6667	6.25	0.1296
B	1	3.6000	3.6000	1.35	0.3652
C	1	10.0000	10.0000	3.75	0.1924
B:C	1	0.6667	0.6667	0.25	0.6667

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.6667	16.6667	6.2500	0.1296
B	1	2.6667	2.6667	1.0000	0.4226
C	1	8.1667	8.1667	3.0625	0.2222
B:C	1	0.6667	0.6667	0.2500	0.6667

9.9.2 p626

(149) MODEL

```
v2p626 = read.table("C:/G/Rt/Kemp/v2p626.txt", head=TRUE)
v2p626 = af(v2p626, c("A", "B", "C"))
ANOVA(y ~ A + B + C + A:B, v2p626) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	42.092	10.5231	22.002	0.04395 *
RESIDUALS	2	0.957	0.4783		
CORRECTED TOTAL	6	43.049			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.2088	16.2088	33.890	0.02826 *
B	1	4.8150	4.8150	10.068	0.08662 .
C	1	15.7339	15.7339	32.898	0.02908 *
A:B	1	5.3346	5.3346	11.154	0.07916 .

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	25.4131	25.4131	53.136	0.01830 *
B	1	8.6630	8.6630	18.113	0.05102 .
C	1	19.5193	19.5193	40.812	0.02364 *
A:B	1	5.3346	5.3346	11.154	0.07916 .

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	29.7950	29.7950	62.297	0.01568 *
B	1	11.7460	11.7460	24.559	0.03839 *
C	1	19.5193	19.5193	40.812	0.02364 *
A:B	1	5.3346	5.3346	11.154	0.07916 .

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

(150) MODEL

```
ANOVA(y ~ A + B + C + A:C, v2p626) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	4	39.229	9.8072	5.1346	0.1696
RESIDUALS	2	3.820	1.9100		
CORRECTED TOTAL	6	43.049			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	16.2088	16.2088	8.4862	0.1004
B	1	4.8150	4.8150	2.5209	0.2533
C	1	15.7339	15.7339	8.2376	0.1030
A:C	1	2.4711	2.4711	1.2937	0.3733

\$`Type II`

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

```

A      1 25.4131 25.4131 13.3052 0.06762 .
B      1  6.0361  6.0361  3.1602 0.21743
C      1 15.7339 15.7339  8.2376 0.10298
A:C    1  2.4711  2.4711  1.2937 0.37327
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

$`Type III`
      Df Sum Sq Mean Sq F value Pr(>F)
A      1 20.1428 20.1428 10.5459 0.08317 .
B      1  6.0361  6.0361  3.1602 0.21743
C      1 11.8863 11.8863  6.2232 0.13007
A:C    1  2.4711  2.4711  1.2937 0.37327
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

(151) MODEL

```
ANOVA(y ~ A + B + C + B:C, v2p626) # OK
```

```

$ANOVA
Response : y

      Df Sum Sq Mean Sq F value Pr(>F)
MODEL      4 37.340   9.3349   3.2701 0.2477
RESIDUALS   2  5.709   2.8546
CORRECTED TOTAL 6 43.049

```

```

$`Type I`
      Df Sum Sq Mean Sq F value Pr(>F)
A      1 16.2088 16.2088  5.6781 0.1400
B      1  4.8150  4.8150  1.6867 0.3236
C      1 15.7339 15.7339  5.5118 0.1434
B:C    1  0.5819  0.5819  0.2038 0.6959

```

```

$`Type II`
      Df Sum Sq Mean Sq F value Pr(>F)
A      1 21.9995 21.9995  7.7067 0.1090
B      1  8.6630  8.6630  3.0347 0.2236
C      1 15.7339 15.7339  5.5118 0.1434
B:C    1  0.5819  0.5819  0.2038 0.6959

```

```

$`Type III`
      Df Sum Sq Mean Sq F value Pr(>F)
A      1 21.9995 21.9995  7.7067 0.1090
B      1  7.0709  7.0709  2.4770 0.2562
C      1 13.3221 13.3221  4.6669 0.1633
B:C    1  0.5819  0.5819  0.2038 0.6959

```

9.10 Chapter 17

9.10.1 p642

(152) MODEL

```
v2p642 = read.table("C:/G/Rt/Kemp/v2p642.txt", head=TRUE)
v2p642 = af(v2p642, 2:11)
ANOVA(Y ~ A + B + C + D + E + F + G, v2p642) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	11.0	1.57143	1.6688	0.1646
RESIDUALS	24	22.6	0.94167		
CORRECTED TOTAL	31	33.6			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	5.7800	5.7800	6.1381	0.02066 *
B	1	0.1800	0.1800	0.1912	0.66587
C	1	0.1250	0.1250	0.1327	0.71879
D	1	2.5312	2.5312	2.6881	0.11415
E	1	0.6613	0.6613	0.7022	0.41031
F	1	0.0112	0.0112	0.0119	0.91387
G	1	1.7113	1.7113	1.8173	0.19023

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	5.7800	5.7800	6.1381	0.02066 *
B	1	0.1800	0.1800	0.1912	0.66587
C	1	0.1250	0.1250	0.1327	0.71879
D	1	2.5312	2.5312	2.6881	0.11415
E	1	0.6613	0.6613	0.7022	0.41031
F	1	0.0112	0.0112	0.0119	0.91387
G	1	1.7113	1.7113	1.8173	0.19023

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	5.7800	5.7800	6.1381	0.02066 *
B	1	0.1800	0.1800	0.1912	0.66587
C	1	0.1250	0.1250	0.1327	0.71879
D	1	2.5312	2.5312	2.6881	0.11415
E	1	0.6613	0.6613	0.7022	0.41031
F	1	0.0112	0.0112	0.0119	0.91387

```
G 1 1.7113 1.7113 1.8173 0.19023
```

```
---
```

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

```
(153) MODEL
```

```
ANOVA(log(S) ~ A + B + C + D + E + F + G, v2p642) # OK
```

```
$ANOVA
```

```
Response : log(S)
```

		Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL		7	266.43	38.062		
RESIDUALS		24	0.00	0.000		
CORRECTED TOTAL		31	266.43			

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.511	1.511	Inf < 2.2e-16 ***	
B	1	0.600	0.600	Inf < 2.2e-16 ***	
C	1	0.284	0.284	Inf < 2.2e-16 ***	
D	1	0.384	0.384	Inf < 2.2e-16 ***	
E	1	0.741	0.741	Inf < 2.2e-16 ***	
F	1	261.783	261.783	Inf < 2.2e-16 ***	
G	1	1.127	1.127	Inf < 2.2e-16 ***	

```
---
```

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.511	1.511	Inf < 2.2e-16 ***	
B	1	0.600	0.600	Inf < 2.2e-16 ***	
C	1	0.284	0.284	Inf < 2.2e-16 ***	
D	1	0.384	0.384	Inf < 2.2e-16 ***	
E	1	0.741	0.741	Inf < 2.2e-16 ***	
F	1	261.783	261.783	Inf < 2.2e-16 ***	
G	1	1.127	1.127	Inf < 2.2e-16 ***	

```
---
```

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.511	1.511	Inf < 2.2e-16 ***	
B	1	0.600	0.600	Inf < 2.2e-16 ***	
C	1	0.284	0.284	Inf < 2.2e-16 ***	
D	1	0.384	0.384	Inf < 2.2e-16 ***	
E	1	0.741	0.741	Inf < 2.2e-16 ***	
F	1	261.783	261.783	Inf < 2.2e-16 ***	
G	1	1.127	1.127	Inf < 2.2e-16 ***	

```
---
```

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

9.11 Chapter 19

9.11.1 p700

(154) MODEL

```
v2p700 = read.table("C:/G/Rt/Kemp/v2p700.txt", head=TRUE)
v2p700 = af(v2p700, 2:5)
ANOVA(Y ~ P + S + T + C, v2p700) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	12	378.80	31.5670	57.256	0.003319 **
RESIDUALS	3	1.65	0.5513		
CORRECTED TOTAL	15	380.46			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	3	53.888	17.963	32.580	0.008646 **
S	3	154.508	51.503	93.414	0.001845 **
T	3	149.848	49.949	90.597	0.001930 **
C	3	20.561	6.854	12.431	0.033708 *

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	2	2.220	1.110	2.0133	0.278974
S	3	111.966	37.322	67.6941	0.002969 **
T	3	161.828	53.943	97.8403	0.001722 **
C	3	20.561	6.854	12.4311	0.033708 *

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	2	2.220	1.110	2.0133	0.278974
S	3	111.966	37.322	67.6941	0.002969 **
T	3	161.828	53.943	97.8403	0.001722 **
C	3	20.561	6.854	12.4311	0.033708 *

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

9.11.2 p703

(155) MODEL

```
v2p703 = read.table("C:/G/Rt/Kemp/v2p703.txt", head=TRUE)
v2p703$C = ifelse(v2p703$C == 0, 4, v2p703$C)
v2p703 = af(v2p703, 2:5)
ANOVA(Y ~ P + S + T + C, v2p703) # OK
```

\$ANOVA

Response : Y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	13	385.18	29.6293	21.766	0.0005673 ***
RESIDUALS	6	8.17	1.3613		
CORRECTED TOTAL	19	393.35			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	4	56.408	14.102	10.3596	0.0073255 **
S	3	119.260	39.753	29.2036	0.0005620 ***
T	3	190.430	63.477	46.6312	0.0001498 ***
C	3	19.083	6.361	4.6728	0.0518237 .

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	4	52.288	13.072	9.6028	0.0088641 **
S	3	167.414	55.805	40.9952	0.0002163 ***
T	3	190.430	63.477	46.6312	0.0001498 ***
C	3	19.083	6.361	4.6728	0.0518237 .

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
P	4	52.287	13.072	9.6028	0.0088641 **
S	3	167.414	55.805	40.9952	0.0002163 ***
T	3	190.430	63.477	46.6312	0.0001498 ***
C	3	19.083	6.361	4.6728	0.0518237 .

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

10 Lawson - DAE with SAS

Reference

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

```
require(daewr)
```

10.1 Chapter 2

10.1.1 p22

(156) MODEL

```
ANOVA(height ~ time, bread) # OK
```

\$ANOVA

Response : height

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	2	21.573	10.7865	4.6022	0.042 *
RESIDUALS	9	21.094	2.3438		
CORRECTED TOTAL	11	42.667			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
time	2	21.573	10.787	4.6022	0.042 *

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
time	2	21.573	10.787	4.6022	0.042 *

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
time	2	21.573	10.787	4.6022	0.042 *

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

10.1.2 p32

(157) MODEL

```
ANOVA(height^(1 - 1.294869) ~ time, bread) # OK
```

\$ANOVA

Response : height^(1 - 1.294869)

```

      Df    Sum Sq  Mean Sq F value  Pr(>F)
MODEL          2 0.0130560 0.0065280  5.9356 0.02271 *
RESIDUALS       9 0.0098983 0.0010998
CORRECTED TOTAL 11 0.0229544
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df    Sum Sq  Mean Sq F value  Pr(>F)
time    2 0.013056 0.006528  5.9356 0.02271 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df    Sum Sq  Mean Sq F value  Pr(>F)
time    2 0.013056 0.006528  5.9356 0.02271 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type III`
      Df    Sum Sq  Mean Sq F value  Pr(>F)
time    2 0.013056 0.006528  5.9356 0.02271 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

10.1.3 p42

(158) MODEL

```
ANOVA(yield ~ treat, sugarbeet) # OK
```

```

$ANOVA
Response : yield
      Df Sum Sq Mean Sq F value    Pr(>F)
MODEL      3 291.00  97.002    45.9 1.718e-07 ***
RESIDUALS  14  29.59   2.113
CORRECTED TOTAL 17 320.59
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type I`
      Df Sum Sq Mean Sq F value    Pr(>F)
treat   3    291  97.002    45.9 1.718e-07 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

$`Type II`
      Df Sum Sq Mean Sq F value    Pr(>F)
treat   3    291  97.002    45.9 1.718e-07 ***

```



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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treat	3	291	97.002	45.9	1.718e-07 ***

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

10.2 Chapter 3

10.2.1 p63

(159) MODEL

```
ANOVA(CO ~ Eth + Ratio + Eth:Ratio, COdata) # OK
```

```
$ANOVA
```

```
Response : CO
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	1654.0	206.750	40.016	3.861e-06 ***
RESIDUALS	9	46.5	5.167		
CORRECTED TOTAL	17	1700.5			

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth:Ratio	4	678	169.5	32.806	2.240e-05 ***

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth:Ratio	4	678	169.5	32.806	2.240e-05 ***

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth:Ratio	4	678	169.5	32.806	2.240e-05 ***

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

(160) MODEL

```
ANOVA(CO ~ Ratio + Eth + Ratio:Eth, COdata) # OK
```

\$ANOVA

Response : CO

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	1654.0	206.750	40.016	3.861e-06 ***
RESIDUALS	9	46.5	5.167		
CORRECTED TOTAL	17	1700.5			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio:Eth	4	678	169.5	32.806	2.240e-05 ***

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio:Eth	4	678	169.5	32.806	2.240e-05 ***

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Ratio	2	652	326.0	63.097	5.067e-06 ***
Eth	2	324	162.0	31.355	8.790e-05 ***
Ratio:Eth	4	678	169.5	32.806	2.240e-05 ***

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

10.2.2 p74

(161) MODEL

```
ANOVA(CO ~ Eth + Ratio + Eth:Ratio, COdata[-18,]) # OK
```

\$ANOVA

Response : CO

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	8	1423.0	177.879	31.978	2.749e-05 ***
RESIDUALS	8	44.5	5.563		
CORRECTED TOTAL	16	1467.5			

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

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Eth	2	472.66	236.33	42.486	5.482e-05 ***
Ratio	2	395.33	197.66	35.535	0.0001048 ***
Eth:Ratio	4	555.04	138.76	24.945	0.0001427 ***

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

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Eth	2	398.26	199.13	35.799	0.0001020 ***
Ratio	2	395.33	197.66	35.535	0.0001048 ***
Eth:Ratio	4	555.04	138.76	24.945	0.0001427 ***

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

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Eth	2	319.45	159.73	28.715	0.0002235 ***
Ratio	2	511.45	255.73	45.973	4.105e-05 ***
Eth:Ratio	4	555.04	138.76	24.945	0.0001427 ***

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

10.2.3 p91

```
(162) MODEL
```

```
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 + teehtg, 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

```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
B	1	0.01992	0.01992		
C	1	0.51534	0.51534		
D	1	0.01532	0.01532		
E	1	0.05965	0.05965		
F	1	0.00879	0.00879		
G	1	0.01851	0.01851		

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.04984	0.04984		
B	1	0.01992	0.01992		
C	1	0.51534	0.51534		
D	1	0.01532	0.01532		
E	1	0.05965	0.05965		
F	1	0.00879	0.00879		
G	1	0.01851	0.01851		

(186) MODEL

```
ANOVA(lns2 ~ A + B + C + D + E + F + G, tile) # OK
```

\$ANOVA

Response : lns2

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	12.305	1.7578		
RESIDUALS	0	0.000			
CORRECTED TOTAL	7	12.305			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.6436	1.6436		
B	1	0.3109	0.3109		
C	1	7.1858	7.1858		
D	1	2.3199	2.3199		
E	1	0.0248	0.0248		
F	1	0.7379	0.7379		
G	1	0.0820	0.0820		

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.6436	1.6436		
B	1	0.3109	0.3109		
C	1	7.1858	7.1858		
D	1	2.3199	2.3199		
E	1	0.0248	0.0248		
F	1	0.7379	0.7379		
G	1	0.0820	0.0820		

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	1.6436	1.6436		
B	1	0.3109	0.3109		
C	1	7.1858	7.1858		
D	1	2.3199	2.3199		
E	1	0.0248	0.0248		
F	1	0.7379	0.7379		
G	1	0.0820	0.0820		

10.9.2 p521

(187) MODEL

```
strng = reshape(tile,
  direction = "long",
  varying = list(c("y1", "y2")),
  v.names = "y",
  idvar = c("A", "B", "C", "D", "E", "F", "G"),
  timevar = "H",
  times = c(-1, 1))
ANOVA(y ~ A/H + B/H + C/H + D/H + E/H + F/H + G/H, strng) # OK
```

\$ANOVA

Response : y

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	1.65427	0.11816	0.1433	0.9807
RESIDUALS	1	0.82473	0.82473		
CORRECTED TOTAL	15	2.47901			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.09968	0.09968	0.1209	0.7870
A:H	1	0.04015	0.04015	0.0487	0.8618
B	1	0.03984	0.03984	0.0483	0.8623
H:B	1	0.00043	0.00043	0.0005	0.9854
C	1	1.03069	1.03069	1.2497	0.4646
H:C	1	0.15307	0.15307	0.1856	0.7410
D	1	0.03064	0.03064	0.0372	0.8788
H:D	1	0.04690	0.04690	0.0569	0.8510
E	1	0.11929	0.11929	0.1446	0.7686
H:E	1	0.01883	0.01883	0.0228	0.9045
F	1	0.01758	0.01758	0.0213	0.9077
H:F	1	0.01384	0.01384	0.0168	0.9180
G	1	0.03702	0.03702	0.0449	0.8671
H:G	1	0.00632	0.00632	0.0077	0.9444

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.09968	0.09968	0.1209	0.7870

A:H	1	0.04015	0.04015	0.0487	0.8618
B	1	0.03984	0.03984	0.0483	0.8623
H:B	1	0.00043	0.00043	0.0005	0.9854
C	1	1.03069	1.03069	1.2497	0.4646
H:C	1	0.15307	0.15307	0.1856	0.7410
D	1	0.03064	0.03064	0.0372	0.8788
H:D	1	0.04690	0.04690	0.0569	0.8510
E	1	0.11929	0.11929	0.1446	0.7686
H:E	1	0.01883	0.01883	0.0228	0.9045
F	1	0.01758	0.01758	0.0213	0.9077
H:F	1	0.01384	0.01384	0.0168	0.9180
G	1	0.03702	0.03702	0.0449	0.8671
H:G	1	0.00632	0.00632	0.0077	0.9444

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.09968	0.09968	0.1209	0.7870
A:H	1	0.04015	0.04015	0.0487	0.8618
B	1	0.03984	0.03984	0.0483	0.8623
H:B	1	0.00043	0.00043	0.0005	0.9854
C	1	1.03069	1.03069	1.2497	0.4646
H:C	1	0.15307	0.15307	0.1856	0.7410
D	1	0.03064	0.03064	0.0372	0.8788
H:D	1	0.04690	0.04690	0.0569	0.8510
E	1	0.11929	0.11929	0.1446	0.7686
H:E	1	0.01883	0.01883	0.0228	0.9045
F	1	0.01758	0.01758	0.0213	0.9077
H:F	1	0.01384	0.01384	0.0168	0.9180
G	1	0.03702	0.03702	0.0449	0.8671
H:G	1	0.00632	0.00632	0.0077	0.9444

10.9.3 p525

(188) MODEL

```
prod2 = af(prodstd, 1:7)
ANOVA(Pof ~ A + B + C + D + E + F + G + A:G + A:E:F + B:E:G + C:E:G + C:E:G:F +
      D:E + D:F, prod2) # OK
```

\$ANOVA

Response : Pof

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	47	769.49	16.3721	5.1667	2.737e-05 ***
RESIDUALS	24	76.05	3.1688		
CORRECTED TOTAL	71	845.54			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	2	50.577	25.288	7.9806	0.0022023	**
B	2	13.384	6.692	2.1118	0.1429491	
C	2	68.594	34.297	10.8234	0.0004463	***
D	2	23.674	11.837	3.7355	0.0386914	*
E	1	275.733	275.733	87.0165	1.878e-09	***
F	1	161.700	161.700	51.0296	2.204e-07	***
G	1	1.051	1.051	0.3318	0.5699896	
A:G	2	26.567	13.284	4.1921	0.0274494	*
A:E:F	7	28.404	4.058	1.2806	0.3013844	
B:E:G	7	22.453	3.208	1.0123	0.4475160	
C:E:G	6	35.546	5.924	1.8696	0.1277692	
C:E:F:G	10	24.607	2.461	0.7766	0.6500534	
D:E	2	21.745	10.873	3.4312	0.0489076	*
D:F	2	15.450	7.725	2.4379	0.1086730	

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	2	50.577	25.288	7.9806	0.0022023	**
B	2	13.384	6.692	2.1118	0.1429491	
C	2	68.594	34.297	10.8234	0.0004463	***
D	2	23.674	11.837	3.7355	0.0386914	*
E	1	275.733	275.733	87.0165	1.878e-09	***
F	1	161.700	161.700	51.0296	2.204e-07	***
G	1	1.051	1.051	0.3318	0.5699896	
A:G	2	26.567	13.284	4.1921	0.0274494	*
A:E:F	6	24.623	4.104	1.2951	0.2970196	
B:E:G	6	19.770	3.295	1.0398	0.4246194	
C:E:G	6	35.546	5.924	1.8696	0.1277692	
C:E:F:G	10	24.607	2.461	0.7766	0.6500534	
D:E	2	21.745	10.873	3.4312	0.0489076	*
D:F	2	15.450	7.725	2.4379	0.1086730	

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

\$`Type III`

CAUTION: Singularity Exists !

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	2	50.577	25.288	7.9806	0.0022023	**
B	2	13.384	6.692	2.1118	0.1429491	
C	2	68.594	34.297	10.8234	0.0004463	***
D	2	23.674	11.837	3.7355	0.0386914	*
E	1	275.733	275.733	87.0165	1.878e-09	***
F	1	161.700	161.700	51.0296	2.204e-07	***
G	1	1.051	1.051	0.3318	0.5699896	
A:G	2	26.567	13.284	4.1921	0.0274494	*

A:E:F	6	24.623	4.104	1.2951	0.2970196
B:E:G	6	19.770	3.295	1.0398	0.4246194
C:E:G	6	35.546	5.924	1.8696	0.1277692
C:E:F:G	10	24.607	2.461	0.7766	0.6500534
D:E	2	21.745	10.873	3.4312	0.0489076 *
D:F	2	15.450	7.725	2.4379	0.1086730

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

10.9.4 p532

(189) MODEL

```
ANOVA(torque ~ A + B + C + D + E + A:B + A:C + A:D + A:E, Smotor) # OK
```

\$ANOVA

Response : torque

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	15	0.0112217	0.00074811	102.2	0.009731 **
RESIDUALS	2	0.0000146	0.00000732		
CORRECTED TOTAL	17	0.0112363			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.0039545	0.0039545	540.2187	0.001846 **
B	2	0.0003817	0.0001909	26.0732	0.036937 *
C	2	0.0057241	0.0028620	390.9837	0.002551 **
D	2	0.0000265	0.0000133	1.8104	0.355820
E	1	0.0000984	0.0000984	13.4406	0.067009 .
A:B	2	0.0010068	0.0005034	68.7668	0.014333 *
A:C	2	0.0000031	0.0000016	0.2134	0.824110
A:D	2	0.0000009	0.0000004	0.0599	0.943521
A:E	1	0.0000258	0.0000258	3.5198	0.201458

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.0039545	0.0039545	540.2187	0.001846 **
B	2	0.0003817	0.0001909	26.0732	0.036937 *
C	2	0.0032014	0.0016007	218.6753	0.004552 **
D	2	0.0000268	0.0000134	1.8319	0.353123
E	1	0.0000423	0.0000423	5.7744	0.138172
A:B	2	0.0010068	0.0005034	68.7668	0.014333 *
A:C	2	0.0000031	0.0000016	0.2134	0.824110
A:D	2	0.0000052	0.0000026	0.3536	0.738760
A:E	1	0.0000258	0.0000258	3.5198	0.201458

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.0034241	0.0034241	467.7636	0.002131 **
B	2	0.0003817	0.0001909	26.0732	0.036937 *
C	2	0.0032014	0.0016007	218.6753	0.004552 **
D	2	0.0000268	0.0000134	1.8319	0.353123
E	1	0.0000423	0.0000423	5.7744	0.138172
A:B	2	0.0010068	0.0005034	68.7668	0.014333 *
A:C	2	0.0000031	0.0000016	0.2134	0.824110
A:D	2	0.0000052	0.0000026	0.3536	0.738760
A:E	1	0.0000258	0.0000258	3.5198	0.201458

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

10.9.5 p535

(190) MODEL

```
ANOVA(shrinkage ~ A + B + C + D + E + F + G + A:B + A:C + A:D + A:E + A:F + A:G +  
      B:D, inject) # OK
```

\$ANOVA

Response : shrinkage

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	14	6659.4	475.67	129.08	1.97e-05 ***
RESIDUALS	5	18.4	3.68		
CORRECTED TOTAL	19	6677.8			

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

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	770.1	770.1	208.9722	2.858e-05 ***
B	1	5076.6	5076.6	1377.6289	2.674e-07 ***
C	1	3.1	3.1	0.8311	0.403773
D	1	7.6	7.6	2.0522	0.211416
E	1	0.6	0.6	0.1526	0.712112
F	1	0.6	0.6	0.1526	0.712112
G	1	95.1	95.1	25.7972	0.003837 **
A:B	1	564.1	564.1	153.0699	6.112e-05 ***
A:C	1	10.6	10.6	2.8664	0.151230
A:D	1	115.6	115.6	31.3602	0.002508 **
A:E	1	14.1	14.1	3.8161	0.108185
A:F	1	1.6	1.6	0.4240	0.543677
A:G	1	0.1	0.1	0.0170	0.901459
B:D	1	0.1	0.1	0.0170	0.901459

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	1	770.1	770.1	208.9722	2.858e-05	***
B	1	5076.6	5076.6	1377.6289	2.674e-07	***
C	1	3.1	3.1	0.8311	0.403773	
D	1	7.6	7.6	2.0522	0.211416	
E	1	0.6	0.6	0.1526	0.712112	
F	1	0.6	0.6	0.1526	0.712112	
G	1	95.1	95.1	25.7972	0.003837	**
A:B	1	564.1	564.1	153.0699	6.112e-05	***
A:C	1	10.6	10.6	2.8664	0.151230	
A:D	1	115.6	115.6	31.3602	0.002508	**
A:E	1	14.1	14.1	3.8161	0.108185	
A:F	1	1.6	1.6	0.4240	0.543677	
A:G	1	0.1	0.1	0.0170	0.901459	
B:D	1	0.1	0.1	0.0170	0.901459	

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	1	770.1	770.1	208.9722	2.858e-05	***
B	1	5076.6	5076.6	1377.6289	2.674e-07	***
C	1	3.1	3.1	0.8311	0.403773	
D	1	7.6	7.6	2.0522	0.211416	
E	1	0.6	0.6	0.1526	0.712112	
F	1	0.6	0.6	0.1526	0.712112	
G	1	95.1	95.1	25.7972	0.003837	**
A:B	1	564.1	564.1	153.0699	6.112e-05	***
A:C	1	10.6	10.6	2.8664	0.151230	
A:D	1	115.6	115.6	31.3602	0.002508	**
A:E	1	14.1	14.1	3.8161	0.108185	
A:F	1	1.6	1.6	0.4240	0.543677	
A:G	1	0.1	0.1	0.0170	0.901459	
B:D	1	0.1	0.1	0.0170	0.901459	

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

10.9.6 p539

(191) MODEL

```
eptax = cbind(eptaxr[1:16,], y2=eptaxr[17:32,9], y3=eptaxr[33:48,9],
              y5=eptaxr[49:64,9])
eptax$ybar = (eptax$y + eptax$y2 + eptax$y3 + eptax$y5)/4
```

```
ANOVA(ybar ~ A + B + C + D + E + F + G + H + A:B + A:C + A:D + A:E + A:F + A:G +
      A:H, eptax) # OK
```

```
$ANOVA
```

```
Response : ybar
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	15	2.8452	0.18968		
RESIDUALS	0	0.0000			
CORRECTED TOTAL	15	2.8452			

```
$`Type I`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.02686	0.02686		
B	1	0.00042	0.00042		
C	1	0.06306	0.06306		
D	1	2.49443	2.49443		
E	1	0.00304	0.00304		
F	1	0.03209	0.03209		
G	1	0.02954	0.02954		
H	1	0.12879	0.12879		
A:B	1	0.00047	0.00047		
A:C	1	0.03218	0.03218		
A:D	1	0.01185	0.01185		
A:E	1	0.00380	0.00380		
A:F	1	0.01674	0.01674		
A:G	1	0.00186	0.00186		
A:H	1	0.00012	0.00012		

```
$`Type II`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.02686	0.02686		
B	1	0.00042	0.00042		
C	1	0.06306	0.06306		
D	1	2.49443	2.49443		
E	1	0.00304	0.00304		
F	1	0.03209	0.03209		
G	1	0.02954	0.02954		
H	1	0.12879	0.12879		
A:B	1	0.00047	0.00047		
A:C	1	0.03218	0.03218		
A:D	1	0.01185	0.01185		
A:E	1	0.00380	0.00380		
A:F	1	0.01674	0.01674		
A:G	1	0.00186	0.00186		
A:H	1	0.00012	0.00012		

```
$`Type III`
```

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
A	1	0.02686	0.02686		
B	1	0.00042	0.00042		
C	1	0.06306	0.06306		
D	1	2.49443	2.49443		
E	1	0.00304	0.00304		
F	1	0.03209	0.03209		
G	1	0.02954	0.02954		
H	1	0.12879	0.12879		
A:B	1	0.00047	0.00047		
A:C	1	0.03218	0.03218		
A:D	1	0.01185	0.01185		
A:E	1	0.00380	0.00380		
A:F	1	0.01674	0.01674		
A:G	1	0.00186	0.00186		
A:H	1	0.00012	0.00012		

11 Searle - Linear Models 2e

Reference

- Searle SR, Gruber MHJ. Linear Models 2e, Kindle Edition. John Wiley & Sons Inc. 2016.

11.1 7.2 (p390, 59%)

(192) MODEL

```
weight = c(8,13,9,12,7,11,6,12,12,14,9,7,14,16,10,14,11,13)
treatment = c("ta","ta","ta","ta","ta","ta","tb","tb","tb","tb","tc","tc","tc",
              "tc","tc","tc","tc","tc")
variety = c("va","va","va","vc","vd","vd","va","va","vb","vb","vb","vb","vc",
            "vc","vd","vd","vd","vd")
d1 = data.frame(weight, treatment, variety)
ANOVA(weight ~ treatment*variety, d1)
```

\$ANOVA

Response : weight

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
MODEL	7	82	11.714	2.0918	0.14
RESIDUALS	10	56	5.600		
CORRECTED TOTAL	17	138			

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	2	10.500	5.250	0.9375	0.42348
variety	3	36.786	12.262	2.1896	0.15232
treatment:variety	2	34.714	17.357	3.0995	0.08965 .

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	2	9.486	4.7429	0.8469	0.45731
variety	3	36.786	12.2619	2.1896	0.15232
treatment:variety	2	34.714	17.3571	3.0995	0.08965 .

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	2	12.471	6.2353	1.1134	0.36595
variety	3	34.872	11.6240	2.0757	0.16719
treatment:variety	2	34.714	17.3571	3.0995	0.08965 .

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

```
options(contrasts = c("contr.sum", "contr.poly"))
Anova(lm(weight ~ treatment*variety, d1), type=3, singular.ok=TRUE) # NOT OK
```

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

Anova Table (Type III tests)

Response: weight

	Sum Sq	Df	F values	Pr(>F)
treatment	0.000	0		
variety	0.000	0		
treatment:variety	34.714	2	3.0995	0.08965 .
Residuals	56.000	10		

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

11.2 7.2 (p393, 60%)

(193) MODEL

```
percent = c(31,33,44,36,38,26,37,59,42,42,34,42,28,39,36,32,38,42,36,22,42,46,
            26,37,43)
refinery = c(rep("g",9),rep("n",8),rep("s",8))
process = as.factor(c(1,1,1,1,1,1,2,2,2,1,1,1,1,2,2,2,2,1,1,1,2,2,2,2))
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	0.6.0	193	193 (100%)	0 (0%)
car	3.0.10	193	< 174 (90%)	>= 20 (10%)

All of the results in sasLM 0.6.0 were identical, while type III SSs of Model (83) and (84) were different from those of SAS in sasLM 0.1.2 package.

Slight differences in the last digits between type II and type III SS (when they should be same) are resulted from the round-to-even number way of R rounding function.

If you are uncertain about the equivalence of the 'sasLM' to 'SAS,' you can use 'SAS University Edition' for free.

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

13 Session Information

R version 4.1.0 (2021-05-18)

Platform: x86_64-w64-mingw32/x64 (64-bit)

Running under: Windows 10 x64 (build 17763)

Matrix products: default

locale:

[1] LC_COLLATE=Korean_Korea.949 LC_CTYPE=Korean_Korea.949

[3] LC_MONETARY=Korean_Korea.949 LC_NUMERIC=C

[5] LC_TIME=Korean_Korea.949

attached base packages:

[1] stats graphics grDevices utils datasets methods base

other attached packages:

[1] daewr_1.2-7 car_3.0-10 carData_3.0-4 sasLM_0.6.0 rmarkdown_2.8

loaded via a namespace (and not attached):

[1] tinytex_0.31	zoo_1.8-9	xfun_0.23
[4] partitions_1.10-2	haven_2.4.1	lattice_0.20-44
[7] colorspace_2.0-1	vctrs_0.3.8	htmltools_0.5.1.1
[10] yaml_2.2.1	gmp_0.6-2	utf8_1.2.1
[13] rlang_0.4.11	pillar_1.6.1	foreign_0.8-81
[16] readxl_1.3.1	lifecycle_1.0.0	stringr_1.4.0
[19] combinat_0.0-8	cellranger_1.1.0	DoE.base_1.1-6
[22] zip_2.1.1	evaluate_0.14	knitr_1.33
[25] rio_0.5.26	forcats_0.5.1	lmtest_0.9-38
[28] curl_4.3.1	numbers_0.8-2	fansi_0.4.2
[31] vcd_1.4-8	conf.design_2.0.0	Rcpp_1.0.6
[34] polynom_1.4-0	scatterplot3d_0.3-41	abind_1.4-5
[37] FrF2_2.2-2	hms_1.1.0	digest_0.6.27
[40] stringi_1.6.2	openxlsx_4.2.3	grid_4.1.0
[43] mathjaxr_1.4-0	tools_4.1.0	magrittr_2.0.1
[46] tibble_3.1.2	crayon_1.4.1	pkgconfig_2.0.3
[49] MASS_7.3-54	ellipsis_0.3.2	data.table_1.14.0
[52] sfsmisc_1.1-11	igraph_1.2.6	compiler_4.1.0