Examples of NOT OK using car package

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Contents

1   Tested Version and Books used for the Validation

1.1   Packages Used

- 'sasLM' version: 0.9.12

- 'SAS' version: 9.4 Licensed and University Edition

- 'car' version: 3.1.2

- R version: R version 4.3.1 (2023-06-16 ucrt)

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

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

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

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

1.2   Books and Articles used for the Test

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

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

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

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

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

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

7. Searle SR, Gruber MHJ. Linear Models 2e, Kindle Edition. John Wiley & Sons Inc. 2016.

2 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.

(1) MODEL

```
Snee = read.csv("http://r.acr.kr/Snee_EMS_ANOVA1974.csv")
Snee = af(Snee, c("Machine", "Analyst", "Test", "Day"))
Snee
```

```
   Machine Analyst Test Day    Y
1        1       1    1   1  6.1
2        1       1    1   2  8.5
3        1       1    1   3  8.6
4        1       1    1   4  9.3
5        1       1    1   5  8.1
6        1       1    1   6  8.5
7        1       1    1   7  9.8
8        1       1    1   8  9.0
9        1       1    1   9 11.0
10       1       1    1  10  9.7
11       1       1    1  11 10.5
12       1       1    1  12  8.3
13       1       1    1  13  8.4
14       1       1    1  14 10.2
15       1       1    1  15  9.3
16       1       1    1  16  7.1
17       1       1    1  17  5.8
18       1       1    1  18  8.9
19       1       1    1  19 11.5
20       1       1    1  20 10.3
21       1       1    1  21  9.1
22       1       1    1  22  5.7
23       1       1    1  23  8.5
24       1       1    1  24  9.6
25       1       1    1  25  9.4
26       1       1    1  26 10.3
27       1       1    1  27  7.0
28       1       1    1  28 11.5
29       1       1    1  29  6.0
30       1       1    1  30  8.0
31       1       1    1  31 13.4
32       1       1    1  32 12.1
33       1       1    1  33 14.2
34       1       1    1  34 10.0
35       1       1    1  35  6.5
36       1       1    1  36  6.5
```

37	1	1	1	37	9.2
38	1	1	1	38	11.0
39	1	1	1	39	8.6
40	1	1	1	40	8.9
41	1	1	1	41	6.6
42	1	1	1	42	8.4
43	1	1	2	1	6.6
44	1	1	2	2	9.6
45	1	1	2	3	6.7
46	1	1	2	4	7.2
47	1	1	2	5	7.1
48	1	1	2	6	9.0
49	1	1	2	7	9.8
50	1	1	2	8	8.0
51	1	1	2	9	10.9
52	1	1	2	10	10.6
53	1	1	2	11	8.4
54	1	1	2	12	10.6
55	1	1	2	13	7.2
56	1	1	2	14	8.0
57	1	1	2	15	8.7
58	1	1	2	16	8.7
59	1	1	2	17	6.8
60	1	1	2	18	6.6
61	1	1	2	19	7.1
62	1	1	2	20	10.0
63	1	1	2	21	9.5
64	1	1	2	22	7.7
65	1	1	2	23	8.8
66	1	1	2	24	12.2
67	1	1	2	25	10.4
68	1	1	2	26	10.6
69	1	1	2	27	10.6
70	1	1	2	28	7.3
71	1	1	2	29	7.0
72	1	1	2	30	7.0
73	1	1	2	31	9.2
74	1	1	2	32	11.7
75	1	1	2	33	10.6
76	1	1	2	34	10.4
77	1	1	2	35	8.4
78	1	1	2	36	6.8
79	1	1	2	37	10.1
80	1	1	2	38	11.0
81	1	1	2	39	10.0
82	1	1	2	40	8.0
83	1	1	2	41	7.2
84	1	1	2	42	8.8

85	1	2	1	1	6.6
86	1	2	1	2	8.2
87	1	2	1	3	8.0
88	1	2	1	4	6.5
89	1	2	1	5	2.3
90	1	2	1	6	4.0
91	1	2	1	7	11.7
92	1	2	1	8	6.8
93	1	2	1	9	10.5
94	1	2	1	10	10.3
95	1	2	1	11	10.0
96	1	2	1	12	8.8
97	1	2	1	13	6.7
98	1	2	1	14	8.9
99	1	2	1	15	9.9
100	1	2	1	16	8.2
101	1	2	1	17	7.5
102	1	2	1	18	6.6
103	1	2	1	19	3.1
104	1	2	1	20	7.2
105	1	2	1	21	10.7
106	1	2	1	22	8.4
107	1	2	1	23	7.6
108	1	2	1	24	12.6
109	1	2	1	25	9.6
110	1	2	1	26	12.6
111	1	2	1	27	10.8
112	1	2	1	28	5.1
113	1	2	1	29	6.6
114	1	2	1	30	8.6
115	1	2	1	31	12.5
116	1	2	1	32	10.4
117	1	2	1	33	10.6
118	1	2	1	34	7.2
119	1	2	1	35	7.8
120	1	2	1	36	4.4
121	1	2	1	37	8.7
122	1	2	1	38	11.2
123	1	2	1	39	10.3
124	1	2	1	40	7.0
125	1	2	1	41	7.7
126	1	2	1	42	7.6
127	2	1	1	1	8.8
128	2	1	1	2	8.1
129	2	1	1	3	7.4
130	2	1	1	4	8.0
131	2	1	1	5	9.5
132	2	1	1	6	9.2

```
133      2       1    1    7 12.8
134      2       1    1    8  9.2
135      2       1    1    9 11.3
136      2       1    1   10  9.3
137      2       1    1   11  4.0
138      2       1    1   12  9.7
139      2       1    1   13  4.6
140      2       1    1   14  2.1
141      2       1    1   15  9.7
142      2       1    1   16 10.0
143      2       1    1   17 10.2
144      2       1    1   18  9.2
145      2       1    1   19 10.8
146      2       1    1   20  9.4
147      2       1    1   21 10.3
148      2       1    1   22 10.3
149      2       1    1   23  8.3
150      2       1    1   24 11.6
151      2       1    1   25  9.4
152      2       1    1   26 11.3
153      2       1    1   27 11.4
154      2       1    1   28  9.6
155      2       1    1   29  2.2
156      2       1    1   30  6.6
157      2       1    1   31 11.5
158      2       1    1   32  9.1
159      2       1    1   33  4.6
160      2       1    1   34  7.9
161      2       1    1   35  9.0
162      2       1    1   36  8.1
163      2       1    1   37  9.4
164      2       1    1   38 10.9
165      2       1    1   39  9.0
166      2       1    1   40  7.8
167      2       1    1   41  9.3
168      2       1    1   42  6.8
```

GLM(Y ~ Day/Machine/Analyst/Test, Snee)

$ANOVA
Response : Y

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

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

```
      NA 8.736905         NA          1
```

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

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

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

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

3 Goodnight

Reference

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

3.1 p33

(2) MODEL

```
p33 = read.csv("http://r.acr.kr/Goodnight-p33.csv")
p33 = af(p33, c("A", "B"))
p33
```

```
  A B    y
1 1 1 2.96
2 1 2 7.90
3 2 1 4.79
4 2 2 9.55
5 3 3 9.53
```

```
GLM(y ~ A + B + A:B, p33) # p35
```

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


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


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


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


$`Type III`
CAUTION: Singularity Exists !
    Df  Sum Sq Mean Sq F value Pr(>F)
```

```
A    1  3.0276  3.0276
B    1 23.5225 23.5225
A:B  1  0.0081  0.0081
```

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

4 SAS for Linear Models 4e

Reference

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

4.1 p403

(3) MODEL

```
p403 = read.table("http://r.acr.kr/sas4lm/p403.txt", header=TRUE)
p403 = af(p403, c("PATIENT", "VISIT"))
p403
```

```
   PATIENT SEQUENCE VISIT BASEHR  HR      DRUG RESIDT RESIDS
1        1        1     B      2   86  86  placebo      0      0
2        1        1     B      3   86 106     test     -1     -1
3        1        1     B      4   62  79 standard      1      0
4        2        2     F      2   48  66     test      0      0
5        2        2     F      3   58  56  placebo      1      0
6        2        2     F      4   74  79 standard     -1     -1
7        3        3     B      2   78  84  placebo      0      0
8        3        3     B      3   78  76     test     -1     -1
9        3        3     B      4   82  91 standard      1      0
10       4        4     D      2   66  79 standard      0      0
11       4        4     D      3   72 100     test      0      1
12       4        4     D      4   90  82  placebo      1      0
13       5        5     C      2   74  74     test      0      0
14       5        5     C      3   90  71 standard      1      0
15       5        5     C      4   66  62  placebo      0      1
16       6        6     B      2   62  64  placebo      0      0
17       6        6     B      3   74  90     test     -1     -1
18       6        6     B      4   58  85 standard      1      0
19       7        7     A      2   94  75 standard      0      0
20       7        7     A      3   72  82  placebo      0      1
21       7        7     A      4  100 102     test     -1     -1
22       8        8     A      2   54  63 standard      0      0
23       8        8     A      3   54  58  placebo      0      1
24       8        8     A      4   66  62     test     -1     -1
25       9        9     D      2   82  91 standard      0      0
26       9        9     D      3   96  86     test      0      1
27       9        9     D      4   78  88  placebo      1      0
28      10       10     C      2   86  82     test      0      0
29      10       10     C      3   70  71 standard      1      0
30      10       10     C      4   58  62  placebo      0      1
31      11       11     F      2   82  80     test      0      0
32      11       11     F      3   80  78  placebo      1      0
33      11       11     F      4   72  75 standard     -1     -1
34      12       12     E      2   96  90  placebo      0      0
```

```
35      12       E      3      92  93 standard       -1      -1
36      12       E      4      82  88     test        0       1
37      13       D      2      78  87 standard        0       0
38      13       D      3      72  80     test        0       1
39      13       D      4      76  78  placebo        1       0
40      14       F      2      98  86     test        0       0
41      14       F      3      86  86  placebo        1       0
42      14       F      4      70  79 standard       -1      -1
43      15       A      2      86  71 standard        0       0
44      15       A      3      66  70  placebo        0       1
45      15       A      4      74  90     test       -1      -1
46      16       E      2      86  86  placebo        0       0
47      16       E      3      90 103 standard       -1      -1
48      16       E      4      82  86     test        0       1
49      17       A      2      66  83 standard        0       0
50      17       A      3      82  86  placebo        0       1
51      17       A      4      86 102     test       -1      -1
52      18       F      2      66  82     test        0       0
53      18       F      3      78  80  placebo        1       0
54      18       F      4      74  95 standard       -1      -1
55      19       E      2      74  80  placebo        0       0
56      19       E      3      78  79 standard       -1      -1
57      19       E      4      70  74     test        0       1
58      20       B      2      66  70  placebo        0       0
59      20       B      3      74  62     test       -1      -1
60      20       B      4      62  67 standard        1       0
61      21       C      2      82  90     test        0       0
62      21       C      3      90 103 standard        1       0
63      21       C      4      76  82  placebo        0       1
64      22       C      2      82  82     test        0       0
65      22       C      3      66  83 standard        1       0
66      22       C      4      90  82  placebo        0       1
67      23       E      2      82  66  placebo        0       0
68      23       E      3      74  87 standard       -1      -1
69      23       E      4      82  82     test        0       1
70      24       D      2      72  75 standard        0       0
71      24       D      3      82  86     test        0       1
72      24       D      4      74  82  placebo        1       0
```

GLM(HR ~ SEQUENCE + PATIENT %in% SEQUENCE + VISIT + DRUG + RESIDS + RESIDT, p403)

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

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


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


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


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


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

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

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

Anova Table (Type III tests)

Response: HR
```

```
                  Sum Sq Df F values   Pr(>F)
SEQUENCE             0.0  0
VISIT              146.8  2   1.2991  0.28350
DRUG               343.9  2   3.0443  0.05826 .
RESIDS             309.2  1   5.4731  0.02414 *
RESIDT               0.8  1   0.0149  0.90351
SEQUENCE:PATIENT 4692.3 18   4.6147 2.21e-05 ***
Residuals        2372.6 42
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

4.2 p417

(4) MODEL

```
p417 = read.table("http://r.acr.kr/sas4lm/p417.txt", header=TRUE)
p417 = af(p417, c("TRT", "POT", "PLANT"))
p417
```

```
   Obs TRT POT PLANT  Y
1    1   1   1     1 15
2    2   1   1     2 13
3    3   1   1     3 16
4    4   1   2     1 17
5    5   1   2     2 19
6    6   1   3     1 12
7    7   2   1     1 20
8    8   2   1     2 21
9    9   2   2     1 20
10  10   2   2     2 23
11  11   2   2     3 19
12  12   2   2     4 19
13  13   3   1     1 12
14  14   3   1     2 13
15  15   3   1     3 14
16  16   3   2     1 11
17  17   3   3     1 12
18  18   3   3     2 13
19  19   3   3     3 15
20  20   3   3     4 11
21  21   3   3     5  9
```

```
GLM(Y ~ TRT + POT %in% TRT, p417) # p418 Output 11.28
```

```
$ANOVA
Response : Y
              Df  Sum Sq Mean Sq F value    Pr(>F)
MODEL          7 267.226  38.175  12.433 7.522e-05 ***
RESIDUALS     13  39.917   3.071
```

```
CORRECTED TOTAL 20 307.143
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

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

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

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

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

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

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

Anova Table (Type III tests)

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

4.3   p431

(5) MODEL

```
p431 = read.table("http://r.acr.kr/sas4lm/p431.txt", header=TRUE)
p431 = af(p431, c("line", "sire", "agedam", "steerno"))
p431
```

	Obs	line	sire	agedam	steerno	age	intlwt	avdlygn
1	1	1	1	1	3	192	390	2.24
2	2	1	1	1	3	154	403	2.65
3	3	1	1	1	4	185	432	2.41
4	4	1	1	1	4	193	457	2.25
5	5	1	1	1	5	186	483	2.58
6	6	1	1	1	5	177	469	2.67
7	7	1	1	1	5	177	428	2.71
8	8	1	1	1	5	163	439	2.47
9	9	1	1	2	4	188	439	2.29
10	10	1	1	2	4	178	407	2.26
11	11	1	1	2	5	198	498	1.97
12	12	1	1	2	5	193	459	2.14
13	13	1	1	2	5	186	459	2.44
14	14	1	1	2	5	175	375	2.52
15	15	1	1	2	5	171	382	1.72
16	16	1	1	2	5	168	417	2.75
17	17	1	1	3	3	154	389	2.38
18	18	1	1	3	4	184	414	2.46
19	19	1	1	3	5	174	483	2.29
20	20	1	1	3	5	170	430	2.30
21	21	1	1	3	5	169	443	2.94
22	22	2	2	4	3	158	381	2.50
23	23	2	2	4	3	158	365	2.44
24	24	2	2	4	4	169	386	2.44
25	25	2	2	4	4	144	339	2.15
26	26	2	2	4	5	159	419	2.54
27	27	2	2	4	5	152	469	2.74
28	28	2	2	4	5	149	379	2.50
29	29	2	2	4	5	149	375	2.54
30	30	2	2	5	3	189	395	2.65
31	31	2	2	5	4	187	447	2.52
32	32	2	2	5	4	165	430	2.67
33	33	2	2	5	5	181	453	2.79
34	34	2	2	5	5	177	385	2.33
35	35	2	2	5	5	151	414	2.67
36	36	2	2	5	5	147	353	2.69
37	37	3	3	6	4	184	411	3.00
38	38	3	3	6	4	184	420	2.49
39	39	3	3	6	5	187	427	2.25
40	40	3	3	6	5	184	409	2.49
41	41	3	3	6	5	183	337	2.02
42	42	3	3	6	5	177	352	2.31

```
43  43   3   7    3     43 205   472    2.57
44  44   3   7    3     44 193   340    2.37
45  45   3   7    4     45 162   375    2.64
46  46   3   7    5     46 206   451    2.37
47  47   3   7    5     47 205   472    2.22
48  48   3   7    5     48 187   402    1.90
49  49   3   7    5     49 178   464    2.61
50  50   3   7    5     50 175   414    2.13
51  51   3   8    3     51 200   466    2.16
52  52   3   8    3     52 184   356    2.33
53  53   3   8    3     53 175   449    2.52
54  54   3   8    4     54 178   360    2.45
55  55   3   8    5     55 189   385    1.44
56  56   3   8    5     56 184   431    1.72
57  57   3   8    5     57 183   401    2.17
58  58   3   9    3     58 166   404    2.68
59  59   3   9    4     59 187   482    2.43
60  60   3   9    4     60 186   350    2.36
61  61   3   9    4     61 184   483    2.44
62  62   3   9    5     62 180   425    2.66
63  63   3   9    5     63 177   420    2.46
64  64   3   9    5     64 175   440    2.52
65  65   3   9    5     65 164   405    2.42
```

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

$ANOVA
Response : avdlygn

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

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

$Fitness

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

$`Type I`

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

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


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


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

```
# p433 Output 11.40
```

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

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

Anova Table (Type III tests)

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

5 Sahai - Unbalanced

Reference

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

5.1 Table 15.3

(6) MODEL

```
T15.3 = read.table("http://r.acr.kr/sahai/T15.3.txt")
colnames(T15.3) = c("Dam", "Sire", "pH")
T15.3 = af(T15.3, c("Dam", "Sire"))
T15.3
```

```
   Dam Sire   pH
1    1    1 7.48
2    1    1 7.48
3    1    1 7.52
4    1    1 7.54
5    6    1 7.54
6    6    1 7.36
7    6    1 7.36
8    6    1 7.40
9   11    1 7.52
10  11    1 7.54
11  11    1 7.52
12  11    1 7.56
13  11    1 7.53
14   1    2 7.48
15   1    2 7.53
16   1    2 7.43
17   1    2 7.39
18   6    2 7.44
19   6    2 7.47
20   6    2 7.48
21   6    2 7.48
22  11    2 7.56
23  11    2 7.39
24  11    2 7.52
25  11    2 7.49
26  11    2 7.48
27   2    1 7.45
28   2    1 7.43
29   2    1 7.49
30   2    1 7.40
31   2    1 7.40
32   6    3 7.43
33   6    3 7.52
```

34	6	3	7.50
35	6	3	7.46
36	6	3	7.39
37	12	1	7.50
38	12	1	7.45
39	12	1	7.43
40	12	1	7.44
41	12	1	7.49
42	2	2	7.50
43	2	2	7.45
44	2	2	7.43
45	2	2	7.36
46	7	1	7.41
47	7	1	7.42
48	7	1	7.36
49	7	1	7.47
50	12	2	7.52
51	12	2	7.43
52	12	2	7.38
53	12	2	7.33
54	3	1	7.40
55	3	1	7.45
56	3	1	7.42
57	3	1	7.48
58	7	2	7.47
59	7	2	7.36
60	7	2	7.43
61	7	2	7.38
62	7	2	7.41
63	13	1	7.39
64	13	1	7.37
65	13	1	7.33
66	13	1	7.43
67	13	1	7.42
68	3	2	7.45
69	3	2	7.33
70	3	2	7.40
71	3	2	7.46
72	7	3	7.53
73	7	3	7.40
74	7	3	7.44
75	7	3	7.40
76	7	3	7.45
77	13	2	7.43
78	13	2	7.38
79	13	2	7.44
80	3	3	7.40
81	3	3	7.47

```
82      3      3 7.40
83      3      3 7.47
84      3      3 7.47
85      8      1 7.52
86      8      1 7.53
87      8      1 7.48
88     13      3 7.46
89     13      3 7.44
90     13      3 7.37
91     13      3 7.54
92      4      1 7.38
93      4      1 7.48
94      4      1 7.46
95      8      2 7.40
96      8      2 7.48
97      8      2 7.50
98      8      2 7.40
99      8      2 7.51
100    14      1 7.50
101    14      1 7.53
102    14      1 7.51
103    14      1 7.43
104     4      2 7.37
105     4      2 7.31
106     4      2 7.45
107     4      2 7.41
108     9      1 7.40
109     9      1 7.34
110     9      1 7.37
111     9      1 7.45
112    14      2 7.44
113    14      2 7.45
114    14      2 7.39
115    14      2 7.52
116     5      1 7.44
117     5      1 7.51
118     5      1 7.49
119     5      1 7.51
120     5      1 7.52
121     9      2 7.42
122     9      2 7.37
123     9      2 7.46
124     9      2 7.40
125    14      3 7.42
126    14      3 7.48
127    14      3 7.45
128    14      3 7.51
129    14      3 7.48
```

```
130    5     2 7.49
131    5     2 7.49
132    5     2 7.49
133    5     2 7.50
134   10     1 7.39
135   10     1 7.31
136   10     1 7.30
137   10     1 7.41
138   10     1 7.48
139   15     1 7.47
140   15     1 7.49
141   15     1 7.45
142   15     1 7.43
143   15     1 7.42
144    5     3 7.48
145    5     3 7.59
146    5     3 7.59
147   10     2 7.50
148   10     2 7.44
149   10     2 7.40
150   10     2 7.45
151   15     2 7.45
152   15     2 7.42
153   15     2 7.52
154   15     2 7.51
155   15     2 7.32
156   15     3 7.51
157   15     3 7.51
158   15     3 7.53
159   15     3 7.45
160   15     3 7.51
```

```
GLM(pH ~ Dam/Sire, T15.3) # p301


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


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


$`Type I`
```

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

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

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

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

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

Anova Table (Type III tests)

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

5.2 Table 16.3

(7) MODEL

```r
T16.3 = read.csv("http://r.acr.kr/sahai/T16.3.csv")
colnames(T16.3) = c("Plot", "Sample", "Subsample", "Residue")
T16.3 = af(T16.3, c("Plot", "Sample", "Subsample"))
T16.3
```

```
  Plot Sample Subsample Residue
1    1      1         1    0.52
2    1      1         1    0.43
3    1      1         2    0.40
4    1      1         2    0.52
```

5	1	2	1	0.26
6	1	2	2	0.54
7	1	3	1	0.52
8	2	1	1	0.50
9	2	1	1	0.59
10	2	1	2	0.47
11	2	1	2	0.50
12	2	2	1	0.04
13	2	2	2	0.43
14	2	3	1	1.08
15	3	1	1	0.34
16	3	1	1	0.26
17	3	1	2	0.32
18	3	1	2	0.45
19	3	2	1	0.25
20	3	2	2	0.38
21	3	3	1	0.29
22	4	1	1	0.18
23	4	1	1	0.24
24	4	1	2	0.31
25	4	1	2	0.29
26	4	2	1	0.13
27	4	2	2	0.25
28	4	3	1	0.10
29	5	1	1	1.05
30	5	1	1	0.66
31	5	1	2	0.60
32	5	1	2	0.51
33	5	2	1	0.95
34	5	2	2	0.84
35	5	3	1	0.92
36	6	1	1	0.52
37	6	1	1	0.66
38	6	1	2	0.55
39	6	1	2	0.40
40	6	2	1	0.33
41	6	2	2	0.26
42	6	3	1	0.41
43	7	1	1	0.77
44	7	1	1	0.56
45	7	1	2	0.51
46	7	1	2	0.60
47	7	2	1	0.44
48	7	2	2	0.50
49	7	3	1	0.44
50	8	1	1	0.89
51	8	1	1	0.92
52	8	1	2	0.75

```
53    8     1        2     0.58
54    8     2        1     0.64
55    8     2        2     0.54
56    8     3        1     0.36
57    9     1        1     0.50
58    9     1        1     0.67
59    9     1        2     0.60
60    9     1        2     0.53
61    9     2        1     0.60
62    9     2        2     0.71
63    9     3        1     0.92
64   10     1        1     0.58
65   10     1        1     0.52
66   10     1        2     0.56
67   10     1        2     0.44
68   10     2        1     0.46
69   10     2        2     0.52
70   10     3        1     0.52
71   11     1        1     0.24
72   11     1        1     0.36
73   11     1        2     0.48
74   11     1        2     0.30
75   11     2        1     0.53
76   11     2        2     0.50
77   11     3        1     0.39
```

`GLM(Residue ~ Plot/Sample/Subsample, T16.3) # p344`

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

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

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

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

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

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

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

Anova Table (Type III tests)

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

```
# NOT OK
```

6 Federer - Variations

Reference

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

6.1 Example 2.2

(8) MODEL

```
ex2.2 = read.table("http://r.acr.kr/split/sbex2_2.txt", header=TRUE)
ex2.2 = af(ex2.2, c("Row", "Column", "R", "S"))
ex2.2
```

```
   Row Column R S       Y
1    1      1 1 1 1027.85
2    1      1 1 2  982.74
3    1      1 1 3 1007.24
4    1      1 1 4 1008.47
5    1      2 2 1 1004.33
6    1      2 2 2  977.86
7    1      2 2 3  999.15
8    1      2 2 4  990.86
9    1      3 3 1  992.57
10   1      3 3 2  993.71
11   1      3 3 3 1012.57
12   1      3 3 4  968.25
13   1      4 4 1  994.60
14   1      4 4 2 1021.81
15   1      4 4 3  995.03
16   1      4 4 4 1002.17
17   1      5 5 1 1019.89
18   1      5 5 2 1017.48
19   1      5 5 3  987.82
20   1      5 5 4  995.63
21   2      4 1 1  996.18
22   2      4 1 2  981.96
23   2      4 1 3  985.63
24   2      4 1 4  965.80
25   2      5 2 1  996.61
26   2      5 2 2 1011.94
27   2      5 2 3  972.76
28   2      5 2 4 1011.99
29   2      2 3 1 1021.61
30   2      2 3 2 1014.46
31   2      2 3 3  980.03
32   2      2 3 4 1014.80
33   2      3 4 1 1028.78
```

```
34    2       3 4 2 1006.01
35    2       3 4 3 1015.04
36    2       3 4 4 1000.72
37    2       1 5 1  994.91
38    2       1 5 2  999.91
39    2       1 5 3 1010.29
40    2       1 5 4 1018.49
41    3       5 1 1  985.72
42    3       5 1 2 1012.60
43    3       5 1 3  984.62
44    3       5 1 4  973.47
45    3       1 2 1 1013.52
46    3       1 2 2 1017.40
47    3       1 2 3  996.63
48    3       1 2 4  989.91
49    3       4 3 1 1003.92
50    3       4 3 2  999.33
51    3       4 3 3  995.70
52    3       4 3 4  988.14
53    3       2 4 1 1010.08
54    3       2 4 2  997.66
55    3       2 4 3 1012.12
56    3       2 4 4 1019.53
57    3       3 5 1 1004.83
58    3       3 5 2  983.86
59    3       3 5 3 1018.60
60    3       3 5 4 1020.95
61    4       2 1 1  991.79
62    4       2 1 2  979.47
63    4       2 1 3 1004.70
64    4       2 1 4 1032.75
65    4       3 2 1 1004.52
66    4       3 2 2  996.53
67    4       3 2 3 1016.95
68    4       3 2 4  983.79
69    4       1 3 1  990.17
70    4       1 3 2  972.21
71    4       1 3 3 1002.17
72    4       1 3 4 1017.56
73    4       5 4 1 1006.13
74    4       5 4 2 1005.57
75    4       5 4 3 1003.18
76    4       5 4 4  992.21
77    4       4 5 1 1011.02
78    4       4 5 2  982.79
79    4       4 5 3 1018.23
80    4       4 5 4  976.68
81    5       3 1 1  993.54
```

```
82    5       3 1 2 1006.80
83    5       3 1 3 1001.24
84    5       3 1 4 1010.73
85    5       4 2 1  985.04
86    5       4 2 2  987.54
87    5       4 2 3  990.53
88    5       4 2 4  982.68
89    5       5 3 1 1012.14
90    5       5 3 2  999.32
91    5       5 3 3 1005.51
92    5       5 3 4  998.86
93    5       1 4 1  985.12
94    5       1 4 2  984.14
95    5       1 4 3 1010.74
96    5       1 4 4 1004.63
97    5       2 5 1  967.39
98    5       2 5 2 1009.78
99    5       2 5 3 1027.49
100   5       2 5 4 1001.61
```

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

$ANOVA
Response : Y

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

$Fitness

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

$`Type I`

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

$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Row	0				
R	4	1159.8	289.94		
S	3	351.9	117.29		

```
R:S          12    826.0    68.83
Row:R         0
S:Column     12  3863.3   321.94
R:S:Column   48 11982.3   249.63


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

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

6.2   Example 3.1

(9) MODEL

```
ex3.1a = read.table("http://r.acr.kr/split/Ex3.1-example.txt", header=TRUE)
ex3.1a = af(ex3.1a, c("row", "P", "column", "R", "S"))
ex3.1a
```

```
    row P column R S height
1     1 1      1 3 4    103
2     1 1      1 3 2     98
3     1 1      1 3 3    101
4     1 1      1 3 1    101
5     1 1      2 4 2    100
6     1 1      2 4 3     98
7     1 1      2 4 1    100
8     1 1      2 4 4     99
9     1 1      3 5 3     99
10    1 1      3 5 1     99
11    1 1      3 5 2    100
12    1 1      3 5 4     97
13    1 1      4 2 2     99
14    1 1      4 2 1    102
15    1 1      4 2 3     99
16    1 1      4 2 4    100
17    1 1      5 1 1    102
18    1 1      5 1 2    107
19    1 1      5 1 3     98
20    1 1      5 1 4     99
```

21	1 2	1 3 4	101
22	1 2	1 3 2	101
23	1 2	1 3 3	99
24	1 2	1 3 1	100
25	1 2	2 4 2	97
26	1 2	2 4 3	85
27	1 2	2 4 1	99
28	1 2	2 4 4	97
29	1 2	3 5 3	98
30	1 2	3 5 1	96
31	1 2	3 5 2	88
32	1 2	3 5 4	98
33	1 2	4 2 2	95
34	1 2	4 2 1	90
35	1 2	4 2 3	99
36	1 2	4 2 4	87
37	1 2	5 1 1	98
38	1 2	5 1 2	98
39	1 2	5 1 3	99
40	1 2	5 1 4	89
41	2 1	1 2 4	99
42	2 1	1 2 2	97
43	2 1	1 2 3	98
44	2 1	1 2 1	95
45	2 1	2 3 2	99
46	2 1	2 3 3	98
47	2 1	2 3 1	96
48	2 1	2 3 4	93
49	2 1	3 1 3	97
50	2 1	3 1 1	99
51	2 1	3 1 2	95
52	2 1	3 1 4	98
53	2 1	4 4 2	97
54	2 1	4 4 1	95
55	2 1	4 4 3	99
56	2 1	4 4 4	94
57	2 1	5 5 1	98
58	2 1	5 5 2	93
59	2 1	5 5 3	98
60	2 1	5 5 4	96
61	2 2	1 2 4	99
62	2 2	1 2 2	89
63	2 2	1 2 3	98
64	2 2	1 2 1	94
65	2 2	2 3 2	98
66	2 2	2 3 3	91
67	2 2	2 3 1	97
68	2 2	2 3 4	96

69	2	2	3	1	3	94
70	2	2	3	1	1	97
71	2	2	3	1	2	98
72	2	2	3	1	4	96
73	2	2	4	4	2	99
74	2	2	4	4	1	89
75	2	2	4	4	3	97
76	2	2	4	4	4	98
77	2	2	5	5	1	99
78	2	2	5	5	2	96
79	2	2	5	5	3	93
80	2	2	5	5	4	98
81	3	1	1	4	4	99
82	3	1	1	4	2	88
83	3	1	1	4	3	98
84	3	1	1	4	1	96
85	3	1	2	5	2	98
86	3	1	2	5	3	99
87	3	1	2	5	1	92
88	3	1	2	5	4	88
89	3	1	3	2	3	98
90	3	1	3	2	1	85
91	3	1	3	2	2	88
92	3	1	3	2	4	95
93	3	1	4	1	2	97
94	3	1	4	1	1	87
95	3	1	4	1	3	96
96	3	1	4	1	4	88
97	3	1	5	3	1	88
98	3	1	5	3	2	85
99	3	1	5	3	3	78
100	3	1	5	3	4	78
101	3	2	1	4	4	88
102	3	2	1	4	2	85
103	3	2	1	4	3	78
104	3	2	1	4	1	80
105	3	2	2	5	2	80
106	3	2	2	5	3	79
107	3	2	2	5	1	77
108	3	2	2	5	4	78
109	3	2	3	2	3	90
110	3	2	3	2	1	91
111	3	2	3	2	2	92
112	3	2	3	2	4	93
113	3	2	4	1	2	99
114	3	2	4	1	1	97
115	3	2	4	1	3	98
116	3	2	4	1	4	99

117	3	2		5	3	1	80
118	3	2		5	3	2	81
119	3	2		5	3	3	82
120	3	2		5	3	4	83
121	4	1		1	1	4	80
122	4	1		1	1	2	81
123	4	1		1	1	3	84
124	4	1		1	1	1	80
125	4	1		2	2	2	90
126	4	1		2	2	3	90
127	4	1		2	2	1	90
128	4	1		2	2	4	90
129	4	1		3	3	3	99
130	4	1		3	3	1	98
131	4	1		3	3	2	97
132	4	1		3	3	4	99
133	4	1		4	5	2	95
134	4	1		4	5	1	95
135	4	1		4	5	3	95
136	4	1		4	5	4	96
137	4	1		5	4	1	99
138	4	1		5	4	2	95
139	4	1		5	4	3	98
140	4	1		5	4	4	98
141	4	2		1	1	4	98
142	4	2		1	1	2	99
143	4	2		1	1	3	97
144	4	2		1	1	1	99
145	4	2		2	2	2	88
146	4	2		2	2	3	87
147	4	2		2	2	1	88
148	4	2		2	2	4	86
149	4	2		3	3	3	99
150	4	2		3	3	1	97
151	4	2		3	3	2	96
152	4	2		3	3	4	95
153	4	2		4	5	2	89
154	4	2		4	5	1	88
155	4	2		4	5	3	87
156	4	2		4	5	4	85
157	4	2		5	4	1	90
158	4	2		5	4	2	90
159	4	2		5	4	3	90
160	4	2		5	4	4	97
161	5	1		1	5	4	98
162	5	1		1	5	2	98
163	5	1		1	5	3	99
164	5	1		1	5	1	97

```
165   5 1      2 1 2      98
166   5 1      2 1 3      97
167   5 1      2 1 1      98
168   5 1      2 1 4      89
169   5 1      3 4 3      88
170   5 1      3 4 1      87
171   5 1      3 4 2      88
172   5 1      3 4 4      88
173   5 1      4 3 2      98
174   5 1      4 3 1      95
175   5 1      4 3 3      97
176   5 1      4 3 4      99
177   5 1      5 2 1      98
178   5 1      5 2 2      98
179   5 1      5 2 3      95
180   5 1      5 2 4      99
181   5 2      1 5 4      88
182   5 2      1 5 2      87
183   5 2      1 5 3      99
184   5 2      1 5 1      98
185   5 2      2 1 2      99
186   5 2      2 1 3      95
187   5 2      2 1 1      99
188   5 2      2 1 4      90
189   5 2      3 4 3      98
190   5 2      3 4 1      99
191   5 2      3 4 2      99
192   5 2      3 4 4      92
193   5 2      4 3 2      88
194   5 2      4 3 1      86
195   5 2      4 3 3      87
196   5 2      4 3 4      83
197   5 2      5 2 1      99
198   5 2      5 2 2      96
199   5 2      5 2 3      98
200   5 2      5 2 4      99
```

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

$ANOVA
Response : height

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

$Fitness

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


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


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


$`Type III`
          Df  Sum Sq Mean Sq F value Pr(>F)
row        4 2017.03  504.26
R          4   90.63   22.66
P          1  253.13  253.13
S          3   16.38    5.46
R:S       12  195.05   16.25
row:P      4  167.25   41.81
R:P        4  504.95  126.24
row:R:P   32 2933.52   91.67
P:S        3   14.30    4.77
row:P:S   24  234.68    9.78
R:P:S     12  100.33    8.36
row:R:P:S 96 1007.52   10.49
```

```
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
```

(10) MODEL

- p94 Appendix 3.1

```
ex3.1b = read.table("http://r.acr.kr/split/spexvar3.txt", header=TRUE)
ex3.1b = af(ex3.1b, c("rep", "var", "nit", "row", "col"))
ex3.1b
```

```
   row col rep var nit set reps yield
1    1   1   1   3   3   1    1   156
2    1   2   1   3   2   1    1   118
3    1   3   4   3   2   2    1   109
4    1   4   4   3   3   2    1    99
5    2   1   1   3   1   1    1   140
6    2   2   1   3   4   1    1   105
7    2   3   4   3   4   2    1    63
8    2   4   4   3   1   2    1    70
9    3   1   1   1   4   1    1   111
10   3   2   1   1   1   1    1   130
11   3   3   4   2   4   2    1    80
12   3   4   4   2   2   2    1    94
13   4   1   1   1   3   1    1   174
14   4   2   1   1   2   1    1   157
15   4   3   4   2   3   2    1   126
16   4   4   4   2   1   2    1    82
17   5   1   1   2   4   1    1   117
18   5   2   1   2   1   1    1   114
19   5   3   4   1   1   2    1    90
20   5   4   4   1   2   2    1   100
21   6   1   1   2   2   1    1   161
22   6   2   1   2   3   1    1   141
23   6   3   4   1   3   2    1   116
24   6   4   4   1   4   2    1    62
25   7   1   2   3   2   1    2   104
26   7   2   2   3   4   1    2    70
27   7   3   5   2   3   2    2    96
28   7   4   5   2   4   2    2    60
29   8   1   2   3   1   1    2    89
```

```
30    8    2    2    3    3    1    2    117
31    8    3    5    2    2    2    2     89
32    8    4    5    2    1    2    2    102
33    9    1    2    1    3    1    2    122
34    9    2    2    1    4    1    2     74
35    9    3    5    1    2    2    2    112
36    9    4    5    1    3    2    2     86
37   10    1    2    1    1    1    2     89
38   10    2    2    1    2    1    2     81
39   10    3    5    1    4    2    2     68
40   10    4    5    1    1    2    2     64
41   11    1    2    2    1    1    2    103
42   11    2    2    2    4    1    2     64
43   11    3    5    3    2    2    2    132
44   11    4    5    3    3    2    2    124
45   12    1    2    2    2    1    2    132
46   12    2    2    2    3    1    2    133
47   12    3    5    3    1    2    2    129
48   12    4    5    3    4    2    2     89
49   13    1    3    2    1    1    3    108
50   13    2    3    2    2    1    3    126
51   13    3    6    1    2    2    3    118
52   13    4    6    1    4    2    3     53
53   14    1    3    2    3    1    3    149
54   14    2    3    2    4    1    3     70
55   14    3    6    1    3    2    3    113
56   14    4    6    1    1    2    3     74
57   15    1    3    3    3    1    3    144
58   15    2    3    3    1    1    3    124
59   15    3    6    2    3    2    3    104
60   15    4    6    2    2    2    3     86
61   16    1    3    3    2    1    3    121
62   16    2    3    3    4    1    3     96
63   16    3    6    2    4    2    3     89
64   16    4    6    2    1    2    3     82
65   17    1    3    1    4    1    3     61
66   17    2    3    1    3    1    3    100
67   17    3    6    3    4    2    3     97
68   17    4    6    3    1    2    3     99
69   18    1    3    1    1    1    3     91
70   18    2    3    1    2    1    3     97
71   18    3    6    3    2    2    3    119
72   18    4    6    3    3    2    3    121
```

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

$ANOVA
Response : yield

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


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


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


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


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

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

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

Anova Table (Type III tests)

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

6.3 Example 5.1

(11) MODEL

```
ex5.1 = read.table("http://r.acr.kr/split/sbsp.txt", header=TRUE)
ex5.1 = af(ex5.1, c("R", "A", "C", "B", "Tx"))
ex5.1
```

```
   R A C B Tx Y
1  1 1 1 2  1 2
2  1 1 1 1  2 5
3  1 1 2 2  4 6
4  1 1 2 1  3 9
5  1 1 3 1  6 8
6  1 1 3 2  5 5
7  1 2 1 2  4 9
8  1 2 1 1  3 7
9  1 2 2 2  6 8
10 1 2 2 1  5 4
11 1 2 3 1  1 3
12 1 2 3 2  2 5
13 2 2 1 2  6 8
14 2 2 1 1  5 5
15 2 2 2 2  1 3
16 2 2 2 1  2 5
17 2 2 3 1  4 9
18 2 2 3 2  3 7
```

```
19 2 1 1 2  3 3
20 2 1 1 1  6 4
21 2 1 2 2  5 3
22 2 1 2 1  1 0
23 2 1 3 1  2 1
24 2 1 3 2  4 2
25 3 1 1 2  5 5
26 3 1 1 1  1 5
27 3 1 2 2  2 5
28 3 1 2 1  4 9
29 3 1 3 1  3 7
30 3 1 3 2  6 8
31 3 2 1 2  2 6
32 3 2 1 1  4 8
33 3 2 2 2  3 7
34 3 2 2 1  6 8
35 3 2 3 1  5 6
36 3 2 3 2  1 3
```

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

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

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

```
$`Type I`
     Df  Sum Sq Mean Sq F value     Pr(>F)
R     2  33.500 16.7500 14.4373 0.0008391 ***
A     1  16.000 16.0000 13.7908 0.0034197 **
R:A   2  32.167 16.0833 13.8626 0.0009856 ***
C     2   0.500  0.2500  0.2155 0.8094766
B     1   1.778  1.7778  1.5323 0.2415358
C:B   2   0.389  0.1944  0.1676 0.8478141
Tx    5 103.333 20.6667 17.8131 6.055e-05 ***
A:Tx  5   6.521  1.3042  1.1241 0.4027183
B:Tx  4   2.050  0.5126  0.4418 0.7761730
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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


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

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

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


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

```r
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
 (12) MODEL
```

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

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

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

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

```
$`Type II`
```

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


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

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

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


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

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

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

Anova Table (Type III tests)

Response: Y

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

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

6.4 Example 7.1

(13) MODEL

```
ex7.1 = read.table("http://r.acr.kr/split/asped.txt", header=TRUE)
ex7.1 = af(ex7.1, c("R", "G", "F"))
ex7.1
```

```
    Y R  G F
1   2 1 25 1
2   4 1 25 2
3   6 1 25 3
4   1 1 26 1
5   3 1 26 2
6   5 1 26 3
7   9 1 27 1
8   9 1 27 2
9   8 1 27 3
10  9 1 28 1
11  9 1 28 2
12  7 1 28 3
13  2 1  1 1
14  5 1  1 2
15  7 1  1 3
```

```
16   3 1    2 1
17   6 1    2 2
18   5 1    2 3
19   4 1    3 1
20   7 1    3 2
21   6 1    3 3
22   5 1    4 1
23   8 1    4 2
24   4 1    4 3
25   6 1    5 1
26   8 1    5 2
27   8 1    5 3
28   7 1    6 1
29   8 1    6 2
30   7 1    6 3
31   3 2   25 1
32   3 2   25 2
33   7 2   25 3
34   2 2   26 1
35   2 2   26 2
36   4 2   26 3
37   8 2   27 1
38   8 2   27 2
39   8 2   27 3
40   7 2   28 1
41   8 2   28 2
42   9 2   28 3
43   1 2    7 1
44   2 2    7 2
45   3 2    7 3
46   2 2    8 1
47   3 2    8 2
48   5 2    8 3
49   3 2    9 1
50   4 2    9 2
51   4 2    9 3
52   4 2   10 1
53   4 2   10 2
54   5 2   10 3
55   8 2   11 1
56   8 2   11 2
57   8 2   11 3
58   3 2   12 1
59   5 2   12 2
60   7 2   12 3
61   4 3   25 1
62   6 3   25 2
63   8 3   25 3
```

```
64    2 3 26 1
65    5 3 26 2
66    7 3 26 3
67    8 3 27 1
68    7 3 27 2
69    9 3 27 3
70    7 3 28 1
71    7 3 28 2
72    9 3 28 3
73    7 3 13 1
74    7 3 13 2
75    9 3 13 3
76    5 3 14 1
77    6 3 14 2
78    8 3 14 3
79    3 3 15 1
80    5 3 15 2
81    6 3 15 3
82    7 3 16 1
83    7 3 16 2
84    9 3 16 3
85    6 3 17 1
86    8 3 17 2
87    8 3 17 3
88    5 3 18 1
89    7 3 18 2
90    8 3 18 3
91    4 4 25 1
92    5 4 25 2
93    6 4 25 3
94    5 4 26 1
95    2 4 26 2
96    5 4 26 3
97    9 4 27 1
98    9 4 27 2
99    9 4 27 3
100   9 4 28 1
101   8 4 28 2
102   7 4 28 3
103   5 4 19 1
104   8 4 19 2
105   9 4 19 3
106   6 4 20 1
107   6 4 20 2
108   8 4 20 3
109   7 4 21 1
110   4 4 21 2
111   8 4 21 3
```

```
112 8 4 22 1
113 7 4 22 2
114 9 4 22 3
115 9 4 23 1
116 8 4 23 2
117 9 4 23 3
118 9 4 24 1
119 8 4 24 2
120 9 4 24 3
```

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

```
$ANOVA
Response : Y
                 Df Sum Sq Mean Sq F value    Pr(>F)
MODEL            95 577.82  6.0824  5.3082 1.068e-05 ***
RESIDUALS        24  27.50  1.1458
CORRECTED TOTAL 119 605.32
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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

```
$`Type I`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3  84.76 28.2528 24.6570 1.655e-07 ***
G   27 343.48 12.7216 11.1025 4.286e-08 ***
R:G  9  11.75  1.3056  1.1394    0.3749
F    2  59.85 29.9250 26.1164 9.481e-07 ***
G:F 54  77.98  1.4441  1.2603    0.2718
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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

```
$`Type III`
    Df Sum Sq Mean Sq F value    Pr(>F)
R    3   5.75  1.9167  1.6727    0.1994
```

```
G    27 343.48 12.7216 11.1025 4.286e-08 ***
R:G  9   11.75  1.3056  1.1394    0.3749
F    2   50.50 25.2525 22.0385 3.686e-06 ***
G:F 54   77.98  1.4441  1.2603    0.2718
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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

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

Anova Table (Type III tests)

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

6.5 Example 7.3

(14) MODEL

```
ex7.3 = read.table("http://r.acr.kr/split/assped.txt", header=TRUE)
ex7.3 = af(ex7.3, c("R", "T", "G", "F"))
ex7.3
```

```
   Y R T  G F
1  2 1 1  1 1
2  4 1 1  1 2
3  6 1 1  1 3
4  3 1 1  2 1
5  5 1 1  2 2
6  7 1 1  2 3
7  7 1 1  3 1
8  7 1 1  3 2
9  9 1 1  3 3
10 8 1 1  4 1
11 8 1 1  4 2
12 9 1 1  4 3
13 8 1 1  5 1
14 8 1 1  5 2
15 9 1 1  5 3
```

```
16   2 1 1 21 1
17   5 1 1 21 2
18   7 1 1 21 3
19   4 1 1 22 1
20   6 1 1 22 2
21   7 1 1 22 3
22   6 1 1 23 1
23   7 1 1 23 2
24   8 1 1 23 3
25   3 1 2  1 1
26   4 1 2  1 2
27   5 1 2  1 3
28   4 1 2  2 1
29   6 1 2  2 2
30   8 1 2  2 3
31   7 1 2  3 1
32   8 1 2  3 2
33   9 1 2  3 3
34   9 1 2  4 1
35   8 1 2  4 2
36   9 1 2  4 3
37   7 1 2  5 1
38   9 1 2  5 2
39   9 1 2  5 3
40   3 1 2 21 1
41   6 1 2 21 2
42   7 1 2 21 3
43   5 1 2 22 1
44   7 1 2 22 2
45   8 1 2 22 3
46   6 1 2 23 1
47   7 1 2 23 2
48   8 1 2 23 3
49   4 2 1  6 1
50   5 2 1  6 2
51   6 2 1  6 3
52   6 2 1  7 1
53   7 2 1  7 2
54   8 2 1  7 3
55   7 2 1  8 1
56   8 2 1  8 2
57   9 2 1  8 3
58   7 2 1  9 1
59   8 2 1  9 2
60   9 2 1  9 3
61   3 2 1 10 1
62   5 2 1 10 2
63   6 2 1 10 3
```

```
64    3 2 1 21  1
65    5 2 1 21  2
66    7 2 1 21  3
67    5 2 1 22  1
68    5 2 1 22  2
69    7 2 1 22  3
70    6 2 1 23  1
71    7 2 1 23  2
72    9 2 1 23  3
73    5 2 2  6  1
74    6 2 2  6  2
75    7 2 2  6  3
76    6 2 2  7  1
77    7 2 2  7  2
78    7 2 2  7  3
79    7 2 2  8  1
80    9 2 2  8  2
81    8 2 2  8  3
82    7 2 2  9  1
83    7 2 2  9  2
84    9 2 2  9  3
85    4 2 2 10  1
86    5 2 2 10  2
87    7 2 2 10  3
88    2 2 2 21  1
89    4 2 2 21  2
90    5 2 2 21  3
91    6 2 2 22  1
92    7 2 2 22  2
93    8 2 2 22  3
94    6 2 2 23  1
95    7 2 2 23  2
96    8 2 2 23  3
97    4 3 1 11  1
98    5 3 1 11  2
99    6 3 1 11  3
100 7 3 1 12  1
101 8 3 1 12  2
102 8 3 1 12  3
103 6 3 1 13  1
104 7 3 1 13  2
105 7 3 1 13  3
106 7 3 1 14  1
107 7 3 1 14  2
108 9 3 1 14  3
109 2 3 1 15  1
110 3 3 1 15  2
111 4 3 1 15  3
```

```
112 4 3 1 21 1
113 5 3 1 21 2
114 5 3 1 21 3
115 6 3 1 22 1
116 7 3 1 22 2
117 8 3 1 22 3
118 7 3 1 23 1
119 8 3 1 23 2
120 8 3 1 23 3
121 5 3 2 11 1
122 5 3 2 11 2
123 6 3 2 11 3
124 8 3 2 12 1
125 8 3 2 12 2
126 9 3 2 12 3
127 7 3 2 13 1
128 7 3 2 13 2
129 9 3 2 13 3
130 7 3 2 14 1
131 8 3 2 14 2
132 8 3 2 14 3
133 4 3 2 15 1
134 5 3 2 15 2
135 7 3 2 15 3
136 3 3 2 21 1
137 6 3 2 21 2
138 6 3 2 21 3
139 7 3 2 22 1
140 7 3 2 22 2
141 9 3 2 22 3
142 7 3 2 23 1
143 8 3 2 23 2
144 9 3 2 23 3
145 1 4 1 16 1
146 3 4 1 16 2
147 5 4 1 16 3
148 2 4 1 17 1
149 4 4 1 17 2
150 5 4 1 17 3
151 3 4 1 18 1
152 4 4 1 18 2
153 6 4 1 18 3
154 4 4 1 19 1
155 5 4 1 19 2
156 7 4 1 19 3
157 5 4 1 20 1
158 5 4 1 20 2
159 7 4 1 20 3
```

```
160 5 4 1 21 1
161 6 4 1 21 2
162 8 4 1 21 3
163 5 4 1 22 1
164 7 4 1 22 2
165 7 4 1 22 3
166 6 4 1 23 1
167 8 4 1 23 2
168 9 4 1 23 3
169 2 4 2 16 1
170 2 4 2 16 2
171 4 4 2 16 3
172 3 4 2 17 1
173 5 4 2 17 2
174 6 4 2 17 3
175 4 4 2 18 1
176 6 4 2 18 2
177 7 4 2 18 3
178 5 4 2 19 1
179 7 4 2 19 2
180 7 4 2 19 3
181 6 4 2 20 1
182 7 4 2 20 2
183 8 4 2 20 3
184 4 4 2 21 1
185 6 4 2 21 2
186 7 4 2 21 3
187 7 4 2 22 1
188 8 4 2 22 2
189 8 4 2 22 3
190 7 4 2 23 1
191 8 4 2 23 2
192 9 4 2 23 3
```

GLM(Y ~ R + T + R:T + G + G:T + R:T:G + F + F:T + F:G + F:G:T, ex7.3)

$ANOVA
Response : Y

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

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

$Fitness

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

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

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

$`Type III`
       Df Sum Sq Mean Sq  F value      Pr(>F)
R        3  12.49   4.162  13.2206 5.655e-06 ***
T        1  11.16  11.158  35.4430 8.021e-07 ***
R:T      3   1.15   0.384   1.2206  0.316281
G       22 389.01  17.682  56.1668 < 2.2e-16 ***
T:G     22  18.42   0.837   2.6601  0.004445 **
R:T:G   12   8.78   0.731   2.3235  0.025315 *
F        2 120.56  60.282 191.4828 < 2.2e-16 ***
T:F      2   0.82   0.411   1.3060  0.283432
G:F     44  23.47   0.533   1.6943  0.053191 .
T:G:F   44  10.74   0.244   0.7753  0.790640
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
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
```

6.6 Example 8.1

(15) MODEL

```
ex8.1 = read.table("http://r.acr.kr/split/asbed.txt", header=TRUE)
ex8.1 = af(ex8.1, c("R", "A", "B"))
ex8.1
```

```
     Y R  A B
1    9 1  1 1
2    2 1  1 2
3    8 1  1 7
4    7 1  1 8
5    5 1  1 9
6    9 1  2 1
7    7 1  2 2
8    3 1  2 7
9    5 1  2 8
10   4 1  2 9
11   9 1  3 1
12   2 1  3 2
13   8 1  3 7
14   7 1  3 8
15   5 1  3 9
16   9 1 10 1
17   1 1 10 2
```

```
18    9 1 10 7
19    7 1 10 8
20    5 1 10 9
21    9 1 11 1
22    7 1 11 2
23    3 1 11 7
24    5 1 11 8
25    4 1 11 9
26    9 1 12 1
27    2 1 12 2
28    8 1 12 7
29    7 1 12 8
30    5 1 12 9
31    9 1 13 1
32    7 1 13 2
33    3 1 13 7
34    5 1 13 8
35    4 1 13 9
36    9 2  4 3
37    7 2  4 4
38   13 2  4 7
39    8 2  4 8
40    8 2  4 9
41    9 2  5 3
42   12 2  5 4
43    8 2  5 7
44    7 2  5 8
45    8 2  5 9
46    9 2  6 3
47    7 2  6 4
48   13 2  6 7
49    9 2  6 8
50   12 2  6 9
51    9 2 10 3
52   11 2 10 4
53    9 2 10 7
54    7 2 10 8
55    5 2 10 9
56    9 2 11 3
57    7 2 11 4
58   13 2 11 7
59    5 2 11 8
60    4 2 11 9
61    9 2 12 3
62   12 2 12 4
63    8 2 12 7
64    7 2 12 8
65    5 2 12 9
```

```
66     9 2 13 3
67     7 2 13 4
68    13 2 13 7
69     5 2 13 8
70     4 2 13 9
71    19 3  7 5
72    17 3  7 6
73    13 3  7 7
74    15 3  7 8
75    14 3  7 9
76    19 3  8 5
77    12 3  8 6
78    18 3  8 7
79    17 3  8 8
80    45 3  8 9
81    19 3  9 5
82    17 3  9 6
83    13 3  9 7
84    25 3  9 8
85    34 3  9 9
86    15 3 10 5
87     9 3 10 6
88    11 3 10 7
89    10 3 10 8
90    10 3 10 9
91     9 3 11 5
92    17 3 11 6
93    13 3 11 7
94    15 3 11 8
95    14 3 11 9
96     9 3 12 5
97    12 3 12 6
98     8 3 12 7
99    17 3 12 8
100 15 3 12 9
101  9 3 13 5
102 17 3 13 6
103 13 3 13 7
104 15 3 13 8
105 14 3 13 9
```

GLM(Y ~ R + A + R:A + B + B:R + A:B + A:B:R, ex8.1)

$ANOVA
Response : Y

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

```
CORRECTED TOTAL 104 3951.8

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

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

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

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

```r
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
```

6.7   Example 9.2

 (16) MODEL

```r
ex9.2 = read.table("http://r.acr.kr/split/Ex9.2-sbex.txt", header=TRUE)
ex9.2 = af(ex9.2, c("rep", "hyb", "gen"))
ex9.2
```

```
   yield rep hyb gen
```

1	48	1	3	1
2	46	1	3	3
3	43	1	3	2
4	46	1	8	1
5	45	1	8	3
6	42	1	8	2
7	46	1	2	1
8	44	1	2	3
9	42	1	2	2
10	42	1	1	1
11	46	1	1	3
12	44	1	1	2
13	43	1	6	1
14	45	1	6	3
15	44	1	6	2
16	47	1	7	1
17	49	1	7	3
18	47	1	7	2
19	48	1	0	1
20	45	1	0	3
21	45	1	0	2
22	46	1	9	1
23	48	1	9	3
24	47	1	9	2
25	46	1	4	1
26	48	1	4	3
27	47	1	4	2
28	49	1	5	1
29	49	1	5	3
30	48	1	5	2
31	46	2	4	2
32	48	2	4	3
33	42	2	4	1
34	45	2	3	2
35	44	2	3	3
36	42	2	3	1
37	46	2	9	2
38	46	2	9	3
39	44	2	9	1
40	45	2	5	2
41	45	2	5	3
42	43	2	5	1
43	43	2	1	2
44	50	2	1	3
45	44	2	1	1
46	48	2	7	2
47	51	2	7	3
48	48	2	7	1

```
49    44    2    2    2
50    48    2    2    3
51    47    2    2    1
52    44    2    8    2
53    46    2    8    3
54    46    2    8    1
55    47    2    6    2
56    48    2    6    3
57    44    2    6    1
```

```
GLM(yield ~ rep + hyb + rep:hyb + gen + gen:rep + gen:hyb, ex9.2)
```

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

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

```
$`Type I`
        Df Sum Sq Mean Sq F value      Pr(>F)
rep      1  0.239  0.2388  0.1719 0.6839085
hyb      9 66.796  7.4218  5.3437 0.0018370 **
rep:hyb  8 67.000  8.3750  6.0300 0.0011569 **
gen      2 36.351 18.1754 13.0863 0.0004293 ***
rep:gen  2 16.923  8.4616  6.0924 0.0107858 *
hyb:gen 18 60.504  3.3613  2.4201 0.0408545 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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

```
$`Type III`
```

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

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

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

Anova Table (Type III tests)

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

6.8 Example 10.1

(17) MODEL

```
ex10.1 = read.table("http://r.acr.kr/split/Ex10.1-New.txt", header=TRUE)
ex10.1 = af(ex10.1, c("Site", "Block", "A", "B", "C"))
ex10.1
```

```
    Obs Site Block  A  B  C Yield
1    1    1    1   R1 A1 B1 C1  6979
2    2    1    1   R1 A1 B1 C2  7272
3    3    1    1   R1 A1 B1 C3  7565
4    4    1    1   R1 A1 B1 C4  7827
5    5    1    1   R1 A1 B2 C1  8113
6    6    1    1   R1 A1 B2 C2  7025
7    7    1    1   R1 A1 B2 C3  7340
8    8    1    1   R1 A1 B2 C4  7637
9    9    1    1   R1 A2 B1 C1  7910
10  10    1    1   R1 A2 B1 C2  8250
```

```
11  11  1   R1 A2 B1 C3  8611
12  12  1   R1 A2 B1 C4  8865
13  13  1   R1 A2 B2 C1  9090
14  14  1   R1 A2 B2 C2  9453
15  15  1   R1 A2 B2 C3  9762
16  16  1   R1 A2 B2 C4  8440
17  17  1   R1 A3 B1 C1  8785
18  18  1   R1 A3 B1 C2  8963
19  19  1   R1 A3 B1 C3  9278
20  20  1   R1 A3 B1 C4 11100
21  21  1   R1 A3 B2 C1 10800
22  22  1   R1 A3 B2 C2 10600
23  23  1   R1 A3 B2 C3 10200
24  24  1   R1 A3 B2 C4 10100
25  25  1   R1 A4 B1 C1  9834
26  26  1   R1 A4 B1 C2 10200
27  27  1   R1 A4 B1 C3 10400
28  28  1   R1 A4 B1 C4 10900
29  29  1   R1 A4 B2 C1 11000
30  30  1   R1 A4 B2 C2 12600
31  31  1   R1 A4 B2 C3 12400
32  32  1   R1 A4 B2 C4 12100
33  33  1   R1 A5 B1 C1 11900
34  34  1   R1 A5 B1 C2 11500
35  35  1   R1 A5 B1 C3 11800
36  36  1   R1 A5 B1 C4 12100
37  37  1   R1 A5 B2 C1 12400
38  38  1   R1 A5 B2 C2 12700
39  39  1   R1 A5 B2 C3 12800
40  40  1   R1 A5 B2 C4 13300
41  41  1   R2 A1 B1 C1  7132
42  42  1   R2 A1 B1 C2  7412
43  43  1   R2 A1 B1 C3  7659
44  44  1   R2 A1 B1 C4  7947
45  45  1   R2 A1 B2 C1  8241
46  46  1   R2 A1 B2 C2  7273
47  47  1   R2 A1 B2 C3  7493
48  48  1   R2 A1 B2 C4  7837
49  49  1   R2 A2 B1 C1  8050
50  50  1   R2 A2 B1 C2  8398
51  51  1   R2 A2 B1 C3  8700
52  52  1   R2 A2 B1 C4  8954
53  53  1   R2 A2 B2 C1  9380
54  54  1   R2 A2 B2 C2  9478
55  55  1   R2 A2 B2 C3 10000
56  56  1   R2 A2 B2 C4  8498
57  57  1   R2 A3 B1 C1  8944
58  58  1   R2 A3 B1 C2  9070
```

```
59   59    1     R2 A3 B1 C3  9388
60   60    1     R2 A3 B1 C4 11300
61   61    1     R2 A3 B2 C1 10900
62   62    1     R2 A3 B2 C2 10600
63   63    1     R2 A3 B2 C3 10400
64   64    1     R2 A3 B2 C4 10100
65   65    1     R2 A4 B1 C1 10100
66   66    1     R2 A4 B1 C2 10300
67   67    1     R2 A4 B1 C3 10500
68   68    1     R2 A4 B1 C4 10900
69   69    1     R2 A4 B2 C1 11200
70   70    1     R2 A4 B2 C2 12800
71   71    1     R2 A4 B2 C3 12600
72   72    1     R2 A4 B2 C4 12300
73   73    1     R2 A5 B1 C1 11900
74   74    1     R2 A5 B1 C2 11700
75   75    1     R2 A5 B1 C3 11800
76   76    1     R2 A5 B1 C4 12200
77   77    1     R2 A5 B2 C1 12500
78   78    1     R2 A5 B2 C2 12800
79   79    1     R2 A5 B2 C3 12900
80   80    1     R2 A5 B2 C4 13500
81   81    1     R3 A1 B1 C1  6794
82   82    1     R3 A1 B1 C2  7055
83   83    1     R3 A1 B1 C3  7368
84   84    1     R3 A1 B1 C4  7664
85   85    1     R3 A1 B2 C1  7918
86   86    1     R3 A1 B2 C2  6842
87   87    1     R3 A1 B2 C3  7215
88   88    1     R3 A1 B2 C4  7454
89   89    1     R3 A2 B1 C1  7768
90   90    1     R3 A2 B1 C2  7976
91   91    1     R3 A2 B1 C3  8356
92   92    1     R3 A2 B1 C4  8555
93   93    1     R3 A2 B2 C1  8885
94   94    1     R3 A2 B2 C2  9164
95   95    1     R3 A2 B2 C3  9592
96   96    1     R3 A2 B2 C4  8204
97   97    1     R3 A3 B1 C1  8464
98   98    1     R3 A3 B1 C2  8901
99   99    1     R3 A3 B1 C3  9021
100 100    1     R3 A3 B1 C4 11000
101 101    1     R3 A3 B2 C1 10700
102 102    1     R3 A3 B2 C2 10400
103 103    1     R3 A3 B2 C3 10200
104 104    1     R3 A3 B2 C4  9949
105 105    1     R3 A4 B1 C1  9642
106 106    1     R3 A4 B1 C2  9990
```

```
107 107    1    R3 A4 B1 C3 10300
108 108    1    R3 A4 B1 C4 10500
109 109    1    R3 A4 B2 C1 10900
110 110    1    R3 A4 B2 C2 12400
111 111    1    R3 A4 B2 C3 12200
112 112    1    R3 A4 B2 C4 11900
113 113    1    R3 A5 B1 C1 11600
114 114    1    R3 A5 B1 C2 11400
115 115    1    R3 A5 B1 C3 11600
116 116    1    R3 A5 B1 C4 11800
117 117    1    R3 A5 B2 C1 12200
118 118    1    R3 A5 B2 C2 12400
119 119    1    R3 A5 B2 C3 12700
120 120    1    R3 A5 B2 C4 13200
121 121    2    R1 A1 B1 C1  6940
122 122    2    R1 A1 B1 C2  7267
123 123    2    R1 A1 B1 C3  7475
124 124    2    R1 A1 B1 C4  7868
125 125    2    R1 A1 B2 C1  8077
126 126    2    R1 A1 B2 C2  7078
127 127    2    R1 A1 B2 C3  7299
128 128    2    R1 A1 B2 C4  7643
129 129    2    R1 A2 B1 C1  7916
130 130    2    R1 A2 B1 C2  8193
131 131    2    R1 A2 B1 C3  8653
132 132    2    R1 A2 B1 C4  8873
133 133    2    R1 A2 B2 C1  9036
134 134    2    R1 A2 B2 C2  9449
135 135    2    R1 A2 B2 C3  9770
136 136    2    R1 A2 B2 C4  8316
137 137    2    R1 A3 B1 C1  8793
138 138    2    R1 A3 B1 C2  8943
139 139    2    R1 A3 B1 C3  9291
140 140    2    R1 A3 B1 C4 11100
141 141    2    R1 A3 B2 C1 10900
142 142    2    R1 A3 B2 C2 10600
143 143    2    R1 A3 B2 C3 10200
144 144    2    R1 A3 B2 C4  9879
145 145    2    R1 A4 B1 C1  9861
146 146    2    R1 A4 B1 C2 10200
147 147    2    R1 A4 B1 C3 10300
148 148    2    R1 A4 B1 C4 10800
149 149    2    R1 A4 B2 C1 10900
150 150    2    R1 A4 B2 C2 12600
151 151    2    R1 A4 B2 C3 12400
152 152    2    R1 A4 B2 C4 12100
153 153    2    R1 A5 B1 C1 11800
154 154    2    R1 A5 B1 C2 11500
```

```
155 155     2     R1 A5 B1 C3 11600
156 156     2     R1 A5 B1 C4 12100
157 157     2     R1 A5 B2 C1 12400
158 158     2     R1 A5 B2 C2 12600
159 159     2     R1 A5 B2 C3 12800
160 160     2     R1 A5 B2 C4 13300
161 161     2     R2 A1 B1 C1  6819
162 162     2     R2 A1 B1 C2  7137
163 163     2     R2 A1 B1 C3  7398
164 164     2     R2 A1 B1 C4  7680
165 165     2     R2 A1 B2 C1  7903
166 166     2     R2 A1 B2 C2  6968
167 167     2     R2 A1 B2 C3  7172
168 168     2     R2 A1 B2 C4  7494
169 169     2     R2 A2 B1 C1  7811
170 170     2     R2 A2 B1 C2  8000
171 171     2     R2 A2 B1 C3  8350
172 172     2     R2 A2 B1 C4  8730
173 173     2     R2 A2 B2 C1  8956
174 174     2     R2 A2 B2 C2  9195
175 175     2     R2 A2 B2 C3  9547
176 176     2     R2 A2 B2 C4  8183
177 177     2     R2 A3 B1 C1  8484
178 178     2     R2 A3 B1 C2  8865
179 179     2     R2 A3 B1 C3  9115
180 180     2     R2 A3 B1 C4 11100
181 181     2     R2 A3 B2 C1 10700
182 182     2     R2 A3 B2 C2 10400
183 183     2     R2 A3 B2 C3 10000
184 184     2     R2 A3 B2 C4  9830
185 185     2     R2 A4 B1 C1  9789
186 186     2     R2 A4 B1 C2  9977
187 187     2     R2 A4 B1 C3 10200
188 188     2     R2 A4 B1 C4 10500
189 189     2     R2 A4 B2 C1 10900
190 190     2     R2 A4 B2 C2 12500
191 191     2     R2 A4 B2 C3 12300
192 192     2     R2 A4 B2 C4 11800
193 193     2     R2 A5 B1 C1 11600
194 194     2     R2 A5 B1 C2 11300
195 195     2     R2 A5 B1 C3 11500
196 196     2     R2 A5 B1 C4 12000
197 197     2     R2 A5 B2 C1 12100
198 198     2     R2 A5 B2 C2 12600
199 199     2     R2 A5 B2 C3 12700
200 200     2     R2 A5 B2 C4 13100
201 201     2     R3 A1 B1 C1  7189
202 202     2     R3 A1 B1 C2  7371
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203 203    2    R3 A1 B1 C3  7700
204 204    2    R3 A1 B1 C4  8047
205 205    2    R3 A1 B2 C1  8337
206 206    2    R3 A1 B2 C2  7327
207 207    2    R3 A1 B2 C3  7595
208 208    2    R3 A1 B2 C4  7867
209 209    2    R3 A2 B1 C1  8105
210 210    2    R3 A2 B1 C2  8396
211 211    2    R3 A2 B1 C3  8807
212 212    2    R3 A2 B1 C4  8953
213 213    2    R3 A2 B2 C1  9390
214 214    2    R3 A2 B2 C2  9733
215 215    2    R3 A2 B2 C3  9858
216 216    2    R3 A2 B2 C4  8640
217 217    2    R3 A3 B1 C1  9035
218 218    2    R3 A3 B1 C2  9194
219 219    2    R3 A3 B1 C3  9442
220 220    2    R3 A3 B1 C4 11400
221 221    2    R3 A3 B2 C1 11000
222 222    2    R3 A3 B2 C2 10800
223 223    2    R3 A3 B2 C3 10600
224 224    2    R3 A3 B2 C4 10200
225 225    2    R3 A4 B1 C1  9976
226 226    2    R3 A4 B1 C2 10300
227 227    2    R3 A4 B1 C3 10600
228 228    2    R3 A4 B1 C4 11000
229 229    2    R3 A4 B2 C1 11200
230 230    2    R3 A4 B2 C2 12800
231 231    2    R3 A4 B2 C3 12600
232 232    2    R3 A4 B2 C4 12200
233 233    2    R3 A5 B1 C1 11900
234 234    2    R3 A5 B1 C2 11700
235 235    2    R3 A5 B1 C3 11800
236 236    2    R3 A5 B1 C4 12300
237 237    2    R3 A5 B2 C1 12600
238 238    2    R3 A5 B2 C2 12900
239 239    2    R3 A5 B2 C3 13000
240 240    2    R3 A5 B2 C4 13500
241 241    3    R1 A1 B1 C1  7035
242 242    3    R1 A1 B1 C2  7161
243 243    3    R1 A1 B1 C3  7590
244 244    3    R1 A1 B1 C4  7909
245 245    3    R1 A1 B2 C1  8123
246 246    3    R1 A1 B2 C2  7088
247 247    3    R1 A1 B2 C3  7270
248 248    3    R1 A1 B2 C4  7705
249 249    3    R1 A2 B1 C1  7992
250 250    3    R1 A2 B1 C2  8293
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251 251    3    R1 A2 B1 C3  8574
252 252    3    R1 A2 B1 C4  8872
253 253    3    R1 A2 B2 C1  9159
254 254    3    R1 A2 B2 C2  9451
255 255    3    R1 A2 B2 C3  9779
256 256    3    R1 A2 B2 C4  8399
257 257    3    R1 A3 B1 C1  8683
258 258    3    R1 A3 B1 C2  8991
259 259    3    R1 A3 B1 C3  9314
260 260    3    R1 A3 B1 C4 11300
261 261    3    R1 A3 B2 C1 10800
262 262    3    R1 A3 B2 C2 10600
263 263    3    R1 A3 B2 C3 10400
264 264    3    R1 A3 B2 C4 10100
265 265    3    R1 A4 B1 C1  9803
266 266    3    R1 A4 B1 C2 10100
267 267    3    R1 A4 B1 C3 10500
268 268    3    R1 A4 B1 C4 10700
269 269    3    R1 A4 B2 C1 11100
270 270    3    R1 A4 B2 C2 12600
271 271    3    R1 A4 B2 C3 12500
272 272    3    R1 A4 B2 C4 12100
273 273    3    R1 A5 B1 C1 11900
274 274    3    R1 A5 B1 C2 11600
275 275    3    R1 A5 B1 C3 11700
276 276    3    R1 A5 B1 C4 12000
277 277    3    R1 A5 B2 C1 12400
278 278    3    R1 A5 B2 C2 12600
279 279    3    R1 A5 B2 C3 12900
280 280    3    R1 A5 B2 C4 13400
281 281    3    R2 A1 B1 C1  7007
282 282    3    R2 A1 B1 C2  7311
283 283    3    R2 A1 B1 C3  7557
284 284    3    R2 A1 B1 C4  7935
285 285    3    R2 A1 B2 C1  8209
286 286    3    R2 A1 B2 C2  7048
287 287    3    R2 A1 B2 C3  7322
288 288    3    R2 A1 B2 C4  7783
289 289    3    R2 A2 B1 C1  8055
290 290    3    R2 A2 B1 C2  8247
291 291    3    R2 A2 B1 C3  8590
292 292    3    R2 A2 B1 C4  8901
293 293    3    R2 A2 B2 C1  9210
294 294    3    R2 A2 B2 C2  9521
295 295    3    R2 A2 B2 C3  9746
296 296    3    R2 A2 B2 C4  8480
297 297    3    R2 A3 B1 C1  8766
298 298    3    R2 A3 B1 C2  9014
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299 299    3    R2 A3 B1 C3  9370
300 300    3    R2 A3 B1 C4 11200
301 301    3    R2 A3 B2 C1 11000
302 302    3    R2 A3 B2 C2 10700
303 303    3    R2 A3 B2 C3 10300
304 304    3    R2 A3 B2 C4 10100
305 305    3    R2 A4 B1 C1  9872
306 306    3    R2 A4 B1 C2 10100
307 307    3    R2 A4 B1 C3 10400
308 308    3    R2 A4 B1 C4 10800
309 309    3    R2 A4 B2 C1 11100
310 310    3    R2 A4 B2 C2 12600
311 311    3    R2 A4 B2 C3 12500
312 312    3    R2 A4 B2 C4 12200
313 313    3    R2 A5 B1 C1 11900
314 314    3    R2 A5 B1 C2 11600
315 315    3    R2 A5 B1 C3 11700
316 316    3    R2 A5 B1 C4 12100
317 317    3    R2 A5 B2 C1 12400
318 318    3    R2 A5 B2 C2 12700
319 319    3    R2 A5 B2 C3 12900
320 320    3    R2 A5 B2 C4 13400
321 321    3    R3 A1 B1 C1  7108
322 322    3    R3 A1 B1 C2  7295
323 323    3    R3 A1 B1 C3  7675
324 324    3    R3 A1 B1 C4  7948
325 325    3    R3 A1 B2 C1  8220
326 326    3    R3 A1 B2 C2  7142
327 327    3    R3 A1 B2 C3  7413
328 328    3    R3 A1 B2 C4  7826
329 329    3    R3 A2 B1 C1  8038
330 330    3    R3 A2 B1 C2  8358
331 331    3    R3 A2 B1 C3  8718
332 332    3    R3 A2 B1 C4  9000
333 333    3    R3 A2 B2 C1  9410
334 334    3    R3 A2 B2 C2  9520
335 335    3    R3 A2 B2 C3  9812
336 336    3    R3 A2 B2 C4  8452
337 337    3    R3 A3 B1 C1  8894
338 338    3    R3 A3 B1 C2  9137
339 339    3    R3 A3 B1 C3  9409
340 340    3    R3 A3 B1 C4 11300
341 341    3    R3 A3 B2 C1 10900
342 342    3    R3 A3 B2 C2 10700
343 343    3    R3 A3 B2 C3 10400
344 344    3    R3 A3 B2 C4 10100
345 345    3    R3 A4 B1 C1  9975
346 346    3    R3 A4 B1 C2 10200
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347 347      3      R3 A4 B1 C3 10500
348 348      3      R3 A4 B1 C4 10900
349 349      3      R3 A4 B2 C1 11200
350 350      3      R3 A4 B2 C2 12700
351 351      3      R3 A4 B2 C3 12500
352 352      3      R3 A4 B2 C4 12200
353 353      3      R3 A5 B1 C1 11900
354 354      3      R3 A5 B1 C2 11600
355 355      3      R3 A5 B1 C3 11800
356 356      3      R3 A5 B1 C4 12300
357 357      3      R3 A5 B2 C1 12500
358 358      3      R3 A5 B2 C2 12800
359 359      3      R3 A5 B2 C3 12900
360 360      3      R3 A5 B2 C4 13500
361 361      4      R1 A1 B1 C1  6995
362 362      4      R1 A1 B1 C2  7287
363 363      4      R1 A1 B1 C3  7580
364 364      4      R1 A1 B1 C4  7774
365 365      4      R1 A1 B2 C1  8150
366 366      4      R1 A1 B2 C2  7026
367 367      4      R1 A1 B2 C3  7322
368 368      4      R1 A1 B2 C4  7698
369 369      4      R1 A2 B1 C1  7970
370 370      4      R1 A2 B1 C2  8243
371 371      4      R1 A2 B1 C3  8520
372 372      4      R1 A2 B1 C4  8812
373 373      4      R1 A2 B2 C1  9088
374 374      4      R1 A2 B2 C2  9508
375 375      4      R1 A2 B2 C3  9718
376 376      4      R1 A2 B2 C4  8326
377 377      4      R1 A3 B1 C1  8744
378 378      4      R1 A3 B1 C2  9061
379 379      4      R1 A3 B1 C3  9310
380 380      4      R1 A3 B1 C4 11300
381 381      4      R1 A3 B2 C1 10900
382 382      4      R1 A3 B2 C2 10600
383 383      4      R1 A3 B2 C3 10200
384 384      4      R1 A3 B2 C4  9971
385 385      4      R1 A4 B1 C1  9832
386 386      4      R1 A4 B1 C2 10200
387 387      4      R1 A4 B1 C3 10500
388 388      4      R1 A4 B1 C4 10700
389 389      4      R1 A4 B2 C1 11000
390 390      4      R1 A4 B2 C2 12600
391 391      4      R1 A4 B2 C3 12500
392 392      4      R1 A4 B2 C4 12100
393 393      4      R1 A5 B1 C1 11800
394 394      4      R1 A5 B1 C2 11600
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395 395    4    R1 A5 B1 C3 11800
396 396    4    R1 A5 B1 C4 12100
397 397    4    R1 A5 B2 C1 12300
398 398    4    R1 A5 B2 C2 12600
399 399    4    R1 A5 B2 C3 12900
400 400    4    R1 A5 B2 C4 13300
401 401    4    R2 A1 B1 C1  6796
402 402    4    R2 A1 B1 C2  7122
403 403    4    R2 A1 B1 C3  7489
404 404    4    R2 A1 B1 C4  7695
405 405    4    R2 A1 B2 C1  8050
406 406    4    R2 A1 B2 C2  7010
407 407    4    R2 A1 B2 C3  7324
408 408    4    R2 A1 B2 C4  7540
409 409    4    R2 A2 B1 C1  7933
410 410    4    R2 A2 B1 C2  8130
411 411    4    R2 A2 B1 C3  8423
412 412    4    R2 A2 B1 C4  8674
413 413    4    R2 A2 B2 C1  9138
414 414    4    R2 A2 B2 C2  9380
415 415    4    R2 A2 B2 C3  9704
416 416    4    R2 A2 B2 C4  8313
417 417    4    R2 A3 B1 C1  8584
418 418    4    R2 A3 B1 C2  8890
419 419    4    R2 A3 B1 C3  9246
420 420    4    R2 A3 B1 C4 11100
421 421    4    R2 A3 B2 C1 10700
422 422    4    R2 A3 B2 C2 10500
423 423    4    R2 A3 B2 C3 10200
424 424    4    R2 A3 B2 C4  9882
425 425    4    R2 A4 B1 C1  9785
426 426    4    R2 A4 B1 C2 10100
427 427    4    R2 A4 B1 C3 10300
428 428    4    R2 A4 B1 C4 10800
429 429    4    R2 A4 B2 C1 11000
430 430    4    R2 A4 B2 C2 12500
431 431    4    R2 A4 B2 C3 12400
432 432    4    R2 A4 B2 C4 12100
433 433    4    R2 A5 B1 C1 11700
434 434    4    R2 A5 B1 C2 11500
435 435    4    R2 A5 B1 C3 11700
436 436    4    R2 A5 B1 C4 12100
437 437    4    R2 A5 B2 C1 12300
438 438    4    R2 A5 B2 C2 12600
439 439    4    R2 A5 B2 C3 12800
440 440    4    R2 A5 B2 C4 13300
441 441    4    R3 A1 B1 C1  7125
442 442    4    R3 A1 B1 C2  7505
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443 443    4    R3 A1 B1 C3  7752
444 444    4    R3 A1 B1 C4  8099
445 445    4    R3 A1 B2 C1  8409
446 446    4    R3 A1 B2 C2  7332
447 447    4    R3 A1 B2 C3  7512
448 448    4    R3 A1 B2 C4  7917
449 449    4    R3 A2 B1 C1  8176
450 450    4    R3 A2 B1 C2  8382
451 451    4    R3 A2 B1 C3  8861
452 452    4    R3 A2 B1 C4  9056
453 453    4    R3 A2 B2 C1  9419
454 454    4    R3 A2 B2 C2  9700
455 455    4    R3 A2 B2 C3 10000
456 456    4    R3 A2 B2 C4  8573
457 457    4    R3 A3 B1 C1  8953
458 458    4    R3 A3 B1 C2  9278
459 459    4    R3 A3 B1 C3  9538
460 460    4    R3 A3 B1 C4 11400
461 461    4    R3 A3 B2 C1 11100
462 462    4    R3 A3 B2 C2 10800
463 463    4    R3 A3 B2 C3 10600
464 464    4    R3 A3 B2 C4 10300
465 465    4    R3 A4 B1 C1 10000
466 466    4    R3 A4 B1 C2 10400
467 467    4    R3 A4 B1 C3 10700
468 468    4    R3 A4 B1 C4 11000
469 469    4    R3 A4 B2 C1 11200
470 470    4    R3 A4 B2 C2 12900
471 471    4    R3 A4 B2 C3 12600
472 472    4    R3 A4 B2 C4 12400
473 473    4    R3 A5 B1 C1 12000
474 474    4    R3 A5 B1 C2 11700
475 475    4    R3 A5 B1 C3 12000
476 476    4    R3 A5 B1 C4 12300
477 477    4    R3 A5 B2 C1 12500
478 478    4    R3 A5 B2 C2 12900
479 479    4    R3 A5 B2 C3 13000
480 480    4    R3 A5 B2 C4 13700
```

```
f10.1 = Yield ~ Site/Block + A/Site + B/Site + A:B + A:B:Site + A:B:Site:Block +
        C + A:C + B:C + A:B:C + C:Site + A:C:Site + B:C:Site + A:B:C:Site
GLM(f10.1, ex10.1)
```

```
$ANOVA
Response : Yield
                 Df     Sum Sq Mean Sq F value    Pr(>F)
MODEL           239 1639561484 6860090    2162 < 2.2e-16 ***
RESIDUALS       240     761522    3173
```

```
CORRECTED TOTAL 479 1640323006
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


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


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


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

```
Site:A:B:C      36       82475       2291 7.2200e-01 0.87941
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$`Type III`
               Df     Sum Sq    Mean Sq    F value   Pr(>F)
Site            3     552717     184239 5.8064e+01 < 2e-16 ***
Site:Block      8    7062320     882790 2.7822e+02 < 2e-16 ***
A               4 1387680917  346920229 1.0933e+05 < 2e-16 ***
Site:A         12      34068       2839 8.9470e-01 0.55301
B               1  100939695  100939695 3.1812e+04 < 2e-16 ***
Site:B          3       1618        539 1.6990e-01 0.91662
A:B             4   31444008    7861002 2.4775e+03 < 2e-16 ***
Site:A:B       12      33737       2811 8.8600e-01 0.56185
Site:Block:A:B 72     186911       2596 8.1810e-01 0.84155
C               3   19356264    6452088 2.0334e+03 < 2e-16 ***
A:C            12   26075792    2172983 6.8483e+02 < 2e-16 ***
B:C             3   23901387    7967129 2.5109e+03 < 2e-16 ***
A:B:C          12   41996729    3499727 1.1030e+03 < 2e-16 ***
Site:C          9      47625       5292 1.6677e+00 0.09747 .
Site:A:C       36     104110       2892 9.1140e-01 0.61768
Site:B:C        9      61111       6790 2.1400e+00 0.02701 *
Site:A:B:C     36      82475       2291 7.2200e-01 0.87941
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
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 ***
```

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```
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
```

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Reference

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

7.1 p410

(18) MODEL

```
v1p410 = read.table("http://r.acr.kr/kemp/v1p410.txt", head=TRUE)
v1p410$carry = ifelse(v1p410$carry == 0, 3, v1p410$carry)
v1p410 = af(v1p410,c("period", "sequence", "steer", "trt", "carry"))
v1p410
```

	period	sequence	steer	trt	carry	y
1	1	1	1	1	3	50
2	2	1	1	2	1	61
3	3	1	1	3	2	53
4	1	1	2	1	3	55
5	2	1	2	2	1	63
6	3	1	2	3	2	57
7	1	2	3	2	3	44
8	2	2	3	3	2	42
9	3	2	3	1	3	57
10	1	2	4	2	3	51
11	2	2	4	3	2	46
12	3	2	4	1	3	59
13	1	3	5	3	3	35
14	2	3	5	1	3	55
15	3	3	5	2	1	47
16	1	3	6	3	3	41
17	2	3	6	1	3	56
18	3	3	6	2	1	50
19	1	4	7	1	3	54
20	2	4	7	3	1	48
21	3	4	7	2	3	51
22	1	4	8	1	3	58
23	2	4	8	3	1	51
24	3	4	8	2	3	54
25	1	5	9	2	3	50
26	2	5	9	1	2	57
27	3	5	9	3	1	51
28	1	5	10	2	3	55
29	2	5	10	1	2	59
30	3	5	10	3	1	55
31	1	6	11	3	3	41
32	2	6	11	2	3	56

```
33       3        6     11    1      2 58
34       1        6     12    3      3 46
35       2        6     12    2      3 58
36       3        6     12    1      2 61
```
```
GLM(y ~ period + sequence + steer:sequence + trt + carry, v1p410) # OK
```

$ANOVA
Response : y

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

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

$Fitness

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

$`Type I`

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

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

$`Type II`

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

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

$`Type III`

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

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

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

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

Anova Table (Type III tests)

Response: y

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

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

8   Searle - Linear Models 2e

Reference

- Searle SR, Gruber MHJ. Linear Models 2e, Kindle Edition. John Wiley & Sons Inc. 2016.

8.1   7.2 (p390, 59%)

(19) MODEL

```
weight = c(8,13,9,12,7,11,6,12,12,14,9,7,14,16,10,14,11,13)
treatment = c("ta","ta","ta","ta","ta","ta","tb","tb","tb","tb","tc","tc","tc",
              "tc","tc","tc","tc","tc")
variety = c("va","va","va","vc","vd","vd","va","va","vb","vb","vb","vb","vc",
            "vc","vd","vd","vd","vd")
d1 = data.frame(weight, treatment, variety)
GLM(weight ~ treatment*variety, d1)
```

```
$ANOVA
Response : weight
                  Df Sum Sq Mean Sq F value Pr(>F)
MODEL              7     82  11.714  2.0918   0.14
RESIDUALS         10     56   5.600
CORRECTED TOTAL 17    138


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


$`Type I`
                  Df Sum Sq Mean Sq F value  Pr(>F)
treatment          2 10.500   5.250  0.9375 0.42348
variety            3 36.786  12.262  2.1896 0.15232
treatment:variety  2 34.714  17.357  3.0995 0.08965 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$`Type II`
                  Df Sum Sq Mean Sq F value  Pr(>F)
treatment          2  9.486  4.7429  0.8469 0.45731
variety            3 36.786 12.2619  2.1896 0.15232
treatment:variety  2 34.714 17.3571  3.0995 0.08965 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


$`Type III`
                  Df Sum Sq Mean Sq F value  Pr(>F)
treatment          2 12.471  6.2353  1.1134 0.36595
variety            3 34.872 11.6240  2.0757 0.16719
```

77

```
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
```

8.2 7.2 (p393, 60%)

(20) MODEL

```
percent = c(31,33,44,36,38,26,37,59,42,42,34,42,28,39,36,32,38,42,36,22,42,46,
            26,37,43)
refinery = c(rep("g",9),rep("n",8),rep("s",8))
process = as.factor(c(1,1,1,1,1,1,2,2,2,1,1,1,1,2,2,2,2,1,1,1,2,2,2,2,2))
source0 = c("t","t","t","t","o","m","t","t","o","m","i","i","i","t","o","m","m",
            "t","o","i","o","o","m","i","i")
d2 = data.frame(percent, refinery, process, source=source0)
GLM(percent ~ refinery*source, d2)
```

```
$ANOVA
Response : percent
                Df  Sum Sq Mean Sq F value Pr(>F)
MODEL           10  442.56  44.256  0.6361 0.7616
RESIDUALS       14  974.00  69.571
CORRECTED TOTAL 24 1416.56


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


$`Type I`
                Df  Sum Sq Mean Sq F value Pr(>F)
refinery         2  20.963  10.481  0.1507 0.8615
source           3 266.124  88.708  1.2751 0.3212
refinery:source  5 155.474  31.095  0.4469 0.8086
```

```
$`Type II`
              Df  Sum Sq Mean Sq F value Pr(>F)
refinery       2  25.535  12.767  0.1835 0.8343
source         3 266.124  88.708  1.2751 0.3212
refinery:source 5 155.474  31.095  0.4469 0.8086


$`Type III`
              Df  Sum Sq Mean Sq F value Pr(>F)
refinery       2  10.766   5.383  0.0774 0.9259
source         3 282.633  94.211  1.3542 0.2972
refinery:source 5 155.474  31.095  0.4469 0.8086
```

```
options(contrasts=c("contr.sum", "contr.poly"))
Anova(lm(percent ~ refinery*source, d2), type=3, singular.ok=TRUE) # NOT OK
```

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

Anova Table (Type III tests)

Response: percent
                Sum Sq Df F values Pr(>F)
refinery          2.52  1   0.0362 0.8518
source          268.19  2   1.9275 0.1822
refinery:source 155.47  5   0.4469 0.8086
Residuals       974.00 14
```

9 Web site examples

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

 (21) MODEL

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

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


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


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


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


$`Type III`
CAUTION: Singularity Exists !
          Df Sum Sq Mean Sq F value    Pr(>F)
sugar      2 2.1318  1.0659  4.0446 0.045426 *
milk       1 1.0041  1.0041  3.8102 0.074672 .
sugar:milk 2 5.9439  2.9719 11.2769 0.001754 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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

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

Analysis of Variance Table

Response: babble
          Df Sum Sq Mean Sq  F value    Pr(>F)
sugar      3 465.64 155.213 588.9486 2.756e-13 ***
milk       1   0.96   0.956   3.6279  0.081061 .
sugar:milk 2   5.94   2.972  11.2769  0.001754 **
Residuals 12   3.16   0.264
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```
```
Anova(r21, type=2) # NOT OK

Anova Table (Type II tests)

Response: babble
           Sum Sq Df  F value      Pr(>F)
sugar      453.76  3 573.9233 3.214e-13 ***
milk         0.96  1   3.6279  0.081061 .
sugar:milk   5.94  2  11.2769  0.001754 **
Residuals    3.16 12
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```
```
Anova(r21, type=3) # NOT OK

Anova Table (Type III tests)

Response: babble
           Sum Sq Df  F value    Pr(>F)
sugar      454.77  3 575.1970 3.172e-13 ***
milk         1.00  1   3.8102  0.074672 .
sugar:milk   5.94  2  11.2769  0.001754 **
Residuals    3.16 12
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

10 Bioequivalence (BE) data example

(22) MODEL

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

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


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


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


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


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

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

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

Anova Table (Type III tests)

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

11 Sesssion Information

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

Matrix products: default


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

time zone: Asia/Seoul
tzcode source: internal

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

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

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