

# Examples of NOT OK using car package

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# 1 Tested Version and Books used for the Validation

## 1.1 Packages Used

- 'sasLM' version: 0.8.0
- 'SAS' version: 9.4 Licensed and University Edition
- 'car' version: 3.0.12
- R version: R version 4.1.3 (2022-03-10)

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

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

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

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

## 1.2 Books and Articles used for the Test

1. 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
```

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

```
$`Type I`
```

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

```
$`Type II`
```

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

```
$`Type III`
```

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

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

### 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

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

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

32	11	F	3	80	78	placebo	1	0
33	11	F	4	72	75	standard	-1	-1
34	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

```

R-square Coef Var Root MSE  HR Mean
0.7298134 9.301326 7.515988 80.80556

```

\$`Type I`

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

---

```

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

```

\$`Type II`

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

---

```

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

```

\$`Type III`

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

---

```

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

```

```

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

```

Note: model has aliased coefficients

sums of squares computed by model comparison

Anova Table (Type III tests)

Response: HR

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

---

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

## 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
```

R-square	Coef Var	Root MSE	Y Mean
0.8700388	11.35742	1.752288	15.42857

```
$`Type I`
```

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

```
---
```

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

```
$`Type II`
```

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

```
---
```

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

```
$`Type III`
```

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

```
---
```

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

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

Note: model has aliased coefficients

sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Y

Sum Sq	Df	F values	Pr(>F)
--------	----	----------	--------

```

TRT      22.310  1    7.266 0.01835 *
TRT:POT  30.306  5    1.974 0.14991
Residuals 39.917 13

```

---

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

### 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	3	1	192	390	2.24
2	2	1	1	3	2	154	403	2.65
3	3	1	1	4	3	185	432	2.41
4	4	1	1	4	4	193	457	2.25
5	5	1	1	5	5	186	483	2.58
6	6	1	1	5	6	177	469	2.67
7	7	1	1	5	7	177	428	2.71
8	8	1	1	5	8	163	439	2.47
9	9	1	2	4	9	188	439	2.29
10	10	1	2	4	10	178	407	2.26
11	11	1	2	5	11	198	498	1.97
12	12	1	2	5	12	193	459	2.14
13	13	1	2	5	13	186	459	2.44
14	14	1	2	5	14	175	375	2.52
15	15	1	2	5	15	171	382	1.72
16	16	1	2	5	16	168	417	2.75
17	17	1	3	3	17	154	389	2.38
18	18	1	3	4	18	184	414	2.46
19	19	1	3	5	19	174	483	2.29
20	20	1	3	5	20	170	430	2.30
21	21	1	3	5	21	169	443	2.94
22	22	2	4	3	22	158	381	2.50
23	23	2	4	3	23	158	365	2.44
24	24	2	4	4	24	169	386	2.44
25	25	2	4	4	25	144	339	2.15
26	26	2	4	5	26	159	419	2.54
27	27	2	4	5	27	152	469	2.74
28	28	2	4	5	28	149	379	2.50
29	29	2	4	5	29	149	375	2.54
30	30	2	5	3	30	189	395	2.65
31	31	2	5	4	31	187	447	2.52

32	32	2	5	4	32	165	430	2.67
33	33	2	5	5	33	181	453	2.79
34	34	2	5	5	34	177	385	2.33
35	35	2	5	5	35	151	414	2.67
36	36	2	5	5	36	147	353	2.69
37	37	3	6	4	37	184	411	3.00
38	38	3	6	4	38	184	420	2.49
39	39	3	6	5	39	187	427	2.25
40	40	3	6	5	40	184	409	2.49
41	41	3	6	5	41	183	337	2.02
42	42	3	6	5	42	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
```

```
R-square Coef Var Root MSE avdlygn Mean
0.511696 9.295956 0.2241612 2.411385
```

```
$`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
```

```
R-square  Coef Var  Root MSE  pH Mean
0.4589074 0.6676053 0.04973534 7.449813
```

```
$`Type I`
```

```
      Df  Sum Sq  Mean Sq F value    Pr(>F)
Dam      14 0.178017 0.0127155  5.1405 1.563e-07 ***
Dam:Sire 22 0.080024 0.0036374  1.4705  0.09662 .
---
```

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

```
$`Type II`
```

```
      Df  Sum Sq  Mean Sq F value    Pr(>F)
Dam      14 0.178017 0.0127155  5.1405 1.563e-07 ***
Dam:Sire 22 0.080024 0.0036374  1.4705  0.09662 .
---
```

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

```
$`Type III`
```

```
      Df  Sum Sq  Mean Sq F value    Pr(>F)
Dam      14 0.179405 0.0128146  5.1805 1.347e-07 ***
Dam:Sire 22 0.080024 0.0036374  1.4705  0.09662 .
---
```

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

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

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

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

```
Response: pH
```

```
      Sum Sq  Df F values    Pr(>F)
Dam      0.081011   6  5.4584 4.898e-05 ***
Dam:Sire 0.080024  22  1.4705  0.09662 .
Residuals 0.304253 123
---
```

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

## 5.2 Table 16.3

```
(7) MODEL
```

```
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

R-square	Coef Var	Root MSE	Residue Mean
0.9352456	19.94535	0.100193	0.5023377

\$`Type I`

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

---

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

\$`Type II`

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

---

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

\$`Type III`

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

---

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

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

Note: model has aliased coefficients

sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Residue

	Sum Sq	Df	F values	Pr(>F)
Plot	0.00000	0		
Plot:Sample	0.36613	11	3.3156	0.00805 **
Plot:Sample:Subsample	0.35758	22	1.6191	0.13306
Residuals	0.22085	22		

---

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

# NOT OK

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

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

```
$`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

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

\$`Type I`

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

\$`Type II`

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
row	4	2017.03	504.26		
R	4	90.63	22.66		
P	1	253.12	253.12		
S	3	16.38	5.46		
R:S	12	195.05	16.25		
row:P	4	167.25	41.81		

R:P	4	504.95	126.24
row:R:P	32	2933.52	91.67
P:S	3	14.30	4.77
row:P:S	24	234.68	9.78
R:P:S	12	100.33	8.36
row:R:P:S	96	1007.52	10.50

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

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

Model :

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

(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
```

	R-square	Coef Var	Root MSE	yield Mean
	0.9250491	10.29615	10.70513	103.9722

```
$`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
```

R-square Coef Var Root MSE Y Mean  
0.9389372 19.58405 1.077122 5.5

\$`Type I`

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

---

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

\$`Type II`

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

---

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

\$`Type III`

CAUTION: Singularity Exists !

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

---

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

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

Model :

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

Complete :

```

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

```

```

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

```

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

Anova Table (Type III tests)

Response: Y

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

---

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

(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

R-square Coef Var Root MSE Y Mean  
0.9770335 15.05598 0.8280787 5.5

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

```

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

```

Note: model has aliased coefficients

sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Y

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

```
A:B:Tx      7.962  4    2.9029 0.103880
Residuals  4.800  7
```

```
---
```

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

## 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	577.83	6.0824	5.3082	1.068e-05 ***
RESIDUALS	24	27.50	1.1458		

CORRECTED TOTAL 119 605.33

---

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

\$Fitness

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

\$`Type I`

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

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	5.75	1.9167	1.6727	0.1994
G	27	343.48	12.7216	11.1025	4.286e-08 ***
R:G	9	11.75	1.3056	1.1394	0.3749
F	2	59.85	29.9250	26.1164	9.481e-07 ***
G:F	54	77.98	1.4441	1.2603	0.2718

---

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

\$`Type III`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
R	3	5.75	1.9167	1.6727	0.1994
G	27	343.48	12.7216	11.1025	4.286e-08 ***
R:G	9	11.75	1.3056	1.1394	0.3749
F	2	50.51	25.2525	22.0385	3.686e-06 ***
G:F	54	77.98	1.4441	1.2603	0.2718

---

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

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

Note: model has aliased coefficients

sums of squares computed by model comparison

Anova Table (Type III tests)

Response: Y

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

---

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

## 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
```

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

```
$`Type I`
```

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

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

```
---
```

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

```
$`Type II`
```

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

```
---
```

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

```
$`Type III`
```

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

```
---
```

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

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

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

Anova Table (Type III tests)

Response: Y

	Sum Sq	Df	F values	Pr(>F)
R	0.000	0		
T	0.000	0		

```

G          73.444  2 116.6471 < 2.2e-16 ***
F          120.563  2 191.4828 < 2.2e-16 ***
R:T         0.000  0
T:G          5.778  2   9.1765 0.0006018 ***
T:F          0.822  2   1.3060 0.2834316
G:F          23.469 44   1.6943 0.0531910 .
R:T:G        8.778 12   2.3235 0.0253153 *
T:G:F       10.740 44   0.7753 0.7906401
Residuals   11.333 36
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 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
```

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

```
$`Type I`
```

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

```

R      2 1787.68  893.84
A     12  601.24   50.10
R:A    6   24.93    4.16
B      8  156.87   19.61
R:B    4  319.87   79.97
A:B   60 1012.26   16.87
R:A:B 12   49.00    4.08

```

\$`Type II`

```

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

```

\$`Type III`

```

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

```

```

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

```

## 6.7 Example 9.2

(16) MODEL

```

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
```

R-square	Coef Var	Root MSE	yield Mean
0.9177062	2.574747	1.178511	45.77193

```
$`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	R1	A1	B1	C1	6979
2	2	1	R1	A1	B1	C2	7272
3	3	1	R1	A1	B1	C3	7565
4	4	1	R1	A1	B1	C4	7827
5	5	1	R1	A1	B2	C1	8113
6	6	1	R1	A1	B2	C2	7025
7	7	1	R1	A1	B2	C3	7340
8	8	1	R1	A1	B2	C4	7637
9	9	1	R1	A2	B1	C1	7910

10	10	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
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
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
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
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
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
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

```

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

```

\$`Type I`

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

---

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

\$`Type II`

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

```

Site:A:C      36      104110      2892 9.1140e-01 0.61768
Site:B:C       9       61111      6790 2.1400e+00 0.02701 *
Site:A:B:C     36       82475      2291 7.2200e-01 0.87941
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

\$`Type III`

```

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

```

```

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

```

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

Anova Table (Type III tests)

Response: Yield

```

      Sum Sq  Df    F values    Pr(>F)
Site      552717   3 5.8064e+01 < 2e-16 ***
A      1387680917   4 1.0933e+05 < 2e-16 ***
B      100939695   1 3.1812e+04 < 2e-16 ***
C      19356264   3 2.0334e+03 < 2e-16 ***
Site:Block      0   0
Site:A      34068  12 8.9470e-01 0.55301
Site:B      1618   3 1.6990e-01 0.91662
A:B      31444008   4 2.4775e+03 < 2e-16 ***
A:C      26075792  12 6.8483e+02 < 2e-16 ***

```

B:C	23901388	3	2.5109e+03	< 2e-16	***
Site:C	47625	9	1.6677e+00	0.09747	.
Site:A:B	33737	12	8.8600e-01	0.56185	
A:B:C	41996729	12	1.1030e+03	< 2e-16	***
Site:A:C	104110	36	9.1140e-01	0.61768	
Site:B:C	61111	9	2.1400e+00	0.02701	*
Site:Block:A:B	186911	72	8.1810e-01	0.84155	
Site:A:B:C	82475	36	7.2200e-01	0.87941	
Residuals	761522	240			

---

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

## 7 Hinkelmann & Kempthorne - Volume 1

### Reference

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

### 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
```

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

```
$`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","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

R-square	Coef Var	Root MSE	weight Mean
0.5942029	21.51302	2.366432	11

\$`Type I`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	2	10.500	5.250	0.9375	0.42348
variety	3	36.786	12.262	2.1896	0.15232
treatment:variety	2	34.714	17.357	3.0995	0.08965 .

---

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

\$`Type II`

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
treatment	2	9.486	4.7429	0.8469	0.45731
variety	3	36.786	12.2619	2.1896	0.15232
treatment:variety	2	34.714	17.3571	3.0995	0.08965 .

---

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

\$`Type III`

```

              Df Sum Sq Mean Sq F value Pr(>F)
treatment      2 12.471   6.2353   1.1134 0.36595
variety         3 34.872  11.6240   2.0757 0.16719
treatment:variety 2 34.714  17.3571   3.0995 0.08965 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

```

options(contrasts = c("contr.sum", "contr.poly"))
Anova(lm(weight ~ treatment*variety, d1), type=3, singular.ok=TRUE) # NOT OK

```

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

Anova Table (Type III tests)

```

Response: weight
              Sum Sq Df F values Pr(>F)
treatment      0.000   0
variety         0.000   0
treatment:variety 34.714   2   3.0995 0.08965 .
Residuals      56.000  10
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```

## 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))
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

```
R-square Coef Var Root MSE percent Mean
0.3124188 22.39782 8.340949          37.24
```

```
$`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

R-square	Coef Var	Root MSE	babble Mean
0.9933519	10.13217	0.5133631	5.066667

\$`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 Session Information

R version 4.1.3 (2022-03-10)

Platform: x86\_64-w64-mingw32/x64 (64-bit)

Running under: Windows 10 x64 (build 19044)

Matrix products: default

locale:

[1] LC\_COLLATE=Korean\_Korea.949 LC\_CTYPE=Korean\_Korea.949

[3] LC\_MONETARY=Korean\_Korea.949 LC\_NUMERIC=C

[5] LC\_TIME=Korean\_Korea.949

attached base packages:

[1] stats graphics grDevices utils datasets methods base

other attached packages:

[1] car\_3.0-12 carData\_3.0-5 sasLM\_0.8.0 mvtnorm\_1.1-3 rmarkdown\_2.13

loaded via a namespace (and not attached):

[1] digest\_0.6.29 MASS\_7.3-55 magrittr\_2.0.2 evaluate\_0.15

[5] rlang\_1.0.2 stringi\_1.7.6 cli\_3.2.0 tools\_4.1.3

[9] stringr\_1.4.0 tinytex\_0.37 abind\_1.4-5 xfun\_0.30

[13] yaml\_2.3.5 fastmap\_1.1.0 compiler\_4.1.3 htmltools\_0.5.2

[17] knitr\_1.37