SAS Lab 4 For Statistics 514

Topics:
Chapter 21. Two-Factor Studies–One Case Per Treatment
Chapter 22. Two-Factor Studies–Unequal Sample Sizes and Unequal Treatment Importance

```
*Attendance 21.1 one case per treatment, 2-ANOVA;
DATA PROZACYIELD;
  INPUT CATALYST $ BLEND $ YIELD @@;
        if catalyst = 1 then x1 = 1;
        if catalyst = 4 then x1 = -1;
        if catalyst = 2 or catalyst = 3 then x1 = 0;
        if catalyst = 2 then x2 = 1;
        if catalyst = 4 then x2 = -1;
        if catalyst = 1 or catalyst = 3 then x2 = 0;
        if catalyst = 3 then x3 = 1;
        if catalyst = 4 then x3 = -1;
        if catalyst = 1 or catalyst = 2 then x3 = 0;
        if blend = 1 then x4 = 1;
        if blend = 5 then x4 = -1;
        if blend = 2 or blend = 3 or blend = 4 then x4 = 0;
        if blend = 2 then x5 = 1;
        if blend = 5 then x5 = -1;
        if blend = 1 or blend = 3 or blend = 4 then x5 = 0;
        if blend = 3 then x6 = 1;
        if blend = 5 then x6 = -1;
        if blend = 1 or blend = 2 or blend = 4 then x6 = 0;
        if blend = 4 then x7 = 1;
        if blend = 5 then x7 = -1;
        if blend = 1 or blend = 2 or blend = 3 then x7 = 0;
DATALINES;
1 1 89  1 2 84  1 3 81  1 4 87  1 5 79
2 1 88  2 2 77  2 3 87  2 4 92  2 5 81
3 1 97  3 2 92  3 3 87  3 4 89  3 5 80
4 1 94  4 2 79  4 3 85  4 4 84  4 5 88
;
PROC MEANS DATA=prozacyield noprint;
        VAR yield;
        BY catalyst blend;
        OUTPUT OUT=prozacyieldout MEAN=MNyield;
RUN;
proc print data=prozacyieldout;
        title 'treatment means';
        var catalyst blend mnyield;
run;
PROC GPLOT DATA=prozacyieldout;
        TITLE 'treatment means plot, prozac by blend';
        PLOT mnyield*blend=catalyst;
RUN;
PROC GPLOT DATA=prozacyieldout;
        TITLE 'treatment means plot, prozac by catalyst';
        PLOT mnyield*catalyst=blend;
RUN;
proc means data=prozacyield noprint;
        title 'treatment means';
        var yield;
        by catalyst;
        output out=catalystout mean=mncatalyst;
run;
proc print data=catalystout;
        title 'treatment means, by catalyst';
        var catalyst mncatalyst;
run;
proc sort data=prozacyield;
        by blend;
run;
proc means data=prozacyield noprint;
        title 'treatment means, by blend';
        var yield;
        by blend;
        output out=blendout mean=mnblend;
run;
proc print data=blendout;
        title 'treatment means, by blend';
        var blend mnblend;
run;
PROC ANOVA DATA=PROZACYIELD;
        TITLE 'TWO FACTOR ANOVA, PROZAC, ONE CASE PER TREATMENT';
        CLASS CATALYST BLEND;
        MODEL YIELD = CATALYST BLEND;
RUN;
proc glm data=prozacyield;
        title 'regression of ANOVA';
        model yield = x1 x2 x3 x4 x5 x6 x7;
        output out=prozacyieldout p=pred r=resid stdp=stdp;
run;
proc sort data=prozacyieldout;
        by catalyst blend;
run;
proc print data=prozacyieldout;
        title 'response, predicted and residuals';
        var x1 x2 x3 x4 x5 x6 x7 yield pred resid stdp;
run;
QUIT;
```

```
*Attendance 21.2 one case per treatment, 2ANOVA;
*Tukey test for additivity;
DATA PROZACYIELD;
  INPUT CATALYST $ BLEND $ YIELD @@;
DATALINES;
1 1 89  1 2 84  1 3 81  1 4 87  1 5 79
2 1 88  2 2 77  2 3 87  2 4 92  2 5 81
3 1 97  3 2 92  3 3 87  3 4 89  3 5 80
4 1 94  4 2 79  4 3 85  4 4 84  4 5 88
;
PROC MEANS DATA=prozacyield noprint;
        VAR yield;
        BY catalyst blend;
        OUTPUT OUT=prozacyieldout MEAN=MNyield;
RUN;
proc print data=prozacyieldout;
        title 'treatment means';
        var catalyst blend mnyield;
run;
PROC GPLOT DATA=prozacyieldout;
        TITLE 'treatment means plot, prozac by blend';
        PLOT mnyield*blend=catalyst;
RUN;
PROC GPLOT DATA=prozacyieldout;
        TITLE 'treatment means plot, prozac by catalyst';
        PLOT mnyield*catalyst=blend;
RUN;
proc means data=prozacyield noprint;
        title 'treatment means';
        var yield;
        by catalyst;
        output out=catalystout mean=mncatalyst;
run;
proc print data=catalystout;
        title 'treatment means, by catalyst';
        var catalyst mncatalyst;
run;
proc sort data=prozacyield;
        by blend;
run;
proc means data=prozacyield noprint;
        title 'treatment means, by blend';
        var yield;
        by blend;
        output out=blendout mean=mnblend;
run;
proc print data=blendout;
        title 'treatment means, by blend';
        var blend mnblend;
run;
PROC ANOVA DATA=PROZACYIELD;
        TITLE 'TWO FACTOR ANOVA, PROZAC, ONE CASE PER TREATMENT';
        CLASS CATALYST BLEND;
        MODEL YIELD = CATALYST BLEND;
RUN;
QUIT;
```

```
*ATTENDANCE 4, 22.2 Regression Approach to TWO FACTOR ANOVA;
*UNequal treatment, SURVIVAL TIME for rats;
DATA SURVIVAL;
     INPUT TIME POISON $ ANTIDOTE $ CASE X1 X2 X3 X1X2 X1X3;
DATALINES;
8.3     1       1       1       1       1       0       1       0
7.2     1       1       2       1       1       0       1       0
7.5     1       1       3       1       1       0       1       0
9.1     1       2       1       1       0       1       0       1
9.4     1       2       2       1       0       1       0       1
10.1    1       3       1       1       -1      -1      -1      -1
11.1    1       3       2       1       -1      -1      -1      -1
1.8     2       1       1       -1      1       0       -1      0
3.8     2       1       2       -1      1       0       -1      0
12.1    2       2       1       -1      0       1       0       -1
15.1    2       3       1       -1      -1      -1      1       1
16.2    2       3       2       -1      -1      -1      1       1
14.4    2       3       3       -1      -1      -1      1       1
;
PROC MEANS DATA=survival noprint;
        VAR time;
        BY poison antidote;
        OUTPUT OUT=survivalout MEAN=MNtime;
RUN;
proc print data=survivalout;
        title 'treatment means';
        var poison antidote mntime;
run;
proc gplot data=survivalout;
        title 'treatment means plot, by poison';
        plot mntime*poison=antidote;
run;
proc gplot data=survivalout;
        title 'treatment means plot, by antidote';
        plot mntime*antidote=poison;
run;
PROC glm DATA=SURVIVAL;
        TITLE '22.2 full regression model';
        MODEL TIME = X1 X2 X3 X1X2 X1X3;
        output out=survivalout p=pred r=resid stdp=stdp;
RUN;
proc print data=survivalout;
        title '22.2 response, predicted and residuals';
        var poison antidote case x1 x2 x3 time pred resid stdp;
run;
proc gplot data=survivalout;
        title '22.2 residual plot';
        plot resid*pred;
run;
proc capability data=survivalout noprint graphics;
        title '22.2 normal probability plot for residuals';
        probplot resid;
run;
PROC glm DATA=SURVIVAL;
        TITLE '22.2 reduced regression model, no interaction';
        MODEL TIME = X1 X2 X3;
RUN;
PROC glm DATA=SURVIVAL;
        TITLE '22.2 reduced regression model, no poison';
        MODEL TIME = X2 X3 X1X2 X1X3;
RUN;
PROC glm DATA=SURVIVAL;
        TITLE '22.2 reduced regression model, no antidote';
        MODEL TIME = X1 X1X2 X1X3;
RUN;
DATA SURVIVAL;
     INPUT TIME POISON $ ANTIDOTE $ CASE;
DATALINES;
8.3     1       1       1
7.2     1       1       2
7.5     1       1       3
9.1     1       2       1
9.4     1       2       2
10.1    1       3       1
11.1    1       3       2
1.8     2       1       1
3.8     2       1       2
12.1    2       2       1
15.1    2       3       1
16.2    2       3       2
14.4    2       3       3
;
PROC GLM DATA=SURVIVAL;
        TITLE '22.2 two factor ANOVA, full model';
        CLASS POISON ANTIDOTE;
        MODEL TIME = POISON | ANTIDOTE;
        MEANS POISON | ANTIDOTE;
RUN;
QUIT;
```

```
*ATTENDANCE 4, 22.3 Inferences in TWO FACTOR ANOVA;
*UNequal sample size, SURVIVAL TIME for rats;
DATA SURVIVAL;
    INPUT TIME POISON $ ANTIDOTE $ CASE;
DATALINES;
8.3     1       1       1
7.2     1       1       2
7.5     1       1       3
9.1     1       2       1
9.4     1       2       2
10.1    1       3       1
11.1    1       3       2
1.8     2       1       1
3.8     2       1       2
12.1    2       2       1
15.1    2       3       1
16.2    2       3       2
14.4    2       3       3
;
PROC GLM DATA=SURVIVAL;
        TITLE '22.3 inferences for two factor ANOVA';
        CLASS POISON ANTIDOTE;
        MODEL TIME = POISON | ANTIDOTE;
RUN;
QUIT;
```

```
*ATTENDANCE 4, 22.4 Regression Approach to TWO FACTOR ANOVA;
*empty cell (2,1) sample, SURVIVAL TIME for rats;
DATA SURVIVAL;
     INPUT TIME POISON $ ANTIDOTE $ CASE;
DATALINES;
8.3     1       1       1
7.2     1       1       2
7.5     1       1       3
9.1     1       2       1
9.4     1       2       2
10.1    1       3       1
11.1    1       3       2
12.1    2       2       1
15.1    2       3       1
16.2    2       3       2
14.4    2       3       3
;
PROC MEANS DATA=survival noprint;
          VAR time;
          BY poison antidote;
          OUTPUT OUT=survivalout MEAN=MNtime;
RUN;
proc print data=survivalout;
          title '22.4 treatment means, empty cell (2,1)';
          var poison antidote mntime;
run;
proc gplot data=survivalout;
          title '22.4 treatment means plot, by poison';
          plot mntime*poison=antidote;
run;
proc gplot data=survivalout;
          title '22.4 treatment means plot, by antidote';
          plot mntime*antidote=poison;
run;
DATA SURVIVAL;
     INPUT TIME POISON $ ANTIDOTE $ CASE;
DATALINES;
9.1         1       2       1
9.4         1       2       2
10.1    1       3       1
11.1    1       3       2
12.1    2       2       1
15.1    2       3       1
16.2    2       3       2
14.4    2       3       3
;
PROC GLM DATA=SURVIVAL;
          TITLE '22.4 two factor ANOVA, full model, empty cell';
          CLASS POISON ANTIDOTE;
          MODEL TIME = POISON | ANTIDOTE;
          MEANS POISON | ANTIDOTE;
RUN;
DATA SURVIVAL;
     INPUT TIME POISON $ ANTIDOTE $ CASE X1 X2 X3 X1X2 X1X3;
DATALINES;
8.3         1       1       1       1       1       0       1       0
7.2         1       1       2       1       1       0       1       0
7.5         1       1       3       1       1       0       1       0
9.1         1       2       1       1       0       1       0       1
9.4         1       2       2       1       0       1       0       1
10.1    1       3       1       1       -1      -1      -1      -1
11.1    1       3       2       1       -1      -1      -1      -1
12.1    2       2       1       -1      0       1       0       -1
15.1    2       3       1       -1      -1      -1      1       1
16.2    2       3       2       -1      -1      -1      1       1
14.4    2       3       3       -1      -1      -1      1       1
;
PROC glm DATA=SURVIVAL;
          TITLE '22.4 full regression model, no interaction';
          MODEL TIME = X1 X2 X3;
RUN;
PROC glm DATA=SURVIVAL;
          TITLE '22.4 reduced regression model, no poison';
          MODEL TIME = X2 X3;
RUN;
PROC glm DATA=SURVIVAL;
          TITLE '22.4 reduced regression model, no antidote';
          MODEL TIME = X1;
RUN;
QUIT;
```

```
*ATTENDANCE 4, 22.5 Regression Approach to TWO FACTOR ANOVA;
*UNequal importance, SURVIVAL TIME for rats;
DATA SURVIVAL;
    INPUT TIME POISON $ ANTIDOTE $ CASE X1 X2 X3 X1X2 X1X3;
DATALINES;
8.3     1   1   1   1   1   0   1   0
7.2     1   1   2   1   1   0   1   0
7.5     1   1   3   1   1   0   1   0
9.1     1   2   1   1   0   1   0   1
9.4     1   2   2   1   0   1   0   1
10.1    1   3   1   1   -1  -1  -1  -1
11.1    1   3   2   1   -1  -1  -1  -1
1.8     2   1   1   -1  1   0   -1  0
3.8     2   1   2   -1  1   0   -1  0
12.1    2   2   1   -1  0   1   0   -1
15.1    2   3   1   -1  -1  -1  1   1
16.2    2   3   2   -1  -1  -1  1   1
14.4    2   3   3   -1  -1  -1  1   1
;
PROC glm DATA=SURVIVAL;
        TITLE '22.5 full regression model';
        MODEL TIME = X1 X2 X3 X1X2 X1X3;
        output out=survivalout p=pred r=resid stdp=stdp;
RUN;
PROC GLM DATA=SURVIVAL;
        TITLE '22.5 two factor ANOVA, full model';
        CLASS POISON ANTIDOTE;
        MODEL TIME = POISON | ANTIDOTE;
RUN;
QUIT;
```

```
*Practice Quiz 2, 21.5 TWO FACTOR ANOVA, ONE CASE PER TREATMENT;
DATA BRAINSTORM;
    INPUT IDEAS TYPE $ SIZE;
DATALINES;
18      1       1
22      1       2
31      1       3
32      1       4
15      2       1
23      2       2
29      2       3
33      2       4
;
PROC MEANS DATA=BRAINSTORM noprint;
        VAR IDEAS;
        BY TYPE SIZE;
        OUTPUT OUT=BRAINSTORMout MEAN=MNIDEA;
RUN;
proc print data=brainstormout;
        title '21-5(a) treatment means';
        var type size mnidea;
run;
proc means data=brainstorm noprint;
        title '21-5(a) treatment means';
        var ideas;
        by type;
        output out=braintypeout mean=mntype;
run;
proc print data=braintypeout;
        title '21-5(a) treatment means';
        var type mntype;
run;
proc sort data=brainstorm;
        by size;
run;
proc means data=brainstorm noprint;
        title '21-5(a) treatment means';
        var ideas;
        by size;
        output out=brainsizeout mean=mnsize;
run;
proc print data=brainsizeout;
        title '21-5(a) treatment means';
        var size mnsize;
run;
PROC GPLOT DATA=BRAINSTORMout;
        TITLE '21-5(a) treatment means plot, brainstorming';
        PLOT MNIDEA*SIZE=type;
RUN;
PROC ANOVA DATA=BRAINSTORM;
        TITLE '21-5(b) 2--factor ANOVA, one case per treatment';
        CLASS TYPE SIZE;
        MODEL IDEAS = TYPE SIZE;
RUN;
proc glm data=brainstorm;
        title '21-5(c) Bonferroni multiple pairs, brainstorming';
        class type;
        model ideas = type;
        contrast 'L1' type 1 -1;
        estimate 'L1' type 1 -1;
        output out=brainout lcl=clcl ucl= cucl stdr=cstdr;
run;
QUIT;
```

```
*Practice Quiz 2, 21.6 TWO FACTOR ANOVA;
*ONE CASE PER TREATMENT;
DATA BRAINSTORM;
  INPUT IDEAS TYPE SIZE;
        if type = 1 then x1 = 1;
        if type = 2 then x1 = -1;
        if size = 1 then x2 = 1;
        if size = 4 then x2 = -1;
        if size = 2 or size = 3 then x2 = 0;
        if size = 2 then x3 = 1;
        if size = 4 then x3 = -1;
        if size = 1 then x3 = 0;
        if size = 3 then x3 = 0;
        if size = 3 then x4 = 1;
        if size = 4 then x4 = -1;
        if size = 1 then x4 = 0;
        if size = 2 then x4 = 0;
DATALINES;
18      1       1
22      1       2
31      1       3
32      1       4
15      2       1
23      2       2
29      2       3
33      2       4
;
proc glm data=brainstorm;
        title '21-6(b) regression of single factor ANOVA';
        model ideas = x1 x2 x3 x4;
        output out=brainstormout p=pred r=resid stdp=stdp;
run;
proc print data=brainstormout;
        title '21-6(b) response, predicted and residuals';
        var x1 x2 x3 x4 ideas pred resid stdp;
run;
QUIT;
```

```
*Practice Quiz 2, 21.7 TWO FACTOR ANOVA;
*ONE CASE PER TREATMENT;
DATA BRAINSTORM;
  INPUT IDEAS TYPE SIZE;
DATALINES;
18      1       1
22      1       2
31      1       3
32      1       4
15      2       1
23      2       2
29      2       3
33      2       4
;
PROC MEANS DATA=BRAINSTORM noprint;
        VAR IDEAS;
        BY TYPE SIZE;
        OUTPUT OUT=BRAINSTORMout MEAN=MNIDEA;
RUN;
proc print data=brainstormout;
        title 'treatment means';
        var type size mnidea;
run;
proc means data=brainstorm noprint;
        title 'treatment means';
        var ideas;
        by type;
        output out=braintypeout mean=mntype;
run;
proc print data=braintypeout;
        title 'treatment means';
        var type mntype;
run;
proc sort data=brainstorm;
        by size;
run;
proc means data=brainstorm noprint;
        title 'treatment means';
        var ideas;
        by size;
        output out=brainsizeout mean=mnsize;
run;
proc print data=brainsizeout;
        title 'treatment means';
        var size mnsize;
run;
PROC ANOVA DATA=BRAINSTORM;
        TITLE '2--factor ANOVA, one case per treatment';
        CLASS TYPE SIZE;
        MODEL IDEAS = TYPE SIZE;
RUN;
QUIT;
```

```
*Practice Quiz 2, 22.6 TWO FACTOR ANOVA;
*unequal sample size, unequal treatment importance;
DATA professor;
  INPUT earnings subject degree case int x1 x2 x3 x4 x5 unknown;
        x14 = x1*x4;
        x15 = x1*x5;
        x24 = x2*x4;
        x25 = x2*x5;
        x34 = x3*x4;
        x35 = x3*x5;
DATALINES;
1.7   1   1   1   1   0   0   1   0   1
1.9   1   1   2   1   1   0   0   1   0   1
1.8   1   2   1   1   1   0   0   0   1   0
2.1   1   2   2   1   1   0   0   0   1   0
2.5   1   3   1   1   1   0   0   -1  -1  -1
2.7   1   3   2   1   1   0   0   -1  -1  -1
2.9   1   3   3   1   1   0   0   -1  -1  -1
2.5   1   3   4   1   1   0   0   -1  -1  -1
2.6   1   3   5   1   1   0   0   -1  -1  -1
2.8   1   3   6   1   1   0   0   -1  -1  -1
2.7   1   3   7   1   1   0   0   -1  -1  -1
2.9   1   3   8   1   1   0   0   -1  -1  -1
2.5   2   1   1   1   0   1   0   1   0   0
2.3   2   1   2   1   0   1   0   1   0   0
2.6   2   1   3   1   0   1   0   1   0   0
2.4   2   1   4   1   0   1   0   1   0   0
2.7   2   2   1   1   0   1   0   0   1   0
2.4   2   2   2   1   0   1   0   0   1   0
2.6   2   2   3   1   0   1   0   0   1   0
2.4   2   2   4   1   0   1   0   0   1   0
2.5   2   2   5   1   0   1   0   0   1   0
3.5   2   3   1   1   0   1   0   -1  -1  0
3.3   2   3   2   1   0   1   0   -1  -1  0
3.6   2   3   3   1   0   1   0   -1  -1  0
3.4   2   3   4   1   0   1   0   -1  -1  0
2.7   3   1   1   1   0   0   1   1   0   0
2.8   3   1   2   1   0   0   1   1   0   0
2.9   3   2   1   1   0   0   1   0   1   0
3     3   2   2   1   0   0   1   0   1   0
2.8   3   2   3   1   0   0   1   0   1   0
2.7   3   2   4   1   0   0   1   0   1   0
3.7   3   3   1   1   0   0   1   -1  -1  0
3.6   3   3   2   1   0   0   1   -1  -1  0
3.7   3   3   3   1   0   0   1   -1  -1  0
3.8   3   3   4   1   0   0   1   -1  -1  0
3.9   3   3   5   1   0   0   1   -1  -1  0
2.5   4   1   1   1   -1  -1  -1  1   0   -1
2.6   4   1   2   1   -1  -1  -1  1   0   -1
2.3   4   2   1   1   -1  -1  -1  0   1   0
2.8   4   2   2   1   -1  -1  -1  0   1   0
3.3   4   3   1   1   -1  -1  -1  -1  -1  1
3.4   4   3   2   1   -1  -1  -1  -1  -1  1
3.3   4   3   3   1   -1  -1  -1  -1  -1  1
3.5   4   3   4   1   -1  -1  -1  -1  -1  1
3.6   4   3   5   1   -1  -1  -1  -1  -1  1
;
proc glm data=professor noprint;
        title 'regression of ANOVA';
        model earnings = x1 x2 x3 x4 x5 x14 x15 x24 x25 x34 x35;
        output out=professorout p=pred r=resid stdp=stdp;
run;
proc print data=professorout;
        title '22-6(d) response, predicted and residuals';
        var subject degree case x1 x2 x3 x4 x5 earnings pred resid stdp;
run;
proc gplot data=professorout;
        title '22-6(d) residual plot';
        plot resid*pred;
run;
proc capability data=professorout noprint graphics;
        title '22-6(e) normal probability plot for residuals, professor';
        probplot resid;
run;
QUIT;
```

```
*Practice Quiz 2, 22.7 TWO FACTOR ANOVA;
*unequal sample size, unequal treatment importance;
DATA professor;
  INPUT earnings subject degree case int x1 x2 x3 x4 x5 unknown;
        x14 = x1*x4;
        x15 = x1*x5;
        x24 = x2*x4;
        x25 = x2*x5;
        x34 = x3*x4;
        x35 = x3*x5;
DATALINES;
1.7   1   1   1   1   0   0   1   0   1
1.9   1   1   2   1   1   0   0   1   0   1
1.8   1   2   1   1   1   0   0   0   1   0
2.1   1   2   2   1   1   0   0   0   1   0
2.5   1   3   1   1   1   0   0   -1  -1  -1
2.7   1   3   2   1   1   0   0   -1  -1  -1
2.9   1   3   3   1   1   0   0   -1  -1  -1
2.5   1   3   4   1   1   0   0   -1  -1  -1
2.6   1   3   5   1   1   0   0   -1  -1  -1
2.8   1   3   6   1   1   0   0   -1  -1  -1
2.7   1   3   7   1   1   0   0   -1  -1  -1
2.9   1   3   8   1   1   0   0   -1  -1  -1
2.5   2   1   1   1   0   1   0   1   0   0
2.3   2   1   2   1   0   1   0   1   0   0
2.6   2   1   3   1   0   1   0   1   0   0
2.4   2   1   4   1   0   1   0   1   0   0
2.7   2   2   1   1   0   1   0   0   1   0
2.4   2   2   2   1   0   1   0   0   1   0
2.6   2   2   3   1   0   1   0   0   1   0
2.4   2   2   4   1   0   1   0   0   1   0
2.5   2   2   5   1   0   1   0   0   1   0
3.5   2   3   1   1   0   1   0   -1  -1  0
3.3   2   3   2   1   0   1   0   -1  -1  0
3.6   2   3   3   1   0   1   0   -1  -1  0
3.4   2   3   4   1   0   1   0   -1  -1  0
2.7   3   1   1   1   0   0   1   1   0   0
2.8   3   1   2   1   0   0   1   1   0   0
2.9   3   2   1   1   0   0   1   0   1   0
3     3   2   2   1   0   0   1   0   1   0
2.8   3   2   3   1   0   0   1   0   1   0
2.7   3   2   4   1   0   0   1   0   1   0
3.7   3   3   1   1   0   0   1   -1  -1  0
3.6   3   3   2   1   0   0   1   -1  -1  0
3.7   3   3   3   1   0   0   1   -1  -1  0
3.8   3   3   4   1   0   0   1   -1  -1  0
3.9   3   3   5   1   0   0   1   -1  -1  0
2.5   4   1   1   1   -1  -1  -1  1   0   -1
2.6   4   1   2   1   -1  -1  -1  1   0   -1
2.3   4   2   1   1   -1  -1  -1  0   1   0
2.8   4   2   2   1   -1  -1  -1  0   1   0
3.3   4   3   1   1   -1  -1  -1  -1  -1  1
3.4   4   3   2   1   -1  -1  -1  -1  -1  1
3.3   4   3   3   1   -1  -1  -1  -1  -1  1
3.5   4   3   4   1   -1  -1  -1  -1  -1  1
3.6   4   3   5   1   -1  -1  -1  -1  -1  1
;
PROC MEANS DATA=professor noprint;
        VAR earnings;
        BY subject degree;
        OUTPUT OUT=professorout MEAN=MNearnings;
RUN;
proc print data=professorout;
        title '22-7(a) treatment means';
        var subject degree mnearnings;
run;
proc gplot data=professorout;
        title '22-7(a), treatment means plot, by subject';
        plot mnearnings*subject=degree;
run;
proc gplot data=professorout;
        title '22-7(a), treatment means plot, by degree';
        plot mnearnings*degree=subject;
run;
proc glm data=professor;
        title '22-7(c) regression of ANOVA, full';
        model earnings = x1 x2 x3 x4 x5 x14 x15 x24 x25 x34 x35;
        output out=professorout p=pred r=resid stdp=stdp;
run;
proc glm data=professor;
        title '22-7(c) regression of ANOVA, reduced, interaction';
        model earnings = x1 x2 x3 x4 x5;
        output out=professorout p=pred r=resid stdp=stdp;
run;
proc glm data=professor;
        title '22-7(d) regression of ANOVA, reduced, subject';
        model earnings = x4 x5 x14 x15 x24 x25 x34 x35;
        output out=professorout p=pred r=resid stdp=stdp;
run;
proc glm data=professor;
        title '22-7(d) regression of ANOVA, reduced, degree';
        model earnings = x1 x2 x3 x14 x15 x24 x25 x34 x35;
        output out=professorout p=pred r=resid stdp=stdp;
run;
PROC MIXED DATA=professor;
        TITLE '22.7(e,f) pairwise CIs subject, degree';
        CLASS SUBJECT DEGREE;
        MODEL EARNINGS = SUBJECT | DEGREE;
        LSMEANS SUBJECT | DEGREE / DIFF;
RUN;
QUIT;
```

```
*Practice Quiz 2, 22.8 TWO FACTOR ANOVA;
*unequal sample size, no interaction;
DATA professor;
  INPUT earnings subject degree case int x1 x2 x3 x4 x5 unknown;
        x14 = x1*x4;
        x15 = x1*x5;
        x24 = x2*x4;
        x25 = x2*x5;
        x34 = x3*x4;
        x35 = x3*x5;
DATALINES;
1.7   1   1   1   1   1   0   0   1   0   1
1.9   1   1   2   1   1   0   0   1   0   1
1.8   1   2   1   1   1   0   0   0   1   0
2.1   1   2   2   1   1   0   0   0   1   0
2.5   1   3   1   1   1   0   0   -1  -1  -1
2.7   1   3   2   1   1   0   0   -1  -1  -1
2.9   1   3   3   1   1   0   0   -1  -1  -1
2.5   1   3   4   1   1   0   0   -1  -1  -1
2.6   1   3   5   1   1   0   0   -1  -1  -1
2.8   1   3   6   1   1   0   0   -1  -1  -1
2.7   1   3   7   1   1   0   0   -1  -1  -1
2.9   1   3   8   1   1   0   0   -1  -1  -1
2.5   2   1   1   1   0   1   0   1   0   0
2.3   2   1   2   1   0   1   0   1   0   0
2.6   2   1   3   1   0   1   0   1   0   0
2.4   2   1   4   1   0   1   0   1   0   0
2.7   2   2   1   1   0   1   0   0   1   0
2.4   2   2   2   1   0   1   0   0   1   0
2.6   2   2   3   1   0   1   0   0   1   0
2.4   2   2   4   1   0   1   0   0   1   0
2.5   2   2   5   1   0   1   0   0   1   0
3.5   2   3   1   1   0   1   0   -1  -1  0
3.3   2   3   2   1   0   1   0   -1  -1  0
3.6   2   3   3   1   0   1   0   -1  -1  0
3.4   2   3   4   1   0   1   0   -1  -1  0
2.7   3   1   1   1   0   0   1   1   0   0
2.8   3   1   2   1   0   0   1   1   0   0
2.9   3   2   1   1   0   0   1   0   1   0
3     3   2   2   1   0   0   1   0   1   0
2.8   3   2   3   1   0   0   1   0   1   0
2.7   3   2   4   1   0   0   1   0   1   0
3.7   3   3   1   1   0   0   1   -1  -1  0
3.6   3   3   2   1   0   0   1   -1  -1  0
3.7   3   3   3   1   0   0   1   -1  -1  0
3.8   3   3   4   1   0   0   1   -1  -1  0
3.9   3   3   5   1   0   0   1   -1  -1  0
2.5   4   1   1   1   -1  -1  -1  1   0   -1
2.6   4   1   2   1   -1  -1  -1  1   0   -1
2.3   4   2   1   1   -1  -1  -1  0   1   0
2.8   4   2   2   1   -1  -1  -1  0   1   0
3.3   4   3   1   1   -1  -1  -1  -1  -1  1
3.4   4   3   2   1   -1  -1  -1  -1  -1  1
3.3   4   3   3   1   -1  -1  -1  -1  -1  1
3.5   4   3   4   1   -1  -1  -1  -1  -1  1
3.6   4   3   5   1   -1  -1  -1  -1  -1  1
;
proc glm data=professor;
        title '22-8(a) regression of ANOVA, full, no interaction';
        model earnings = x1 x2 x3 x4 x5;
        output out=professorout p=pred r=resid stdp=stdp;
run;
proc glm data=professor;
        title '22-8(a) regression of ANOVA, reduced, subject';
        model earnings = x4 x5;
        output out=professorout p=pred r=resid stdp=stdp;
run;
proc glm data=professor;
        title '22-8(b) regression of ANOVA, reduced, degree';
        model earnings = x1 x2 x3;
        output out=professorout p=pred r=resid stdp=stdp;
run;
QUIT;
```

```
*Practice Quiz 2, 22.12 TWO FACTOR ANOVA;
*no cell 11 sample, assume no interaction;
DATA professor;
  INPUT earnings subject degree case int x1 x2 x3 x4 x5 unknown;
DATALINES;
1.8   1   2   1   1   1   0   0   0   1   0
2.1   1   2   2   1   1   0   0   0   1   0
2.5   1   3   1   1   1   0   0   -1  -1  -1
2.7   1   3   2   1   1   0   0   -1  -1  -1
2.9   1   3   3   1   1   0   0   -1  -1  -1
2.5   1   3   4   1   1   0   0   -1  -1  -1
2.6   1   3   5   1   1   0   0   -1  -1  -1
2.8   1   3   6   1   1   0   0   -1  -1  -1
2.7   1   3   7   1   1   0   0   -1  -1  -1
2.9   1   3   8   1   1   0   0   -1  -1  -1
2.5   2   1   1   1   0   1   0   1   0   0
2.3   2   1   2   1   0   1   0   1   0   0
2.6   2   1   3   1   0   1   0   1   0   0
2.4   2   1   4   1   0   1   0   1   0   0
2.7   2   2   1   1   0   1   0   0   1   0
2.4   2   2   2   1   0   1   0   0   1   0
2.6   2   2   3   1   0   1   0   0   1   0
2.4   2   2   4   1   0   1   0   0   1   0
2.5   2   2   5   1   0   1   0   0   1   0
3.5   2   3   1   1   0   1   0   -1  -1  0
3.3   2   3   2   1   0   1   0   -1  -1  0
3.6   2   3   3   1   0   1   0   -1  -1  0
3.4   2   3   4   1   0   1   0   -1  -1  0
2.7   3   1   1   1   0   0   1   1   0   0
2.8   3   1   2   1   0   0   1   1   0   0
2.9   3   2   1   1   0   0   1   0   1   0
3     3   2   2   1   0   0   1   0   1   0
2.8   3   2   3   1   0   0   1   0   1   0
2.7   3   2   4   1   0   0   1   0   1   0
3.7   3   3   1   1   0   0   1   -1  -1  0
3.6   3   3   2   1   0   0   1   -1  -1  0
3.7   3   3   3   1   0   0   1   -1  -1  0
3.8   3   3   4   1   0   0   1   -1  -1  0
3.9   3   3   5   1   0   0   1   -1  -1  0
2.5   4   1   1   1   -1  -1  -1  1   0   -1
2.6   4   1   2   1   -1  -1  -1  1   0   -1
2.3   4   2   1   1   -1  -1  -1  0   1   0
2.8   4   2   2   1   -1  -1  -1  0   1   0
3.3   4   3   1   1   -1  -1  -1  -1  -1  1
3.4   4   3   2   1   -1  -1  -1  -1  -1  1
3.3   4   3   3   1   -1  -1  -1  -1  -1  1
3.5   4   3   4   1   -1  -1  -1  -1  -1  1
3.6   4   3   5   1   -1  -1  -1  -1  -1  1
;
proc glm data=professor;
        title '22-12(a,b) regression of ANOVA, full, no interaction';
        model earnings = x1 x2 x3 x4 x5;
        output out=professorout p=pred r=resid stdp=stdp;
run;
proc glm data=professor;
        title '22-12(a,b) regression of ANOVA, reduced for A, no interaction';
        model earnings = x4 x5;
        output out=professorout p=pred r=resid stdp=stdp;
run;
proc glm data=professor;
        title '22-12(a,b) regression of ANOVA, reduced for B, no interaction';
        model earnings = x1 x2 x3;
        output out=professorout p=pred r=resid stdp=stdp;
run;
QUIT;
```

```
*Practice Quiz 2, 22.17 TWO FACTOR ANOVA;
*weights proportional to sample sizes;
DATA professor;
  INPUT earnings subject degree case int x1 x2 x3 x4 x5 unknown;
        x14 = x1*x4;
        x15 = x1*x5;
        x24 = x2*x4;
        x25 = x2*x5;
        x34 = x3*x4;
        x35 = x3*x5;
DATALINES;
1.7   1   1   1   1   1   0   0   1   0   1
1.9   1   1   2   1   1   0   0   1   0   1
1.8   1   2   1   1   1   0   0   0   1   0
2.1   1   2   2   1   1   0   0   0   1   0
2.5   1   3   1   1   1   0   0   -1  -1  -1
2.7   1   3   2   1   1   0   0   -1  -1  -1
2.9   1   3   3   1   1   0   0   -1  -1  -1
2.5   1   3   4   1   1   0   0   -1  -1  -1
2.6   1   3   5   1   1   0   0   -1  -1  -1
2.8   1   3   6   1   1   0   0   -1  -1  -1
2.7   1   3   7   1   1   0   0   -1  -1  -1
2.9   1   3   8   1   1   0   0   -1  -1  -1
2.5   2   1   1   1   0   1   0   1   0   0
2.3   2   1   2   1   0   1   0   1   0   0
2.6   2   1   3   1   0   1   0   1   0   0
2.4   2   1   4   1   0   1   0   1   0   0
2.7   2   2   1   1   0   1   0   0   1   0
2.4   2   2   2   1   0   1   0   0   1   0
2.6   2   2   3   1   0   1   0   0   1   0
2.4   2   2   4   1   0   1   0   0   1   0
2.5   2   2   5   1   0   1   0   0   1   0
3.5   2   3   1   1   0   1   0   -1  -1  0
3.3   2   3   2   1   0   1   0   -1  -1  0
3.6   2   3   3   1   0   1   0   -1  -1  0
3.4   2   3   4   1   0   1   0   -1  -1  0
2.7   3   1   1   1   0   0   1   1   0   0
2.8   3   1   2   1   0   0   1   1   0   0
2.9   3   2   1   1   0   0   1   0   1   0
3     3   2   2   1   0   0   1   0   1   0
2.8   3   2   3   1   0   0   1   0   1   0
2.7   3   2   4   1   0   0   1   0   1   0
3.7   3   3   1   1   0   0   1   -1  -1  0
3.6   3   3   2   1   0   0   1   -1  -1  0
3.7   3   3   3   1   0   0   1   -1  -1  0
3.8   3   3   4   1   0   0   1   -1  -1  0
3.9   3   3   5   1   0   0   1   -1  -1  0
2.5   4   1   1   1   -1  -1  -1  1   0   -1
2.6   4   1   2   1   -1  -1  -1  1   0   -1
2.3   4   2   1   1   -1  -1  -1  0   1   0
2.8   4   2   2   1   -1  -1  -1  0   1   0
3.3   4   3   1   1   -1  -1  -1  -1  -1  1
3.4   4   3   2   1   -1  -1  -1  -1  -1  1
3.3   4   3   3   1   -1  -1  -1  -1  -1  1
3.5   4   3   4   1   -1  -1  -1  -1  -1  1
3.6   4   3   5   1   -1  -1  -1  -1  -1  1
;
proc glm data=professor;
        title '22-17 regression of ANOVA, full, proportional to sample';
        model earnings = x1 x2 x3 x4 x5 x14 x15 x24 x25 x34 x35;
        output out=professorout p=pred r=resid stdp=stdp;
run;
PROC ANOVA DATA=professor;
        TITLE '22-17 two factor ANOVA, SSA';
        CLASS subject degree;
        MODEL earnings = subject degree subject*degree;
RUN;
QUIT;
```