Sep 03, 07 4:48 **x4_1.sas** Page 1/1

```
/* x4_1.sas */
/* Purpose:  */

title1 'Example 4.1.';

data a;
  input y temp p1 p2 p3 p4 p5;
  t=(temp-190)/10;
  cards;
0.75 200 -3  5 -1  3 -1
1.00 210 -2  0  1 -7  4
1.35 200 -1 -3  1  1 -5
1.80 230  0 -4  0  6  0
2.60 240  1 -3 -1  1  5
3.60 250  2  0 -1 -7 -4
5.45 260  3  5  1  3  1
;

proc print;
title2 'List of data.';

proc reg data=a;
  model y=p1 p2 p3 p4 p5 /xpx i;
title2 'Analysis of full model. (polynomium of order 5.)';

proc reg data=a;
  model y=p1 p2 p3 p4 /xpx i;
title2 'Analysis of reduced model. (polynomium of order 4.)';

proc reg data=a;
  model y=p1 p2 p3 /xpx i;
title2 'Analysis of reduced model. (polynomium of order 3.)';

proc reg data=a;
  model y=p1 p2 /xpx i;
title2 'Analysis of reduced model. (polynomium of order 2.)';

proc reg data=a;
  model y=p1 /xpx i;
title2 'Analysis of reduced model. (polynomium of order 1.)';

proc glm data=a;
  model y=p1 p2 p3 p4 p5 /xpx inverse solution;
title2 'Alternative analysis of full model. (polynomium of order 5.)';
title3 '(NB: compare TYPE I sums of squares etc. with example!)';

proc glm data=a;
  model y=p1 p2 p3 /xpx inverse solution;
title2 'Alternative analysis of reduced model. (polynomium of order 3.)';

run;
```

Example 4.1. 1
List of data.

Obs	y	temp	p1	p2	p3	p4	p5	t
1	0.75	200	−3	5	−1	3	−1	1
2	1.00	210	−2	0	1	−7	4	2
3	1.35	200	−1	−3	1	1	−5	1
4	1.80	230	0	−4	0	6	0	4
5	2.60	240	1	−3	−1	1	5	5
6	3.60	250	2	0	−1	−7	−4	6
7	5.45	260	3	5	1	3	1	7

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Example 4.1. 2
Analysis of full model. (polynomium of order 5.)

The REG Procedure
Model: MODEL1

Model Crossproducts X'X X'Y Y'Y

Variable	Intercept	p1	p2	p3
Intercept	7	0	0	0
p1	0	28	0	0
p2	0	0	84	0
p3	0	0	0	6
p4	0	0	0	0
p5	0	0	0	0
y	16.55	20.55	11.95	0.85

Model Crossproducts X'X X'Y Y'Y

Variable	p4	p5	y
Intercept	0	0	16.55
p1	0	0	20.55
p2	0	0	11.95
p3	0	0	0.85
p4	154	0	1.15
p5	0	84	0.55
y	1.15	0.55	56.0475

Example 4.1. 3
Analysis of full model. (polynomium of order 5.)

The REG Procedure
Model: MODEL1
Dependent Variable: y

Number of Observations Read 7
Number of Observations Used 7

X'X Inverse, Parameter Estimates, and SSE

Variable	Intercept	p1	p2	p3
Intercept	0.1428571429	0	0	0
p1	0	0.0357142857	0	0
p2	0	0	0.0119047619	0
p3	0	0	0	0.1666666667
p4	0	0	0	0
p5	0	0	0	0
y	2.3642857143	0.7339285714	0.1422619048	0.1416666667

X'X Inverse, Parameter Estimates, and SSE

Variable	p4	p5	y
Intercept	0	0	2.3642857143
p1	0	0	0.7339285714
p2	0	0	0.1422619048
p3	0	0	0.1416666667
p4	0.0064935065	0	0.0074675325
p5	0	0.0119047619	0.006547619
y	0.0074675325	0.006547619	0.0037040043

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	16.91487	3.38297	913.33	0.0251
Error	1	0.00370	0.00370		
Corrected Total	6	16.91857			

Root MSE	0.06086	R-Square	0.9998
Dependent Mean	2.36429	Adj R-Sq	0.9987
Coeff Var	2.57416		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	2.36429	0.02300	102.78	0.0062
p1	1	0.73393	0.01150	63.81	0.0100
p2	1	0.14226	0.00664	21.42	0.0297
p3	1	0.14167	0.02485	5.70	0.1105
p4	1	0.00747	0.00490	1.52	0.3699
p5	1	0.00655	0.00664	0.99	0.5045

```
                              Example 4.1.                                          4
              Analysis of reduced model. (polynomium of order 4.)

                           The REG Procedure
                            Model: MODEL1

                   Model Crossproducts X'X X'Y Y'Y

Variable           Intercept                p1                p2

Intercept                  7                 0                 0
p1                         0                28                 0
p2                         0                 0                84
p3                         0                 0                 0
p4                         0                 0                 0
y                      16.55             20.55             11.95

                   Model Crossproducts X'X X'Y Y'Y

Variable                  p3                p4                 y

Intercept                  0                 0             16.55
p1                         0                 0             20.55
p2                         0                 0             11.95
p3                         6                 0              0.85
p4                         0               154              1.15
y                       0.85              1.15           56.0475
```

Example 4.1. 5
Analysis of reduced model. (polynomium of order 4.)

The REG Procedure
Model: MODEL1
Dependent Variable: y

Number of Observations Read 7
Number of Observations Used 7

X'X Inverse, Parameter Estimates, and SSE

Variable	Intercept	p1	p2
Intercept	0.1428571429	0	0
p1	0	0.0357142857	0
p2	0	0	0.0119047619
p3	0	0	0
p4	0	0	0
y	2.3642857143	0.7339285714	0.1422619048

X'X Inverse, Parameter Estimates, and SSE

Variable	p3	p4	y
Intercept	0	0	2.3642857143
p1	0	0	0.7339285714
p2	0	0	0.1422619048
p3	0.1666666667	0	0.1416666667
p4	0	0.0064935065	0.0074675325
y	0.1416666667	0.0074675325	0.0073051948

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	16.91127	4.22782	1157.48	0.0009
Error	2	0.00731	0.00365		
Corrected Total	6	16.91857			

Root MSE	0.06044	R-Square	0.9996
Dependent Mean	2.36429	Adj R-Sq	0.9987
Coeff Var	2.55624		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	2.36429	0.02284	103.50	<.0001
p1	1	0.73393	0.01142	64.26	0.0002
p2	1	0.14226	0.00659	21.57	0.0021
p3	1	0.14167	0.02467	5.74	0.0290
p4	1	0.00747	0.00487	1.53	0.2649

Example 4.1. 6
Analysis of reduced model. (polynomium of order 3.)

The REG Procedure
Model: MODEL1

Model Crossproducts X'X X'Y Y'Y

Variable	Intercept	p1	p2	p3	y
Intercept	7	0	0	0	16.55
p1	0	28	0	0	20.55
p2	0	0	84	0	11.95
p3	0	0	0	6	0.85
y	16.55	20.55	11.95	0.85	56.0475

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Example 4.1. 7
Analysis of reduced model. (polynomium of order 3.)

The REG Procedure
Model: MODEL1
Dependent Variable: y

Number of Observations Read 7
Number of Observations Used 7

X'X Inverse, Parameter Estimates, and SSE

Variable	Intercept	p1	p2	p3	y
Intercept	0.1428571429	0	0	0	2.3642857143
p1	0	0.0357142857	0	0	0.7339285714
p2	0	0	0.0119047619	0	0.1422619048
p3	0	0	0	0.1666666667	0.1416666667
y	2.3642857143	0.7339285714	0.1422619048	0.1416666667	0.0158928571

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	16.90268	5.63423	1063.54	<.0001
Error	3	0.01589	0.00530		
Corrected Total	6	16.91857			

Root MSE	0.07278	R-Square	0.9991
Dependent Mean	2.36429	Adj R-Sq	0.9981
Coeff Var	3.07851		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	2.36429	0.02751	85.94	<.0001
p1	1	0.73393	0.01376	53.36	<.0001
p2	1	0.14226	0.00794	17.91	0.0004

p3	1	0.14167	0.02971	4.77	0.0175

Example 4.1. 8
Analysis of reduced model. (polynomium of order 2.)

The REG Procedure
Model: MODEL1

Model Crossproducts X'X X'Y Y'Y

Variable	Intercept	p1	p2	y
Intercept	7	0	0	16.55
p1	0	28	0	20.55
p2	0	0	84	11.95
y	16.55	20.55	11.95	56.0475

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Example 4.1. 9
Analysis of reduced model. (polynomium of order 2.)

The REG Procedure
Model: MODEL1
Dependent Variable: y

Number of Observations Read	7
Number of Observations Used	7

X'X Inverse, Parameter Estimates, and SSE

Variable	Intercept	p1	p2	y
Intercept	0.1428571429	0	0	2.3642857143
p1	0	0.0357142857	0	0.7339285714
p2	0	0	0.0119047619	0.1422619048
y	2.3642857143	0.7339285714	0.1422619048	0.1363095238

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	16.78226	8.39113	246.24	<.0001
Error	4	0.13631	0.03408		
Corrected Total	6	16.91857			

Root MSE	0.18460	R-Square	0.9919
Dependent Mean	2.36429	Adj R-Sq	0.9879
Coeff Var	7.80788		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	2.36429	0.06977	33.89	<.0001
p1	1	0.73393	0.03489	21.04	<.0001
p2	1	0.14226	0.02014	7.06	0.0021

Example 4.1. 10

Analysis of reduced model. (polynomium of order 1.)

The REG Procedure

Model: MODEL1

Model Crossproducts X'X X'Y Y'Y

Variable	Intercept	p1	y
Intercept	7	0	16.55
p1	0	28	20.55
y	16.55	20.55	56.0475

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```

Example 4.1. 11

Analysis of reduced model. (polynomium of order 1.)

The REG Procedure

Model: MODEL1

Dependent Variable: y

Number of Observations Read	7
Number of Observations Used	7

X'X Inverse, Parameter Estimates, and SSE

Variable	Intercept	p1	y
Intercept	0.1428571429	0	2.3642857143
p1	0	0.0357142857	0.7339285714
y	2.3642857143	0.7339285714	1.8363392857

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	15.08223	15.08223	41.07	0.0014
Error	5	1.83634	0.36727		
Corrected Total	6	16.91857			

Root MSE	0.60603	R-Square	0.8915
Dependent Mean	2.36429	Adj R-Sq	0.8698
Coeff Var	25.63253		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	2.36429	0.22906	10.32	0.0001
p1	1	0.73393	0.11453	6.41	0.0014

Example 4.1. 12

Alternative analysis of full model. (polynomium of order 5.)

(NB: compare TYPE I sums of squares etc. with example!)

The GLM Procedure

Number of Observations Read	7
Number of Observations Used	7

```
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```

Example 4.1. 13

Alternative analysis of full model. (polynomium of order 5.)

(NB: compare TYPE I sums of squares etc. with example!)

The GLM Procedure

The X'X Matrix

	Intercept	p1	p2	p3
Intercept	7	0	0	0
p1	0	28	0	0
p2	0	0	84	0
p3	0	0	0	6
p4	0	0	0	0
p5	0	0	0	0
y	16.55	20.55	11.95	0.85

The X'X Matrix

	p4	p5	y
Intercept	0	0	16.55
p1	0	0	20.55
p2	0	0	11.95
p3	0	0	0.85
p4	154	0	1.15
p5	0	84	0.55
y	1.15	0.55	56.0475

```
                          Example 4.1.                                     14
       Alternative analysis of full model. (polynomium of order 5.)
         (NB: compare TYPE I sums of squares etc. with example!)

                         The GLM Procedure

                        X'X Inverse Matrix

                     Intercept             p1             p2             p3

Intercept         0.1428571429              0              0              0
p1                           0   0.0357142857              0              0
p2                           0              0   0.0119047619              0
p3                           0              0              0   0.1666666667
p4                           0              0              0              0
p5                           0              0              0              0
y                 2.3642857143   0.7339285714   0.1422619048   0.1416666667

                        X'X Inverse Matrix

                                 p4                p5                 y

      Intercept                   0                 0      2.3642857143
      p1                          0                 0      0.7339285714
      p2                          0                 0      0.1422619048
      p3                          0                 0      0.1416666667
      p4               0.0064935065                 0      0.0074675325
      p5                          0      0.0119047619       0.006547619
      y                0.0074675325       0.006547619      0.0037040043
```



```
                          Example 4.1.                                     15
       Alternative analysis of full model. (polynomium of order 5.)
         (NB: compare TYPE I sums of squares etc. with example!)

                         The GLM Procedure

Dependent Variable: y

                                        Sum of
 Source                      DF        Squares    Mean Square   F Value   Pr > F

 Model                        5    16.91486742     3.38297348    913.33   0.0251

 Error                        1     0.00370400     0.00370400

 Corrected Total              6    16.91857143


               R-Square     Coeff Var      Root MSE        y Mean

               0.999781      2.574161      0.060861      2.364286


 Source                      DF      Type I SS    Mean Square   F Value   Pr > F

 p1                           1    15.08223214    15.08223214   4071.87   0.0100
 p2                           1     1.70002976     1.70002976    458.97   0.0297
 p3                           1     0.12041667     0.12041667     32.51   0.1105
 p4                           1     0.00858766     0.00858766      2.32   0.3699
 p5                           1     0.00360119     0.00360119      0.97   0.5045


 Source                      DF    Type III SS    Mean Square   F Value   Pr > F

 p1                           1    15.08223214    15.08223214   4071.87   0.0100
 p2                           1     1.70002976     1.70002976    458.97   0.0297
 p3                           1     0.12041667     0.12041667     32.51   0.1105
 p4                           1     0.00858766     0.00858766      2.32   0.3699
 p5                           1     0.00360119     0.00360119      0.97   0.5045


                                               Standard
       Parameter         Estimate              Error    t Value    Pr > |t|

       Intercept      2.364285714        0.02300312     102.78      0.0062
       p1             0.733928571        0.01150156      63.81      0.0100
       p2             0.142261905        0.00664043      21.42      0.0297
       p3             0.141666667        0.02484621       5.70      0.1105
       p4             0.007467532        0.00490428       1.52      0.3699
       p5             0.006547619        0.00664043       0.99      0.5045

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                          Example 4.1.                                     16
     Alternative analysis of reduced model. (polynomium of order 3.)

                         The GLM Procedure

                   Number of Observations Read           7
                   Number of Observations Used           7
```

Example 4.1. 17
Alternative analysis of reduced model. (polynomium of order 3.)

The GLM Procedure

The X'X Matrix

	Intercept	p1	p2	p3	y
Intercept	7	0	0	0	16.55
p1	0	28	0	0	20.55
p2	0	0	84	0	11.95
p3	0	0	0	6	0.85
y	16.55	20.55	11.95	0.85	56.0475

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Example 4.1. 18
Alternative analysis of reduced model. (polynomium of order 3.)

The GLM Procedure

X'X Inverse Matrix

	Intercept	p1	p2	p3	y
Intercept	0.1428571429	0	0	0	2.3642857143
p1	0	0.0357142857	0	0	0.7339285714
p2	0	0	0.0119047619	0	0.1422619048
p3	0	0	0	0.1666666667	0.1416666667
y	2.3642857143	0.7339285714	0.1422619048	0.1416666667	0.0158928571

Example 4.1. 19
Alternative analysis of reduced model. (polynomium of order 3.)

The GLM Procedure

Dependent Variable: y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	16.90267857	5.63422619	1063.54	<.0001
Error	3	0.01589286	0.00529762		
Corrected Total	6	16.91857143			

R-Square	Coeff Var	Root MSE	y Mean
0.999061	3.078509	0.072785	2.364286

Source	DF	Type I SS	Mean Square	F Value	Pr > F
p1	1	15.08223214	15.08223214	2846.98	<.0001
p2	1	1.70002976	1.70002976	320.90	0.0004
p3	1	0.12041667	0.12041667	22.73	0.0175

Source	DF	Type III SS	Mean Square	F Value	Pr > F
p1	1	15.08223214	15.08223214	2846.98	<.0001
p2	1	1.70002976	1.70002976	320.90	0.0004
p3	1	0.12041667	0.12041667	22.73	0.0175

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept	2.364285714	0.02751005	85.94	<.0001
p1	0.733928571	0.01375502	53.36	<.0001
p2	0.142261905	0.00794147	17.91	0.0004
p3	0.141666667	0.02971425	4.77	0.0175