Random effects and nested models with SAS

```
/*************  classical2.sas ********************
Three levels of factor A, four levels of B
      Both fixed
      Both random
      A fixed, B random
      B nested within A
***********************************************/

options linesize = 79 pagesize=100 noovp formdlim='-';

data mixedup;
     infile 'mixedup.data';
     input ID Y A B;

proc glm;
     title 'Default proc glm: Both Fixed';
     class A B ;
     model y = a | b;
     means a*b;

proc glm;
     title 'Both Random with proc glm';
     class A B ;
     model y = a | b;
     random a b a*b / test ;
     /* Have to specify interaction random too,
        and explicitly ask for tests */

proc glm;
     title 'A Fixed, B Random';
     class A B ;
     model y = a | b;
     random b a*b / test;

proc glm;
     title 'A fixed, B random and nested within A';
     class A B ;
     model y = a b(a);
     random b(a) / test;

proc mixed cl;
     title 'A fixed, B random and nested within A';
     title2 'Using proc mixed';
     class A B ;
     model y = a ;
     random b(a);

proc glm;
     title 'Both random, B nested within A';
     class A B ;
     model y = a b(a);
     random a b(a) / test;

proc sort; by A B; /* Data must be sorted in order of nesting*/
proc nested;
     title 'Nested random effects with proc nested';
     class A B;
     var Y;

proc mixed cl;
     title 'Pure nested with proc mixed';
     class A B ;
     model y =  ;
     random a b(a);
```

The GLM Procedure

Class Level Information

Class	Levels	Values
A	3	1 2 3
B	4	1 2 3 4

Number of Observations Read 36
Number of Observations Used 36

The GLM Procedure

Dependent Variable: Y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	723.6220996	65.7838272	6.69	<.0001
Error	24	236.0284247	9.8345177		
Corrected Total	35	959.6505243			

R-Square	Coeff Var	Root MSE	Y Mean
0.754048	29.78261	3.136003	10.52964

Source	DF	Type I SS	Mean Square	F Value	Pr > F
A	2	448.1563126	224.0781563	22.78	<.0001
B	3	146.2572697	48.7524232	4.96	0.0081
A*B	6	129.2085173	21.5347529	2.19	0.0796

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	2	448.1563126	224.0781563	22.78	<.0001
B	3	146.2572697	48.7524232	4.96	0.0081
A*B	6	129.2085173	21.5347529	2.19	0.0796

The GLM Procedure

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B	3	146.2572697	48.7524232	4.96	0.0081
A*B	6	129.2085173	21.5347529	2.19	0.0796

Source	Type III Expected Mean Square
A	Var(Error) + 3 Var(A*B) + 12 Var(A)
B	Var(Error) + 3 Var(A*B) + 9 Var(B)
A*B	Var(Error) + 3 Var(A*B)

Both Random with proc glm 7

The GLM Procedure
Tests of Hypotheses for Random Model Analysis of Variance

Dependent Variable: Y

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	2	448.156313	224.078156	10.41	0.0112
B	3	146.257270	48.752423	2.26	0.1813
Error: MS(A*B)	6	129.208517	21.534753		

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A*B	6	129.208517	21.534753	2.19	0.0796
Error: MS(Error)	24	236.028425	9.834518		

A Fixed, B Random 8

The GLM Procedure

Class Level Information

Class	Levels	Values
A	3	1 2 3
B	4	1 2 3 4

Number of Observations Read	36
Number of Observations Used	36

A Fixed, B Random 9

The GLM Procedure

Dependent Variable: Y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	723.6220996	65.7838272	6.69	<.0001
Error	24	236.0284247	9.8345177		
Corrected Total	35	959.6505243			

R-Square	Coeff Var	Root MSE	Y Mean
0.754048	29.78261	3.136003	10.52964

Source	DF	Type I SS	Mean Square	F Value	Pr > F
A	2	448.1563126	224.0781563	22.78	<.0001
B	3	146.2572697	48.7524232	4.96	0.0081
A*B	6	129.2085173	21.5347529	2.19	0.0796

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	2	448.1563126	224.0781563	22.78	<.0001
B	3	146.2572697	48.7524232	4.96	0.0081
A*B	6	129.2085173	21.5347529	2.19	0.0796

The GLM Procedure

Source	Type III Expected Mean Square
A	Var(Error) + 3 Var(A*B) + Q(A)
B	Var(Error) + 3 Var(A*B) + 9 Var(B)
A*B	Var(Error) + 3 Var(A*B)

The GLM Procedure

Tests of Hypotheses for Mixed Model Analysis of Variance

Dependent Variable: Y

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	2	448.156313	224.078156	10.41	0.0112
B	3	146.257270	48.752423	2.26	0.1813
Error: MS(A*B)	6	129.208517	21.534753		

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A*B	6	129.208517	21.534753	2.19	0.0796
Error: MS(Error)	24	236.028425	9.834518		

The GLM Procedure

Class Level Information

Class	Levels	Values
A	3	1 2 3
B	4	1 2 3 4

Number of Observations Read 36
Number of Observations Used 36

The GLM Procedure

Dependent Variable: Y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	723.6220996	65.7838272	6.69	<.0001
Error	24	236.0284247	9.8345177		
Corrected Total	35	959.6505243			

R-Square	Coeff Var	Root MSE	Y Mean
0.754048	29.78261	3.136003	10.52964

Source	DF	Type I SS	Mean Square	F Value	Pr > F
A	2	448.1563126	224.0781563	22.78	<.0001
B(A)	9	275.4657870	30.6073097	3.11	0.0126

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	2	448.1563126	224.0781563	22.78	<.0001
B(A)	9	275.4657870	30.6073097	3.11	0.0126

The GLM Procedure

Source	Type III Expected Mean Square
A	Var(Error) + 3 Var(B(A)) + Q(A)
B(A)	Var(Error) + 3 Var(B(A))

The GLM Procedure
Tests of Hypotheses for Mixed Model Analysis of Variance

Dependent Variable: Y

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	2	448.156313	224.078156	7.32	0.0130
Error: MS(B(A))	9	275.465787	30.607310		

Source	DF	Type III SS	Mean Square	F Value	Pr > F
B(A)	9	275.465787	30.607310	3.11	0.0126
Error: MS(Error)	24	236.028425	9.834518		

Using proc mixed

The Mixed Procedure

Model Information

Data Set	WORK.MIXEDUP
Dependent Variable	Y
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information

Class	Levels	Values
A	3	1 2 3
B	4	1 2 3 4

Dimensions

Covariance Parameters	2
Columns in X	4
Columns in Z	12
Subjects	1
Max Obs Per Subject	36

Number of Observations

Number of Observations Read	36
Number of Observations Used	36
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	191.55201049	
1	1	186.75737473	0.00000000

Convergence criteria met.

Covariance Parameter Estimates

Cov Parm	Estimate	Alpha	Lower	Upper
B(A)	6.9243	0.05	2.4834	57.3781
Residual	9.8345	0.05	5.9960	19.0328

Fit Statistics

-2 Res Log Likelihood	186.8
AIC (smaller is better)	190.8
AICC (smaller is better)	191.2
BIC (smaller is better)	191.7

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
A	2	9	7.32	0.0130

The GLM Procedure

Class Level Information

Class	Levels	Values
A	3	1 2 3
B	4	1 2 3 4

Number of Observations Read 36
Number of Observations Used 36

The GLM Procedure

Dependent Variable: Y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	723.6220996	65.7838272	6.69	<.0001
Error	24	236.0284247	9.8345177		
Corrected Total	35	959.6505243			

R-Square	Coeff Var	Root MSE	Y Mean
0.754048	29.78261	3.136003	10.52964

Source	DF	Type I SS	Mean Square	F Value	Pr > F
A	2	448.1563126	224.0781563	22.78	<.0001
B(A)	9	275.4657870	30.6073097	3.11	0.0126

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	2	448.1563126	224.0781563	22.78	<.0001
B(A)	9	275.4657870	30.6073097	3.11	0.0126

The GLM Procedure

Source	Type III Expected Mean Square
A	Var(Error) + 3 Var(B(A)) + 12 Var(A)
B(A)	Var(Error) + 3 Var(B(A))

The GLM Procedure
Tests of Hypotheses for Random Model Analysis of Variance

Dependent Variable: Y

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	2	448.156313	224.078156	7.32	0.0130
Error: MS(B(A))	9	275.465787	30.607310		

Source	DF	Type III SS	Mean Square	F Value	Pr > F
B(A)	9	275.465787	30.607310	3.11	0.0126
Error: MS(Error)	24	236.028425	9.834518		

The NESTED Procedure

Coefficients of Expected Mean Squares

Source	A	B	Error
A	12	3	1
B	0	3	1
Error	0	0	1

Nested Random Effects Analysis of Variance for Variable Y

Variance Source	DF	Sum of Squares	F Value	Pr > F	Error Term
Total	35	959.650524			
A	2	448.156313	7.32	0.0130	B
B	9	275.465787	3.11	0.0126	Error
Error	24	236.028425			

Nested Random Effects Analysis of Variance for Variable Y

Variance Source	Mean Square	Variance Component	Percent of Total
Total	27.418586	32.881352	100.0000
A	224.078156	16.122571	49.0326
B	30.607310	6.924264	21.0583
Error	9.834518	9.834518	29.9091

Y Mean	10.52964444
Standard Error of Y Mean	2.49487339

The Mixed Procedure

Model Information

Data Set	WORK.MIXEDUP
Dependent Variable	Y
Covariance Structure	Variance Components
Estimation Method	REML
Residual Variance Method	Profile
Fixed Effects SE Method	Model-Based
Degrees of Freedom Method	Containment

Class Level Information

Class	Levels	Values
A	3	1 2 3
B	4	1 2 3 4

Dimensions

Covariance Parameters	3
Columns in X	1
Columns in Z	15
Subjects	1
Max Obs Per Subject	36

Number of Observations

Number of Observations Read	36
Number of Observations Used	36
Number of Observations Not Used	0

Iteration History

Iteration	Evaluations	-2 Res Log Like	Criterion
0	1	218.80195545	
1	1	199.38591766	0.00000000

Convergence criteria met.

Covariance Parameter Estimates

Cov Parm	Estimate	Alpha	Lower	Upper
A	16.1226	0.05	3.8361	1927.28
B(A)	6.9243	0.05	2.4834	57.3781
Residual	9.8345	0.05	5.9960	19.0328