Rabbits Repeated Measures and MIXED/CS Fit in SAS

```
proc mixed data=stack;
  class trt rabbit time;
  model y=trt time trt*time;
  repeated / type=cs sub=rabbit(trt) r;
run;
```

The Mixed Procedure

Estimated R Matrix for rabbit(trt) 1 Amiodar

Row	Col1	Col2	Col3	Col4
1	0.6617	0.08336	0.08336	0.08336
2	0.08336	0.6617	0.08336	0.08336
3	0.08336	0.08336	0.6617	0.08336
4	0.08336	0.08336	0.08336	0.6617

Covariance Parameter Estimates

Cov Parm	Subject	Estimate
CS	rabbit(trt)	0.08336
Residual		0.5783

Fit Statistics

-2 Res Log Likelihood	134.7
AIC (smaller is better)	138.7
AICC (smaller is better)	139.0
BIC (smaller is better)	140.1

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
trt	2	12	19.40	0.0002
time	3	36	9.27	0.0001
trt*time	6	36	2.90	0.0207

Therefore in the usual notation,

$\widehat{\sigma}^2$ **= 0.08336 + 0.5783 = 0.66166 and** $\widehat{\rho}$ **= 1 / (1 + 0.5783/0.08336) = 0.12599.**

Return to GA Babies – Birth-order by Age (INITAGE) Interaction is NS

```
proc mixed data=one;
  class momid;
  model bweight=birthord cinitage/s;
  repeated / type=un sub=momid r rcorr;
run;
```

The Mixed Procedure

Number of Observations

Number of Observations Read	1000
Number of Observations Used	1000
Number of Observations Not Used	0

Estimated R Matrix for momid 39

Row	Col1	Col2	Col3	Col4	Col5
1	327863	63436	98192	81783	119379
2	63436	299155	154504	141898	125142
3	98192	154504	358509	209998	140785
4	81783	141898	209998	321304	147599
5	119379	125142	140785	147599	324783

Estimated R Correlation Matrix for momid 39

Row	Col1	Col2	Col3	Col4	Col5
1	1.0000	0.2026	0.2864	0.2520	0.3658
2	0.2026	1.0000	0.4718	0.4577	0.4015
3	0.2864	0.4718	1.0000	0.6187	0.4126
4	0.2520	0.4577	0.6187	1.0000	0.4569
5	0.3658	0.4015	0.4126	0.4569	1.0000

Fit Statistics

-2 Res Log Likelihood	15252.7
AIC (smaller is better)	15282.7
AICC (smaller is better)	15283.2
BIC (smaller is better)	15332.2

Null Model Likelihood Ratio Test

DF	Chi-Square	Pr > ChiSq
14	255.27	<.0001

Solution for Fixed Effects

Effect	Estimate	Std Error	DF	t Value	Pr > |t|
Intercept	2999.42	38.0613	198	78.81	<.0001
birthord	44.4091	9.8355	198	4.52	<.0001
cinitage	28.6249	8.7935	198	3.26	0.0013

Type 3 Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
birthord	1	198	20.39	<.0001
cinitage	1	198	10.60	0.0013

PROC MIXED SUMMARY

Covariance Structure	Num. Var. Components	-2LL	AIC
Unstructured	15	15,252.7	15,282.7
AR(1) – not shown	2	15,336.1	15,340.1
CS – not shown	2	15,298.8	15,302.8

```
proc genmod data=one;
  class momid;
  model bweight=birthord cinitage/dist=normal link=identity;
  repeated subject=momid / type=un; run;
```

```
                                The GENMOD Procedure
                                  Model Information
                               Data Set              WORK.ONE
                               Distribution            Normal
                               Link Function         Identity
                               Dependent Variable     bweight
                            Number of Observations Read        1000
                            Number of Observations Used        1000

                                 Class Level Information
          Class      Levels    Values
          momid         200    39 62 79 80 84 92 108 113 125 135 199 200 221 247 ...

                          Criteria For Assessing Goodness Of Fit
                 Criterion                 DF           Value        Value/DF
                 Deviance                 997    324458344.08     325434.6480
                 Scaled Deviance          997       1000.0000          1.0030
                 Pearson Chi-Square       997    324458344.08     325434.6480
                 Scaled Pearson X2        997       1000.0000          1.0030
                 Log Likelihood                   -7763.8948
         Algorithm converged.

                            Analysis Of Initial Parameter Estimates
                                    Standard     Wald 95% Confidence       Chi-
  Parameter    DF    Estimate       Error           Limits            Square    Pr > ChiSq
  Intercept     1    2995.640     42.2436    2912.844    3078.436    5028.72        <.0001
  birthord      1     46.6080     12.7369     21.6441     71.5719      13.39        0.0003
  cinitage      1     26.7323      5.5968     15.7627     37.7018      22.81        <.0001
  Scale         1    569.6125     12.7369    545.1877    595.1315
NOTE: The scale parameter was estimated by maximum likelihood.

                                  GEE Model Information
                          Correlation Structure               Unstructured
                          Subject Effect                 momid (200 levels)
                          Number of Clusters                           200
                          Correlation Matrix Dimension                   5
                          Maximum Cluster Size                           5
                          Minimum Cluster Size                           5
         Algorithm converged.
                           Analysis Of GEE Parameter Estimates
                            Empirical Standard Error Estimates
                                    Standard   95% Confidence
                 Parameter Estimate    Error       Limits           Z Pr > |Z|
                 Intercept 2998.092  37.9907 2923.631 3072.552   78.92   <.0001
                 birthord   44.6770   9.8226  25.4250  63.9290    4.55   <.0001
                 cinitage   28.0936   9.1012  10.2557  45.9316    3.09   0.0020
```

Random-Effects Model fit as on pp.276-7

```
proc nlmixed data=one;
  parms b0=0 b1BO=20 b1AGE=20 sigma_u=300 sigma_e=300;
  var_u=sigma_u*sigma_u; var_e=sigma_e*sigma_e;
  mean=b0+u+b1BO*birthord+b1AGE*cinitage;
  model bweight~normal(mean,var_e);
  random u~normal(0,var_u) subject=momid;
run;
```

The NLMIXED Procedure

Specifications

Data Set	WORK.ONE
Dependent Variable	bweight
Distribution for Dependent Variable	Normal
Random Effects	u
Distribution for Random Effects	Normal
Subject Variable	momid
Optimization Technique	Dual Quasi-Newton
Integration Method	Adaptive Gaussian Quadrature

Dimensions

Observations Used	1000
Observations Not Used	0
Total Observations	1000
Subjects	200
Max Obs Per Subject	5
Parameters	5
Quadrature Points	1

NOTE: GCONV convergence criterion satisfied.

Fit Statistics

-2 Log Likelihood	15320
AIC (smaller is better)	15330
AICC (smaller is better)	15330
BIC (smaller is better)	15346

Parameter Estimates

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper
b0	2995.65	41.4872	199	72.21	<.0001	0.05	2913.84	3077.46
b1BO	46.6067	9.9448	199	4.69	<.0001	0.05	26.9961	66.2174
b1AGE	26.7324	8.9576	199	2.98	0.0032	0.05	9.0685	44.3964
sigma_u	-355.90	23.5173	199	-15.13	<.0001	0.05	-402.27	-309.52
sigma_e	444.74	11.1186	199	40.00	<.0001	0.05	422.82	466.67