```
options ls=80 nocenter nodate;

data resp1;
infile 'c:\zucker\binary\examples\corbin-dat.txt';
input center id treatmnt $ sex $ age baseline visit1-visit4;
id_no = _n_;

/*
Patients in each of two centers are randomly assigned to groups receiving the
active treatment or a placebo. During treatment, respiratory status (coded here
as 0=poor, 1=good) is determined for each of four visits. The variables center,
treatment, sex, and baseline (baseline respiratory status) are classification
variables with two levels. The variable age (age at time of entry into the study)
is a continuous variable.
*/

data resp2;
set;
keep id_no active center2 female age baseline visit outcome;
active=(treatmnt='A');
center2=(center=2);
female=(sex='F');
visit=1;  outcome=visit1;  output;
visit=2;  outcome=visit2;  output;
visit=3;  outcome=visit3;  output;
visit=4;  outcome=visit4;  output;

proc nlmixed cov;
parms b0=0, b1=0, b2=0, b3=0, b4=0, b5=0, b6=0, g11=1, g21=0, g22=1;
bounds g11,g22>0;
psi = b0 + b1*center2 + b2*active + b3*female
  + b4*age + b5*baseline + b6*visit + z1 + z2*visit;
p = exp(psi)/(1+exp(psi));
model outcome ~ binary(p);
random z1 z2 ~ normal([0,0],[g11,g21,g22]) subject=id_no;
run;

proc nlmixed cov;
parms b0=0, b1=0, b2=0, b3=0, b4=0, b5=0, g11=1;
bounds g11>0;
psi = b0 + b1*center2 + b2*active + b3*female
  + b4*age + b5*baseline + z1;
p = exp(psi)/(1+exp(psi));
model outcome ~ binary(p);
random z1 ~ normal(0,g11) subject=id_no;
run;

proc genmod descending;
class id_no;
model outcome=center2 active female age baseline / dist=bin;
repeated subject=id_no / type=ind covb;
run;
```
The SAS System   1

The NLMIXED Procedure

Specifications

Data Set	WORK.RESP2
Dependent Variable	outcome
Distribution for Dependent Variable	Binary
Random Effects	z1 z2
Distribution for Random Effects	Normal
Subject Variable	id_no
Optimization Technique	Dual Quasi-Newton
Integration Method	Adaptive Gaussian Quadrature

The NLMIXED Procedure

Specifications

Data Set	WORK.RESP2
Dependent Variable	outcome
Distribution for Dependent Variable	Binary
Random Effects	z1
Distribution for Random Effects	Normal
Subject Variable	id_no
Optimization Technique	Dual Quasi-Newton
Integration Method	Adaptive Gaussian Quadrature

The NLMIXED Procedure

Specifications

Data Set	WORK.RESP2
Dependent Variable	outcome
Distribution for Dependent Variable	Binary
Random Effects	z1 z2
Distribution for Random Effects	Normal
Subject Variable	id_no
Optimization Technique	Dual Quasi-Newton
Integration Method	Adaptive Gaussian Quadrature

Dimensions

Observations Used	444
Observations Not Used	0
Total Observations	444
Subjects	111
Max Obs Per Subject	4
Parameters	10
Quadrature Points	9

```
                            Parameters

      b0          b1          b2          b3          b4          b5          b6          g11

       0           0           0           0           0           0           0           1

              Parameters

     g21         g22     NegLogLike

       0           1     245.632006


                        Iteration History

  Iter     Calls     NegLogLike        Diff      MaxGrad        Slope

     1         4     244.200147     1.431859     12.58778       -1281.8
     2         6     232.045394     12.15475     51.31038      -6.23094
     3         8     225.541516     6.503878     38.81916      -5.11925
     4        11     221.234745     4.306771     33.83561      -1.35086
     5        15     219.613352     1.621393     76.08851      -5.81181
     6        16      218.80952     0.803832     16.04599      -2.86898
     7        17     217.549415     1.260106     10.38279      -8.34175
     8        19     216.911486     0.637929     48.02593      -1.14015
     9        20     216.265579     0.645907     59.53515      -0.82307
    10        75     215.940103     0.325476      20.0119      -0.32153
    11        77     215.878838     0.061266     28.20205      -0.44335
    12       114     215.573051     0.305787     43.67527      -0.22959
    13       115      215.43478      0.13827     10.02147      -0.52224
    14       116     215.203267     0.231513     12.21992      -0.38401
    15       118     215.074168     0.129099     2.762213      -0.17121


The SAS System                                                                          4

The NLMIXED Procedure

                        Iteration History

  Iter     Calls     NegLogLike        Diff      MaxGrad        Slope

    16       120      215.06374     0.010428     3.626724      -0.01939
    17       122     215.059943     0.003796     2.050041      -0.00389
    18       124     215.047117     0.012827     10.65888      -0.00395
    19       125     215.025929     0.021187     0.886699      -0.01371
    20       127     215.014614     0.011315     5.389362      -0.01179
    21       129      214.94995     0.064664     21.30831      -0.00875
    22       130     214.915235     0.034716     22.86678      -0.03697
    23       132     214.891432     0.023803     0.397505      -0.04001
    24       134     214.883684     0.007748     2.126537      -0.00335
    25       136     214.862445     0.021239     1.618152      -0.00525
    26       138     214.855147     0.007298     0.550038      -0.00829
    27       140      214.85501     0.000137      0.19479       -0.0002
    28       141     214.854889     0.000121     0.269985      -0.00004
    29       142     214.854698      0.00019     0.061569      -0.00016
    30       144     214.854635     0.000064     0.021122       -0.0001
    31       146     214.854632      2.72E-6     0.004165      -3.84E-6
    32       148     214.854626     6.132E-6     0.017051      -8.83E-7
```

NOTE: GCONV convergence criterion satisfied.

Fit Statistics

-2 Log Likelihood   429.7
AIC (smaller is better)   449.7
AICC (smaller is better)   450.2
BIC (smaller is better)   476.8

Parameter Estimates

		Standard					
Parameter	Estimate	Error	DF	t Value	Pr > |t|	Alpha	Lower
b0	-1.4741	0.8954	109	-1.65	0.1026	0.05	-3.2488
b1	0.9261	0.5842	109	1.59	0.1158	0.05	-0.2318
b2	2.1528	0.6006	109	3.58	0.0005	0.05	0.9624
b3	0.1770	0.7089	109	0.25	0.8033	0.05	-1.2280
b4	-0.02136	0.02234	109	-0.96	0.3410	0.05	-0.06564

Parameter Estimates

Parameter	Upper	Gradient
b0	0.3005	0.000729
b1	2.0840	0.00069
b2	3.3431	0.000097
b3	1.5819	0.00029
b4	0.02291	0.017051

The SAS System   5

The NLMIXED Procedure

Parameter Estimates

		Standard					
Parameter	Estimate	Error	DF	t Value	Pr > |t|	Alpha	Lower
b5	3.1312	0.6644	109	4.71	<.0001	0.05	1.8144
b6	-0.1142	0.1416	109	-0.81	0.4217	0.05	-0.3948
g11	3.4416	3.1035	109	1.11	0.2699	0.05	-2.7095
g21	-0.06280	0.7587	109	-0.08	0.9342	0.05	-1.5665
g22	0.2306	0.3409	109	0.68	0.5002	0.05	-0.4451

Parameter Estimates

Parameter	Upper	Gradient
b5	4.4480	0.001294
b6	0.1664	0.000113
g11	9.5927	-0.00018
g21	1.4409	0.00112
g22	0.9063	0.001901

Covariance Matrix of Parameter Estimates

Row	Parameter	b0	b1	b2	b3	b4	b5
1	b0	0.8018	-0.01794	-0.2126	0.007942	-0.01386	-0.2116
2	b1	-0.01794	0.3413	0.02405	-0.04947	-0.00357	-0.04946
3	b2	-0.2126	0.02405	0.3607	0.09431	-0.00079	0.1430
4	b3	0.007942	-0.04947	0.09431	0.5025	-0.00444	0.04864
5	b4	-0.01386	-0.00357	-0.00079	-0.00444	0.000499	0.000115
6	b5	-0.2116	-0.04946	0.1430	0.04864	0.000115	0.4414
7	b6	-0.04154	-0.00312	-0.00547	-0.00211	0.000156	-0.00757
8	g11	-0.05643	0.4396	0.6251	0.2146	-0.01838	0.8411
9	g21	0.003112	-0.07970	-0.1166	-0.04019	0.003542	-0.1542
10	g22	-0.05342	0.01488	0.05991	0.000832	-0.00011	0.08492

Covariance Matrix of Parameter Estimates

Row	b6	g11	g21	g22
1	-0.04154	-0.05643	0.003112	-0.05342
2	-0.00312	0.4396	-0.07970	0.01488
3	-0.00547	0.6251	-0.1166	0.05991
4	-0.00211	0.2146	-0.04019	0.000832
5	0.000156	-0.01838	0.003542	-0.00011
6	-0.00757	0.8411	-0.1542	0.08492
7	0.02005	-0.06501	0.01245	-0.00218
8	-0.06501	9.6319	-2.0388	0.5905
9	0.01245	-2.0388	0.5756	-0.2023
10	-0.00218	0.5905	-0.2023	0.1162

The SAS System   6

The NLMIXED Procedure

Specifications

Data Set	WORK.RESP2
Dependent Variable	outcome
Distribution for Dependent Variable	Binary
Random Effects	z1
Distribution for Random Effects	Normal
Subject Variable	id_no
Optimization Technique	Dual Quasi-Newton
Integration Method	Adaptive Gaussian Quadrature

Dimensions

Observations Used	444
Observations Not Used	0
Total Observations	444
Subjects	111
Max Obs Per Subject	4
Parameters	7
Quadrature Points	5

```
                           Parameters

        b0         b1         b2         b3         b4         b5        g11   NegLogLike

         0          0          0          0          0          0          1   267.239405


                         Iteration History

   Iter     Calls     NegLogLike         Diff     MaxGrad        Slope

      1         4     266.298759     0.940646    27.09786     -1710.73
      2         7     226.620128     39.67863     72.6669     -24.9901
      3         9     220.889768     5.730359    12.18331     -4.99001
      4        11     219.461637     1.428131    3.697341     -0.50065
      5        13     216.676879     2.784759    40.87854     -1.03224
      6        15     216.376439      0.30044    29.99924     -0.40181
      7        17      216.34151     0.034929    4.580421     -0.02848
      8        19     216.327365     0.014146    11.55009     -0.01398
      9        20     216.308929     0.018436    0.220094     -0.00526
     10        22     216.306028     0.002901    1.024081     -0.00304
     11        24     216.305529     0.000498    1.051831      -0.0005
     12        26     216.302947     0.002582    0.607675     -0.00037
     13        28     216.302842     0.000106    0.259697     -0.00015
     14        30      216.30207     0.000772    0.257842     -0.00006
     15        32     216.302049     0.000021    0.051169     -0.00003
     16        34     216.302048      4.31E-7    0.007632     -7.33E-7


          NOTE: GCONV convergence criterion satisfied.
```

The SAS System   7

The NLMIXED Procedure

```
              Fit Statistics

-2 Log Likelihood                  432.6
AIC (smaller is better)            446.6
AICC (smaller is better)           446.9
BIC (smaller is better)            465.6
```

```
                        Parameter Estimates

                     Standard
Parameter   Estimate    Error    DF   t Value   Pr > |t|   Alpha      Lower

b0           -1.4659   0.7591   110    -1.93     0.0560     0.05     -2.9703
b1            0.9697   0.5350   110     1.81     0.0726     0.05    -0.09053
b2            2.0061   0.5331   110     3.76     0.0003     0.05      0.9497
b3            0.2410   0.6601   110     0.37     0.7157     0.05     -1.0671
b4          -0.02660  0.01982   110    -1.34     0.1822     0.05    -0.06588
b5            2.8852   0.5661   110     5.10    <.0001      0.05      1.7634
g11           3.7440   1.1844   110     3.16     0.0020     0.05      1.3969
```

```
         Parameter Estimates

Parameter       Upper      Gradient

b0            0.03846     0.000592
b1             2.0300     -0.0001
b2             3.0626      0.00031
b3             1.5492     0.000863
b4            0.01267     0.007632
b5             4.0070     -0.00006
g11            6.0912     0.000257


              Covariance Matrix of Parameter Estimates

Row  Parameter        b0         b1         b2         b3         b4         b5

  1  b0           0.5763    -0.02921    -0.1683   -0.00773   -0.01090    -0.1567
  2  b1          -0.02921     0.2862     0.01083   -0.05183   -0.00243   -0.05517
  3  b2           -0.1683     0.01083    0.2842     0.08088   -0.00052    0.07845

   Covariance
    Matrix of
   Parameter
   Estimates

  Row       g11

   1    -0.1572
   2     0.09001
   3      0.1884


The SAS System                                                               8

The NLMIXED Procedure



              Covariance Matrix of Parameter Estimates

Row  Parameter        b0         b1         b2         b3         b4         b5

  4  b3          -0.00773   -0.05183    0.08088     0.4357   -0.00340    0.04135
  5  b4          -0.01090   -0.00243   -0.00052   -0.00340   0.000393   0.000219
  6  b5           -0.1567   -0.05517    0.07845    0.04135   0.000219     0.3204
  7  g11          -0.1572    0.09001     0.1884    0.02638   -0.00206     0.2682

   Covariance
    Matrix of
   Parameter
   Estimates

  Row       g11

   4     0.02638
   5    -0.00206
   6     0.2682
   7     1.4027
```

The GENMOD Procedure

       Model Information

Data Set   WORK.RESP2
Distribution   Binomial
Link Function   Logit
Dependent Variable   outcome

Number of Observations Read   444
Number of Observations Used   444
Number of Events   248
Number of Trials   444

                     Class Level Information

Class   Levels   Values

id_no   111   1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
                      21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
                      38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54
                      55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71
                      72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87
                   ...

        Response Profile

 Ordered   Total
   Value   outcome   Frequency

      1   1   248
      2   0   196

PROC GENMOD is modeling the probability that outcome='1'.

   Parameter Information

Parameter   Effect

Prm1   Intercept
Prm2   center2
Prm3   active
Prm4   female
Prm5   age
Prm6   baseline

        Criteria For Assessing Goodness Of Fit

Criterion   DF   Value   Value/DF

Deviance   438   487.4873   1.1130
Scaled Deviance   438   487.4873   1.1130
Pearson Chi-Square   438   444.7942   1.0155
Scaled Pearson X2   438   444.7942   1.0155

The GENMOD Procedure

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Log Likelihood		-243.7436	

Algorithm converged.

Analysis Of Initial Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	-0.8561	0.3351	-1.5130	-0.1992	6.53	0.0106
center2	1	0.6495	0.2383	0.1825	1.1165	7.43	0.0064
active	1	1.2654	0.2350	0.8048	1.7259	28.99	<.0001
female	1	0.1368	0.2933	-0.4381	0.7117	0.22	0.6410
age	1	-0.0188	0.0088	-0.0360	-0.0015	4.53	0.0334
baseline	1	1.8457	0.2393	1.3768	2.3147	59.51	<.0001
Scale	0	1.0000	0.0000	1.0000	1.0000		

NOTE: The scale parameter was held fixed.

GEE Model Information

Correlation Structure	Independent
Subject Effect	id_no (111 levels)
Number of Clusters	111
Correlation Matrix Dimension	4
Maximum Cluster Size	4
Minimum Cluster Size	4

Covariance Matrix (Model-Based)

	Prm1	Prm2	Prm3	Prm4	Prm5	Prm6
Prm1	0.11232	-0.004580	-0.03174	-0.003199	-0.002169	-0.02618
Prm2	-0.004580	0.05677	0.0005355	-0.01195	-0.000482	-0.01015
Prm3	-0.03174	0.0005355	0.05523	0.01592	-0.000116	0.01432
Prm4	-0.003199	-0.01195	0.01592	0.08604	-0.000616	0.008287
Prm5	-0.002169	-0.000482	-0.000116	-0.000616	0.0000777	9.9682E-6
Prm6	-0.02618	-0.01015	0.01432	0.008287	9.9682E-6	0.05725

The GENMOD Procedure

                           Covariance Matrix (Empirical)

              Prm1   Prm2   Prm3   Prm4   Prm5   Prm6

Prm1   0.20829   0.0003096   -0.05616   -0.001820   -0.004137   -0.05072
Prm2   0.0003096   0.12477   -0.01695   -0.04834   -0.000338   -0.03832
Prm3   -0.05616   -0.01695   0.12019   0.05855   -0.000886   0.03250
Prm4   -0.001820   -0.04834   0.05855   0.19382   -0.002264   0.03742
Prm5   -0.004137   -0.000338   -0.000886   -0.002264   0.0001681   -0.000383
Prm6   -0.05072   -0.03832   0.03250   0.03742   -0.000383   0.11970

Algorithm converged.

                     Analysis Of GEE Parameter Estimates
                      Empirical Standard Error Estimates

                         Standard   95% Confidence
Parameter Estimate   Error   Limits   Z Pr > |Z|

Intercept -0.8561   0.4564   -1.7506   0.0384   -1.88   0.0607
center2   0.6495   0.3532   -0.0428   1.3418   1.84   0.0660
active   1.2654   0.3467   0.5859   1.9448   3.65   0.0003
female   0.1368   0.4402   -0.7261   0.9996   0.31   0.7560
age   -0.0188   0.0130   -0.0442   0.0067   -1.45   0.1480
baseline   1.8457   0.3460   1.1676   2.5238   5.33   <.0001