PROC GLIMMIX is a new SAS procedure, still experimental at present, which will fit logistic regression. It has several advantages over PROC LOGISTIC, including the ability to fit random effects. It is also capable of fitting errors that are distributed differently than normal.

```
PROC GLIMMIX < options > ;
    BY variables ;   CLASS variables ;
    FREQ variable ;  ID variables ;  WEIGHT variable ;
    PARMS (value-list) . . . < / options > ;
    RANDOM random-effects < / options > ;
    programming statements
    MODEL response<(response options)> = < fixed-effects >< /options > ;
    MODEL events/trials = < fixed-effects >< /options > ;
    CONTRAST ’label’ effect values < . . . effect values > < /options > ;
    ESTIMATE ’label’ effect values < . . . effect values > < /options > ;
    LSMEANS effects < / options > ;
    OUTPUT < OUT=SAS-data-set ><keyword<(keyword-options)><=name>> . . .
        <keyword<(keyword-options)><=name>>< / options > ;
```

Note the presence of the RANDOM statement, and both CONTRAST and ESTIMATE statements (Logistic has CONTRAST only).

PROC GLIMMIX is capable of fitting errors that are normally distributed, binary, binomial or any of a number of other distributions. A list of those distributions is given below. All information and tables are from documentation provided as SAS online documentation [SAS Institute Inc. 2004. SAS OnlineDoc® 9.1.3. Cary, NC: SAS Institute Inc.] or documentation provided with SAS PROC GLIMMIX.

DISTRIBUTION | DIST | D | ERROR | ERR = keyword

When unspecified, the distribution defaults are:

- the normal distribution for continuous response variables
- the multinomial distribution for classification or character variables
- the binomial distribution for the events/trial syntax

DIST=	Distribution	Default Link Function	Numeric Value
BINARY	binary	logit	4
BINOMIAL | BIN | B	binomial	logit	3
EXPONENTIAL | EXPO	exponential	log	9
GAMMA | GAM	gamma	log	5
GAUSSIAN |G | NORMAL | N	normal	identity	1
GEOMETRIC | GEOM	geometric	log	8
INVGAUSS | IGAUSSIAN | IG	inverse Gaussian	inverse squared (power(−2))	6
LOGNORMAL |LOGN	log-normal	identity	11
MULTINOMIAL | MULTI | MULT	multinomial cumulative	logit	NA
NEGBINOMIAL | NEGBIN | NB	negative binomial	log	7
POISSON | POI | P	Poisson	log	2
TCENTRAL | TDIST | T	t	identity	10
BYOBS(variable)	multivariate	varied	NA

```
1          ********************************************************;
2          *** Logistic Regression - Disease outbreak example     ***;
3          *** NKNW table 14.3  (Appendix C3)                     ***;
4          *** Study of a disease outbreak from a mosquito born   ***;
5          *** disease within two sectors of a city.              ***;
6          ********************************************************;
7
8          dm'log;clear;output;clear';
9          options nodate nocenter nonumber ps=512 ls=132 nolabel;
10
11         TITLE1 'Logistic Regression - NKNW Example 14.3';
12         data Disease; infile cards missover;
13            input case Age Status1 Status2 sector Disease;
14            * Status classes are upper (0, 0), Middle (1, 0) and Lower (0, 1);
15            status = 'Upper ';
16            if status1 eq 1 then status = 'Middle';
17            if status2 eq 1 then status = 'Lower';
18            label case = 'case number'
19                  age  = 'Patients age'
20                  status  = 'Socioeconomic status upper, middle and lower'
21                   disease = 'Disease present = 1';
22         Cards;
NOTE: The data set WORK.DISEASE has 98 observations and 7 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.02 seconds
121        ;
122
123        ods html;
NOTE: Writing HTML Body file: sashtml.htm
124        ods graphics on;
NOTE: ODS Statistical Graphics will require a SAS/GRAPH license when it is declared production.
125
NOTE: Version 1.0 of the GLIMMIX procedure is experimental.
126        proc glimmix data=Disease plots=(all);
127           class status sector;
128           TITLE2 'Logistic regression on Disease data using PROC GLIMMIX';
129           model Disease = Age Status SECTOR / dist = binary solution;
130              estimate '1'  status   1   0  -1;
131              estimate '2'  status   0   1  -1;
132              estimate '3'  status   1  -1   0;
133              estimate 'linear'     status   -1   0   1;
134              estimate 'quadratic'  status   -1   2  -1;
135           lsmeans Status sector / pdiff adjust = tukey cl;
136          ods output diffs=ppp lsmeans=mmm;
137          ods listing exclude diffs;* lsmeans; *this is now just a comment;
138        run;

NOTE: The GLIMMIX procedure is modeling the probability that Disease='0'.
NOTE: Convergence criterion (GCONV=1E-8) satisfied.
NOTE: Graphs of LS-mean control differences are only produced for LSMEANS statements with
compatible difference types.
NOTE: Analysis of mean graphs are only produced for LSMEANS statements with compatible
difference types.
WARNING: Statistical graphics displays created with ODS are experimental in this release.
NOTE: The data set WORK.MMM has 5 observations and 11 variables.
NOTE: The data set WORK.PPP has 4 observations and 17 variables.
NOTE: The PROCEDURE GLIMMIX printed page 1.
NOTE: PROCEDURE GLIMMIX used (Total process time):
      real time           7.11 seconds
      cpu time            4.49 seconds
139        TITLE3 'Post hoc adjustment with macro by Arnold Saxton';
140        * SAS Macro by Arnold Saxton: Saxton, A.M. 1998.  A macro for              ;
141        * converting mean separation output to letter groupings in Proc Mixed.     ;
142        * In Proc. 23rd SAS Users Group Intl., SAS Institute, Cary, NC, pp1243-1246.;
143        %include 'C:\Geaghan\Current\EXST3201\Fall2005\SAS\pdmix800.sas';
816        %pdmix800(ppp,mmm,alpha=.05,sort=yes);
PDMIX800 08.08.2003 processing
```

```
3.3684192583
Tukey-Kramer  values for status  are 1.47423  (avg) 1.42673  (min) 1.55702  (max).
2.8083481215
Tukey-Kramer  values for sector  are 0.99612  (avg) 0.99612  (min) 0.99612  (max).
817        RUN; QUIT;
```

Logistic Regression - NKNW Example 14.3
Logistic regression on Disease data using PROC GLIMMIX

The GLIMMIX Procedure

Model Information

Data Set	WORK.DISEASE
Response Variable	Disease
Response Distribution	Binary
Link Function	Logit
Variance Function	Default
Variance Matrix	Diagonal
Estimation Technique	Maximum Likelihood
Degrees of Freedom Method	Residual

Class Level Information

Class	Levels	Values
status	3	Lower Middle Upper
sector	2	0 1

Number of Observations Read	98
Number of Observations Used	98

Response Profile

Ordered Value	Disease	Total Frequency
1	0	67
2	1	31

The GLIMMIX procedure is modeling the probability that Disease='0'.

Dimensions

Columns in X	7
Columns in Z	0
Subjects (Blocks in V)	1
Max Obs per Subject	98

Optimization Information

Optimization Technique	Newton-Raphson
Parameters in Optimization	5
Lower Boundaries	0
Upper Boundaries	0
Fixed Effects	Not Profiled

Iteration History

Iteration	Restarts	Evaluations	Objective Function	Change	Max Gradient
0	0	4	50.591520622	.	0.618601
1	0	2	50.527208466	0.06431216	0.027632
2	0	2	50.527075143	0.00013332	0.000065
3	0	2	50.527075142	0.00000000	3.63E-10

The “gradient” is derived from the first partial derivatives with respect to the parameters.

Convergence criterion (GCONV=1E-8) satisfied.

```
Fit Statistics
-2 Log Likelihood              101.05
AIC  (smaller is better)       111.05
AICC (smaller is better)       111.71
BIC  (smaller is better)       123.98
CAIC (smaller is better)       128.98
HQIC (smaller is better)       116.28
Pearson Chi-Square              92.24
Pearson Chi-Square / DF          0.99
```

Table 17. Information Criteria

Criteria	Formula	Reference
AIC	$-2\ell + 2d$	Akaike (1974)
AICC	$-2\ell + 2dn^*/(n^* - d - 1)$	Hurvich and Tsai (1989) Burnham and Anderson (1998)
HQIC	$-2\ell + 2d \log \log n$	Hannan and Quinn (1979)
BIC	$-2\ell + d \log n$	Schwarz (1978)
CAIC	$-2\ell + d(\log n + 1)$	Bozdogan (1987)

The AIC (Akaike's information criteria (Akaike 1974)), AICC (small sample bias corrected version of AIC), BIC (Bayesian inference criterion), CAIC (consistent Akaike's information criterion), and HQIC (Hannan Quinn information criteria) fit statistics reported by the GLIMMIX procedure. Calculations above are from SAS where, ℓ denotes the log likelihood (which may be restricted and a pseudo or quasi likelihood), d is the dimension of the model, and n or n* reflect the size of the data. These values vary for different options, methods and restrictions.

```
Parameter Estimates
                                                Standard
Effect       status    sector     Estimate       Error       DF     t Value     Pr > |t|     Gradient
Intercept                           0.7382      0.5814       93        1.27       0.2074     -363E-12
Age                               -0.02975     0.01350       93       -2.20       0.0300     -2.53E-9
status       Lower                  0.3053      0.6041       93        0.51       0.6146      -37E-11
status       Middle                -0.4088      0.5990       93       -0.68       0.4967     7.05E-12
status       Upper                       0           .        .           .            .            .
sector                 0            1.5747      0.5016       93        3.14       0.0023     -373E-12
sector                 1                 0           .        .           .            .            .
```

The "gradient" is derived from the first partial derivatives with respect to the parameters and should be VERY small numbers if the estimates are good.

```
Type III Tests of Fixed Effects
              Num      Den
Effect         DF       DF    F Value    Pr > F
Age             1       93       4.85    0.0300
status          2       93       0.60    0.5493
sector          1       93       9.86    0.0023

Estimates
                             Standard
Label         Estimate          Error       DF     t Value     Pr > |t|
1               0.3053         0.6041       93        0.51       0.6146
2              -0.4088         0.5990       93       -0.68       0.4967
3               0.7140         0.6537       93        1.09       0.2775
linear         -0.3053         0.6041       93       -0.51       0.6146
quadratic      -1.1228         1.0988       93       -1.02       0.3095

                               status Least Squares Means
                       Standard
status     Estimate       Error       DF     t Value     Pr > |t|      Alpha        Lower        Upper
Lower        1.0810      0.4594       93        2.35       0.0207       0.05       0.1687       1.9933
Middle       0.3669      0.4598       93        0.80       0.4268       0.05      -0.5461       1.2800
Upper        0.7757      0.3859       93        2.01       0.0473       0.05     0.009513       1.5420

                               sector Least Squares Means
                       Standard
sector     Estimate       Error       DF     t Value     Pr > |t|      Alpha        Lower        Upper
0            1.5286      0.3596       93        4.25       <.0001       0.05       0.8145       2.2427
1          -0.04615      0.3487       93       -0.13       0.8950       0.05      -0.7386       0.6463
```

The "ilink" option was not included on this LSMeans statement.

```
172          ods output diffs=ppp lsmeans=mmm;
173          ods listing exclude diffs;* lsmeans; *this is now just a comment;
174        run;
```

```
NOTE: The GLIMMIX procedure is modeling the probability that Disease='0'.
NOTE: Convergence criterion (GCONV=1E-8) satisfied.
NOTE: Graphs of LS-mean control differences are only produced for LSMEANS statements with compatible
difference types.
NOTE: Analysis of mean graphs are only produced for LSMEANS statements with compatible difference types.
WARNING: Statistical graphics displays created with ODS are experimental in this release.
NOTE: The data set WORK.MMM has 5 observations and 11 variables.
NOTE: The data set WORK.PPP has 4 observations and 17 variables.
NOTE: The data set WORK.NEXT1 has 98 observations and 12 variables.
NOTE: The PROCEDURE GLIMMIX printed pages 7-9.
NOTE: PROCEDURE GLIMMIX used (Total process time):
      real time           6.69 seconds
      cpu time            4.63 seconds
175         TITLE3 'Post hoc adjustment with macro by Arnold Saxton';
176         * SAS Macro by Arnold Saxton: Saxton, A.M. 1998.  A macro for              ;
177         * converting mean separation output to letter groupings in Proc Mixed.     ;
178         * In Proc. 23rd SAS Users Group Intl., SAS Institute, Cary, NC, pp1243-1246.;
179         %include 'C:\Geaghan\Current\EXST3201\Fall2005\SAS\pdmix800.sas';
852         %pdmix800(ppp,mmm,alpha=.05,sort=yes);
PDMIX800 08.08.2003 processing  3.3684192583
Tukey-Kramer  values for status  are 1.47423  (avg) 1.42673  (min) 1.55702  (max).
2.8083481215
Tukey-Kramer  values for sector  are 0.99612  (avg) 0.99612  (min) 0.99612  (max).
853         RUN;
854         QUIT;
```

Logistic Regression - NKNW Example 14.3
Logistic regression on Disease data using PROC GLIMMIX
Post hoc adjustment with macro by Arnold Saxton

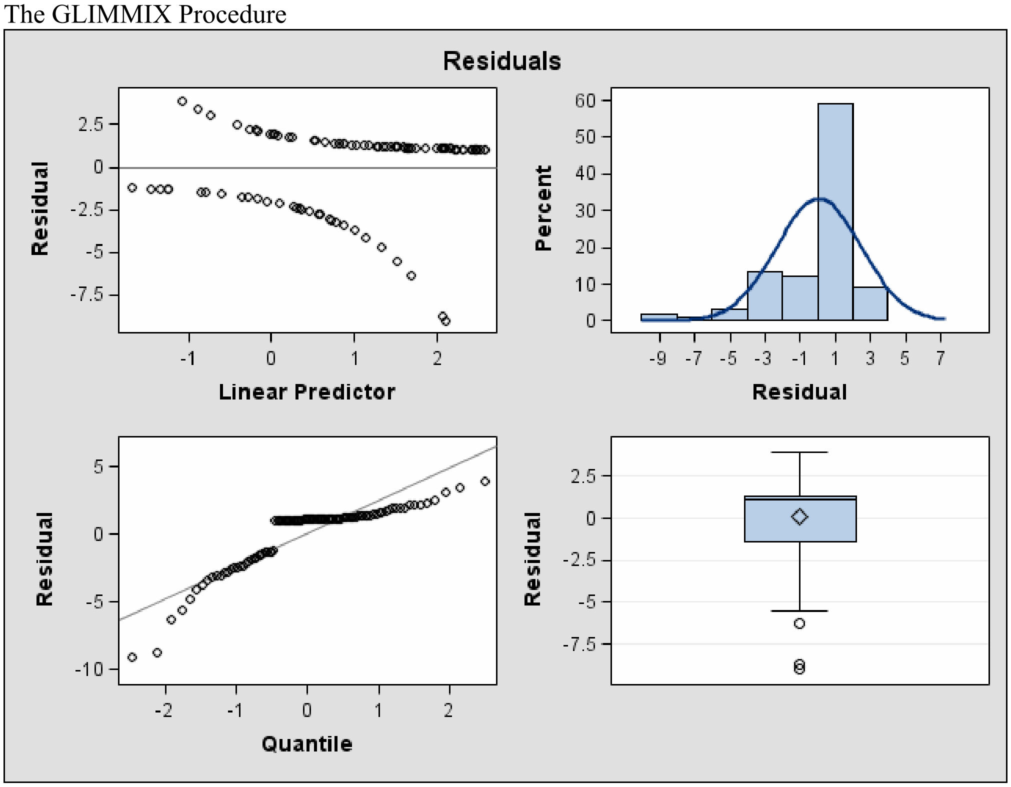
Effect=status ADJUSTMENT=Tukey-Kramer(P<.05) bygroup=1

Obs	status	sector	Estimate	StdErr	Alpha	Lower	Upper	MSGROUP
1	Lower	_	1.0810	0.4594	0.05	0.1687	1.9933	A
2	Upper	_	0.7757	0.3859	0.05	0.009513	1.5420	A
3	Middle	_	0.3669	0.4598	0.05	-0.5461	1.2800	A

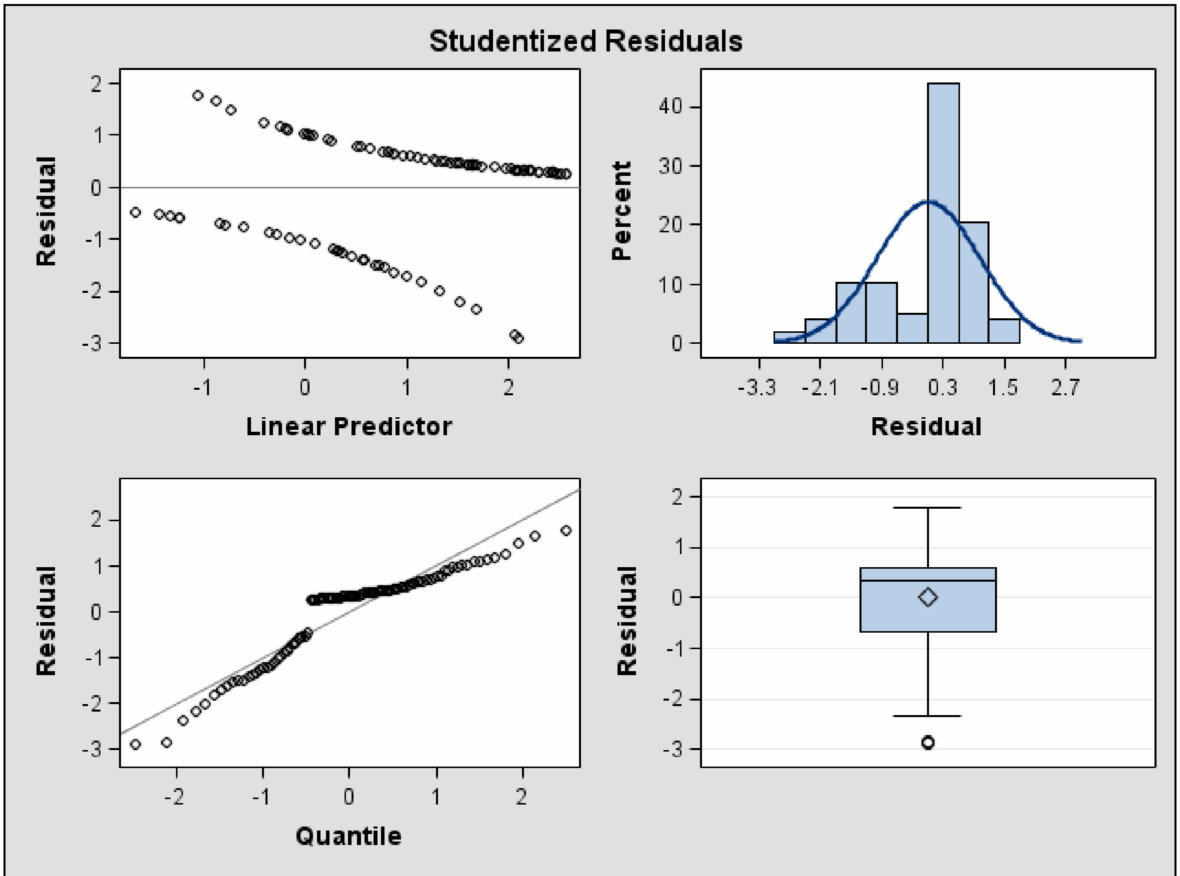
Effect=sector ADJUSTMENT=Tukey-Kramer(P<.05) bygroup=2

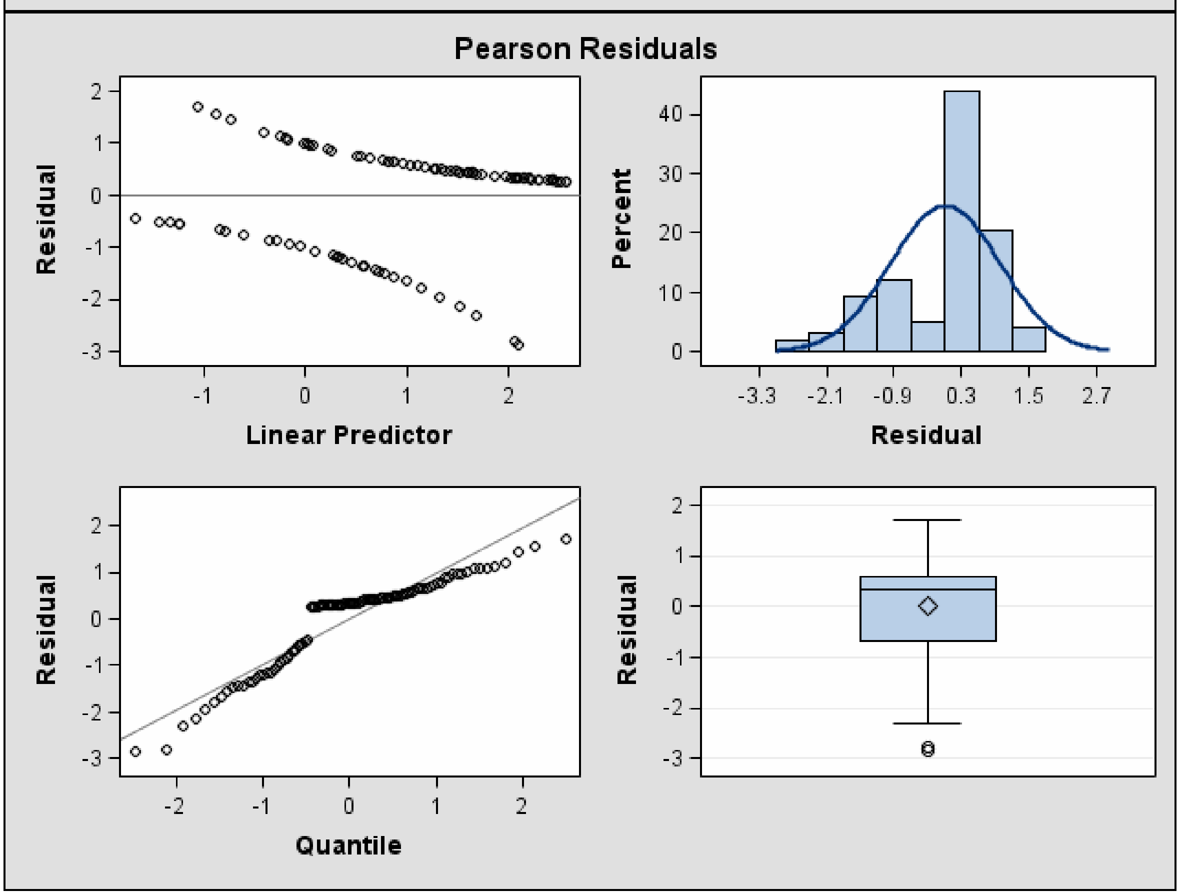
Obs	status	sector	Estimate	StdErr	Alpha	Lower	Upper	MSGROUP
4		0	1.5286	0.3596	0.05	0.8145	2.2427	A
5		1	-0.04615	0.3487	0.05	-0.7386	0.6463	B

The GLIMMIX Procedure



The GLIMMIX Procedure





```
      data MMM; set mmm;
         ODDS = exp(estimate);   Prob = odds/(1+odds);
         LODDS = exp(Lower);  Lcl=lodds/(1+lodds);
         UODDS = exp(Upper);  Ucl=uodds/(1+uodds);
      run;
NOTE: There were 5 observations read from the data set WORK.MMM.
NOTE: The data set WORK.MMM has 5 observations and 17 variables.
NOTE: DATA statement used (Total process time):
      real time           0.01 seconds
      cpu time            0.02 seconds

      proc print data=mmm;
         title3 "Back transformed predictions from LSMeans";
         var sector estimate Lodds Odds Uodds LCL Prob Ucl;
      run;
NOTE: There were 5 observations read from the data set WORK.MMM.
NOTE: The PROCEDURE PRINT printed page 3.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.22 seconds
      cpu time            0.09 seconds
```

Logistic Regression - NKNW Example 14.3
Logistic regression on Disease data using PROC GLIMMIX
Back transformed predictions from LSMeans

Obs	sector	Estimate	LODDS	ODDS	UODDS	Lcl	Prob	Ucl
1	_	1.0810	1.18375	2.94760	7.33966	0.54207	0.74668	0.88009
2	_	0.3669	0.57922	1.44332	3.59649	0.36678	0.59072	0.78244
3	_	0.7757	1.00956	2.17219	4.67374	0.50238	0.68476	0.82375
4	0	1.5286	2.25809	4.61171	9.41853	0.69307	0.82180	0.90402
5	1	-0.04615	0.47779	0.95490	1.90844	0.32331	0.48846	0.65617

```
NOTE: Version 1.0 of the GLIMMIX procedure is experimental.
      proc glimmix data=Disease plots=(all);
         class status sector;
         TITLE2 'Logistic regression on Disease data using PROC GLIMMIX';
         model Disease = Age Status / dist = binary solution;
         random  SECTOR;
         lsmeans Status / pdiff adjust = tukey cl ilink;
         output out=next1 resid=resid pred(noblup noilink)=predM pred(blup noilink)=pred
                lcl(noblup noilink)=lowerM ucl(noblup noilink)=upperM
                pred(noblup ilink)=PROBM pred(blup ilink)=PROB
                lcl(noblup ilink)=LPROBM ucl(noblup ilink)=UPROBM;
        ods output diffs=ppp lsmeans=mmm;
        ods listing exclude diffs;* lsmeans; *this is now just a comment;
      run;
NOTE: The GLIMMIX procedure is modeling the probability that Disease='0'.
NOTE: Convergence criterion (PCONV=1.11022E-8) satisfied.
NOTE: Graphs of LS-mean control differences are only produced for LSMEANS statements with
compatible difference types.
NOTE: Analysis of mean graphs are only produced for LSMEANS statements with compatible
difference types.
WARNING: Statistical graphics displays created with ODS are experimental in this release.
NOTE: The data set WORK.MMM has 3 observations and 14 variables.
NOTE: The data set WORK.PPP has 3 observations and 15 variables.
NOTE: The data set WORK.NEXT1 has 98 observations and 16 variables.
NOTE: The PROCEDURE GLIMMIX printed page 4.
NOTE: PROCEDURE GLIMMIX used (Total process time):
      real time           3.26 seconds
      cpu time            1.74 seconds
      TITLE3 'Post hoc adjustment with macro by Arnold Saxton';
      * SAS Macro by Arnold Saxton: Saxton, A.M. 1998.  A macro for               ;
      * converting mean separation output to letter groupings in Proc Mixed.      ;
      * In Proc. 23rd SAS Users Group Intl., SAS Institute, Cary, NC, pp1243-1246.;
```

```
846        %include 'C:\Geaghan\Current\EXST3201\Fall2005\SAS\pdmix800.sas';
1519       %pdmix800(ppp,mmm,alpha=.05,sort=yes);
PDMIX800 08.08.2003 processing
3.3684192583
Tukey-Kramer  values for status  are 1.45608  (avg) 1.40809  (min) 1.53919  (max).
1520       RUN; QUIT;


Logistic Regression - NKNW Example 14.3
Logistic regression on Disease data using PROC GLIMMIX

The GLIMMIX Procedure

Model Information
Data Set                     WORK.DISEASE
Response Variable            Disease
Response Distribution        Binary
Link Function                Logit
Variance Function            Default
Variance Matrix              Not blocked
Estimation Technique         Residual PL
Degrees of Freedom Method    Containment

Class Level Information
Class     Levels    Values
status         3    Lower Middle Upper
sector         2    0 1

Number of Observations Read          98
Number of Observations Used          98

Response Profile
 Ordered                        Total
   Value    Disease         Frequency
       1    0                      67
       2    1                      31

The GLIMMIX procedure is modeling the probability that Disease='0'.

Dimensions
G-side Cov. Parameters         1
Columns in X                   5
Columns in Z                   2
Subjects (Blocks in V)         1
Max Obs per Subject           98

Optimization Information
Optimization Technique        Dual Quasi-Newton
Parameters in Optimization    1
Lower Boundaries              1
Upper Boundaries              0
Fixed Effects                 Profiled
Starting From                 Data

Iteration History
                                               Objective                        Max
Iteration    Restarts    Subiterations          Function          Change    Gradient
        0           0                3      451.67374683      0.33580707    0.000012
        1           0                2      457.48050142      0.01058775    8.588E-7
        2           0                1       457.7655054      0.00012044    6.384E-8
        3           0                0      457.76651758      0.00000000    2.822E-7

 Convergence criterion (PCONV=1.11022E-8) satisfied.
```

Fit Statistics

-2 Res Log Pseudo-Likelihood	457.77
Pseudo-AIC (smaller is better)	459.77
Pseudo-AICC (smaller is better)	459.81
Pseudo-BIC (smaller is better)	458.46
Pseudo-CAIC (smaller is better)	459.46
Pseudo-HQIC (smaller is better)	457.03
Pearson Chi-Square	90.82
Pearson Chi-Square / DF	0.97

Covariance Parameter Estimates

Cov Parm	Estimate	Standard Error
sector	1.1142	1.7491

Solutions for Fixed Effects

Effect	status	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept		1.5042	0.9278	1	1.62	0.3519
Age		-0.02958	0.01332	93	-2.22	0.0288
status	Lower	0.3443	0.5966	93	0.58	0.5653
status	Middle	-0.4012	0.5912	93	-0.68	0.4990
status	Upper	0	.	.	.	.

Type III Tests of Fixed Effects

Effect	Num DF	Den DF	F Value	Pr > F
Age	1	93	4.93	0.0288
status	2	93	0.67	0.5153

status Least Squares Means

status	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper	Mean	Standard Error Mean	Lower Mean	Upper Mean
Lower	1.1030	0.8746	93	1.26	0.2104	0.05	-0.6338	2.8398	0.7508	0.1636	0.3466	0.9448
Middle	0.3575	0.8733	93	0.41	0.6832	0.05	-1.3767	2.0917	0.5884	0.2115	0.2015	0.8901
Upper	0.7587	0.8376	93	0.91	0.3673	0.05	-0.9045	2.4220	0.6811	0.1819	0.2881	0.9185

Effect=status ADJUSTMENT=Tukey-Kramer(P<.05) bygroup=1

Obs	status	Estimate	StdErr	Mu	StdErrMu	Alpha	Lower	Upper	LowerMu	UpperMu	MSGROUP
1	Lower	1.1030	0.8746	0.7508	0.1636	0.05	-0.6338	2.8398	0.3466	0.9448	A
2	Upper	0.7587	0.8376	0.6811	0.1819	0.05	-0.9045	2.4220	0.2881	0.9185	A
3	Middle	0.3575	0.8733	0.5884	0.2115	0.05	-1.3767	2.0917	0.2015	0.8901	A

```
1522       proc sort data=next1; by age status sector; run;
NOTE: There were 98 observations read from the data set WORK.NEXT1.
NOTE: The data set WORK.NEXT1 has 98 observations and 16 variables.
NOTE: PROCEDURE SORT used (Total process time):
      real time           0.01 seconds
      cpu time            0.02 seconds
1523       proc print data=next1;
1524          title3 "Raw output statistics";
1525          var case age status sector pred predm LowerM UpperM;
1526       run;
NOTE: There were 98 observations read from the data set WORK.NEXT1.
NOTE: The PROCEDURE PRINT printed page 6.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.27 seconds
      cpu time            0.16 seconds
```

The statistics below were produced by the following output statement. For the purpose of this analysis the the variable "SECTOR" was treated as a random variable. Note the difference between the two predicted values "predM" produced with the NOBLUP option and "pred" done with the BLUP option. A BLUP is the Best Linear Unbiased Predictor.

```
        output out=next1 resid=resid pred(noblup noilink)=predM pred(blup noilink)=pred
               lcl(noblup noilink)=lowerM ucl(noblup noilink)=upperM
               pred(noblup ilink)=PROBM pred(blup ilink)=PROB
               lcl(noblup ilink)=LPROBM ucl(noblup ilink)=UPROBM;
```

Compare a few observations with the same age and status, but which differ for the "random" effect, SECTOR. The NOBLUP option averages across the random effect, the BLUP option gives a separate value adjusted for each level of the random effect. The BLUP might be more desirable for the study of residuals, while the NOBLUP for predicted values and confidence intervals.

```
Logistic Regression - NKNW Example 14.3
Logistic regression on Disease data using PROC GLIMMIX
Back transformed predictions
```

Obs	case	Age	status	sector	resid	pred	predM	lowerM	upperM
1	40	1	Lower	1	1.0511	2.97417	1.81883	-0.04493	3.68260
2	28	2	Lower	0	1.0129	4.35202	1.78926	-0.06506	3.64358
3	63	2	Lower	0	1.0129	4.35202	1.78926	-0.06506	3.64358
4	37	3	Middle	1	1.1191	2.12768	1.01418	-0.80775	2.83611
5	79	3	Upper	0	1.0196	3.93311	1.41543	-0.39382	3.22467
6	92	4	Lower	0	1.0139	4.27497	1.73011	-0.10632	3.56654
7	34	4	Upper	0	1.0204	3.89310	1.38585	-0.41295	3.18466
8	62	5	Lower	0	1.0145	4.23696	1.70053	-0.12746	3.52852
9	7	6	Lower	0	1.0150	4.19929	1.67096	-0.14894	3.49085
10	82	6	Lower	0	1.0150	4.19929	1.67096	-0.14894	3.49085
11	89	6	Lower	0	1.0150	4.19929	1.67096	-0.14894	3.49085
12	**90**	**6**	**Lower**	**0**	**1.0150**	**4.19929**	**1.67096**	**-0.14894**	**3.49085**
13	**38**	**6**	**Lower**	**1**	**1.0619**	**2.78242**	**1.67096**	**-0.14894**	**3.49085**
14	76	6	Middle	0	1.0323	3.43305	0.92546	-0.87370	2.72462
15	**3**	**6**	**Upper**	**0**	**1.0221**	**3.81406**	**1.32670**	**-0.45222**	**3.10563**
16	**19**	**6**	**Upper**	**1**	**-11.9923**	**2.39719**	**1.32670**	**-0.45222**	**3.10563**
17	91	7	Lower	0	1.0156	4.16197	1.64138	-0.17077	3.45354
18	93	8	Lower	0	1.0162	4.12501	1.61181	-0.19296	3.41657
19	87	8	Middle	0	1.0347	3.36052	0.86631	-0.91947	2.65208
20	**86**	**8**	**Upper**	**0**	**1.0238**	**3.73640**	**1.26755**	**-0.49286**	**3.02796**
21	**18**	**8**	**Upper**	**1**	**1.0983**	**2.31953**	**1.26755**	**-0.49286**	**3.02796**
22	32	9	Middle	0	1.0360	3.32481	0.83673	-0.94291	2.61637
23	**94**	**9**	**Middle**	**0**	**1.0360**	**3.32481**	**0.83673**	**-0.94291**	**2.61637**
24	**26**	**9**	**Middle**	**1**	**1.1484**	**1.90793**	**0.83673**	**-0.94291**	**2.61637**
25	14	9	Upper	0	-41.3702	3.69809	1.23798	-0.51370	2.98966
26	75	11	Lower	0	1.0180	4.01628	1.52308	-0.26169	3.30785
27	**97**	**11**	**Lower**	**0**	**1.0180**	**4.01628**	**1.52308**	**-0.26169**	**3.30785**
28	**36**	**11**	**Lower**	**1**	**-14.4558**	**2.59941**	**1.52308**	**-0.26169**	**3.30785**
29	24	11	Middle	1	1.1592	1.83763	0.77758	-0.99090	2.54606
30	46	12	Middle	1	1.1648	1.80304	0.74801	-1.01547	2.51148
31	42	13	Upper	1	-9.4285	2.13162	1.11968	-0.60070	2.84005
32	**88**	**14**	**Lower**	**0**	**1.0200**	**3.91090**	**1.43436**	**-0.33375**	**3.20246**
33	**25**	**14**	**Lower**	**1**	**1.0826**	**2.49403**	**1.43436**	**-0.33375**	**3.20246**
34	53	14	Upper	1	-9.1266	2.09515	1.09010	-0.62338	2.80358
35	20	15	Upper	1	-8.8386	2.05906	1.06053	-0.64644	2.76750
36	31	16	Lower	0	1.0214	3.84254	1.37521	-0.38370	3.13411
37	**64**	**16**	**Lower**	**0**	**1.0214**	**3.84254**	**1.37521**	**-0.38370**	**3.13411**
38	**45**	**16**	**Lower**	**1**	**-12.3098**	**2.42567**	**1.37521**	**-0.38370**	**3.13411**
39	23	16	Upper	1	-8.5637	2.02336	1.03095	-0.66989	2.73180
40	39	17	Middle	1	-6.1342	1.63593	0.60013	-1.14411	2.34437
41	5	18	Lower	0	-44.6296	3.77574	1.31605	-0.43519	3.06730
42	61	18	Lower	0	1.0229	3.77574	1.31605	-0.43519	3.06730
43	**80**	**18**	**Middle**	**0**	**1.0488**	**3.02056**	**0.57056**	**-1.17101**	**2.31212**
44	**27**	**18**	**Middle**	**1**	**1.2012**	**1.60369**	**0.57056**	**-1.17101**	**2.31212**
45	56	18	Upper	1	1.1418	1.95313	0.97180	-0.71797	2.66157
46	96	19	Lower	0	1.0237	3.74292	1.28648	-0.46153	3.03449
47	**30**	**20**	**Lower**	**0**	**1.0245**	**3.71050**	**1.25690**	**-0.48826**	**3.00206**
48	**47**	**20**	**Lower**	**1**	**-10.9108**	**2.29363**	**1.25690**	**-0.48826**	**3.00206**
49	78	20	Middle	0	-20.2453	2.95727	0.51140	-1.22602	2.24883

50	21	21	Middle	1	-5.5238	1.50935	0.48183	-1.25413	2.21779
51	66	22	Lower	0	1.0261	3.64685	1.19775	-0.54291	2.93842
52	16	22	Upper	1	-7.1564	1.81749	0.85350	-0.81892	2.52592
53	11	23	Upper	0	1.0407	3.20147	0.82392	-0.84518	2.49303
54	12	23	Upper	0	1.0407	3.20147	0.82392	-0.84518	2.49303
55	**67**	**24**	**Upper**	**0**	**1.0420**	**3.16899**	**0.79435**	**-0.87185**	**2.46055**
56	**43**	**24**	**Upper**	**1**	**1.1734**	**1.75212**	**0.79435**	**-0.87185**	**2.46055**
57	81	25	Middle	0	1.0604	2.80607	0.36353	-1.37058	2.09764
58	6	26	Lower	0	1.0295	3.52436	1.07945	-0.65702	2.81592
59	9	26	Middle	0	-17.0714	2.77704	0.33395	-1.40070	2.06861
60	13	27	Upper	0	1.0462	3.07405	0.70562	-0.95437	2.36562
61	71	27	Upper	0	1.0462	3.07405	0.70562	-0.95437	2.36562
62	**72**	**27**	**Upper**	**0**	**-22.6294**	**3.07405**	**0.70562**	**-0.95437**	**2.36562**
63	**54**	**27**	**Upper**	**1**	**-6.2445**	**1.65718**	**0.70562**	**-0.95437**	**2.36562**
64	70	28	Upper	0	1.0477	3.04324	0.67605	-0.98271	2.33481
65	73	28	Upper	0	1.0477	3.04324	0.67605	-0.98271	2.33481
66	68	30	Upper	0	1.0506	2.98289	0.61690	-1.04066	2.27446
67	8	31	Middle	0	-14.9841	2.63792	0.18608	-1.55733	1.92949
68	55	31	Upper	1	1.2151	1.53648	0.58732	-1.07027	2.24492
69	59	31	Upper	1	1.2151	1.53648	0.58732	-1.07027	2.24492
70	95	32	Lower	0	-29.5794	3.35269	0.90200	-0.84025	2.64425
71	22	32	Middle	1	-4.3017	1.19442	0.15650	-1.58985	1.90286
72	1	33	Upper	0	1.0553	2.89553	0.52817	-1.13075	2.18710
73	98	35	Lower	0	1.0379	3.27225	0.81328	-0.93726	2.56381
74	33	35	Middle	0	1.0794	2.53377	0.06778	-1.68978	1.82533
75	2	35	Upper	0	1.0585	2.83940	0.46902	-1.19292	2.13096
76	10	37	Middle	0	1.0834	2.48403	0.00863	-1.75834	1.77559
77	15	37	Upper	1	-4.9277	1.36806	0.40987	-1.25676	2.07650
78	50	38	Middle	1	-3.8373	1.04286	-0.02095	-1.79319	1.75129
79	85	39	Middle	0	1.0875	2.43581	-0.05052	-1.82842	1.72738
80	57	39	Upper	1	1.2684	1.31526	0.35072	-1.32225	2.02370
81	49	40	Middle	1	-3.7058	0.99539	-0.08010	-1.86403	1.70383
82	35	44	Lower	1	1.1950	1.63497	0.54710	-1.24921	2.34341
83	77	46	Lower	0	1.0494	3.00696	0.48795	-1.32263	2.29853
84	69	46	Upper	0	1.0773	2.56009	0.14369	-1.56426	1.85165
85	58	50	Upper	1	1.3487	1.05347	0.02539	-1.71112	1.76190
86	84	51	Lower	0	1.0550	2.90090	0.34007	-1.51232	2.19246
87	74	52	Upper	0	-12.3326	2.42769	-0.03376	-1.78677	1.71925
88	41	53	Middle	1	-3.0574	0.72143	-0.46458	-2.35902	1.42986
89	65	59	Lower	0	-16.6141	2.74817	0.10347	-1.83279	2.03974
90	4	60	Upper	0	1.1032	2.27091	-0.27036	-2.10319	1.56248
91	29	61	Lower	0	1.0663	2.71300	0.04432	-1.91592	2.00456
92	60	61	Upper	1	1.4335	0.83591	-0.29993	-2.14421	1.54434
93	**83**	**65**	**Lower**	**0**	**-15.0972**	**2.64598**	**-0.07398**	**-2.08550**	**1.93754**
94	**48**	**65**	**Lower**	**1**	**1.2926**	**1.22910**	**-0.07398**	**-2.08550**	**1.93754**
95	17	67	Upper	1	-3.0820	0.73334	-0.47739	-2.39655	1.44178
96	51	68	Middle	1	-2.5991	0.46943	-0.90821	-2.99428	1.17787
97	44	70	Upper	1	-2.9854	0.68581	-0.56611	-2.52647	1.39424
98	52	74	Upper	1	-2.8701	0.62597	-0.68441	-2.70323	1.33441

The statistics below were produced sorted with a "nodupkey" option, so there should no longer be repetitions of the sort variables. This dataset would not contain all of the residuals, but contains one occurrence of each predicted value (averaged over the random effect). The values were output with the following statement.

```
output out=next1 resid=resid pred(noblup noilink)=predM pred(blup noilink)=pred
       lcl(noblup noilink)=lowerM ucl(noblup noilink)=upperM
       pred(noblup ilink)=PROBM pred(blup ilink)=PROB
       lcl(noblup ilink)=LPROBM ucl(noblup ilink)=UPROBM;
```

Compare the values back transformed by hand (CalcLcl, Calcprob, CalcUcl) with the ones output with the ILINK option (probM, lprobm, uprobm). Note that the value of "pred" would differ for different levels of the random variable, but repetitions have been deleted.

```
1528       proc sort data=next1 nodupkey; by age status; run;
NOTE: There were 98 observations read from the data set WORK.NEXT1.
NOTE: 25 observations with duplicate key values were deleted.
NOTE: The data set WORK.NEXT1 has 73 observations and 16 variables.
NOTE: PROCEDURE SORT used (Total process time):
      real time           0.02 seconds
      cpu time            0.02 seconds
1529       data next1; set next1;
1530          ODDS = exp(predm);   Calcprob = odds/(1+odds);
1531          LODDS = exp(lowerm); Calclcl=lodds/(1+lodds);
1532          UODDS = exp(upperm); CalcUcl=uodds/(1+uodds);
1533       run;
NOTE: There were 73 observations read from the data set WORK.NEXT1.
NOTE: The data set WORK.NEXT1 has 73 observations and 22 variables.
NOTE: DATA statement used (Total process time):
      real time           0.02 seconds
      cpu time            0.03 seconds
1534       proc print data=next1;
1535          title3 "Back transformed predictions";
1536          var case age status sector prob LPROBM probM UPROBM CalcLcl Calcprob CalcUcl;
1537       run;
NOTE: There were 73 observations read from the data set WORK.NEXT1.
NOTE: The PROCEDURE PRINT printed page 7.
NOTE: PROCEDURE PRINT used (Total process time):
      real time           0.32 seconds
      cpu time            0.22 seconds
1538
1539       ods graphics off;
1540       ods html close;
```

Obs	case	Age	status	sector	PROB	LPROBM	PROBM	UPROBM	Calclcl	Calcprob	CalcUcl
1	40	1	Lower	1	0.95139	0.48877	0.86043	0.97546	0.48877	0.86043	0.97546
2	28	2	Lower	0	0.98728	0.48374	0.85684	0.97451	0.48374	0.85684	0.97451
3	37	3	Middle	1	0.89356	0.30837	0.73384	0.94460	0.30837	0.73384	0.94460
4	79	3	Upper	0	0.98079	0.40280	0.80462	0.96175	0.40280	0.80462	0.96175
5	92	4	Lower	0	0.98628	0.47344	0.84943	0.97252	0.47344	0.84943	0.97252
6	34	4	Upper	0	0.98002	0.39820	0.79993	0.96025	0.39820	0.79993	0.96025
7	62	5	Lower	0	0.98575	0.46818	0.84560	0.97149	0.46818	0.84560	0.97149
8	7	6	Lower	0	0.98522	0.46283	0.84170	0.97043	0.46283	0.84170	0.97043
9	76	6	Middle	0	0.96872	0.29448	0.71615	0.93846	0.29448	0.71615	0.93846
10	3	6	Upper	0	0.97842	0.38883	0.79029	0.95712	0.38883	0.79029	0.95712
11	91	7	Lower	0	0.98466	0.45741	0.83772	0.96934	0.45741	0.83772	0.96934
12	93	8	Lower	0	0.98409	0.45191	0.83366	0.96822	0.45191	0.83366	0.96822
13	87	8	Middle	0	0.96645	0.28507	0.70398	0.93414	0.28507	0.70398	0.93414
14	18	8	Upper	1	0.91048	0.37922	0.78032	0.95382	0.37922	0.78032	0.95382
15	26	9	Middle	1	0.87079	0.28031	0.69778	0.93191	0.28031	0.69778	0.93191
16	14	9	Upper	0	0.97583	0.37433	0.77521	0.95210	0.37433	0.77521	0.95210
17	36	11	Lower	1	0.93082	0.43495	0.82099	0.96470	0.43495	0.82099	0.96470
18	24	11	Middle	1	0.86267	0.27073	0.68516	0.92731	0.27073	0.68516	0.92731
19	46	12	Middle	1	0.85852	0.26591	0.67874	0.92494	0.26591	0.67874	0.92494
20	42	13	Upper	1	0.89394	0.35418	0.75393	0.94480	0.35418	0.75393	0.94480
21	25	14	Lower	1	0.92372	0.41733	0.80758	0.96093	0.41733	0.80758	0.96093
22	53	14	Upper	1	0.89043	0.34901	0.74840	0.94287	0.34901	0.74840	0.94287

23	20	15	Upper	1	0.88686	0.34379	0.74279	0.94089	0.34379	0.74279	0.94089
24	31	16	Lower	0	0.97901	0.40524	0.79822	0.95828	0.40524	0.79822	0.95828
25	23	16	Upper	1	0.88323	0.33852	0.73710	0.93888	0.33852	0.73710	0.93888
26	39	17	Middle	1	0.83698	0.24157	0.64569	0.91249	0.24157	0.64569	0.91249
27	5	18	Lower	0	0.97759	0.39289	0.78852	0.95552	0.39289	0.78852	0.95552
28	27	18	Middle	1	0.83253	0.23667	0.63889	0.90988	0.23667	0.63889	0.90988
29	56	18	Upper	1	0.87579	0.32784	0.72548	0.93472	0.32784	0.72548	0.93472
30	96	19	Lower	0	0.97686	0.38662	0.78355	0.95411	0.38662	0.78355	0.95411
31	30	20	Lower	0	0.97612	0.38030	0.77849	0.95267	0.38030	0.77849	0.95267
32	78	20	Middle	0	0.95061	0.22688	0.62514	0.90455	0.22688	0.62514	0.90455
33	21	21	Middle	1	0.81897	0.22199	0.61818	0.90184	0.22199	0.61818	0.90184
34	66	22	Lower	0	0.97459	0.36751	0.76813	0.94971	0.36751	0.76813	0.94971
35	16	22	Upper	1	0.86026	0.30599	0.70130	0.92594	0.30599	0.70130	0.92594
36	11	23	Upper	0	0.96089	0.30044	0.69507	0.92365	0.30044	0.69507	0.92365
37	43	24	Upper	1	0.85222	0.29487	0.68876	0.92133	0.29487	0.68876	0.92133
38	81	25	Middle	0	0.94300	0.20253	0.58989	0.89067	0.20253	0.58989	0.89067
39	6	26	Lower	0	0.97137	0.34141	0.74639	0.94353	0.34141	0.74639	0.94353
40	9	26	Middle	0	0.94142	0.19770	0.58272	0.88781	0.19770	0.58272	0.88781
41	13	27	Upper	0	0.95581	0.27801	0.66943	0.91417	0.27801	0.66943	0.91417
42	70	28	Upper	0	0.95449	0.27235	0.66286	0.91172	0.27235	0.66286	0.91172
43	68	30	Upper	0	0.95180	0.26102	0.64951	0.90674	0.26102	0.64951	0.90674
44	8	31	Middle	0	0.93326	0.17403	0.54639	0.87319	0.17403	0.54639	0.87319
45	55	31	Upper	1	0.82295	0.25535	0.64275	0.90421	0.25535	0.64275	0.90421
46	95	32	Lower	0	0.96619	0.30148	0.71136	0.93366	0.30148	0.71136	0.93366
47	22	32	Middle	1	0.76753	0.16940	0.53905	0.87021	0.16940	0.53905	0.87021
48	1	33	Upper	0	0.94763	0.24402	0.62906	0.89908	0.24402	0.62906	0.89908
49	98	35	Lower	0	0.96346	0.28145	0.69281	0.92850	0.28145	0.69281	0.92850
50	33	35	Middle	0	0.92648	0.15580	0.51694	0.86120	0.15580	0.51694	0.86120
51	2	35	Upper	0	0.94477	0.23274	0.61515	0.89388	0.23274	0.61515	0.89388
52	10	37	Middle	0	0.92301	0.14700	0.50216	0.85515	0.14700	0.50216	0.85515
53	15	37	Upper	1	0.79707	0.22153	0.60106	0.88860	0.22153	0.60106	0.88860
54	50	38	Middle	1	0.73940	0.14268	0.49476	0.85212	0.14268	0.49476	0.85212
55	85	39	Middle	0	0.91952	0.13843	0.48737	0.84908	0.13843	0.48737	0.84908
56	57	39	Upper	1	0.78839	0.21044	0.58679	0.88326	0.21044	0.58679	0.88326
57	49	40	Middle	1	0.73015	0.13423	0.47999	0.84603	0.13423	0.47999	0.84603
58	35	44	Lower	1	0.83685	0.22284	0.63346	0.91241	0.22284	0.63346	0.91241
59	77	46	Lower	0	0.95289	0.21038	0.61962	0.90876	0.21038	0.61962	0.90876
60	69	46	Upper	0	0.92825	0.17304	0.53586	0.86432	0.17304	0.53586	0.86432
61	58	50	Upper	1	0.74144	0.15302	0.50635	0.85345	0.15302	0.50635	0.85345
62	84	51	Lower	0	0.94789	0.18060	0.58421	0.89957	0.18060	0.58421	0.89957
63	74	52	Upper	0	0.91891	0.14347	0.49156	0.84803	0.14347	0.49156	0.84803
64	41	53	Middle	1	0.67292	0.08635	0.38590	0.80688	0.08635	0.38590	0.80688
65	65	59	Lower	0	0.93981	0.13791	0.52584	0.88491	0.13791	0.52584	0.88491
66	4	60	Upper	0	0.90644	0.10879	0.43282	0.82671	0.10879	0.43282	0.82671
67	29	61	Lower	0	0.93779	0.12832	0.51108	0.88128	0.12832	0.51108	0.88128
68	60	61	Upper	1	0.69760	0.10487	0.42557	0.82410	0.10487	0.42557	0.82410
69	48	65	Lower	1	0.77366	0.11051	0.48151	0.87408	0.11051	0.48151	0.87408
70	17	67	Upper	1	0.67554	0.08344	0.38287	0.80873	0.08344	0.38287	0.80873
71	51	68	Middle	1	0.61525	0.04768	0.28737	0.76456	0.04768	0.28737	0.76456
72	44	70	Upper	1	0.66503	0.07402	0.36213	0.80127	0.07402	0.36213	0.80127
73	52	74	Upper	1	0.65158	0.06278	0.33528	0.79157	0.06278	0.33528	0.79157