Multinomial Logistic Regression using SAS and PROC CATMOD[1]

Multinomial Logistic Regression can be used with a categorical dependent variable that has more than two categories. Multinomial Logistic Regression can be done with SAS using PROC CATMOD. For this example, the dependent variable marcat is marital status. The syntax for proc catmod is as follows.

```
PROC CATMOD ;
weight adjwt ;                    * This procedure DOES NOT normalize weights.  If using a
                                  weight, be sure to adjust so the mean of weights is 1.  See:
                                  http://staff.washington.edu/glynn/adjustsa.pdf
DIRECT black age anychild ;       * To make results more easily interpretable, include all
                                  independent variables in the DIRECT statement (dummy coded
                                  and continuous variables) ;
MODEL marcat = black age anychild / ML NOITER NODESIGN NOPROFILE NOGLS;
   * ML asks for Maximum Likelihood estimates.  The options that begin with "NO" ask SAS
   to refrain from showing you some output that it would show you by default.
```

The dependent variable marcat is marital status. This example uses 1990 IPUMS data. All black and white women aged 25 to 45 were included in the sample. The independent variables are:

1) Black   Black women are coded 1, and white women are coded 0.
2) Age   Woman's age
3) Anychild   Coded 1 if the woman has an "own" child living in her household with her.

The weighted means of all of the variables are:

Variable	N	Mean	Std Dev	Minimum	Maximum
marcat	399307	3.2822040	1.1245330	1.0000000	4.0000000
black	399307	0.1293563	0.3355943	0	1.0000000
AGE	399307	34.5148307	5.8836194	25.0000000	45.0000000
anychild	399307	0.6661534	0.4715863	0	1.0000000

The weighted frequencies for the dependent variable are:

marcat	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1 never married	69252.05	17.34	69252.05	17.34
2 widowed	4277.163	1.07	73529.21	18.41
3 div, sep	70310.48	17.61	143839.7	36.02
4 Married, spouse present	255467.3	63.98	399307	100.00

By default, PROC CATMOD uses the highest numbered category as the comparison group. It is possible to make the comparison group the lowest category by sorting the data in descending order, and then specifying "order = data" on the PROC CATMOD statement. For example:

```
proc sort; by descending marcat ;
PROC CATMOD order = data  ;
```

However, you should remember that sorting can be time, CPU and disk intensive with large data sets. It may be better to create the dependent variable to conform with SAS defaults.

```
                      The CATMOD Procedure
                         Data Summary

     Response           marcat      Response Levels       4
     Weight Variable    ADJWT       Populations          84
     Data Set           XX          Total Frequency  399307
     Frequency Missing  O           Observations     399307


                   Maximum Likelihood Analysis
           Maximum likelihood computations converged.
            Maximum Likelihood Analysis of Variance

          Source              DF    Chi-Square    Pr > ChiSq
          ─────────────────────────────────────────────────
          Intercept            3      20481.74       <.0001
          black                3      25635.56       <.0001
          AGE                  3      15149.88       <.0001
          anychild             3      63473.99       <.0001

          Likelihood Ratio   240       6242.95       <.0001


               Analysis of Maximum Likelihood Estimates

            Function              Standard        Chi-
Parameter   Number    Estimate      Error       Square     Pr > ChiSq
─────────────────────────────────────────────────────────────────────
Intercept     1        2.9108      0.0302      9287.64        <.0001
              2       -7.4275      0.1140      4242.79        <.0001
              3       -1.4108      0.0275      2639.26        <.0001
black         1        2.1762      0.0144     22717.52        <.0001
              2        1.5502      0.0371      1749.19        <.0001
              3        1.3374      0.0125     11531.87        <.0001
AGE           1       -0.0931     0.000912    10428.48        <.0001
              2        0.1024      0.00290     1249.08        <.0001
              3        0.0205     0.000756      732.42        <.0001
anychild      1       -2.9085      0.0118     61029.54        <.0001
              2       -0.8530      0.0336       643.88        <.0001
              3       -1.0820      0.00945    13096.45        <.0001
```

There are three lines of output for each independent variable. Examine the column labeled as "Function Number".

1 = lowest category compared to highest (never married / married spouse present)
2 = 2nd lowest category compared to highest (widowed / married spouse present)
3 = 3nd lowest category compared to highest (sep, divorced / married spouse present)

An example of interpreting results: Women who have any of their own children living with them are less likely to be never-married (-2.9085) , widowed (-0.8530) , or divorced or separated (-1.0820), when controlling for race and age.

The odds ratio - or exponent of the regression coefficient is not presented in the output. It can be calculated with a spreadsheet - for example, using Excel, =exp(-2.9085) = 0.054558

An example of presenting results for multinomial logistic regression follows.

Results of Multinomial Logistic Regression, Marital Status of Black and White Women Age 25-45.

	Never Married	Widowed	Divorced/Separated
Black	2.18***	1.55***	1.34***
	(.01)	(.04)	(.01)
Age	-0.09***	0.10***	0.02***
	(.00)	(.00)	(.00)
Own Child in home	-2.91***	-0.85***	-1.08***
	(.01)	(.03)	(.01)
Intercept	2.91***	-7.43***	-1.41***
	(.03)	(.11)	(.03)
N	69,252	4,277	70,310

Total N = 399,307
Notes: Reference category for the equation is Married with Spouse Present.
         Standard errors in parentheses.
         * p # .05   ** p # .01   *** p # .001 (two-tailed tests).

The program used for these results follows.

```
* mlogit2.sas ;
title1 'mlogit2, use 19902 IPUMS, white and black women age 25 to to 45' ;
options compress = yes linesize = 72 ;
libname t2 'C:\all\help\helpnew\mlogit' ;

proc format ;
 value marcat
  4 = 'Married, spouse present'     3 = 'div, sep'
  2 = 'widowed'                     1 = 'never married' ;

data xx ; set t2.mlogit;
proc means ;
weight adjwt ;
var marcat black age anychild ;
run ;
proc freq ;
tables marcat ;
weight adjwt ;
format marcat marcat. ; run ;
PROC CATMOD ;
weight adjwt ;
DIRECT black age anychild ;
MODEL marcat = black age anychild  / ML NOITER NODESIGN NOPROFILE NOGLS;
format marcat marcat. ;
run ;
```