**5.2.1– SAS: Logistic Regression with Polytomous Response**

Example: Individuals were surveyed regarding how important they viewed AC and power steering in cars. The sex (M or W), age (1=18-23, 2=24-40, 3=40+), and response (1=little importance, 2=important, 3=very important) of each individual was recorded. The count of responses in each sex/age/response combination was summarized. We want to determine whether and how the sex and age of individuals affects their response.

**/\* Define options \*/**

**ods html image\_dpi=300 style=journal;**

**/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Example 1 \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**

**/\* Nominal Logistic Regression \*/**

**/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**

**data car; input sex $ age response count @@; cards;**

**W 1 1 26 W 1 2 12 W 1 3 7 W 2 1 9**

**W 2 2 21 W 2 3 15 W 3 1 5 W 3 2 14**

**W 3 3 41 M 1 1 40 M 1 2 17 M 1 3 8**

**M 2 1 17 M 2 2 15 M 2 3 12 M 3 1 8**

**M 3 2 15 M 3 3 18**

**;**

**/\* Note that this is equivalent to:**

**data car; input sex $ age response; cards;**

**W 1 1**

**W 1 1**

**... (26 times)**

**W 1 1**

**W 1 2**

**W 1 2**

**... (12 times)**

**W 1 2**

**...**

**... (all the other categorical combinations)**

**...**

**M 3 3**

**M 3 3**

**... (18 times)**

**M 3 3**

**;**

**\*/**

**/\* Define dummy variables \*/**

**data car; set car;**

**S = 1;**

**if sex = 'W' then S = 0;**

**A2 = 0;**

**if age = 2 then A2 = 1;**

**A3 = 0;**

**if age = 3 then A3 = 1;**

**run;**

**/\* Run nominal logistic regression \*/**

**/\* I want response=1 to be last so**

**it will be the reference category \*/**

**proc sort data=car; by descending response;**

**proc logistic data=car;**

**freq count;**

**model response(order=data) = S A2 A3 / link=glogit;**

**/\* glogit is generalized logit function,**

**specifies nominal logistic regression \*/**

**title1 'Nominal Logistic Regression';**

**run;**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | | ***Nominal Logistic Regression*** |  | **Response Profile** | | | | --- | --- | --- | | **Ordered Value** | **response** | **Total Frequency** | | **1** | 3 | 101 | | **2** | 2 | 94 | | **3** | 1 | 105 |   Logits modeled use response=1 as the reference category.     | **Model Convergence Status** | | --- | | Convergence criterion (GCONV=1E-8) satisfied. |      | **Testing Global Null Hypothesis: BETA=0** | | | | | --- | --- | --- | --- | | **Test** | **Chi-Square** | **DF** | **Pr > ChiSq** | | **Likelihood Ratio** | 77.8419 | 6 | <.0001 | | **Score** | 74.9761 | 6 | <.0001 | | **Wald** | 62.9703 | 6 | <.0001 |      | **Analysis of Maximum Likelihood Estimates** | | | | | | | | --- | --- | --- | --- | --- | --- | --- | | **Parameter** | **response** | **DF** | **Estimate** | **Standard Error** | **Wald Chi-Square** | **Pr > ChiSq** | | **Intercept** | **3** | 1 | -1.0391 | 0.3305 | 9.8843 | 0.0017 | | **Intercept** | **2** | 1 | -0.5908 | 0.2840 | 4.3286 | 0.0375 | | **S** | **3** | 1 | -0.8129 | 0.3210 | 6.4122 | 0.0113 | | **S** | **2** | 1 | -0.3881 | 0.3005 | 1.6677 | 0.1966 | | **A2** | **3** | 1 | 1.4780 | 0.4009 | 13.5912 | 0.0002 | | **A2** | **2** | 1 | 1.1283 | 0.3416 | 10.9059 | 0.0010 | | **A3** | **3** | 1 | 2.9165 | 0.4229 | 47.5594 | <.0001 | | **A3** | **2** | 1 | 1.5876 | 0.4029 | 15.5270 | <.0001 |      | **Odds Ratio Estimates** | | | | | | --- | --- | --- | --- | --- | | **Effect** | **response** | **Point Estimate** | **95% Wald Confidence Limits** | | | **S** | **3** | 0.444 | 0.236 | 0.832 | | **S** | **2** | 0.678 | 0.376 | 1.223 | | **A2** | **3** | 4.384 | 1.998 | 9.620 | | **A2** | **2** | 3.090 | 1.582 | 6.037 | | **A3** | **3** | 18.477 | 8.066 | 42.327 | | **A3** | **2** | 4.892 | 2.221 | 10.775 | |

**/\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Example 2 \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*/**

**/\* Ordinal Logistic Regression \*/**

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**proc logistic data=car;**

**freq count; /\* defines weights on each row of data \*/**

**model response(order=data) = S A2 A3;**

**/\* no link specified, defaults to logit,**

**which gives proportional odds model for**

**ordinal logistic regression \*/**

**title1 'Ordinal Logistic Regression';**

**run;**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | | ***Ordinal Logistic Regression*** |      | **Response Profile** | | | | --- | --- | --- | | **Ordered Value** | **response** | **Total Frequency** | | **1** | 3 | 101 | | **2** | 2 | 94 | | **3** | 1 | 105 |   Probabilities modeled are cumulated over the lower Ordered Values.     | **Model Convergence Status** | | --- | | Convergence criterion (GCONV=1E-8) satisfied. |      | **Score Test for the Proportional Odds Assumption** | | | | --- | --- | --- | | **Chi-Square** | **DF** | **Pr > ChiSq** | | 0.7139 | 3 | 0.8699 |        | **Testing Global Null Hypothesis: BETA=0** | | | | | --- | --- | --- | --- | | **Test** | **Chi-Square** | **DF** | **Pr > ChiSq** | | **Likelihood Ratio** | 77.2485 | 3 | <.0001 | | **Score** | 70.0452 | 3 | <.0001 | | **Wald** | 68.0278 | 3 | <.0001 |      | **Analysis of Maximum Likelihood Estimates** | | | | | | | | --- | --- | --- | --- | --- | --- | --- | | **Parameter** |  | **DF** | **Estimate** | **Standard Error** | **Wald Chi-Square** | **Pr > ChiSq** | | **Intercept** | **3** | 1 | -1.6546 | 0.2536 | 42.5742 | <.0001 | | **Intercept** | **2** | 1 | -0.0433 | 0.2303 | 0.0354 | 0.8508 | | **S** |  | 1 | -0.5762 | 0.2261 | 6.4936 | 0.0108 | | **A2** |  | 1 | 1.1468 | 0.2773 | 17.1079 | <.0001 | | **A3** |  | 1 | 2.2322 | 0.2904 | 59.0806 | <.0001 |      | **Odds Ratio Estimates** | | | | | --- | --- | --- | --- | | **Effect** | **Point Estimate** | **95% Wald Confidence Limits** | | | **S** | 0.562 | 0.361 | 0.875 | | **A2** | 3.148 | 1.828 | 5.421 | | **A3** | 9.320 | 5.275 | 16.467 | |