PROC LOGISTIC can fit a logistic or probit model to a binary or multinomial response. By default, a binary logistic model is fit to a binary response variable, and an ordinal logistic model is fit to a multinomial response variable. To fit a binary or ordinal probit model in these cases, specify the LINK=PROBIT option in the MODEL statement. To fit a nominal (unordered) logistic model to a nominal multinomial response variable, specify the LINK=GLOGIT option. Another approach is to fit a classification tree model. Beginning in SAS® 9.4 TS1M3, use the HPSPLIT procedure. See the examples in the [HPSPLIT documentation](http://support.sas.com/kb/22930.html).

For a binary response, the CTABLE option in the MODEL statement of PROC LOGISTIC produces actual-by-predicted classification tables for a range of cutoff values applied to the predicted event probabilities for the observations. This option is not available for multinomial responses. For binary or multinomial responses, use the PREDPROBS=INDIVIDUAL option in the OUTPUT statement of PROC LOGISTIC. This option creates a data set with separate variables containing predicted probabilities for the response levels and a variable (\_INTO\_) containing the predicted response category. You can also request bias-adjusted (cross validated) predicted values and predicted response categories for binary-response models by using the PREDPROBS=CROSSVALIDATE option.

With the data set from either OUTPUT statement option, you can use PROC FREQ to create a cross classification table, often called a *confusion matrix*, of the actual and predicted response variables for the data used to fit the model. Similarly, an actual by predicted table can be created for a validation data set by using the SCORE statement which also produces a data set containing predicted probability variables and a variable (I\_*y*, where *y* is the name of your response variable) containing the predicted response category. Note that the validation data set must contain the observed responses in order to produce the table.

**Example 1: For the original data**

The following uses the example titled "Nominal Response Data: Generalized Logits Model" in the [LOGISTIC documentation](http://support.sas.com/kb/22930.html). The nominal multinomial response, Style, has three levels and PROC LOGISTIC is used to fit a nominal logistic model to the data. The PREDPROBS=INDIVIDUAL option saves the predicted probabilities and the predicted response level (\_INTO\_) in the data set PREDS. PROC FREQ displays the confusion matrix by cross classifying the actual and predicted response variables. The cell counts of the matrix are saved in data set CellCounts. The subsequent DATA step adds a variable, Match, which indicates when the actual and predicted response levels agree. The mean of Match, computed by PROC MEANS, is the proportion of observations correctly classified by the nominal logistic model.

proc logistic data=school;

freq Count;

class School Program(ref=first);

model Style(order=data)=School Program / link=glogit;

output out=preds predprobs=individual;

run;

proc freq data=preds;

table Style\*\_INTO\_ / out=CellCounts;

run;

data CellCounts;

set CellCounts;

Match=0;

if Style=\_INTO\_ then Match=1;

run;

proc means data=CellCounts mean;

freq count;

var Match;

run;

The results show that the nominal logistic model did not classify any of the observations into the TEAM response level and that 33% of the observations were correctly classified by the model.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  |  | | --- | --- | --- | --- | --- | | |  | | --- | | **Frequency** | | **Percent** | | **Row Pct** | | **Col Pct** | | | | **Table of STYLE by \_INTO\_** | | | | | --- | --- | --- | --- | | **STYLE** | **\_INTO\_(Formatted Value of the Predicted Response)** | | | | **class** | **self** | **Total** | | **class** | |  | | --- | | 5 | | 27.78 | | 83.33 | | 33.33 | | |  | | --- | | 1 | | 5.56 | | 16.67 | | 33.33 | | |  | | --- | | 6 | | 33.33 | |  | |  | | | **self** | |  | | --- | | 5 | | 27.78 | | 83.33 | | 33.33 | | |  | | --- | | 1 | | 5.56 | | 16.67 | | 33.33 | | |  | | --- | | 6 | | 33.33 | |  | |  | | | **team** | |  | | --- | | 5 | | 27.78 | | 83.33 | | 33.33 | | |  | | --- | | 1 | | 5.56 | | 16.67 | | 33.33 | | |  | | --- | | 6 | | 33.33 | |  | |  | | | **Total** | |  | | --- | | 15 | | 83.33 | | |  | | --- | | 3 | | 16.67 | | |  | | --- | | 18 | | 100.00 | | |   The MEANS Procedure   | **Analysis Variable : match** | | --- | | **Mean** | | 0.3333333 | |

**Example 2: For original and validation data**

The following uses the example titled "Scoring Data Sets" in the [LOGISTIC documentation](http://support.sas.com/kb/22930.html). These statements create a validation data set named NewCrops. It contains five observations from each of the crop types.

data NewCrops;

input Crop $ x1-x4;

datalines;

Clover 48 54 30 30

Clover 66 26 39 58

Clover 55 34 21 66

Clover 17 -2 18 43

Clover 34 26 60 90

Corn 12 27 25 11

Corn 16 24 19 70

Corn 15 21 30 32

Corn 15 25 27 30

Corn 14 23 27 31

Cotton 42 52 58 64

Cotton 30 38 66 32

Cotton 31 43 -8 78

Cotton 37 38 -7 35

Cotton 28 33 11 49

Soybeans 20 16 19 28

Soybeans 15 19 28 11

Soybeans 21 23 23 25

Soybeans 18 21 23 24

Soybeans 16 37 23 18

Sugarbeets 18 29 19 29

Sugarbeets 43 32 29 7

Sugarbeets 21 20 1 47

Sugarbeets 18 43 18 59

Sugarbeets 32 46 27 17

;

In the following statements, the OUTMODEL= option saves the model information to a data set so that it can be used later to score additional data. As in Example 1, the OUTPUT scores the original data and the following steps produce the confusion matrix and the correctly-classified proportion. The SCORE statement uses the fitted model to score the NewCrops data set and saves the result in a data set named NewCropPred.

proc logistic data=Crops outmodel=CropModel;

model Crop=x1-x4 / link=glogit;

output out=preds predprobs=individual;

score data=NewCrops out=NewCropPred;

run;

proc freq data=preds;

table Crop\*\_INTO\_ / out=CellCounts;

run;

data CellCounts;

set CellCounts;

Match=0;

if Crop=\_INTO\_ then Match=1;

run;

proc means data=CellCounts mean;

freq count;

var Match;

run;

The results show that the model correctly classified approximately 53% of the observations in the original data set.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
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Similarly, these statements produce the confusion matrix and correct classification proportion for the validation data set, NewCrops. Note that the variable containing the predicted response from the SCORE statement is I\_Crop rather than \_INTO\_ as produced by the OUTPUT statement.

proc freq data=NewCropPred;

table Crop\*I\_Crop / out=CellCounts;

run;

data CellCounts;

set CellCounts;

Match=0;

if Crop=I\_Crop then Match=1;

run;

proc means data=CellCounts mean;

freq count;

var Match;

run;

The results indicate that the model was able to correctly classify 52% of the observations in the validation data set.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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Should you need to score additional data sets, you can use the saved model information from the OUTMODEL= option. For example, the following statements score a data set named MoreCrops.

proc logistic inmodel=CropModel;

score data=MoreCrops out=MoreCropPred;

run;

**Operating System and Release Information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Product Family | Product | System | SAS Release | |
| Reported | Fixed\* |
| SAS System | SAS/STAT | All | n/a |  |

**\*** For software releases that are not yet generally available, the Fixed Release is the software release in which the problem is planned to be fixed.