Report Writing, SAS/GRAPH® Creation, and Output Verification using SAS/ASSIST®

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Abstract

Since the release of SAS/ASSIST, SAS® has given users more flexibility in the routine generation of SAS output, including graphs. Novice users can now “point-and-click” their way to table and graph generation. In addition, the code generated by the user’s selections is constructed and provided in the SAS Log. If desired, this code can be copied into a program for future submissions. Generating SAS/ASSIST output is also beneficial in verifying table output generated from a SAS program. A user may use a combination of SAS data summarization procedures and a Data _null_ to generate a listing of the summarized data. They can then use SAS/ASSIST to generate a Proc Tabulate of the data and verify that their output is correct.

Introduction

SAS/ASSIST has given SAS users a robust tool to assist them in the daily requirements of their professional positions. Be it an applications programmer for a leading automobile manufacturing company or a single-person data management business, SAS/ASSIST can make the users SAS-life much easier. This paper will touch on a few of the basics of SAS/ASSIST as they pertain to the pharmaceutical industry and STATPROBE, Inc.

STATPROBE, Inc. is a contract research organization whose primary clients are pharmaceutical and medical device companies. SAS is the programming language used to generate the listing and summary tables to support research reports. In addition, SAS is used for graph creation, data management, and statistics. SAS/ASSIST is used to produce output. This output can be used for verification of another program’s output or for the report itself. At STATPROBE, Inc. SAS/ASSIST has been used primarily for output verification and validation. Verification and validation are an extremely important subject when dealing with investigational drug reports. These reports are a part of the foundation for a drug to be available to the general public. Therefore, the data presented must be correct.

Listing Report Writing

STATPROBE, Inc. can provide multiple report formats depending on a client’s request. Some clients request Proc Prints of the data in order for them to validate and verify the data entry that may have been done at STATPROBE, Inc. For the moderate to advanced SAS user, this type of report writing is pretty mundane. For a new user, or a novice SAS user, Proc Print and all of its accompanying options may be a source of brain overflow. SAS/ASSIST provides a interactive interface to produce Proc Print output.

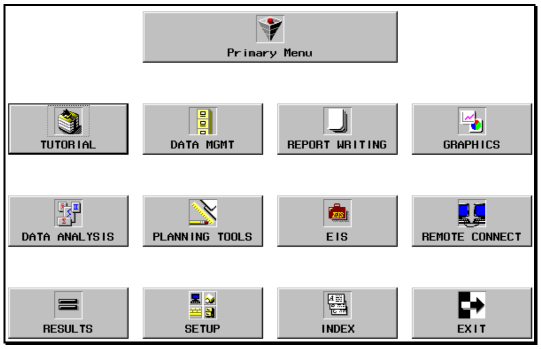


Figure 1. Primary Menu

Figure 1 displays the primary menu of SAS/ASSIST. There are 12 selections a user can make. The selections are the buttons displayed. To produce a Proc Print, the user selects the ‘REPORT WRITING’ button. Once selected, SAS/ASSIST displays the menu shown in Figure 2.

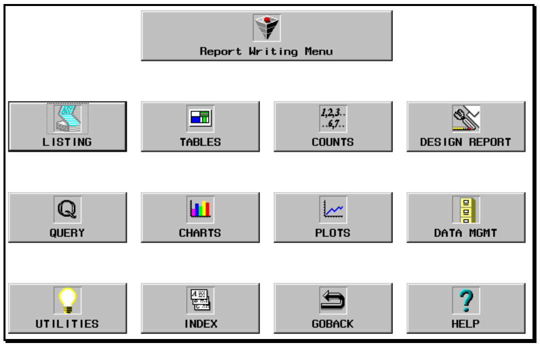
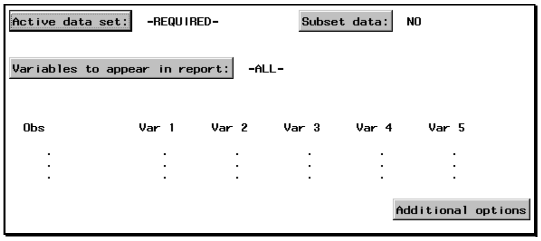


Figure 2. Report Writing Menu

At this point, the user chooses the type of report they would like to produce. For this example, we will concentrate on the 'LISTING' button that produces a Proc Print. Once the user selects the 'LISTING' button, a menu identical to Figure 3 appears.



Active data set: -REQUIRED-

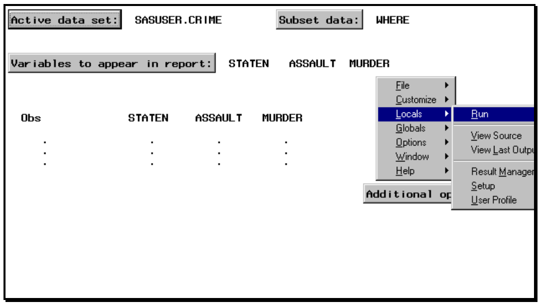
Subset data: NO

Variables to appear in report: -ALL-

Figure 3. Proc Print Selection Screen

The user interactively selects the data set to print, data subset criteria, variables to appear in the report, and additional options. SAS/ASSIST interactively displays a list box of the data sets available if the user clicks on the 'ACTIVE DATA SET' button. Similarly, list boxes and selection boxes appear if the user selects the other buttons on the selection screen.

The user selects the data set SASUSER.CRIME, issues a where clause to subset the data, and defines the variables STATEN, ASSAULT, and MURDER to appear in the Proc Print. To generate the report, the user clicks their right mouse button and selects *Locals->Run* from the pull down menu as seen in Figure 4.



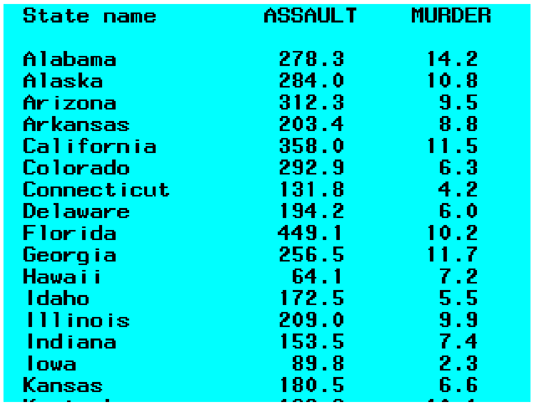
Active data set: SASUSER.CRIME

Subset data: WHERE

Variables to appear in report: STATEN ASSAULT MURDER

Figure 4. Interactive Submission to Generate Listing.

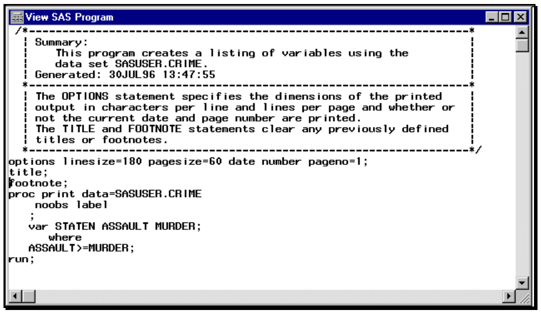
Once the run has been performed, the output seen in Table 1 is generated.



```
State name          ASSAULT    MURDER

Alabama              278.3      14.2
Alaska               284.0      10.8
Arizona              312.3       9.5
Arkansas             203.4       8.8
California           358.0      11.5
Colorado             292.9       6.3
Connecticut          131.8       4.2
Delaware             194.2       6.0
Florida              449.1      10.2
Georgia              256.5      11.7
Hawaii                64.1       7.2
Idaho                172.5       5.5
Illinois             209.0       9.9
Indiana              153.5       7.4
Iowa                  89.8       2.3
Kansas               180.5       6.6
```

Table 1. SAS/ASSIST Listing Output

The 'ADDITIONAL OPTIONS' button seen in Figures 3, 4, and 5 allows users to specify variable/labeling options, data subset options, and general options. By selecting *Locals->View Source* the user gets a display of the SAS code that generated the output based on their specifications (Figure 5).



```
 /*-------------------------------------------------------------*
  | Summary:                                                    |
  |    This program creates a listing of variables using the    |
  |    data set SASUSER.CRIME.                                  |
  | Generated: 30JUL96 13:47:55                                 |
  *-------------------------------------------------------------*
  | The OPTIONS statement specifies the dimensions of the printed |
  | output in characters per line and lines per page and whether or |
  | not the current date and page number are printed.          |
  | The TITLE and FOOTNOTE statements clear any previously defined |
  | titles or footnotes.                                        |
  *-------------------------------------------------------------*/
options linesize=180 pagesize=60 date number pageno=1;
title;
footnote;
proc print data=SASUSER.CRIME
    noobs label
   ;
   var STATEN ASSAULT MURDER;
      where
   ASSAULT>=MURDER;
run;
```

Figure 5. Source Code

The user can cut and paste the source code to the SAS program editor if they wish to do so.

Summary Report Writing

Interactively generating a Proc Tabulate summary table is another report used at STATPROBE, Inc. To define the tabulate table, the user clicks on the 'TABLES' button from the Report Writing Menu (Figure 2). Figure 6 displays the menu that appears once this action is taken.

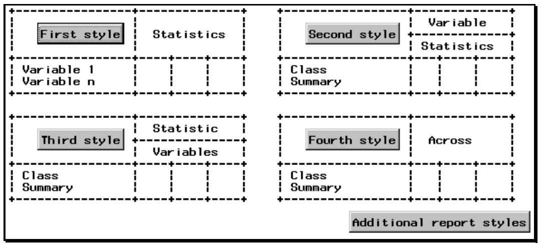
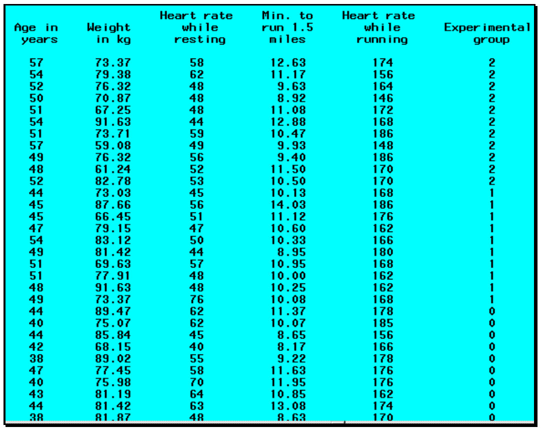


Figure 6. Table Menu

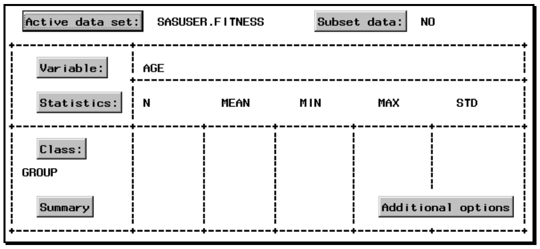
At this point, the user can select from the different summarization table styles. The ‘ADDITIONAL REPORT STYLES’ button displays additional summarization table styles.



Age in years	Weight in kg	Heart rate while resting	Min. to run 1.5 miles	Heart rate while running	Experimental group
57	73.37	58	12.63	174	2
54	79.38	62	11.17	156	2
52	76.32	48	9.63	164	2
50	70.87	48	8.92	146	2
51	67.25	48	11.08	172	2
54	91.63	44	12.88	168	2
51	73.71	59	10.47	186	2
57	59.08	49	9.93	148	2
49	76.32	56	9.40	186	2
48	61.24	52	11.50	170	2
52	82.78	53	10.50	170	2
44	73.03	45	10.13	168	1
45	87.66	56	14.03	186	1
45	66.45	51	11.12	176	1
47	79.15	47	10.60	162	1
54	83.12	50	10.33	166	1
49	81.42	44	8.95	180	1
51	69.63	57	10.95	168	1
51	77.91	48	10.00	162	1
48	91.63	48	10.25	162	1
49	73.37	76	10.08	168	1
44	89.47	62	11.37	178	0
40	75.07	62	10.07	185	0
44	85.84	45	8.65	156	0
42	68.15	40	8.17	166	0
38	89.02	55	9.22	178	0
47	77.45	58	11.63	176	0
40	75.98	70	11.95	176	0
43	81.19	64	10.85	162	0
44	81.42	63	13.08	174	0
38	81.87	48	8.63	170	0

Table 2. Fitness Data Set

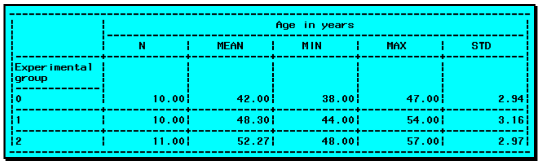
If a user wanted to summarize the ages of the people in the fitness data set (Table 2) over their experimental groups they could use the SAS/ASSIST table button. The report style buttons preview the presentation of the report. The ‘SECOND STYLE’ button has a class variable as its rows, and variables as its columns. Under each of the variables defined by the user, statistics can be selected to be output. The definition of this report is displayed in Figure 7.



Active data set: SASUSER.FITNESS
Subset data: NO
Variable: AGE
Statistics: N MEAN MIN MAX STD
Class: GROUP

Figure 7. Fitness Report Definition

The user has defined SASUSER.FITNESS as the active data set to use, defined GROUP as the class variable to be displayed in the rows, and the variable AGE to be summarized with N, MEAN, MIN, MAX, and STD as the statistics. The resulting output is displayed in Figure 8.



	Age in years				
	N	MEAN	MIN	MAX	STD
Experimental group					
0	10.00	42.00	38.00	47.00	2.94
1	10.00	48.30	44.00	54.00	3.16
2	11.00	52.27	48.00	57.00	2.97

Figure 8. Fitness Report Output

As with the listing, SAS/ASSIST provides the source code that, when run, creates the fitness report output.

SAS/GRAPH Creation

Writing the code to create graphs in SAS can be frustrating unless the SAS programmer has the knowledge of the options available for the different graphing procedures. For the novice user, SAS/ASSIST provides an interactive graph development tool. To access the interactive graph development application, click on the ‘GRAPHICS’ button from the primary menu (Figure 1). SAS/ASSIST then prompts the user to select high or low resolution graphs. After selecting the presentation resolution, the screen in Figure 9 appears.

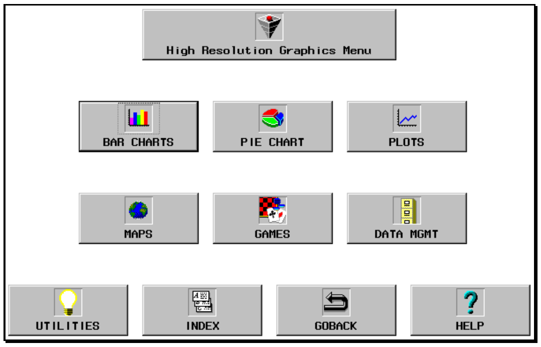


Figure 9. High Resolution Graphic Menu

The graphic menu allows the user to define bar charts, pie charts, plots, and other applications. As with the report writing applications, the user defines the graphing criteria interactively. SAS/ASSIST uses a combination of list boxes and selection lists to give the user flexibility in their definitions.

To produce a bar chart, the user would select the ‘BAR CHARTS’ button in the graphic menu screen. Once the selection has been made, the user is prompted as to whether they would like to define a horizontal bar chart or a vertical bar chart. Provided the user selects horizontal bar chart, the screen in Figure 10 appears.

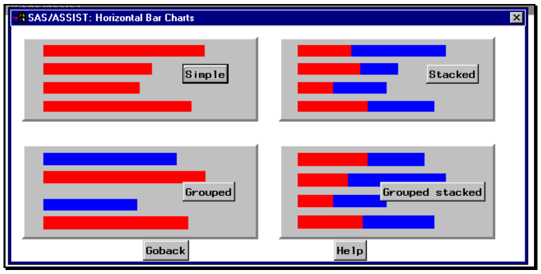
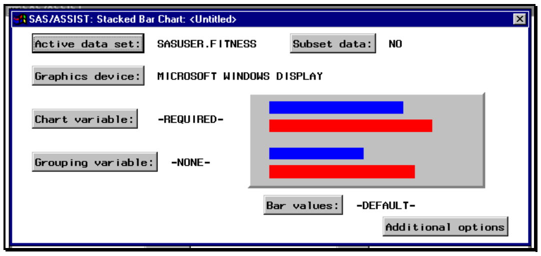


Figure 10. Horizontal Bar Chart Screen

This screen displays the different types of horizontal bar charts that can be presented. The choices are: simple, stacked, grouped, and grouped stacked. With some knowledge of the type of graph the user would like to see, they select the type of graph based on these definitions.

Let's assume the user wants to produce a grouped graph. Once the grouped graph icon is selected, a dialog box appears (Figure 11).



SAS/ASSIST: Stacked Bar Chart: <Untitled>

Active data set: SASUSER.FITNESS

Subset data: NO

Graphics device: MICROSOFT WINDOWS DISPLAY

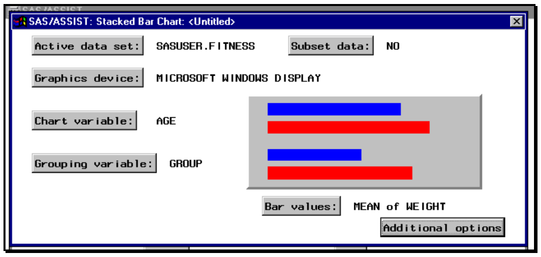
Chart variable: -REQUIRED-

Grouping variable: -NONE-

Bar values: -DEFAULT-

Figure 11. Grouped Bar Dialog Box

At this point, the selection process is similar to that described in the report writing section. The user selects the active data set to use, chart variable (y-axis), grouping variable, bar values (x-axis), data subset criteria, and additional options. The additional options include: general options, color and pattern options, number of bars, axis options, and legend options. Figure 12 shows a grouped bar dialog box with the criteria defined.



SAS/ASSIST: Stacked Bar Chart: <Untitled>

Active data set: SASUSER.FITNESS

Subset data: NO

Graphics device: MICROSOFT WINDOWS DISPLAY

Chart variable: AGE

Grouping variable: GROUP

Bar values: MEAN of WEIGHT

Figure 12. Defined Grouped Bar Dialog Box

For this example, the user is using the fitness data (Table 2). They are grouping by the experimental group, the vertical axis will be the ages, and the horizontal bars will be the mean of the weights. The resulting graph after a *Locals->Run* is shown in Table 3.

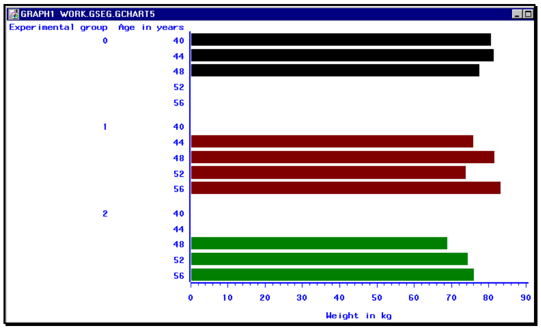


Table 3. Grouped Bar Horizontal Bar Chart

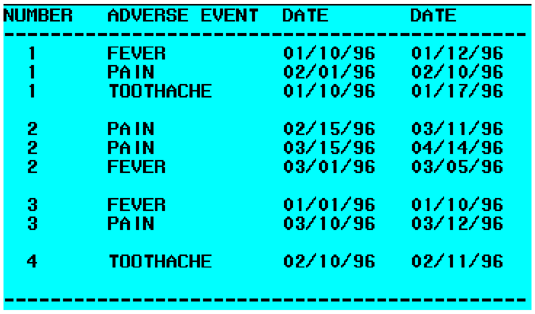
Using SAS/ASSIST, novice users can interactively define the graph criteria and paste the code into their program.

Output Verification

The main use of SAS/ASSIST at STATPROBE, Inc. is for output verification. STATPROBE, Inc. produces listing and summary tables for its clients. It is of the utmost importance that the listings and summaries be correct. Previous methods of ensuring that the programs were correct involved spot-check and tedious hand-counts of the data. While this practice is still used, SAS/ASSIST provides the tools for the novice user to produce output using report writing and graphing to help facilitate the verification process.

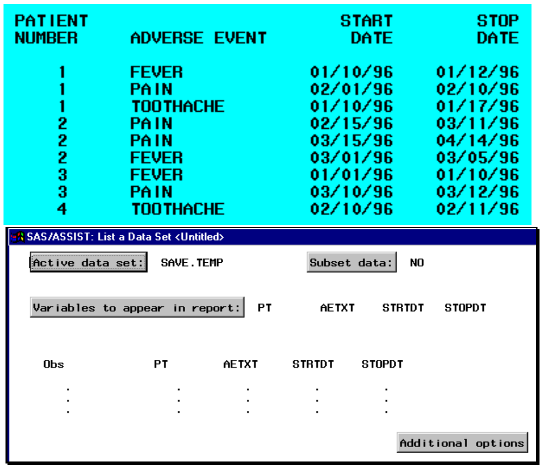
To validate listings, Proc Prints of the data set(s) being used are compared to the STATPROBE, Inc. listing output. STATPROBE, Inc. uses a Data _null_ to produce its listing and summary output. Data _null_ allows the user more flexibility in the "look" of the output. SAS/ASSIST provides tools to interactively define the options to produce a nice print out of the data to check against the Data _null_ report.

For example, a dummy data set created at STATPROBE, Inc. appears as a listing in Table 4. Table 5 displays the same data using a Proc Print defined through SAS/ASSIST, as well as the definition screen for the SAS/ASSIST print.



```
NUMBER   ADVERSE EVENT  DATE        DATE
------------------------------------------
  1      FEVER          01/10/96    01/12/96
  1      PAIN           02/01/96    02/10/96
  1      TOOTHACHE      01/10/96    01/17/96

  2      PAIN           02/15/96    03/11/96
  2      PAIN           03/15/96    04/14/96
  2      FEVER          03/01/96    03/05/96

  3      FEVER          01/01/96    01/10/96
  3      PAIN           03/10/96    03/12/96

  4      TOOTHACHE      02/10/96    02/11/96

------------------------------------------
```

Table 4. Listing of the Temp Data Set



```
PATIENT                          START      STOP
NUMBER    ADVERSE EVENT          DATE       DATE

   1      FEVER                01/10/96   01/12/96
   1      PAIN                 02/01/96   02/10/96
   1      TOOTHACHE            01/10/96   01/17/96
   2      PAIN                 02/15/96   03/11/96
   2      PAIN                 03/15/96   04/14/96
   2      FEVER                03/01/96   03/05/96
   3      FEVER                01/01/96   01/10/96
   3      PAIN                 03/10/96   03/12/96
   4      TOOTHACHE            02/10/96   02/11/96
```

SAS/ASSIST: List a Data Set <Untitled>

Active data set: SAVE.TEMP

Subset data: NO

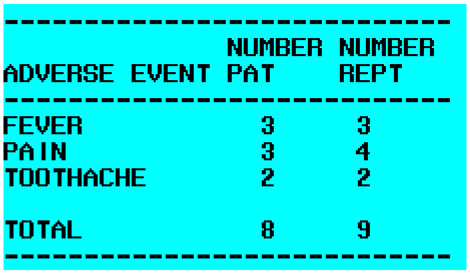
Variables to appear in report: PT AETXT STRTDT STOPDT

```
Obs          PT      AETXT    STRTDT    STOPDT
 .            .        .        .         .
 .            .        .        .         .
 .            .        .        .         .
```

Table 5. SAS/ASSIST Listing of the Temp Data Set, Definition Screen

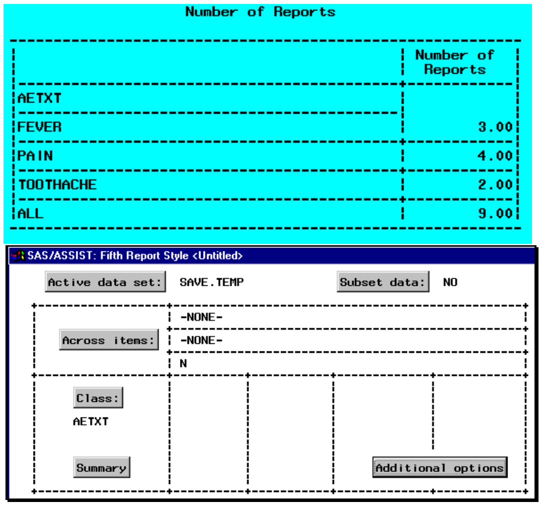
The Proc Print of the data in Table 5 would be used to verify that the data output in Table 4 using a Data _null_ was correct. This assurance would be done by spot-checking the Proc Print versus the Data _null_ output.

Similarly, summary tables can be verified using the interactive Proc Tabulate definition through SAS/ASSIST. For the TEMP data, the data summarized would be the number of patients with an adverse event and the number of adverse events reported. Example output from a Data _null_ is shown in Table 6, while Table 7 displays the number of adverse event reports using the interactive Proc Tabulate application. Novice users would produce two tabulates, one displaying the number of patients with an adverse event and the other displaying the number of reports. The distinct values of the adverse event text variable (AETXT) are what the user would like to summarize. Therefore, it is the class variable.



```
---------------------------
                NUMBER NUMBER
ADVERSE EVENT   PAT    REPT
---------------------------
FEVER             3      3
PAIN              3      4
TOOTHACHE         2      2

TOTAL             8      9
---------------------------
```

Table 6. Data _null_ TEMP Data Set Summary.



```
                   Number of Reports

---------------------------------------------------------
|                                          | Number of |
|                                          |  Reports  |
|------------------------------------------+-----------|
|AETXT                                     |           |
|------------------------------------------|           |
|FEVER                                     |       3.00|
|------------------------------------------+-----------|
|PAIN                                      |       4.00|
|------------------------------------------+-----------|
|TOOTHACHE                                 |       2.00|
|------------------------------------------+-----------|
|ALL                                       |       9.00|
---------------------------------------------------------
```

SAS/ASSIST: Fifth Report Style <Untitled>

Active data set: SAVE.TEMP

Subset data: NO

Across items: -NONE- -NONE- N

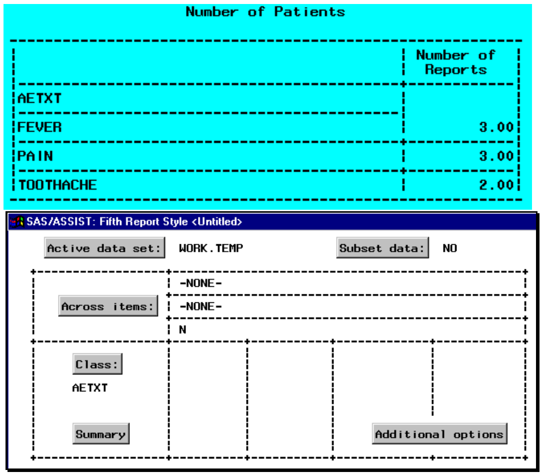
Class: AETXT

Table 7. SAS/ASSIST Tables Summary and Definition (Number of Reports).

To produce the SAS/ASSIST table displaying the number of reports for each adverse event, the user defined the active data set (SAVE.TEMP), the class variable (AETXT) and the statistic desired (number of non-missing values). In addition, the user selected the summary button to get the TOTAL line to appear in the report.

Verifying the SAS/ASSIST output versus the Data _null_ output shows that the data points match.

Table 8 contains the output for the number of distinct patients in each class value.



```
                   Number of Patients

---------------------------------------------------------
|                                          | Number of |
|                                          |  Reports  |
|------------------------------------------+-----------|
|AETXT                                     |           |
|------------------------------------------|           |
|FEVER                                     |       3.00|
|------------------------------------------+-----------|
|PAIN                                      |       3.00|
|------------------------------------------+-----------|
|TOOTHACHE                                 |       2.00|
```

SAS/ASSIST: Fifth Report Style <Untitled>

Active data set: WORK.TEMP

Subset data: NO

Across items: -NONE- -NONE- N

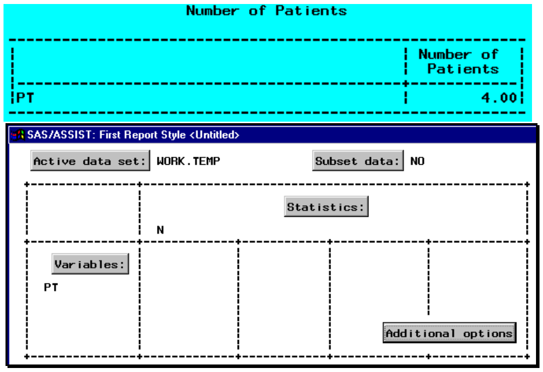
Class: AETXT

Table 8. SAS/ASSIST Number of Patients.

In comparing Table 8 versus Table 6 there are no differences. However, the total number of patients was not displayed in Table 8. Therefore, the user would generate another table to get the number of patients overall.

Notice that the Table 8 active data set is WORK.TEMP instead of SAVE.TEMP. This is done because the data contains multiple observations per patient. In counting the number of patients, they should only be counted once. Therefore, the SAVE.TEMP data set was sent through a Proc Sort with the nodupkey option on AETXT and PT. This provides the working data set with a patient having only one observation per distinct AETXT.

Table 9 displays the SAS/ASSIST table for the overall number of patients.



```
                    Number of Patients

 ------------------------------------------------------------
 |                                            | Number of   |
 |                                            |  Patients   |
 |--------------------------------------------+-------------|
 |PT                                          |         4.00|
 ------------------------------------------------------------
```

SAS/ASSIST: First Report Style <Untitled>

Active data set: WORK.TEMP

Subset data: NO

Statistics: N

Variables: PT

Table 9. SAS/ASSIST Number of Patients Table.

In comparing the value in Table 9 versus the total number of patients in Table 6 the user would notice a discrepancy. Table 9 says that there were 4 patients total, while table 6 says there were 8 patients total. At this point, the user looks back at the Proc Print in Table 5 and hand-counts the number of patients since they were so minimal. That would show that 4 is the correct answer and that the program that created Table 6 was incorrect. Figure 13 contains the program that generated Table 6.

```
Libname save 'c:\mydocu~1';
Proc sort data=save.temp out=temp nodupkey;
  By aetxt pt;
Proc summary data=temp;
  Class aetxt;
  Var pt;
  Output out=stat1 n=numpat;
Run;
Proc sort data=save.temp out=temp;
  By aetxt;
Proc summary data=temp;
  Class aetxt;
  Output out=stat2;
Run;
Proc sort data=stat1;
  By aetxt;
Proc sort data=stat2;
  By aetxt;
Data all;
  Merge stat1 stat2;
  By aetxt;
Run;
Proc sort data=all;
  By descending _type_ aetxt;
Run;
```

Figure 13. Data _null_ Summary Program

The reason for the discrepancy is that the user is taking the Proc Summary output and keeping the summary statistics where _type_=0. In this case, this statistic is the sum of the number of observations where PT is not missing. Therefore, it is counting the number of observations and not the number of distinct patients for the total. With this information, the user can modify the program so that it outputs the correct summary data.

Conclusion

SAS/ASSIST is a great tool for report generation, interactive graphic definition/presentation, and validation/verification. New SAS users and advanced SAS users can use SAS/ASSIST to assist them in a variety of ways. This paper scratched the surface of SAS/ASSIST with some examples of report writing, graphs, and validation/verification techniques used at STATPROBE, Inc. There are many more useful applications in SAS/ASSIST for programmers, data managers, and statisticians to implement in their daily job responsibilities.

Acknowledgments

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