A High-Level Summary Table Generation Language Supplying the Missing Link between PROC MEANS using a CLASS Statement and PROC TABULATE

Dorothy E. Pugh, Independent Consultant

ABSTRACT

FlexTab is a high-level language used to generate summary tables using categorical derived variables. The FlexTab compiler, written in SAS®, uses as a flat file containing FlexTab code as input, generating SAS code requiring minor modifications from the programmer to generate such a table. FlexTab is the missing link between PROC MEANS with a CLASS statement and PROC TABULATE. Each line of FlexTab code specifies 1) which variables are in that CLASS statement, 2) what summary statistic to perform on them, 3) what observations to select from the output data set based on the values of the variables in the CLASS statement, and 4) where to put the result in the generated summary table. To the computer-naïve user, however, FlexTab code is a straightforward statement of requirements. This paper provides a detailed description of how the compiler and its generated code work. Copies of the compiler code are available upon request.

INTRODUCTION

PROC TABULATE and PROC REPORT have certain shortcomings: they put many restrictions on the observations you can use to calculate denominators directly from an input data set. PROC TABULATE requires that the denominators be the same as the Ns for the CLASS variables. PROC REPORT gives you more flexibility in defining with its COMPUTE blocks, but you lose the flexibility with totals and subtotals that PROC TABULATE gives you, unless you choose to use the LINE statement, which is a de facto PUT statement. Neither PROC REPORT nor PROC TABULATE are really WYSIWYG: the layout of the final table doesn't stand out unless it's very simple. Finally, both PROC's are black boxes: neither creates a SAS data set of computed summary statistics that you can actually print out as a diagnostic measure.

With FlexTab, a high-level WYSIWYG (what you see is what you get) frequency table generation language written in SAS, you can have your cake and eat it too, in part because it generates PROC TABULATE code. Using it, you can control the observations used in Ns (including both numerators and denominators of fractions) and the cells they are presented in. The compiler (which translates the FlexTab code into SAS code) generates a PROC MEANS step using a CLASS statement for every CLASS variable you specify. The output data set of this PROC MEANS contains counts for every combination of unique values for every combination of CLASS variables. The compiler identifies the observations with the same combinations of class variable values that the FlexTab code specifies and, for each specified column *n*, creates a COL*n* variable and sets it to the value of _FREQ_. Denominator values are RETAINed variables set either to the value of a previously defined COLn variable or newly created. Fractions (which can be converted into percents via a PROC FORMAT step) are the ratios of previously defined COLn variable values and those of previously defined denominator variables. The resulting data set is the input data set to PROC TABULATE code also generated by the compiler. This SAS source code file in turn generates a summary table.

HOW TO USE FLEXTAB: EXAMPLE

Here is a step-by-step illustration of how to use FlexTab to create a summary table. First, you create a flat file containing FlexTab code. Then, you run the FLEXTAB.SAS program, which generates SAS code. This SAS code needs you to complete 1) derivation of discrete variables, one for the PROC TABULATE CLASS statement and any more needed to select observations for the summary statistics, 2) addition of column headers and their formats, 3) addition of the format for the first column of the table, and 4) replacement of every instance of "?" in the PROC TABULATE code with either a "," or a "*".

This table shows the difference in reviewer quality by clinical center in a hypothetical clinical trial, thereby identifying centers with possible reviewer training problems. A value of AGREE = 1 means another QC reviewer agreed with the review decision.

Step 1: Example FlexTab code and a line-by-line explanation of what it means

```
class center baseline agree staffid;
2>baseline(1)*agree(.)*staffid(.) = count;
3>baseline(1)*agree(1)*staffid(.) = count;
4>3/baseline(1)*agree(.)*staffid(.) = count;
5>baseline(0)*agree(.)*staffid(.) = count;
6>baseline(0)*agree(1)*staffid(.) = count;
7>baseline(0)*agree(1)*staffid(.)/5 = count;
8>staffid in center = count;
9>staffid(agree = sum(=>6)) in center = count;
10>9/8 = count;
```

First line: List all CLASS (categorical) variables to be used, including those the values of which you will use to control the observations used in calculations. Put the "row" (Column 1) variable ("center") first.

Second line: The "2>" indicates that the output will go in column 2. We start numbering with column 2 because there is one "row" variable, which occupies column 1. This code selects all the observations for which the variable BASELINE = 1 and AGREE and STAFFID have any value, counts them, and puts them in column 2. CENTER is not used in this expression: however, its equivalent would be:

```
2>center(. 1-8)* baseline(1)*agree(.)*staffid(.) = count;
2>center(.1-4)*baseline(1)*agree(.)*staffid(.) = count,
    center(5-8)*baseline(1)*agree(.)*staffid(.) = count;
```

Lines 3,5 and 6 follow the same basic logic.

Fourth line: This line calculates a fraction. The numerator is the same as the N generated by the third line, and is referenced by the "3" accordingly. The denominator, after the "/", is another N calculated the same way as those in lines 2 and 3.
Seventh line: This time, the denominator is the same as the N generated by the fifth line, and is referenced by the "5."
Eighth line: Use the "in" operator to count the number of STAFFID's per CENTER, i.e., the number of unique values of STAFFID within CENTER.
Ninth line: This line 1) takes the sum of AGREE=1 observations for each STAFFID, and 2) counts the number of STAFFID's per CENTER (as defined above) who have at least 6 observations with AGREE=1.
Tenth line: To get the column 10 value, we divide the column 9 value by the column 8 value (as computed above) by simply referring to their column numbers.

Step 2: Generation of data manipulation and table generation code. FLEXTAB.SAS has two input parameters, the filespec for the input file, a flat file containing the code given in Step 1, and the filespec for the output file, which contains the code below for this example. Note that you still need to fill in the blanks and to replace every "?" with valid SAS code. For instance, "colhd2" refers to the header for column 2 of the output summary table, and "colfmt2" refers to its corresponding format. The code used to create data set INDATA for this example is shown in Appendix A.

```
proc format;
   picture countfmt
      low-high = ' 0009  '
      other    = ' 0  '
   ;
   picture pctfmt
      low - <0 = ' N/A ' (noedit)
      other    = '  009.9 '  (mult=1000)
      ;
   value rowfmt
      . = 'Overall'
      ???
      ;
run;

%let title=;
%let rowsize=;
%let misstxt=;
%let formchar= _ _  _  _ ;
%let box=;      /* Header of first column */
%let colhd2 = ;
%let colhd3 = ;
%let colhd4 = ;
%let colhd5 = ;
%let colhd6 = ;
%let colhd7 = ;
%let colhd8 = ;
%let colhd9 = ;
%let colhd10 = ;

%let colfmt2 =;
%let colfmt3 =;
%let colfmt4 =;
%let colfmt5 =;
%let colfmt6 =;
%let colfmt7 =;
%let colfmt8 =;
%let colfmt9 =;
%let colfmt10 =;


****************************************
*      Build Data indata               *
* -> create categorical variables      *;
****************************************;

data indata;
   ???
run;

data indata;
   set indata;
   people = 1;
   numer = 1;
run;

proc sort data=indata;
   by center staffid;
run;

data indata;
   set indata;
   by center staffid;
   if first.staffid  and staffid  gt .z then
      count8 = 1;
run;

proc sort data=indata;
   by center staffid;
run;

proc means data=indata noprint;
   by center staffid;
   var agree ;
   output out=sums ;
          sum =sum ;
run;

data sums ;
   set sums (where=(sum ge 6 ));
   by center staffid;
   count9  = agree;
run;
```

```
data indata;
   merge indata sums ;
   by center staffid;
   if not first.staffid then count9  = . ;
run;

proc sort data=indata;
   by center baseline agree staffid;
run;


proc means data=indata noprint;
   class center baseline agree staffid;
   var count8 count9 numer people ;
   output out=stats
          n =count8 count9 countnum countpeo
          sum =sum8 sum9 sumnum sumpeo
;
run;

proc sort data=stats;
   by center baseline agree staffid;
run;

data stats;
   set stats;
   by center baseline agree staffid;
   retain den4_1;
   retain denom5 denom8;
   if baseline  in (1 )  and agree  in (. )  and staffid  in (. )
      then col2  = sumnum; ;
   if baseline  in (1 )  and agree  in (1 )  and staffid  in (. )
      then col3  = sumnum; ;
   if baseline  in (1 )  and agree  in (. )  and staffid  in (. )
      then den4_1  = sumpeo; ;
   if baseline  in (0 )  and agree  in (. )  and staffid  in (. )
      then col5  = countnum; ;
   if baseline  in (0 )  and agree  in (1 )  and staffid  in (. )
      then col6  = countnum; ;
   if col5  ne . then denom5  = col5 ;
   if baseline eq . and agree eq . and staffid eq .
      then col8  = count8 ;
   if baseline eq . and agree eq . and staffid eq .
      then col9  = count9 ;
   if col8  ne . then denom8  = col8 ;

   col4  = col3 /den4_1 ;
   if baseline  in (0 )  and agree  in (1 )  and
      staffid  in (. )  and denom5 ne . then
      col7  = sumnum /denom5 ;
   col10  = col9 /  denom8 ;
   if col2 ne . or col3 ne . or col4 ne . or
      col5 ne . or col6 ne . or col7 ne . or
      col8 ne . or col9 ne . or col10 ne .;
run;

PROC TABULATE DATA = stats
            NOSEPS
            MISSING
            FORMCHAR= " &formchar ";
   VAR col2 - col10 ;
   FORMAT center rowfmt. ;
   CLASS  center;
   TABLE center = ' ' ?   /* replace each ? with
      , or *   */
      (
      col2 = "&colhd2"*mean=' '*f=&colfmt2
      col3 = "&colhd3"*mean=' '*f=&colfmt3
      col4 = "&colhd4"*mean=' '*f=&colfmt4
      col5 = "&colhd5"*mean=' '*f=&colfmt5
      col6 = "&colhd6"*mean=' '*f=&colfmt6
      col7 = "&colhd7"*mean=' '*f=&colfmt7
      col8 = "&colhd8"*mean=' '*f=&colfmt8
      col9 = "&colhd9"*mean=' '*f=&colfmt9
      col10 = "&colhd10"*mean=' '*f=&colfmt10
      )
      /PRINTMISS
       MISSTEXT =  "&misstxt"
       RTS = &rowsize
       BOX = " &box " ;
run;
```

Step 3: Fill in the blanks and "?'s" on the above file and run it. Note that you should replace the "?" in the TABLE statement of the PROC TABULATE code with a "*" or a ",". Final summary table output for this example is presented in Appendix B. A printout of the final data set input to PROC TABULATE code is presented in Appendix C.

COMPILER DESIGN

A compiler is a program that reads input code written in one computer language, parses it (i.e., analyzes its structure and components), and generates equivalent code in another, usually lower-level, language. This section will explain how this compiler was designed and display an intermediate data set, a data dictionary that contains a data set containing the results of the parsing.

SAS is not an ideal language for writing a compiler. For one thing, it is not capable of doing recursion, i.e., the calling of subroutines/functions/macros by one another in any sequence that you might specify. Recursion allows you to write code which nests expressions at a depth limited only by your computer's resource allocations. However, in a language like SAS, a compiler would have limited ability to generalize and all combinations would have to be spelled out by the parser. Fortunately, the expression complexity that FlexTab is able to handle is sufficient for the typical programming problem.

The compilation process consists of 1) parsing the code, i.e., recognizing and storing grammatical units (i.e., by applying rules of that input language's grammar, and 2) converting each grammatical unit into code for an equivalent grammatical unit in the output language. In this case, FLEXTAB.SAS reads the input code as an input flat file, parses it, puts the language

units into a SAS data set, and, on the basis of its content, writes equivalent SAS code to an output flat file.

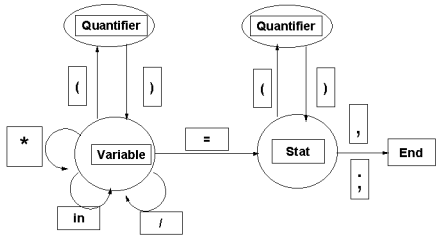
The grammar of this language is analogous to that of English. English sentences are broken up into syntactical units, such as “subjects” and “predicates.” In turn, each syntactical unit is broken up into “parts of speech” which include nouns, verbs, adjectives, adverbs, etc. This is not a hierarchical relationship, however, since, for instance, a noun can be either part of a “subject” or a “predicate.” However, different “parts of speech” are allowable in a “subject” and others in a “predicate.”

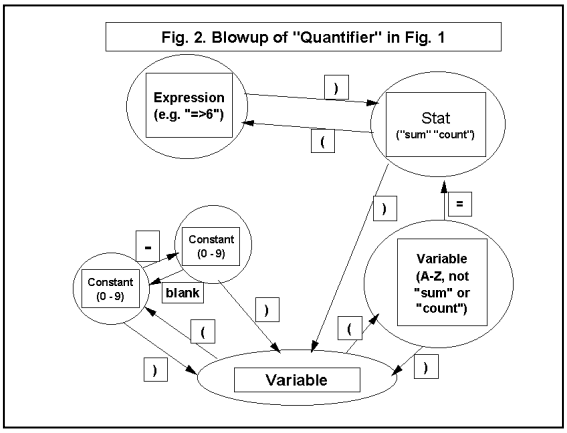
Imagine, then, a new grammar in which the syntactical units have numbers. Within them, “Variable” and “Stat” are roughly equivalent to nouns or noun clauses, and are modified by “quantifiers,” which may be constants, variables or expressions. Operators, somewhat like verbs in English, are “*” (intersection), “/” (division), “,” (end of a phrase), “;” (end of a sentence). A sentence fully describes the contents of a summary table column, while a phrase describes part of a column, sometimes as little as a table cell. Another operator, “in,” represents the observation count for one variable within each unique value of another.

At the end of the parsing step, FLEXTAB.SAS generates a data dictionary containing its interpretation of the code in the form of a SAS data set. This data set contains a line for every variable and operator which in turn contains variables which indicate how they should be handled. The second part of FLEXTAB.SAS uses this data set to determine what SAS code needs to be generated. Appendix D contains a printout of the observations of the data dictionary SAS data set produced by the above example which pertain to column 9 of the output summary table.

A state transition diagram describing the language grammar serves as a compiler programming aid in the way that a flow chart serves as a data processing program aid. It is displayed in Figures 1 and 2. Figure 2 is an expansion of the “Quantifier” state in Figure 1 describing the special construction in Statement 9 of the FLEXTAB.SAS code above.

Figure 1. State Transition Diagram





ANOTHER EXAMPLE

It is important to note that PROC TABULATE will generate rows for every combination of unique values of all variables in the CLASS statement, regardless of whether these combinations exist in the data. For example, if you are reporting baseball statistics for Team 1 and 2, where Team 1 has Players 1, 2 and 3, and Team 2 has Players 4,5 and 6, PROC TABULATE will generate rows for Players 1 through 6 for *both* Team 1 and Team 2. Therefore, you are better off deriving one CLASS variable from multiple discrete variables and using a format that displays what these values really mean.

One feature the previous example does not illustrate is the use of one category variable as a row sequence number designator, which can in turn have a complicated format illustrating hierarchical relationships. For this example, you will need to add this format to the designated section of the code generated by FLEXTAB.SAS, i.e., near the top where "value rowfmt" is shown.

```
VALUE rowfmt
      1 = 'Hypertension                Yes'
      2 = '     No'
      3 = '    Unknown'
      4 = '     Missing'
      5 = 'Diabetes mellitus           Yes'
      6 = '    No'
      7 = '    Unknown'
      8 = '    Missing'
      9 = 'Insulin treated diabetes    Yes'
     10 = '    No'
     11 = '   Unknown'
     12 = '    Missing'
     13 = 'Oral hypoglycemic Rx        Yes'
     14 = '   No'
     15 = '   Unknown'
     16 = '   Missing'
     17 = 'Smoking History             Yes'
     18 = '    No'
     19 = '    Unknown'
     20 = '    Missing'
     21 = 'Hypercholesterolemia        Yes'
     22 = '    No'
     23 = '    Unknown'
     24 = '    Missing'
     25 = 'Estrogen Prior to MI        Yes'
     26 = '    No'
     27 = '   Unknown'
     28 = '    Missing'
     29 = 'Estrogen use, Current       Yes'
     30 = '    No'
     31 = '   Unknown'
     32 = '    Missing'
      ;
```

There is one more consideration in producing this format. SAS will discard all the blanks when producing the summary table the way the format is. Therefore, a special blank character has to be entered in place of the first of a block of existing blanks, so that, e.g., the last line above would be "32 = '&blnk Missing' " third line above it would be "29 = 'Estrogen use, Current &blnk.Yes' "; The macro variable &blnk would be created this way:

```
%let ffx = FF;

data _ null _;
   call symput('blnk',trim(left(input("&ffx",$hex2.))));
run;
```

Here is the accompanying FlexTab code:

```
data indata;
trvar r0-r32;
class varno group sex;
3>varno(1-24)*sex(' ') = sum,
    varno(25-32)*sex('F') = sum;
4>varno(1-8)*sex(' ')/varno(0)*sex(' ') = sum,
    varno(9-12)*sex(' ')/varno(5)*sex(' ') = sum,
    varno(13-24)*sex(' ')/varno(0)*sex(' ') = sum,
    varno(25-28)*sex('F')/varno(0)*sex('F') = sum,
    varno(29-32)*sex('F')/varno(25)*sex('F') = sum;
```

Although you will need to create the r0-r32 variables by assigning a 1 to r0 and either 1 or 0 to the rest of this series of logical variables, FLEXTAB.SAS creates VARNO, i.e., the first listed CLASS variable, by transposing r0-r32.

This is a table with many different N's and denominators. For some entries, we need to report data that applies only to diabetic patients (VARNO=5), women (SEX='F'), or women who have taken estrogen prior to MI (SEX='F'*VARNO(25)).

Note that the second line starts with "3>". This indicates that there are two categorical variables this time (VARNO and GROUP) that will appear in the CLASS statement of the PROC TABULATE code that this FlexTab code will generate. Two columns are specified (3 and 4), but the final number of columns depends on what you replace the "?" with in the TABLE statement. If you replace it with "*", you will have four columns, one each for VARNO and GROUP, and two reflecting, respectively, the counts and fractions as specified. However, if you replace the "?" with ",", the results will not be quite as WYSIWYG: You will have one COLUMN for VARNO values, then six others:, the unique values of GROUP by the two columns above. Since GROUP values were not restricted by the above FlexTab statements, they default to the two unique values GROUP assumes, plus a third overall category.

This is the SAS code produced by the above FlexTab code:

```
proc format;
   picture countfmt
      low-high = ' 0009  '
      other    = ' 0  '
   ;
   picture pctfmt
      low - <0 = ' N/A ' (noedit)
```

```
      other    = '  009.9 '  (mult=1000)
      ;
   value rowfmt
      . = 'Overall'
      ???
   ;
run;


%let title=;
%let rowsize=;
%let misstxt=;
%let formchar= _ _  _  _ ;
%let box=;     /* Header of first column */
%let colhd3 = ;
%let colhd4 = ;


%let colfmt3 =;
%let colfmt4 =;


*********************************************
*     Build Data indata                     *
* -> user creates categorical variables     *;
*********************************************;


data indata;
   ???
run;


data indata(drop=r0-r32 );
   set indata;
   array _trvars(varno) r0-r32;
      do over _trvars;
         numer = _trvars - 1;
         people = 1;
         output;
      end;
run;


proc sort data=indata;
   by varno group sex;
run;


proc means data=indata noprint;
   class varno group sex;
   var numer people ;
   output out=stats
          sum =sumnum sumpeo
;
run;

proc sort data=stats;
   by varno group sex;
run;

data stats;
   set stats;
   by varno group sex;
   retain den4_1 den4_2 den4_3 den4_4 den4_5;
   if 1 <=varno <=24  and sex  in (' ' )
      then col3  = sumnum; ;
   if 25 <=varno <=32  and sex  in ('F' )
      then col3  = sumnum; ;
   if varno  in (0 )  and sex  in (' ' )
      then den4_1  = sumpeo; ;
   if varno  in (5 )  and sex  in (' ' )
      then den4_2  = sumpeo; ;
   if varno  in (0 )  and sex  in (' ' )
      then den4_3  = sumpeo; ;
   if varno  in (0 )  and sex  in ('F' )
      then den4_4  = sumpeo; ;
   if varno  in (25 )  and sex  in ('F' )
      then den4_5  = sumpeo; ;

   if 1 <=varno <=8  and sex  in (' ' )  and den4_1 ne .
      then col4  = sumnum /den4_1 ;
   if 9 <=varno <=16  and sex  in (' ' )  and den4_2 ne .
      then col4  = sumnum /den4_2 ;
   if 17 <=varno <=24  and sex  in (' ' )  and den4_3 ne .
      then col4  = sumnum /den4_3 ;
   if 25 <=varno <=28  and sex  in ('F' )  and den4_4 ne .
      then col4  = sumnum /den4_4 ;
   if 29 <=varno <=32  and sex  in ('F' )  and den4_5 ne .
      then col4  = sumnum /den4_5 ;
   if col3 ne . or col4 ne .;
run;

PROC TABULATE DATA = stats
              NOSEPS
              MISSING
              FORMCHAR= "&formchar";
   VAR col3 - col4 ;
   FORMAT varno rowfmt. ;
   CLASS  varno group;
   TABLE varno = ' ' ?  group = ' ' ?   /* replace each ? with , or *   */
      (
      col3 = "&colhd3"*mean=' '*f=&colfmt3
      col4 = "&colhd4"*mean=' '*f=&colfmt4
      )
      /PRINTMISS
       MISSTEXT =  "&misstxt"
       RTS = &rowsize
       BOX = " &box " ;
run;
```

CONCLUSION

We have shown you how to use FlexTab to do most of the work toward generating an important type of summary table with complexities that once represented a quality assurance nightmare. The section explaining the compiler should serve as a guide to help you modify your own copy of the code from me, which I will distribute on request. This new language can, at the very least, serve as a useful communication tool between you and the most harried statistician or medical monitor. At the other extreme of possibilities, it can help you 1) to identify bugs in the most complex algorithms generating categorical variables, 2) to spot extra, i.e., unwanted, observations in your data set, 3)

to display troublesome trends in complex abstracted or otherwise categorical data, including signs of danger in biomedical data. I especially hope that this prototype program will someday lead to the development of a power tool reducing the current burden on the clinical monitoring aspect of clinical trials programming enough to keep clinical trials from being the bottleneck in the prohibitively expensive drug development process.

ACKNOWLEDGMENTS

SAS is a registered trademark or trademark of SAS Institute Inc. in the USA and other countries. ® indicates USA registration. Other brand and product names are registered trademarks of their respective companies.

REFERENCES

Abolafia, Jeffrey M. and Stephen M. Noga (1997), "The Tabulate Procedure: One Step Beyond the Final Chapter," *Proceedings of the Sixth Annual Southeast SAS Users Group Conference*,292-300.

SAS Institute Inc. (1990), *The SAS Guide to TABULATE Processing,* Second Edition, Cary, NC: SAS Institute, Inc.

SAS Institute Inc., *The SAS Guide to the REPORT Procedure: Usage and Reference, Version VI,* First Edition, Cary, NC: SAS Institute, Inc.

AUTHOR CONTACT INFORMATION

Dorothy Pugh

29 Sandstone Ridge Dr.
Durham, NC 27713
(919) 493-1237
dorothypugh@aol.com

APPENDIX A
Example of user-written code creating "raw" input data

```
*****************************************
*      Build Data  IN
*****************************************;
data in;

   do center = 1 to 8;
      do pat = 1 to 5;
         patid = 10*center+pat;
         do vis = 1 to 5;
            baseline = vis gt 2;
            agree = ranuni(357) gt    .5;
            output;
         end;
      end;
   end;
run;

data in;
   set in;
   staffid = 100*center + int(2*ranuni(2));
run;
```

APPENDIX B
Summary Table Output

QC Overread Stats for Staff

Clinical Center	Number Overread Baseline	Number Agr. Baseline	Percent Agr. Baseline	Number Overread Followup	Number Agr. Followup	Percent Agr. Followup	Number of Intervi-ewers	Number with >=6 Overread Agr.	Percent with >=6 Overread Agr.
Overall	120	72	60.0	80	41	51.2	16	13	81.2
A Univ.	15	12	80.0	10	2	20.0	2	2	100.0
B Univ.	15	11	73.3	10	6	60.0	2	2	100.0
C Univ.	15	11	73.3	10	4	40.0	2	2	100.0
D Univ.	15	9	60.0	10	3	30.0	2	1	50.0
E Univ.	15	8	53.3	10	7	70.0	2	2	100.0
F Univ.	15	5	33.3	10	4	40.0	2	1	50.0
G Univ.	15	6	40. 0	10	8	80.0	2	1	50.0
H Univ.	15	10	66.6	10	7	70.0	2	2	100.0

APPENDIX C

Observations from input data set to PROC TABULATE

Obs	center	baseline	agree	staffid	_TYPE_	_FREQ_	count8	count9	people	den4_1	denom5	denom8	col2	col3	col5	col6	col8	col9	col4	col7	col10
1	.	.	.	.	0	200	16	13	200	.	.	16	.	.	.	.	16	13	.	.	0.8125
2	.	0	.	.	4	80	13	.	80	.	80	16	.	.	80	.	.	.	.	.	.
3	.	0	1	.	6	41	9	.	41	.	80	16	.	.	.	41	.	.	.	0.5125	.
4	.	1	.	.	4	120	3	13	120	120	80	16	120	.	.	.	.	.	.	.	.
5	.	1	1	.	6	72	2	11	72	120	80	16	.	72	.	.	.	.	0.60000	.	.
6	1	.	.	.	8	25	2	2	25	120	80	2	.	.	.	.	2	2	.	.	1.0000
7	1	0	.	.	12	10	2	.	10	120	10	2	.	.	10	.	.	.	.	.	.
8	1	0	1	.	14	2	.	.	2	120	10	2	.	.	.	2	.	.	.	0.2000	.
9	1	1	.	.	12	15	.	2	15	15	10	2	15	.	.	.	.	.	.	.	.
10	1	1	1	.	14	12	.	1	12	15	10	2	.	12	.	.	.	.	0.80000	.	.
11	2	.	.	.	8	25	2	2	25	15	10	2	.	.	.	.	2	2	.	.	1.0000
12	2	0	.	.	12	10	2	.	10	15	10	2	.	.	10	.	.	.	.	.	.
13	2	0	1	.	14	6	2	.	6	15	10	2	.	.	.	6	.	.	.	0.6000	.
14	2	1	.	.	12	15	.	2	15	15	10	2	15	.	.	.	.	.	.	.	.
15	2	1	1	.	14	11	.	2	11	15	10	2	.	11	.	.	.	.	0.73333	.	.
16	3	.	.	.	8	25	2	2	25	15	10	2	.	.	.	.	2	2	.	.	1.0000
17	3	0	.	.	12	10	1	.	10	15	10	2	.	.	10	.	.	.	.	.	.
18	3	0	1	.	14	4	1	.	4	15	10	2	.	.	.	4	.	.	.	0.4000	.
19	3	1	.	.	12	15	1	2	15	15	10	2	15	.	.	.	.	.	.	.	.
20	3	1	1	.	14	11	1	2	11	15	10	2	.	11	.	.	.	.	0.73333	.	.
21	4	.	.	.	8	25	2	1	25	15	10	2	.	.	.	.	2	1	.	.	0.5000
22	4	0	.	.	12	10	1	.	10	15	10	2	.	.	10	.	.	.	.	.	.
23	4	0	1	.	14	3	1	.	3	15	10	2	.	.	.	3	.	.	.	0.3000	.
24	4	1	.	.	12	15	1	1	15	15	10	2	15	.	.	.	.	.	.	.	.
25	4	1	1	.	14	9	.	1	9	15	10	2	.	9	.	.	.	.	0.60000	.	.
26	5	.	.	.	8	25	2	2	25	15	10	2	.	.	.	.	2	2	.	.	1.0000
27	5	0	.	.	12	10	1	.	10	15	10	2	.	.	10	.	.	.	.	.	.
28	5	0	1	.	14	7	1	.	7	15	10	2	.	.	.	7	.	.	.	0.7000	.
29	5	1	.	.	12	15	1	2	15	15	10	2	15	.	.	.	.	.	.	.	.
30	5	1	1	.	14	8	1	2	8	15	10	2	.	8	.	.	.	.	0.53333	.	.
31	6	.	.	.	8	25	2	1	25	15	10	2	.	.	.	.	2	1	.	.	0.5000
32	6	0	.	.	12	10	2	.	10	15	10	2	.	.	10	.	.	.	.	.	.
33	6	0	1	.	14	4	1	.	4	15	10	2	.	.	.	4	.	.	.	0.4000	.
34	6	1	.	.	12	15	.	1	15	15	10	2	15	.	.	.	.	.	.	.	.
35	6	1	1	.	14	5	.	.	5	15	10	2	.	5	.	.	.	.	0.33333	.	.
36	7	.	.	.	8	25	2	1	25	15	10	2	.	.	.	.	2	1	.	.	0.5000
37	7	0	.	.	12	10	2	.	10	15	10	2	.	.	10	.	.	.	.	.	.
38	7	0	1	.	14	8	1	.	8	15	10	2	.	.	.	8	.	.	.	0.8000	.
39	7	1	.	.	12	15	.	1	15	15	10	2	15	.	.	.	.	.	.	.	.
40	7	1	1	.	14	6	.	1	6	15	10	2	.	6	.	.	.	.	0.40000	.	.
41	8	.	.	.	8	25	2	2	25	15	10	2	.	.	.	.	2	2	.	.	1.0000
42	8	0	.	.	12	10	2	.	10	15	10	2	.	.	10	.	.	.	.	.	.
43	8	0	1	.	14	7	2	.	7	15	10	2	.	.	.	7	.	.	.	0.7000	.
44	8	1	.	.	12	15	.	2	15	15	10	2	15	.	.	.	.	.	.	.	.
45	8	1	1	.	14	10	.	2	10	15	10	2	.	10	.	.	.	.	0.66667	.	.

APPENDIX D

Selected observations from "data dictionary" data set

----------------------------------- col=9 -----------------------------------

Obs	statement	name	stanam	alphaden	stat	quant	line	inflag	stage	classvar	denom	inop	oldquant	qstage	vartype
59	1	staffid	count	.	variable (ge 6)		0	9	1.0		0	0	agree = sum(ge 6)	1	alpha
60	1		count	.	in		0	9	1.0		0	9		1	
61	1	center	count	.	variable		0	9	1.0		0	9		1	alpha
62	1		count	.	=		0	9	1.5		0	0		1	
63	1	count	count	.	stat		0	9	2.0		0	0		1	alpha
64	1		count	.	;		0	9	5.0		0	0		1	

```
---------------------------------- col=9 ----------------------------------

   s              a                       c            o
   t              l                       l            l            v
   a          s   p                   i   a            d        q   a
   t          t   h s         q       n  s  s d         q        s   r
   e    n     a   a t         u     l f  t  s e i       u        t   t
 O m    a     n   d a         a     i l  a  v n n       a        a   y
 b n    m     a   e t         n     n a  g  a o o       n        g   p
 s t    e     m   n e         t     e g  e  r m p       t        e   e

 59 1 staffid count . variable (ge 6) 0 9 1.0   0 0 agree = sum(ge 6) 1 alpha
 60 1         count . in              0 9 1.0   0 9                   1
 61 1 center  count . variable        0 9 1.0   0 9                   1 alpha
 62 1         count . =               0 9 1.5   0 0                   1
 63 1 count   count . stat            0 9 2.0   0 0                   1 alpha
 64 1         count . ;               0 9 5.0   0 0                   1
```