Applying Metadata Attributes in Analysis Data Sets
Using Macro Variables and Proc SQL in SAS®
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ABSTRACT
In clinical trials, we create analysis data sets from the case report form (CRF) data to enhance the efficiency of the statistical analysis. We may derive new variables in these analysis data sets. Metadata attributes such as data set labels, variable labels and formats are important and useful to users. Specific metadata attributes are often required as an industry standard, such as the CDISC Study Data Tabulation Model (SDTM), for the regulatory submission.

The mapping process however can be cumbersome and manual. This paper will show you how this process can be made easy by using macro variables and PROC SQL in SAS. The SAS macro facility is a tool for text substitution. Using SAS MACRO to apply metadata attributes makes good sense. It can accomplish repetitive tasks quickly and efficiently. The automated process can ensure the accuracy of future updates.

INTRODUCTION
This paper will walk you through a macro program called ADS that applies metadata attributes, specifically data set labels, variable labels and formats, to the final analysis data sets in a data library. The variable labels and formats are pre-defined in an analysis data set specification.

The basic premise of the ADS macro is that we can store information of a data library, such as the data set names, the number of variables within each data set, variable names, variable labels, and formats into macro variables. The ADS macro utilizes these stored macro values to do repetitive tasks for each data set within the data library, e.g. assigning a data set label for each data set. It also performs repetitive tasks on a data set level, such as assigning variable labels and formats for each variable.

The ADS macro utilizes extensively the INTO: clause in PROC SQL to create macro variables because the SQL procedure is an excellent tool for creating macro variables on a metadata level.

The Analysis Data Set Specification
We start with the analysis data set specification that contains information such as the variable name (vname), variable label (vlabel), and format (vformat). This document can be created in a format like Microsoft Excel. We can read the analysis data set specification into SAS using Proc Import or DDE.
<table>
<thead>
<tr>
<th>Obs</th>
<th>Domain</th>
<th>Vname</th>
<th>Vlabel</th>
<th>VFormat</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>DM</td>
<td>RFENDTC</td>
<td>Subject Reference End Date/Time</td>
<td>$16.</td>
</tr>
<tr>
<td>7</td>
<td>DM</td>
<td>SITEID</td>
<td>Study Site Identifier</td>
<td>$2.</td>
</tr>
<tr>
<td>8</td>
<td>DM</td>
<td>BRTHDTC</td>
<td>Date/Time of Birth</td>
<td>$10.</td>
</tr>
<tr>
<td>9</td>
<td>DM</td>
<td>AGE</td>
<td>Age in AGEU at RFSTDTC</td>
<td>8.</td>
</tr>
<tr>
<td>10</td>
<td>DM</td>
<td>AGEU</td>
<td>Age Units</td>
<td>$6.</td>
</tr>
<tr>
<td>11</td>
<td>DM</td>
<td>SEX</td>
<td>Sex</td>
<td>$1.</td>
</tr>
<tr>
<td>12</td>
<td>DM</td>
<td>RACE</td>
<td>Race</td>
<td>$20.</td>
</tr>
<tr>
<td>13</td>
<td>DM</td>
<td>ARMCD</td>
<td>Planned Arm Code</td>
<td>$5.</td>
</tr>
<tr>
<td>14</td>
<td>DM</td>
<td>ARM</td>
<td>Description of Planned Arm</td>
<td>$50.</td>
</tr>
<tr>
<td>15</td>
<td>DM</td>
<td>COUNTRY</td>
<td>Country</td>
<td>$3.</td>
</tr>
<tr>
<td>16</td>
<td>DM</td>
<td>DMDTC</td>
<td>Date/Time of Collection</td>
<td>$16.</td>
</tr>
</tbody>
</table>

The Macro Program

```sas
%macro ads;
  proc sql noprint;
    select memname into:names separated by '|' from dictionary.tables
    where libname eq 'RAWDATA' and memname not in ('DEFINE'); quit;
    %put &names;
    %let i=1;
    %do %while(%scan(&names,&i,|) ne );
      %put **********************;
      %put **********************;
      %put *  %scan(&names,&i,|);
      %put *  ;
      %put *  %scan(&names,&i,|);
      %put *  ;
      %put **********************;
    %end;
  proc sql noprint;
    select domain into:dslabel from rawdata.define
    where domain eq "%scan(&names,&i,|)";
%mend;```

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The Macro Program Deciphered

%macro ads;

/**************************************************************************
The macro program ADS first reads the name of all data sets in the data library RAWDATA as a macro variable &NAMES with the exception of the DEFINE data set using the "into:" clause in PROC SQL. In our case, we only have one data set DM. Note that a delimiter "|" is used to separate the different data sets.
**************************************************************************/
proc sql noprint;
    select memname into:names separated by '|' from dictionary.tables
    where libname eq 'RAWDATA' and memname not in ('DEFINE');
quit;
%end;
The macro then loops through each data set in &NAMES using “%do %while” and “%end” statements. The macro function %SCAN will select the data set stored in &NAMES based on the loop until it reaches a blank. The macro variable &I is first set to 1 and it is incremented by 1 at the end of each loop.

%let i=1;
%do %while(%scan(&names,&i,|) ne );

A macro variable &DSLABEL is created to store the value of the data set label for the DM data using PROC SQL. In our example, the value of the domain variable “DM” in the define data set will be used as the data set label.

%macro loop; proc sql noprint;
select domain into:dslabel
from rawdata.define
where domain eq "%scan(&names,&i,|)";
quit;
%mend loop;

A macro variable &CN is created for the number of variables in DM using PROC SQL. The macro variable &CN will be resolved to 16 because there are 16 variables in DM.

%let cn=%scan(&names,&i,|); 
%let cn=%scan(&names,&i,|);

The following PROC SQL code will create 16 macro variables for the variable names (from &COLUMN1 to &COLUMN16), variable labels (from &LABEL1 to &LABEL16), and variable format (from &VFORM1 to &VFORM16) for the DM data.

%do %while(1 le &CN)
%let vname=%scan(&names,&i,|);
%let vlabel=%scan(&names,&i,|);
%let vformat=%scan(&names,&i,|);
%let COLUMN1=%scan(&names,&i,|);
%let LABEL1=%scan(&names,&i,|);
%let VFORM1=%scan(&names,&i,|);
%put 
%end;
Table 1: The following table shows the macro variables, their resolved values, and the source variables in define.sas7bdat.

<table>
<thead>
<tr>
<th>Macro Variable</th>
<th>Purpose</th>
<th>Resolved value</th>
<th>Source Variable in DEFINE.SAS7BDAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>&amp;NAMES</td>
<td>Data sets in the RAWDATA library</td>
<td>DM</td>
<td>NA</td>
</tr>
<tr>
<td>&amp;DSLABEL</td>
<td>Data set label</td>
<td>DM</td>
<td>DOMAIN</td>
</tr>
<tr>
<td>&amp;CN</td>
<td>Number of variables in DM</td>
<td>16</td>
<td>NA</td>
</tr>
<tr>
<td>&amp;COLUMN1 - &amp;COLUMN16</td>
<td>Variables in DM</td>
<td>Values of VNAME from DM, e.g. &amp;COLUMN1 is resolved to STUDYID</td>
<td>VNAME</td>
</tr>
<tr>
<td>&amp;LABEL1 - &amp;LABEL16</td>
<td>Variable labels in DM</td>
<td>Values of VLABEL from DM, e.g. &amp;LABEL1 is resolved to Study Identifier</td>
<td>VLABEL</td>
</tr>
<tr>
<td>&amp;VFORM1 - &amp;VFORM16</td>
<td>Formats in DM</td>
<td>Values of VFORMAT from DM, e.g. &amp;VFORM1 is resolved to $9</td>
<td>VFORMAT</td>
</tr>
</tbody>
</table>

The ADS macro assigns the data set label in the data setp.

```sas
data derdata.%scan(&names,&i,|) (label="&dslabel") ;
set rawdata.%scan(&names,&i,|) ;
```

A nested do-loop is used to assign the variable labels and formats to the variable names stored in &COLUMN1 - &COLUMN16.

Note that SAS uses multiple ‘&’s to resolve nested macro variables. These multiple ‘&’s are resolved in pairs from left to right. In the example of the macro variable &&&column&j, first ‘&’ is resolved to &, then ‘&’ is resolved to &, and finally ‘&J is resolved to 1, therefore we have &COLUMN1 in the first loop.

Same logic applies to macro variables &&&label&j, and &&&vform&j.

```sas
label &column1 ="&label1";
format &column1 &vform1.;
```

Referencing back to Table 1, the macro variable &column1 is resolved to STUDYID, and &label1 is resolved to Study Identifier, and &vform1 is resolved to $9. As a result, we have the final label and format statements in the first loop as:

```sas
label STUDYID ="Study Identifier";
format STUDYID $9.;
```
%do j=1 %to &cn;
  label &&column&j ="&&label&j";
  format &&column&j &&vform&j..;
%end;
run;

%let i=%eval(&i+1);
%end;
%mend ads;

The do-loop will repeat 16 times within the data set DM as illustrated in the following MPRINT in the SAS log.

MPRINT(ADS):   data derdata.DM (label="DM    ");
MPRINT(ADS):   set rawdata.DM;
MPRINT(ADS):   label STUDYID = 'Study Identifier';
MPRINT(ADS):   format STUDYID $9.;
MPRINT(ADS):   label DOMAIN = 'Domain Abbreviation';
MPRINT(ADS):   format DOMAIN $2.;
MPRINT(ADS):   label USUBJID = 'Unique Subject Identifier';
MPRINT(ADS):   format USUBJID $20.;
MPRINT(ADS):   label SUBJID = 'Subject Identifier for the Study';
MPRINT(ADS):   format SUBJID $3.;
MPRINT(ADS):   label RFSTDTC = 'Subject Reference Start Date/Time';
MPRINT(ADS):   format RFSTDTC $16.;
MPRINT(ADS):   label RFENDTC = 'Subject Reference End Date/Time';
MPRINT(ADS):   format RFENDTC $16.;
MPRINT(ADS):   label SITEID = 'Study Site Identifier';
MPRINT(ADS):   format SITEID $2.;
MPRINT(ADS):   label BRTHDTC = 'Date/Time of Birth';
MPRINT(ADS):   format BRTHDTC $10.;
MPRINT(ADS):   label AGE = 'Age in AGEU at RFSTDTC';
MPRINT(ADS):   format AGE $8.;
MPRINT(ADS):   label AGEU = 'Age Units';
MPRINT(ADS):   format AGEU $6.;
MPRINT(ADS):   label SEX = 'Sex';
MPRINT(ADS):   format SEX $1.;
MPRINT(ADS):   label RACE = 'Race';
MPRINT(ADS):   format RACE $20.;
MPRINT(ADS):   label ARMCD = 'Planned Arm Code';
MPRINT(ADS):   format ARMCD $5.;
MPRINT(ADS):   label ARM = 'Description of Planned Arm';
MPRINT(ADS):   format ARM $50.;
MPRINT(ADS):   label COUNTRY = 'Country';
MPRINT(ADS):   format COUNTRY $3.;
MPRINT(ADS):   label DMDC = 'Date/Time of Collection';
MPRINT(ADS):   format DMDC $16.;
MPRINT(ADS):   run;
CONCLUSION
This paper has introduced a macro called ADS that applies data set labels, variable labels and formats within a data library. We use a data set DM which has 16 variables as an illustration. It is not hard to imagine how the mapping process can be greatly enhanced if we are working on a large database that has a lot more data sets and variables.

By default, the SAS macro facility performs text substitution in a repetitive manner. Therefore it makes perfect sense to use macro variables in conjunction with PROC SQL to apply metadata attributes in analysis data sets.

REFERENCES
Clinical Data Interchange Standards Consortium (CDISC) (2005), Study Data Tabulation Model Implementation Guide: Human Clinical Trials, Austin, TX: CDISC Inc.