Having your cake and eating it too: extracting data and variable attributes from Oracle Clinical

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ABSTRACT
Extracting data from Oracle Clinical into SAS is quite straightforward but getting the variable attributes – labels, formats, etc. – is not. This paper discusses two SAS macros for extracting the data together with the variable attributes.

INTRODUCTION
SAS/Access software lets SAS users extract data from a wide range of databases including Oracle Clinical. But the procedure is plain vanilla, variable attributes such as the label and (date, time, user-defined) format are not included, just the raw data. Oracle Clinical database does contain data on labels, formats, buried here and there in obscure meta-tables. This paper shows how to query Oracle Clinical meta-tables to obtain information on variable attributes, and assign these attributes while extracting the data. This requires a two-step procedure. Macro %extract_fmt creates a format library for the study. Once this is done, macro %ocdata can be used to extract the data and assign variable attributes.

EXTRACTING DATA FROM ORACLE CLINICAL
Extracting data from Oracle Clinical is a piece of cake, provided you’re not too demanding. Here’s a simple example:

```sas
proc sql;
   connect to oracle (user='xxxxxx' orapw='xxxxxx' path='xxxxxx');
   create table demo as
   select *
   from connection to ORACLE
   (select *
    from CLQ001$current.DEMO);
   disconnect from oracle ;
quit;
```

First, a connection to the Oracle database is defined. SQL commands using Oracle syntax is “passed through” to the oracle database in the parenthesized section. The results of this passed through syntax is selected from the Oracle connection using SAS PROC SQL syntax.

After running this example, a temporary dataset called “DEMO” will be created with the contents of the Oracle Clinical table DEMO. Not too difficult. But the variables in this dataset won’t have labels, no user-defined formats will be assigned or made available. It will all be character strings and numbers.

%EXTRACT_FMT AND %OCDATA
For the purpose of this paper, let’s assume that the SAS users are demanding. They want their data, but they want their labels too, and they certainly want their user-defined formats! They want to be able to extract them quickly and easily, either as SAS datasets or as SAS views. If they misspecify something, they want to be told so nicely, by an intelligible error message. %extract_fmt and %ocdata to the rescue!

USER DEFINED FORMATS
The macros for this paper are designed to extract the data from Oracle Clinical together with variable attributes such as labels and user defined formats. The first step is to extract the user-defined formats from Oracle Clinical and store them in a format catalog. These formats are in there, somewhere in the Oracle Clinical database, tucked away in meta-tables like DISCRETE_VALUES and DISCRETE_VALUE_GROUPS. Let’s wheedle them out.
PhUSE 2007

%extract_fmt does this using the PROC SQL ‘pass-through’ facility to query Oracle meta-tables and extract information on formats stored in Oracle for the study in question. %extract_fmt creates a SAS dataset with format information which is then transformed into a format catalog using PROC FORMAT with the CNTLIN option. The SAS output prints the formats in the library specified using PROC FORMAT with the FMILIB option.

%extract_fmt creates both numeric and character formats (the character formats have the same name with a $ prefix). %extract_fmt also creates a numeric informat with the same name as the numeric format. This informat is used by %ocdata to transform character variables into numeric variables when extracting datasets. This is the main reason why %extract_fmt must be run prior to %ocdata.

%EXTRACT_FMT OPTIONS

<table>
<thead>
<tr>
<th>Option</th>
<th>Purpose</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>study</td>
<td>This must be the valid name of a study entered in the Oracle Clinical database. The parameter is not case sensitive, quotes are ignored.</td>
<td>Mandatory</td>
</tr>
<tr>
<td>library</td>
<td>A valid libname for the format catalog. Use library=work to create a temporary format catalog. Use library=library to create a permanent format catalog</td>
<td>Default library</td>
</tr>
<tr>
<td>show</td>
<td>Use show=no to prevent the contents of the format catalog from being printed</td>
<td>Default YES</td>
</tr>
<tr>
<td>rename</td>
<td>Rename invalid OC formats. Syntax: rename=old_fmt_name1=new_fmt_name1 old_fmt_name2=new_fmt_name2 old_fmt_name3=new_fmt_name3</td>
<td>Optional</td>
</tr>
<tr>
<td>v8_fmts</td>
<td>Use v8_fmts=yes to create a format catalog that is compatible with SAS version 8. Format names will be limited to 7 characters and a check will take place to determine whether some formats have the same name after truncation. In that case, the rename option should be used.</td>
<td>Default NO</td>
</tr>
<tr>
<td>user</td>
<td>The OC user name</td>
<td>Mandatory</td>
</tr>
<tr>
<td>orapw</td>
<td>The OC password</td>
<td>Mandatory</td>
</tr>
<tr>
<td>path</td>
<td>The OC path name</td>
<td>Mandatory</td>
</tr>
<tr>
<td>debug</td>
<td>Use debug=yes to print additional information and prevent temporary datasets from being deleted when macro terminates</td>
<td>Default NO</td>
</tr>
</tbody>
</table>

EXTRACTING THE DATA

Once the formats and informats have been stored in a format catalog, the data can be read and attributes can be assigned to variables. %ocdata uses the PROC SQL ‘pass-through’ facility to query Oracle meta-tables and extract information on SAS datasets, variables, labels and formats. %ocdata then reads the datasets and assigns the attributes to the variables.

Character variables for which a user-defined format is available are transformed into numeric variables and the format is assigned. This is done with the input function, using an informat created by %extract_fmt which maps character values to numeric ones. A character version of the variable with the suffix _orig is created as well.

DATE and TIME variables are also transformed during extraction. DATE variables are transformed from string to SAS date variables using the ANYTDTDE. informat and are assigned the date9. format. For TIME variables, the ANYD TIME. informat is used the hhmm. format is assigned. Here too, character versions of the variables are created with the suffix _orig.

%OCDATA OPTIONS

<table>
<thead>
<tr>
<th>Option</th>
<th>Purpose</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>study</td>
<td>This must be the valid name of a study entered in the Oracle Clinical database. The parameter is not case sensitive, quotes are ignored.</td>
<td>Mandatory</td>
</tr>
<tr>
<td>view_type</td>
<td>Name of the Oracle Clinical view type, e.g. current, test</td>
<td>Mandatory</td>
</tr>
<tr>
<td>libref</td>
<td>Name of the libref for the SAS datasets, e.g. work, input</td>
<td>Mandatory</td>
</tr>
<tr>
<td>out_type</td>
<td>Either TABLE or VIEW</td>
<td>Default TABLE</td>
</tr>
<tr>
<td>rename</td>
<td>This parameter must have the same value used in %extract_fmt</td>
<td>Optional</td>
</tr>
<tr>
<td>v8_fmts</td>
<td>This parameter must have the same value used in %extract_fmt</td>
<td>Default NO</td>
</tr>
<tr>
<td>convert</td>
<td>If convert=NO, then date and time variables and variables with a user-defined format are not converted</td>
<td>Default YES</td>
</tr>
</tbody>
</table>
### Option Purpose | Status
---|---
**sas_data_names**<br>If sas_data_names=YES, then the SAS_NAME specified in data_extract_views will used for the datasets | Default NO

**sas_var_names**<br>If sas_var_names=YES, then the SAS_NAME in template_columns for variable names | Default NO

**user**<br>The OC user name | Mandatory

**orapw**<br>The OC password | Mandatory

**path**<br>The OC path name | Mandatory

**debug**<br>Use debug=yes to print additional information and prevent temporary datasets from being deleted when macro terminates | Default NO

---

**EXAMPLE**

The `%extract_fmt` macro must always be used first in order to create the formats and informats that `%ocdata` depends on. Here’s a simple example of its use. The `%extract_fmt` macro requires a valid study name for the library parameter and a valid libref that points to the location where the format catalog is to be stored. The Oracle Clinical login parameters are always required of course.

```
%extract_fmt(study=CLQ001,library=library,user=xxxxx,orapw=xxxxx,path=xxxxx);
```

This will extract the formats from Oracle Clinical and store them in the format catalog ‘library’. `%extract_fmt` will also print a list of the formats and informs it created.

The `%extract_fmt` macro will check whether any of the format names end with a number. In addition, if v8_fmt=yes was specified, `%extract_fmt` will also check whether truncating format names causes two or more formats to have the same name. In either case, an error message is printed to the log and `%extract_fmt` should be run again using the rename option. Here is an example of the usage of the rename option:

```
%extract_fmt(study=CLQ001,library=library,\n   rename=YESNO_CDISC31=YNCDISC YESNO_CLQ=YNCLQ,\n   user=xxxxx,orapw=xxxxx,path=xxxxx);
```

Once a format catalog has been created for the study, we are ready to extract the data itself. The `%ocdata` macro requires a valid study name, a valid Oracle Clinical view type (e.g. test, current), and a valid libref for the location of the SAS datasets. For example:

```
%ocdata(study=CLQ001,view_type=CURRENT,libref=data,\n   rename=YESNO_CDISC31=YNCDISC YESNO_CLQ=YNCLQ,\n   user=xxxxx,orapw=xxxxx,path=xxxxx);
```

This statement will extract the datasets for the CLQ001 study to the location defined by the libref ‘data’. By default, the variables will use the SAS names defined in Oracle Clinical, which are limited to 8 characters. This can be overridden using the option sas_var_names=no. Likewise, the default is to use SAS dataset names defined in Oracle Clinical but this can be overridden using sas_data_names=no. If format names have been renamed in `%extract_fmt`, the same rename parameter must be defined in `%ocdata`. The default is to create SAS datasets but it also possible to create SAS views by specifying out_type=view. In the event you simply want to extract the data without assigning variable attributes, specify convert=no.

The macro starts by deriving the names of the datasets in the study from OC table data_extract_views. For each dataset, `%ocdata` queries OC meta tables to determine the attributes of each variable in the dataset. These attributes are then stored in a series of macro variables.

`%ocdata` then generates an expanded version of the PROC SQL pass-through statement at the beginning of this paper. Each variables is now specified in the select statement and variable attributes are assigned using SAS PROC SQL syntax. Variables with a date, time, or user-defined format are stored as character version with an '_orig' suffix and as a converted variable with an appropriate format.

Here’s an example of the PROC SQL syntax that `%ocdata` would generate to create a dataset:

```sas
create TABLE DATA.DEMO as select
   AGE as AGE_label="Age in AgeU at Reference Date/Time" format=2.0 ,
   BRTHDTC as BRTHDTC_ORIG label="Date/Time of Birth" format=$8. ,
   case
      when compress(BRTHDTC, '.') = '' then .
   else input(BRTHDTC, ANYDMDT.)
   end as BRTHDTC label="Date/Time of Birth" format=date9. ,
   DSSTAT as DSSTAT_ORIG label="Disposition Event Status" format=$YNCDISC. length=15 ,
   case
```
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```sas
when compress(DSSTAT,'.' )=' ' then.
else input(DSSTAT,YNCDISC.)
end as DSSTAT label="Disposition Event Status" format=YNCDISC. ,
HEIGHT as HEIGHT label="Height" format=3.0 ,
WEIGHT as WEIGHT label="Weight" format=5.1 ,
PT as PT label="Patient" format=$10. ,
STUDY as STUDY label="Clinical Study" format=$15. ,
USUBJID as USUBJID label="Unique Subject Identifier" format=$26. ,
VISIT_NUMBER as VISIT label="Visit" format=10.
from connection to ORACLE {
select * 
from CLQ001$CURRENT.DEMO
}
```

The second 'select' statement in parentheses after 'connection to ORACLE' is passed through to the Oracle database just as in the first example. It selects all data from the Oracle Clinical table DEMO. The first select statement uses SAS PROC SQL syntax to select the data for the connection to Oracle while adding labels and other attributes.

BRTHDTC is an example of a date variable. First, a character version is saved as BRTHDTC_ORIG. Then a date variable BRTHDTC is derived and associated with format date9. DSSTAT is an example of a variable with a user-defined format. A formatted character version DSSTAT_ORIG is created, followed by a formatted numeric version under the name DSSTAT. Of course, this requires that format $YNCDISC. and informat YNCDISC. have been created in a format catalog by %extract_fmt.

KNOWN ISSUES

The %extract_fmt and %ocdata macros work wonderfully for the most part. One important limitation though is that %ocdata can't deal with partial dates or time values. Partial date/time values will become missing values, which is one of the reasons why it's important that the original character values are extracted as well.

Another minor shortcoming is that variables are extracted in alphabetical order rather than the order in which they were defined in Oracle Clinical. Actually, the variables are extracted in alphabetical order within the dataset variables and the key variables (pt, study, usubjid and visit_number) in the example above.

Of course, it's quite conceivable that there are many unknown issues, e.g. because the macros are dependent on certain conventions at our department of data management. It's important to validate the macros to verify that all datasets for the study have been extracted with all cases and variables accounted for and that transformed variables correspond with their original counterparts.

CONCLUSION

These macros make it easy to extract data from an Oracle Clinical database with variable attributes properly assigned. They are fairly user friendly, parameters are not case sensitive and the macros will terminate with an error message for common cases of misspecification. My experience is that the macros work well, with the caveats mentioned in the above paragraph.

REFERENCES


ACKNOWLEDGMENTS

These macros build forth on the PharmaSUG papers by Kyle McBride and that by Angela Ringelberg. Part of the code of Kyle McBride's %oc_extract_defs macro is used in %ocdata. %ocdata also uses certain utility functions by Roland Rashleigh-Berry which are available at [http://www.datasavantconsulting.com/roland/sasautos.html](http://www.datasavantconsulting.com/roland/sasautos.html).

Like Kyle McBride's %oc_extract_defs macro, %extract_fmt and %ocdata are free to use and to modify, provided a reference to the original author is maintained.
CONTACT INFORMATION
Your comments and questions are valued and encouraged. Contact the author at:

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APPENDIX A: THE %EXTRACT_FMT MACRO

/*
 *********************************************/
Macro accompanying the PhUSE 2007 paper
Having your cake and eating it too: extracting data and variable attributes
from Oracle Clinical

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For information on the use of this macro, please refer to the paper.

This macro is intended for use in conjunction with the %ocdata macro.

This code may be modified and used free of charge provided a reference to the
original author is maintained.

The %WORDS macros called by this macro was written
by Roland Rashleigh-Berry (rolandberry@hotmail.com)
These macros and further information on their use are available at
http://www.datasavantconsulting.com/roland/sasautos.html

 *********************************************/

%macro extract_fmt(study=,library=,rename=,v8_fmts=NO,
user=ops$stat,orapw=,path=,show=Y,debug=NO)
%local nopr print allfmts allfmts2 elems rnm s i;
%if %length(&study) eq 0 %then %do;
%put ERROR: No study specified;
%goto exit_macro;
%end;
%end;
%if %length(&library) eq 0 %then %do;
%put ERROR: No library specified;
%goto exit_macro;
%end;
%let library=%upcase(%sysfunc(dequote(&library)));
%if %sysfunc(libref(&library)) %then %do;
%put ERROR: library &library not defined;
%goto exit_macro;
%end;
%end;
%if %length(&rename) ne 0 %then %do;
%let rename=%upcase(&rename);
%let rnm s=%words(&rename,deli m=%str( = ));
%if %eval(&rnm s - (&rnm s/2)*2) %then %do;
%put ERROR: rename statement was misspecified (&rename);
%goto exitMacro;
%end;
%end;
%let show=%substr(%upcase(&show),1,1);
%let debug=%substr(%upcase(&debug),1,1);
%let v8_fmts=%substr(%upcase(&v8_fmts),1,1);
%if &debug eq N %then %let nopr print=nopr print;
proc sql nopr print;
   connect to oracle (user="%sysfunc(dequote(&user))"
orapw="%sysfunc(dequote(&orapw))"
path="%sysfunc(dequote(&path))");
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/* get clinical_study_id for study=CTOxxx */
select clinical_study_id
into :id
from connection to ORACLE
(select clinical_study_id, study
from CLINICAL_STUDIES)
where study="&study";

/* ids of formats used in study */
Create table _ex_dcmq as
(select * from connection to ORACLE
(select distinct discrete_val_grp_id as id,
 discrete_val_grp_subset_nm as subset,
 clinical_study_id as study
from DCM_questions)
where study = "id" and
id ^= . and
subset ^= .)
;

/* format codes and labels read in 3 times:
 for numeric formats, character formats
 and numeric informats */
create table _ex_dv as
(select * from connection to ORACLE
(select distinct discrete_value_dvg_id as id,
 discrete_value_dvg_subset_nm as subset,
to_char(display_sn) as strt,
long_label_description as label,
'N' as type
from discrete_values
union
select distinct discrete_value_dvg_id as id,
 discrete_value_dvg_subset_nm as subset,
discrete_value_value as strt,
long_label_description as label,
'C' as type
from discrete_values
union
select distinct discrete_value_dvg_id as id,
 discrete_value_dvg_subset_nm as subset,
discrete_value_value as strt,
to_char(display_sn) as label,
'I' as type
from discrete_values));

/* format names (fmtname) */
create table _ex_dvg as
(select * from connection to ORACLE
(select distinct discrete_value_grp_id as id,
 discrete_val_grp_subset_num as subset,
name as fmtname
from DISCRETE_VALUE_GROUPS));

/* merge the three tables using id and subset as keys */
/* 'blank' as hlo to prevent character value "other"
 from being interpeted as "other values" */
create table _ex_fmt as
select type,
 fmtname,
 dv.subset as subset,
 strt as start,
 trim(label) as label,
 ' ' as hlo
from _ex_dv dv, _ex_dvg dvg, _ex_dcmq dcmq
where dv.id = dvg.id and dvg.id = dcmq.id and
dv.subset=dvg.subset and dvg.subset=dcmq.subset
order by type, fmtname, start, subset desc;

/* Get the number of format names before renaming and truncating */
select distinct fmtname
%let nfmts=%words(&allfmts);
create table __ex_fmt2 as
  select type,
  case
    %if %length(&rename) ne 0 %then $do $to &rename $by 2;
    when fmtname="%scan(&rename,&i,$str(=))" then
      %scan(&rename,$eval($i+1),$str(=))
  %end;
  %else $do;
    when type='N' then substr(fmtname,1,7)
  %end;
%if &v8_fmts eq Y %then %do;
    redundant when statement added for when rename is not used;
    when type='N' then fmtname
  %end;
end as fmtname,
  subset, start, label, hlo
from __ex_fmt;

select distinct fmtname
  into : allfmts2 separated by ' '
  from __ex_fmt2;

%if %words(&allfmts) ne %words(&allfmts2) %then $do;
  %put ERROR: Truncating/renameing format names resulted in an error;
  %put ERROR: Before: &allfmts;
  %put ERROR: After : &allfmts2;
  quit;
%goto exit_macro;
%end;

/* check for invalid format names */
%put format names before: &allfmts;
%put format names after : &allfmts2;
%let elems=%prxmatch(&allfmts2,\d+$/);
%if %length(&elems) ne 0 %then $do;
  %put ERROR: format names ending with one or more digits;
  %put ERROR: &elems;
  quit;
%goto exit_macro;
%end;

disconnect from oracle ;
quit;

/* view created by extract_fmt macro is sorted by type, fmtname, start, subset desc sort using nodupkey option to select only the highest subset value */
proc sort data=__ex_fmt2 nodupkey out=__ex_fmtset;
  by type fmtname start;
run;

/* create the catalog */
proc format library=&lib fmtlib=
  __ex_fmtset;
run;

%if &show eq Y %then %do;
  proc format library=&lib;
run;
%end;

%if &debug EQ N %then %do;
  proc datasets library=work memtype=data nolist;
    delete __ex;
  quit;
%end;
Based on %rxmatch by Roland Rashleigh-Berry (rolandberry@hotmail.com)

%macro prxmatch(list,prxpattern);
  %local prx i;
  %let prx=%sysfunc(prxparse(&prxpattern));
  %do i=1 %to %words(&list);
    %if %sysfunc(prxmatch(&prx,%scan(&list,&i,%str( ))) %then %scan(&list,&i,%str( ));
  %end;
  %syscall prxfree(prx);
%mend;

/*
Macro WORDS
by Roland Rashleigh-Berry (rolandberry@hotmail.com)
These macros and further information on their use are available at http://www.datasavantconsulting.com/roland/sasautos.html
*/
%macro words(str,delim=%str( ));
  %local i;
  %let i=1;
  %do %while(%length(%scan(&str,&i,&delim)) GT 0);
    %let i=%eval(&i + 1);
  %end;
  %eval(&i - 1)
%mend;
APPENDIX B: THE %OCDATA MACRO

/*
 *******************************************
 Macro accompanying the PhUSE 2007 paper
 Having your cake and eating it too: extracting data and variable attributes
 from Oracle Clinical

 By
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 For information on the use of this macro, please refer to the paper.

 This macro is intended for use in conjunction with the %extract_fmt macro.

 This code may be modified and used free of charge provided a reference to the
 original author is maintained.

 Note: Parts of this macro were taken from the %OC_EXTRACT_DEFS macro in
 Kyle McBride’s paper "Automating the Documentation of Oracle Clinical Database
 Specifications", presented at PharmaSUG 2004

 The %WORDS, %MATCH %NODUP and %VARLIST macros called by this macro were written
 by Roland Rashleigh-Berry (rolandberry@hotmail.com).
 These macros and further information on their use are available at
 http://www.datasavantconsulting.com/roland/sasautos.html
 *******************************************
 */

%macro ocdata(study=,view_type=,libref=,out_type=table,rename=,convert=YES,
              sas_data_names=YES, sas_var_names=YES,v8_fmts=NO,
              user=,orapw=,path=,debug=NO);
%local nprint;
%let convert=%substr(%upcase(&convert),1,1);
%let sas_data_names=%substr(%upcase(&sas_data_names),1,1);
%let sas_var_names=%substr(%upcase(&sas_var_names),1,1);
%let v8_fmts=%substr(%upcase(&v8_fmts),1,1);
%let debug=%substr(%upcase(&debug),1,1);
%if &debug eq N %then %let nprint=noprint;
%if %length(&study) eq 0 %then %do;
  %put ERROR: No study specified;
  %goto exit_macro;
%end;
%if %length(&view_type) eq 0 %then %do;
  %put ERROR: No view type specified;
  %goto exit_macro;
%end;
%let view_type=%upcase(%sysfunc(dequote(&view_type)));
%if %length(&libref) eq 0 %then %let libref=WORK;
%let libref=%upcase(%sysfunc(dequote(&libref)));
%if %sysfunc(libref(&libref)) %then %do;
  %put ERROR: libref &libref not defined;
  %goto exit_macro;
%end;
%let out_type=%trim(%upcase(%sysfunc(dequote(&out_type))));
%if &out_type ne TABLE & &out_type ne VIEW %then %do;
  %put ERROR: out_type must be either TABLE or VIEW;
  %goto exit_macro;
%end;
PhUSE 2007

%end;

%if %length(rename) ne 0 %then %do;
  %let rename=%qcases(rename);
  %let rnm=%words(rename,dell=%str( = ));
%if %eval(%rnm = (%rnm/2)^2) %then %do;
    %put ERROR: rename statement was misspecified (rename);
    %goto exit_macro;
%end;
%end;

proc sql nocprint;
  connect to oracle (user="%sysfunc(dequote(&user))"
    orapw="%sysfunc(dequote(&orapw))"
    path="%sysfunc(dequote(&path))") ;
  /* extract clinical_study_id for this study as key
     for subsequent selections */
  select clinical_study_id into :id
    from connection to ORACLE
    (select clinical_study_id, study
     from CLINICAL_STUDIES)
    where study="&study";
%if &sqlrc ne 0 %then %do;
  %put ERROR: Querying clinical_study_id for &study produced an SQL error (&sqlrc);
  %goto exit;
%end;
%end;

%local ndata;
%let ndata=&sqlobs;
%put ndata=&ndata;

/* just use the OC dataset names by default */
%if &sas_data_names eq N %then %let sname_list=%name_list;

%local i tid ktid name sname;
%do i=1 %to &ndata;
%let tid=%qscan( &tid_list,&i,%str( ));
%let ktid=%qscan( &ktid_list,&i,%str( ));
%let name=%qscan( &name_list,&i,%str( ));
%let sname=%qscan(&sname_list,&i,%str( ));
/ * if an external view was created then there is no information on 
 variable attributes in any of the meta tables 
 tid and ktid will be either periods '.' or blank 
 Present solution is to extract the data as is, 
 without labels or formats */
%if %length(%sysfunc(compress( &tid,','))) eq 0 |%length(%sysfunc(compress( &ktid,','))) eq 0 %then %do;
create table &libref..&name as
(select * from connection to ORACLE
(select * from &study.$&view_type..&name));
%put;
%put NOTE: No variable attributes could be extracted for dataset
&libref..&name;
%end;
%else %do;
%get_data(&tid,&ktid,&name,&sname);
%end;
%end;
%exit:
disconnect from oracle;
quit;
%if &debug EQ N %then %do;
proc datasets library=work memtype=data nolist;
delete _oc;
quit;
%end;
%exit_macro:
%mend;
%macro get_data(tid,ktid,name,sname);
create table _oc_dat_info as
select * from connection to ORACLE
(select distinct
 to_number(NULL) dcm_id,
 to_number(NULL) dcm_que_dcm_subset_sn,
 &tid template_id,
 &ktid key_template_id,
 %str('%name%') view_name,
 tc.name oracle_name,
 tc.sas_name,
 tc.sas_label,
 'ORACLE_VARIABLE' attribute_name,
 em.data_type_code type,
 em.length,
 to_char(NULL) defined_format,
 em.sas_format sas_format
from template_columns tc,
extract_macros em
where tc.template_id = &ktid
and tc.key_extract_macro_id = em.extract_macro_id
UNION
select distinct
 dcmq.dcm_id,
 dcmq.dcm_que_dcm_subset_sn,
 &tid template_id,
 &ktid key_template_id,
 %str('%name%') view_name,
 tc.name oracle_name,
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tc.sas_name,
tc.sas_label,
tc.attribute_name,
dcmq.question_data_type_code type,
dcmq.length,
dvg.name defined_format,
case
  when tc.attribute_name='DVG_NUMBER'
    then substr(dvg.name,1,8)||'.'
  when dcmq.question_data_type_code = 'NUMBER'
    then dcmq.length+least(1,dcmq.decimal_places) || '.'
    dcmq.decimal_places
  when dcmq.question_data_type_code in ('CHAR','DATE')
    then '%$'||dcmq.length||'.'
  else to_char(NULL)
end as sas_format
from template_columns tc,
  view_template_questions vtq,
  view_question_mappings vqm,
  dcm_questions dcmq,
  discrete_value_groups dv,
dci_modules dm
where tc.template_id = &tid
  and tc.template_question_id = vtq.view_template_question_id
  and vtq.view_template_question_id = vqm.parent_question_id
  and vtq.question_id = vqm.question_id
  and vqm.dcm_question_id = dcmq.dcm_question_id
  and vqm.dcm_occurrence_sn = dcmq.occurrence_sn
  and dcmq.discrete_valgrp_id = dv.discrete_value_grp_id (+)
  and dcmq.discrete_valgrp_subset_num=dv.discrete_valgrp_subset_num (+)
  and dcmq.dcm_id = dm.dcm_id
  and dcmq.dcm_que_dcm_subset_sn = dm.dcm_subset_sn
having dcm_que_dcm_subset_sn =
  max(dcm_que_dcm_subset_sn) or
  dcm_que_dcm_subset_sn = .;

%local i nvar;
%let nvar=&sqlobs;
select oracle_name,
  %if &sas_var_names eq N %then %do;
    oracle_name as sas_name,
  %end;
  %else %do;
    sas_name,
  %end;
  sas_label,
  %if %length(&rename) ne 0 %then %do;
    defined_format,
    %case defined_format
      %do i=1 %to &rnms %by 2;
        %if %scan(&rename,i,%str(=)) then
          %scan(&rename,%eval(&i+1),%str(=))
      %end;
    %end;
  %end;
  sas_format,
  type,
  length
into :var1:var&nvar,
    :svar1:svar&nvar,
  :lab1:lab&nvar,
    :fmt1:fmt&nvar,
  :sasfmt1:sasfmt&nvar,
  :type1:type&nvar,
    :length1:length&nvar
from __oc_dat_info;
%if %length(&nvar) eq 0 %then %do;
%put ERROR: No variables found for TID=&tid, KTID=&KTID, name=&name, sname=&sname; goto exit;
end;
@if &nvar < 1 %then %do;
%put ERROR: Zero variables found for TID=&tid, KTID=&KTID, name=&name, sname=&sname;
%goto exit;
@end;
@if &nvar > 100 %then %do;
%put ERROR: More than 100 variables found for TID=&tid, KTID=&KTID, name=&name, sname=&sname;
%goto exit;
@end;
/* extract the dataset from OC without any formatting, check whether the variable names derived from OC are correct */
create table _octmp as
select * from connection to ORACLE
(select * from &study.&view_type..&name);
@if &sqlrc ne 0 %then %do;
%put ERROR: Table &study.&view_type..&name could not be extracted;
%goto exit;
@end;
%local j allvars;
%do j=1 %to &nvar;
%let allvars=&allvars &&var&j;
%end;
@if %words(%match(&allvars,&varlist(_octmp))) ne &nvar %then %do;
%put ERROR: The OC tables did not produce the correct set of variables;
%put WARNING: &name: &varlist(_octmp);
%put WARNING: derived: &allvars;
%put WARNING: &libref..&name will be created without attributes;
create table &libref..&name as select * from _octmp;
%goto exit;
%end;
/* create the dataset with attributes */
%local comma cfmt fmt nfmt;
create &out_type &libref..&name as select
%let comma=,
%do j=1 %to &nvar;
/* %put <&&var&j> <&&type&j> <&&fmt&j> <&&sasfmt&j> ;*/
%if &j eq &nvar %then %let comma=;
%if &type&j eq TIME & %str(%substr(&sasfmt&j,1,1)) eq $ & %convert eq Y %then %do;
&&var&j as &&svar&j.._ORIG label="&&lab&j" format=&fmt. &comma
%end;
%else when compress(&var&j,' ') = ' ' then .
else input(&var&j,ANYDTIME.)
end as &&svar&j label="&&lab&j" format=hhmm. &comma
%end;
%else when compress(&var&j,' ') = ' ' then .
else input(&var&j,ANYYMDT.)
end as &&svar&j label="&&lab&j" format=date9. &comma
%end;
%else if %length(&fmt&j) eq 0 & %length(&sasfmt&j) ne 0 %then %do;
/* no user defined format: */
&&var&j as &&svar&j label="&&lab&j" format=&sasfmt&j &comma
%end;
%else if &type&j eq CHAR & %convert eq Y %then %do;
%if &v8_fmts eq Y %then %do;
%
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%let cfmt=%substr(&fmt&j,1,7);
%let ifmt= %substr(&fmt&j,1,7);
%let nfmt= %substr(&fmt&j,1,7);
$end;
%else $do;
  %let cfmt=&&fmt&j;
  %let ifmt=&&fmt&j;
  %let nfmt=&&fmt&j;
$end;
&&var&j as &&var&j...ORIG
  label="&&lab&j" format=&cfmt length=&length&j &comma
  case
    when compress(&&var&j,'.')=' ' then .
    else input(&&var&j,&&ifmt)
  end as &&var&j label="&&lab&j" format=&nfmt &comma
%end;
%else $if &&type&j eq NUMBER & convert eq Y $then $do;
  &&var&j as &&var&j label="&&lab&j" format=&nfmt &comma
%end;
%else $do;
  &&var&j as &&var&j label="&&lab&j" &comma
$end;
$end;
from connection to ORACLE
  (select *
   from &study.$&view_type..&name);
/* disconnect from oracle ;*/
/*quit;*/
$exit:
%mend;
%macro substrn(string, position, length);
  %if %length(&length) eq 0 %then %sysfunc(substrn(&string,&position));
  %else %sysfunc(substrn(&string,&position,&length));
%mend;
/*
Based on %rxmatch by Roland Rashleigh-Berry (rolandberry@hotmail.com)
*/
%macro prxmatch(list,prxpattern);
  %local prx i;
  %let prx=%qsysfunc(prxparse(&prxpattern));
  %do i=1 %to %words(&list);
    %if %sysfunc(prxmatch(&prx,%scan(&list,&i,%str( ))) %then %scan(&list,&i,%str( ))
  %end;
  %syscall prxfree(prx);
%mend;
/*
Macros WORDS MATCH NODUP and VARLIST
by Roland Rashleigh-Berry (rolandberry@hotmail.com)
These macros and further information on their use are available at
http://www.datasavantconsulting.com/roland/sasautos.html
*/
%macro words(str,delim=%str( ));
  %local i;
  %let i=1;
  %do %while(%length(%qscan(&str,&i,&delim)) GT 0);
    %let i=%eval(&i + 1);
  %end;
  %eval(&i - 1)
%mend;
%macro match(ref,list,nodup=yes,casesens=no,fixcase=no);
  %local error list2 nref nlist i j item match refitem;
  %let error=0;
  %for
    %let i=%eval(1);
    %do %while(%length(%qscan(&ref,list,i,%str( ))) GT 0);
      %let i=%eval(&i + 1);
    %end;
    %let error=%eval(error + 1);
    %end;
  %end;
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%global _nomatch;
%let _nomatch=_;

%let nodup=%upcase(%substr(&nodup,1,1));
%let casesens=%upcase(%substr(&casesens,1,1));
%let fixcase=%upcase(%substr(&fixcase,1,1));

%if "&nodup" EQ "Y" %then %let list2=%nodup(&list,casesens=&casesens);
%else %let list2=&list;

%let nref=%words(&ref);
%let nlist=%words(&list2);

%if not &nref %then %do;
  %put ERROR: (match) No elements in reference list;
  %let error=1;
%end;

%if not &nlist %then %do;
  %put ERROR: (match) No elements in list under test;
  %let error=1;
%end;

%if &error %then %goto error;

%do i=1 %to &nlist;
  %let item=%scan(&list2,&i,%str( ));
  %let match=NO;
  %do j=1 %to &nref;
    %let refitem=%scan(&ref,&j,%str( ));
    %if "%casesens" EQ "N" %then %do;
      %if "%upcase(&item)" EQ "%upcase(&refitem)" %then %do;
        %let match=YES;
        %let j=&nref;
      %end;
    %end;
  %end;
  %else %do;
    %if "&item" EQ "&refitem" %then %do;
      %let match=YES;
      %let j=&nref;
    %end;
  %end;
%end;

%if &match EQ YES %then %do;
  %if "&fixcase" EQ "N" %then &item;
  %else &refitem;
%end;
%else %let _nomatch=_nomatch &_item;
%end;
%goto skip;
%error: %put ERROR: (match) Leaving match macro due to error(s) listed.;
%skip;
%end;

%macro nodup(list,casesens=no);
%local i j match item error;
%let error=0;
%if not %length(&casesens) %then %let casesens=no;
%let casesens=%upcase(%substr(&casesens,1,1));

%if not %index(YN,&casesens) %then %do;
  %put ERROR: (nodup) casesens must nbe set to yes or no;
  %let error=1;
%end;

%if &error %then %goto error;

%do i=1 %to %words(&list);
  %let item=%scan(&list,&i,%str( ));
  %let match=NO;

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%if &i LT @words(&list) %then %do;
  %do j=%eval(&i+1) %to @words(&list);
  %if &casesens EQ Y %then %do;
    %if "&item" EQ "%scan(&list,&j,%str( ))" %then %let match=YES;
  %end;
  %else %do;
    %if "&upcase(&item)" EQ "%upcase(%scan(&list,&j,%str( )))"
    %then %let match=YES;
  %end;
%end;
%if &match EQ NO %then &item;
%end;
%error: %put ERROR: (nodup) Leaving nodup macro due to error(s) listed.;
%skip:
%end;
%macro varlist(ds);
  %local dsid rc nvars i varlist;
  %let dsid=%sysfunc(open(&ds,is));
  %if &dsid EQ 0 %then %do;
    %put ERROR: (varlist) Dataset &ds not opened due to the following reason:;
    %put %sysfunc(sysmsg());
  %end;
  %else %do;
    %let nvars=%sysfunc(attrn(&dsid,nvars));
    %if &nvars LT 1 %then %put ERROR: (varlist) No variables in dataset &ds;
    %else %do;
      %do i=1 %to &nvars;
        %let varlist=%sysfunc(varname(&dsid,&i));
        %if %length(&varlist) EQ 0 %then %let varlist=$varlist %sysfunc(varname(&dsid,&i));
      %end;
      %let rc=%sysfunc(close(&dsid));
      %end;
      %let rc=%sysfunc(close(&dsid));
    %end;
    %end;
%end;
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