



Paper CT05:

CALL EXECUTE will figure it out: Data-driven Figure Programming



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Graphs in Clinical Trials

- Better way of understanding results
- Mean plots, Individual concentration plots, etc
- Multiple repeats needed for varying:
 - Study population
 - Parts
 - Periods
 - Treatment groups
 - Parameters of Interest
 - Type – linear, semi-logarithmic, actual values, change from baseline
- BY statement of SAS/GRAPH®
 - can be used
 - limited control on presentation of varying attributes



I will create a figure macro!

- Linear and Semi Logarithmic mean plots
- Study information

- Part 1

- 0 – 24hr timepoint

- 2 parameters with varying units

- Part 2

- 0 – 72hr timepoint

- 2 parameters with varying units

```
%plot_series( in_data      = /* Name of input dataset */  
              , subset     = /* WHERE statement condition */  
              , groupvar   = /* Treatment variable */  
              , xvar       = /* X-axis variable */  
              , xlabel     = /* X-axis label */  
              , yvar       = /* Y-axis variable */  
              , ytype      = /* Type of y-axis to be used, DISCRETE | LINEAR | LOG | TIME */  
              , legend_title = /* Text for the legend */  
              , fix_value   = /* Values for the ticks on the x-axis */  
              , ylabel     = /* Y-axis label */  
              );
```



Macro Call #1

- Study Part 1 : 0 – 24 hr timepoint
- First parameter
- Linear Plot

```
* 1st param - linear;  
title1 j=1 "Part 1" ;  
title1 j=1 "Analyte: XXX1" j=r "Linear Scale";  
%plot_series( in_data = adpc  
              , subset = partn = 1 and paramn = 10  
              , groupvar = trtpn  
              , xvar = atptn  
              , xlabel = Timepoint  
              , yvar = aval  
              , ytype = linear  
              , legend_title= Treatment:  
              , fix_xvalues = 0 to 24 by 2  
              , ylabel = Plasma Concentration (ng/mL)  
              );
```



Macro Call #2

- Study Part 1 : 0 – 24 hr timepoint
- First parameter
- Semi Logarithmic Plot

```
* 1st param - semi log;
title1 j=1 "Part 1" ;
title1 j=1 "Analyte: XXX1" j=r "Semi-Logarithmic Scale";
%plot_series( in_data      = adpc
              , subset    = partn = 1 and paramn = 10
              , groupvar  = trtpn
              , xvar      = atptn
              , xlabel    = Timepoint
              , yvar      = aval
              , ytype     = log
              , legend_title= Treatment:
              , fix_xvalues = 0 to 24 by 2
              , ylabel    = Plasma Concentration (ng/mL)
              );
```



Macro Call #3

- Study Part 1 : 0 – 24 hr timepoint
- Second parameter
- Linear Plot

```
* 2nd param - linear;
title1 j=1 "Part 1" ;
title1 j=1 "Analyte: XXX2" j=r "Linear Scale";
%plot_series( in_data      = adpc
              , subset    = partn = 1 and paramn = 20
              , groupvar  = trtpn
              , xvar      = atptn
              , xlabel    = Timepoint
              , yvar      = aval
              , ytype     = linear
              , legend_title= Treatment:
              , fix_xvalues = 0 to 24 by 2
              , ylabel    = Plasma Concentration (ng[Eq]/mL)
              );
```



Macro Call #4

- Study Part 1 : 0 – 24 hr timepoint
- Second parameter
- Semi Logarithmic Plot

```
*2nd param - semi log;  
title1 j=1 "Part 1";  
title2 j=1 "Analyte XXX2" j=r "Semi-Logarithmic Scale";  
%plot_series( in_data = adpc  
              , subset = partn = 1 and paramn = 20  
              , groupvar = trtpn  
              , xvar = atptn  
              , xlabel = Timepoint  
              , yvar = aval  
              , ytype = log  
              , legend_title = Treatment:  
              , fix_value = 0 to 24 by 2  
              , ylabel = Plasma Concentration (ng[Eq]/mL)  
              );
```



Macro Call #5

- Study Part 2 : 0 – 72 hr timepoint
- First parameter
- Linear Plot

```
*1st param - linear;  
title1 j=1 "Part 2";  
title2 j=1 "Analyte XXX1" j=r "Linear Scale";  
%plot_series( in_data = adpc  
              , subset = partn = 2 and paramn = 10  
              , groupvar = trtpn  
              , xvar = atptn  
              , xlabel = Timepoint  
              , yvar = aval  
              , ytype = linear  
              , legend_title = Treatment:  
              , fix_value = 0 to 72 by 2  
              , ylabel = Plasma Concentration (ng/mL)  
              );
```



Macro Call #6

- Study Part 2 : 0 – 72 hr timepoint
- First parameter
- Semi Logarithmic Plot

```
*1st param - semi log;  
title1 j=1 "Part 2";  
title2 j=1 "Analyte XXX1" j=r "Semi-Logarithmic Scale";  
%plot_series( in_data = adpc  
              , subset = partn = 2 and paramn = 10  
              , groupvar = trtpn  
              , xvar = atptn  
              , xlabel = Timepoint  
              , yvar = aval  
              , ytype = log  
              , legend_title = Treatment:  
              , fix_value = 0 to 72 by 2  
              , ylabel = Plasma Concentration (ng/mL)  
              );
```



Macro Call #7

- Study Part 2 : 0 – 72 hr timepoint
- Second parameter
- Linear Plot

```
*2nd param - linear;  
title1 j=1 "Part 2";  
title2 j=1 "Analyte XXX2" j=r "Linear Scale";  
%plot_series( in_data = adpc  
              , subset = partn = 2 and paramn = 20  
              , groupvar = trtpn  
              , xvar = atptn  
              , xlabel = Timepoint  
              , yvar = aval  
              , ytype = linear  
              , legend_title = Treatment:  
              , fix_value = 0 to 72 by 2  
              , ylabel = Plasma Concentration (ng[Eq]/mL)  
              );
```



Macro Call #8

- Study Part 2 : 0 – 72 hr timepoint
- Second parameter
- Semi Logarithmic Plot

```
*2nd param - semi log;  
title1 j=1 "Part 2";  
title2 j=1 "Analyte XXX2" j=r "Semi-Logarithmic Scale";  
%plot_series( in_data = adpc  
              , subset = partn = 2 and paramn = 20  
              , groupvar = trtpn  
              , xvar = atptn  
              , xlabel = Timepoint  
              , yvar = aval  
              , ytype = log  
              , legend_title = Treatment:  
              , fix_value = 0 to 72 by 2  
              , ylabel = Plasma Concentration (ng[Eq]/mL)  
              );
```



Figure Macro Creation Success!

BUT....

- Blocks of repeat macro calls – lot of space in the program
- Not data driven
 - manual macro inputs
 - hard to maintain especially when data is not yet final

What if...



```
DATA _null_;
  SET in_data ;
  ...

  * First sample call;
  * * Title1 setup;
  CALL EXECUTE ('TITLE1 J=L H=9PT "Study Part: ' || strip(part) || '" J=R "Parameter: ' || strip(param) || '";' );
  * * Title2 setup;
  CALL EXECUTE ('TITLE2 J=R H=9PT "Linear Scale";');
  * * Figure macro call ;
  cmd1 = CATS('%nrstr(%plot_series( in_data      = tmp
                                   , groupvar    = trtan
                                   , xvar        = atptn
                                   , xlabel      = Timepoint
                                   , yvar        = aval
                                   , ytype       = linear
                                   , legend_title= Treatment: '
                                   , ', fix_xvalues = ', xvalues
                                   , ', ylabel      = ', ylabel
                                   , '));'
              );
  CALL EXECUTE (cmd1);
```

CALL EXECUTE



- DATA Step Call Routines for Macros
- Syntax

```
CALL EXECUTE (argument);
```

Required Argument

- a character string, enclosed in quotation marks

```
CALL EXECUTE ( '%macroname;' );
```

- the name of a DATA step character variable whose value is a text expression or a SAS statement to be generated

```
CALL EXECUTE (varname);
```

- a character expression that is resolved by the DATA step to a macro text expression or a SAS statement

```
CALL EXECUTE ( '%macroname (' || paramvalue || ');' );
```



Implementing CALL EXECUTE in Figure Programming

1. Figure macro creation
2. Figure attributes setup in a DATA STEP
3. Figure macro calls execution in the same DATA STEP



1st step: Figure Macro Creation

- Freedom on assigning figure attributes and ease in sub setting the data

```
%MACRO plot_series
  ( in_data      =
    , subset      =
    , groupvar    =
    , groupfmt    =
    , xvar        =
    , xlabel      =
    , fix_xvalues =
    , fmt_xvalues =
    , yvar        =
    , ylabel      =
    , ytype       = linear
    , att_m       =
    , att_id      =
    , legend_title=
  );

PROC SGPLOT DATA = &in_data.
  %IF %LENGTH(&att_m.) > 0 %THEN DATTRMAP = &att_m. ;
  NOAUTOLEGEND
  ;
  %IF %LENGTH(&subset.) > 0 %THEN %DO;
    %STR(WHERE &subset.);
  %END;

  %IF %LENGTH(&groupfmt.) > 0 %THEN FORMAT &groupvar. &groupfmt;;
  SERIES X = &xvar Y = &yvar /
    %IF %LENGTH(&groupvar.) > 0 %THEN GROUP      = &groupvar.;
    MARKERS
    %IF %LENGTH(&att_id.) > 0 %THEN ATTRID      = &att_id.;
    LINEATTRS = (PATTERN = 1)
    NAME      = "series"
  ;
```

2nd step: Figure Attributes Setup



```
PROC SORT DATA = in_data;
  BY partn paramn;
RUN;
```

← Sorting = Sequence of macro calls

```
DATA _null_;
  SET in_data END=LAST;
  BY partn paramn;

  LENGTH cmd cmd1 cmd2 $ 2000 ylabel xvalues xformat subset $200;
```

```
IF LAST.paramn THEN DO; ← Call the macro for unique occurrence
```

```
* Variable(s) for varying y-axis label;
YLABEL = 'Absolute Value (' || STRIP(paramu) || ')';

* Variable for varying x-values / x-value format;
IF partn = 1 THEN do;
  xvalues = "&xvalues1.";
  xformat = 'name_format1.';
END;
ELSE IF partn = 2 THEN DO;
  xvalues = "&xvalues2.";
  xformat = 'name_format2.';
END;
```

← Input for **ylabel** macro parameter

← Input for **fix_xvalues** macro parameter

← Input for **fmt_xvalues** macro parameter



3rd step: CALL EXECUTE routines in the DATA STEP

- Subsetting the input data to only the unique BY variables occurrence

```
cmd = CATS('DATA tmp; SET in_data (WHERE = (paramn =', paramn, ' AND partn =', partn, ')); RUN;');  
CALL EXECUTE (cmd) ;
```

← Argument Option #2

- Invoking TITLE statements

```
* * Title1 setup;  
CALL EXECUTE ('TITLE1 J=L H=9PT "Study Part: ' || strip(part) || '" J=R "Parameter: ' || strip(param) || '";')  
* * Title2 setup;  
CALL EXECUTE ('TITLE2 J=R H=9PT "Linear Scale";');
```

← Argument Option #1

← Argument Option #3



3rd step: CALL EXECUTE routines in the DATA STEP

- %plot_series macro call is stored to cmd1
- 'macro blind' by using the %NRSTR MACRO function

```
* * Figure macro call ;
cmd1 = CATS('%nrstr(%plot_series( in_data      = tmp
                                , groupvar    = trtan
                                , xvar        = atptn
                                , xlabel      = Timepoint
                                , yvar        = aval
                                , ytype       = linear
                                , legend_title= Treatment: '
                                , ', fix_xvalues = ', xvalues
                                , ', ylabel     = ', ylabel
                                , '));'
                                );
CALL EXECUTE (cmd1);
```



3rd step: CALL EXECUTE routines in the DATA STEP

- 2nd macro call for the semi logarithmic plot
- Same DATA STEP

```
* Second sample call - Semi Logarithmic Plot;
* * Title1 setup ;
CALL EXECUTE ('TITLE1 J=L H=9PT "Study Part: ' || strip(part) || '" J=R "Parameter: ' || strip(param) || '";') ;
* * Title2 setup ;
CALL EXECUTE ('TITLE2 J=R H=9PT "SemiLogarithmic Scale";');
* * Figure macro call ;
cmd2 = CATS('%nrstr(%plot_series( in_data      = tmp
                                , groupvar    = trtan
                                , xvar        = atptn
                                , xlabel      = Timepoint
                                , yvar        = aval
                                , ytype       = log
                                , legend_title= 'treatment: '
                                , ' , fix_xvalues = ' , xvalues
                                , ' , ylabel     = ' , ylabel
                                , '));'
            );
CALL EXECUTE (cmd2);
```



CALL EXECUTE in Figure Programming Recap

1. Figure macro creation
 - %plot_series macro was created
2. Figure attributes setup in a DATA step
 - ylabel and xvalues variable were created as macro parameter inputs
3. CALL EXECUTE routines in the same DATA step
 - routine for sub setting the input data
 - routine for invoking titles
 - routine for calling %plot_series



Figure Macro Creation using CALL EXECUTE Success!

- Fewer repeats of the figure macro call – less space in the program
- Data driven
 - macro inputs are derived from conditions set by the programmer
 - No maintenance needed if the data structure doesn't change

THANK YOU!



Presenter: Mitchikou Tseng

For further questions:

- info.nl@ocs-consulting.com
- See me at the OCS Life Sciences booth (#14) in the next break after this session

Other presentations from OCS:

- PP23 – SanityCheckR: data quality control with R Shiny
- SI05 – Maturing standardisation; the switch from spreadsheet-based standards to an MDR
- SI07 – Do it yourself: Case Report Form (CRF) annotation
- TT14 – The impact of migrating to SAS Viya 202X (aka SAS Viya 4)