Stylish Kaplan-Meier Survival Plot using SAS(R) 9.4 Graph Template Language

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ABSTRACT

An eye catching graph provides a visual display of data summaries reported in tables. In Oncology clinical trials, the commonly used method to display the results of time to event data analysis is to combine the Kaplan-Meier Survival Plot in PROC LIFETEST with ODS Graphics to compare different treatment groups based on the log-rank test. The new release of SAS/STAT ® 14.1 added many options to control the appearance and format of survival outputs not available in previous versions. Nevertheless, SAS programmers still find that the options in PROC LIFETEST are not sufficient to produce the outputs data reviewers desire. If you are in this situation, the solution is to use SAS ® 9.4 Graph Template Language (GTL). This paper provides a step-by-step approach to modify the macros and macro variables used in the graph template. SAS programmers at all levels are able to control the results of survival plots on Windows and Unix OS environments.

INTRODUCTION

New options in SAS/STAT ® 14.1, provide more flexibility when producing survival plots: you can now display At Risk Table either inside or outside the graph, display At Risk Table with specified At Risk Value and Tick Marks, display Label by group rather than group number, display Group Labels in a desired group order, suppress default Censored Value, etc. However, there are still many commonly requested output features beyond the OPTION= statement that can control survival plots. For example, data reviewers frequently request the addition of a summary of statistics on the graph. To accomplish this, one approach is to extract individual statistics one-by-one from SAS ODS (such as median survival time and its 95% Confident Interval, Log Rank P–value, survival time etc.), then convert each of these statistics into independent macro variables which can be annotated on the survival curve later on. Using GTL, however, you can get the result using only a single macro statement. In this paper, figures 1 and 2 are taken from the SAS documentation introducing examples of survival plots with new OPTIONs. Figures 3 and 4 are produced using the graph template modification techniques described in this article.

STEP-BY-STEP: HOW TO MODIFY GRAPHS USING SAS ® 9.4 GRAPH TEMPLATE LANGUAGE

When you run PROC LIFETEST with ODS graphics on option to create Kaplan-Meier Survival Plots, you are using the graph templates. The following two examples show SAS code to produce survival plots with default graph templates. (Copyright 2015, SAS Institute Inc., Cary, NC, USA. All Rights Reserved. Reproduced with permission of SAS Institute Inc., Cary, NC., 23.1, page 810, *Default Kaplan-Meier Plot* and Figure 23.9, page 818, *Moving the At-Risk Table outside the Plot)*

Example 1: Default Kaplan-Meier Plot.
```
        ods graphics on;

        proc lifetest data=sashelp.BMT;
             time T * Status(0);
             strata Group;
         run;
```

Example 2: Adding the number of subject at risk table outside of graph;
                                        displaying group labels and tick values.
```
    proc lifetest data=sashelp.BMT
    plots=survival (atrisk (atrisktick maxlen=13 outside)=0 500 750 1000 1250 1500 1750 2000 2500);
             time T * Status(0);
             strata Group;
    run;
```

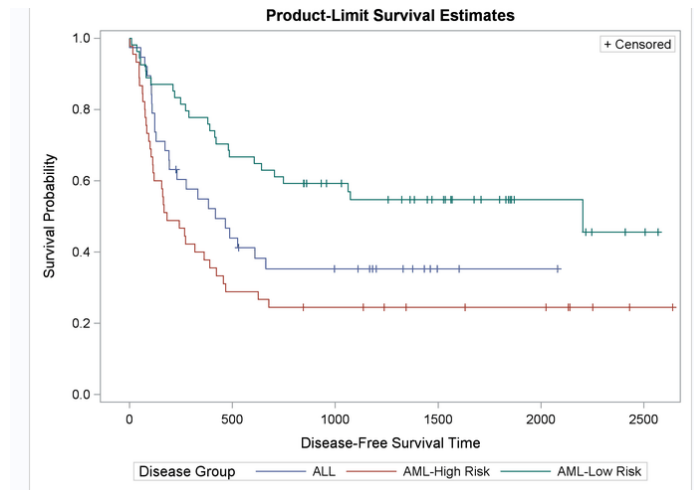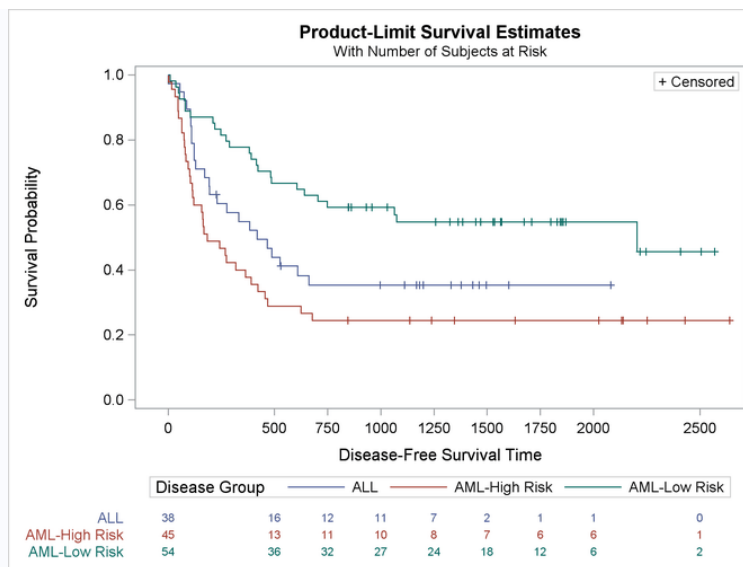Figure 1: Default Kaplan-Meier Plot.

Figure 2: Controlling At-Risk Tick Marks and Table Location, Suppressing P-value and Adding Group Labels.

STEPS TO MODIFY SURVIVAL PLOT TEMPLALE
 If you need to modify survival plots beyond the example shown, it is time to modify the default templates. ODS Trace On statement before PROC LIFETEST displays the template name on the SAS log. You can find the survival plot template by submitting the following SAS code:

```
proc template;
    source Stat.Lifetest.Graphics.ProductLimitSurvival;
run;
```

 The survival graph templates consist of various Macros and macro variables which you can easily modify and re-compile to produce desired outputs. For more detailed information, please read the chapters "Customizing the Kaplan-Meier Survival Plot" in SAS/STAT ® 14.1 User's Guide.

Pre-requisite. Get macros by running the following process.

```
data _null_;
%let url = //support.sas.com/documentation/onlinedoc/stat/ex_code/131;
infile "http:&url/templft.html" device=url;
file 'macros.tmp';
input;
if index(_infile_, '</pre>') then stop;
if pre then put _infile_;
if index(_infile_, '<pre>') then pre + 1;
run;
%inc 'macros.tmp' / nosource;
```

Step 1: Submit the following macro from the sample library to SAS:

  %ProvideSurvivalMacros

 This is the parent macro that provides default macros and macro variables. Running this macro also runs the macro called %CompileSurvivalTemplate macro at the end. This macro compiles the templates:**Stat.Lifetest.Graphics.ProductLimitSurvival (to create at risk table inside) and Stat.Lifetest.Graphics.ProductLimitSurvival2 (to create at risk table outside).** You need to keep the contents of these two macros — %ProvideSurvivalMacros and %CompileSurvivalTemplate — as they are. Your changes to macros and macro variables will happen outside these two macros.

Step 2: Each modification (changing titles, lines, fonts, legend etc.) can be done by modifying the macros originally defined, then re-compiling the survival plot template by running the following macro: (This step will be explained in detail later):

  %CompileSurvivalTemplate

Step 3: After changing the survival template, run PROC LIFETEST to produce your modified graph.

Step 4: Run %ProvideSurvivalMacros to restore the default macro and macro variables.

Step 5: As a final step, it is good practice to delete the modified templates stored in SAS user template Item store. One template is for the At Risk Subject Table created inside the graph, and another template for outside the graph.
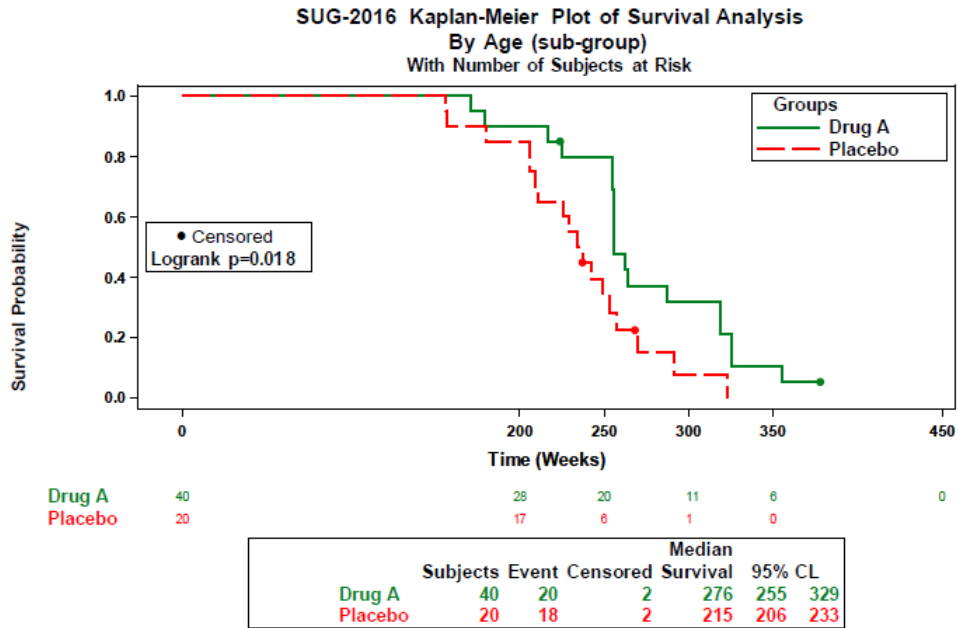
```
proc template;
   delete Stat.Lifetest.Graphics.ProductLimitSurvival   / store=sasuser.templat;
   delete Stat.Lifetest.Graphics.ProductLimitSurvival2 / store=sasuser.templat;
run;
```

EXAMPLES - HOW TO MODIFY GRAPHS USING SAS ® 9.4 GRAPH TEMPLATE LANGUAGE

Figure 3: Adding a statistical table, third title, and inset legend; modifying lines (thickness, pattern, color) and font size.

To get the external event table:

    %SurvivalSummaryTable

To change the location of the legend inside the table and censor value/p-value:

    %let LegendOpts = title =GROUPNAME location=inside across=1 autoalign=(TopRight);

    %let InsetOpts = autoalign=(CenterLeft)

                border=true BackgroundColor=GraphWalls:Color Opaque=true;

To change the censor value:

```
    %let censored = markerattrs=(symbol=circlefilled size=3px);
    %let censorstr = "(*ESC*) {Unicode '25cf'x} Censored"
            / textattrs=GraphValueText (family=GrphUnicodeText:FontFamily):
```

To change lines:

```
    %let StepOpts = lineattrs=(thickness=3.0);
    %let GraphOpts = DataContrastColors=(Green Red);
    %let GraphOpts = attrpriority=none
                        DataLinePatterns=(Solid  MediumDash);
```

To change titles, add title, Y-axis and X-axis:

```
%let tatters = textattrs=(size=12pt weight=bold family='arial');
%let TitleText1 =" SUGI 2016  Kaplan Meier Plot of Survival Analysis";
```

```
%macro AddTitle;
    Entrytitle "By Age (sub-group)" /textattrs=GraphValueText   &tatters;
%mend;
```

```
%let yoptions =  label="Survival Probability"
                labelattrs=(size=10pt weight=bold)
                tickvalueattrs=(size=8pt)
                linearopts=(viewmin=0  viewmax=1  tickvaluelist=(0 .2 .4 .6 .8 1.0));
```

```
%let xoptions =  shortlabel=XNAME  offsetmin=.5
                 labelattrs=(size=10pt weight=bold)
                 tickvalueattrs=(size=8pt)
                 linearopts=(viewmax=MAXTIME  tickvaluelist=XTICKVALS
                        tickvaluefitpolicy=XTICKVALFITPOL);                 ;
```
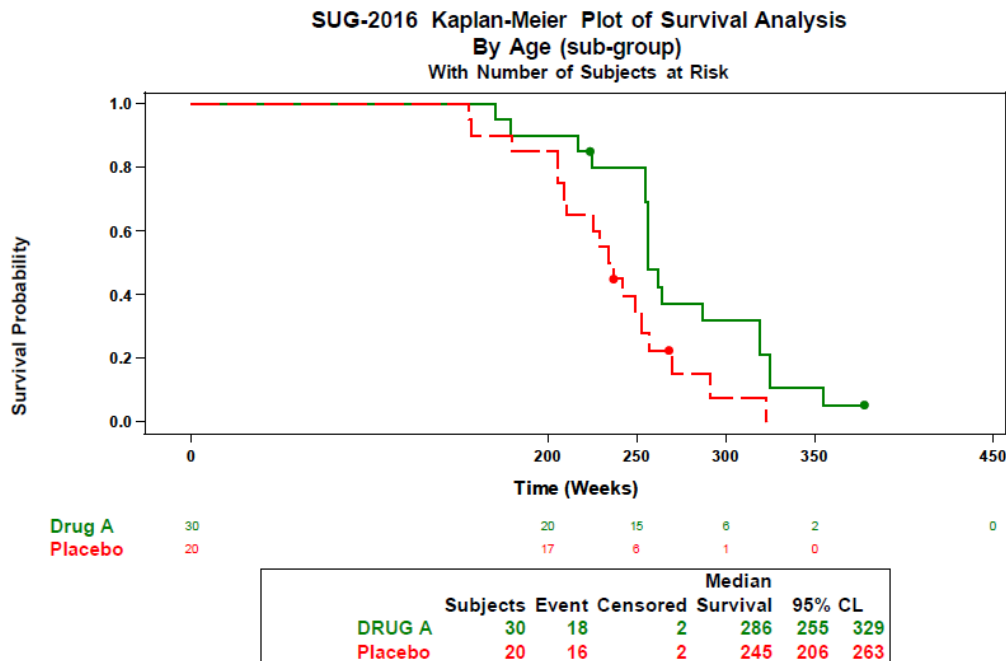
Figure 4: Removing Legend and Censor/P-value from the previous graph.

To suppress censored value/p-value:

  %let InsetOpts = ;

  %let LegendOpts = :

CONCLUSIONS

This paper presents brief steps on how to customize Kaplan-Meier Survival Plot using SAS ® 9.4 Graph Template Language. After running your initial graph template preparing step, you simply need to: 1) run %ProvideSurvivalMacros, 2) modify macros and macro variables, then run the %CompileSurvivalTemplate macro to re-compile macro definitions, 3) run PROC LIFETEST with your modified macro definitions, 4) restore defaults macros and macro variables by running %ProvideSurvivalMacros again, and finally 5) delete your two modified templates from the whole process. ODS, SAS/STAT and Graph Template Language all together enable a SAS programmer to easily control survival plots. Graph Template Language is a complex process, and if you are new to graph templates, you may need some learning time to understand concepts including Dynamic variables, Style templates and Item stores, which I skipped in this presentation. For more information on customizing the Kaplan Meier Survival Plot in the SAS/STAT® 14.1 User's Guide, follow the link below:

http://support.sas.com/documentation/cdl/en/statug/68162/HTML/default/viewer.htm#statug_kaplan_toc.htm

REFERENCES

Copyright 2015, SAS Institute Inc., Cary, NC, USA. All Rights Reserved. Reproduced with permission of SAS Institute Inc., Cary, NC., 23.1, page 810, *Default Kaplan-Meier Plot* and Figure 23.9, page 818, *Moving the At-Risk Table outside the Plot*

SAS Institute Inc. (2015), SAS/STAT(R) 14.1 User's Guide, "Customizing the Kaplan-Meier Survival Plot" SAS Institute Inc., Cary, NC

Warren F. Kuhfeld and Ying So, SAS Institute Inc. (2014), "Creating and Customizing the Kaplan-Meier Survival Plot in PROC LIFETEST in the SAS/STAT (R) 13.1 Release", Paper SP14-SAS-2014

Sanjay Matange, SAS Institute Inc. (2014), " Up Your Game with Graph Template Language Layouts", Paper DG14-SAS, ParmaSUG 2014.

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