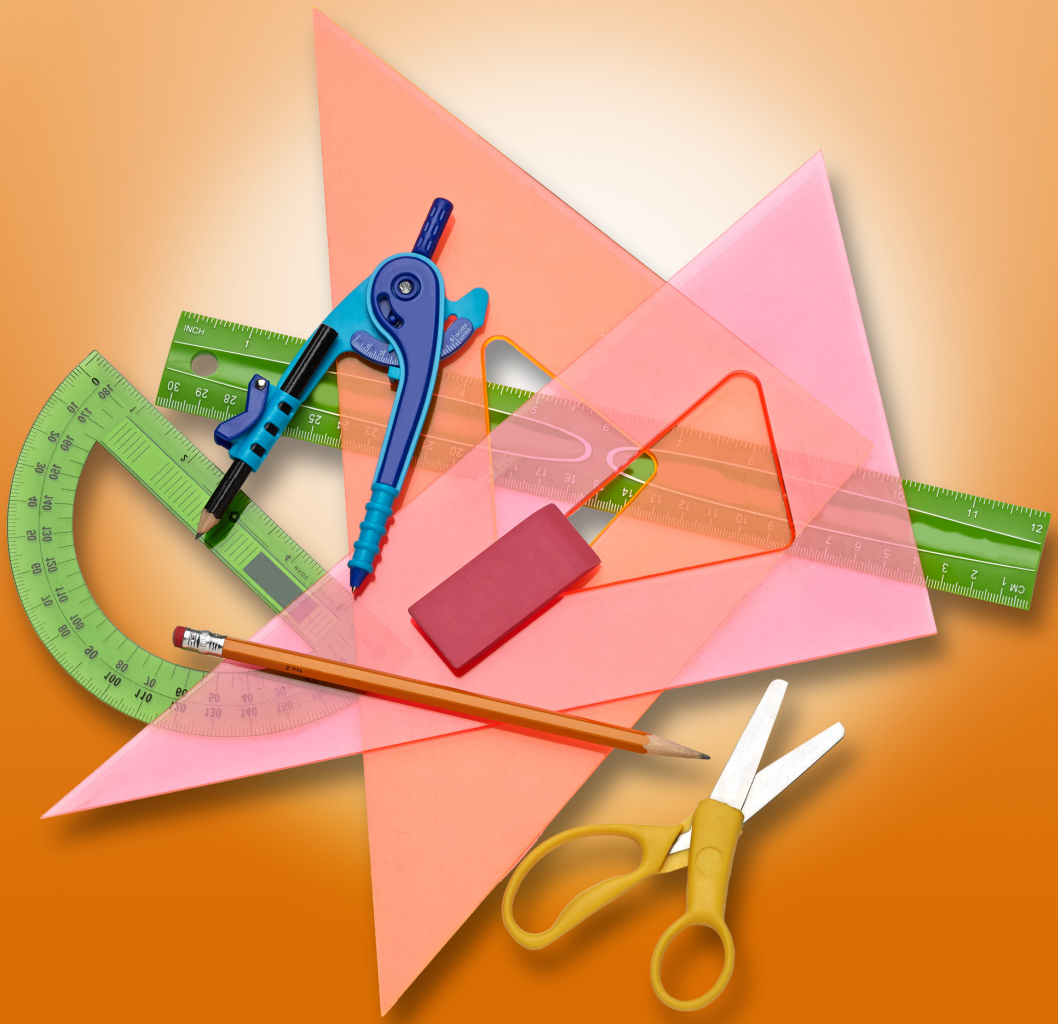
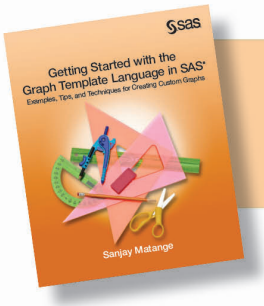
Getting Started with the Graph Template Language in SAS®

Examples, Tips, and Techniques for Creating Custom Graphs



Sanjay Matange



From *Getting Started with the Graph Template Language in SAS®*. Full book available for purchase here.

Contents

About This Book xi
About The Author xv
Acknowledgments xvii
Chapter 1: Introduction to SAS ODS Graphics 1
1.1 A Brief History of SAS ODS Graphics 3
1.2 Automatic Graphs from SAS Procedures 4
1.3 What Is the SAS Graph Template Language (GTL)? 5
1.4 Why Should You Learn GTL? 5
1.5 Making Graphs Using the Statistical Graphics (SG) Procedures 6
1.6 Making Graphs Using the ODS Graphics Designer 6
1.7 Data Sets and Custom Styles Used in This Book 7
1.8 Color and Gray-scale Graphs 7
1.9 Effective Graphics and the Use of Decorative Skins 7
1.10 SAS 9.2, SAS 9.3, and SAS 9.4 Features 8
Chapter 2: Introduction to SAS Graph Template Language 9
2.1 Getting Started 11
2.2 Creating a Simple GTL Graph 11
2.3 Components of GTL 12
2.4 GTL Graph Terminology 13
2.5 Plots 14
2.5.1 Basic Plots 14
2.5.2 Categorical Plots 15
2.5.3 Distribution Plots 15
2.5.4 Fit Plots 15
2.5.5 Parametric Plots 16

2.5.6 3-D Plots 16
2.5.7 Other Plots 16
2.6 Layouts 16
2.6.1 BEGINGRAPH 17
2.6.2 LAYOUT OVERLAY 17
2.6.3 LAYOUT REGION (SAS 9.3) 18
2.6.4 LAYOUT OVERLAYEQUATED 18
2.6.5 LAYOUT OVERLAY3D 19
2.6.6 LAYOUT GRIDDED 19
2.6.7 LAYOUT LATTICE 20
2.6.8 LAYOUT DATALATTICE 20
2.6.9 LAYOUT DATAPANEL 21
2.6.10 LAYOUT PROTOTYPE 22
2.7 Titles, Footnotes, and Entries and Unicode 22
2.8 Axes 23
2.9 Legends 23
2.10 Attribute Maps 24
2.11 Dynamics and Macro Variables 24
2.12 Expressions and Conditionals 25
2.13 Styles and Plot Attributes 25
2.14 Draw Statements 25
2.15 Annotation 26
2.16 Summary 26
Chapter 3: Building Your First Graph 29
3.1 Overview 31
3.1.1 Terminology 32
3.2 Starting with a Basic Histogram 33
3.3 Adding Normal and Kernel Density Curves 34
3.4 Setting Plot Properties 35
3.5 Adding a Legend 37
3.6 Adding the Title and Footnote 38
3.7 Adding a Separate Horizontal Box Plot 39
3.8 Using Uniform X-Axes 41
3.9 Using Common External X-Axis 42
3.10 Setting Output Options 43

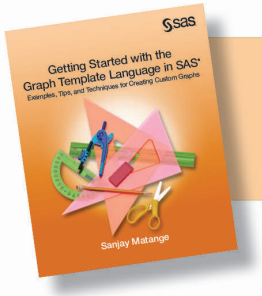
3.11 Full Code for the Graph 44
3.12 Review 45
3.13 Summary 45
Chapter 4: Creating Single-Cell Graphs 47
4.1 Overview 49
Equated Plot 50
3-D Plot 50
4.2 Basic Plots 51
4.2.1 Scatter Plot 52
4.2.2 Series Plot 53
4.2.3 Step Plot 54
4.2.4 Band Plot 55
4.2.5 High Low Plot (TYPE = Line) 56
4.2.6 High Low Plot (TYPE = Bar) 57
4.2.7 Bubble Plot 58
4.2.8 Needle Plot 59
4.2.9 Vector Plot 60
4.3 Categorical Plots 61
4.3.1 Bar Chart 61
4.3.2 Axis Table (SAS 9.4) 62
4.3.3 Line Chart 63
4.3.4 Pie Chart 64
4.4 Distribution Plots 65
4.4.1 Histogram 65
4.4.2 Density Plots 66
4.4.3 Box Plot – Horizontal - Discrete 67
4.4.4 Box Plot – Vertical – Interval with Groups 68
4.5 Fit Plots 69
4.5.1 Regression Plot 69
4.5.2 Loess Plot 70
4.5.3 Penalized B-Spline Plot 71
4.5.4 Ellipse Plot 72
4.6 Other Plots and 3-D Plots 73
4.6.1 Reference Line and Drop Line 73
4.6.2 Heat Map Parametric Plot 74

4.6.3 Line Parametric and Ellipse Parametric Plots 75
4.6.4 Contour Plot 76
4.6.5 3-D Surface Plot 77
4.6.6 3-D Bivariate Histogram 78
4.7 Real World Examples 79
4.7.1 Model Fit Plot 79
4.7.2 Distribution Plot 80
4.7.3 Survival Plot 81
Chapter 5: Creating Multi-Cell Graphs 83
5.1 Overview 85
5.2 Layout Data Lattice 86
5.2.1 Row and Column Data Lattice 88
5.2.2 Column Data Lattice with Union-All Data Range 89
5.2.3 Column Data Lattice with Union Data Range 90
5.2.4 Proportional Data Lattice 91
5.2.5 Data Lattice with Side Bar 92
5.2.6 Row Data Lattice 93
5.2.7 Data Lattice with Multi-Page Output 94
5.3 Layout Data Panel 95
5.3.1 Two Class Data Panel 97
5.3.2 Data Panel with One Class Variable 98
5.3.3 Data Panel with One Class Variable and Number of Columns 99
5.3.4 Data Panel with One Class Variable, Columns, and Union 100
5.3.5 Data Panel with One Class Variable and Proportional Columns 101
5.3.6 Data Panel with Side Bar 102
5.3.7 Data Panel with Multi-Page Output 103
5.4 Layout Lattice 104
5.4.1 Row Lattice with Independent Axes 106
5.4.2 Row Lattice with Common Axis 107
5.4.3 Row Lattice with Common Axis and Unequal Weights 108
5.4.4 Column Lattice with Column Headings 109
5.4.5 Nested Lattice 110
5.4.6 Gridded Layout with Embedded Statistics Table 111
5.5 Real World Examples 112
5.5.1 Lab Values by Study Week 112

5.5.2 LFT Safety Panel, Baseline versus Study 113
5.5.3 Most Frequent On-Therapy Adverse Events by Relative Risk 114
5.5 Summary 115
Chapter 6: Customizing Axes, Legends, and Text 117
6.1 Overview 119
6.2 Axes 120
6.2.1 Common Axis Features 123
6.2.2 Linear Axis Features 124
6.2.3 Discrete Axis Features 125
6.2.4 Log Axis Features 126
6.2.5 Time Axis Features 127
6.3 Legends 128
6.3.1 Discrete Legend 129
6.3.2 Continuous Legend 130
6.4 Adding Titles, Footnotes, and Entries 131
6.4.1 Titles and Footnotes 132
6.4.2 Entries 133
6.4 Summary 134
Chapter 7: Attribute Maps, Draw, and Annotate 135
7.1 Overview 137
7.2 Discrete Attribute Maps 138
7.2.1 Discrete Attributes Map – Line Attributes 139
7.2.2 Discrete Attributes Map – Fill Attributes 140
7.3 Range Attribute Maps 141
7.3.1 Range Attributes Map – Discrete Colors 142
7.3.2 Range Attributes Map – Gradient Colors 143
7.4 Inline Draw Statements 144
7.4.1 Draw Text 145
7.5 Data Set Based Annotation 146
7.5.1 Data Set Based Annotation 147
7.6 Summary 148
Chapter 8: Styles, ODS Options, and More 149
8.1 Overview 151
8.2 Style, Style Elements, and Attributes 152

8.3 Frequently Used ODS Options 153
ODS Graphics Options 153
ODS Destination Options 153
8.4 Macro Variables, Dynamics, Conditionals, and Functions 154
8.4.1 Macro Variables 154
8.4 2 Dynamics 155
8.4.3 Conditionals 156
8.4.4 Function Evaluation 157
8.5 Summary 158
Index 159

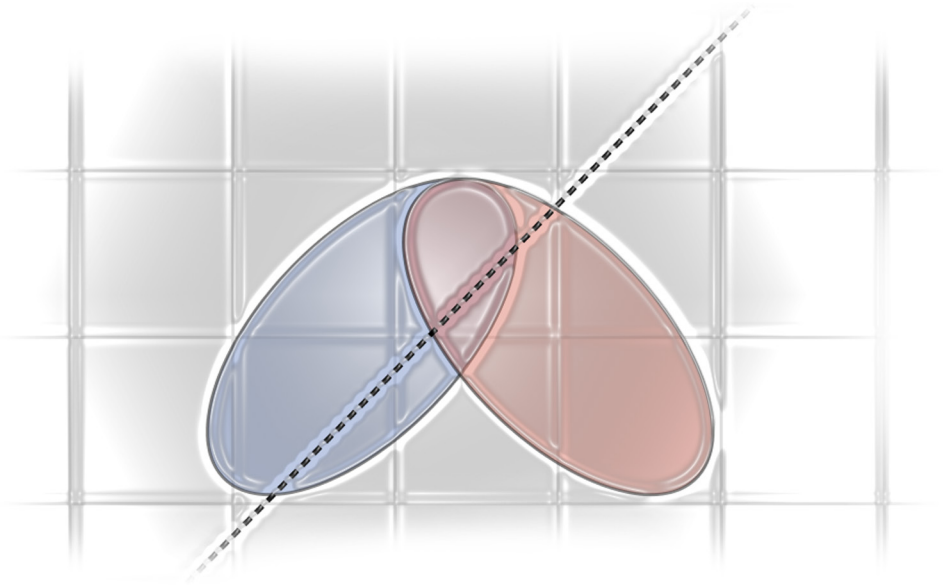
From *Getting Started with the Graph Template Language in SAS® :Examples, Tips, and Techniques for Creating Custom Graphs* by Sanjay Matange. Copyright © 2013, SAS Institute Inc., Cary, North Carolina, USA. All RIGHTS RESERVED.



From *Getting Started with the Graph Template Language in SAS®.* Full book available for purchase here.

Chapter 3: Building Your First Graph

3.1 Overview 31
3.2 Starting with a Basic Histogram 33
3.3 Adding Normal and Kernel Density Curves 34
3.4 Setting Plot Properties. 35
3.5 Adding a Legend 37
3.6 Adding the Title and Footnote 38
3.7 Adding a Separate Horizontal Box Plot 39
3.8 Using Uniform X-Axes 41
3.9 Using Common External X-Axis 42
3.10 Setting Output Options 43
3.11 Full Code for the Graph 44
3.12 Review 45
3.13 Summary 45



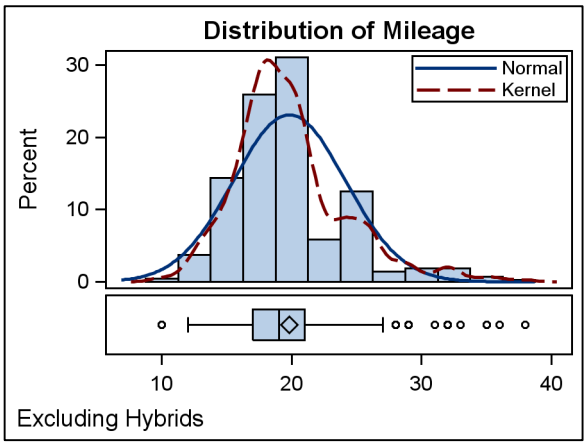
You miss 100 percent of the shots you never take. - Wayne Gretzky

Let us now dive directly into building your first graph. We will build a graph to visualize the distribution of vehicle mileage as shown in Section 3.1. To build this graph, we will use many key features of GTL. By the end of this exercise, you will have a good grasp of the process of building graphs using GTL.

In the example below, we will just go ahead and use the syntax needed to create the graph. Don't worry about the details at this time. You will learn the details in later chapters.

3.1 Overview

We will take a step-by-step approach to building this graph to illustrate the building-block process used to create all GTL graphs. Let us first examine the features of this graph.



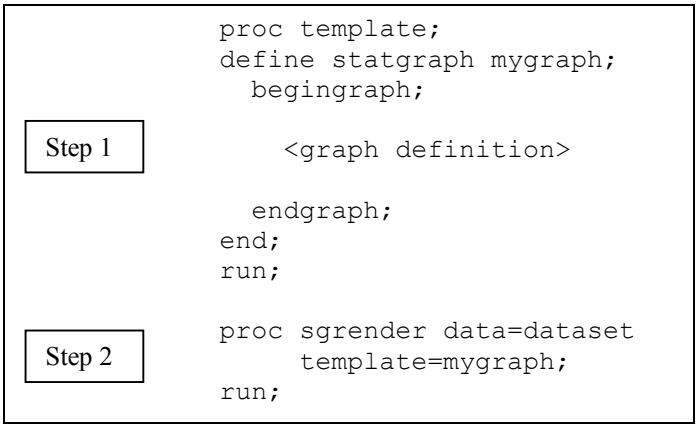
This graph has the following features:

- A title and a footnote.
- Two cells of unequal heights for the display of the data.
- The upper cell has the following:
  - A histogram.
  - A normal density curve.
  - A kernel density curve.
  - A legend.
- The lower cell has a box plot.
- The two cells have a common external x-axis.

Before we get started, let us review the terminology that we will use for the different parts of the graph shown in the figure above. You will see these terms used frequently throughout the book, and understanding the terms will make it easier to discuss the features.

3.1.1 Terminology

- The resulting visual in the output file is called a GRAPH.
- A graph can have one or more CELLS. The graph in Section 3.1 has two cells.
- The cells contain the visual representation of the data, and generally contain:
  - Up to two sets of X and Y axes.
  - One or more plots that are overlaid in a common data space.
  - Other insets like legends, statistics tables, or text entries.
  - All plots, charts, and other visual representation of data are called PLOT.
- Zero or more TITLEs that are all displayed at the top of the graph.
- Zero or more FOOTNOTEs that are all displayed at the bottom of the graph.



Creating a graph with GTL is a two-step process as shown above.

- **Step 1**: Define a STATGRAPH template with a name by using the TEMPLATE procedure. The structure and features of the graph are defined using GTL. In this step, the template is compiled and saved. No graph is created.

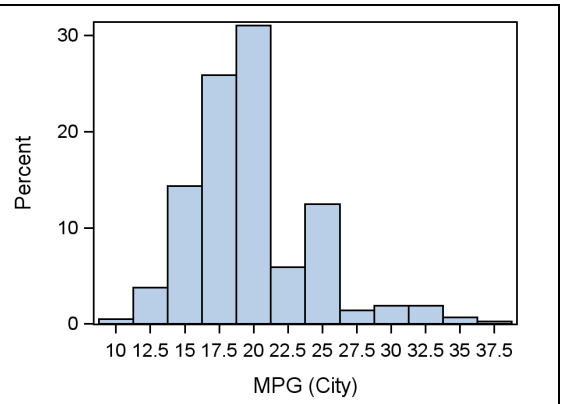
- **Step 2**: Create the graph by using the SGRENDER procedure. This step associates the data with the template to produce the graph.

3.2 Starting with a Basic Histogram

Though the graph in section 3.1 has two cells, we will start by building the basic histogram first. We will add the second cell with the box plot later. To create the basic histogram, we will use a histogram statement in a layout overlay.

```
proc template;
  define statgraph gtl.dist1;
    begingraph;
      layout overlay;
         histogram mpg_city;
      endlayout;
    endgraph;
  end;
run;

proc sgrender
data=sashelp.cars
     template=gtl.dist1;
  where type ne 'Hybrid';
run;
```



In the program shown above, we have used a LAYOUT OVERLAY block to define this graph as highlighted above. The program produces the graph shown above on the right. Note that the default axis type for a histogram is BIN, where each bin is labeled (if possible). The default scale for the Y axis is percent.

The LAYOUT OVERLAY statement defines a single cell container within which we can put multiple plot statements. In this case, we have only one plot statement – the histogram. But we will add more plots soon. The histogram statement needs a numeric column as a required parameter. Here we have used a specific column name mpg_city. In order for this graph to be successfully created, a numeric column with this name must exist in the data set.

In the PROC SGRENDER step, we have specified the data set and the template names that are used together to create this graph. The variable mpg_city is expected in the data set.

Let us examine the syntax in the PROC TEMPLATE step program shown above. The part of the syntax that is not highlighted is essentially boilerplate. Every template must have this code, so you can just cut and paste that part. The only thing unique in that part of the code is the name of the template. Of course, there are some statement options that we will examine later.

We only need three lines of unique code to define the template for this graph. The SGRENDER step uses the template and a subset of the data to render the graph shown on the right.

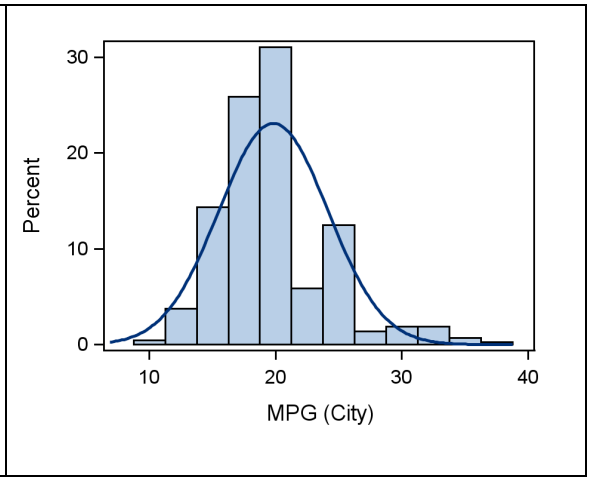
3.3 Adding Normal and Kernel Density Curves

Often, the addition of normal and kernel density curves on a histogram helps in a better understanding of the distribution of the data. In GTL, these are not built in as options on the histogram statement, but are independent plot statements that can be used in combination with the histogram.

To add the normal density curve to the graph, we add a DENSITYPLOT statement to the graph specification in the PROC TEMPLATE step within the LAYOUT OVERLAY block. The new statement is highlighted in the program shown below. Density plots come in two flavors: normal and kernel. The default is normal, so no additional options need to be specified.

```
proc template;
  define statgraph gtl.dist2;
    begingraph;
      layout overlay;
        histogram mpg_city /
          binaxis=false;
        densityplot mpg_city;
      endlayout;
    endgraph;
  end;
run;

proc sgrender
data=sashelp.cars
     template=gtl.dist2;
  where type ne 'Hybrid';
run;
```



The graph created by the program is shown above on the right. The template now includes a DENSITYPLOT statement with the same analysis variable mpg_city. We have set BINAXIS=false for the histogram to get a linear x-axis and changed the template name.

This step highlights an important feature of GTL layouts. The LAYOUT OVERLAY statement defines a CELL; all plot statements placed in it are drawn in the same common area of the cell. All plots in a cell share a common set of axes. The extents of the axes are a union of the data contributed by each plot. Then, all the plots are drawn with the correct scaling.

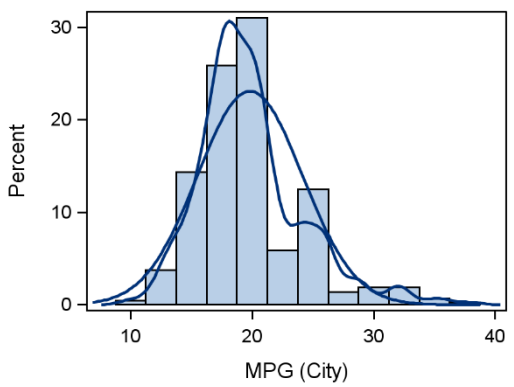
The plots are drawn in the order in which they are specified, with the last plot drawn on top. In the graph shown above, the density curve is drawn on top of the histogram. If the order of the statements is reversed, the histogram will be drawn last, and might obscure parts of the density plot.

The axis derives many of its attributes from the primary plot. In this case, the histogram is primary because it is the first plot in the container. Previously we had a "bin" axis. Now, since the histogram has a linear axis, the x-axis is changed to linear.

Now let us add the kernel density estimate curve to the graph. As you guessed, all you need to do is add another density plot statement with the appropriate options. The new template is shown below on the left, with the addition of the second density plot with the KERNEL() option. The resulting graph is shown below on the right. Additional options for kernel density estimates can be provided within the parentheses. In this case, we are using only the default settings.

```
proc template;
  define statgraph gtl.dist3;
    begingraph;
      layout overlay;
        histogram mpg_city /
            binaxis=false;
        densityplot mpg_city;
        densityplot mpg_city /
            kernel();
      endlayout;
    endgraph;
  end;
run;

proc sgrender data=sashelp.cars
     template=gtl.dist3;
  where type ne 'Hybrid';
run;
```



3.4 Setting Plot Properties

When plots are drawn in a graph, the visual attributes of the plot are derived from the appropriate style element of the active style for each open destination. A sample mapping from graphical element to style element is provided in Chapter 8. For now, it is sufficient to know the following mappings:

The histogram fill color is derived from the GRAPHDATADEFAULT style element.

The density plot line color and pattern are derived from GRAPHFIT style element.

Since we have drawn two density plots, both plots are drawn using the GRAPHFIT style element. So it is hard to distinguish between the two density curves at this point. To effectively convey the right information, we need to change the visual properties of one of the density curves. To do that, we use the appropriate attribute options for the plot statement.

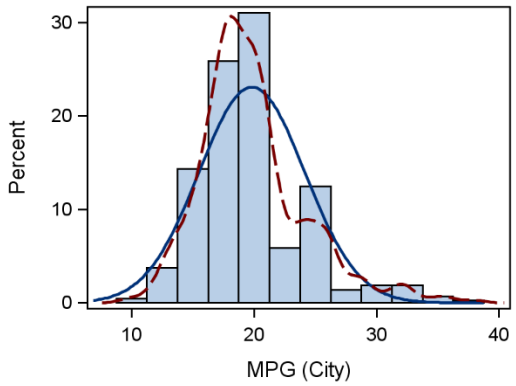
The density plot statement has an option called LINEATTRS with the following specification:

LINEATTRS=<style-element> (COLOR=value PATTERN=value)

We can use this option to set the color and pattern of the line. If we use the settings shown below, this plot will be drawn using a red dashed line.

```
LINEATTRS=(COLOR=red PATTERN=dash)
```

```
proc template;
  define statgraph gtl.dist4;
    begingraph;
      layout overlay;
        histogram mpg_city /
            binaxis=false;
         densityplot mpg_city;
         densityplot mpg_city /
           kernel()
           lineattrs=graphfit2;
       endlayout;
    endgraph;
  end;
run;
proc sgrender data=sashelp.cars
     template=gtl.dist4;
  where type ne 'Hybrid';
run;
```



However, specifying a hard-coded color is not the recommended practice for GTL programming. A template graph can be rendered to multiple ODS destinations at the same time, each destination having its own default active style. A hard-coded color can conflict with other colors of the style, resulting in a poor quality graph.

For this reason, it is recommended that you use style references to assign visual attributes to any plot. Since all style elements and attributes are carefully designed to play well with each other, the visual integrity of the graph is retained. For special cases, a hard-coded color is just fine.

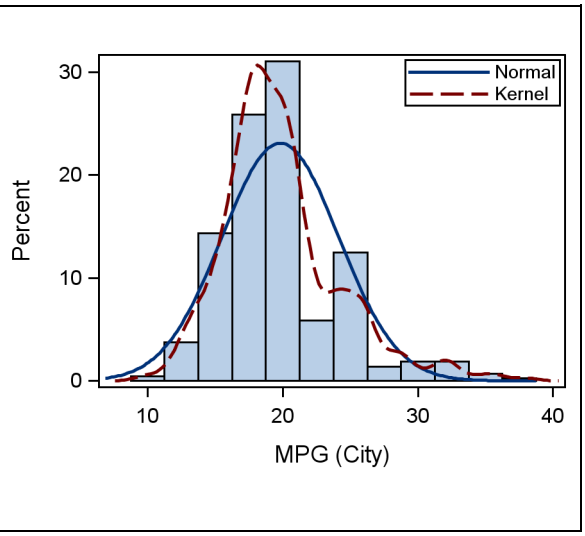
Keeping this in mind, let us now assign a different set of visual attributes to the kernel density plot. All styles that are supplied by SAS include a large set of style elements, each used by some graph element by default. However, a few additional elements are also included. One such element is GRAPHFIT2. This element is not automatically used with any plot, and is designed to be used in such cases. In the program above, we have set LINEATTRS=GRAPHFIT2 for the kernel density curve. The resulting graph is shown above on the right.

3.5 Adding a Legend

Now it is easier to distinguish between the two density curves, but it is still not clear which curve is which. To help decode this information, we need to provide a legend as follows:

- Name each plot that needs to be included in the legend.
- Use the DISCRETELEGEND statement with the names of the plots to be included.

```
proc template;
 define statgraph gtl.dist5;
  begingraph;
   layout overlay;
     histogram mpg_city /
       binaxis=false;
     densityplot mpg_city /
       name='Normal';
     densityplot mpg_city /
       name='Kernel' kernel()
       lineattrs=graphfit2;
     discretelegend 'Normal'
       'Kernel' / across=1
       location=inside
       halign=right valign=top;
   endlayout;
  endgraph;
 end;
run;
```



Note: In the program code shown above on the left, we have no longer shown the PROC SGRENDER step. To conserve space, we do not show the render step of the program unless necessary. There is no change to this step, except a change in the name of the template, and this step is required to create the graph. In this set of examples, most of the coding change is in the template code.

The code required to add a discrete legend to the graph is highlighted in the program above. First, we provide names to the statements that we wish to include in the legend. Since we only want to include the two density plots, we provide names only for the two density plot statements.

Now we add the DISCRETELEGEND statement, and provide the list of plot names that are to be included in the legend. In this case, we have provided the names "Normal" and "Kernel". If we don't provide the options after the "/", this legend will be drawn in its default location below the x-axis. Since some white space is available inside the cell, we can put the legend in the top right corner by specifying LOCATION=inside and providing the appropriate VALIGN and HALIGN options. ACROSS=1 places all of the legend entries in one column.

The definition of the upper cell of the graph in Section 3.1 is now complete. The code block from the LAYOUT OVERLAY to ENDLAYOUT in the above program that is enclosed in the brace

defines the upper cell. As we go ahead with building this graph, we will refer to this block of code as the "upper cell," and we will not display its contents to save space.

3.6 Adding the Title and Footnote

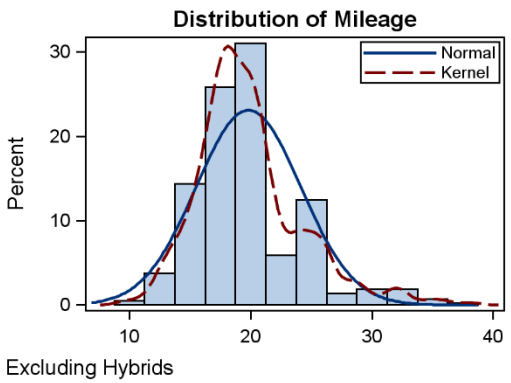
In the program shown below, <Upper cell plot statements> represents the statements needed to create the histogram. We need the space to show the statements that we use to enhance the graph.

```
proc template;
 define statgraph gtl.dist6;
  begingraph;
   entrytitle
     'Distribution of Mileage';
   entryfootnote halign=left
     'Excluding Hybrids';

   layout overlay /xaxisopts=
          (display=(ticks
          tickvalues));

     < upper cell
       plot statements >

   endlayout;
  endgraph;
 end;
run;
```



Here we have added a title and a footnote. These statements must be placed within the context of the outermost BEGINGRAPH block. The TITLE and FOOTNOTE statements can be placed anywhere in the outer block. The title is always drawn at the top of the graph, and the footnote is always drawn at the bottom. Multiple title and footnote statements can be provided, and they are drawn in the order in which they are specified. For the footnote, we have specified HALIGN=left.

Since the title already contains the reference to the analysis variable, it is not necessary to include the x-axis label, which displays the same information. So, to reduce unnecessary ink in the graph, we have suppressed the display of the x-axis label by setting the DISPLAY suboptions in the XAXISOPTS option. Here we have excluded LABEL from the list of suboptions.

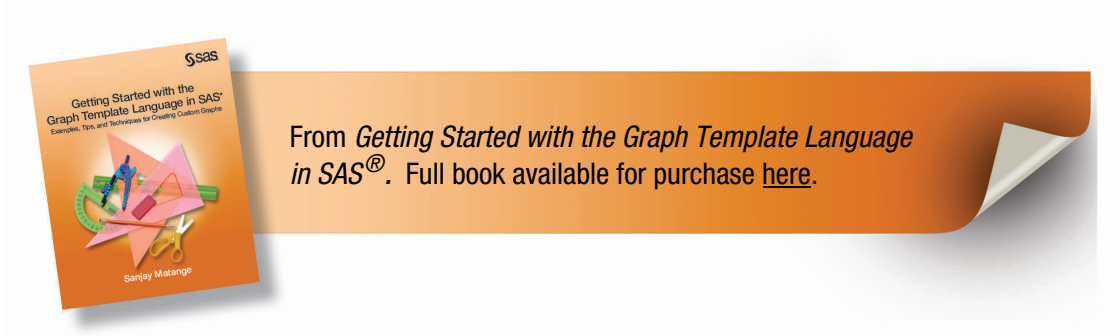
This is the preferred way to remove an axis label and recover the space normally reserved for it. We could provide a blank label by setting LABEL=" " for the x-axis. In this case, a blank label would be drawn, and the space for the label would still be reserved.

This axis setting illustrates an important aspect of the GTL graph structure. As mentioned earlier, multiple plots statements can be included inside a LAYOUT OVERLAY. These plots are overlaid, and the axis data range is the union of the data ranges from all the plots in the overlay container.

One implication of this is that the axis does not belong to any one plot, but to the overlay container (another term for a layout).

So, the options to customize any of the axes are on the LAYOUT OVERLAY statement, and not on one of the plot statements. None of the plot statements have any axis options. In this case, we want to suppress the axis label for the x-axis. To do this, we use the XAXISOPTS option on the LAYOUT OVERLAY statement and set the appropriate suboption. We will examine the various options available for the axes in subsequent chapters.

Note: This short excerpt was taken from a chapter in the published book.



From *Getting Started with the Graph Template Language in SAS® : Examples, Tips, and Techniques for Creating Custom Graphs* by Sanjay Matange. Copyright © 2013, SAS Institute Inc., Cary, North Carolina, USA. All RIGHTS RESERVED.

Index

A

ACROSS option, DISCRETELEGEND statement 37
annotations 13, 26, 137, 146–147
ARROWHEADSHAPE option, VECTORPLOT statement 60
aspect ratio, uniform 50
attribute maps 13, 24, 137
  discrete 138–140
  range 141–143
automatic graphs
  GTL used by 5
  SAS procedures for 4
axes 13, 14, 45, 120–127
  axis table for 62
  common, for multiple cells 42, 107
  discrete axis 120–121, 122, 125
  in LAYOUT DATALATTICE statement 87
  in LAYOUT DATAPANEL statement 96
  interval axes 67, 68, 80
  linear axis 120–121, 122, 124
  log axis 120–121, 122, 126
  number of 23, 120
  options for 39, 49–50
  removing label for 38–39
  time axis 120–121, 122, 127
  types of 23, 120–122
  uniform, for multiple cells 41
  uniform aspect ratio for, ensuring 50
AXISTABLE statement 62

B

background 14
BANDPLOT statement 55
bands
See BANDPLOT statement
See confidence band
See MODELBAND statement
BARCHART statement 61
  BARWIDTH option 92, 102
  GROUPDISPLAY option 61
BARWIDTH option, BARCHART statement 92, 102
Base SAS procedures 4, 5
BASELINEINTERCEPT option, NEEDLEPLOT statement 59
basic plots 14–15, 51–60
BEGINGRAPH statement 12, 17
BIHISTOGRAM3DPARM statement (bivariate histogram) 78
BLOCKPLOT statement 81
BOXPLOT statement 39–40, 67, 68
BREAK option, STEPPLOT statement 54
BUBBLEPLOT statement 58

C

categorical plots 15, 61–64
CATEGORY parameter, BARCHART statement 61
cells 14, 32
  See also multi-cell graphs
  See also single-cell graphs
CLASS option, AXISTABLE statement 62
classification panels 17, 115
  See also LAYOUT DATALATTICE statement
  See also LAYOUT DATAPANEL statement
  See also SGPANEL procedure
CLASSVARS option, LAYOUT DATAPANEL statement 95–96, 97
CLI option, REGRESSIONPLOT statement 69, 79
CLM option, LOESSPLOT statement 70
color graphs 7
COLORRESPONSE parameter, HEATMAPPARM statement 74
COLUMN2AXIS statement 120
COLUMN2HEADERS statement 109
COLUMNAXES statement 42, 107, 108
COLUMNAXIS statement 42, 120

COLUMNAXISOPTS option
LAYOUT DATALATTICE statement 89
LAYOUT DATAPANEL statement 98
COLUMNDATARANGE option
LAYOUT DATALATTICE statement 90
LAYOUT DATAPANEL statement 100, 101
LAYOUT LATTICE statement 41, 107, 108
UNIONALL as default value for 88, 89
COLUMNS option
LAYOUT DATAPANEL statement 99, 100, 101, 102, 103
LAYOUT LATTICE statement 40
COLUMNVAR parameter, LAYOUT DATALATTICE statement 21, 86–87, 88, 89, 90, 91
COLUMNWEIGHT option
LAYOUT DATALATTICE statement 87, 91
LAYOUT DATAPANEL statement 96, 101
conditionals 13, 25, 156
confidence band 69, 70, 71, 79
confidence ellipse 72
CONTINUOUSLEGEND statement 24, 128, 130
CONTOURPLOTPARM statement 76
CONTOURTYPE option, CONTOURPLOTPARM statement 76
CURVELABEL option, SERIESPLOT statement 53
custom graphs 3
GTL and ODS Graphics for 5, 153
ODS Graphics Designer for 6
SG procedures for 6
custom styles 7
CYCLEATTRS option, LAYOUT PROTOTYPE statement 92, 102

D

data sets
annotations based on 13, 26, 137, 146–147
specifying 11–12, 32, 33
used in examples 7
data skins (decorative skins) 7–8, 57, 58, 61
DATALABEL option, SCATTERPLOT statement 52
DATALABELPOSITION option, NEEDLEPLOT statement 59
DATASKIN option
BARCHART statement 61
BUBBLEPLOT statement 58
HIGHLOWPLOT statement 57
DATATRANSPARENCY option, ELLIPSEPARM statement 75
decorative skins (data skins) 7–8, 57, 58, 61
DENSITYPLOT statement 34–37, 66
Designer
See ODS Graphics Designer
destinations 3, 153
See also HTML destination
See also LISTING destination
See also ODS LISTING statement
default style for 5, 13, 151
options for 153
resolution for 43
discrete attribute maps 13, 24, 137, 138–140
discrete axis 120–121, 122, 125
DISCRETEATTRMAP statement 24, 138–140
DISCRETELEGEND statement 23–24, 37, 52, 80, 128, 129
DISCRETEOPTS option, axes 125
DISPLAY option
axes 121, 123
ELLIPSE statement 72
Distribution of Mileage example 31, 44
distribution plots 15, 31, 44, 65–68, 80
DMS mode, ODS Graphics settings in 4
DRAW* statements 13, 25–26, 137, 144–145
DRAWTEXT statement 144–145
DROPLINE statement 73
DYNAMIC statement 155
dynamic variables 13, 24–25, 155

E

ELLIPSE statement 72
ELLIPSEPARM statement 72, 75
ENDGRAPH statement 12
ENDLAYOUT statement 12, 33
entries 13, 14, 22
    See also specific ENTRY statements
ENTRY statement 22, 111, 131, 133–134
ENTRYFOOTNOTE statement 22, 38, 131, 132
ENTRYTITLE statement 12, 22, 38, 131, 132
equated plots 18–19, 50, 76
examples
    distribution plots 31, 44, 80
    lab values by study week 112
    LFT safety panel, baseline versus study 113
    model fit plot 79
    most frequent on-therapy adverse events 114–115
    survival plot 81
expressions 13, 25

F

FILLATTRS option
    BARCHART statement 152
    VALUE statement 140
FILLEDOUTLINEMARKERS option, SCATTERPLOT statement 133
fit plots 15, 69–72, 79
footnotes 13, 14, 22, 32
    See also ENTRYFOOTNOTE statement
forward slash (/), preceding options 37
function evaluation 157–158

G

Graph Template Language
    See GTL
GRAPHDATA1-GRAPHDATA12 style elements 24, 137
GRAPHDATADEFAULT style element 25, 35
GRAPHFIT style element 35, 66
GRAPHFIT2 style element 36, 66
graphs
    See also layouts
    See also multi-cell graphs
    See also plots
    See also single-cell graphs
    automatic 4, 5
    color graphs 7
    components of 12–14, 31–32, 45, 119
    creating 11–12, 31–32, 49–50
    custom 3, 5, 6, 153
    gray-scale graphs 7
    principles of effective graphics for 7–8
    resolution of 43
    size of 43
    types of 13–14
GRAPHTITLETEXT style element 25
gray-scale graphs 7
GRIDDISPLAY option, axes 121
GROUP option, BOXPLOT statement 68
GROUPDISPLAY option, BARCHART statement 61
GTL (Graph Template Language)
    components of 12–14
    features of 5, 11
    viewing from ODS Graphics Designer 6
GTL template
    See templates

H

HALIGN option
    DISCRETELEGEND statement 37
    ENTRY* statements 131, 132, 133–134
    ENTRYFOOTNOTE statement 38
HEADERLABELDISPLAY option, LAYOUT DATALATTICE statement 88
HEATMAPPARM statement 74
HEIGHT option, ODS GRAPHICS statement 43
HIGH parameter, HIGHLOWPLOT statement 56
HIGHCAP option, HIGHLOWPLOT statement 57
HIGHLABEL option, HIGHLOWPLOT statement 56, 57
HIGHLOWPLOT statement 56, 57

HISTOGRAM statement 12, 33, 35–36, 65, 80
See also BIHISTOGRAM3DPARM statement
HTML destination
default style for 25, 151
in DMS mode 4
options for 153
resolution for 43
HTMLBLUE style 25, 151

I

IF-THEN-ELSE statement 25, 156
IMAGE_DPI option, ODS LISTING statement 43
inline DRAW statements
See DRAW* statements
INNERMARGIN statement
axis table in 62
block plot in 81
interval axes 67, 68, 80

K

kernel density curves 34–35
KERNEL() option, DENSITYPLOT statement 35, 66

L

LABEL option, axes 121
LABELATTRS option
axes 122
HIGHLOWPLOT statement 57
LABELFITPOLICY option, axes 121
LABELPOSITION option, axes 121
LAYOUT DATALATTICE statement 21, 85, 86–94
column only 89, 90
components of 86–87
LAYOUT PROTOTYPE statement in 22, 86, 88
multi-page output for 94
options for 87
proportional 91
row and column 88, 113
row only 93
with sidebar 87, 92
LAYOUT DATAPANEL statement 21–22, 85, 95–103
components of 95–96
LAYOUT PROTOTYPE statement in 22, 95, 97
multi-page output for 103
options for 96
with one class variable 98, 112
with one class variable and multiple columns 99, 100, 101
with sidebar 96, 102
with two class variables 97
LAYOUT GRIDDED statement 20, 85, 111
LAYOUT LATTICE statement 20, 42, 45, 85, 104–110
column lattice 109, 114–115
components of 104–105
LAYOUT OVERLAY statement in 104–105, 106
nesting 106, 110
options for 105
row lattice 39–40, 106, 107, 108
LAYOUT OVERLAY statement 17–18, 38–39, 45
in LAYOUT LATTICE statement 104–105, 106
options for 49–50, 121, 123
LAYOUT OVERLAY3D statement 19, 50, 77, 78
LAYOUT OVERLAYEQUATED statement 18–19, 50, 76
LAYOUT PROTOTYPE statement 22, 85
CYCLEATTRS option 92, 102
in LAYOUT DATALATTICE statement 22, 86, 88
in LAYOUT DATAPANEL statement 22, 95, 97
LAYOUT REGION statement 18, 64
layouts 12–13, 16–17, 45
See also specific LAYOUT statements
LEGENDITEM statement 129

legends 13, 14
See also CONTINUOUSLEGEND statement
See also DISCRETELEGEND statement
creating 37–38, 128–130
in sidebar 87, 92
types of 23–24, 128
line mode, ODS Graphics settings in 4
linear axis 120–121, 122, 124
LINEAROPTS option, axes 124
LINEATTRS option
DENSITYPLOT statement 36, 66
HIGHLOWPLOT statement 56
LINECHART statement 63
VALUE statement 139
VECTORPLOT statement 60
LINECHART statement 63
LINEPARM statement 75
LISTING destination
default style for 25
in line mode 4
options for 153
resolution for 43
LISTING style 25
LOCATION option, DISCRETELEGEND statement 37
LOESSPLOT statement 70
log axis 120–121, 122, 126
LOGOPTS option, axes 126
LOW parameter, HIGHLOWPLOT statement 56
LOWLABEL option, HIGHLOWPLOT statement 56

M

macro variables 13, 24–25, 154
MARKERATTRS option, NEEDLEPLOT statement 59
MARKERCHARACTER option, SCATTERPLOT statement 52
MODELBAND statement 69, 71, 79
multi-cell classification panels 17, 115
See also LAYOUT DATALATTICE statement
See also LAYOUT DATAPANEL statement
See also SGPANEL procedure
multi-cell graphs
creating 31–32, 85
layouts for 17, 85
MVAR statement 154

N

NAME option, DENSITYPLOT statement 37
NEEDLEPLOT statement 59
NMVAR statement 154
NOBORDER option, ODS GRAPHICS statement 43
normal density curves 34–35

O

ODS (Output Delivery System) 3
ODS (Output Delivery System) destinations 3, 153
See also HTML destination
See also LISTING destination
See also ODS LISTING statement
default style for 5, 13, 151
options for 153
resolution for 43
ODS (Output Delivery System) Graphics 3–4
ODS (Output Delivery System) Graphics Designer 6
ODS (Output Delivery System) Styles 25
See also styles
ODS GRAPHICS statement 43, 153
ODS LISTING statement 43, 152
OFFSETMAX option, axes 121–122
OFFSETMIN option, axes 121–122, 123
ORDER option
LAYOUT GRIDDED statement 111
LAYOUT LATTICE statement 109
ORIENT option, BOXPLOT statement 67
Output Delivery System
See ODS

P

parametric plots 16, 74–76
PBSPLINEPLOT statement (penalized B-spline plot) 71
PIECHART statement 64
plot attributes 13
plots 12, 45
  See also specific plot statements
  basic plots 14–15, 51–60
  categorical plots 15, 61–64
  distribution plots 15, 31, 44, 65–68, 80
  equated plots 18–19, 50, 76
  fit plots 15, 69–72, 79
  list of 14–16
  parameters for 49–50
  parametric plots 16, 74–76
  3-D plots 16, 50, 77–78

R

range attribute maps 13, 24, 137, 141–143
RANGE statement 141–143
RANGEATTRMAP statement 24, 141–143
RANGEATTRVAR statement 142, 143
RANGECOLOR option, RANGE statement 142
RANGECOLORMODEL option, RANGE statement 143
REFERENCELINE statement 73, 113
REGRESSIONPLOT statement 69, 79
RELATIVESCALETYPE option, BUBBLEPLOT statement 58
RESET option, ODS GRAPHICS statement 43
resolution of graph 43
RESPONSE parameter, BARCHART statement 61
ROW2AXIS statement 120
ROWAXES statement 109
ROWAXIS statement 109, 120
ROWAXISOPTS option
  LAYOUT DATALATTICE statement 89
  LAYOUT DATAPANEL statement 98
ROWDATARANGE option, LAYOUT DATALATTICE statement 93
ROWS option
  LAYOUT DATALATTICE statement 94
  LAYOUT DATAPANEL statement 103
  LAYOUT GRIDDED statement 111
ROWVAR parameter, LAYOUT DATALATTICE statement 21, 87, 88
ROWWEIGHTS option, LAYOUT LATTICE statement 42, 108

S

SAS
  documentation for 6
  versions of, used in this book 8
SAS 9.2
  decorative skins support in 7
  GTL features in 5
  ODS Graphics features in 3, 4
  SAS procedures in 4
SAS 9.3
  attribute maps in 13, 24
  basic plots in 14–15
  BOXPLOT options in 67
  categorical plots in 15
  decorative skins support in 7–8
  DRAW statement in 13, 25–26
  layouts in 17, 18
  parametric plots in 16
  SAS procedures in 4
  style defaults in 25, 151
SAS 9.4
  annotations in 13, 26
  axis features in 122, 125
  axis tables in 62, 81
  BANDPLOT options in 55
  BARCHART parameters in 61
  COLUMNWEIGHT option in 87, 91, 96, 101
  decorative skins support in 8
  FILLEDOUTLINEMARKERS option in 133
  inset data in 87, 96
  LABELFITPOLICY option in 121

LABELPOSITION option in 121
SUBPIXEL option in 53, 54, 55
SAS functions, evaluating 157–158
SAS procedures 4, 5
SAS/ETS procedures 4, 5
SASHELP.CLASS data set 21
SASHELP.TMPLMAST templates 27
SAS/HPF procedures 4, 5
SAS/QC procedures 4, 5
SAS/STAT procedures 4, 5
SASUSER.TEMPLAT templates 27
SCATTERPLOT statement 52, 79, 81
See also SGSCATTER procedure
SERIESPLOT statement 53
SG (Statistical Graphics) procedures 6
SGANNO data set 13, 26, 146–147
.sgd file extension 6
SGDESIGN procedure 6
SGE (Statistical Graphics Engine) 22, 154
SGE functions, evaluating 157–158
SGPANEL procedure 6
SGPLOT procedure 6
SGRENDER procedure 11–12, 32, 33, 146–147
SGSCATTER procedure 6
SHORTLABEL option, axes 121
SIDEBAR statement 87, 92, 96, 102
single-cell graphs
creating 49–50
layouts for 17
SGPLOT procedure for 6
size of graph 43
skins, data (decorative) 7–8, 57, 58, 61
slash (/), preceding options 37
SMOOTH option, PBSPLINEPLOT statement 71
SMOOTHCONNECT option, SERIESPLOT statement 53
STAT option
AXISTABLE statement 62
LINECHART statement 63
STATGRAPH template 5, 11–12, 32
Statistical Graphics Procedures by Example (Matange and Heath, 2011) 6, 7
Statistical Graphics (SG) procedures 6
statistics table 111
STEPPLOT statement 54, 81
style elements 25, 151
specifying with CYCLEATTRS 92, 102
specifying with FILLATTRS 152
specifying with LINEATTRS 35–36
STYLE parameter, ODS LISTING statement 152
styles 7, 13, 25, 151–152
SUBPIXEL option, BEGINGRAPH statement 53, 54, 55
SURFACEPLOTPARM statement 77
SURFACETYPE option, SURFACEPLOTPARM statement 77
survival plots 81

T

TEMPLATE procedure 5, 11–12, 32
templates
creating 5, 11–12, 32
location of 27
TEXTATTRS option, ENTRY* statements 111, 131, 132, 133–134
THREECOLORRAMP style element 24, 130
3-D plots 16, 50, 77–78
TICKINTERVALSTYLE option, axes 23
TICKVALUEATTRS option, axes 122
time axis 120–121, 122, 127
TIMEOPTS option, axes 127
titles 13, 14, 22, 32, 38
See also ENTRYTITLE statement
TYPE option
axes 121
ELLIPSE statement 72

U

Unicode characters 22

V

VALIGN option, DISCRETELEGEND statement 37

VALUE statement 138–140
variables
    dynamic variables 13, 24–25, 155
    macro variables 13, 24–25, 154
VECTORPLOT statement 60

W

wall 14
WIDTH option, ODS GRAPHICS statement 43

X

X parameter, HIGHLOWPLOT statement 56
X2AXISOPTS option, LAYOUT OVERLAY
        statement 121
XAXISOPTS option, LAYOUT OVERLAY
        statement 38–39, 121, 123

Y

Y parameter, HIGHLOWPLOT statement 56
Y2AXISOPTS option, LAYOUT OVERLAY
        statement 121, 123
YAXISOPTS option, LAYOUT OVERLAY
        statement 121, 123

Symbols

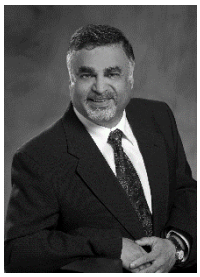
/ (slash), preceding options 37

Numbers

3-D plots 16, 50, 77–78

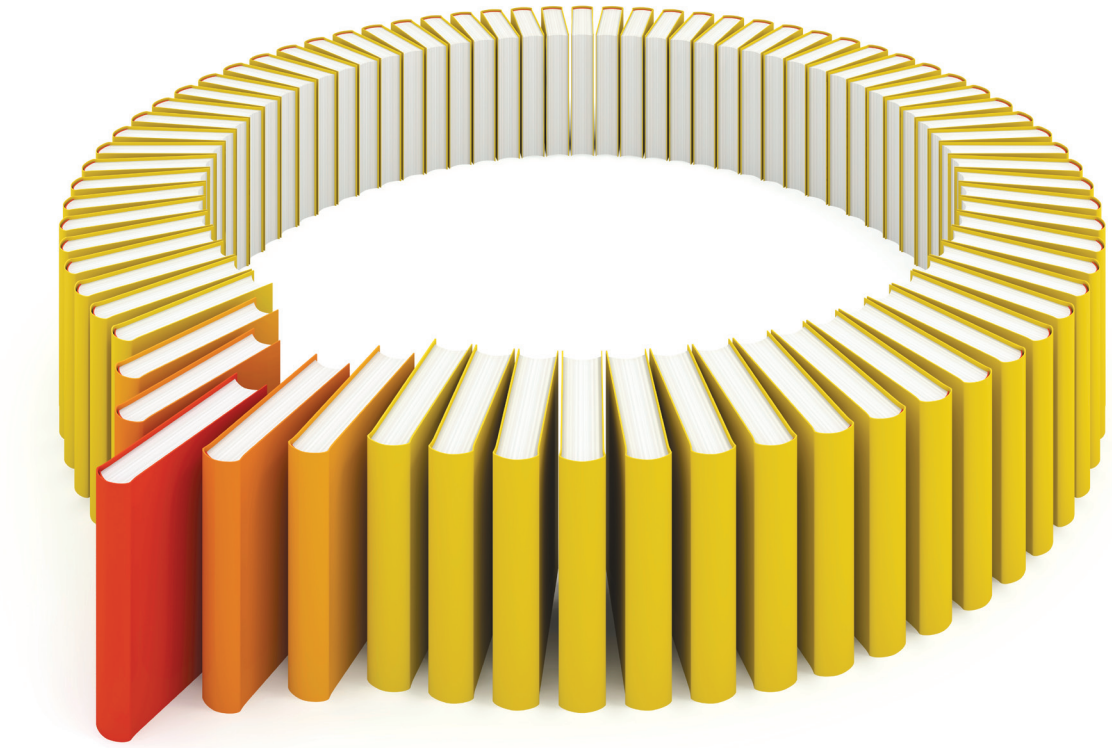
From *Getting Started with the Graph Template Language in SAS® : Examples, Tips, and Techniques for Creating Custom Graphs* by Sanjay Matange. Copyright © 2013, SAS Institute Inc., Cary, North Carolina, USA. All RIGHTS RESERVED.

About The Author



Sanjay Matange is Research & Development Director in the Data Visualization Division at SAS, responsible for the development and support of the ODS Graphics software. This includes the Graph Template Language (GTL), Statistical Graphics (SG) procedures, ODS Graphics Designer, and other related graphics applications. Sanjay has been with SAS for more than 20 years. He is co-author of two patents and author of two SAS Press books.

Learn more about this author by visiting his author page at http://support.sas.com/matange. There you can download free chapters, access example code and data, read the latest reviews, get updates, and more.



Gain Greater Insight into Your SAS® Software with SAS Books.

Discover all that you need on your journey to knowledge and empowerment.

support.sas.com/bookstore
for additional books and resources.

sas
THE POWER TO KNOW®

SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc. in the USA and other countries. ® indicates USA registration. Other brand and product names are trademarks of their respective companies. © 2013 SAS Institute Inc. All rights reserved. S107969US.0413