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# **SAS/STAT<sup>®</sup> 13.2 User's Guide ODS Graphics Template Modification**



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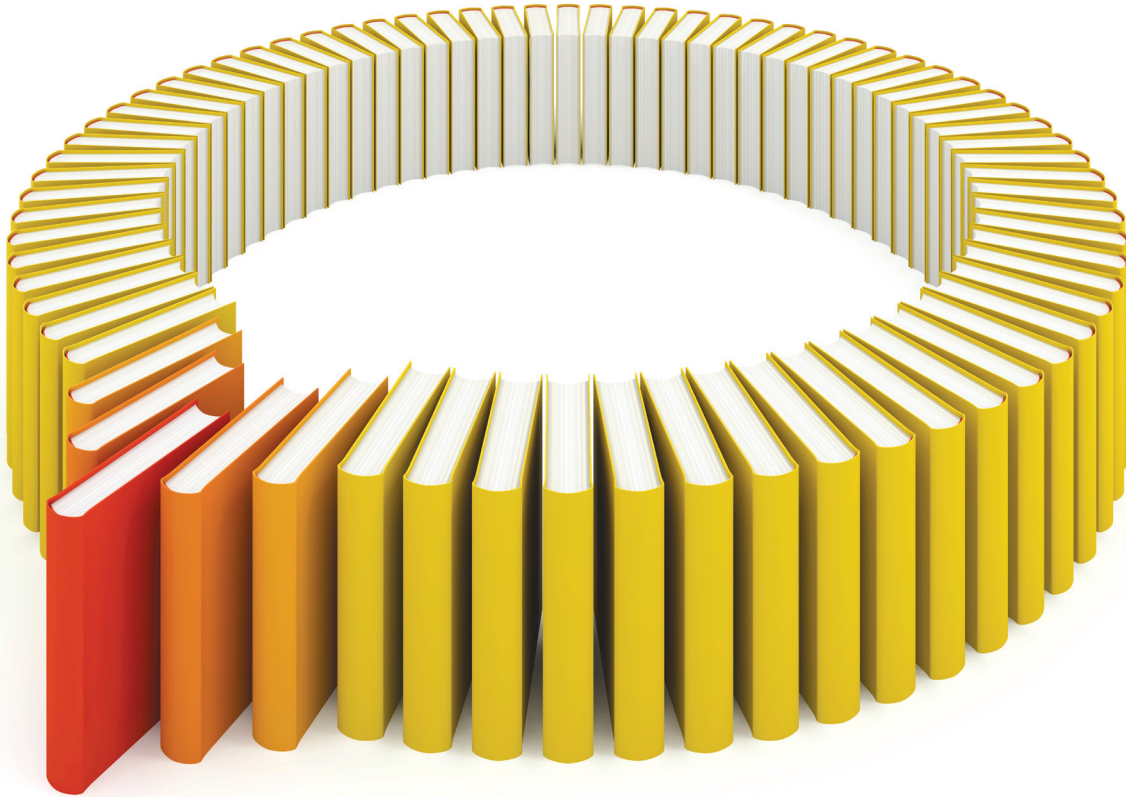
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## Chapter 22

# ODS Graphics Template Modification

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## Graph Templates

This chapter discusses the graph template language and graph template modification in ODS Graphics. Be sure that you are familiar with Chapter 21, “[Statistical Graphics Using ODS](#),” before reading this chapter.

Graph templates control the layout and details of graphs produced with ODS Graphics. The SAS System provides a template for every graph produced by statistical procedures. Graph template definitions are written in the Graph Template Language (GTL). This powerful language includes statements for specifying plot layouts (such as lattices or overlays), plot types (such as scatter plots and histograms), and text elements (such as titles, footnotes, and insets). It also provides support for built-in computations (such as histogram binning) and the evaluation of expressions. Options are available for specifying colors, marker symbols, and other attributes of plot features.

Graphs, like all SAS output, are constructed from two underlying components, a data component (or data object) and a template. Procedures supply a table of data values and statistical results to plot. Together, the data object and the template form an output object that ODS displays in one or more output destinations. You can control this display in two ways. You can use the ODS Graphics Editor (discussed in the section “[ODS Graphics Editor](#)” on page 636 in Chapter 21, “[Statistical Graphics Using ODS](#),”) to modify the output object (but not the underlying data object or template), and you can use the GTL to modify the template. With just a little knowledge of the GTL, you can modify or edit templates, even when you do not understand most of the syntax used in the template definition. See examples starting with [Example 22.1](#).

**NOTE: You do not need to know anything about the GTL to create statistical graphics.**

This section provides an overview of the Graph Template Language. It also describes how to locate, display, edit, and save templates. A *template definition* is a set of SAS statements that is used together with PROC TEMPLATE to create a compiled template. In addition to graph templates, two other common types of templates are table templates and style templates. A table template describes how to display the output for an output object that is rendered as a table. A style template provides formatting information for visual aspects of your SAS output, including both tables and graphs. In most applications, you do not have to modify the templates that are supplied by SAS. However, when customization is necessary, you can modify the default template with the template language and PROC TEMPLATE.

Compiled templates are stored in a template store, which is a type of item store. (An item store is a special type of SAS file.) The default templates supplied by SAS are stored in the Sashelp.Tmplmst template store. If you are using the SAS windowing environment, an easy way to display, edit, and save your templates is by using the Templates window. For an introduction to the graph template language, see Kuhfeld (2010).

For detailed information about managing templates, see the *SAS Output Delivery System: User's Guide* and the *SAS Graph Template Language: User's Guide*. For details about the syntax of the graph template language, see the *SAS Graph Template Language: Reference*.

## The Graph Template Language

Graph template definitions begin with a `DEFINE STATGRAPH` statement in `PROC TEMPLATE`, and they end with an `END` statement. Embedded in every graph template is a `BEGINGRAPH/ENDGRAPH` block, and embedded in that block are one or more `LAYOUT` blocks. You can specify the `DYNAMIC` statement to define dynamic variables (which the procedure uses to pass values to the template definition), the `MVAR` and `NMVAR` statements to define macro variables (which you can use to pass values to the template definition), and the `NOTES` statement to provide descriptive information about the graph. The default templates supplied by SAS for statistical procedures are often lengthy and complex, because they provide ODS Graphics with comprehensive and detailed information about graph construction. Here is one of the simpler graph templates for a statistical procedure:

```
define statgraph Stat.MDS.Graphics.Fit;
  notes "MDS Fit Plot";
  dynamic head;
  begingraph / designwidth=default designheight;
    entrytitle HEAD;
    layout overlayequated / equatetype=square;
      scatterplot y=FITDATA x=FITDIST / markerattrs=(size=5px);
      lineparm slope=1 x=0 y=0 / extend=true lineattrs=GRAPHREFERENCE;
    endlayout;
  endgraph;
end;
```

This template, supplied for the MDS procedure, creates a scatter plot of two variables, `FitData` and `FitDist`, along with a diagonal reference line that passes through the origin. The plot is square and the axes are equated so that a centimeter on one axis represents the same data range as a centimeter on the other axis. The plot title is provided by the evaluation of the dynamic variable `Head`, which is set by the procedure. It is not unusual for this plot to contain hundreds or even thousands of points, so a five-pixel marker is specified, which is smaller than the seven-pixel marker used by default in most styles.

The statements available in the graph template language can be classified as follows:

- Control statements specify the conditional or iterative flow of control. By default, flow of control is sequential. In other words, each statement is used in the order in which it appears.
- Layout statements specify the arrangement of the components of the graph. Layout statements are arranged in blocks that begin with a `LAYOUT` statement and end with an `ENDLAYOUT` statement. The blocks can be nested. Within a layout block, there can be plot, text, and other statements that define one or more graph components. Options provide control for attributes of layouts and components.

- Plot statements specify a number of commonly used displays, including scatter plots, histograms, contour plots, surface plots, and box plots. Plot statements are always provided within a layout block. The plot statements include options to specify the data columns from the data object that is used in the graph. For example, in the SCATTERPLOT statement, there are mandatory X= and Y= arguments that specify which data columns are used for the X (horizontal) and Y (vertical) axes in the plot. (In the preceding example, FitData and FitDist are the names of columns in the data object that PROC MDS creates for this graph.) There is also a GROUP= option that specifies a data column as an optional classification variable.
- Text statements specify the descriptions that accompany graphs. An entry is any textual description, including titles, footnotes, and legends; it can include symbols to identify graph elements.

The following statements display another of the simpler template definitions—the definition of the scatter plot available in PROC KDE (see [Figure 54.6.1](#) in Chapter 54, “[The KDE Procedure](#),”):

```
proc template;
  define statgraph Stat.KDE.Graphics.ScatterPlot;
    dynamic _TITLE _DEPLABEL _DEPLABEL2;
    BeginGraph;
      EntryTitle _TITLE;
      layout Overlay;
        scatterplot x=X y=Y / markerattrs=GRAPHDATADEFAULT;
      EndLayout;
    EndGraph;
  end;
run;
```

Here, the PROC TEMPLATE and RUN statements have been added to show how you would compile the template if you wanted to modify it. The DEFINE STATGRAPH statement in PROC TEMPLATE begins the graph template definition, and the END statement ends the definition. The DYNAMIC statement defines three dynamic variables that PROC KDE sets at run time. The variable \_Title provides the title of the graph. The variables \_DepLabel and \_DepLabel2 contain the names of the X- and Y-variables, respectively. If you were to modify this template, you could use these dynamic text variables in any text element of the graph template.

The overall display is specified with the LAYOUT OVERLAY statement inside the BEGIN-GRAPH/ENDGRAPH block. The title of the graph is specified with the ENTRYTITLE statement. The main plot is a scatter plot specified with the SCATTERPLOT statement. The options in the SCATTERPLOT statement are given after the slash and specify display options such as marker attributes (symbol, color, and size). These attributes can be specified directly, as in the PROC MDS template, or more typically by using indirect references to style attributes, as in the PROC KDE template. The values of these attributes are specified in the definition of the style you are using and are automatically set to different values if you specify a different style. For more information about style references, see the section “[Styles](#)” on page 641 in Chapter 21, “[Statistical Graphics Using ODS](#).” The ENDLAYOUT statement ends the main layout block. For details about the syntax of the graph template language, see the *SAS Graph Template Language: Reference*.

You can write your own templates and use them to display raw data or output from procedures. For example, consider the iris data from [Example 35.1](#) of Chapter 35, “[The DISCRIM Procedure](#).” The iris data set is available from the Sashelp library.

The following statements create a template for a scatter plot of the variables PetalLength and PetalWidth with a legend:

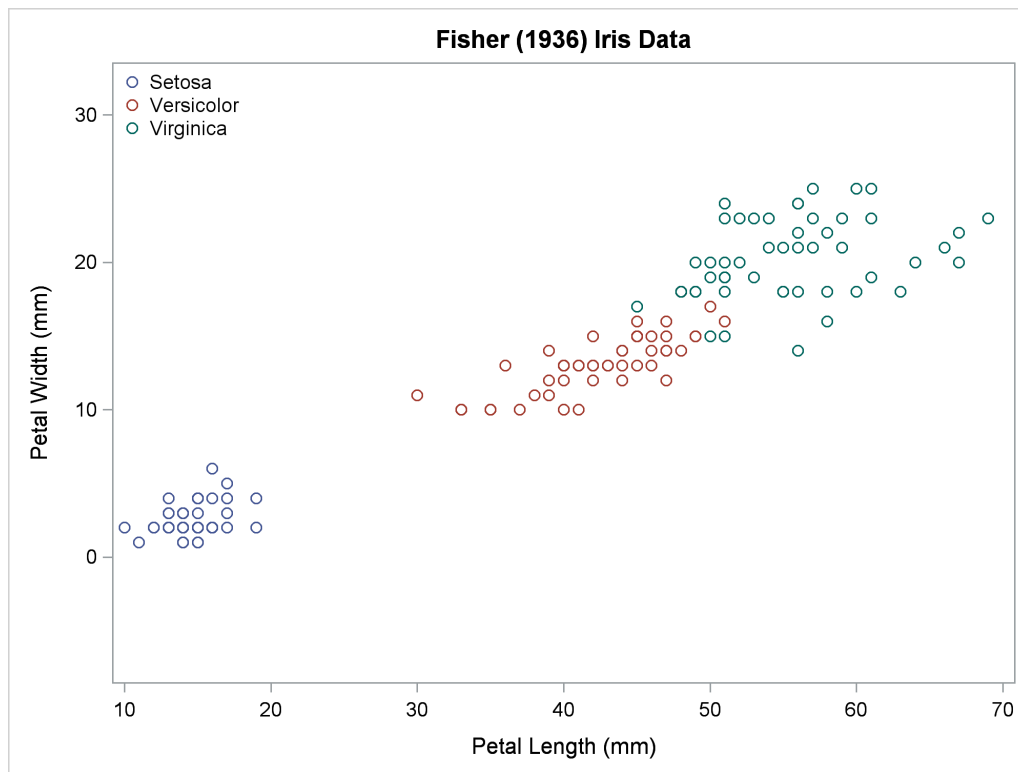
```
proc template;
  define statgraph scatter;
    begingraph;
      entrytitle 'Fisher (1936) Iris Data';
      layout overlayequated / equatetype=fit;
        scatterplot x=petallength y=petalwidth /
          group=species name='iris';
      layout gridded / autoalign=(topleft);
        discretelegend 'iris' / border=false opaque=false;
      endlayout;
    endlayout;
  endgraph;
end;
run;
```

The layout is OVERLAYEQUATED, which equates the axes in the plot. However, unlike the PROC MDS template, which used EQUATETYPE=SQUARE to make a square plot, the EQUATETYPE=FIT option specifies that the lengths of the axes in this plot should fill the entire plotting area. A legend is placed internally in the top-left portion of the plot. There are three groups of observations, indicated by the three species, and each group is plotted with a separate color and symbol that depends on the ODS style. The legend identifies each group. The NAME= option provides the link between the SCATTERPLOT statement and the DISCRETELEGEND statement. An explicit link is needed since some graphical displays are based on multiple plotting statements.

The following step creates the plot by using the SGRENDER procedure, the Sashelp.Iris data set, and the custom template **scatter**:

```
proc sgrender data=sashelp.iris template=scatter;
run;
```

The syntax of PROC SGRENDER is very simple, because all of the graphical options appear in the template. The scatter plot in [Figure 22.1](#) shows the results.

**Figure 22.1** Petal Width and Petal Length in Three Iris Species

The intent of this example is to illustrate how you can write a template to create a scatterplot. PROC TEMPLATE and PROC SGRENDER provide you with the power to create highly customized displays. However, usually you can use the SGPLOT, SGSCATTER or SGPANEL procedures instead, which are much simpler to use. These procedures are discussed in the section “[Statistical Graphics Procedures](#)” on page 688 in Chapter 21, “[Statistical Graphics Using ODS](#).” See the section “[Grouped Scatter Plot with PROC SGPLOT](#)” on page 604 and [Figure 21.12](#) in Chapter 21, “[Statistical Graphics Using ODS](#),” for an example that plots these data with PROC SGPLOT.

## Locating Templates

Before you can customize a graph, you must determine which template is used to create the original graph. You can do this by submitting the ODS TRACE ON statement before the procedure statements that create the graph. The fully qualified template name is displayed in the SAS log. Here is an example:

```
ods trace on;
ods graphics on;

proc reg data=sashelp.class;
  model Weight = Height;
run; quit;
```

The preceding statements create the following trace output, which provides information about both the graphs and tables produced by PROC REG:

## Output Added:

```

-----
Name:      NObs
Label:     Number of Observations
Template:  Stat.Reg.NObs
Path:     Reg.MODEL1.Fit.Weight.NObs
-----

```

## Output Added:

```

-----
Name:      ANOVA
Label:     Analysis of Variance
Template:  Stat.REG.ANOVA
Path:     Reg.MODEL1.Fit.Weight.ANOVA
-----

```

## Output Added:

```

-----
Name:      FitStatistics
Label:     Fit Statistics
Template:  Stat.REG.FitStatistics
Path:     Reg.MODEL1.Fit.Weight.FitStatistics
-----

```

## Output Added:

```

-----
Name:      ParameterEstimates
Label:     Parameter Estimates
Template:  Stat.REG.ParameterEstimates
Path:     Reg.MODEL1.Fit.Weight.ParameterEstimates
-----

```

## Output Added:

```

-----
Name:      DiagnosticsPanel
Label:     Fit Diagnostics
Template:  Stat.REG.Graphics.DiagnosticsPanel
Path:     Reg.MODEL1.ObswiseStats.Weight.DiagnosticPlots.DiagnosticsPanel
-----

```

## Output Added:

```

-----
Name:      ResidualPlot
Label:     Height
Template:  Stat.REG.Graphics.ResidualPlot
Path:     Reg.MODEL1.ObswiseStats.Weight.ResidualPlots.ResidualPlot
-----

```

## Output Added:

```

-----
Name:      FitPlot
Label:     Fit Plot
Template:  Stat.REG.Graphics.Fit
Path:     Reg.MODEL1.ObswiseStats.Weight.FitPlot
-----

```

This is also illustrated in [Example 22.1](#) and the section “The ODS Statement” on page 525 in Chapter 20, “Using the Output Delivery System.”

## Displaying Templates

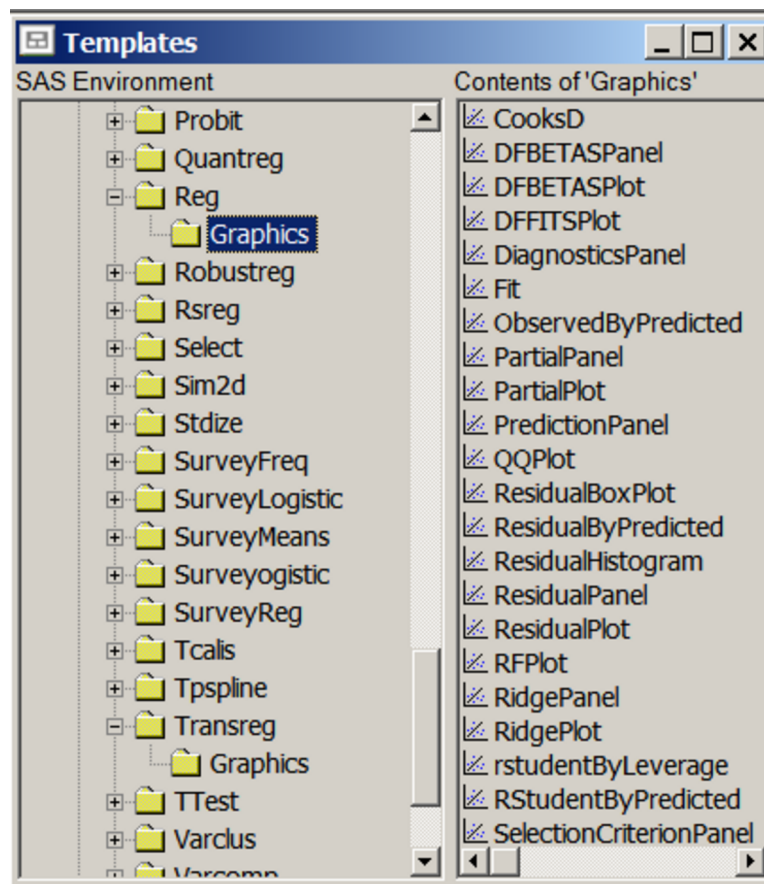
Once you have found the fully qualified name of a template, you can display its definition (source program) by using one of these methods:

- Open the Templates window by issuing the command **odstemplates** (**odst** for short) in the command line of the SAS windowing environment. The template window is shown in [Figure 22.2](#). If you expand the Sashelp.Tmplmst node, you can view all the available templates and double-click any template icon to display its definition. This is illustrated in [Example 22.1](#).
- Use the SOURCE statement in PROC TEMPLATE to display a template definition in the SAS log or write the definition to a file.

For example, the following statements display the template for the PROC REG residual plot:

```
proc template;
  source Stat.REG.Graphics.ResidualPlot;
run;
```

**Figure 22.2** Requesting the Templates Window in the Command Line



The template is displayed as follows:

```
define statgraph Stat.Reg.Graphics.ResidualPlot;
  notes "Residual Plot";
  dynamic _XVAR _SHORTXLABEL _TITLE _LOESSLABEL _DEPNAME
    _MODELLABEL _SMOOTH;
  BeginGraph;
    entrytitle halign=left textattrs=GRAPHVALUETEXT
      _MODELLABEL halign=center
      textattrs=GRAPHTITLETEXT _TITLE " for " _DEPNAME;
    entrytitle textattrs=GRAPHVALUETEXT _LOESSLABEL;
    layout overlay / xaxisopts=(shortlabel=_SHORTXLABEL);
    referenceline y=0;
    scatterplot y=RESIDUAL x=_XVAR / primary=true
      rolename=(_tip1=OBSERVATION _id1=ID1 _id2=ID2
        _id3=ID3 _id4=ID4 _id5=ID5) tip=(y x
        _tip1 _id1 _id2 _id3 _id4 _id5);
    if (EXISTS(_SMOOTH))
      loessplot y=_SMOOTH x=_XVAR /
        tiplabel=(y="Smoothed Residual");
    endif;
  endlayout;
EndGraph;
end;
```

PROC TEMPLATE also tells you where the template is located. In this case, it prints the following note:

```
NOTE: Path 'Stat.Reg.Graphics.ResidualPlot' is in: SASHELP.TMPLMST.
```

The word “Path” in ODS has several meanings. In this context, it refers to any name or label hierarchy. In the note, the levels of the template name form a path. In the trace output, the levels of the plot name form a different path.

---

## Editing Templates

You can modify the format and appearance of a particular graph by doing the following:

- Modify its template definition (source program).
- Submit the revised template to create a new compiled template, which is stored in a template store.
- Ensure that the ODS template search path includes the template store that contains your new template.

Template stores are designated read-only (such as Sashelp.Tmplmst) or updatable (such as Sasuser.Templat).

If you view the templates in an updatable template store from the Templates window, you can select **Open** or **Edit** from the pop-up menu. Either the Template Browser or Template Editor window opens. In the Template Editor window, you can make changes and submit the code directly. For read-only templates or when you select **Open**, the Template Browser window opens and you must copy the definition to an editor window to make changes. Since templates supplied by SAS are in the read-only Sashelp library, an easy way to obtain an editable program file is to use the SOURCE statement with the FILE= option in PROC TEMPLATE to write the template definition to a file as follows:

```
proc template;
  source Stat.REG.Graphics.ResidualPlot / file="residtpl.sas";
run;
```

By default, the file is saved in the SAS current folder. Alternatively, you can omit the slash and the FILE= option and copy and paste the source from the SAS log into an editor. Either way, you must add a PROC TEMPLATE statement before the generated source statements and optionally a RUN statement after the END statement before you submit your modified definition.

Graph templates are self-contained and do not support inheritance (via the PARENT= option) as do table templates. Consequently, the EDIT statement in PROC TEMPLATE is not supported for graph templates.

Here are some important points about what you can and cannot change in a template supplied by SAS while preserving its overall functionality:

- Do not change the template name. A statistical procedure can access only a predefined list of templates. If you change the name, the procedure cannot find your template. You must keep the original name and make sure that it is in a template store that is searched before Sashelp.Tmplmst. You control this with the ODS PATH statement (see the section “[The Default Template Stores and the Template Search Path](#)” on page 640 in Chapter 21, “[Statistical Graphics Using ODS](#),” the section “[Saving Customized Templates](#)” on page 721, and subsequent sections for more information about the template search path and the ODS PATH statement).
- Do not change the names of columns. The underlying data object contains predefined column names that you must use. Be very careful if you change how a column is used in a template. Usually, columns are not interchangeable.
- Do not change the names of DYNAMIC variables. Procedures set values only for a predefined list of dynamic variables. Changing dynamic variable names can lead to runtime errors. Do not add dynamic variables, because the procedure cannot set their values. A few procedures document additional dynamic variables that can be defined in the template if you want to add more information to the output, such additional statistics in an inset table.
- Do not change the names of statements (for example, from a SCATTERPLOT to a NEEDLEPLOT or other type of plot).

You can change any of the following:

- You can add macro variables that behave like dynamic variables. They are resolved at the time that the statistical procedure is run, and not at the time that the template is compiled. They are defined with an MVAR or NMVAR statement at the beginning the template. You can set the value of each macro variable with a %LET statement before the statistical procedure is run. See [Example 22.5](#). You can also move a variable from a DYNAMIC statement to an MVAR or NMVAR statement if you want to set it yourself rather than letting the procedure set it.
- You can change the graph size.
- You can change graph titles, footnotes, axis labels, and any other text that appears in the graph.
- You can change which plot features are displayed.
- You can change axis features, such as grid lines, offsets, view ports, tick value formatting, and so on.

- You can change the content and arrangement of insets (small tables of statistics embedded in some graphs).
- You can change the legend location, contents, border, background, title, and so on.

See the *SAS Graph Template Language: Reference* for information about the syntax of the statements in the Graph Template Language.

---

## Saving Customized Templates

After you edit the template definition, you can submit your PROC TEMPLATE statements as you would any other SAS program. If you are using the Template Editor window, select **Submit** from the **Run** menu. See [Example 22.1](#). Alternatively, submit your PROC TEMPLATE statements from the Program Editor. ODS automatically saves the compiled template in the first template store that it can update, according to the currently defined template search path. If you have not changed the template search path, then the modified template is saved in the Sasuser.Templat template store. You can display the current template search path with the following statement:

```
ods path show;
```

The log messages for the default template search path are as follows:

```
Current ODS PATH list is:
```

- ```
1. SASUSER.TEMPLAT (UPDATE)
2. SASHELP.TMPLMST (READ)
```

If you want to store modified templates in another template store, you can use the ODS PATH statement to add that template store to the front of the list. To use these templates, you must make sure the template search path is set correctly before you attempt to access them in the other SAS sessions. See the section “[Using Customized Templates](#)” on page 721.

---

## Using Customized Templates

When you create ODS output (either graphs or tables), ODS searches sequentially through each template store in the template search path for a template that matches the one requested. If you have not changed the default template search path, then ODS searches the Sasuser.Templat store first, then Sashelp.Tmplmst. ODS uses the first template that it finds with the requested name. **NOTE:** Templates with the same name can exist in more than one template store.

The ODS PATH statement specifies the template stores to search, as well as the order in which to search them. You can change the default template search path by using the ODS PATH statement. For example, the following statement sets the template search path so that the template store Work.Mystore is searched first, followed by Sashelp.Tmplmst:

```
ods path work.mystore(update) sashelp.tmplmst(read);
```

The UPDATE option provides update access as well as read access to Work.Mystore. The READ option provides read-only access to Sashelp.Tmplmst. With this path, the template store Sasuser.Templat is no longer searched. You can verify this with the following statement:

```
ods path show;
```

The log messages generated by the preceding statement are as follows:

```
Current ODS PATH list is:
```

1. WORK.MYSTORE (UPDATE)
2. SASHELP.TMPLMST (READ)

For more information, see the *SAS Output Delivery System: User's Guide* and the *SAS Graph Template Language: User's Guide*. [Example 22.1](#) illustrates all the steps of displaying, editing, saving, and using customized templates.

---

## Reverting to the Default Templates

Customized templates are stored in Sasuser.Templat or in some other template store that you create. The templates supplied by SAS are in the read-only template store Sashelp.Tmplmst. If you have modified any of the supplied templates and you want to use the original default templates, you can change your template search path as follows:

```
ods path sashelp.tmplmst(read) sasuser.templat(update);
```

This way the default templates are found first. Alternatively, you can save all of your customized templates in a user-defined template store (for example Mylib.Mystore). To access these templates, you submit the following statement before running your analysis:

```
libname mylib '.';
ods path mylib.mystore(update) sashelp.tmplmst(read);
```

When you are done, you can reset the default template search path as follows:

```
ods path reset;
```

This restores the template search path to its original state (`sasuser.templat(update) sashelp.tmplmst(read)`). You can also save your customized template as part of your SAS program. You can delete your customized template from the Sasuser.Templat template store when you are done, as in the following statements:

```
proc template;
  delete Stat.REG.Graphics.ResidualPlot / store=sasuser.templat;
run;
```

The option STORE=SASUSER.TEMPLAT is not required. However, if you have administrator privileges on your computer, this option helps you ensure that you do not accidentally delete templates from Sashelp.Tmplmst.

The following note is printed in the SAS log:

```
NOTE: 'Stat.REG.Graphics.ResidualPlot' has been deleted from: SASUSER.TEMPLAT
```

You can run the following step to delete the entire Sasuser.Templat store of customized templates:

```
ods path sashelp.tmplmst(read);
proc datasets library=sasuser nolist;
    delete templat(memtype=itemstor);
run;
ods path sasuser.templat(update) sashelp.tmplmst(read);
```

---

## Graph Template Modification Macro

You can use the `%ModTmpl` autocall macro to insert BY line information, titles, and footnotes in ODS Graphics. You can also use it to remove titles and perform other template modifications. See Kuhfeld (2009) for more information about this macro.

You do not have to include autocall macros (for example, with a `%include` statement). You can call them directly once they are properly installed. If your site has installed the autocall libraries supplied by SAS and uses the standard configuration of SAS supplied software, you need to ensure that the SAS system option MAUTOSOURCE is in effect to begin using the autocall macros. For more information about autocall libraries, see the *SAS Macro Language: Reference*. For details about installing autocall macros, consult your host documentation.

The `%ModTmpl` macro has the following options:

### **BY=***by-variable-list*

specifies the list of BY variables. Also see BYLIST=. When graphs are produced (by default or when the STEPS= value contains 'G'), you must specify the BY= option. Otherwise, when you are only modifying the template, you do not need to specify the BY= option. **NOTE:** This option has been rendered obsolete by the BYLINE= option in the ODS GRAPHICS statement.

### **BYLIST=***by-statement-list*

specifies the full syntax of the BY statement. You can specify a full BY statement syntax including the DESCENDING or NOTSORTED options. If only BY variables are needed, specify only BY=. If you also need options, then specify the BY variables in the BY= option and the full syntax in the BYLIST= option (for example, specify BY=A B and BYLIST=A DESCENDING B). **NOTE:** This option has been rendered obsolete by the BYLINE= option in the ODS GRAPHICS statement.

### **DATA=***SAS-data-set*

specifies the input SAS data set. If you do not specify the DATA= option, the macro uses the most recently created SAS data set.

### **FILE=***filename*

specifies the file in which to store the original templates. This is a temporary file. You can specify either a quoted file name or the name from a FILENAME statement that you provide before you call the macro. The default is *"template.txt"*.

**OPTIONS=***options*

specifies one or more of the following options (case is ignored):

**LOG**

displays a note in the SAS log when each BY group has finished.

**FIRST**

adds the ENTRYTITLE or ENTRYFOOTNOTE statements as the first titles or footnotes. By default, the statements are added after the last titles or footnotes. Most graph templates provided by SAS do not use footnotes; so this option usually affects only entry titles.

**NOQUOTES**

specifies that the values of the system titles and footnotes are to be moved to the ENTRYTITLE or ENTRYFOOTNOTE statements without the outer quotation marks. With OPTIONS=NOQUOTES, you can specify options in the titles or footnotes in addition to the text. However, you must ensure that you quote the text that provides the actual title or footnote.

The following is an example of an ordinary footnote:

```
footnote "My Footer";
```

With this FOOTNOTE statement and without OPTIONS=NOQUOTES, the macro creates the following ENTRYFOOTNOTE statement:

```
entryfootnote "My Footer";
```

The following footnotes are used with OPTIONS=NOQUOTES:

```
footnote 'halign=left "My Footer"';  
footnote2 '"My Second Footer"';
```

With these FOOTNOTE statements and OPTIONS=NOQUOTES, the macro creates the following ENTRYFOOTNOTE statements:

```
entryfootnote halign=left "My Footer";  
entryfootnote "My Second Footer";
```

**REPLACE**

replaces the unconditionally added entry titles and entry footnotes in the templates (those that are not part of IF or ELSE statements) with the system titles and footnotes. The system titles and footnotes are those that are specified in the TITLE or FOOTNOTE statements. You can instead use the TITLES=SAS-*data-set* option to specify titles and footnotes with a data set. If OPTIONS=REPLACE is specified, then OPTIONS=TITLES is ignored.

**SOURCE**

displays the generated source code. By default, the template source code is not displayed.

**TITLES**

displays the system titles and footnotes with the graphs. The system titles and footnotes are those that are specified in the TITLE or FOOTNOTE statements. You can instead use the TITLES=SAS-*data-set* option to specify titles and footnotes with a data set. If you also specify

OPTIONS=FIRST, the system titles and footnotes are inserted before the previously existing entry titles and entry footnotes in the templates. Otherwise, they are inserted at the end.

You can specify OPTIONS=TITLES or OPTIONS=REPLACE, or insert BY lines, or do both. If you do both, and you do not like where the BY line is inserted relative to your titles and footnotes, just specify OPTIONS=NOQUOTES and `_ByLine0` to place the BY line wherever you choose. The following TITLE statements illustrate:

```
title1 '"My First Title"';
title2 '_byline0';
title3 '"My Last Title"';
```

Also, you can embed BY information in a title or a footnote, again with OPTIONS=NOQUOTES. For example:

```
title '"Spline Fit By Sex, " _byline0';
```

When `_ByLine0` is specified in any of the titles or footnotes, then the usual BY line is not added.

The following example removes all titles and footnotes:

```
footnote;
title;
%modtmplt(options=replace, template=Stat.Transreg.Graphics, steps=t)
```

#### **STATEMENT=***entry-statement-fragment*

specifies the statement that contains the BY line that gets added to the template along with any statement options. The default is **Statement=EntryFootNote halign=left TextAttrs=GraphValueText**. Other examples include:

```
Statement=EntryTitle
Statement=EntryFootNote halign=left TextAttrs=GraphLabelText
```

#### **STEPS=***steps*

specifies the macro steps to run. Case and white space are ignored. the macro modifies the templates (when 'T' is specified), produces the graphs for each BY group (when 'G' is specified), and deletes the modified templates (when 'D' is specified). The default is STEPS=TGd. You can instead have it perform a subset of these three tasks by specifying a subset of terms in the STEPS= option.

When you use the `%ModTmpl` macro to add BY lines, you usually do not need to delete the templates before you run your procedure again in the normal way. The template modification inserts the BY line through a macro variable and an MVAR statement. When the macro variable `_ByLine0` is undefined, the ENTRYTITLE or ENTRYFOOTNOTE statement drops out as if it were not there at all.

```

STMTOPTS1= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >
STMTOPTS2= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >
STMTOPTS3= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >
STMTOPTS4= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >
STMTOPTS5= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >
STMTOPTS6= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >
STMTOPTS7= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >
STMTOPTS8= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >
STMTOPTS9= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >
STMTOPTS10= n ADD | REPLACE | DELETE | BEFORE | AFTER statement-name < options >

```

These ten options add or replace options in up to 10 selected statements. The following example illustrates:

```

%modtplt (template=Stat.glm.graphics.residualhistogram, steps=t,
          stmtopts1=. add discretelegend autoalign=(topleft),
          stmtopts2=1 add densityplot legendlabel='Normal Density',
          stmtopts3=2 add densityplot legendlabel='Kernel Density',
          stmtopts4=1 add overlay yaxisopts=(griddisplay=on)
          yaxisopts=(label='Normal and Kernel Density'))

proc glm plots=diagnostics(unpack) data=sashelp.class;
  model weight = height;
run;

%modtplt (template=Stat.glm.graphics.residualhistogram, steps=d)

```

These options require you to specify a series of values. The first value is the statement number (or missing to modify options on all statements that match the statement name). The second value is: ADD, REPLACE, DELETE, BEFORE, or AFTER. When the second value is ADD or REPLACE, it controls whether you add new options or replace existing options. Alternatively, the second value can be BEFORE or AFTER to add a new statement before or after the named statement. When the value is DELETE, the corresponding statement is deleted. The third value is a statement name. All remaining options are options for the statement named by the third value (with ADD and REPLACE) or for a new statement (with BEFORE and AFTER). In the STMTOPTS1= example, an option is added to all DISCRETELEGEND statements. In the STMTOPTS2= example, an option is added to the first DensityPlot statement. In the STMTOPTS4= example, an option is added to the LAYOUT OVERLAY statement. In most cases, the statement name is the first name that begins the statement. The LAYOUT statement is an exception. In the case of layouts, specify the second name (OVERLAY, GRIDDED, LATTICE, and so on) for the third value. Note that a statement such as **if (expression) EntryTitle...**; is an IF statement not an ENTRYTITLE statement.

If an option is specified multiple times on a GTL statement, the last specification overrides previous specifications. Hence, you do not need to know and respecify all of the options. You can just add an option to the end, and it overrides the previous value. You can use these options only to modify statements that contain a slash, and only to modify the options that come after the slash. Note that in STMTOPTS4=, the YAXISOPTS= option is specified twice. It could have been equivalently specified once as follows:

```
yaxisopts=(griddisplay=on label='Normal and Kernel Density'))
```

The actual specification adds the GRIDDISPLAY=ON to the Y axis options (which by default has only a label specification). The old label is unchanged until the LABEL= option in the second YAXISOPTS= specification overrides it. In other words, YAXISOPTS=(GRIDDISPLAY=ON) augments the old YAXISOPTS= option; it does not replace it.

The following steps delete the legend and instead provide a footnote:

```
%modtmplt(template=Stat.glm.graphics.residualhistogram, steps=t,
           stmtopts1=. delete discretelegend,
           stmtopts2=1 after begingraph entryfootnote
                  textattrs=GraphLabelText(color=cx445694) 'Normal '
                  textattrs=GraphLabelText(color=cxA23A2E) 'Kernel')

proc glm plots=diagnostics(unpack) data=sashelp.class;
  model weight = height;
run;

%modtmplt(template=Stat.glm.graphics.residualhistogram, steps=d)
```

#### **TEMPLATE=SAS-template**

specifies the name of the template to modify. You can specify just the first few levels to modify a series of templates. For example, to modify all of PROC REG's graph templates, specify **TEMPLATE=Stat.Reg.Graphics**. This option is required.

#### **TITLES=SAS-data-set**

specifies a data set that contains titles or footnotes or both. By default, when the system titles or footnotes are used (when **OPTIONS=TITLES** or **OPTIONS=REPLACE** is specified), PROC SQL is used to determine the titles and footnotes. You can instead create this data set yourself so that you can set the graph titles independently from the system titles and footnotes. The data set must contain two variables: **Type** (**Type='T'** for titles and **Type='F'** for footnotes), and **Text**, which contains the titles and footnotes. Other variables are ignored. Specify the titles and footnotes in the order in which you want them to appear.

#### **TITLEOPTS=entry-statement-options**

specifies the options for system titles and footnotes. For example, you can specify the **HALIGN=** and **TEXTATTRS=** options as in the **STATEMENT=** option. By default, no title options are used. With **OPTIONS=NOQUOTES**, you can specify options individually.

---

## Examples of ODS Graphics Template Modification

---

### Example 22.1: Customizing Graphs Through Template Changes

This example shows how to use PROC TEMPLATE to customize the appearance and content of an ODS graph. It is divided into several parts; each part illustrates a different aspect of the template that you can easily change. You are never required to change a template, but you can if you want to change aspects of the plot.

#### Modifying Graph Titles and Axis Labels

This section illustrates the discussion in the section “[Graph Templates](#)” on page 712 in the context of changing the default title and Y-axis label for a Q-Q plot created with PROC ROBUSTREG. The data set Stack is created by the following statements:

```
data stack;
  input  x1 x2 x3 y @@;
  datalines;
80 27 89 42      80 27 88 37      75 25 90 37
62 24 87 28      62 22 87 18      62 23 87 18
... more lines ...
;
```

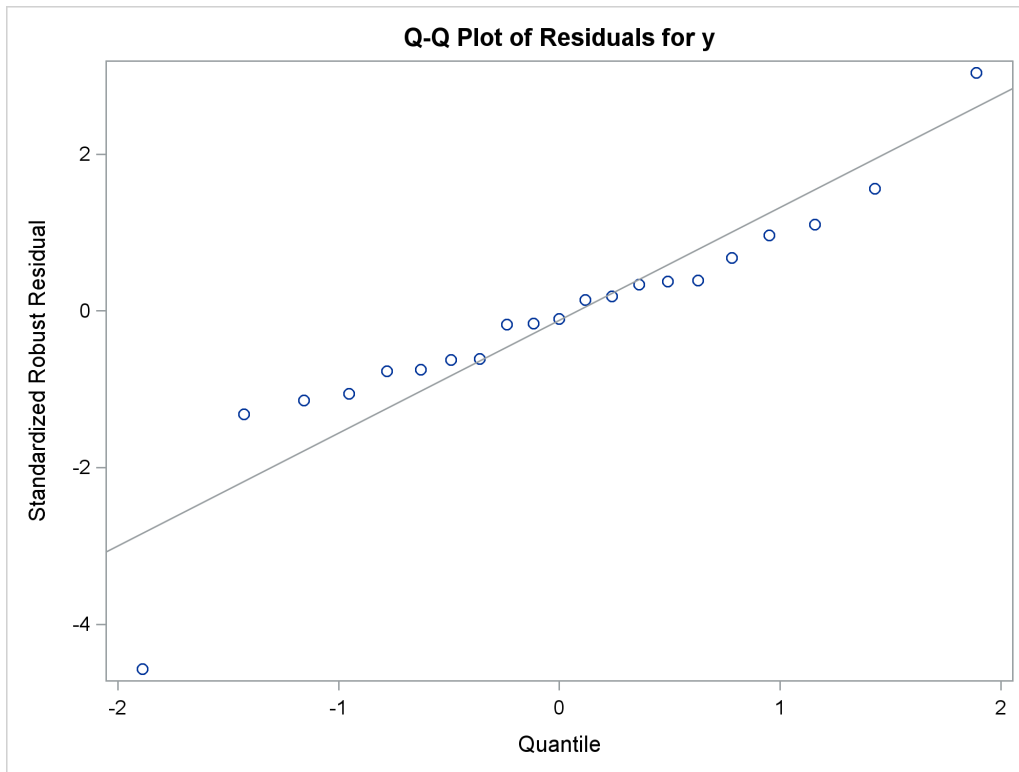
The following statements request a Q-Q plot for robust residuals created by PROC ROBUSTREG:

```
ods trace on;
ods graphics on;

proc robustreg data=stack plots=qqplot;
  ods select QQPlot;
  model y = x1 x2 x3;
run;

ods trace off;
```

The Q-Q plot is shown in [Output 22.1.1](#).

**Output 22.1.1** Default Q-Q Plot from PROC ROBUSTREG

The ODS TRACE ON statement requests a record of all the ODS output objects created by PROC ROBUSTREG. The trace output is as follows:

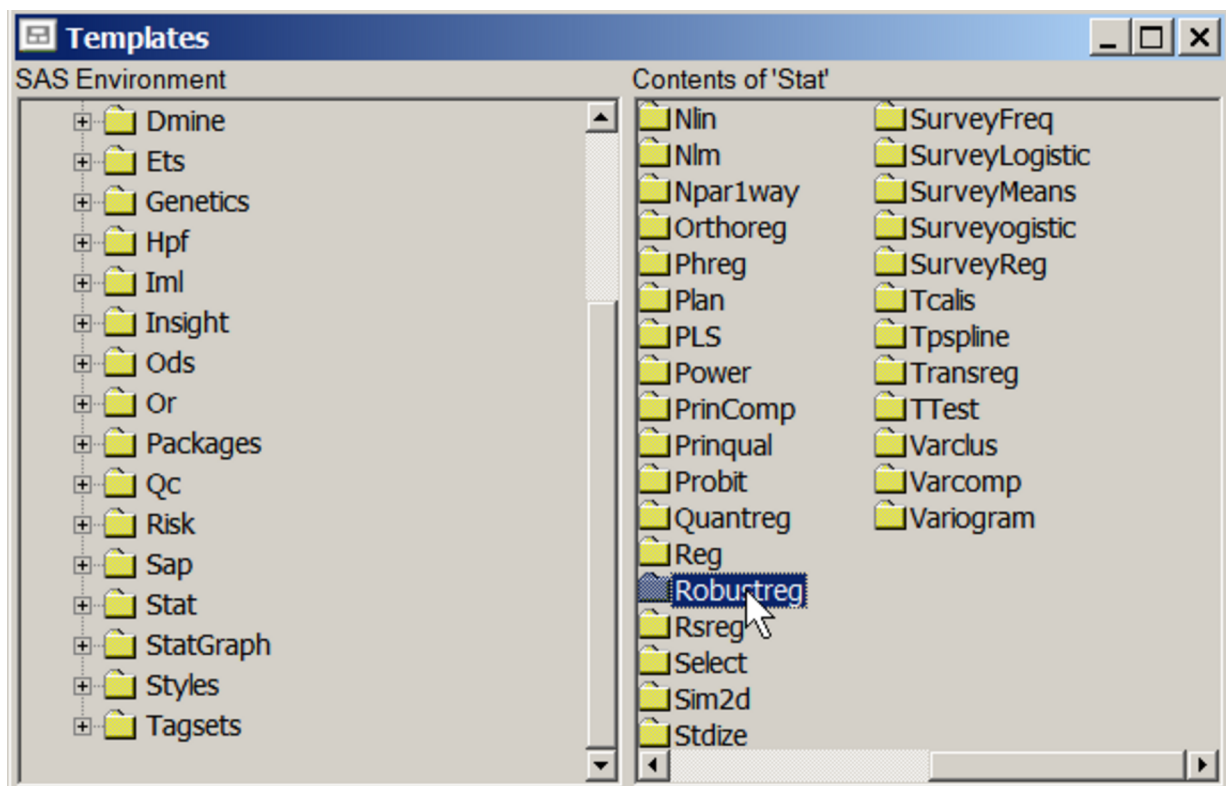
**Output Added:**

```
-----
Name:      QQPlot
Label:     Residual Q-Q Plot
Template:  Stat.Robustreg.Graphics.QQPlot
Path:     Robustreg.DiagnosticPlots.QQPlot
-----
```

ODS Graphics creates the Q-Q plot from an ODS data object named QQPlot and a graph template named **Stat.Robustreg.Graphics.QQPlot**, which is the default template provided by SAS. Default templates supplied by SAS are saved in the Sashelp.Tmplmst template store (see the section “[Graph Templates](#)” on page 712).

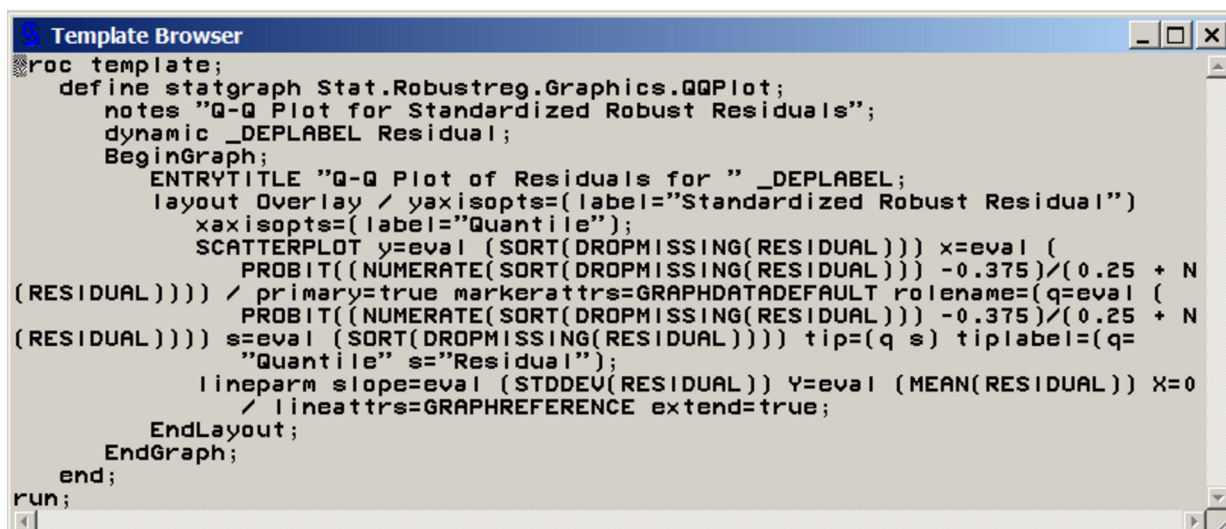
To display the default template definition, open the Templates window by typing **odstemplates** (or **odst** for short) in the command line. Expand Sashelp.Tmplmst and click the **Stat** folder. [Output 22.1.2](#) shows the contents of the **Stat** folder.

Output 22.1.2 The Template Window



Next, open the **Robustreg** folder and then open the **Graphics** folder. Then right-click the **QQPlot** template icon and select **Open**. This opens the Template Browser window shown in Output 22.1.3. You can copy this template to an editor to edit it.

Output 22.1.3 Default Template Definition for Q-Q Plot



Alternatively, you can submit the following statements to display the `QQPlot` template definition in the SAS log:

```
proc template;
  source Stat.Robustreg.Graphics.QQPlot;
run;
```

The `SOURCE` statement specifies the fully qualified template name. You can copy and paste the template source into the Program Editor and modify it. The template, with a `PROC TEMPLATE` and `RUN` statement added, is shown next:

```
proc template;
  define statgraph Stat.Robustreg.Graphics.QQPlot;
    notes "Q-Q Plot for Standardized Robust Residuals";
    dynamic _DEPLABEL Residual;
    BeginGraph;
      ENTRYTITLE "Q-Q Plot of Residuals for " _DEPLABEL;
      layout Overlay / yaxisopts=(label="Standardized Robust Residual")
        xaxisopts=(label="Quantile");
      SCATTERPLOT y=eval (SORT(DROPMISSING(RESIDUAL))) x=eval (
        PROBIT( (NUMERATE(SORT(DROPMISSING(RESIDUAL))) -0.375)/(0.25
          + N(RESIDUAL)))) / primary=true markerattrs=GRAPHDATADEFAULT
        rolename=(q=eval (
          PROBIT( (NUMERATE(SORT(DROPMISSING(RESIDUAL))) -0.375)/(0.25
            + N(RESIDUAL)))) s=eval (SORT(DROPMISSING(RESIDUAL))))
        tip=(q s) tiplabel=(q="Quantile" s="Residual");
      lineparm slope=eval (STDDEV(RESIDUAL)) Y=eval (MEAN(RESIDUAL))
        X=0 / lineattrs=GRAPHREFERENCE extend=true;
    EndLayout;
  EndGraph;
end;
run;
```

In the template, the default title of the Q-Q plot is specified by the `ENTRYTITLE` statement. The variable `_DepLabel` is a dynamic variable that provides the name of the dependent variable in the regression analysis. In this case, the name is `y`. In this template, the label for the axes are specified by the `LABEL=` suboption of the `YAXISOPTS=` option for the `LAYOUT OVERLAY` statement. In other templates, the axis labels come from the column labels of the X-axis and Y-axis columns of the data object. You can see these labels by specifying `ODS OUTPUT` with the plot data object and running `PROC CONTENTS` with the resulting SAS data set.

Suppose you want to change the default title to “Analysis of Residuals”, and you want the Y-axis label to display the name of the dependent variable. First, replace the `ENTRYTITLE` statement with the following statement:

```
entrytitle "Analysis of Residuals";
```

Next, replace the `LABEL=` suboption with the following:

```
label=("Standardized Robust Residual for " _DEPLABEL)
```

You can use dynamic text variables such as `_DepLabel` in any text element.

You can then submit the modified template definition as you would any SAS program, for example, by selecting **Submit** from the **Run** menu. After submitting the PROC TEMPLATE statements, you should see the following message in the SAS log:

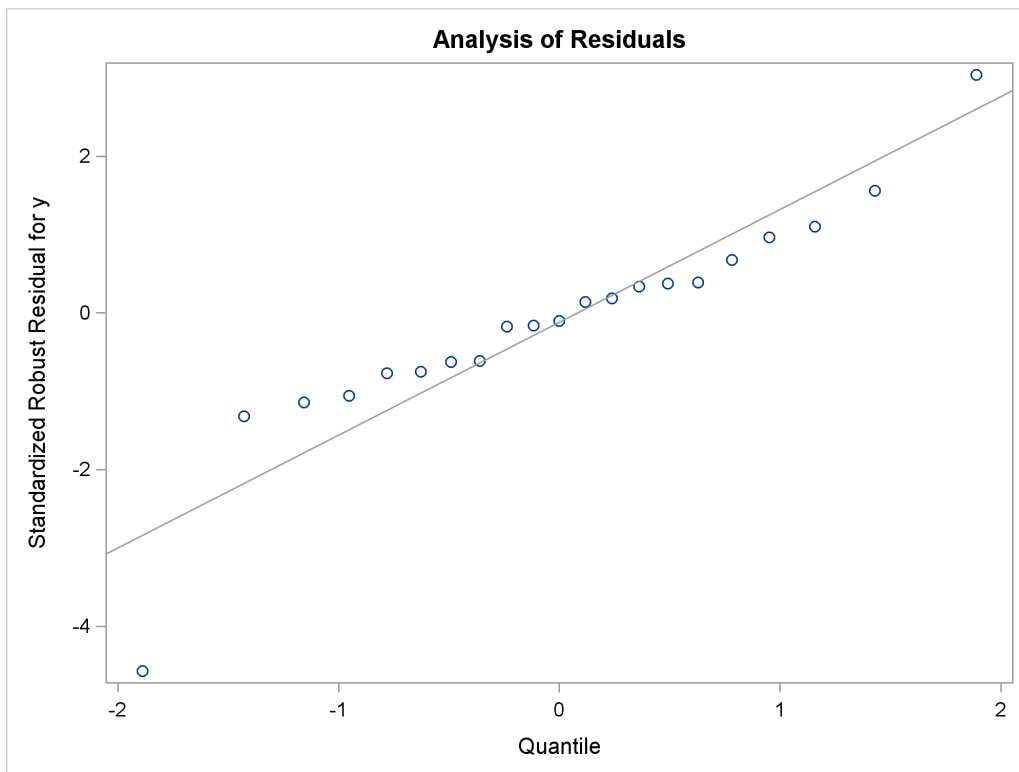
```
NOTE: STATGRAPH 'Stat.Robustreg.Graphics.QQPlot' has been
      saved to: SASUSER.TEMPLAT
```

For more information about graph templates and the graph template language, see the section “[Graph Templates](#)” on page 712.

Finally, resubmit the PROC ROBUSTREG statements to display the Q-Q plot created with your modified template. The following statements create [Output 22.1.4](#):

```
proc template;
  define statgraph Stat.Robustreg.Graphics.QQPlot;
    notes "Q-Q Plot for Standardized Robust Residuals";
    dynamic _DEPLABEL Residual;
    BeginGraph;
      entrytitle "Analysis of Residuals";
      layout Overlay /
        yaxisopts=(label=("Standardized Robust Residual for " _DEPLABEL))
        xaxisopts=(label="Quantile");
        SCATTERPLOT y=eval (SORT(DROPMISSING(RESIDUAL))) x=eval (
          PROBIT( (NUMERATE(SORT(DROPMISSING(RESIDUAL))) -0.375)/(0.25
            + N(RESIDUAL)))) / primary=true markerattrs=GRAPHDATADEFAULT
          rolename=(q=eval (
            PROBIT( (NUMERATE(SORT(DROPMISSING(RESIDUAL))) -0.375)/(0.25
              + N(RESIDUAL)))) s=eval (SORT(DROPMISSING(RESIDUAL))))
          tip=(q s) tiplabel=(q="Quantile" s="Residual");
        lineparm slope=eval (STDDEV(RESIDUAL)) Y=eval (MEAN(RESIDUAL))
          X=0 / lineattrs=GRAPHREFERENCE extend=true;
      EndLayout;
    EndGraph;
  end;
run;

proc robustreg data=stack plots=qqplot;
  ods select QQPlot;
  model y = x1 x2 x3;
run;
```

**Output 22.1.4** Q-Q Plot with Modified Title and Y-Axis Label

If you have not changed the default template search path, the modified template `QQPlot` is used automatically because `Sasuser.Templat` occurs before `Sashelp.Tmplmst` in the ODS search path. See the sections “[Saving Customized Templates](#)” on page 721, “[Using Customized Templates](#)” on page 721, and “[Reverting to the Default Templates](#)” on page 722 for more information about the template search path and the ODS PATH statement.

You do not need to rerun the PROC ROBUSTREG analysis after you modify a graph template if you have stored the plot in an ODS document. After you modify your template, you can submit the PROC DOCUMENT statements in [Example 21.4](#) in Chapter 21, “[Statistical Graphics Using ODS](#),” to replay the Q-Q plot with the modified template. You can run the following statements to revert to the default template:

```
proc template;
  delete Stat.Robustreg.Graphics.QQPlot / store=sasuser.templat;
run;
```

## Modifying Colors, Line Styles, and Markers

This section shows you how to customize colors, line attributes, and marker symbol attributes by modifying a graph template. In the `QQPlot` template definition shown in [Output 22.1.3](#), the SCATTERPLOT statement specifies a scatter plot of normal quantiles versus ordered standardized residuals. The attributes of the marker symbol in the scatter plot are specified by: `MarkerAttrs=GraphDataDefault`. This is a reference to the style element `GraphDataDefault`. See the section “[Style Elements and Attributes](#)” on page 644 in Chapter 21, “[Statistical Graphics Using ODS](#),” for more information.

The actual value of the marker symbol depends on the style that you are using. In this case, since the HTMLBLUE style is used, the marker symbol is a circle. You can specify a filled cir-

cle as the marker symbol by overriding the symbol portion of the style specification as follows:  
**MarkerAttrs=GraphDataDefault(symbol=CircleFilled).**

The value of the SYMBOL= option can be any valid marker symbol or a reference to a style attribute of the form **style-element:attribute**. It is recommended that you use style attributes because they are chosen to provide consistency and appropriate emphasis based on display principles for statistical graphics. If you specify values directly in a template, you are overriding the style and you run the risk of creating a graph that is inconsistent with the style template. For more information about the syntax of the Graph Template Language and style elements for graphics, see the *SAS Graph Template Language: Reference* and the *SAS Output Delivery System: User's Guide*.

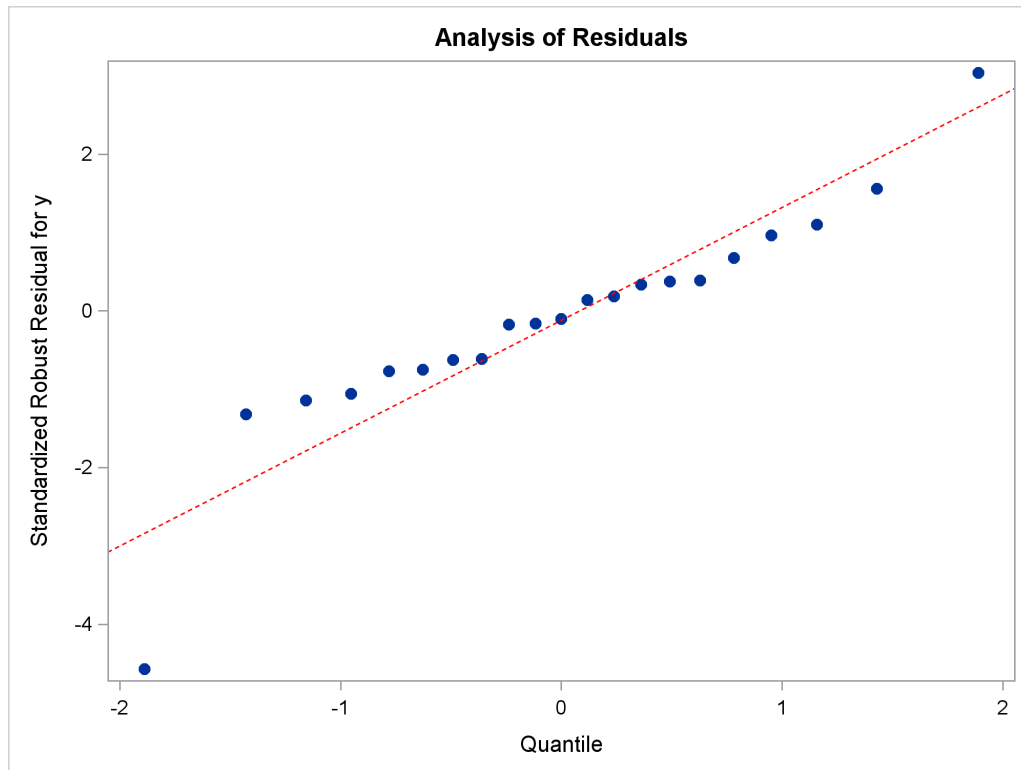
Similarly, you can change the line color and pattern with the LINEATTRS= option in the LINEPARM statement. The LINEPARM statement displays a straight line specified by slope and intercept parameters. The following option changes the color of the line to red and the line pattern to dashed, by overriding those aspects of the style specification: **LineAttrs=GraphReference(color=red pattern=dash)**. To see the results, submit the modified template definition and the PROC ROBUSTREG statements as follows to create [Output 22.1.5](#):

```
proc template;
  define statgraph Stat.Robustreg.Graphics.QQPlot;
    notes "Q-Q Plot for Standardized Robust Residuals";
    dynamic _DEPLABEL Residual;
    BeginGraph;
      entrytitle "Analysis of Residuals";
      layout Overlay /
        yaxisopts=(label=("Standardized Robust Residual for " _DEPLABEL))
        xaxisopts=(label="Quantile");
        SCATTERPLOT y=eval (SORT(DROPMISSING(RESIDUAL))) x=eval (
          PROBIT( (NUMERATE (SORT(DROPMISSING(RESIDUAL))) -0.375) / (0.25
            + N(RESIDUAL)))) / primary=true
          markerattrs=GraphDataDefault(symbol=CircleFilled)
          rolename=(q=eval (
            PROBIT( (NUMERATE (SORT(DROPMISSING(RESIDUAL))) -0.375) / (0.25
              + N(RESIDUAL)))) s=eval (SORT(DROPMISSING(RESIDUAL))))
          tip=(q s) tiplabel=(q="Quantile" s="Residual");
        lineparm slope=eval (STDDEV(RESIDUAL)) Y=eval (MEAN(RESIDUAL))
          X=0 / lineattrs=GraphReference(color=red pattern=dash)
          extend=true;
      EndLayout;
    EndGraph;
  end;
run;

ods graphics on;

proc robustreg data=stack plots=qqplot;
  ods select QQPlot;
  model y = x1 x2 x3;
run;
```

**Output 22.1.5** Q-Q Plot with Modified Marker Symbols and Line



Alternatively, you can replay the plot with PROC DOCUMENT, as in [Example 21.4](#) in Chapter 21, “[Statistical Graphics Using ODS](#).”

## Modifying Tick Marks and Grid Lines

This section illustrates how to modify axis tick marks and control grid lines. For example, you can specify the following statement to request tick marks ranging from  $-4$  to  $2$  in the Y-axis:

```
layout Overlay / yaxisopts=(linearopts=(tickvaluelist=(-4 -3 -2 -1 0 1 2)));
```

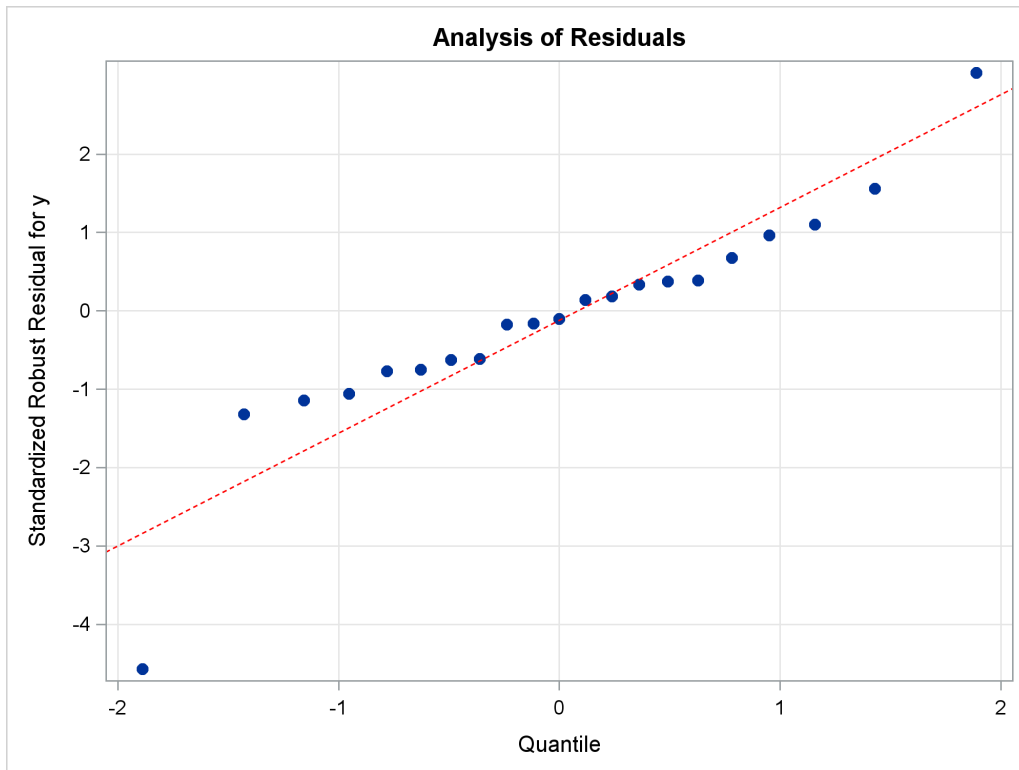
The LINEAROPTS= option is used for standard linearly scaled axes (as opposed to log-scaled axes). You use the TICKVALUELIST= to specify the tick marks.

You can control the grid lines by using the GRIDDISPLAY= suboption in the YAXISOPTS= option. Typically, you specify either GRIDDISPLAY=AUTO\_OFF (grid lines are not displayed unless the **GraphGridLines** element in the current style contains **DisplayOpts="ON"**) or GRIDDISPLAY=AUTO\_ON (grid lines are displayed unless the **GraphGridLines** element in the current style contains **DisplayOpts="OFF"**). Here, the template is modified by specifying GRIDDISPLAY=AUTO\_ON for both axes. The following statements produce [Output 22.1.6](#):

```
proc template;
  define statgraph Stat.Robustreg.Graphics.QQPlot;
    notes "Q-Q Plot for Standardized Robust Residuals";
    dynamic _DEPLABEL Residual;
    BeginGraph;
      entrytitle "Analysis of Residuals";
      layout Overlay / yaxisopts=(gridDisplay=Auto_On
        linearopts=(tickvaluelist=(-4 -3 -2 -1 0 1 2))
        label=("Standardized Robust Residual for " _DEPLABEL))
        xaxisopts=(gridDisplay=Auto_On label="Quantile");
      SCATTERPLOT y=eval (SORT(DROPMISSING(RESIDUAL))) x=eval(
        PROBIT( (NUMERATE(SORT(DROPMISSING(RESIDUAL))) -0.375)/(0.25
          + N(RESIDUAL)))) / primary=true
        markerattrs=GraphDataDefault(symbol=CircleFilled)
        rolename=(q=eval (
          PROBIT( (NUMERATE(SORT(DROPMISSING(RESIDUAL))) -0.375)/(0.25
            + N(RESIDUAL)))) s=eval (SORT(DROPMISSING(RESIDUAL))))
        tip=(q s) tiplabel=(q="Quantile" s="Residual");
      lineparm slope=eval (STDDEV(RESIDUAL)) Y=eval (MEAN(RESIDUAL))
        X=0 / lineattrs=GraphReference(color=red pattern=dash)
        extend=true;
      EndLayout;
    EndGraph;
  end;
run;

ods graphics on;

proc robustreg data=stack plots=qqplot;
  ods select QQPlot;
  model y = x1 x2 x3;
run;
```

**Output 22.1.6** Q-Q Plot with Modified Y-Axis Tick Marks and Grids

You can restore the default template by running the following step:

```
proc template;
  delete Stat.Robustreg.Graphics.QQPlot / store=sasuser.templat;
run;
```

See the section “[Modifying the Style to Show Grid Lines](#)” on page 737 for more information about grid lines.

## Modifying the Style to Show Grid Lines

The section “[Modifying Tick Marks and Grid Lines](#)” on page 736 explains that grid lines in graphs are controlled both by template options and by the style. Some graphs never display grid lines because they would interfere with the display. Some graphs always display grid lines because they are a critical part of the display. In both cases, grid control is so important that the template writer is not willing to give control to the style. If you want to change the grid display setting for these graphs, you must edit their templates. Most templates, however, let the style control the grid lines. They either do not display grid lines unless the style forces them on, or they display grid lines unless the style forces them off. The HTMLBLUE, STATISTICAL, DEFAULT, and most other styles use the setting **DisplayOpts** = "Auto". Then templates that specify **GRIDDISPLAY**=AUTO\_OFF (the default) do not display grid lines, and templates that specify **GRIDDISPLAY**=AUTO\_ON do display grid lines. You can easily make a new style with **DisplayOpts** = "On" or **DisplayOpts** = "Off" if you would prefer to see grid lines more or less often. This example shows how to set **DisplayOpts** = "On".

First, you need to find the style source for setting grid lines. The following step displays the HTMLBLUE style and its parent styles, STATISTICAL and DEFAULT:

```
proc template;
  source Styles.HTMLBlue;
  source Styles.Statistical;
  source Styles.Default;
run;
```

The advantage of displaying all three styles together is that you can do one search of the results. If grids are defined in the HTMLBLUE style, you will find that first. Otherwise, you will first find the definition in one of the parent styles. An abridged version of the results follows:

```
. . .
class GraphGridLines /
  displayopts = "auto"
  linethickness = 1px
  linestyle = 1
  contrastcolor = GraphColors('ggrid')
  color = GraphColors('ggrid');
. . .
```

You can use this to create a new style that inherits from the HTMLBLUE style, but sets the display options for grids to ON, as in the following example:

```
proc template;
  define style Styles.MyGrids;
    parent=styles.HTMLBlue;
    class GraphGridLines /
      displayopts = "on"
      linethickness = 1px
      linestyle = 1
      contrastcolor = GraphColors('ggrid')
      color = GraphColors('ggrid');
    end;
  end;
run;
```

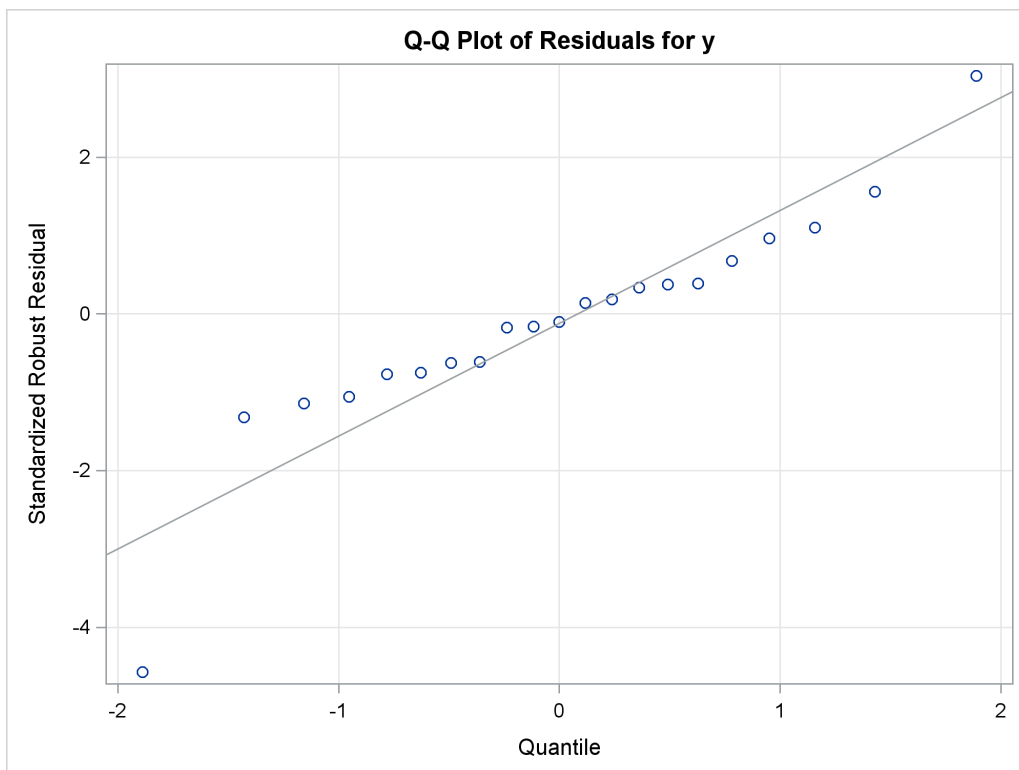
You can use this new style as in the following example:

```
ods graphics on;
ods listing style=mygrids;

proc robustreg data=stack plots=qqplot;
  ods select QQPlot;
  model y = x1 x2 x3;
run;
```

The preceding statements produce [Output 22.1.7](#), which shows the Q-Q plot with grid lines displayed. The default graph template, supplied by SAS, is used because the custom template created in the section “[Modifying Tick Marks and Grid Lines](#)” on page 736 is deleted at the end of that section.

**Output 22.1.7** A Style that Makes Grid Lines the Typical Default



## Example 22.2: Adding Equations and Special Characters to Fit Plots

This example shows how to run the REG and TRANSREG procedures to get fit plots. The R square, mean, and equation for the regression model are output to data sets, and the results are processed and then displayed in subsequent fit plots. This example also illustrates Unicode and how to add special characters to graphs (for example,  $\hat{\mu}$  and  $R^2$ ). The Unicode Consortium <http://unicode.org/> provides a list of character codes at <http://www.unicode.org/charts/charindex.html>.

### Simple Linear Regression

The following step runs PROC REG to fit a simple regression model and creates [Output 22.2.2](#) and [Output 22.2.1](#):

```
ods graphics on;
ods trace on;

proc reg data=sashelp.class;
    model weight = height;
run;
```

#### Output 22.2.1 PROC REG Output

The REG Procedure

Model: MODEL1

Dependent Variable: Weight

Number of Observations Read 19

Number of Observations Used 19

Analysis of Variance

| Source          | DF | Sum of Squares | Mean Square | F Value | Pr > F |
|-----------------|----|----------------|-------------|---------|--------|
| Model           | 1  | 7193.24912     | 7193.24912  | 57.08   | <.0001 |
| Error           | 17 | 2142.48772     | 126.02869   |         |        |
| Corrected Total | 18 | 9335.73684     |             |         |        |

Root MSE 11.22625

R-Square 0.7705

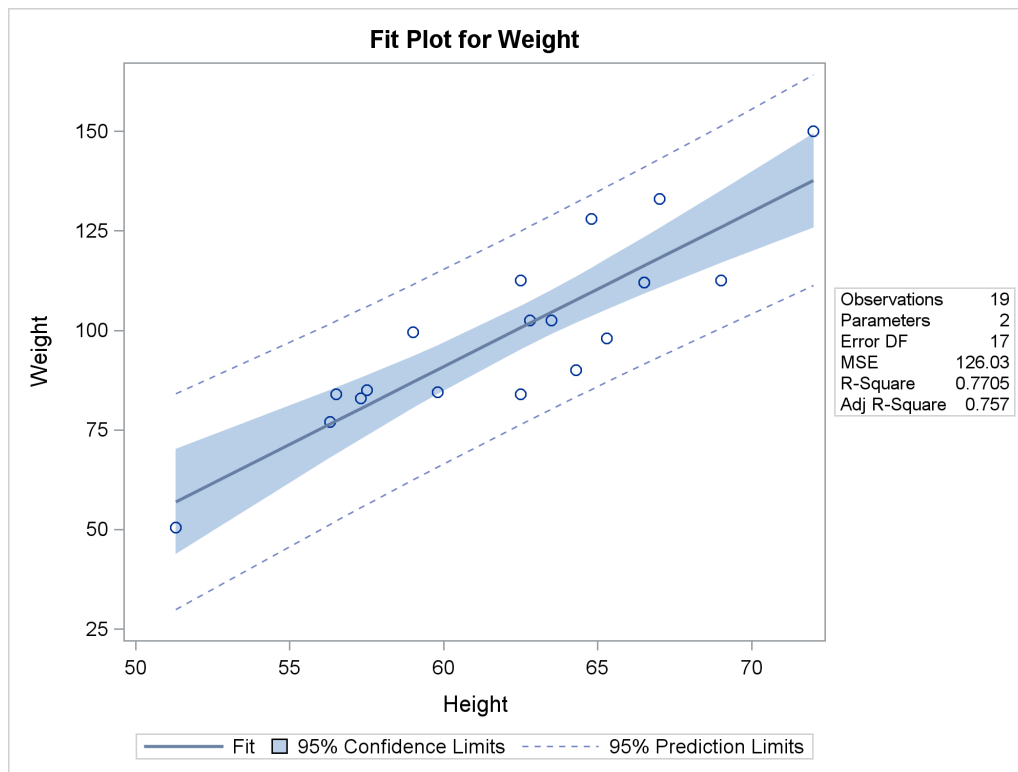
Dependent Mean 100.02632

Adj R-Sq 0.7570

Coeff Var 11.22330

Parameter Estimates

| Variable  | DF | Parameter Estimate | Standard Error | t Value | Pr >  t |
|-----------|----|--------------------|----------------|---------|---------|
| Intercept | 1  | -143.02692         | 32.27459       | -4.43   | 0.0004  |
| Height    | 1  | 3.89903            | 0.51609        | 7.55    | <.0001  |

**Output 22.2.2** PROC REG Fit Plot

The fit statistics table following the “Analysis of Variance” table displays the R square and the mean. The last table displays the parameter estimates. This information is produced and processed for inclusion in the fit plot as follows:

```
proc reg data=sashelp.class;
  ods output fitstatistics=fs ParameterEstimates=c;
  model weight = height;
run;

data _null_;
  set fs;
  if _n_ = 1 then call symputx('R2' , put (nvalue2, 4.2) , 'G');
  if _n_ = 2 then call symputx('mean', put (nvalue1, best6.), 'G');
run;
```

```

data _null_;
  set c;
  length s $ 200;
  retain s ' ';
  if _n_ = 1 then
    s = trim(dependent) || ' = ' ||                /* dependent = */
      put(estimate, best5. -L);                    /* intercept */
  else if abs(estimate) > 1e-8 then do;             /* skip zero coefficients */
    s = trim(s) || ' ' ||                          /* string so far */
      scan('+ -', 1 + (estimate < 0), ' ')          /* + (add) or - (subtract) */
      || ' ' ||
      trim(put(abs(estimate), best5. -L))           /* abs(coefficient) */
      || ' ' || variable;                          /* variable name */
  end;                                              /* e for error added next */
  call symputx('formula', trim(s) || ' + e', 'G');
run;

```

Two SAS data sets are made from the tabular output, and the R square, mean, and equation for the regression model are stored in macro variables. The following step uses PROC SGPLOT with an INSET statement to display the linear fit plot along with the R square, mean, and equation for the regression model:

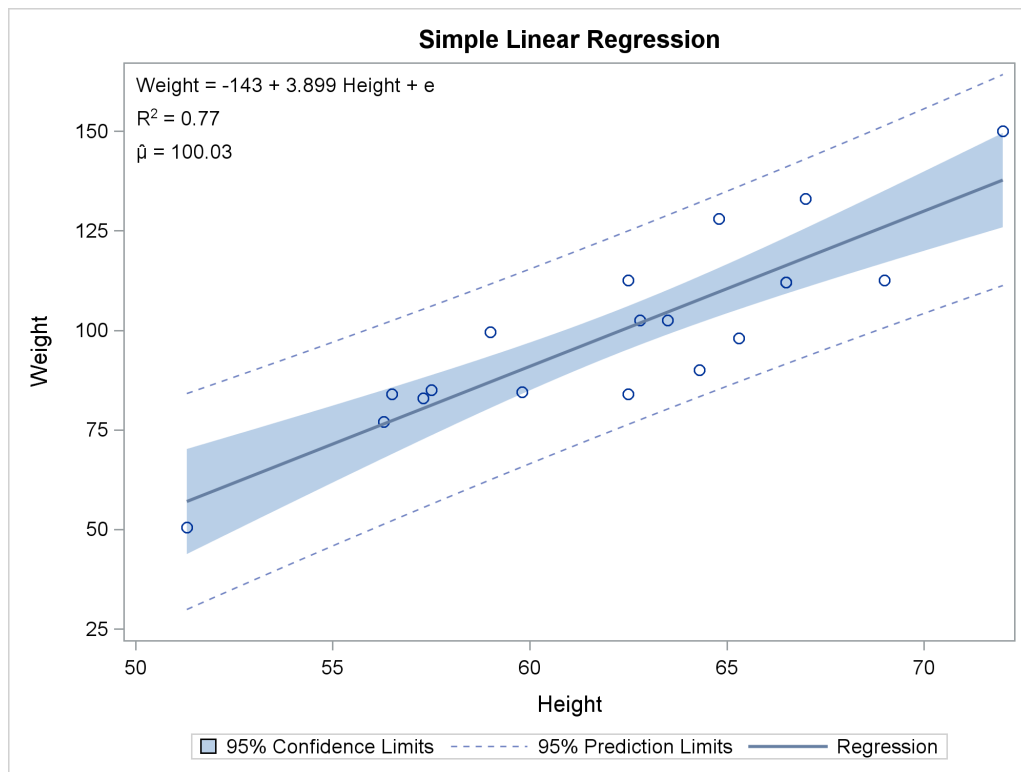
```

proc sgplot data=sashelp.class;
  title 'Simple Linear Regression';
  inset "&formula"
    "R(*ESC*){sup '2'} = &r2"
    "(*ESC*){unicode mu}(*ESC*){unicode hat} = &mean" / position=topleft;
  reg y=weight x=height / clm cli;
run;

```

The results are displayed in [Output 22.2.3](#).

Each separate string in the INSET statement is displayed in a separate line. The first string is the formula, which is generated in the second DATA step. The next string is the R square, and it consists of an ‘R’, an escaped superscript 2, and the value of R square (which is stored in a macro variable). The string for the mean consists of two Unicode specifications, one for the Greek letter  $\mu$ , and one to put a hat over it. These special character specifications appear in quotes and are escaped with `(*ESC*)` so that they are processed as special characters rather than as literal text. Typically, you must escape special characters in quotes, and not escape them when they are not in quotes. See the section “[Unicode and Special Characters](#)” on page 748 for a list of a few of the more commonly used Unicode characters.

**Output 22.2.3** Fit Plot from PROC SGPLOT with Equation

The same information can be added to the graph that PROC REG produces by adding the following statements to the PROC REG template for a fit plot:

```
mvar formula;

layout gridded / autoalign=(topleft topright bottomleft
                           bottomright);
  entry halign=left formula;
  entry halign=left "R"2 = " eval(put(_rsquare, 4.2));
  entry halign=left "(*ESC*){unicode mu}{*ESC*}{unicode hat} = "
    eval(put(_depmean, best6.))
  / textattrs=GraphValueText
    (family=GraphUnicodeText:FontFamily);

endlayout;
```

The MVAR statement names macro variables whose values are added to the graph. The MVAR statement is added to the PROC REG fit plot template near the top. The LAYOUT GRIDDED block creates a table that consists of the equation, R square, and mean. The LAYOUT GRIDDED block is added to the PROC REG fit plot template inside the LAYOUT OVERLAY. The option `autoalign=(topleft topright bottomleft bottomright)` is used to position the table in a part of the graph that is open, first trying the top left corner.

In this example, in the LAYOUT GRIDDED block, two dynamic variables for R square, and the mean are used instead of the macro variables that were made in previous steps. The origin of the names of the two dynamic variables that are used in this example are revealed in the next step when the source code for the PROC REG fit plot is displayed. The first ENTRY statement creates a text line for the formula and left-justifies it. The second ENTRY statement creates the R square line. It consists of a literal 'R', a specification for a superscript

of 2 ( $\{\text{sup } 2\}$ ), an equal sign surrounded by spaces, and the formatted value of the dynamic variable with the R square. The third ENTRY statement creates the mean line. It consists of two Unicode specifications, one for the Greek letter  $\mu$ , and one to put a hat over it. These special character specifications appear in quotes (unlike the  $\{\text{sup } 2\}$ ) and are escaped with (**\*ESC\***) so that they are processed as special characters rather than as literal text. Typically, you must escape special characters in quotes, and not escape them when they are not in quotes. Note that **sup** along with **sub** (subscript) must not appear in quotes in the GTL, but they can appear in quotes in PROC SGPLOT (as was previously shown). The option **textattrs=GraphValueText (family=GraphUnicodeText:FontFamily)** is specified to ensure that a font that recognizes Unicode characters is used. See the section “Unicode and Special Characters” on page 748 for a list of a few of the more commonly used Unicode characters.

You can use the trace information from the PROC REG step (not shown) and the following step to display the template for the fit plot:

```
proc template;
  source Stat.Reg.Graphics.Fit;
run;
```

Some of the results are as follows:

```
define statgraph Stat.Reg.Graphics.Fit;
  notes "Fit Plot";
  dynamic _DEPLABEL _DEPNAME _MODELLABEL _SHOWSTATS _NSTATSCOLS _SHOWNObs
    _SHOWTOTFREQ _SHOWNParm _SHOWEDF _SHOWMSE _SHOWRSquare _SHOWAdjRSq
    _SHOWSSE _SHOWDepMean _SHOWCV _SHOWAIC _SHOWBIC _SHOWCP _SHOWGMSEP
    _SHOWJP _SHOWPC _SHOWSBC _SHOWSP _NObs _NParm _EDF _MSE _RSquare
    _AdjRSq _SSE _DepMean _CV _AIC _BIC _CP _GMSEP _JP _PC _SBC _SP
    _PREDLIMITS _CONFLIMITS _XVAR _SHOWCLM _SHOWCLI _WEIGHT _SHORTXLABEL
    _SHORTYLABEL _TITLE _TOTFreq;
  BeginGraph;
    entrytitle halign=left textattrs=GRAPHVALUETEXT _MODELLABEL
      halign=center textattrs=GRAPHTITLETEXT _TITLE " for " _DEPNAME;
    layout Overlay / yaxisopts=(label=_DEPLABEL shortlabel=_SHORTYLABEL)
      xaxisopts=(shortlabel=_SHORTXLABEL);
      .
      .
      .
      if (_SHOWRSQUARE^=0)
        entry halign=left "R-Square" / valign=top;
        entry halign=right eval (PUT(_RSQUARE,BEST6.)) / valign=top;
      endif;
      .
      .
      .
      if (_SHOWDEPMEAN^=0)
        entry halign=left "Dependent Mean" / valign=top;
        entry halign=right eval (PUT(_DEPMEAN,BEST6.)) / valign=top;
      endif;
      .
      .
      .
    endif;
  endlayout;
EndGraph;
end;
```

The preceding results show that the dynamic variables `_RSquare` and `_DepMean` contain the R square and the mean of the dependent variable. The MVAR statement and the LAYOUT GRIDDED block can be added to the template, and in the interest of maximizing graph size, the table of statistics can be removed, creating the following template:

```
proc template;
  define statgraph Stat.Reg.Graphics.Fit;
    notes "Fit Plot";
    mvar formula;
    dynamic _DEPLABEL _DEPNAME _MODELLABEL _SHOWSTATS _NSTATSCOLS _SHOWNObs
      _SHOWTOTFREQ _SHOWNParm _SHOWEDF _SHOWMSE _SHOWRSquare _SHOWAdjRSq
      _SHOWSSE _SHOWDepMean _SHOWCV _SHOWAIC _SHOWBIC _SHOWCP _SHOWGMSEP
      _SHOWJP _SHOWPC _SHOWSBC _SHOWSP _NObs _NParm _EDF _MSE _RSquare
      _AdjRSq _SSE _DepMean _CV _AIC _BIC _CP _GMSEP _JP _PC _SBC _SP
      _PREDLIMITS _CONFLIMITS _XVAR _SHOWCLM _SHOWCLI _WEIGHT _SHORTXLABEL
      _SHORTYLABEL _TITLE _TOTFREQ;
    BeginGraph;
      entrytitle halign=left textattrs=GRAPHVALUETEXT _MODELLABEL
        halign=center textattrs=GRAPHTITLETEXT _TITLE " for " _DEPNAME;
      layout Overlay / yaxisopts=(label=_DEPLABEL shortlabel=_SHORTYLABEL)
        xaxisopts=(shortlabel=_SHORTXLABEL);
      if (_SHOWCLM=1)
        BANDPLOT limitupper=UPPERCLMEAN limitlower=LOWERCLMEAN x=_XVAR /
          fillattrs=GRAPHCONFIDENCE connectorder=axis name="Confidence"
          LegendLabel=_CONFLIMITS;
      endif;
      layout gridded / autoalign=(topleft topright bottomleft
        bottomright);
      entry halign=left formula;
      entry halign=left "R" {sup '2'} " = " eval(put(_rsquare, 4.2));
      entry halign=left "(*ESC*) {unicode mu} (*ESC*) {unicode hat} = "
        eval(put(_depmean, best6.))
        / textattrs=GraphValueText
          (family=GraphUnicodeText:FontFamily);
      endlayout;
      if (_SHOWCLI=1)
        if (_WEIGHT=1)
          SCATTERPLOT y=PREDICTEDVALUE x=_XVAR / markerattrs=(size=0)
            datatransparency=.6 yerrorupper=UPPERCL yerrorlower=LOWERCL
            name="Prediction" LegendLabel=_PREDLIMITS;
        else
          BANDPLOT limitupper=UPPERCL limitlower=LOWERCL x=_XVAR /
            display=(outline) outlineattrs=GRAPHPREDICTIONLIMITS
            connectorder=axis name="Prediction"
            LegendLabel=_PREDLIMITS;
        endif;
      endif;
      SCATTERPLOT y=DEPVAR x=_XVAR / markerattrs=GRAPHDATADEFAULT primary=
        true rolename=( _tip1=OBSERVATION _id1=ID1 _id2=ID2 _id3=ID3 _id4=
        ID4 _id5=ID5) tip=(y x _tip1 _id1 _id2 _id3 _id4 _id5);
      SERIESPLOT y=PREDICTEDVALUE x=_XVAR / lineattrs=GRAPHFIT
        connectorder=xaxis name="Fit" LegendLabel="Fit";
      if (_SHOWCLI=1 OR _SHOWCLM=1)
        DISCRETELEGEND "Fit" "Confidence" "Prediction" / across=3 HALIGN=
        CENTER VALIGN=BOTTOM;
      endif;
    endlayout;
  enddefine;
endproc;
```

```

EndGraph;
end;
run;

```

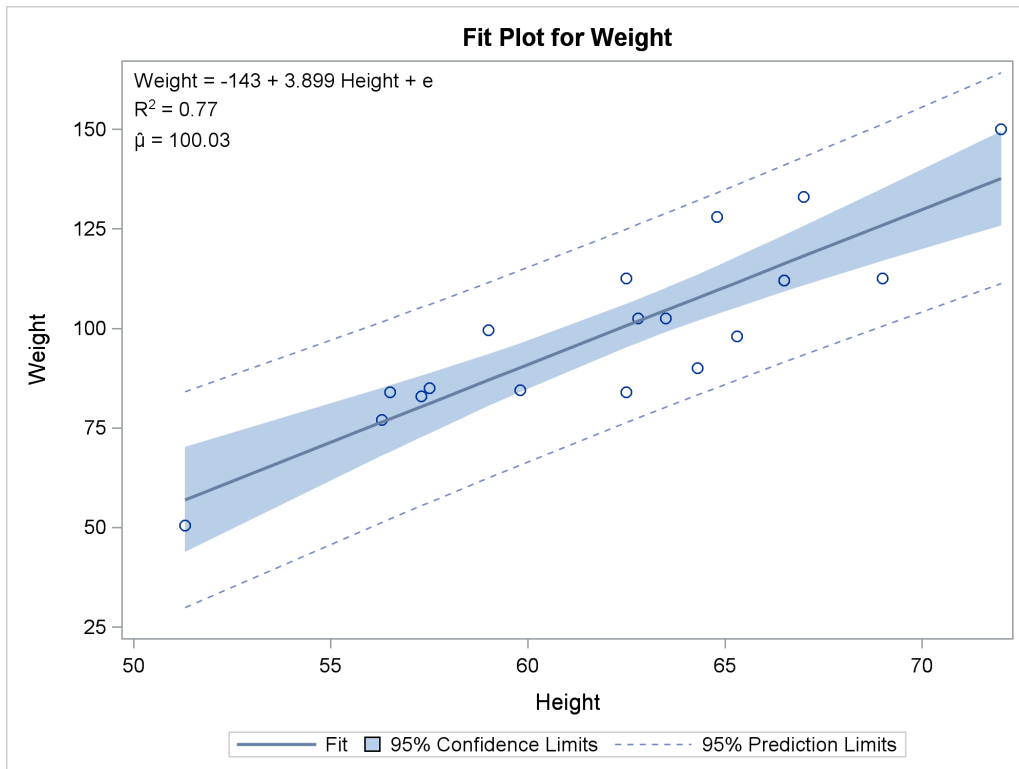
The following step uses the modified template to create [Output 22.2.4](#):

```

proc reg data=sashelp.class;
  model weight = height;
run;

```

**Output 22.2.4** PROC REG Fit Plot with the Equation



You can restore the default template by running the following step:

```

proc template;
  delete Stat.Reg.Graphics.Fit / store=sasuser.templat;
run;

```

## Cubic Fit Function

The following steps run PROC TRANSREG to find a cubic fit function and display the equation in a plot generated by PROC SGPLOT:

```

proc transreg data=sashelp.class ss2;
  ods output fitstatistics=fs coef=c;
  model identity(weight) = pspline(height);
run;

data _null_;

```

```

set fs;
if _n_ = 1 then call symputx('R2' , put(value2, 4.2) , 'G');
if _n_ = 2 then call symputx('mean', put(value1, best6.), 'G');
run;

data _null_;
set c end=eof;
length s $ 200 c $ 1;
retain s ' ';
if _n_ = 1 then
    s = scan(dependent, 2, '()') || ' = ' ||      /* dependent = */
    put(coefficient, best5. -L);                  /* intercept */
else if abs(coefficient) > 1e-8 then do;          /* skip zero coefficients */
    s = trim(s) || ' ' ||                          /* string so far */
    scan('+ -', 1 + (coefficient < 0), ' ') /* + (add) or - (subtract) */
    || ' ' ||
    trim(put(abs(coefficient), best5. -L )) /* abs(coefficient) */
    || ' ' || scan(variable, 2, '._');          /* variable name */
    c = scan(variable, 2, '._');                 /* grab power */
    if c ne '1' then                             /* skip power for linear */
        s = trim(s) ||                          /* string so far */
        "(*ESC*){sup ' " || c || "'}";          /* add superscript */
    end;                                          /* e for error added next */
    if eof then call symputx('formula', trim(s) || ' + e', 'G');
run;

proc sgplot data=sashelp.class;
title 'Cubic Fit Function';
inset "&formula"
    "R(*ESC*){sup '2'} = &r2"
    "(*ESC*){unicode mu}(*ESC*){unicode hat} = &mean" / position=topleft;
reg y=weight x=height / degree=3 cli clm;
run;

```

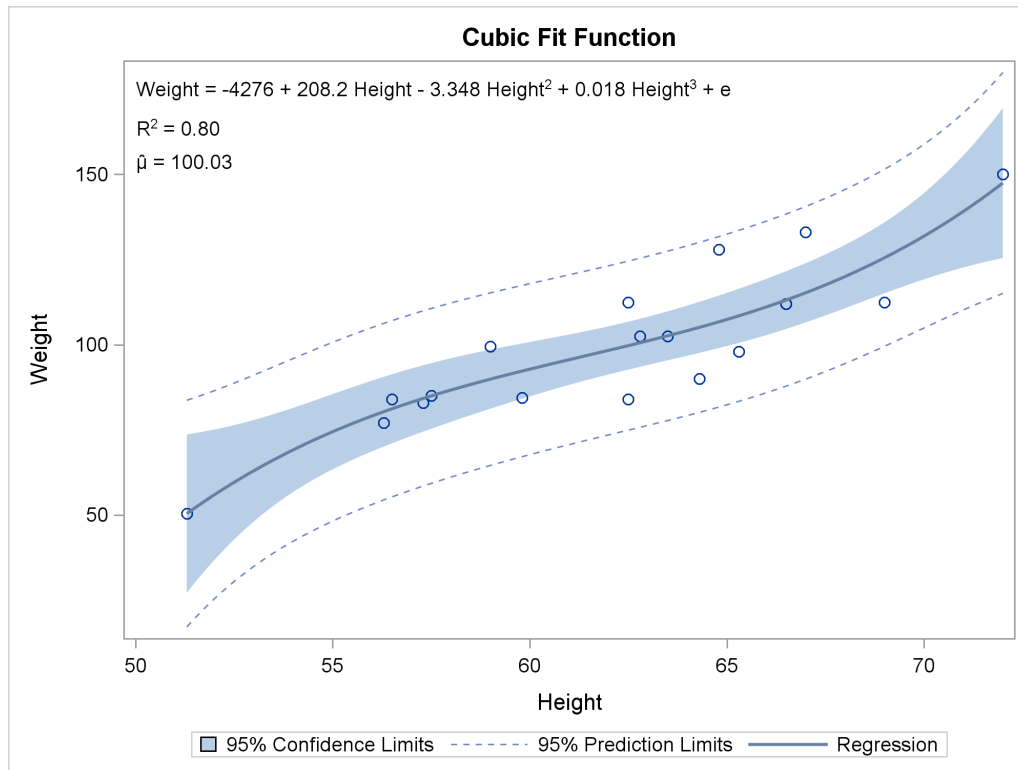
These steps create [Output 22.2.5](#).

The PROC TRANSREG MODEL statement fits a model with an untransformed dependent variable and a cubic polynomial function of the independent variable. By default, PSPLINE fits a cubic polynomial spline with no knots, which is simply a cubic polynomial. The fit statistics and parameter estimates are output to data sets, and their values are stored in macro variables. There are three independent variables plus the intercept. Variable names and exponents are extracted from the TRANSREG parameter names of Pspline.Height\_1, Pspline.Height\_2, and Pspline.Height\_3 by using the SCAN function. Exponents are added by using the specifications "**(\*ESC\*){sup '2'}**" and "**(\*ESC\*){sup '3'}**", which are explained in more detail with the INSET statement.

PROC SGPLOT with an INSET statement makes the plot. Each separate string is displayed in a separate line. The first string is the formula, which is generated in the second DATA step. The next string is the R square: it consists of an 'R', an escaped superscript 2, and the value of R square (which is stored in a macro variable). The string for the mean consists of two Unicode specifications, one for the Greek letter  $\mu$ , and one to put a hat over it. These special character specifications appear in quotes and are escaped with **(\*ESC\*)** so that they are processed as special characters rather than as literal text. Typically, you must escape special characters in quotes, and not escape them when they are not in quotes. See section [“Simple Linear Regression”](#) on page 740 for more information about Unicode characters. See the section

“Unicode and Special Characters” on page 748 for a list of a few of the more commonly used Unicode characters.

**Output 22.2.5** Cubic Fit Function with the Equation



## Unicode and Special Characters

The following steps illustrate Unicode specifications for a number of commonly used characters and create [Output 22.2.6](#) and [Output 22.2.7](#), which are charts of Unicode characters:

```
%let l = halign=left;
proc template;
  define statgraph class;
    begingraph / designheight=550px designwidth=520px;
      layout overlay / xaxisopts=(display=none) yaxisopts=(display=none);
      layout gridded / columns=3 autoalign=(topleft);
        entry &l textattrs=(weight=bold) 'Description';
        entry &l textattrs=(weight=bold) 'Displayed';
        entry &l textattrs=(weight=bold) "Unicode";
        entry &l 'R Square';
        entry &l 'R' {sup '2'};
        entry &l "'R' {sup '2'}";
        entry &l 'y hat sub i';
        entry &l 'y' {unicode hat}{sub 'i'};
        entry &l "'y' {unicode hat}{sub 'i'}";
        entry &l 'less than or equal';
        entry &l 'a ' {unicode '2264'x} ' b';
        entry &l "'a ' {unicode '2264'x} ' b'";
    endgraph;
  end;
end;
```

```

entry &l 'greater than or equal    ';
entry &l 'b ' {unicode '2265'x} ' a';
entry &l "'b ' {unicode '2265'x} ' a'";
entry &l 'infinity';
entry &l {unicode '221e'x};
entry &l "{unicode '221e'x}";
entry &l 'almost equal';
entry &l 'a ' {unicode '2248'x} ' b';
entry &l "'a ' {unicode '2248'x} ' b'";
entry &l 'combining tilde';
entry &l 'El nin' {unicode tilde} 'o';
entry &l "'El nin' {unicode tilde} 'o'";
entry &l 'grave accent';
entry &l 'cre' {unicode '0300'x} 'me';
entry &l "'cre' {unicode '0300'x} 'me'";
entry &l 'circumflex, acute accent  ';
entry &l 'bru' {unicode '0302'x} 'le' {unicode '0301'x} 'e';
entry &l "'bru' {unicode '0302'x} 'le' {unicode '0301'x} 'e'";
entry &l 'alpha';
entry &l {unicode alpha} '    ' {unicode alpha_u};
entry &l "{unicode alpha} '    ' {unicode alpha_u}";
entry &l 'beta';
entry &l {unicode beta} '    ' {unicode beta_u};
entry &l "{unicode beta} '    ' {unicode beta_u}";
entry &l 'gamma';
entry &l {unicode gamma} '    ' {unicode gamma_u};
entry &l "{unicode gamma} '    ' {unicode gamma_u}";
entry &l 'delta';
entry &l {unicode delta} '    ' {unicode delta_u};
entry &l "{unicode delta} '    ' {unicode delta_u}";
entry &l 'epsilon';
entry &l {unicode epsilon} '    ' {unicode epsilon_u};
entry &l "{unicode epsilon} '    ' {unicode epsilon_u}";
entry &l 'zeta';
entry &l {unicode zeta} '    ' {unicode zeta_u};
entry &l "{unicode zeta} '    ' {unicode zeta_u}";
entry &l 'eta';
entry &l {unicode eta} '    ' {unicode eta_u};
entry &l "{unicode eta} '    ' {unicode eta_u}";
entry &l 'theta';
entry &l {unicode theta} '    ' {unicode theta_u};
entry &l "{unicode theta} '    ' {unicode theta_u}";
entry &l 'iota';
entry &l {unicode iota} '    ' {unicode iota_u};
entry &l "{unicode iota} '    ' {unicode iota_u}";
entry &l 'kappa';
entry &l {unicode kappa} '    ' {unicode kappa_u};
entry &l "{unicode kappa} '    ' {unicode kappa_u}";
entry &l 'lambda';
entry &l {unicode lambda} '    ' {unicode lambda_u};
entry &l "{unicode lambda} '    ' {unicode lambda_u}";
entry &l 'mu';
entry &l {unicode mu} '    ' {unicode mu_u};
entry &l "{unicode mu} '    ' {unicode mu_u}";

```

```

entry &l 'nu';
entry &l {unicode nu} ' ' {unicode nu_u};
entry &l "{unicode nu} ' ' {unicode nu_u}";
entry &l 'xi';
entry &l {unicode xi} ' ' {unicode xi_u};
entry &l "{unicode xi} ' ' {unicode xi_u}";
entry &l 'omicron';
entry &l {unicode omicron} ' ' {unicode omicron_u};
entry &l "{unicode omicron} ' ' {unicode omicron_u}";
entry &l 'pi';
entry &l {unicode pi} ' ' {unicode pi_u};
entry &l "{unicode pi} ' ' {unicode pi_u}";
entry &l 'rho';
entry &l {unicode rho} ' ' {unicode rho_u};
entry &l "{unicode rho} ' ' {unicode rho_u}";
entry &l 'sigma';
entry &l {unicode sigma} ' ' {unicode sigma_u};
entry &l "{unicode sigma} ' ' {unicode sigma_u}";
entry &l 'tau';
entry &l {unicode tau} ' ' {unicode tau_u};
entry &l "{unicode tau} ' ' {unicode tau_u}";
entry &l 'upsilon';
entry &l {unicode upsilon} ' ' {unicode upsilon_u};
entry &l "{unicode upsilon} ' ' {unicode upsilon_u}";
entry &l 'phi';
entry &l {unicode phi} ' ' {unicode phi_u};
entry &l "{unicode phi} ' ' {unicode phi_u}";
entry &l 'chi';
entry &l {unicode chi} ' ' {unicode chi_u};
entry &l "{unicode chi} ' ' {unicode chi_u}";
entry &l 'psi';
entry &l {unicode psi} ' ' {unicode psi_u};
entry &l "{unicode psi} ' ' {unicode psi_u}";
entry &l 'omega';
entry &l {unicode omega} ' ' {unicode omega_u};
entry &l "{unicode omega} ' ' {unicode omega_u}";
endlayout;
scatterplot y=weight x=height / markerattrs=(size=0);
endlayout;
endgraph;
end;
run;

```

```

proc sgrender data=sashelp.class template=class;
run;

%macro m(u);
  entry halign=left "(*ESC*){unicode &u.x} {unicode &u.x}" /
    textattrs=GraphValueText (family=GraphUnicodeText:FontFamily);
%mend;

proc template;
  define statgraph markers;
    begingraph / designheight=510px designwidth=350px;
      layout overlay / xaxisopts=(display=none) yaxisopts=(display=none);
      layout gridded / columns=1 autoalign=(topright);
      entry " ";
      %m('2193')    %m('002A')    %m('25cb')    %m('25cf')
      %m('25c7')    %m('2666')    %m('003e')    %m('0023')
      %m('2336')    %m('002b')    %m('25a1')    %m('25a0')
      %m('2606')    %m('2605')    %m('22a4')    %m('223c')
      %m('25b3')    %m('25b2')    %m('222a')    %m('0058')
      %m('0059')    %m('005a')
    endlayout;
    scatterplot x=x1 y=y / group=m;
    scatterplot x=x2 y=y / markercharacter=m;
    scatterplot x=x3 y=y / markerattrs=(size=0);
    endlayout;
  endgraph;
end;
run;

%modstyle(name=mark, parent=statistical, markers=
  ArrowDown Asterisk Circle CircleFilled Diamond DiamondFilled GreaterThan
  Hash IBeam Plus Square SquareFilled Star StarFilled Tack Tilde Triangle
  TriangleFilled Union X Y Z, linestyle=1, colors=black)

data x;
  retain x1 1 x2 2 x3 3;
  length m $ 20;
  input m @@;
  y = -_n_;
  datalines;
ArrowDown Asterisk Circle CircleFilled Diamond DiamondFilled GreaterThan
Hash IBeam Plus Square SquareFilled Star StarFilled Tack Tilde Triangle
TriangleFilled Union X Y Z
;

ods listing style=mark;
proc sgrender data=x template=markers;
run;
ods listing;

```

**Output 22.2.6** Commonly Used Unicode and Special Characters

| Description              | Displayed           | Unicode                                            |
|--------------------------|---------------------|----------------------------------------------------|
| R Square                 | $R^2$               | 'R' {sup '2'}                                      |
| y hat sub i              | $\hat{y}_i$         | 'y' {unicode hat}{sub 'i'}                         |
| less than or equal       | $a \leq b$          | 'a' {unicode '2264'x} 'b'                          |
| greater than or equal    | $b \geq a$          | 'b' {unicode '2265'x} 'a'                          |
| infinity                 | $\infty$            | {unicode '221e'x}                                  |
| almost equal             | $a \approx b$       | 'a' {unicode '2248'x} 'b'                          |
| combining tilde          | El niño             | 'El nin' {unicode tilde} 'o'                       |
| grave accent             | crème               | 'cre' {unicode '0300'x} 'me'                       |
| circumflex, acute accent | brûlée              | 'bru' {unicode '0302'x} 'le' {unicode '0301'x} 'e' |
| alpha                    | $\alpha$ A          | {unicode alpha} ' ' {unicode alpha_u}              |
| beta                     | $\beta$ B           | {unicode beta} ' ' {unicode beta_u}                |
| gamma                    | $\gamma$ $\Gamma$   | {unicode gamma} ' ' {unicode gamma_u}              |
| delta                    | $\delta$ $\Delta$   | {unicode delta} ' ' {unicode delta_u}              |
| epsilon                  | $\epsilon$ E        | {unicode epsilon} ' ' {unicode epsilon_u}          |
| zeta                     | $\zeta$ Z           | {unicode zeta} ' ' {unicode zeta_u}                |
| eta                      | $\eta$ H            | {unicode eta} ' ' {unicode eta_u}                  |
| theta                    | $\theta$ $\Theta$   | {unicode theta} ' ' {unicode theta_u}              |
| iota                     | $\iota$ I           | {unicode iota} ' ' {unicode iota_u}                |
| kappa                    | $\kappa$ K          | {unicode kappa} ' ' {unicode kappa_u}              |
| lambda                   | $\lambda$ $\Lambda$ | {unicode lambda} ' ' {unicode lambda_u}            |
| mu                       | $\mu$ M             | {unicode mu} ' ' {unicode mu_u}                    |
| nu                       | $\nu$ N             | {unicode nu} ' ' {unicode nu_u}                    |
| xi                       | $\xi$ $\Xi$         | {unicode xi} ' ' {unicode xi_u}                    |
| omicron                  | $\omicron$ O        | {unicode omicron} ' ' {unicode omicron_u}          |
| pi                       | $\pi$ $\Pi$         | {unicode pi} ' ' {unicode pi_u}                    |
| rho                      | $\rho$ P            | {unicode rho} ' ' {unicode rho_u}                  |
| sigma                    | $\sigma$ $\Sigma$   | {unicode sigma} ' ' {unicode sigma_u}              |
| tau                      | $\tau$ T            | {unicode tau} ' ' {unicode tau_u}                  |
| upsilon                  | $\upsilon$ Y        | {unicode upsilon} ' ' {unicode upsilon_u}          |
| phi                      | $\phi$ $\Phi$       | {unicode phi} ' ' {unicode phi_u}                  |
| chi                      | $\chi$ X            | {unicode chi} ' ' {unicode chi_u}                  |
| psi                      | $\psi$ $\Psi$       | {unicode psi} ' ' {unicode psi_u}                  |
| omega                    | $\omega$ $\Omega$   | {unicode omega} ' ' {unicode omega_u}              |

**Output 22.2.7** Markers, Marker Names, Unicode Characters, Unicode Specifications

|   |                |                     |
|---|----------------|---------------------|
| ↓ | ArrowDown      | ↓ {unicode '2193'x} |
| * | Asterisk       | * {unicode '002A'x} |
| ○ | Circle         | ○ {unicode '25cb'x} |
| ● | CircleFilled   | ● {unicode '25cf'x} |
| ◇ | Diamond        | ◇ {unicode '25c7'x} |
| ◆ | DiamondFilled  | ◆ {unicode '2666'x} |
| > | GreaterThan    | > {unicode '003e'x} |
| # | Hash           | # {unicode '0023'x} |
| ⊥ | IBeam          | ⊥ {unicode '2336'x} |
| + | Plus           | + {unicode '002b'x} |
| □ | Square         | □ {unicode '25a1'x} |
| ■ | SquareFilled   | ■ {unicode '25a0'x} |
| ☆ | Star           | ☆ {unicode '2606'x} |
| ★ | StarFilled     | ★ {unicode '2605'x} |
| ⋈ | Tack           | ⋈ {unicode '22a4'x} |
| ~ | Tilde          | ~ {unicode '223c'x} |
| △ | Triangle       | △ {unicode '25b3'x} |
| ▲ | TriangleFilled | ▲ {unicode '25b2'x} |
| U | Union          | U {unicode '222a'x} |
| X | X              | X {unicode '0058'x} |
| Y | Y              | Y {unicode '0059'x} |
| Z | Z              | Z {unicode '005a'x} |

The Unicode Consortium <http://unicode.org/> provides a list of character codes at <http://www.unicode.org/charts/charindex.html>.

The following rules apply to Unicode and special character specifications in ODS graphics:

- Each character can be specified by looking up its code and specifying it as a hexadecimal constant. Example: `{unicode '221e' x}`.
- Lower case Greek letters can be specified by using names instead of hexadecimal constants. Example: `{ unicode alpha}`.
- Upper case Greek letters can be specified by using names followed by `_u` instead of a hexadecimal constants. Example: `{ unicode alpha_u}`.
- Superscript and subscript have special abbreviations. Examples: `{sup 2}` and `{sub 2}`.
- The `sup` and `sub` specifications must not appear escaped and in quotes in the GTL. They must appear outside of quotes.
- Some characters overprint the character that comes before. Example: `'El nin' {tilde} 'o'`, which is equivalent to `'El nin' {unicode '0303' x} 'o'` creates 'El niño'.
- Specifications inside quotes are escaped. Example: `"(*ESC*){unicode beta}"`.
- Specifications outside quotes are not escaped. Example: `{unicode beta}`.

---

### Example 22.3: Customizing Panels

This example illustrates how to modify the regression fit diagnostics panel shown in [Figure 21.1](#) in Chapter 21, “Statistical Graphics Using ODS,” so that it displays a subset of the component plots. The original panel consists of eight plots and a summary statistics box. The ODS trace output from PROC REG shown previously shows that the template for the diagnostics panel is `Stat.REG.Graphics.DiagnosticsPanel`. The following statements display the template:

```
proc template;
  source Stat.REG.Graphics.DiagnosticsPanel;
run;
```

An abridged version of the results is shown next:

```

define statgraph Stat.Reg.Graphics.DiagnosticsPanel;
  notes "Diagnostics Panel";
  dynamic . . .;
  BeginGraph / designheight=defaultDesignWidth;
    entrytitle halign=left textattrs=GRAPHVALUETEXT _MODELLABEL
      halign=center textattrs=GRAPHTITLETEXT "Fit Diagnostics"
      " for " _DEPNAME;
    layout lattice / columns=3 rowgutter=10 columngutter=10
      shrinkfonts=true rows=3;
    layout overlay / xaxisopts=(shortlabel='Predicted');
      . . .
    endlayout;
    layout overlay / xaxisopts=(shortlabel='Predicted');
      . . .
    endlayout;
    layout overlay / xaxisopts=(label='Leverage' offsetmax=0.05)
      . . .
    endlayout;
    layout overlay / yaxisopts=(label="Residual" shortlabel=
      "Resid") xaxisopts=(label="Quantile");
      . . .
    endlayout;
    layout overlayequated / xaxisopts=(shortlabel='Predicted')
      . . .
    endlayout;
    layout overlay / xaxisopts=(linearopts=(integer=true) label=
      "Observation" shortlabel="Obs" offsetmax=0.05) yaxisopts=(
      offsetmin=0.05 offsetmax=0.05);
      . . .
    endlayout;
    layout overlay / xaxisopts=(label="Residual") yaxisopts=(label
      ="Percent");
      . . .
    endlayout;
    layout lattice / columns=2 rows=1 rowdatarange=unionall
      columngutter=0;
      . . .
    endlayout;
    if (_SHOWSTATS =1)
      layout overlay;
      . . .
    endlayout;
    endif;
    if (_SHOWSTATS = 2)
      layout overlay / yaxisopts=(gridDisplay=auto_off label=
        "Residual");
      . . .
    endlayout;
    endif;
  endlayout;
EndGraph;
end;

```

The outermost components of the template are a BEGINGRAPH/ENDGRAPH block with a lattice layout with ROWS=3 and COLUMNS=3 that defines the  $3 \times 3$  panel of plots. Inside that are nine layouts, one for each cell, the last of which is conditionally defined. The LAYOUT statements define the components of the panel from left to right and top to bottom. You can eliminate some of the panels and produce a  $2 \times 2$  panel as follows:

```
proc template;
  define statgraph Stat.Reg.Graphics.DiagnosticsPanel;
    notes "Diagnostics Panel";
    dynamic _DEPLABEL _DEPNAME _MODELLABEL _OUTLEVLABEL _TOTFREQ _NPARM
      _NOBS _OUTCOOKSDLABEL _SHOWSTATS _NSTATSCOLS _DATALABEL _SHOWNObs
      _SHOWTOTFREQ _SHOWNParm _SHOWEDF _SHOWMSE _SHOWRSquare
      _SHOWAdjRSq _SHOWSSE _SHOWDepMean _SHOWCV _SHOWAIC _SHOWBIC
      _SHOWCP _SHOWGMSEP _SHOWJP _SHOWPC _SHOWSBC _SHOWSP _EDF _MSE
      _RSquare _AdjRSq _SSE _DepMean _CV _AIC _BIC _CP _GMSEP _JP _PC
      _SBC _SP;
    BeginGraph / designheight=defaultDesignWidth;
      entrytitle halign=left textattrs=GRAPHVALUETEXT _MODELLABEL
        halign=center textattrs=GRAPHTITLETEXT "Fit Diagnostics"
        " for " _DEPNAME;
      layout lattice / columns=2 rowgutter=10 columngutter=10
        shrinkfonts=true rows=2;
      layout overlay / xaxisopts=(shortlabel='Predicted');
        referenceline y=-2;
        referenceline y=2;
        scatterplot y=RSTUDENT x=PREDICTEDVALUE / primary=true
          datalabel=_OUTLEVLABEL rolename=( _tip1=OBSERVATION _id1=
            ID1 _id2=ID2 _id3=ID3 _id4=ID4 _id5=ID5) tip=(y x _tip1
              _id1 _id2 _id3 _id4 _id5);
      endlayout;
      layout overlay / yaxisopts=(label="Residual" shortlabel=
        "Resid") xaxisopts=(label="Quantile");
        lineparm slope=eval (STDDEV(RESIDUAL)) y=eval (
          MEAN(RESIDUAL)) x=0 / extend=true lineattrs=
            GRAPHREFERENCE;
        scatterplot y=eval (SORT(DROPMISSING(RESIDUAL))) x=eval (
          PROBIT( (NUMERATE(SORT(DROPMISSING(RESIDUAL))) -0.375)/
            (0.25 + N(RESIDUAL)))) / markerattrs=GRAPHDATADEFAULT
          primary=true
          rolename=(s=eval (SORT(DROPMISSING(RESIDUAL))) nq=eval (
            PROBIT( (NUMERATE(SORT(DROPMISSING(RESIDUAL))) -0.375)
              /(0.25 + N(RESIDUAL)))))) tiplabel=(nq="Quantile"
            s="Residual")
          tip=(nq s);
      endlayout;
      layout overlayequated / xaxisopts=(shortlabel='Predicted')
        yaxisopts=(label=_DEPLABEL shortlabel="Observed")
        equatetype=square;
        lineparm slope=1 x=0 y=0 / extend=true lineattrs=
          GRAPHREFERENCE;
        scatterplot y=DEPVAR x=PREDICTEDVALUE / primary=true
          datalabel=_OUTLEVLABEL rolename=( _tip1=OBSERVATION _id1=
            ID1 _id2=ID2 _id3=ID3 _id4=ID4 _id5=ID5) tip=(y x _tip1
```

```

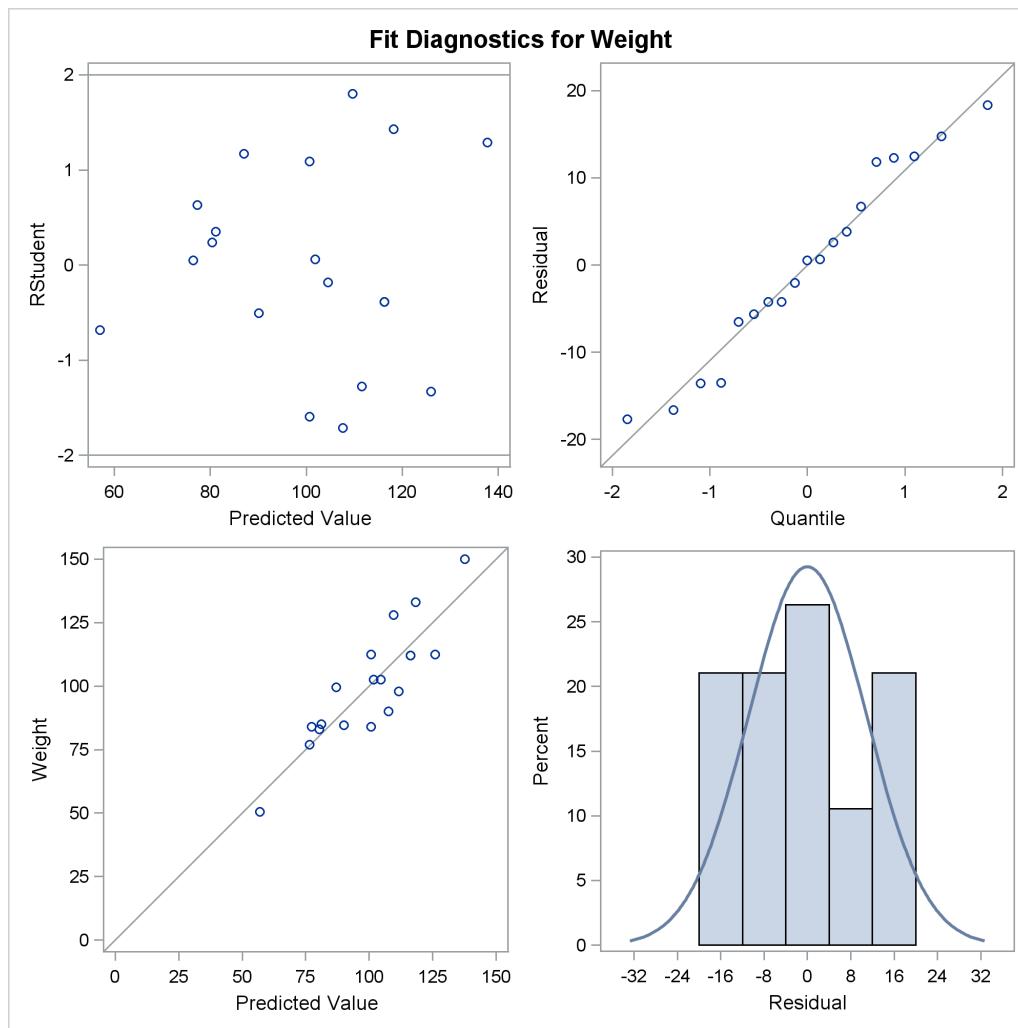
        _id1 _id2 _id3 _id4 _id5);
    endlayout;
    layout overlay / xaxisopts=(label="Residual") yaxisopts=(label
        ="Percent");
        histogram RESIDUAL / primary=true;
        densityplot RESIDUAL / name="Normal" legendlabel="Normal"
            lineattrs=GRAPHFIT;
    endlayout;
endlayout;
EndGraph;
end;
run;

ods graphics on;

proc reg data=sashelp.class;
    model Weight = Height;
run; quit;

```

This template plots the residuals by predicted values, the Q-Q plot, the actual by predicted plot, and the residual histogram. The results are shown in [Output 22.3.1](#).

**Output 22.3.1** Diagnostics Panel with Four Plots

This new template is a straightforward modification of the original template. The COLUMNS=2 and ROWS=2 options in the LAYOUT LATTICE statement request a  $2 \times 2$  lattice. The LAYOUT statement blocks for components 1, 3, 6, 8, and 9 are deleted. **NOTE:** You do not need to understand every aspect of a template to modify it if you can recognize the overall structure and a few key options.

You can restore the original template as follows:

```
proc template;
  delete Stat.REG.Graphics.DiagnosticsPanel / store=sasuser.templat;
run;
```

## Example 22.4: Customizing Axes and Reference Lines

This example illustrates several ways that you can change the plot axes in a scatter plot. The example uses PROC CORRESP to perform a correspondence analysis. It is taken from the section “[Getting Started: CORRESP Procedure](#)” on page 2094 in Chapter 34, “[The CORRESP Procedure](#).” It uses the following data:

```

title "Number of Ph.D.'s Awarded from 1973 to 1978";

data PhD;
  input Science $ 1-19 y1973-y1978;
  label y1973 = '1973'
        y1974 = '1974'
        y1975 = '1975'
        y1976 = '1976'
        y1977 = '1977'
        y1978 = '1978';
  datalines;
Life Sciences      4489 4303 4402 4350 4266 4361
Physical Sciences  4101 3800 3749 3572 3410 3234
Social Sciences    3354 3286 3344 3278 3137 3008
Behavioral Sciences 2444 2587 2749 2878 2960 3049
Engineering        3338 3144 2959 2791 2641 2432
Mathematics        1222 1196 1149 1003  959  959
;

```

The following steps perform the correspondence analysis and create [Output 22.4.1](#):

```

ods graphics on;
ods trace on;

proc corresp data=PhD short;
  ods select configplot;
  var y1973-y1978;
  id Science;
run;

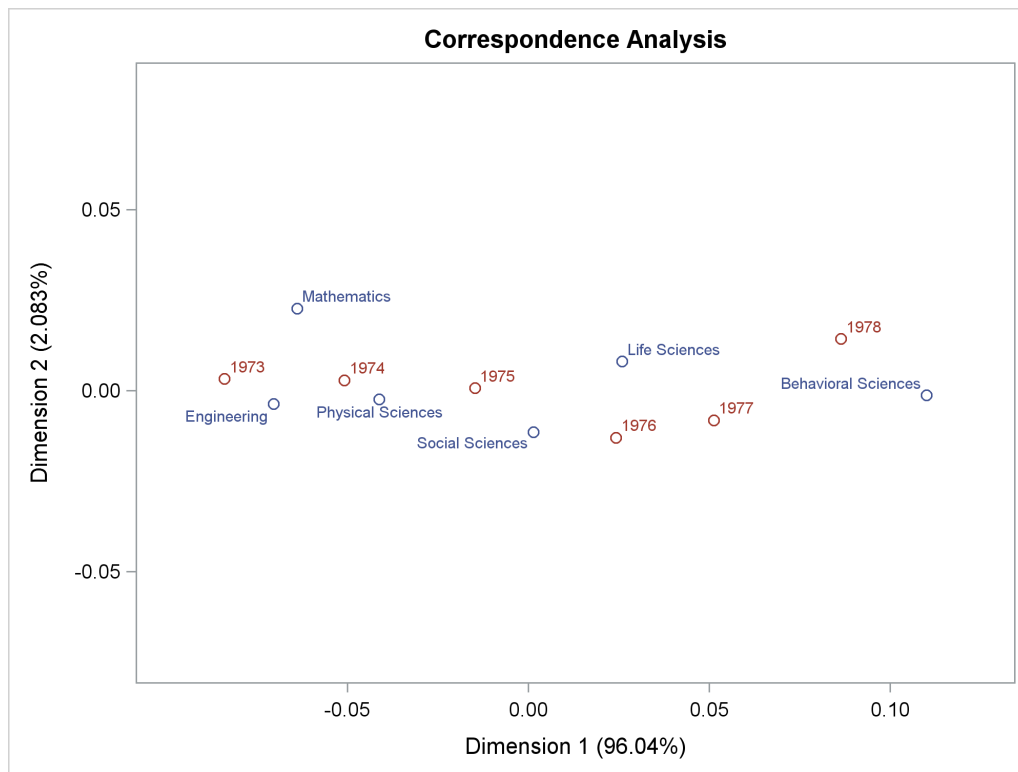
```

The trace output for this step (not shown) shows that the template for this plot is `Stat.Corresp.Graphics.Configuration`. The following step displays this template:

```

proc template;
  source Stat.Corresp.Graphics.Configuration;
run;

```

**Output 22.4.1** Default Scatter Plot

The results are as follows:

```
define statgraph Stat.Corresp.Graphics.Configuration;
  dynamic xVar yVar head legend;
  begingraph;
    entrytitle HEAD;
    layout overlayequated / equatetype=fit xaxisopts=(offsetmin=0.1
      offsetmax=0.1) yaxisopts=(offsetmin=0.1 offsetmax=0.1);
    scatterplot y=YVAR x=XVAR / group=GROUP index=INDEX
      datalabel=LABEL datalabelattrs=GRAPHVALUETEXT
      name="Type" tip=(y x datalabel group)
      tiplabel=(group="Point");
    if (LEGEND)
      discretelegend "Type";
    endif;
  endlayout;
endgraph;
end;
```

You can add reference lines to the scatter plot at specified X and Y values by using the REFERENCELINE statement, as in the following example:

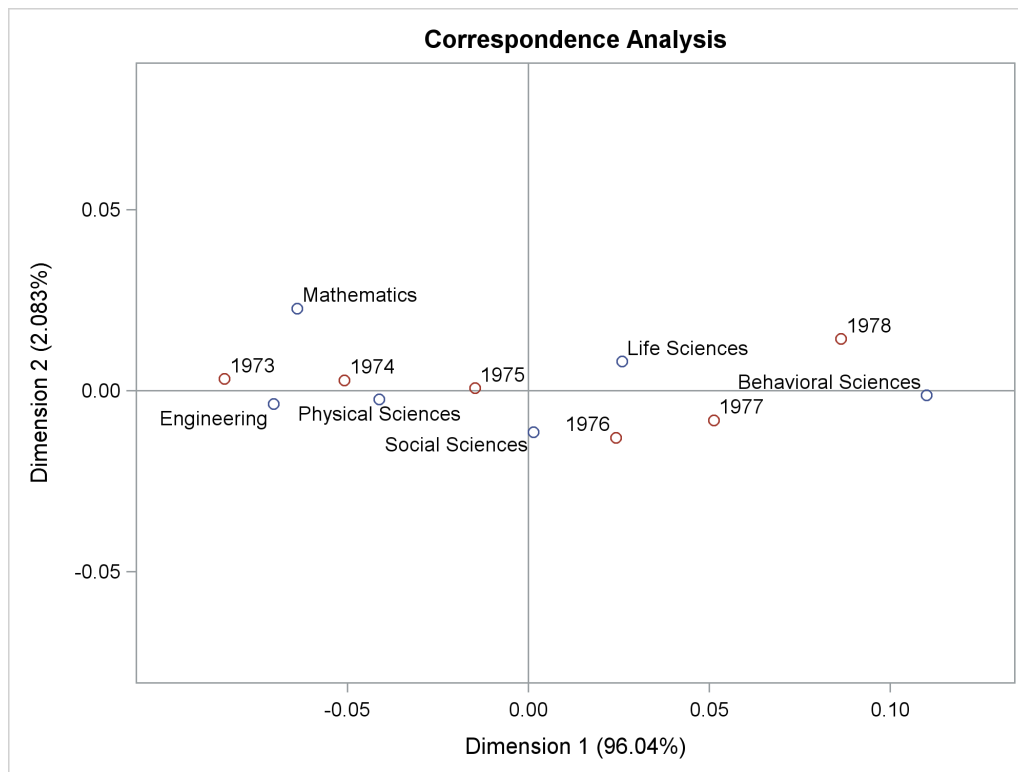
```
proc template;
  define statgraph Stat.Corresp.Graphics.Configuration;
    dynamic xVar yVar head legend;
    beginngraph;
      entrytitle HEAD;
      layout overlayequated / equatetype=fit xaxisopts=(offsetmin=0.1
        offsetmax=0.1) yaxisopts=(offsetmin=0.1 offsetmax=0.1);

      referenceline x=0;
      referenceline y=0;

      scatterplot y=YVAR x=XVAR / group=GROUP index=INDEX
        datalabel=LABEL datalabelattrs=GRAPHVALUETEXT
        name="Type" tip=(y x datalabel group)
        tiplabel=(group="Point");
      if (LEGEND)
        discretelegend "Type";
      endif;
    endlayout;
  endngraph;
end;
run;

proc corresp data=PhD short;
  ods select configplot;
  var y1973-y1978;
  id Science;
run;
```

When you modify templates, it is important to note that the order of the statements within the LAYOUT OVERLAYEQUATED (or more typically, the LAYOUT OVERLAY) is significant. Here, the reference lines are added before the scatter plot so that the reference lines are drawn before the scatter plot. Consequently, labels and markers that coincide with the reference lines are drawn over the reference lines. The results, with reference lines, are displayed in [Output 22.4.2](#).

**Output 22.4.2** Scatter Plot with Reference Lines Added

You can restore the default graph template as follows:

```
proc template;
  delete Stat.Corresp.Graphics.Configuration / store=sasuser.templat;
run;
```

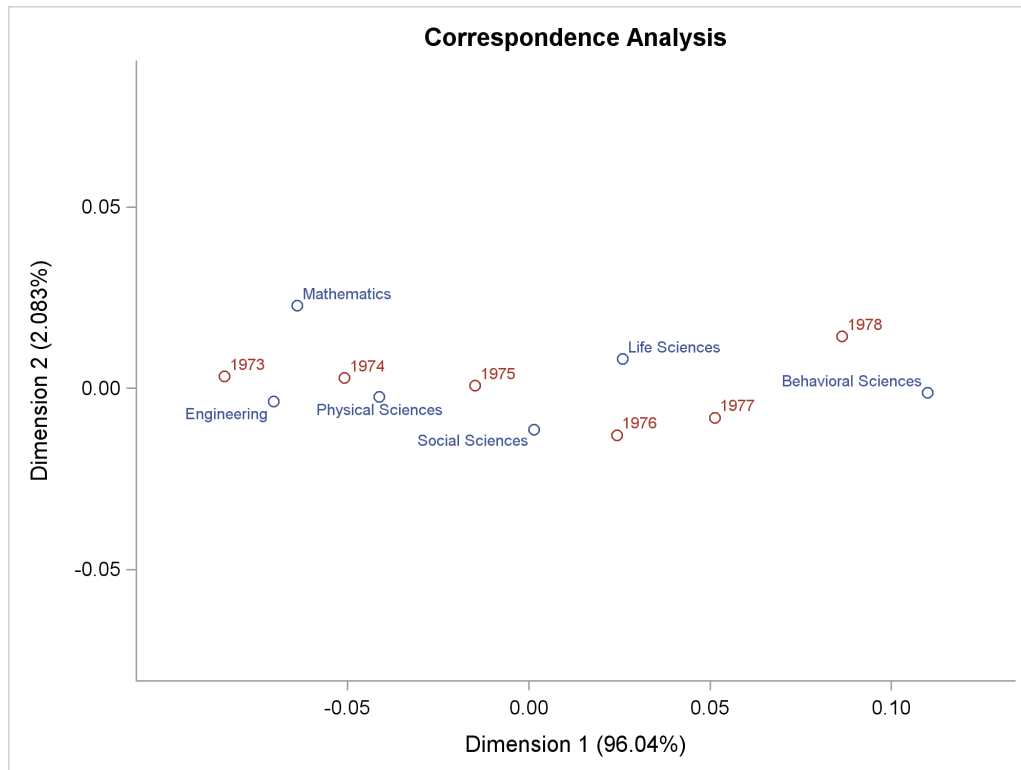
The next steps show how you can change the style so that a frame is not shown:

```
proc template;
  define style noframe;
    parent=styles.htmlblue;
    style graphwalls from graphwalls / frameborder=off;
  end;
run;

ods listing style=noframe;

proc corresp data=PhD short;
  ods select configplot;
  var y1973-y1978;
  id Science;
run;
```

The results, shown in [Output 22.4.3](#), display an X-axis and a Y-axis without a frame. Unlike the previous change, which affects only the ConfigPlot display, this change affects all plots created with the NOFRAME style.

**Output 22.4.3** Scatter Plot with No Axis Frame

Alternatively, you can also add reference lines and delete the entire axis frame using the WALLDISPLAY=NONE and the DISPLAY= option in the graph template, as in the following example:

```
proc template;
  define statgraph Stat.Corresp.Graphics.Configuration;
    dynamic xVar yVar head legend;
    begingraph;
      entrytitle HEAD;

      layout overlayequated / equatetype=fit walldisplay=none
        xaxisopts=(display=(tickvalues) offsetmin=0.1 offsetmax=0.1)
        yaxisopts=(display=(tickvalues) offsetmin=0.1 offsetmax=0.1);

        referenceline x=0;
        referenceline y=0;

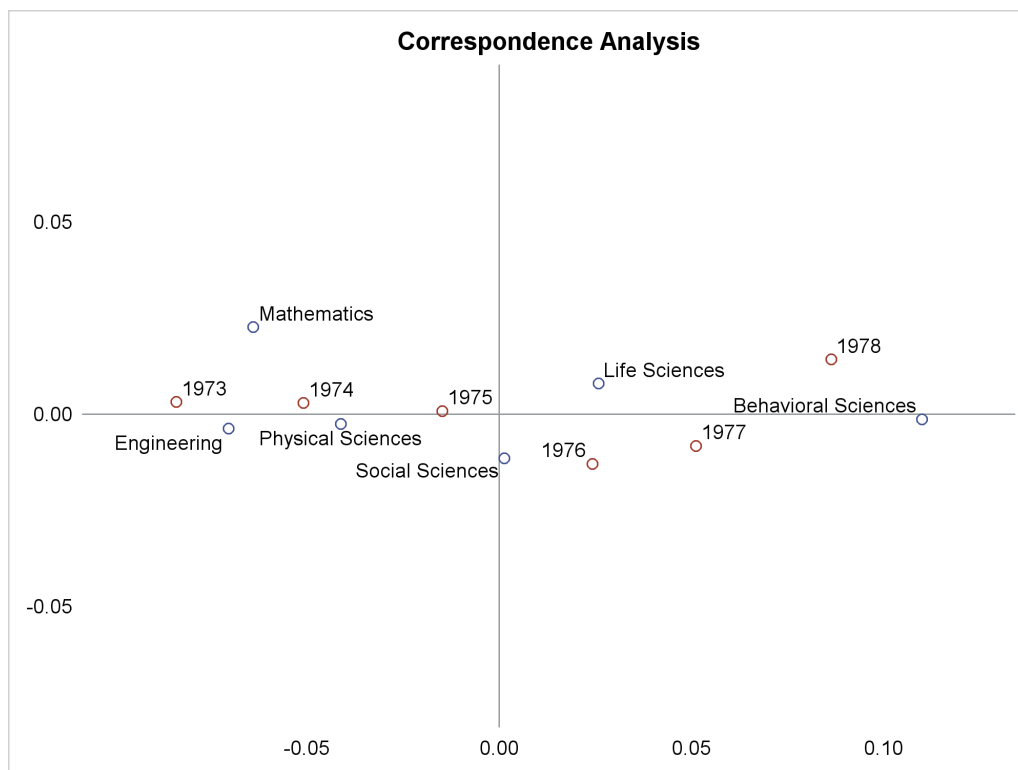
        scatterplot y=YVAR x=XVAR / group=GROUP index=INDEX
          datalabel=LABEL datalabelattrs=GRAPHVALUETEXT
          name="Type" tip=(y x datalabel group)
          tiplabel=(group="Point");
        if (LEGEND)
          discretelegend "Type";
        endif;
      endlayout;
    endgraph;
  end;
run;
```

```
ods listing style=htmlblue;

proc corresp data=PhD short;
  ods select configplot;
  var y1973-y1978;
  id Science;
run;
```

The results are shown in [Output 22.4.4](#).

**Output 22.4.4** Scatter Plot with Internal Axes



Instead of `DISPLAY=(TICKVALUES)`, you can use `DISPLAY=NONE` (not shown) to remove the tick values from the display as well. You can change the tick values, as in the following example:

```
proc template;
  define statgraph Stat.Corresp.Graphics.Configuration;
    dynamic xVar yVar head legend;
    begingraph;
      entrytitle HEAD;

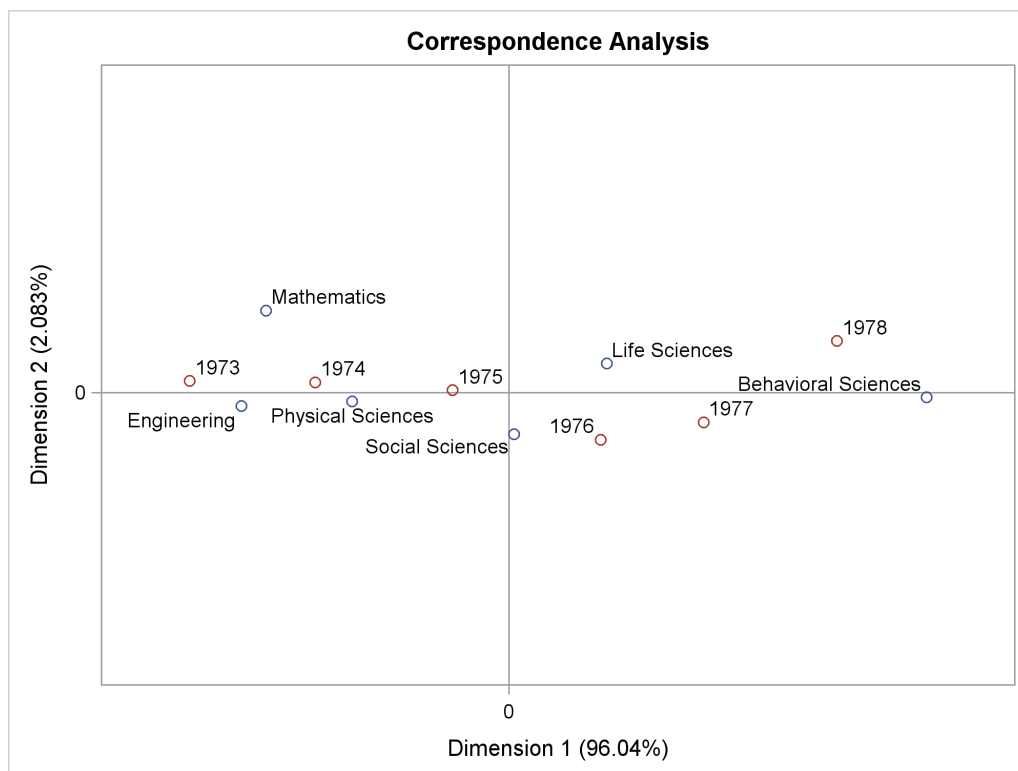
      layout overlayequated / equatetype=fit
        commonaxisopts=(tickvaluelist=(0))
        xaxisopts=(offsetmin=0.1 offsetmax=0.1)
        yaxisopts=(offsetmin=0.1 offsetmax=0.1);

        referenceline x=0;
        referenceline y=0;

        scatterplot y=YVAR x=XVAR / group=GROUP index=INDEX
          datalabel=LABEL datalabelattrs=GRAPHVALUETEXT
          name="Type" tip=(y x datalabel group)
          tiplabel=(group="Point");
        if (LEGEND)
          discretelegend "Type";
        endif;
      endlayout;
    endgraph;
  end;
run;

proc corresp data=PhD short;
  ods select configplot;
  var y1973-y1978;
  id Science;
run;
```

Since the axes in this plot are equated, the ticks are specified using the option `commonaxisopts = (tickvaluelist = (tick-value-list))`. This example only shows ticks at zero, but you can specify lists of values instead. The results are shown in [Output 22.4.5](#).

**Output 22.4.5** Scatter Plot with Tick Marks Specified

If the axes are not equated, then the tick value list is specified with the LINEAROPTS= option, as in the following statement:

```
layout overlay / xaxisopts=(linearopts=(viewmin=-0.1 viewmax=0.1
                                     tickvaluelist=(-0.1 0 0.1))
                   offsetmin=0.1 offsetmax=0.1)
yaxisopts=(linearopts=(viewmin=-0.1 viewmax=0.1
                       tickvaluelist=(-0.1 0 0.1))
            offsetmin=0.1 offsetmax=0.1);
```

The preceding statement uses the VIEWMIN= and VIEWMAX= options to specify the beginning and end of the data range that is shown. Specifying a tick value list does not extend or restrict the range of data shown in the plot. When axes share common options, it might be more convenient to use a macro to specify the options. The following two statements are equivalent to the preceding statement:

```
%let opts = linearopts=(viewmin=-0.1 viewmax=0.1
                      tickvaluelist=(-0.1 0 0.1)) offsetmin=0.1 offsetmax=0.1;
layout overlay / xaxisopts=(&opts) yaxisopts=(&opts);
```

You can restore the default graph template as follows:

```
proc template;
  delete Stat.Corresp.Graphics.Configuration / store=sasuser.templat;
run;
```

---

## Example 22.5: Adding Text to Every Graph

This example shows how to add text to one or more graphs. For example, you can create a macro variable, with project and date information, as follows:

```
%let date = Project 17.104, &sysdate;
```

In order to add this information to a set of graphs, you need to first know the names of their templates. You can list the names of every graph template for SAS/STAT procedures or for a particular procedure as follows:

```
proc template;
  list stat      / where=(type='Statgraph');
  list stat.reg / where=(type='Statgraph');
run;
```

The results for PROC REG are shown in [Output 22.5.1](#).

**Output 22.5.1** PROC REG Templates

Listing of: SASHELP.TMPLSTAT

Path Filter is: Stat.Reg

Sort by: PATH/ASCENDING

| Obs | Path                                          | Type      |
|-----|-----------------------------------------------|-----------|
| 1   | Stat.Reg.Graphics.CooksD                      | Statgraph |
| 2   | Stat.Reg.Graphics.CooksDChart                 | Statgraph |
| 3   | Stat.Reg.Graphics.DFBETASPanel                | Statgraph |
| 4   | Stat.Reg.Graphics.DFBETASPlot                 | Statgraph |
| 5   | Stat.Reg.Graphics.DFFITSPlot                  | Statgraph |
| 6   | Stat.Reg.Graphics.DiagnosticsPanel            | Statgraph |
| 7   | Stat.Reg.Graphics.Fit                         | Statgraph |
| 8   | Stat.Reg.Graphics.FitHeatMap                  | Statgraph |
| 9   | Stat.Reg.Graphics.ObservedByPredicted         | Statgraph |
| 10  | Stat.Reg.Graphics.PartialPanel                | Statgraph |
| 11  | Stat.Reg.Graphics.PartialPlot                 | Statgraph |
| 12  | Stat.Reg.Graphics.PredictionPanel             | Statgraph |
| 13  | Stat.Reg.Graphics.QQPlot                      | Statgraph |
| 14  | Stat.Reg.Graphics.RFPlot                      | Statgraph |
| 15  | Stat.Reg.Graphics.RStudentByPredicted         | Statgraph |
| 16  | Stat.Reg.Graphics.ResidualBoxPlot             | Statgraph |
| 17  | Stat.Reg.Graphics.ResidualByPredicted         | Statgraph |
| 18  | Stat.Reg.Graphics.ResidualHeatMap             | Statgraph |
| 19  | Stat.Reg.Graphics.ResidualHeatPanel           | Statgraph |
| 20  | Stat.Reg.Graphics.ResidualHistogram           | Statgraph |
| 21  | Stat.Reg.Graphics.ResidualPanel               | Statgraph |
| 22  | Stat.Reg.Graphics.ResidualPlot                | Statgraph |
| 23  | Stat.Reg.Graphics.RidgePanel                  | Statgraph |
| 24  | Stat.Reg.Graphics.RidgePlot                   | Statgraph |
| 25  | Stat.Reg.Graphics.SelectionCriterionPanel     | Statgraph |
| 26  | Stat.Reg.Graphics.SelectionCriterionPlot      | Statgraph |
| 27  | Stat.Reg.Graphics.StepSelectionCriterionPanel | Statgraph |
| 28  | Stat.Reg.Graphics.StepSelectionCriterionPlot  | Statgraph |
| 29  | Stat.Reg.Graphics.StudResCooksDChart          | Statgraph |
| 30  | Stat.Reg.Graphics.StudentResChart             | Statgraph |
| 31  | Stat.Reg.Graphics.VIFPlot                     | Statgraph |
| 32  | Stat.Reg.Graphics.rstudentByLeverage          | Statgraph |

You can show the source for the graph templates for SAS/STAT procedures or for a particular procedure as follows:

```
options ls=96;
proc template;
  source stat      / where=(type='Statgraph') ;
  source stat.reg  / where=(type='Statgraph') ;
options ls=80;
```

The results of this step are not shown. However, [Example 22.3](#) shows a portion of the template for the PROC REG diagnostics panel. Here, the OPTIONS statement is used to set a line size of 96, which sometimes works better than the smaller default line size when showing the source for large and complicated templates.

An abridged version of the first few lines of the diagnostics panel template is displayed next:

```
define statgraph Stat.Reg.Graphics.DiagnosticsPanel;
  notes "Diagnostics Panel";
  dynamic . . .;
  BeginGraph / designheight=defaultDesignWidth;
    entrytitle halign=left textattrs=GRAPHVALUETEXT _MODELLABEL
      halign=center textattrs=GRAPHTITLETEXT "Fit Diagnostics"
      " for " _DEPNAME;
    . . .
```

## Adding a Date and Project Stamp to a Few Graphs

You can add the project and date to the bottom of all graphs produced with PROC REG by putting a PROC TEMPLATE statement in front of the template source code, and adding an MVAR and ENTRYFOOTNOTE statement after every BEGINGRAPH statement, as in the following example:

```
proc template;
  define statgraph Stat.Reg.Graphics.DiagnosticsPanel;
    notes "Diagnostics Panel";
    dynamic . . .;
    BeginGraph / designheight=defaultDesignWidth;

      mvar date;
      entryfootnote halign=left textattrs=GraphValueText date;

      entrytitle halign=left textattrs=GRAPHVALUETEXT _MODELLABEL
        halign=center textattrs=GRAPHTITLETEXT "Fit Diagnostics"
        " for " _DEPNAME;
    . . .
```

The MVAR statement enables you to dynamically customize the template and graph at procedure run time, just as the DYNAMIC statement enables the procedure to dynamically customize the template and graph. With the MVAR statement, you can modify the template once and reuse that modification as the macro changes over time. Alternatively, you can modify the templates as follows:

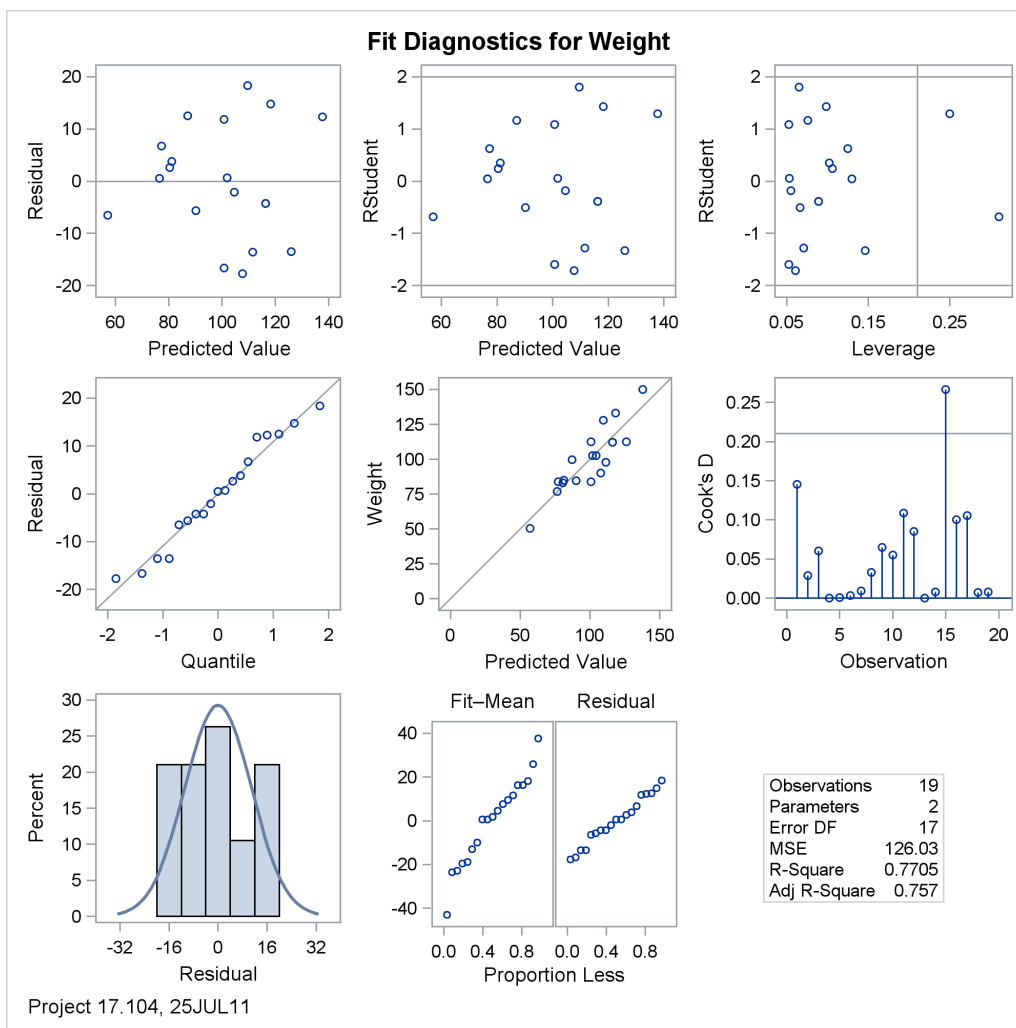
```
entryfootnote halign=left textattrs=GRAPHVALUETEXT "&date";
```

However, you would then have to resubmit your templates every time the macro variable changed. The substitution for the macro variable `date` occurs at different times in the two preceding cases. In the former case, ODS looks for the value of the macro variable `date` at the time the template is used, and then the current date variable is used to set the text in the ENTRYFOOTNOTE statement, every time the template is used. In the latter case, SAS substitutes the value of the macro variable once, at the time that the PROC TEMPLATE step is executed.

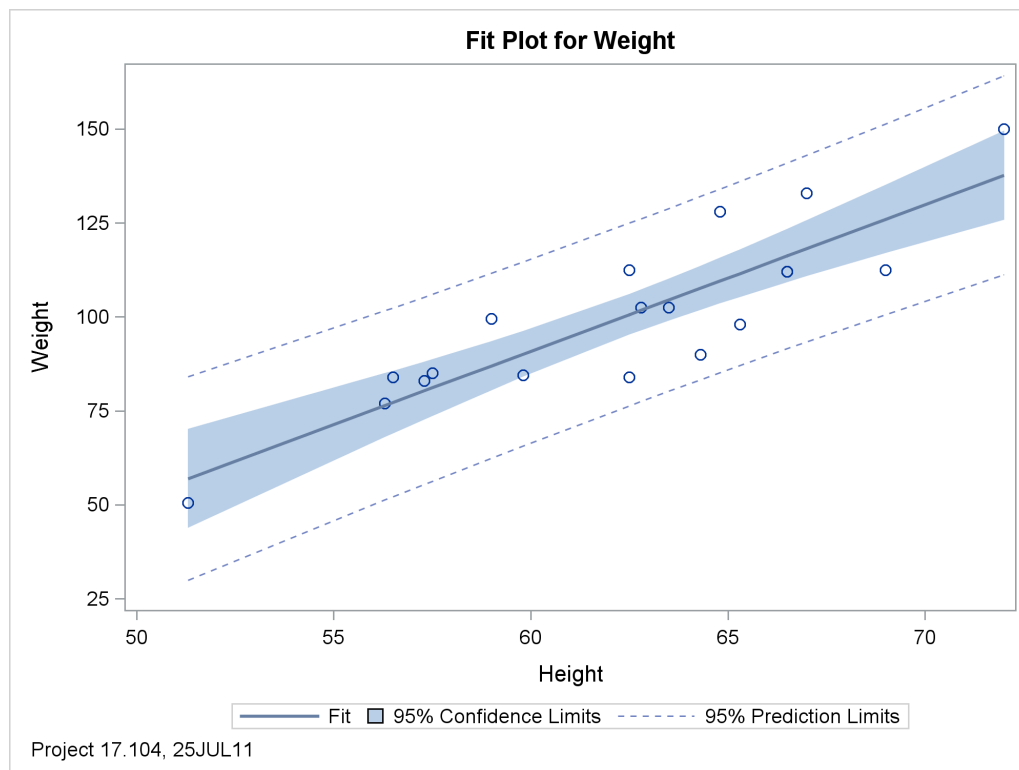
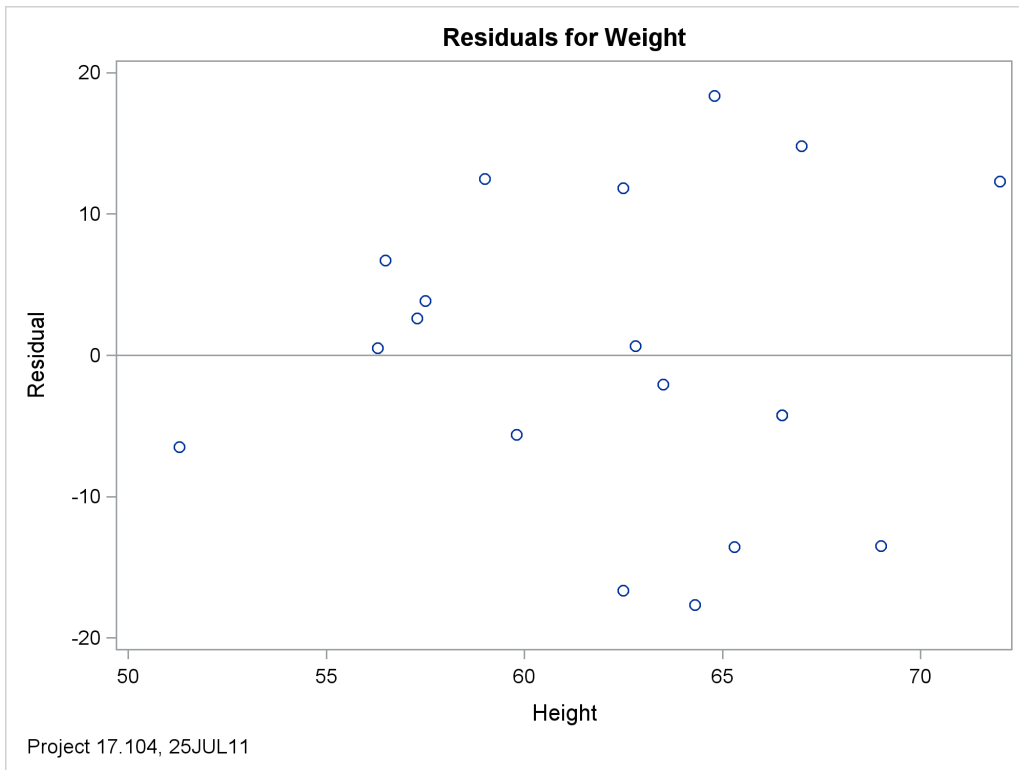
The following steps use the Class data set and produce [Output 22.5.2](#):

```
ods graphics on;

proc reg data=sashelp.class plots=fit(stats=none);
  model weight = height;
run; quit;
```

**Output 22.5.2** PROC REG Plots with Project and Date Stamp

**Output 22.5.2** *continued*



You can restore all of the default templates for PROC REG by running the following step:

```
proc template;
  delete stat.reg / store=sasuser.templat;
run;
```

Alternatively, you can specify **delete stat** to restore all SAS/STAT templates to their default definitions.

You can add text to the top or the bottom of a graph by using the ENTRYTITLE or the ENTRYFOOTNOTE statement, respectively. With both statements, you can put the text in the HALIGN=RIGHT, HALIGN=LEFT, or HALIGN=CENTER positions. You can add text to titles even if they already have a centered title. For example, the ENTRYTITLE statement in the diagnostic panel has text on the left (which is conditionally displayed) and a centered title:

```
entrytitle halign=left textattrs=GraphValueText _MODELLABEL
  halign=center textattrs=GraphTitleText "Fit Diagnostics"
  " for " _DEPNAME;
```

The current title can be followed by HALIGN=RIGHT and more text.

## Adding Data Set Information to a Graph

You might, for example, want to add text to a set of graphs that indicates the most recently created data set. The following example shows you how you can do this with the syslast macro variable:

```
%let data = &syslast;

. . .

mvar data;
entrytitle halign=left textattrs=GraphValueText "Data: " data
  halign=center textattrs=GraphTitleText "Fit Diagnostics"
  " for " _DEPNAME;

. . .
```

Of course, this only makes sense when you are analyzing the last data set created. Alternatively, you can incorporate the name of the data set in the title, as in the following example:

```
%let data = &syslast;

. . .

mvar data;
entrytitle halign=center textattrs=GraphTitleText
  "Fit Diagnostics for Data Set " data;

. . .
```

## Adding a Date and Project Stamp to All Graphs

Sometimes, you can automate the process of template modification. For example, you can automatically add an MVAR and ENTRYFOOTNOTE statement to every graph template, as in the following example:

```
ods path sashelp.tmplmst(read);
proc datasets library=sasuser nolist;
  delete templat(memtype=itemstor);
run;
ods path sasuser.templat(update) sashelp.tmplmst(read);

options ls=256;

proc template;
  source / where=(type='Statgraph') file="tpls.sas";
run;

options ls=80;

data _null_;
  infile 'tpls.sas' lrecl=256 pad;
  input line $ 1-256;
  file 'newtpls.sas';
  put line;
  line = left(lowercase(line));
  if line =: 'begingraph' then
    put 'mvar __date;' /
      'entryfootnote halign=left textattrs=GraphValueText __date;';

  file log;
  if index(line, '__date') then
    put 'ERROR: Name __date already used.' / line;
  if index(line, 'entryfootnote') then put line;
run;

proc template;
  %include 'newtpls.sas' / nosource;
run;
```

These statements write all ODS graph templates to a file, read that file, and write out a new file with an MVAR and ENTRYFOOTNOTE statement added after every BEGINGRAPH statement. Then these new templates are compiled with PROC TEMPLATE. These steps assume that no BEGINGRAPH statement is longer than 256 characters. Most graphs do not have footnotes. Those that do will now have multiple footnotes. You might want to manually combine them or write a more complicated program to handle them. These steps also assume that the name \_\_date is not used anywhere. However, the program does check this and also lists all ENTRYFOOTNOTE statements. Be careful to check the SAS log to ensure that all templates compile without error. Also, before using templates that are automatically modified, make sure your modifications are reasonable.

You can delete `Sasuser.Templat` and hence all modified templates (assuming the default template search path) as follows:

```
ods path sashelp.tmplmst(read);
proc datasets library=sasuser nolist;
    delete templat(memtype=itemstor);
run;
ods path sasuser.templat(update) sashelp.tmplmst(read);
```

---

## Example 22.6: PROC TEMPLATE Statement Order and Primary Plots

This example uses artificial data to illustrate two basic principles of template writing: that statement order matters and that one of the plotting statements is the primary statement. The data are a sample from a bivariate normal distribution. A custom graph template and PROC SGRENDER are used to plot the data along with vectors and ellipses. The plot consists of four components: a scatterplot of the data; vectors whose end points come from other variables in the data set; ellipses whose parameters are specified in the template; and reference lines whose locations are specified in the template. Initially, thick lines are used to show what happens at the places where the lines and points intersect.

The following steps create the input SAS data set:

```
data x;
    input x y;
    label x = 'Normal(0, 4)' y = 'Normal(0, 1)';
    datalines;
-4 0
4 0
0 -2
0 2
;

data y(drop=i);
    do i = 1 to 2500;
        r1 = normal( 104 );
        r2 = normal( 104 ) * 2;
        output;
    end;
run;

data all;
    merge x y;
run;
```

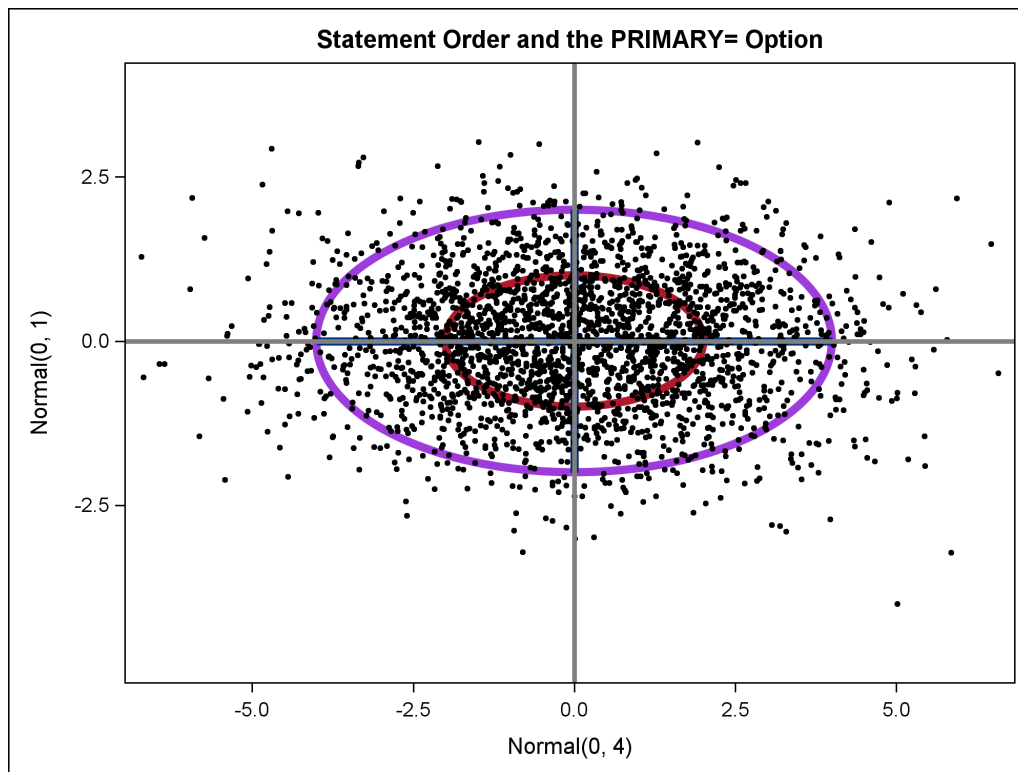
The data set All contains four variables. The variables r1 and r2 contain the random data. These variables contain 2500 nonmissing observations. The data set also contains the variables x and y, which contain the end points for the vectors. These variables contain four nonmissing observations and 2496 observations that are all missing. A data set like this is not unusual when creating overlaid plots. Different overlays often require input data with very different sizes. First, the data are plotted by using a template that is deliberately constructed to demonstrate a number of problems that can occur with statement order.

The following steps create [Output 22.6.1](#):

```
proc template;
  define statgraph Plot;
    begingraph;
      entrytitle 'Statement Order and the PRIMARY= Option';
      layout overlayequated / equatetype=fit;
        ellipseparm semimajor=eval(sqrt(4)) semiminor=1
          slope=0 xorigin=0 yorigin=0 /
          outlineattrs=GraphData2(pattern=solid thickness=5);
        ellipseparm semimajor=eval(2 * sqrt(4)) semiminor=2
          slope=0 xorigin=0 yorigin=0 /
          outlineattrs=GraphData5(pattern=solid thickness=5);
        vectorplot y=y x=x xorigin=0 yorigin=0 /
          arrowheads=false lineattrs=GraphFit(thickness=5);
        scatterplot y=r1 x=r2 /
          markerattrs=(symbol=circlefilled size=3);
        referenceline x=0 / lineattrs=(thickness=3);
        referenceline y=0 / lineattrs=(thickness=3);
      endlayout;
    endgraph;
  end;
run;

ods listing style=listing;

proc sgrender data=all template=plot;
run;
```

**Output 22.6.1** Statements Specified in a Nonoptimal Order

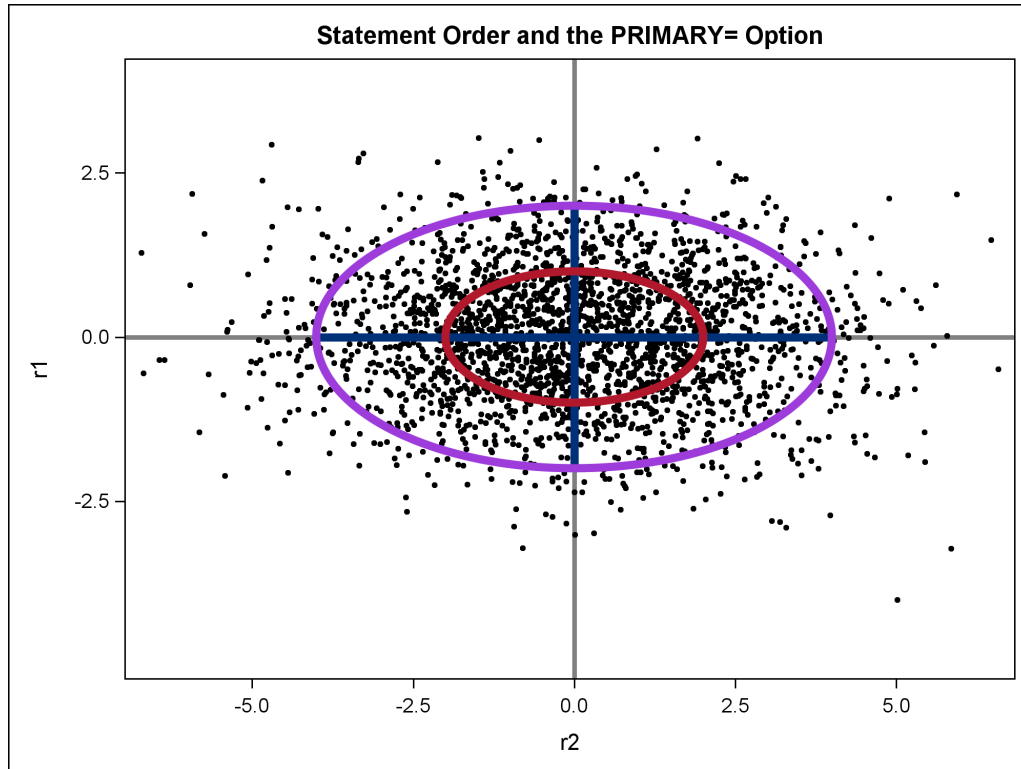
There are a number of problems with the plot in [Output 22.6.1](#). The reference lines obliterate the vectors, and the data are on top of everything but the reference lines. It might be more reasonable to plot the reference lines first, the data next, the vectors next, and the ellipses last. The following steps do this and produce [Output 22.6.2](#):

```
proc template;
  define statgraph Plot;
    begingraph;
      entrytitle 'Statement Order and the PRIMARY= Option';
      layout overlayequated / equatetype=fit;
        referenceline x=0 / lineattrs=(thickness=3);
        referenceline y=0 / lineattrs=(thickness=3);
        scatterplot y=r1 x=r2 /
          markerattrs=(symbol=circlefilled size=3);
        vectorplot y=y x=x xorigin=0 yorigin=0 /
          arrowheads=false lineattrs=GraphFit(thickness=5);
        ellipseparm semimajor=eval(sqrt(4)) semiminor=1
          slope=0 xorigin=0 yorigin=0 /
          outlineattrs=GraphData2(pattern=solid thickness=5);
        ellipseparm semimajor=eval(2 * sqrt(4)) semiminor=2
          slope=0 xorigin=0 yorigin=0 /
          outlineattrs=GraphData5(pattern=solid thickness=5);
      endlayout;
    endgraph;
  end;
run;
```

```
ods listing style=listing;

proc sgrender data=all template=plot;
run;
```

Output 22.6.2 Statement Order Fixed



Output 22.6.2 looks better than Output 22.6.1, but the labels for the axes have changed. Output 22.6.1 has the labels of the variables *x* and *y* as axis labels, whereas Output 22.6.2 uses the names of the variables *r1* and *r2*. This is because in the Output 22.6.1, the first plot is the vector plot of *x* and *y* (which have labels), and in Output 22.6.2, the first plot is the scatter plot of *r1* and *r2* (which do not have labels). By default, the first plot is the *primary plot*, and the primary plot is used to determine the axis type and labels. You can designate the vector plot as the primary plot with the PRIMARY=TRUE option.

The following statements make the final plot, this time with default line thicknesses, and produce [Output 22.6.3](#):

```
proc template;
  define statgraph Plot;
    begingraph;
      entrytitle 'Statement Order and the PRIMARY= Option';
      layout overlayequated / equatetype=fit;
        referenceline x=0;
        referenceline y=0;
        scatterplot y=r1 x=r2 / markerattrs=(symbol=circlefilled size=3);

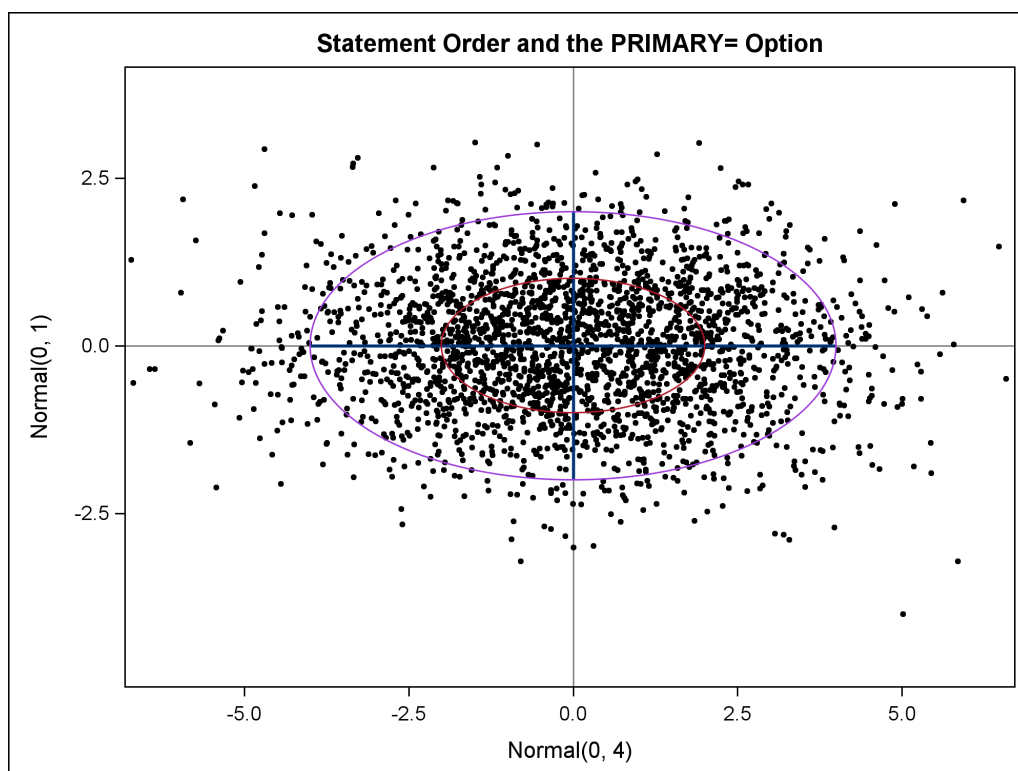
        vectorplot y=y x=x xorigin=0 yorigin=0 / primary=true
          arrowheads=false lineattrs=GraphFit;

        ellipseparm semimajor=eval(sqrt(4)) semiminor=1
          slope=0 xorigin=0 yorigin=0 /
          outlineattrs=GraphData2(pattern=solid);
        ellipseparm semimajor=eval(2 * sqrt(4)) semiminor=2
          slope=0 xorigin=0 yorigin=0 /
          outlineattrs=GraphData5(pattern=solid);
      endlayout;
    endgraph;
  end;
run;

ods listing style=listing;

proc sgrender data=all template=plot;
run;
```

**Output 22.6.3** Statement Order Fixed and Primary Plot Specified



The axis labels in [Output 22.6.3](#) and the overprinting of plot elements look better than in the previous plots. You can further adjust the line thicknesses if you want to emphasize or deemphasize components of this plot. The following list discusses the syntax of the GTL statements used in this example.

- The template has an ENTRYTITLE statement that specifies the title.
- The template has an equated overlay. This means that a centimeter on one axis represents the same data range as a centimeter on the other axis. This is done instead of the more common LAYOUT OVERLAY since with these data, the shape and geometry of the data have meaning even though the ranges of the two axis variables are different. The option EQUATETYPE=SQUARE is used to make a square plot, but since the X-axis variable has a larger range than the Y-axis variable, and since the default plot size is wider than high, EQUATETYPE=FIT is specified. The axes are equated but use the available space.
- A vertical reference line is drawn at X=0, and a horizontal reference line is drawn at Y=0.
- The scatter plot is based on the Y-axis variable r2 and the X-axis variable r1. The markers are filled circles with a size of three pixels. This is smaller than the default size and works well with a plot that displays many points.
- The vector plot is based on the Y-axis variable y and the X-axis variable x. The vectors are solid lines with no heads emanating from the origin (X=0 and Y=0). The color and other line attributes such as thickness come from the attributes of the **GraphFit** style element. This is the primary plot, so the default axis labels are the variable labels for the X= and Y= variables if they exist or the variable names if the variables do not have labels.
- The plot also displays two ellipses with X=0 and Y=0 at their center. Their widths are expressions, and their heights are constant. The expressions are not needed in this example; they are used to illustrate the syntax. The SEMIMAJOR= option specifies half the length of the major axis for the ellipse, and the SEMIMINOR= option specifies half the length of the minor axis for the ellipse. The SLOPE= option specifies the slope of the major axis for the ellipse. The colors of the ellipses and other line properties are based on the **GraphData2** and **GraphData5** style elements, but the line pattern attribute from the style is overridden.

---

## References

- Kuhfeld, W. F. (2009), “Modifying ODS Statistical Graphics Templates in SAS 9.2,” <http://support.sas.com/rnd/app/papers/ods/modtmpl.t.pdf>.
- Kuhfeld, W. F. (2010), *Statistical Graphics in SAS: An Introduction to the Graph Template Language and the Statistical Graphics Procedures*, Cary, NC: SAS Institute Inc.

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