STATGRAPHICS® Sigma Express
for Microsoft Excel®

Getting Started
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This book introduces users of STATGRAPHICS Sigma Express to installation of the program, basic system operation, and methods for analyzing data. The program functions as an "Add-In" for Microsoft Excel. All data entry and management is done in Excel. Statistical calculations are performed by STATGRAPHICS and the output presented in a separate window. Users may then copy and paste the results back to Excel or to Microsoft Word, PowerPoint or other applications.

Additional PDF files with detailed descriptions of each statistical procedure may be accessed from within Microsoft Excel by selecting Help - Procedure Documentation from the STATGRAPHICS Add-In menu.

NOTE: The data files referenced in the manual and in the other PDF files are provided with the program. They may be found in the DATA subdirectory where STATGRAPHICS is installed, which is usually c:\Program Files\Statgraphics\STATGRAPHICS Sigma Express.

StatPoint Technologies, Inc.
April, 2012
Installation

Installing STATGRAPHICS Sigma Express, accessing it from within Microsoft Excel, and first-time activation.

1.1 Installing STATGRAPHICS Sigma Express

STATGRAPHICS Sigma Express is distributed in two ways: over the Internet in a file that may downloaded to your computer, or on a CD-ROM. To use the program, it must first be installed on your hard disk. As with most Windows programs, installation is extremely simple:

**Step 1:** If you received the program on a CD, insert the CD into your CD-ROM drive. After a few moments, the setup program should begin automatically. If it does not, open Windows Explorer and execute the file `sgexpressinstall.exe` in the root directory on the CD-ROM.

If you downloaded the program over the Internet, locate the file that you downloaded and double-click on it to begin the installation process.

**Step 2:** If you are running the program from a CD, a dialog box will be displayed asking you to specify the edition of Microsoft Excel with which STATGRAPHICS will be used and the desired language:
Make the desired selections. This will execute the proper MSI file.

If you downloaded the program from the Internet, you can simply execute the EXE or MSI file that you downloaded.

**Step 3:** Once installation begins, you will be guided through a series of dialog boxes. The first dialog box welcomes you to STATGRAPHICS Sigma Express.
Just press the *Next* button.

**NOTE:** In order to install and activate STATGRAPHICS *Sigma Express* you must have administrator rights to your computer. In the event that you need to have a system administrator present during the installation process, we highly recommend installing and activating the software while they are present.

**Step 4:** The second dialog box displays the license agreement for the software:

![License Agreement Dialog Box](image)

*Figure 1-3. License Agreement Dialog Box*

Read the license agreement carefully. If you accept the terms, click on the indicated radio button and press *Next* to continue. If you do not agree, press *Cancel*. If you do not agree with the terms, you may not use the program.
Step 5: The next dialog box requests information about the location where the program files will be installed:

![Select Installation Folder]

The installer will install STATGRAPHICS Sigma Express to the following folder.

To install in this folder, click "Next". To install to a different folder, enter it below or click "Browse".

Folder:

C:\Program Files (x86)\Statgraphics\STATGRAPHICS Sigma Express

Browse...

Disk Cost...

Install STATGRAPHICS Sigma Express for yourself, or for anyone who uses this computer:

- Everyone
- Just me

Figure 1-4. Customer Information Dialog Box

By default, STATGRAPHICS is installed in a subdirectory of Program Files if you are running a 32-bit version of Windows, or in a subdirectory of Program Files (x86) if you are running a 64-bit version of Windows. You may also allow anyone who uses the computer to have access to STATGRAPHICS by selecting the “Everyone” radio button, or restrict access to only the current user.
Step 6: The final dialog box asks you to confirm that you are ready to proceed with the installation:

![Confirmation Dialog Box](image)

The installer is ready to install STATGRAPHICS Sigma Express on your computer.

Click "Next" to start the installation.

Press Next to begin installing the program files.

Step 7: When the installation is complete, a final dialog box will be displayed:
Click on Close to complete the installation.

1.2 Evaluation Period

The installation program will install STATGRAPHICS Sigma Express and add it to the Excel menu. When you next launch Excel, you will see a menu option labeled STATGRAPHICS:

NOTE: In some cases, STATGRAPHICS will not automatically be added to the Excel menu. This happens for example when Microsoft Office 14 is installed by downloading it from the Internet, since it is then installed in a virtual location. If “STATGRAPHICS”
does not automatically appear on the Excel menu, it can be easily added manually by following the instructions at www.statgraphics.com/express/manualactivation.htm.

If you click on STATGRAPHICS, a menu similar to that shown below will appear:

![Figure 1-8. STATGRAPHICS Menu as Displayed in Excel 2010](image)

The STATGRAPHICS procedures are divided into 7 categories, including the 5 categories of the Six Sigma DMAIC paradigm (Define, Measure, Analyze, Improve, Control) plus additional sections for Tools (which includes Monte Carlo Simulation) and Help.

When you first install STATGRAPHICS, you will be given 15 days to evaluate the program before having to purchase a license. To display the status of your evaluation, select Help - About from the STATGRAPHICS menu to display the dialog box shown below:

![Figure 1-9. Help - About Dialog Box Showing Expiration Date](image)
The dialog box shows the current version number, the edition, and the expiration date.

1.3 Entering a Serial Number and Activation Code

NOTE: To perform the steps described below, you must execute Excel with administrator rights. If you are using Windows Vista or Windows 7, be sure to click on the Excel icon with the RIGHT mouse button (not the left button) and select Run as administrator from the popup menu.

In order to continue using STATGRAPHICS after the end of the evaluation period, you must purchase a license. When you purchase a license, you will receive a serial number that must be entered into the license manager. To do so, select License Manager from the Help menu. This will display the dialog box shown below:

![License Manager Dialog Box](image)

Figure 1-10. License Manager Dialog Box

Press the Activate button to display the following activation dialog box:
Follow the three steps below to activate the program.

**Step 1 - Enter personal information and serial number**
Enter the required information, including your serial number. As soon as you enter a valid serial number, the *Product key* field will be filled with a 16-character key that is unique to your computer. To activate the program, you will need to enter an *Activation Code* that matches that product key.

**Step 2 - Request activation code**
To receive an Activation Code, press either of the two buttons under Step 2:
1. The button labeled 1. Press Here automatically sends your Product Key to StatPoint Technologies over the Internet requesting an Activation Code. A web service will respond to that request immediately, sending the Activation Code to the e-mail address that you supply.

2. The button labeled 2. Press Here accesses your default e-mail program, placing the information in a new e-mail that you can send to StatPoint. E-mail requests will be processed during normal business hours.

To avoid delay, use the first method whenever possible.

**NOTE:** Users who are activating copies obtained under an institutional site license must use the first method. Activation codes will only be sent to e-mail addresses issued by the institution that purchased the site license. Institutional IT personnel should advise users of this requirement.

### Step 3 - Enter activation code
Once your request is processed, an e-mail will be sent to you containing the Activation Code. Enter the code in the field provided under Step 3 and press the Activate button. If the code matches your product key, you will see the following message:

![Activation Message]

Press OK to continue. STATGRAPHICS has now been activated and you can now use any of the procedures.

**NOTE:** If you install STATGRAPHICS on more than one computer, you will need a different activation code for each computer, since it must match the product key.
Template Procedures

*Using STATGRAPHICS template procedures.*

There are two types of procedures available on the STATGRAPHICS menu:

- **Template procedures** - These procedures create a new Excel worksheet and load a template that you complete by editing the worksheet. The data required by these procedures is typed directly into the template.

- **Data analysis procedures** - These procedures operate on data that you have already entered into columns of your Excel WorkBook. They display several dialog boxes for selecting the data and other options and then create a new window with tables and graphs. After examining the output and making any desired changes, tables and graphs may be copied back to the Excel WorkBook or into other applications such as Microsoft Word or PowerPoint.

This chapter discusses use of the template procedures.

### 2.1 Selecting a Template Procedure

To use a template procedure, select the desired item from the STATGRAPHICS menu. For example, suppose you wish to create a priority matrix, which is used to help select between alternative solutions to a problem. To do so:

**Step 1:** First load any Excel workbook.

**Step 2:** Select *Priority Matrix* from the *Measure* menu. This will add a new worksheet to your WorkBook and load the template shown below:
2.2 Completing the Template

To create the priority matrix, type entries directly into the cells of the worksheet containing the template. To do so:

1. Develop a list of solutions. Each solution is assigned to one row of the matrix. Enter a label for each solution in the first open column.

2. Develop a list of criteria on which each solution will be judged. Criteria are assigned to columns of the matrix. Enter a label for each criterion in the first open row.
3. Assign weights to the criteria, $W_1, W_2, ..., W_c$, the relative values of which express the importance of each criteria. Enter the values of the weights in the second open row.

4. Score each solution with respect to each criteria by placing a value $S_{i,j}$ in the appropriate cell of the matrix.

A typical completed priority matrix is shown below:

![Priority Matrix Image]

*Figure 2-2. Completed Priority Matrix*

The worksheet will automatically calculate a total for each solution according to:

$$T_s = \sum_{j=1}^{c} S_{s,j} W_j$$  \hspace{1cm} (2.1)

In the above template, Solution B has the highest total.

To save the results of a template procedure, simply save the current Excel Workbook.
Data Analysis Procedures

Generating an analysis, selecting tables and graphs, specifying options, and saving the results.

Data analysis procedures analyze data that you have already placed in an Excel worksheet. As an example, load the file named nonlin.xls which was copied to the Program Files directory when STATGRAPHICS Sigma Express was installed. The data show the measurements made on the available chlorine in samples of a product taken at different lengths of time after production (from Applied Regression Analysis, third edition, by Draper and Smith, 1998):

![Excel spreadsheet with data](image)

Figure 3-1. Sample Data File from a Stability Study
To analyze data using *STATGRAPHICS Sigma Express*, it is usually placed in columns beginning with a header row containing names for each column. A second header row may be included if desired containing comments for each column. The comment row is often used to display the units of measurement. Subsequent rows contain the data to be analyzed.

Note that:

1. Each column name should be unique and may contain up to 32 characters. Names may contain any characters except a quote (') or a double quote ("), Spaces are allowed.

2. Column names do not have to be placed in the first row. However, the data should follow in the rows immediately below the names.

The sample data set has $n = 44$ observations for chlorine together with its age measured in weeks. It contains a single header row with column names but no comments.

### 3.1 Selecting a Data Analysis Procedure

To execute a data analysis procedure:

**Step 1:** Select the data to be analyzed by highlighting it in Excel. If no data is selected, it is assumed that the entire contents of the current worksheet is desired.

**Step 2:** Select the desired procedure from the STATGRAPHICS menu. To fit a curve relating chlorine to weeks, select *Analyze - Regression Analysis - Simple Regression*.

**Step 3:** Most procedures begin by displaying 2 dialog boxes which are used to specify the columns containing the data to be analyzed. The first dialog box specifies the structure of the Excel worksheet:

![Excel Data Selection Dialog Box](image)

*Figure 3-2. Excel Data Selection Dialog Box*
There are 3 choices:

- **Column names** – indicates that the first non-empty row of the Excel selection contains names for each of the columns.

- **Column names and comments** - indicates that the first non-empty row of the Excel selection contains names for each of the columns, while the row immediately below the names contains a comment.

- **Data only** – indicates that all cells contain data. In this case, column names will be automatically generated to match the column indicators in Excel (“A”, “B”, etc.).

Note that column names do not have to be placed in row #1. However, they must be located in the first non-empty row of the selected range. As an example, the Excel worksheet below shows a valid structure containing both column names and comments:

![Excel Worksheet](image)

*Figure 3-3. Sample Excel Worksheet with Column Names and Comments*
Note that the selected range begins in row #2, so that the column names are located in the first non-empty row of the selection.

The second dialog box requests the names of the columns to be used by the analysis procedure. When performing a *Simple Regression*, the dialog box appears as shown below:

![Data Input Dialog Box for Simple Regression Procedure](image)

The first two input fields are required:

- **Y**: The dependent or response variable.
- **X**: The independent or predictor variable.

In data entry fields, you can enter either the name of a column such as `chlorine` or a STATGRAPHICS expression such as `LOG(chlorine)`. The *Select* field may be used to select a subset of the highlighted rows. For example, if you enter a statement such as `FIRST(20)` in that field, only the first 20 rows in the worksheet selection will be used. The *Select* field is discussed in more detail later.

**Step 4:** Most procedures will next display an *Analysis Options* dialog box which is used to specify options for the procedure to be run. For *Simple Regression*, it has the following form:
The above dialog box allows you to select a model other than a straight line if desired. Usually, the default selections will be adequate when first running the procedure. The options can be easily changed after the initial fit is examined.

**Step 5:** After the options are selected and OK is pressed, a final dialog box will be displayed showing the available tables and graphs:

For this example, 3 tables and 2 graphs have been selected. This selection can also be easily changed after the initial analysis is examined.

Pressing OK will start the procedure.
3.2 Analysis Windows

Once the data and options have been specified, an analysis window will be created:

![Analysis Window for Simple Regression Example](image)

Figure 3-7. Analysis Window for Simple Regression Example

The analysis window is a “splitter window”, with multiple panes divided by movable splitter bars. Tables are located along the left side of the window, while graphs are located along the right.

You can maximize any table or graph by double-clicking on it, in which case it will fill the window:
Double-clicking on the pane a second time restores the multiple pane display.

### 3.2.1 Copying Graphs to Excel

Once a graph has been created, it can be copied to your Excel worksheet (or any other program) by pressing the right-mouse button anywhere on the graph and selecting *Copy* from the pop-up menu:
This places the graph on the Windows clipboard. If you return to Excel, select the cell where the graph should be pasted and then select Paste, it will be placed in the worksheet as shown below:

Since the graph is pasted as a picture, it can be easily moved or resized.
3.2.2 Copying Tables to Excel

Tables may be handled in a similar fashion. For example, double-click on the graph to minimize it and then double-click on the upper left pane to maximize the Analysis Summary:

![Image of STATGRAPHICS Sigma Express - Simple Regression - chlorine vs. weeks]

Figure 3.11. Simple Regression Analysis Summary Table

To copy this output to your Excel worksheet, highlight the output that you wish to copy and press the right-mouse button to display the following pop-up menu:
There are 2 relevant options:

1. *Copy* - select this option to copy the data as numeric values with associated text. When pasted into Excel, the table structure will be preserved so that you can access individual values.

2. *Copy as Metafile* - copies the output as a picture. It will then appear exactly as in STATGRAPHICS, but you will not be able to access individual values.

The figure below shows the output pasted using the first method:
Some resizing of rows and columns may be necessary.

### 3.2.3 Analysis Toolbar

Along the top of the STATGRAPHICS analysis window is an *analysis toolbar*, shown below:

![Analysis Toolbar]

Each of the buttons on this toolbar performs an important operation.

**Data Input Dialog Button**

When pressed, this button displays the data input dialog box originally used to specify the data variables. If you change the data variables and press OK, the analysis will change to reflect the new selections. This enables you to try different combinations of data without having to start a new analysis.
Analysis Options Button

This button redisplay the Analysis Options dialog box shown in Figure 3.5. It could be used in this case to fit a different type of model, such as the Reciprocal-X model shown below:

Figure 3-14. Fitted Reciprocal-X Model

Tables and Graphs Button

This button redisplay the list of tables and graphs that may be added to the analysis window.

Pane Options Button

In addition to options that apply to the entire analysis window, many individual tables and graphs have options that apply only to them. These options are accessible by first maximizing the selected table or graph and then pressing Pane Options. For the Fitted Model Plot, displayed above, the pane options are:
Figure 3-15. Pane Options Dialog Box for the Fitted Model Plot

For example, removing the check mark alongside *Confidence Limits* and pressing *OK* will replot the graph without the inner limits:

![Image of fitted model plot without confidence limits]

Figure 3-16. Fitted Model Plot Without Confidence Limits

27/ Data Analysis Procedures
Save Results Button

This button allows you to save numerical results calculated by the statistical analysis back to columns of your worksheet. For *Simple Regression*, it displays the following choices:

![Save Results Options](image)

**Figure 3-17. Simple Regression Save Results Dialog Box**

To save information:

1. Check the items of interest in the *Save* field.
2. For each item to be saved, assign a column name under *Target Variables*.
3. Press OK. This will put the selected data on the Windows clipboard.
4. Return to your Excel worksheet, highlight the cell where you wish the results to be pasted, and select *Paste*.

This will place the data into the Excel worksheet, as shown below:
Graphics Buttons

Whenever a graph is maximized within the analysis window, several additional buttons are enabled. These buttons include:

- **Graphics options** – displays a dialog box used to change colors, labels, axis scaling, and other similar features.

- **Add text** – used to add additional text to the graph.

- **Jitter** – used to offset points randomly in the horizontal or vertical direction to prevent their overplotting each other.

- **Brush** – colors points on a scatterplot according to the value of a selected variable.

- **Smooth/Rotate** – smoothes a 2-dimensional plot, or rotates a 3-dimensional plot.
Pan or zoom – stretches or zooms the graph in the X-, Y-, or Z-direction.

Explore – dynamically explores response surface and contour plots.

Identify – displays a label identifying a point when clicked on with the mouse.

Locate by name – highlights in red any points with values equal to that entered in the Locate field (used in conjunction with the Identify button).

Locate by row – highlights in red any points corresponding to the row number entered in the Row field.

Each of these buttons is described in detail in Chapter 4.

Exclude Button

Some statistical procedures allow you to interactively remove suspected outliers from an analysis by maximizing a graph, clicking on the suspect point, and pressing this button. For example, the plot in Figure 3-13 shows one point that is well outside the prediction limits. Clicking on that point and pressing the Exclude button causes the model to be refit without the point. The fitted model plot shows the new model, indicating the point (or points) that have been removed with an X:
Figure 3-19. Fitted Model after Excluding a Suspected Outlier

All of the other tables and graphs in the analysis window will also change to reflect the new model.

Multiple points may be excluded from a model by clicking on them one at a time and pressing the Exclude button. Clicking on a point that has been removed will put it back into the model.

Help Button

Pressing this button will open a PDF file describing the selected analysis. These PDF files contain a description of all dialog boxes and options, provide formulas for important statistical calculations, and illustrate the use of the analysis with a typical example.
3.2.4 Statlets®

There are a number of special menu selections called Statlets that are somewhat different than standard analyses. Rather than creating multiple panes with various tables and graphs, they contain only a single graph. In addition, instead of using the Analysis Options and Pane Options dialog boxes, they put all options on a control bar at the top of the analysis window.

As an example, select Analyze – Regression Analysis – Curve-Fitting Statlet from the STATGRAPHICS menu. Complete the data input dialog box as shown below:

![Figure 3-20. Data Input Dialog Box for Curve-Fitting Statlet](image)

The analysis window that appears when OK is pressed is shown below:
A linear regression model has been fit to the data. Notice the extra control bar with the following options:

- **Add regression** – draws the fitted regression line.

- **Add LOWESS smooth** – adds a scatterplot smoother to the display.

- **X power** and **Y power** – fits a linear model relating a power of Y to a power of X, according to the equation $Y^p = a + b X^q$.

- **Limits** – sets the percentage for the prediction limits.

As changes are made on the dialog box, the graph updates immediately. For example, changing the power of X gives a fit with a much better R-squared:
Figure 3-22. Model Fit After Transforming X

Statlets allow you to interact with your data in interesting ways.
3.3 Transformations

As mentioned previously, much flexibility is gained by allowing users to enter algebraic and other expressions on data input dialog boxes. For example, a user wishing to fit a model involving a logarithm or square root may be so directly on a data input box without changing the data in their worksheet. For example, the same reciprocal-X model shown in the previous section could have been fit to the stability study data by fitting a linear model to chlorine versus the reciprocal of weeks. To do so, the data input dialog box would have been completed as shown below:

![Data Input Dialog Box Showing Algebraic Expression for X](image)

Any algebraic expression can be entered in the data input fields, using the following symbols:

<table>
<thead>
<tr>
<th>Operation</th>
<th>Symbol</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addition</td>
<td>+</td>
<td>weeks+8</td>
</tr>
<tr>
<td>Subtraction</td>
<td>-</td>
<td>weeks-2</td>
</tr>
<tr>
<td>Multiplication</td>
<td>*</td>
<td>weeks*10</td>
</tr>
<tr>
<td>Division</td>
<td>/</td>
<td>weeks/100</td>
</tr>
<tr>
<td>Exponentiation</td>
<td>^</td>
<td>weeks^2</td>
</tr>
</tbody>
</table>

When more than one operation is included, normal algebraic precedence rules apply (such as multiplication and division before addition and subtraction).
Expressions may also involve special operators, such as LOG, SQRT or ABS, as in the example below:

![Figure 3-25. Data Input Dialog Box Showing Use of Special Operators](image)

The following table shows the most common operators:

<table>
<thead>
<tr>
<th>Operator</th>
<th>Use</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>Absolute value</td>
<td>ABS(X)</td>
</tr>
<tr>
<td>AVG</td>
<td>Average</td>
<td>AVG(X)</td>
</tr>
<tr>
<td>DIFF</td>
<td>Backward differencing</td>
<td>DIFF(X)</td>
</tr>
<tr>
<td>EXP</td>
<td>Exponential function</td>
<td>EXP(10)</td>
</tr>
<tr>
<td>LAG</td>
<td>Lag by k periods</td>
<td>LAG(X,1)</td>
</tr>
<tr>
<td>LOG</td>
<td>Natural logarithm</td>
<td>LOG(X)</td>
</tr>
<tr>
<td>LOG10</td>
<td>Log base 10</td>
<td>LOG10(X)</td>
</tr>
<tr>
<td>MAX</td>
<td>Maximum</td>
<td>MAX(X)</td>
</tr>
<tr>
<td>MIN</td>
<td>Minimum</td>
<td>MIN(X)</td>
</tr>
<tr>
<td>SD</td>
<td>Standard deviation</td>
<td>SD(X)</td>
</tr>
<tr>
<td>SQRT</td>
<td>Square root</td>
<td>SQRT(X)</td>
</tr>
<tr>
<td>STANDARDIZE</td>
<td>Conversion to Z-scores</td>
<td>STANDARDIZE(X)</td>
</tr>
</tbody>
</table>

![Figure 3-26. Common STATGRAPHICS Operators](image)
3.4 Subset Selections

Every data input dialog box contains an optional input field labeled \((Select:)\). If not blank, this field is used to select a subset of the rows that contain data. For example, to restrict the fit to the first 25 rows of data, enter:

![Figure 3-27. Data Input Dialog Box Using Select Field to Restrict Rows Used](image)

Operators that may be placed in the \(Select\) field are:

<table>
<thead>
<tr>
<th>Entry</th>
<th>Use</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIRST((k))</td>
<td>Selects the first (k) rows.</td>
<td>FIRST(25)</td>
</tr>
<tr>
<td>LAST((k))</td>
<td>Selects the last (k) rows.</td>
<td>LAST(25)</td>
</tr>
<tr>
<td>ROWS((\text{start},\text{end}))</td>
<td>Selects rows between (\text{start}) and (\text{end}), inclusive.</td>
<td>ROWS(11,30)</td>
</tr>
<tr>
<td>EXCLUDE((m))</td>
<td>Selects all rows except row (m).</td>
<td>EXCLUDE(7)</td>
</tr>
<tr>
<td>RANDOM((k))</td>
<td>Selects a random set of (k) rows.</td>
<td>RANDOM(25)</td>
</tr>
</tbody>
</table>

![Figure 3-28. Operators Used in Select Field to Select Subset of Data Rows](image)

Note that row numbers correspond to the location within the selected data, not the row numbers in the Excel worksheet. For example, if column names are located in row 1 of your Excel file, then a statement such as ROWS\(11,30\) will select the data in Excel rows numbered 12 through 31. You may find it convenient to add an additional column to your Excel file with observation numbers, although such a column is not required.
The *Select* field may also contain Boolean expressions to control the selection of rows, as in the dialog box shown below:

![Simple Regression](image)

*Figure 3-29. Data Input Dialog Box Using Boolean Expression in Select Field*

Valid Boolean expressions are shown in the following table:

<table>
<thead>
<tr>
<th>Entry</th>
<th>Use</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>column &lt; value</td>
<td>Selects only rows for which <em>column</em> is less than <em>value</em>.</td>
<td>weeks &lt; 30</td>
</tr>
<tr>
<td>column &lt;= value</td>
<td>Selects only rows for which <em>column</em> is less than or equal to <em>value</em>.</td>
<td>weeks &lt;= 30</td>
</tr>
<tr>
<td>column &gt; value</td>
<td>Selects only rows for which <em>column</em> is greater than <em>value</em>.</td>
<td>weeks &gt; 30</td>
</tr>
<tr>
<td>column &gt;= value</td>
<td>Selects only rows for which <em>column</em> is greater than or equal to <em>value</em>.</td>
<td>weeks &gt;= 30</td>
</tr>
<tr>
<td>column = value</td>
<td>Selects only rows for which <em>column</em> equals <em>value</em>.</td>
<td>weeks = 30</td>
</tr>
<tr>
<td>column &lt;&gt; value</td>
<td>Selects only rows for which <em>column</em> does not equal <em>value</em>.</td>
<td>weeks &lt;&gt; 30</td>
</tr>
<tr>
<td>condition1 &amp; condition2</td>
<td>Selects only rows that meet both conditions.</td>
<td>weeks &lt;= 30 &amp; chlorine &gt; 0.4</td>
</tr>
<tr>
<td>condition1</td>
<td>condition2</td>
<td>Selects only rows that meet at least one of the conditions.</td>
</tr>
</tbody>
</table>

*Figure 3-30. Common Boolean Expressions Used to Select Subset of Rows*
Boolean expressions may involve any data variable, whether part of the current analysis or not. Expressions used with numeric variables are written without quotes. Expressions used with categorical variables require double quotes, as in \textit{Color = "Red"}. 
Chapter 4

Graphics

Modifying graphs, saving graphics profiles, interacting with graphs, saving graphs in image files, and copying graphs to other applications.

The statistical procedures in STATGRAPHICS Sigma Express create hundreds of different types of graphs. To facilitate the data analysis process, default titles, scaling, and other attributes are selected whenever a new graph is created. For analysis purposes, the defaults often suffice. But when it comes time to publish the final results, creating a publication-quality graph is important.

This chapter describes everything you need to know to work with graphs in STATGRAPHICS Sigma Express. It shows you how to dress them up for publication. It shows you how to copy them to applications such as Microsoft Word and PowerPoint. It also shows you how to interact with graphs. For example, you might see an interesting point and wish to know more about it. Or you might want to spin a 3D plot around to get a sense of any relationship that might be present between the variables portrayed on the X, Y and Z axes.

As an example, we will consider again the data in the nonlin.xls file. To begin, the fitted model plot relating the amount of chlorine to the age of the product will serve to illustrate some of the important graphics operations.
4.1 Modifying Graphs

The *Simple Regression* procedure is commonly used to fit curves relating a response variable $Y$ and an explanatory variable $X$. As illustrated in the last chapter, a Reciprocal-$X$ model provides a good fit to the relationship between the *chlorine* column and the *weeks* column.

When first created, a plot of the fitted Reciprocal $X$ model is displayed as shown below:

![Plot of Fitted Model](image)

Figure 4-1. Fitted Model Plot with Default Titles and Scaling

The titles, scaling, point and line types, colors, and other graphics attributes were automatically selected.
4.1.1 Layout Options

To modify a graph once it has been created, first double-click on it so that it fills the analysis window. Then click on the Graphics Options button located on the analysis toolbar. A tabbed dialog box will be displayed, with tabs corresponding to different graphics elements.

The Layout tab of the Graphics Options dialog box is used to change some of the basic features of the graph:

![Graphics Options Dialog Box](image)

Figure 4-2. Layout Tab on Graphics Options Dialog Box

This includes the orientation of the axis tickmarks, the thickness of the axes, and the color of the graph’s background and border. For example, changing the Background color to yellow and adding 3D Effects modifies the plot as shown below:
NOTE: This color change can be seen in the help documentation provided with your software by clicking on Help – Getting Started.
4.1.2 Grid Options

The Grid tab is used to add a grid to the plot:

![Grid Tab on Graphics Options Dialog Box](image)

Adding a gray, dashed-line grid in Both directions produces the following graph:
Figure 4-5. Plot after Adding a Grid
4.1.3 Lines Options

The Lines tab is used to specify the type, color and thickness of lines on a graph:

![Graphics Options Dialog Box](image)

Figure 4-6. Lines Tab on Graphics Options Dialog Box

A plot such as that of the fitted model has three line sets: the line of best fit, the inner confidence limits, and the outer prediction limits. To change any of these types, click on radio button #1, #2 or #3 and then select the desired attributes. Increasing the thickness of the center line results in:
Figure 4-7. Plot after Modifying Thickness of Line Type #1

NOTE: You can only change the thickness of solid lines.
4.1.4 Points Options

The Points tab is used to specify the type, color and size of points on a graph:

Radio button #1 controls the attributes of the first set of points on a graph. In the current example, there is only one set. Changing the points to solid diamonds creates the following plot:
Figure 4-9. Plot after Modifying Point Type #1
4.1.5 Top Title Options

The *Top Title* tab is used to specify the text and font type for the information displayed above a graph:

![Graphics Options dialog box](image)

Figure 4-10. Top Title Tab on Graphics Options Dialog Box

Graphs have up to 2 title lines. An entry such as “{3}” in a title field indicates that the text is automatically generated by the analysis procedure, usually containing variable names or calculated statistics. You may change any title, including those that are automatically created. You may also drag the title to a new location with your mouse directly on the graph:
Fitted Reciprocal X Model for Stability Study
chlorine = 0.368053 + 1.02553/weeks

Figure 4-11. Plot after Modifying the Top Title
4.1.6 Axis Scaling Options

The *Graphics Options* dialog box also contains tabs that allow you to modify the axis titles and scaling:

![Graphics Options dialog box](image)

*Figure 4-12. X-Axis Tab on Graphics Options Dialog Box*

There are several important fields on this dialog box:

1. **Title**: title plotted along the axis.

2. **From, To, By, and Skip**: sets the tickmark scaling. The value in *Skip* is used to prevent displaying certain tickmarks if they run into each other. For example, a value of 1 in the *Skip* field would skip showing every other tickmark.

3. **No Power**: suppresses the display of large and small numbers using labels such as (X 1000).

4. **Axis Labels**: changes the orientation of the tickmark labels.
5. **Scaling**: draws the axis using two different base 10 logarithmic scales.

6. **When Data Change**: specifies whether the scaling should stay constant or change if new data are plotted.

7. **Title Font and Tickmark Font**: changes the color, size, or style of the title and tickmarks.

The output generated from the above dialog box changes is shown below:

![Fitted Reciprocal X Model for Stability Study](image)

*Figure 4-13. Plot after Modifying the Axis Titles and Scaling*
4.1.7 Fill Options

Some plots, such as histograms, contain solid areas. The *Fills* tab on the *Graphics Options* dialog box controls the color and fill type of bars, polygons, and pie slices:

![Graphics Options dialog box]

Radio button #1 controls the first fill type on a graph. In a histogram, all of the bars use the first fill type. On some graphs, such as pie charts, more than one fill type is used. In those cases, radio buttons #2 through #20 control the other fill types.

For plots such as histograms, setting a non-solid fill type is often a good idea when printing the results in black and white:
4.1.8 Text, Labels and Legends Options

For graphs containing additional legends or labels, tabs are included on the Graphics Options dialog box that allow you to change the text and fonts.
4.1.9 Adding New Text

Additional text may also be added to any graph by pressing the *Add text* button on the analysis toolbar. A dialog box will be generated in which to enter the new text:

![Text Options dialog box](image1)

*Figure 4-16. Dialog Box for Adding New Text*

The text string will be initially positioned under the top title, but may be dragged to any location with the mouse:

![Plot after Adding New Text String](image2)

*Figure 4-17. Plot after Adding New Text String*
After text is added, click on it and then press the *Graphics Option* button if changes need to be made.
4.2 Jittering a Scatterplot

When one or both of the variables in a scatterplot are discrete, the chance of points being exactly in the same location and obscuring each other can be large. The analysis toolbar has a Jitter button that overcomes this problem by randomly offsetting points in the horizontal and/or vertical direction. For example, consider the following plot of data contained in the 93cars.xls file:

![Plot of MPG City vs Cylinders](image)

Figure 4-18. Scatterplot of Miles per Gallon versus Cylinders

The plot shows the miles per gallon obtained in city driving by 93 different makes and models of automobiles, plotted versus the number of cylinders in the car’s engine. Although there are 93 rows in the worksheet, there are many less points than that on the plot. The small number of points is due to exact ties amongst the cases, which cause some points to plot exactly on top of others.

If you press the Jitter button on the analysis toolbar, a dialog box will appear allowing you to add a little jitter (random offset) to the points:
In this case, adding a small amount of horizontal jitter gives a much better picture of the location of the points:

![Figure 4-19. Jittering Dialog Box](image)

![Figure 4-20. Scatterplot after Horizontal Jitter](image)

Each point has been offset a small random amount along the horizontal axis. Jittering a plot affects only the display. It has no effect on the data in the datasheet or any calculations made with it.
4.3 Brushing a Scatterplot

An interesting method of visualizing relationships between variables is to color the points of a scatterplot according to the value of another variable. For example, consider the following Matrix Plot for selected variables from the 93cars.xls file:

![Matrix Plot for Data from the 93cars File](image)

The scatterplot in each cell of the matrix plots the values of variables corresponding to its row and column identifiers.

Suppose you wish to visualize how the horsepower of the automobiles is related to the 5 plotted variables. If you press the Brush button on the analysis toolbar, the following dialog box will be displayed:
Select a quantitative variable to use to code the points. After selecting the variable to brush with, a floating dialog box will appear:

The two slider bars are used to specify lower and upper limits for the variable. All points in the plot are colored red if they fall within the specified interval. For example, in the plot below, all automobiles with horsepower between 55.0 and 121.15 are colored red:
It is evident from the above plot that \textit{Horsepower} is strongly correlated with the other variables.
4.4 Smoothing a Scatterplot

To help visualize the relationships between the variables in a scatterplot, a smoother may be added. To smooth a scatterplot, press the *Smooth/Rotate* button on the analysis toolbar. This will display the following dialog box:

![Scatterplot Smoothing Dialog Box](image)

Figure 4-25. Scatterplot Smoothing Dialog Box

Smoothing a scatterplot is done by selecting a set of locations along the X-axis and at each location plotting a weighted average of the specified fraction of the points that are closest to that location. One of the best methods for smoothing is called LOWESS (LOcally WEighted Scatterplot Smoothing), usually with a smoothing fraction between 40% and 60%. The result of smoothing the *Matrix Plot* of the automobile data is shown below:
The smooth helps illustrate the type of relationships between the variables.
4.5 Identifying Points

To display the row number and coordinates corresponding to any point on a graph, you may hold the mouse button down on the point. A small box will be displayed in the upper right corner of the plot, showing the row number and coordinates of the point:

![Plot of MPG City vs Weight](image)

Figure 4-27. Displaying Information about a Selected Point

At the same time, the row number of the point will be placed into the Row field on the analysis toolbar:

![Analysis Toolbar Showing Row Number of Selected Point](image)

Figure 4-28. Analysis Toolbar Showing Row Number of Selected Point

Additional information about the point may be obtained by pressing the Identify button and selecting a column from the Excel worksheet:
In the Point Labels field, select an option for which labels will be displayed. If you select **Click point to label** and press **OK**, clicking on any point will add the value of that variable to the Label field on the analysis toolbar:

![Figure 4-30. Analysis Toolbar Showing Make of Selected Point](image)

The binoculars buttons to the right of the Label and Row fields may be used to locate points on a graph. If you enter a value into either edit field and then press the corresponding Locate button, all points in the graph matching the entered value will be highlighted. For example, the plot below colors the points for all Hondas red:
Figure 4-31. Plot Highlighting All Hondas

This technique is also quite effective on a Matrix Plot. In the following display, all points corresponding to row #42 have been highlighted:
Locating a point in a *Matrix Plot* can help identify whether it is an outlier with respect to more than one variable. The color used to highlight the points is specified on the *Graphics* tab of the *System Preferences* dialog box, accessible from the *Tools* menu.

**Figure 4-32. Matrix Plot Highlighting Row #42**

<table>
<thead>
<tr>
<th>MPG City</th>
<th>MPG Highway</th>
<th>Length</th>
<th>Width</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Plot" /></td>
<td><img src="image2.png" alt="Plot" /></td>
<td><img src="image3.png" alt="Plot" /></td>
<td><img src="image4.png" alt="Plot" /></td>
<td><img src="image5.png" alt="Plot" /></td>
</tr>
</tbody>
</table>
4.6 Copying Graphs to Other Applications

Once a graph has been created in STATGRAPHICS Sigma Express, it can be easily copied to other programs such as Microsoft Excel, Word or PowerPoint by:

1. Maximizing the pane containing the graph.

2. Clicking on the graph with the right mouse button and selecting Copy from the popup menu.

3. Selecting Paste while in the other application.

By default, graphs are pasted in “Picture” format, which corresponds to a Windows metafile. In rare cases when you wish to paste the graph in some other format, you can select Paste Special instead of a simple Paste.

To copy both the graph and its enclosing window, a third-party screen capture tool is recommended. In producing this manual, a program called SnagIt has been used, which is available for purchase at www.techsmith.com. If you use SnagIt, we recommend that you set the Input option to “Window” and the Output option to “Clipboard”. You can then paste images directly into any document.

4.7 Saving Graphs in Image Files

Individual graphs may also be saved in image files by maximizing a graph and then selecting Save Graph from the right-mouse-button popup menu. A dialog box will be displayed on which to specify a file name and image format:
For saving graphs that are to be read into Word or PowerPoint, saving the graph as a Windows metafile gives the most flexibility. If the graph is to be displayed on a web page, saving it as a JPEG file is recommended.
System Preferences

Setting preferences for system behavior.

STATGRAPHICS Sigma Express contains many options, each of which has a default value that has been selected to meet most users’ needs. If desired, you can set new defaults for many of these options. There are 2 main places in the program to do this:

1. **General system behavior**: set by System Preferences, accessible from the Tools menu.

2. **Graphs**: set by selecting Graphics Options while viewing any graph. The Profile tab of the Graphics Options dialog box allows you to save multiple sets of graphics attributes.

5.1 General System Behavior

The default values for general system behavior and selected statistical procedures may be changed by selecting System Preferences from the Tools menu. This displays a tabbed dialog box with a General tab for overall system behavior and other tabs for statistical analysis defaults:
Some of the most important options that may be set are:

- **Confidence Level**: default percentage used for confidence limits, prediction limits, hypothesis tests, and interpretation of $P$-values by the StatAdvisor.

- **Significant Digits**: number of significant digits used when displaying numerical results. The indicated number of digits will be displayed, except for trailing zeroes that will be dropped. A separate entry is provided for saving numerical results back to the Excel worksheet.

- **System Options**: options that apply system-wide.
  
  - **Sort Variable Names**: whether to list column names in alphabetic order on data input dialog boxes. Otherwise, column names will be listed in the same order as in the worksheet.
o **4-Digit Years**: whether dates should be displayed with 4-digit years rather than 2-digit years. By default, 2-digit years such as 2/1/05 are assumed to represent dates between the years 1950-2049.

- **StatAdvisor**: sets the behavior of the StatAdvisor.
  
  o **Add to Text Panes**: whether StatAdvisor output should be added to the bottom of text panes.
  
  o **Highlight References in …**: whether to highlight in a special color values on text panes that are referred to by the StatAdvisor.

- **Analysis Headers**: whether to use a blue font to display the analysis title at the top of the *Analysis Summary* pane.

For a description of the options on the other tabs, refer to the PDF document titled *System Preferences*.

### 5.2 Graphics

Maximizing a pane containing a graph within any analysis window activates the *Graphics Options* button on the analysis toolbar. That button displays a tabbed dialog box that allows you to change the appearance of a graph, as described in detail in Chapter 4. Also included on that dialog box is a tab labeled *Profile*, which enables you to save sets of graphics attributes in user profiles and change the default profile that is used when a new graph is created:
To change the system defaults:

1. Modify the features of a graph in any analysis window. Set the colors, fonts, and other options that you want future graphs to reflect.

2. Select *Graphics Options* from the analysis toolbar and go to the *Profile* tab.

3. Check *Make Default*.

4. Select any of the 12 user profiles and press the *Save as* button (the system profiles are read-only).

5. Enter a name for the profile to be saved:
6. Press OK to save the current set of graphics attributes (colors, fonts, point and line styles, etc.) in a new profile. The next graph created will use the newly saved profile.

You can also apply other saved profiles to a new graph by creating the graph with default settings and then:

1. Select Graphics Options from the analysis toolbar and go to the Profile tab.

2. Select any of the 15 profiles and press the Load button.

The current graph will be immediately updated to reflect the settings in the selected profile.

You can also use the System Profile Designer on the Tools menu to help set all graphics attributes at one time. It displays sample 2D and 3D plots containing all attributes used throughout the program:
Use *Graphics Options* to change all settings and then save a new graphics profile.
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