

Graphing Charts in Microsoft Excel

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Preface

All of the lecture notes and supplementary sample data files are located at <http://biostat.mc.vanderbilt.edu/TheresaScott> under *Current Teaching Material*.

If you have any questions, feel free to contact me at theresa.scott@vanderbilt.edu or (615) 343-1713, or drop by my office D-2217 MCN.

References for this lecture

The following references were used to compile this lecture:

- Websites:
 - The Excel 2003 Module information available from Carnegie Mellon University's Computer Skills Workshop Class (www.cmu.edu/computing/csw).
 - The BayCon Group Microsoft Excel Online Tutorial (www.baycongroup.com/e10.htm).
 - The Florida Gulf Coast University Excel 2000 Tutorial (www.fgcu.edu/support/office2000/excel).
- Books:
 - *Excel Charts* by John Walkenbach (Wiley Publishing, Inc.; 2003).
 - *Creating More Effective Graphs* by Naomi B. Robbins (Wiley-Interscience; 2005).

Section 1

Introduction

In addition to everything we've learned so far, Excel also allows you to present your data visually, in the form of a *chart* (also known as a *graph*).

Displaying data in a well-conceived chart can make your data more understandable.

- Useful for summarizing a series of numbers and their interrelationships.
- Often helps you spot trends and patterns that might otherwise go unnoticed.

Another advantage is that, just like formulas and functions, charts are *dynamic*.

- A chart is linked to the data in your worksheet.
- If the data changes, the chart is automatically updated to reflect those changes.

Before you can create a chart, you must have some *data*.

- Stored in the cells of a worksheet.
- Can be stored in any number of worksheets, and the worksheets can even be in different workbooks.

A chart is essentially an 'object' that Excel creates upon request.

- Consists of one or more *data series*.
- The data for each series is stored in a separate row or column.
- Appearance of the data series depends on the selected *chart type*.
- **EXAMPLE:** A line chart that uses two data series – see the **Example Chart – Line 2 Series** worksheet of the **ExampleCharts.AND.PracticeExercises.xls** workbook.
 - Chart contains two lines, each representing one data series.
 - Each point on the line is determined by the value in a single cell, and is represented by a marker.
 - Can distinguish each of the lines by its thickness, line style, color, or data markers.

Be aware: Although Excel can produce some great charts, it certainly doesn't generate the best-looking charts possible.

- You'll eventually encounter some limitations with Excel's charting features.
- Other software products can generate higher-quality charts and provide a great deal more flexibility.

1.1 Is a Chart Really Necessary?

Before you create a chart, you might ask yourself a simple question: *Is a chart really necessary?*

- Depending on your audience, a chart may not always be the *best* way to present your information.

Before you assume that a chart is required, consider the alternatives and then make a decision.

- For simple data, a nicely formatted table may be a better option.
 - Does the data benefit by being viewed in the form of a chart?
- Creating too many charts may simply overwhelm the audience.
 - Viewing an endless series of charts that don't have a compelling message may disrupt the viewers' attention and cause them to overlook the charts that *do* have a message.

Section 2

Creating a Chart Using the Chart Wizard

The most common – and the most flexible – way to create a chart is to use the Chart Wizard.

The Chart Wizard consists of four sequential dialog boxes that prompt you for various settings of the chart. By the time you reach the last dialog box, the chart is usually fairly close to what is needed.

To use the Chart Wizard:

1. Select the data you want to chart (optional).
2. Start the Chart Wizard by choosing Chart from the Insert drop-menu, or by clicking the Chart Wizard icon on the Standard toolbar.
3. Specify the various options in Step 1 through Step 4 of the Chart Wizard.
 - Step 1 – Chart Type.
 - Step 2 – Chart Source Data.
 - Step 3 – Chart Options.
 - Step 4 – Chart Location.
4. Click Finish to create the chart.

While using the Chart Wizard, you can go back to the preceding step by clicking the Back button. Or, you can click Finish to close the Chart Wizard.

- If you close the Chart Wizard early, Excel creates the chart using the information that you provided up to that point.

IMPORTANT: Don't be too concerned about creating the perfect chart. You can always change, at any time, any choice that you made in the Chart Wizard after the chart is created.

2.1 Selecting the data

Before you start the Chart Wizard, you can select the data that you want to include in the chart.

- The selection should include items such as labels and series identifiers (row and column headings).
- Preselecting the chart data isn't necessary but makes creating the chart easier.

- If you don't select the data before invoking the Chart Wizard, you can select it in the second Chart Wizard dialog box (i.e., Step 2 – Chart Source Data).

NOTE: The data that you use in a chart does not have to be contiguous (i.e. adjacent).¹

- Use the Ctrl key to make multiple selections.
- The initial data must be on a single worksheet.
- If you need to plot data that exists on more than one worksheet, you can add more *series* after the chart is created (or use the Series tab in Step 2 – Chart Source Data).
 - In all cases, however, the data for a single chart series must reside on one sheet.

After you select the data, start the Chart Wizard, either by clicking the Chart Wizard button icon on the Standard toolbar or by selecting Chart from the Insert drop-menu.

2.2 Step 1 – Chart Type

In the first Chart Wizard dialog box, Step 1 – Chart Type, you select the chart type and subtype if necessary.

- The chart types are organized into two tabs: Standard Types and Custom Types.
- The Standard Types tab displays the 14 basic chart types and the subtypes for each.
 - Select the chart type from the Chart type list box and then click the appropriate icon for the subtype from the Chart sub-type icon box.
 - A brief description of the chart sub-type is given when the sub-type is chosen.
 - Click the Press and Hold to View Sample button and keep the mouse button pressed to preview your data with the selected chart type and sub-type.
- The Custom Types tab displays some customized charts (including user-defined custom charts).
 - Select the chart type from the Chart type list box.
 - The dialog box automatically shows a preview of your data with the selected chart type in the Sample: box.

When you decide on a chart type and subtype, click the Next button to move to the next step.

2.2.1 Standard Chart Types

As mentioned, there are 14 basic chart types you can choose from in the Standard Types tab in the Step 1 – Chart Type dialog box:

- Column.
 - One of the most common chart types.
 - Often used to compare discrete items.
 - Displays each data point as a vertical column, the height of which corresponds to the value.
 - The value axis (i.e., continuous axis) is displayed in the vertical axis, which is usually on the left side of the chart.

¹See the 'Charting a Noncontiguous Range' section of **Chapter 3: Working with Chart Series** of *Excel Charts* by John Walkenbach for more details.

- Can specify any number of data series, and the corresponding data points from each series can be stacked on top of each other.
 - * Can depict the differences between items in a series or items across multiple series.
 - * Typically, each data series is depicted in a different color or pattern.
- Bar.
 - Essentially a column chart that has been rotated 90 degrees clockwise.
 - *Advantage:* the category labels may be easier to read.
 - Like a column chart, can include any number of data series, and the bars can be 'stacked' from left to right.
- Line.
 - Often used to plot continuous data and are useful for identifying trends.
 - Normally, the category axis displays equal intervals.
 - Can use any number of data series; the lines are distinguished using different colors, line styles, or markers.
- Pie.
 - Useful when you want to show relative proportions or contributions to a whole.
 - Can use *only* one data series.
 - Most effective with a small number of data points – usually no more than five or six data points (or slices).
 - Values used must all be positive numbers.
 - * Any negative values used will be converted to positive values, which is probably not what you intended.
- XY (Scatter).
 - Another common chart type.
 - Also known as *scattergrams* or *scatter plots*.
 - Differs from most other chart types in that both axes display values – there is no category axis.
 - Often used to show the relationship between two (continuous) variables.
- Area.
 - A line chart in which the area below the line has been colored in.
 - Can be stacked.
- Doughnut.
 - Similar to a pie chart, with two exceptions: it has a hole in the middle and it can display more than one series of data.
 - Does not provide a direct way to identify the series.
 - Displays the data as concentric rings.
 - Should be used sparingly.
 - * Difficult to interpret when used to chart more than one series: the relatively larger sizes of the slices towards the outer part of the doughnut can be deceiving.
 - * Use a column chart instead.
 - * *Best use:* plot a single series as a visual alternative to a pie chart.

- Radar.
 - Has a separate axis for each category, and the axes extend outward from the center of the chart.
 - The value of each data point is plotted on the corresponding axis.
- Surface.
 - Displays two or more data series on a surface.
 - Unlike other charts, Excel uses color to distinguish values, not to distinguish the data series.
 - *Does not* plot 3-D data points.
 - * The series axis for a surface chart, as with all other 3-D charts, is a category axis – not a value axis.
 - * If you have data that is represented by x , y , and z coordinates, it cannot be plotted accurately on a surface plot unless the x and y values are equally spaced.
- Bubble.
 - A XY chart that can display an additional data series, which is represented by the size of the bubbles.
 - As with an XY chart, both axes are values axes – there is no category axis.
- Stock.
 - Most useful for displaying stock market information.
 - Requires three to five data series, depending on the subtype.
 - Not limited to financial data; can be used for a variety of other purposes (e.g., daily temperature).
- Cylinder, Cone, and Pyramid.
 - Essentially the same, except for the shapes that are used.

2.2.2 Custom Chart Types

Excel's *custom* chart types, sometimes known as *user-defined* chart types, are actually standard charts that have been customized in various ways. They are provided as a quick way to generate a customized chart.

NOTE: Several of the custom chart types are *combination charts*.

- Combines two different chart types, such as a column chart and a line chart.
- Each series is assigned to its own chart type.
- Requires that the chart types use the same category axis, but they may have different value axes.
- 3-D charts cannot be combined with another chart type.

The following table lists the custom chart types, including a brief description of how each type has been customized:

Chart Type	How it Has Been Customized
Area Blocks	A rotated 3-D area chart, with two of the axes removed.
B&W Area	An area chart that uses black and white patterns rather than color.
B&W Column	A 3-D clustered column chart (with a data table) that uses black and white patterns rather than color.
B&W Line – Timescale	An area chart that uses black and white gradient fill rather than color.

Chart Type	How it Has Been Customized
B&W Pie	A pie chart that uses black and white patterns rather than color.
Blue Pie	A pie chart with all slices exploded, data labels, and a gradient background.
Colored Lines	A line chart with brightly colored lines and gridlines on a black background.
Column – Area	A combination chart that combines a column chart and an area chart.
Columns with Depth	A 3-D column chart with added depth to the columns.
Cones	A cone chart, rotated so that it is viewed from above.
Floating Bars	A bar chart in which one series has been made invisible.
Line – Column	A combination chart that combines a line chart and a column chart.
Line – Column on 2 Axes	A combination chart that combines a line chart and a column chart and uses two values axes.
Lines on 2 Axes	A line chart that uses two value axes.
Logarithmic	A line chart that uses a logarithmic scale on the value axis.
Outdoor Bars	A bar chart with fill patterns that resemble wood, with a green background.
Pie Explosion	A 3-D pie chart with all slices exploded, on a dark background.
Smooth Lines	A line chart with smoothed lines.
Stack of Colors	A stacked-column chart, with a line connecting the top of each column.
Tubes	A stacked-bar chart with gradient fill to simulate cylindrical bars.

You can also create your own custom chart type:

1. Create a chart.
2. Format and customize the chart.
3. Add the chart to the *custom chart type gallery*:
 - (a) Select the created and customized chart.
 - (b) Choose Chart Type from the Chart drop-menu to display the Chart Type dialog box.
 - (c) Select the Custom Types tab.
 - (d) Choose the User-Defined option.
 - (e) Click the Add button, which will open the Add Custom Chart Type dialog box.
 - (f) Enter a name and (optionally) a description for the custom chart type.
 - (g) Click OK and you'll see your new custom chart type listed in the Chart type list box.
 - (h) Click OK again to close the Chart Type dialog box.
4. Test and refine – test the custom chart type with a different data series.
 - If the chart doesn't look right you may need to make some additional changes to it.
 - After doing so, you will need to go through the previous steps to add the chart to the custom gallery.
 - If you use the same name, Excel will ask whether you want to replace the existing user-defined format – answer in the affirmative.

2.2.3 Choosing a Chart Type

A chart is usually created to make a point or to communicate a specific *message*.

- Often, the message is explicitly stated in the chart's title or in a text box within the chart.
- The chart itself provides visual support.

In almost every case, the underlying message in a chart is some type of *comparison*. Examples of some general types of comparisons include:

Comparison	Example
Compare item to other items.	Compare sales in each of a company's sales regions.
Compare data over time.	Display sales by month and indicate trends over time.
Make relative comparisons.	Depicts relative values in term of pie 'slices'.
Compare data relationships.	Show the relationship between marketing expenditures and sales.
Frequency comparison.	Display the number (or percentage) of students who scored within a particular range.
Identify 'outliers' or unusual situations.	Creating a chart may help identify data that is not representative, especially if you have large number of data points.

Choosing the correct chart type is a key factor in making the message compelling.

- Well worth your time to experiment with various chart types to determine which is most effective.

So, how do you know which chart type to use for your data?

- No cut-and-dry answer to this question.
- Perhaps the best answer is a vague one: *Use the chart type that gets your message across in the simplest way.*

Fortunately, changing a chart's type is a very easy procedure, so you can experiment with various chart types until you find the one that represents your data accurately and clearly – and as simply as possible.

2.2.4 3-D or Not 3-D?

Some of Excel's charts, particularly chart sub-types, are referred to as *3-D charts*. This terminology can be a bit confusing, because some of these so-called 3-D charts aren't technically 3-D charts. Rather, they are *2-D charts with a perspective* look to them; that is, they appear to have some depth.

A true 3-D chart has three axes:

1. a value axis (the height dimension);
 2. a category axis (the width dimension);
 3. and a series axis (the depth dimension).
- The series axis is always a category axis – it cannot depict scaled numerical values.

Generally speaking, a 3-D chart is best used when the goal is to show general trends rather than precise comparisons.

2.3 Step 2 – Chart Source Data

In the second dialog box of the Chart Wizard, Step 2 – Chart Source Data, you specify the data on which the chart will be created.

- Contains two tabs: Data Range and Series.

As mentioned, you can select the data prior to starting the Chart Wizard or you can select the data for the first time during this step.

Once you've specified the correct data to be used, click the Next button to advance to the next dialog box.

2.3.1 Data Range

The Data Range field displays

- the range address of the cells that were selected before you started the Chart Wizard;
- the range address that is Excel's best guess regarding the range to be plotted, if you selected only a single cell before you started the Chart Wizard;
- *OR* no range address if you did not select any cells before you started the Chart Wizard.

If the data range is not correct, you can change it by deleting the address given in the Data range field and then selecting the correct range by clicking-and-dragging in the worksheet.

Specifying the source data using the Data Range tab is easiest when the data is formatted in a similar fashion to the following table:

	Eastern TN	Middle TN	Western TN
January	1250	1500	1100
February	1400	1275	2000
March	1000	1750	1550

When specifying the range address in the Data Range field, you want to include items such as labels and series identifiers (row and column headings; i.e., Eastern TN).

The Data Range tab also allows you to specify the *orientation of the data* – is the data for each series in a single row or a single column.

- Click the Rows or Columns option button next to Series in to specify the orientation of your data is by rows, or by columns, respectively.
- By default Excel always defaults to a chart that has more categories than series.
 - If the data rows outnumber the data columns, then each series is assumed to occupy a column.
 - If the data columns outnumber the data rows, then each series is assumed to occupy a row.

Your choice of orientation will determine how many series the chart has, and it will affect the appearance and (possibly) the legibility of your chart.

→ *Practice Exercise:* Using the Personal Budget data in the Practice Exercise 1 – Range worksheet of the ExampleCharts.AND.PracticeExercises.xls workbook:

1. Select the individual cost data across all six months – the cell range A5:G11.

2. Start the Chart Wizard.
3. Choose a Column chart in Step 1 – Chart Type.
4. In the Data Range tab of Step 2 – Chart Source Data, preview the column chart in both orientations – by rows and by columns.
 - Select Rows and then Columns for the Series in option.

2.3.2 Series

The Series tab allows you to specify each series of data explicitly.

- Remove any incorrect series by selecting them in the Series list box and clicking Remove.
- Add any necessary series by specifying a cell address or text for the series name in the Name field, selecting the range address in the Values field, and then clicking Add.
- Add a category axis label by specifying a cell address or text in the Category (X) axis labels field.

Using the Series tab often gives you more freedom when specifying the source data to be used in the chart.

Useful when the data is formatted in a similar fashion to the following table:

Month	Region	Sales
January	Eastern TN	1250
February	Eastern TN	1400
March	Eastern TN	1000
January	Middle TN	1500
February	Middle TN	1275
March	Middle TN	1750
January	Western TN	1100
February	Western TN	2000
March	Western TN	1550

→ *Practice Exercise:* Using the Heart Rate data in the Practice Exercise 2 – Series worksheet of the ExampleCharts.AND.PracticeExercises.xls workbook:

1. Do not select any cell range before starting the Chart Wizard.
2. Choose a XY (Scatter) chart in Step 1 – Chart Type of the Chart Wizard.
3. In the Series tab of Step 2 – Chart Source Data, add a series for each treatment (tx; drug and placebo) specifying the baseline heart rate (basehr) for the X values and heart rate at 30 minutes (hr30) for the Y values.
 - For the drug series, type Drug in the Name field, select the range F4:F12 for the X values, select the range G4:12 for the Y values, and click Add.
 - For the placebo series, type Placebo in the Name field, select the range F13:F21 for the X values, select the range G13:21 for the Y values, and click Add.

2.4 Step 3 – Chart Options

In the third Chart Wizard dialog box, you specify most of the *options* for the chart. This dialog box has six tabs:

1. **Titles:** Add titles to the chart; must enter the text, not a cell address.
2. **Axes:** Turn on or off axes display and specify the type of axes.
3. **Gridlines:** Specify gridlines, if any.
4. **Legend:** Specify whether to include a legend and where to place it.
5. **Data Labels:** Specify whether to show data labels and what type of labels.
6. **Data Table:** Specify whether to display a table of the data.

NOTE: The options available in Step 3 – Chart Options of the Chart Wizard depend on the type of chart that you selected in Step 1 – Chart Type.

When you make changes, the changes are reflected in the preview chart.

After you select the chart options, click Next to move to the final dialog box.

2.5 Step 4 – Chart Location

The fourth, and final, step of the Chart Wizard, is to specify the *location* of the chart.

- Select **As New Sheet** to create the chart as a *chart sheet*.
 - The chart occupies the entire sheet.
 - Better choice if you plan to print a chart on a page by itself.
 - If you have many charts to create, you may want to create each one on a separate chart sheet to avoid cluttering your worksheet.
 - Makes locating a particular chart easier because you can change the name of the chart sheet's tab to provide a description of the chart that it contains.
 - Displayed in *WYSIWYG* mode ('*What you see is what you get*') – the printed chart looks just like the image on the chart sheet.
- Select **As Object In** to create an *embedded chart*.
 - Basically floats on top of a worksheet.
 - Enables you to print the chart next to the data that it uses.
 - Can be moved and re-sized.

Once you select the location and click Finish, Excel creates and displays the chart.

Section 3

Modifying an Existing Chart

After you've created a chart, you can modify it in many ways.

Before you can customize an existing chart, you must activate it.

- To activate a chart on a chart sheet, click its sheet tab.
- To activate an embedded chart, click anywhere within the chart.
 - Doing so not only activates the chart, but also selects the chart element that you clicked.
 - To *deactivate* an embedded chart, just click anywhere in the worksheet outside of the embedded chart.

TIP: In some cases, you may prefer to work with an embedded chart in a separate window.

- *EXAMPLE:* If the embedded chart is larger than the workbook window.
- **To display an embedded chart in a window**, right-click the chart's Chart Area (the area near the border) and select Chart Window from the shortcut menu.
 - Creates a temporary floating window, which can be moved and resized.
 - To close this temporary window, click the 'X' in the chart window's title bar (or just click anywhere in the worksheet).

NOTE: Excel's menus change when a chart is activated.

- The Chart menu replaces the Data menu, and other menus include commands that are appropriate for working with charts.

3.1 The Chart Toolbar

The *Chart toolbar* is a context-sensitive toolbar that appears when you click an embedded chart, activate a chart sheet, or choose Chart from Toolbars from the View drop-menu.

The toolbar includes nine tools (from left to right), which you can use to make common chart changes:

- Chart Objects:
 - When an embedded chart is activated, displays the name of the selected chart element.
 - Also, allows you to directly select a particular chart element by using the drop-down list.

- **Format Selected Object:**
 - When clicked, displays the **Format** dialog box for the selected chart element, which can be used to make various formatting modifications.
- **Chart Type:**
 - Expands to display 18 chart types when you click the arrow.
 - Can be used to select a different type of chart.
 - After it's expanded, you can drag this tool to a new location – creating, in effect, a miniature floating toolbar.
- **Legend:**
 - Toggles (i.e., shows or hides) the legend display in the active chart.
- **Data Table:**
 - Toggles (i.e., shows or hides) the display of the data table in the active chart.
- **By Row:**
 - Plots the data by rows.
- **By Column:**
 - Plots the data by columns.
- **Angle Clockwise:**
 - Displays the selected text at a -45-degree angle.
- **Angle Counterclockwise:**
 - Displays the selected text at a +45-degree angle.

In addition, several tools on the other toolbars work with charts, including the **Fill Color**, **Font Color**, **Bold**, **Italic**, and **Font** tools.

Excel includes several other chart-related tools that aren't on the **Chart** toolbar. You can customize the toolbar to include these additional tools. **To customize your Chart toolbar:**

1. Make sure the **Chart** toolbar is displayed.
2. Choose **Customize** from **Toolbars** from the **View** drop-menu to display the **Customize** dialog box.
3. Select the **Commands** tab.
4. Choose **Charting** from the **Categories** list box.
5. Click an item in the **Commands** list and drag it to your **Chart** toolbar.
6. Repeat Step 5 for other commands that you'd like to add.

3.2 Changing the Chart Type

To change the chart type of the active chart, use either of the following methods after you activate the chart:

- Click the drop-down arrow next to the Chart Type button on the Chart toolbar.
- Choose the Chart Type from the Chart drop-menu.
- Right-click the chart and choose Chart Type from the shortcut menu.

After selecting the new chart type, the selected chart will be changed to the type you selected.

NOTE: If you've customized some aspects of your chart, choosing a new chart type from the Custom Types tab may override some or all of the changes you've made.

- *EXAMPLE:* If you've added gridlines to the chart and then select a custom chart type that doesn't use gridlines, your gridlines disappear.
- Good idea to make sure that you're satisfied with the chart before you make too many custom changes to it.

→ *Practice Exercise:* Using the Median House Prices data in the Example Chart – Line 2 Series worksheet of the ExampleCharts.AND.PracticeExercises.xls workbook:

- Change the chart type from a Line chart to a Column chart using any of the mentioned methods.

3.3 Changing the Chart Source Data

There are many ways to change the chart source data, but one of the easiest ways is to use the Source Data dialog box to change the series data.

- Activate the chart, and choose Source Data from the Chart drop-menu.
- As we saw in Step 2 – Chart Source Data of the Chart Wizard, the Source Data dialog box has two tabs: Data Range and Series.
- Use Add and Remove buttons in the Series tab to add a new series, or to delete an existing series, respectively.
- You can also modify the range addresses and series names in the Source Data dialog box – select the desired series from the Series list box first.

Because of time and space, only a few subsections are given regarding changing the chart source data. **Chapter 3: Working with Chart Series** of *Excel Charts* by John Walkenbach contains details of many more chart series tasks, including:

- charting a noncontiguous range;
- using series on different sheets;
- controlling a data series by hiding data;
- *AND* using combination charts – creating combination charts and working with multiple axes.

3.3.1 Adjusting the Series Plot Order

It is important to know that every chart series has a plot order parameter.

- When you access the **Series** tab in the **Source Data** dialog box, the **Series** list box displays the chart series in the order in which they are plotted.

To change the series plot order:

- Select any of the series in the chart (i.e., from the **Chart Objects** list in the **Chart** toolbar).
- Open the **Format Data Series** dialog box from the **Format** drop-menu or by clicking the **Format Selected Object** button on the **Chart** toolbar.
- In the the **Format Data Series** dialog box, select a series in the list box.
- Use the **Move Up** and **Move Down** buttons to adjust the position of the selected series.

3.3.2 Handling Missing Data

Sometimes, the data you use in a chart may contain missing data. Excel offers several ways to handle the missing data. You can

- Ignore the missing data – plotted data series will have a gap;
- Treat the missing data as zero values;
- *OR* Interpolate the missing data (for line and XY charts only).

To specify how to handle the missing data:

1. Activate the chart.
2. Choose **Options** from the **Tools** drop-menu.
3. In the **Options** dialog box, click the **Chart** tab.
4. Choose the appropriate option.

NOTE: It's important to understand that these settings are applicable only for the line charts, XY charts, and radar charts. For all other chart types, missing data is simply not plotted.

→ *Practice Exercise:* Using the **Median House Prices** data in the **Example Chart – Line 2 Series** worksheet of the **ExampleCharts.AND.PracticeExercises.xls** workbook:

- Change the chart type back to a **Line** chart.
- Delete some of the median house price values in both columns.
- Apply all three methods of handling missing data separately, and determine the difference in the resulting charts.

3.4 Changing the Chart Options

Customizing a chart involves changing the appearance of its elements, as well as possibly adding new elements to it. These changes can be purely cosmetic (such as changing colors or modifying line widths) or quite substantial (such as changing the axis scales or rotating a 3-D chart).

Just as in modifying a whole chart, to modify a particular *chart element* you must first select it:

- Selecting the chart element with the mouse by clicking it.
 - Some chart elements (such as a chart series, a legend, and data labels) consist of multiple items – to select a particular data point, you need to click twice.
 - May find that some chart elements are difficult to select with the mouse – may take several clicks before the desired element is actually selected.
- Selecting the chart element with the Chart toolbar.
 - As mentioned, the Chart Object drop-down list box on the Chart toolbar lets you select a particular element from the active chart.
 - Only lists the 'top level' elements in the chart.
 - * *EXAMPLE:* To select an individual data point within a series, select the series from the drop-down list box and then use the mouse to select the desired data point.

You can select only one chart element at a time.

- *EXAMPLE:* If you want to change the font for two axis labels, you must work on each label separately.
- *Exceptions:* Elements that consist of multiple parts, such as gridlines – selecting one selects them all.

Once a chart element is selected, you can access the element's **Format** dialog box to format or set options for that element in one of several ways:

- Select the *Selected Element Name* command from the **Format** menu – the **Format** menu displays the actual name of the selected part (i.e., if the value axis is selected, the command is **Selected Axis**).
- Double-click the desired chart element.
- Select the chart element and use the **Ctrl+1** keyboard shortcut.
- Right-click the chart element and choose **Format** from the shortcut menu.

Some of the elements within a chart can be moved. The movable chart elements include the titles, the legend, and the data labels. **To move a chart element**, simply click it to select it; then drag it to the desired location in the chart. **To delete a chart element**, select it and then press the **Delete** key.

Chapter 4: Formatting and Customizing Charts of *Excel Charts* by John Walkenbach contains more details regarding changing the various chart options, including:

- adjusting borders and area (i.e., general appearances);
- formatting chart background elements, and 3-D charts;
- *AND* working with chart titles, a chart's legend, chart axes, gridlines, data labels, and a chart data table.

3.5 Changing the Chart Location

If you created a chart on a chart sheet, you can easily convert it to an embedded chart.

- Activate the chart, and choose **Location** from the **Chart** drop-menu and then select the worksheet that holds the embedded chart from the **As Object In** drop-down box.
- Excel deletes the chart sheet and moves the chart to the sheet that you specify.

This operation also works in the opposite direction: You can select an embedded chart and relocate it to a new chart sheet.

A chart sheet can also contain one or more embedded charts.

- Use the **Location** command from the **Chart** drop-menu to move embedded charts to an existing chart sheet.
- The second drop-down box in the **Chart Location** dialog box includes chart sheets as well as worksheets.

3.6 Other Modifications

Because of time and space, only a few other modifications are mentioned in this lecture. **Chapter 8: Charting Techniques and Tricks** of *Excel Charts* by John Walkenbach contains details of many more modifications that you can use, including:

- adding lines and backgrounds to a chart;
- column and bar chart variations;
- XY chart variations;
- mathematics and statistics applications;
- *AND* creating 'impossible' charts by stacking.

3.6.1 Moving, Resizing, Copying, and Deleting a chart

To move an embedded chart: Click the chart's border and then drag the border to move the chart.

- Useful to use the *page break preview* to move the chart to a desired location – select **Page Break Preview** from the **View** drop-menu (select **Normal** from the **View** drop-menu to return to the normal view).

To resize an embedded chart: Drag any of the eight 'handles' to resize the chart – the handles are the black squares that appear on the chart's corners and edges when you click the chart's border.

- Handles on the corners will resize the chart proportionally, while handles along the lines will stretch the chart.

To resize a chart in a chart sheet: You can also size the chart in a chart sheet according to the window size by using the **Sized with Window** command from the **View** drop-menu.

- When enabled, the chart adjusts itself when you resize the workbook window (it always fits perfectly in the window).
- In this mode, the chart that you're working on may or may not correspond to how it looks when printed.

To make an exact copy of an embedded chart, press and hold down the Ctrl key. Click the chart and then drag the mouse pointer to a new location. **To make a copy of a chart sheet**, use the same procedure but drag the chart sheet's tab.

To delete an embedded chart, press the Ctrl key and click the chart (this selects the chart as an object). Then press the Delete key. **To delete a chart sheet**, right-click its sheet tab and choose Delete from the shortcut menu.

3.6.2 Working with Trendlines

A *trendline* is an additional line added to a chart that depicts general trends in your data.

- 'Best fit' line for the data series – the line such that the differences between each data point and the corresponding value on the trendline is minimized.

A trendline can be added to any of the following chart types:

- XY chart.
- Area chart.
- Bar chart.
- Column chart.
- Line chart.
- Stock market chart.
- Bubble chart.

You *cannot* add a trendline to any type of 3-D chart, stacked chart, radar chart, pie chart, or doughnut chart.

If you add a trendline and then change the chart type, or data series to a nonsupported type, the trendline is deleted.

The type of data used in a chart determines whether the chart is appropriate for a trendline. Generally, charts that are suited for a trendline fall into two categories:

- Paired numeric data, as is typically plotted in an XY chart – both axes are value axes.
- Time-based data, often plotted in XY charts, line charts, column charts, and area charts.
 - Trendlines assume that the category axis contains equal-interval values (i.e., a time-based category axis) – there should be no gaps in the data, and the data should be appropriate.

A trendline is always associated with a particular data series. **To add a trendline to a chart series:**

1. Select the desired data series (i.e., from the Chart Objects list in the Chart toolbar).
2. Select Add Trendline from the Chart drop-menu or right-click the desired series and choose Add Trendline from the shortcut menu.
3. In the Type tab in the Add Trendline dialog box, choose the trendline type from the Trend/Regression type choices, and verify that the correct series is selected in the Based on series list box.
4. In the Options tab in the Add Trendline dialog box, specify other options if necessary – the available options depend on the type of trendline chosen.
 - **Trendline name:** If you choose Custom, you can provide a different caption for the trendline. This is the text that appears in the legend. If you do not specify a custom name, the legend consists of the trendline type, followed by the series name in parentheses.
 - **Forecast:** These options enable you to extend the trendline in either forward, backward, or in both directions. You specify the number of periods to forecast.

- **Set intercept:** Enables you to specify the point on the value axis where the trendline crosses the axis.
- **Display equation on chart:** If checked, the regression equation for the trendline will be displayed on the chart.
- **Display R-squared value on chart:** If checked, the R-squared value for the trendline will be displayed on the chart.

NOTE: A single series can have more than one trendline associated with it.

- *EXAMPLE:* Add two different trendlines to determine which type better fits the data.

Once a trendline has been added to a chart, you can select the trendline and format it just as you can format any other element of the chart. You can also format the trendline's 'data label', which may contain either the trendline equation, or the R-squared value, or both in a similar fashion.

See **Chapter 5: Working with Trendlines and Error Bars** of *Excel Charts* by John Walkenbach for more details regarding trendlines, including:

- linear trendlines;
- nonlinear trendlines – logarithmic, power, exponential, and polynomial;
- *AND* displaying a moving average.

Chapter 5 also discusses other series enhancements: series lines, drop lines, high-low lines, up/down bars, and varied colors for data points.

3.6.3 Using Error Bars

Errors bars, used primarily in scientific applications, indicate 'plus or minus' information that reflects uncertainty in the data.

Error bars are available for chart series of the following 2-D chart types:

- XY chart.
- Bar chart.
- Line chart.
- Area chart.
- Column chart.
- Bubble chart.

Because XY charts and bubble charts each have two value axes, you can display error bars for the x values, the y values, or both.

To add error bars:

1. Select the desired data series in the chart.
2. Access the Format Data Series dialog box, and select the Y Error Bars tab.
 - If the chart is an XY chart or a bubble chart, the dialog box will display an additional tab: X Error Bars.
3. Choose the Display type for the error bars.
 - Y error bars display above each data point, below each data point, or both above and below each data point.
 - X error bars offer the same options, but in the horizontal direction.

4. Select one of the following **Error amount** options:

- **Fixed value:** The error bars will be offset from each data point by a fixed amount that you specify. Each error bar will be the same height (or same width for X error bars).
- **Percentage:** The error bars will be offset from each data point by a percentage of the data point's value. Each error bar will vary in size.
- **Standard deviation(s):** The error bars will be centered along an invisible line that represents the average of the data series values, plus or minus the number of standard deviations specified. The error bars will be fixed in size, will not vary with each data point, and will always be parallel to an axis.
- **Standard error:** The error bars will be offset from each data point by the standard error – the standard deviation divided by the square root of the sample size. Each error bar will be the same height (or same width for X error bars).
- **Custom:** The error bars will be determined by the values in a range you specify. Usually, this range contains formulas.

→ *Practice Exercise:* Using the Median House Prices data in the Example Chart – Line 2 Series worksheet of the ExampleCharts.AND.PracticeExercises.xls workbook:

1. Using the **AVERAGE** and **STDEV** functions, calculate the average and standard deviation of the median house prices in the **Western States** and the **United States** from 1991 to 2001.
2. Create a column chart of the *average* median house price in the **Western States** and the **United States**.
 - Define **Western States** and **United States** as two separate data series.
 - Create the chart as its own chart sheet.
3. Add a *custom* error bar to each column (i.e., series) that displays the average plus or minus the *standard deviation* of each series.

To change the formatting of error bars, double-click any error bar to display the **Format Error Bars** dialog box.

- Can change the line style and adjust the marker style (either on or off).
- Contains a **Y Error Bars** tab, and possibly an **X Error Bars** tab, that enables you to change the options you set when you created the error bars.

See **Chapter 5: Working with Trendlines and Error Bars** of *Excel Charts* by John Walkenbach for more details regarding error bars, including:

- using custom error bars;
- connecting series points to a trendline;
- *AND* error bar alternatives.

Recall, **Chapter 5** also discusses other series enhancements: series lines, drop lines, high-low lines, up/down bars, and varied colors for data points.

Section 4

Other Chart Tasks of Interest

4.1 Printing Charts

How to print a chart depends on whether the chart is an embedded chart, or is a chart sheet:

- Printing an embedded chart:
 - Prints when you print the worksheet.
 - As long as the embedded chart is included in the range to print, Excel prints the chart as it appears on-screen.
 - * Good idea to preview the worksheet first to ensure that the chart does not span multiple pages – select **Print Preview** from the **Print** drop-menu.
 - * Use the *page break preview* to move the chart to a desired location – select **Page Break Preview** from the **View** drop-menu (select **Normal** from the **View** drop-menu to return to the normal view).
 - *Tip*: To print an embedded chart without its associated worksheet data, click the embedded chart to select it, and then follow the instructions for printing chart sheets.
 - If you don't want a particular embedded chart to appear on your printout, right-click the chart and chose **Format Chart Area** from the shortcut menu. Click the **Properties** tab in the **Format Chart Area** dialog box and remove the check mark from the **Print Object** check box.
- Printing a chart sheet:
 - If you created the chart on a chart sheet, Excel prints the chart on a page by itself.
 - Use the **Chart** tab in the **Page Setup** dialog box to specify several options:
 - * Select **Page Setup** from the **File** drop-menu – for a chart sheet, the **Sheet** tab is replaced with a tab named **Chart**.
 - * **Use full page**: Excel prints the chart to the full width and height of the page margins. This usually isn't a good choice because the charts relative proportions change and you lose the WYSIWYG advantage.
 - * **Scale to fit page**: Expands the chart proportionally in both dimensions until one dimension fills the space between the margins. In other words, the aspect ratio of the chart is maintained. This option usually results in the best printout.
 - * **Custom**: Prints the chart as it appears on your screen. Select **Sized with Window** from the **View** drop-menu to make the chart correspond to the window size and proportions. The chart prints at the current window size and proportions.

4.2 Using Excel Charts in Other Applications

Sharing data among Microsoft Applications (i.e., Word, Excel, and PowerPoint) is relatively easy and, for the most part, reliable.

The easiest way to share data among multiple applications is to use the basic copy and paste technique:

1. Select something – a cell, range, some text, a picture, or a chart, for example.
2. Choose Copy from the Edit drop-menu (or use the Ctrl+C keyboard shortcut).
3. Activate something else, such as a different location in the current document or a location in a different document (which could also be in a different application).
4. Choose Paste from the Edit drop-menu (or use the Ctrl+V keyboard shortcut).

Be aware: When you copy and paste an Excel chart into a PowerPoint slide using the basic copy and paste technique, a copy of your *entire* Excel workbook is automatically embedded in the PowerPoint presentation.

- Therefore, if the chart you're copying happens to be contained in a 10-megabyte workbook file, all 10 of those megabytes come along for the ride.
 - Even worse, if you copy and paste another chart from the same workbook into your presentation, another copy of the entire workbook is embedded!
- *NOTE:* The embedded workbook is *not* linked to the original Excel workbook – if you modify the chart in the original workbook, those changes will not be reflected in the PowerPoint slide.
 - Double-click the Excel object in the PowerPoint slide to work with the Excel embedded object using all of Excel's commands.

For optimal control over your pasted chart, choose the destination application's **Paste Special** command from the Edit drop-menu (if it has one). This will display a list of all available paste formats, and you can choose the most appropriate one.

- The Paste options:
 - Microsoft Excel Chart Object: Embeds a copy of the entire Excel workbook (the default).
 - Picture: Pastes the chart as a picture.
 - Picture (Enhanced Metafile): Pastes the chart as a picture; produces the same result as the previous one.
- The Paste link options:
 - Microsoft Excel Chart Object: Creates a link to the original Excel workbook. The chart will always reflect the current data in the workbook. Double-clicking such a linked object will activate Excel with the original workbook opened.

Section 5

Common Chart-Making Mistakes

In a perfect world, every chart you create is a work of art that communicates a message clearly and efficiently. In the real world, of course, charts are subject to a wide variety of problems.

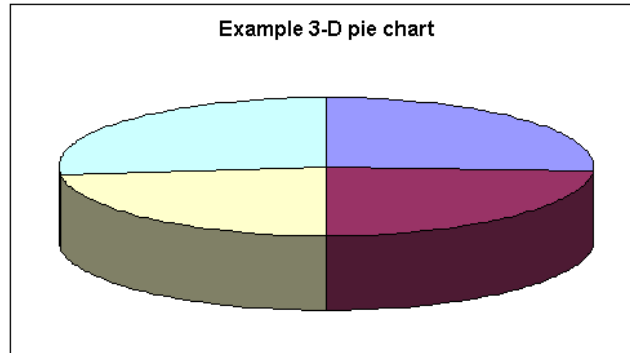
The first question to ask yourself is:

- Does the chart actually convey a message? If your boss asks what the chart means, will you have an answer?

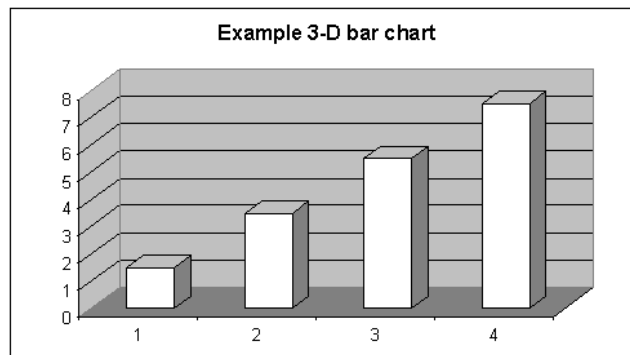
Here are some additional key points to consider when creating a chart:

- **The *accuracy* of the data.** A chart can present data that is perfectly accurate, yet can be very misleading in a number of different ways.
 - Plotting data out of context.
 - Plotting percent change versus actual change – percentage calculations do not take into account the magnitude of the values.
 - Exaggerating difference or similarities – scale of a continuous axis and aspect ratio (the chart’s width-to-height relationship; normally 4:3).
- **The *complexity* of the information presented.** When you’re faced with a decision to make a simple chart or a complex chart, a simpler chart is almost always a better option.
 - Questions to ask yourself:
 - * Is there anything about the chart that could possibly be misleading? Confusing? Not clear?
 - * Is there anything in the chart that isn’t necessary?
 - * Is all the text necessary? Can it be shortened?
 - Follow the KISS principle (*Keep It Simple, Stupid*) – a chart that is unnecessarily complex defeats the purpose.
 - Maximize ‘data ink’ – use ‘ink’ to display data, not chart accoutrements such as grid lines and labels.
 - * Nonessential chart elements can often be deleted with little or no adverse effects on the readability of the chart.
 - * A chart should stand on its own; lengthy explanatory text should not be necessary.
- **The *appropriateness* of the *chart type*.** Just about everyone can understand a simple column chart, but nontechnical types usually cringe at the sight of a radar chart.
 - Questions to ask yourself:
 - * Have I considered using another type of chart?

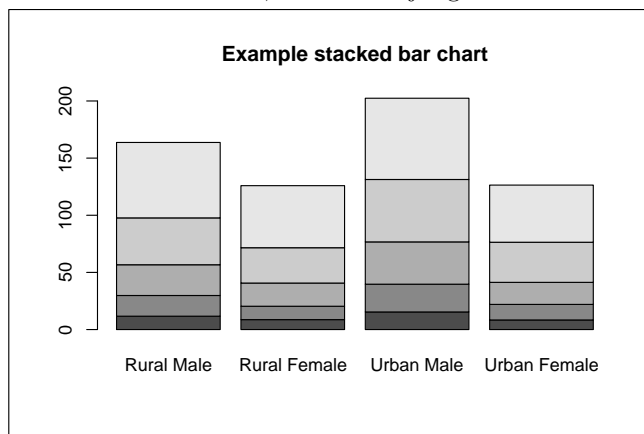
- * Are there too many dimensions in the chart (more than in the data)?
- Some common chart types to avoid – all difficult to read accurately and all hide the structure of the data:
 - * *Pie charts*: the eye is good at judging linear measures, but bad at judging relative areas; very difficult to compare one pie chart to another.



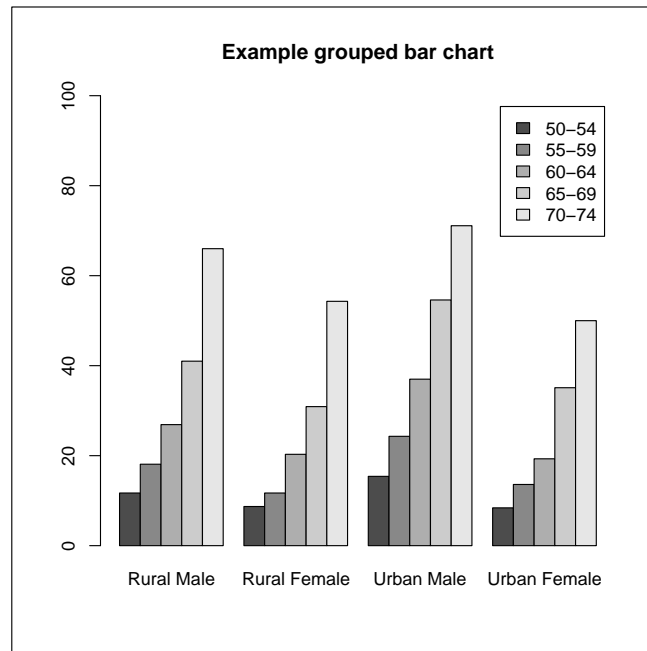
- * *Charts with a three-dimensional effect*: for a three-dimensional bar chart, do you read the bars from the back or from the front? Can the viewer actually derive the values for each data point?



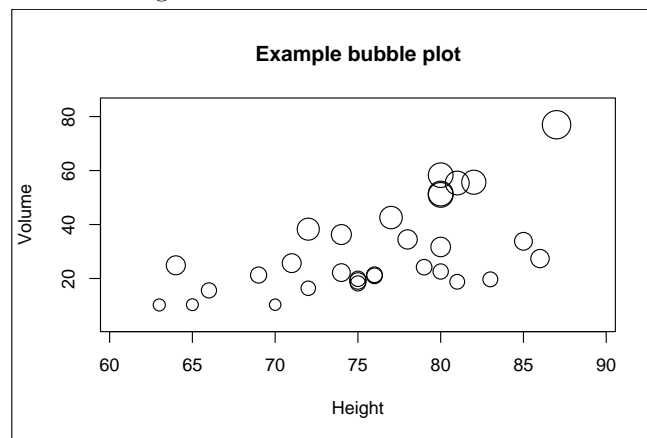
- * *Stacked bar charts*: no common baseline; difficult to judge relative areas.



- * *Grouped bar charts*: difficult to follow the trend for a given group because the data for the other groups fall between the consecutive values of the desired group.

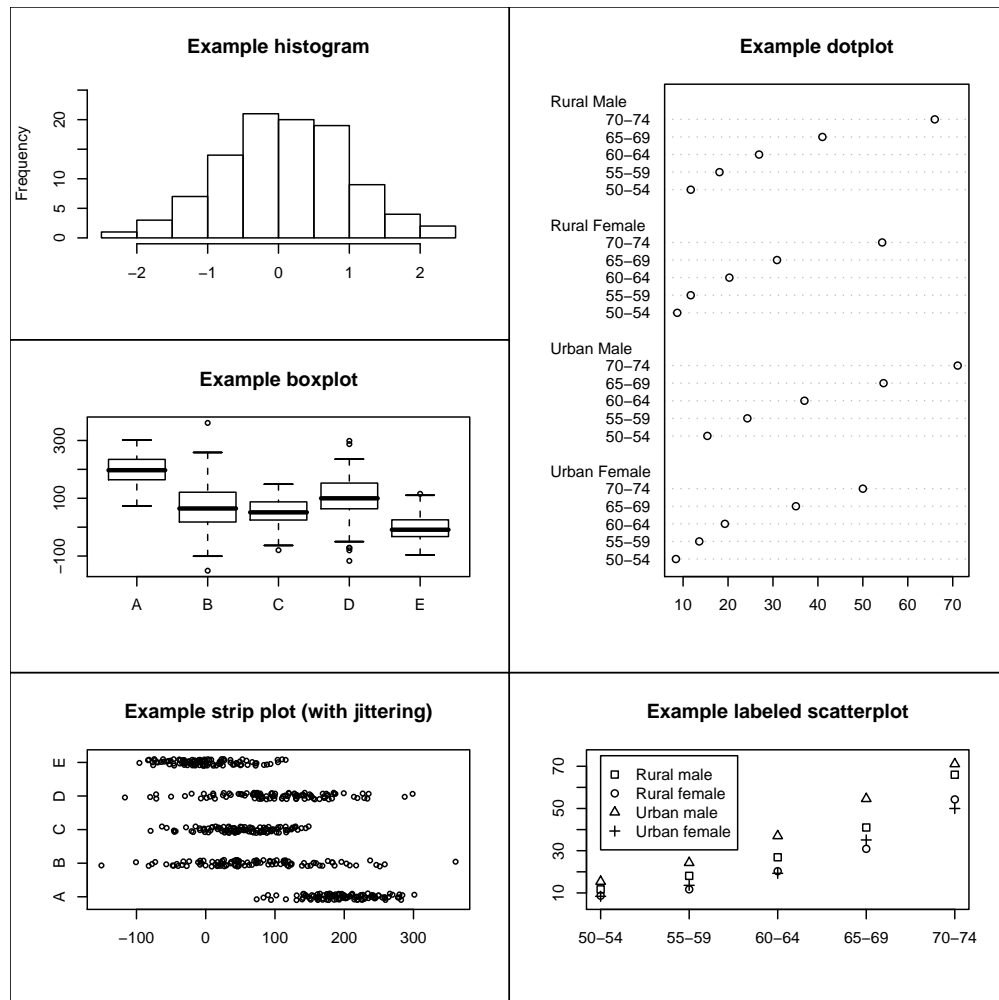


* *Bubble plots:* difficult to distinguish small differences in area between different bubbles.

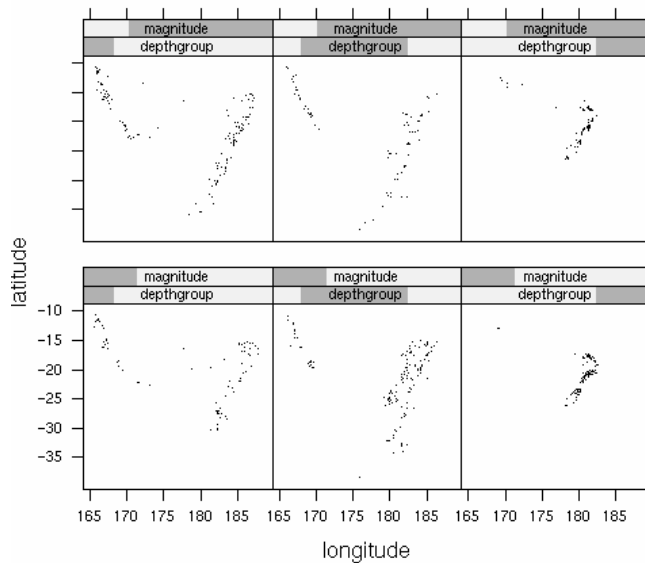


– More effective graphs:

- * Histograms, boxplots, strip plots (with jittering), or dot plots to graph the distribution of one variable.
- * Box plots to compare the distributions of two variables.
- * Scatterplot to graph the relationship between two variables.
- * Labeled scatterplots or trellis displays for graphing three variables.



Fiji Earthquakes



- The overall *style* of the chart. A chart intended for an employee newsletter will probably look

much different than a chart prepared for a Board of Directors meeting.

- That is, on the "formality" scale, is the overall look and tone of the chart appropriate for its intended audience?
- Some general aesthetic guidelines:
 - * Don't let design elements (such as titles, data labels, tick marks, and tick mark labels) detract from the chart.
 - * If possible, avoid using vertically oriented text.
 - * If you display gridlines, make sure that they don't overpower the chart – using a gray dashed line is sufficient.
 - * If you're using multiple charts, it is critical that they all have the same 'look' – color, font, number formatting, sizing, and so on.
 - * *IMPORTANT*: Make sure all the words are spelled correctly!
- Some text font guidelines:
 - * Only one font per chart almost always works.
 - * When in doubt, use the Arial font.
 - * All text should be large enough to be legible.
 - * Use bold or italic to draw attention to a particular element.
 - * Text in a chart should generally be 'proper' case.
- **The choice of colors used in the chart.** A chart that looks great in color may be incomprehensible when printed on a black-and-white printer, photocopied, or faxed.

In addition, consider these general strategies for creating more *effective graphs*:¹

- A large amount of quantitative information can be packed into a small region.
- Graphing data should be an iterative, experimental process.
- Graph data two or more different ways when needed.
 - Different presentations of data emphasize different aspects of the data.
 - It is often useful to see more than one.
- Many useful displays require more careful detailed study.
 - A graph with a large amount of information may require detailed study.

¹One graph is more effective than another if its quantitative information can be decoded more quickly or more easily by most observers.