

Graphing for Math 121/122

This document is designed to show key features for creating good graphs in Excel 2010. We illustrate this with an example from beetle population data, which has a line, a quadratic function, and data points. This document will illustrate the essential steps for all graphs (red) and several regular optional features (blue).

The quadratic model (logistic growth) has the independent variable P_n and the dependent variable P_{n+1} and satisfies the quadratic function:

$$P_{n+1} = 1.979 P_n - 0.002232 P_n^2.$$

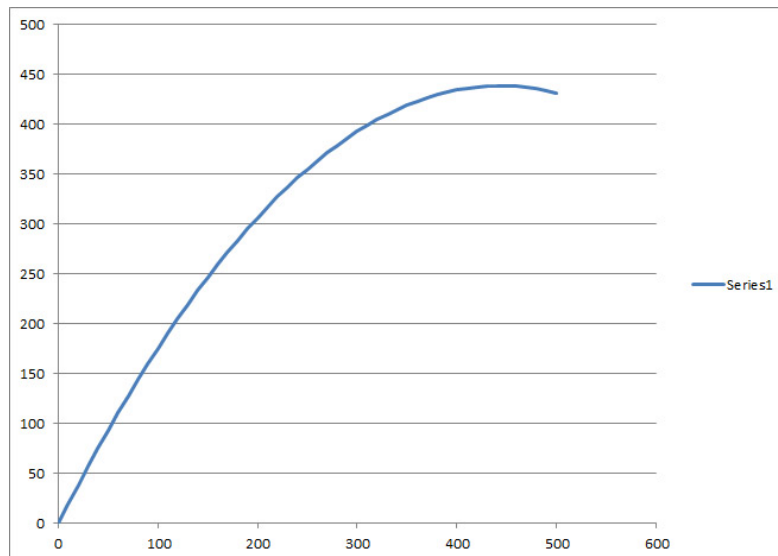
We want to begin by creating a graph of this quadratic function.

Initial Steps for Graphing

Excel is a spreadsheet based software, so the functions need to be entered as tables of data. To create good smooth curves, always use 40-60 data points (exceptions being a straight line requiring very few points or complex curves, which require more points).

1. Create two (or more) columns of data with the independent variable in the first column and the dependent variable in the second column (and other functions in subsequent columns). Always have **40-60 points** for a smooth curve.
2. Highlight (left click and hold mouse) the two data columns to be graphed.
3. Go to the menu tab labeled **Insert**.
4. Select the option **Scatter** and for functions or models select the last option, which creates **lines** between data points. (Data uses the default or **point option**, and we cover this later.
5. This creates the basic graph, which **must** be improved.

Below we show the basic graph produced by Excel for the quadratic function above following the steps listed above.

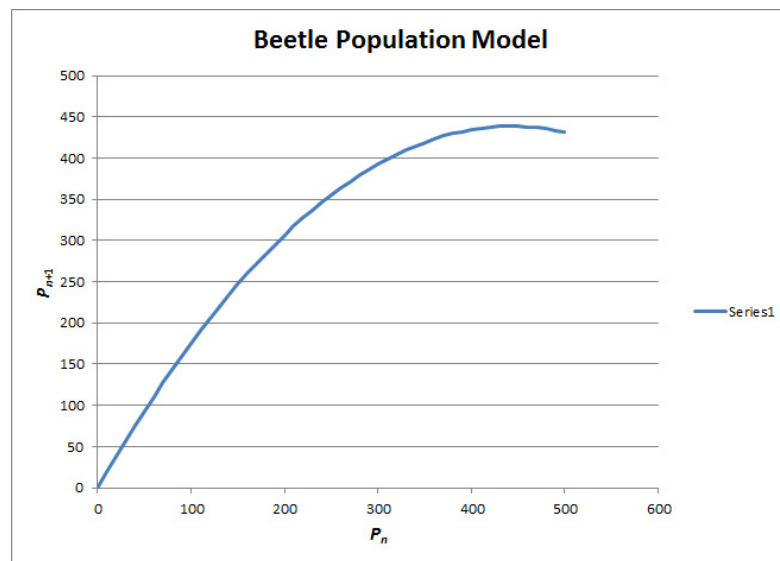


Title, Labeling Axes, Grid, and Scaling

The graph above is not very attractive and lacks information. We need to always have a **title** and **labels for the axes**. Below are essential points for creating an appropriate graph:

1. After creating a graph, the graph should be highlighted with the top menu showing **Chart Tools**.
2. Select the **Layout** tab, then step through the following:
 - (a) Select **Chart Title**, where we prefer **Above Chart**. Replace the default title with a descriptive title, such as **Beetle Population Model**
 - (b) Next select **Axis Titles** to allow changing the labeling of the horizontal and vertical axes.
 - Select **Primary Horizontal Axis Title** with the preferred choice being **Title Below Axis**. For our example we want the label P_n , which requires typing P_n . This is highlighted, then right click and select **font**. First change this to italic (I). Next highlight only the n and right click again selecting **font** and checking **subscript**. Finally select the complete title, then under **font** make the size 12.
 - Select **Primary Vertical Axis Title** with the preferred choice being **Rotated Title**. For our example we want the label P_{n+1} , which requires typing P_{n+1} . Highlight the 'Pn,' then right click and select **font**. First change this to italic (I). Next highlight the 'n+1' and right click again selecting **font** and checking **subscript**.
 - Finally select the complete title, then under **font** make the size 12.
 - An alternate method of formatting the **Axis Titles** is to right click on the title and select **Format Axis**.

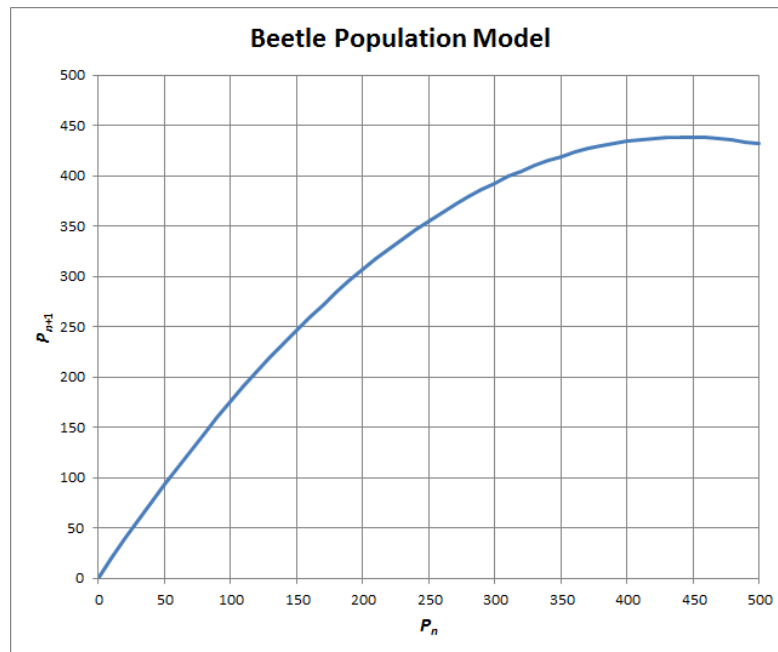
Note that **right clicking** on any object in an Excel graph usually allows you to reformat that object through a new menu window. Now the resulting graph appears as follows:



The next step is to insert vertical grid lines and adjusting the domain of the graph. The default in Excel is to increase the domain beyond the values presented on the spreadsheet, so **this will almost always have to be adjusted**. These features appear under the **Chart Tools** menu still with the tab **Layout**.

1. Select the **Gridlines** feature, then choose **primary Vertical Gridlines**, and finally **Major Gridlines**. This places good vertical gridlines on your graph for easy data reference.
2. Select the **Axes** feature, then step through the following:
 - (a) Right click on the horizontal axis on the graph and select the option **Format Axis**.
 - (b) A window appears labeled **Format Axis**, which has numerous choices. One example we will use later is the **Logarithmic scale** choice.
 - Under **Minimum** check the **Fixed** circle, then select a value that matches the minimum value that you desire. (Often the default of **0** works as it stands.)
 - Under **Maximum** check the **Fixed** circle, then select a value that matches the maximum value that you desire. This virtually always must be changed for full credit on your graph.
 - (c) Usually the Excel default is fine for the vertical axis. However, there will be times you are asked to change the range of your graph, so right click on the vertical axis and again select the option **Format Axis**. From here, it is almost identical to the case described above for the horizontal axis.

Delete the **Series1** label by right clicking on it and selecting the option **delete**. The following graph is a good example of a complete graph for your **Lab Report** if only a single model or function is necessary.



Multiple Graphs and Data

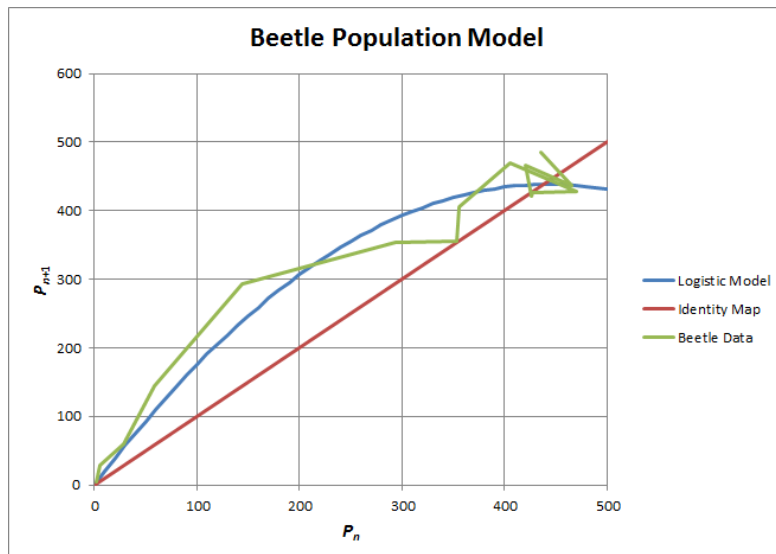
In this example we want to add the graph of a line, called the **Identity Map**, and the original beetle data, which was used to get the quadratic function. The line satisfies the equation:

$$P_{n+1} = P_n.$$

Since this is simply a line, we create a few cells (6) for the function above. Below we show how to add this to our graph. **Note** that we could add the **quadratic** and **line** together by creating the appropriate domain for the example, then in the next two columns insert both the quadratic and linear functions. You highlight all **3 columns** and create the graph as described in the **Initial Steps for Graphing**. In addition, we add the original beetle data that we used to create our Logistic growth model.

1. **Right click on the Graph.**
2. Select the **Select Data** feature, then a new window appears. In this window we **edit** the existing graph label and add the new graphs.
 - (a) Select **Edit**, then a new window appears and under **Series Name:** we enter a label for our quadratic graph (Logistic Model). After clicking **OK**, the new label replaces the **Series1** label.
 - (b) Next we select **Add**, and a new window appears.
 - (c) In this window, type a **Series Name:** for your new data, which in our case is Identity Map for the first set of data. In the box labeled **Series X values:** you highlight the data for the independent variable (usually first column being graphed). Then in the box labeled **Series Y values:** you removed the **{1}** and highlight the data for the dependent variable (usually the column next to the Series X values). After clicking the **OK** button, then new graph should appear with the appropriate data.
 - (d) We repeat this process until we add all the desired graphs.

After adding all the desired data to the graph, we have the following graph for our model.



This graph has several features we want to change to produce the graph in the final desired form. Some of these features are **essential for full credit**, while some are **optional**, but improve the look of the graph.

1. We want the graph to fill the space and **increase the graph area size**. This is easily done by **clicking on the graph** and using the **mouse** to pull the right side of the graph. For this particular graph, we want the actual graph to be more square, so we again use the **mouse** on the edge of the graphing window to pull it into a more square shape.
2. For this particular graph, we adjust the vertical axis so that $P_{n+1} \in [0, 500]$. This was described above.
3. We use the **mouse** to move the legend to a blank part of the graph. **Right click** on the legend, then select **Format legend**. In the new window select **Solid fill** and choose the **Color** (usually white) to match the background.
4. We also **Right Clicked** on the legend, selecting **Font** to increase the font size to **12**.
5. It is **VERY IMPORTANT** that **data** appear as **points**. In the graph above the green curve represents the data. Use the **mouse** to point to one of the **data points**, then **Right Click**. From the menu, select **Change Series Type** and select **XY Scatter** and the graph that appears to have **Points**. After clicking on **OK**, the data should change to the default setting (which was green triangles).
6. We prefer a different **Marker**, so we **right clicked** on a data point and selected **Format Data Series**. With the new window, we choose **Marker Options** and selected the circle from the Built-in choice. We also went to the **Marker Fill** option and selected **Solid fill** with the **Color** blue, matching the model.

Below is an excellent graph to include in your **Lab Report**.

