

**PEER 2010: Using ImageJ to Extract Data from Graphs**  
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Objectives:

1. Familiarize yourself with using ImageJ.
2. Read and understand an original research article that discusses the collection of data.
3. Extract data from a graph.

Directions:

1. Go to the PEER 2010 website, download, and install ImageJ.
2. Go to [www.adobe.com](http://www.adobe.com), download, and install Adobe Reader.
3. Using Google, locate the following articles and download/save in pdf form:
  - a. Calbet, J. A. L. & D. A. MacLean. "Role of Caloric Content on Gastric Emptying in Humans." *J. Physiology* (1997), 498.2, pp. 553-559.
  - b. Sidery, M. B., I. A. Macdonald, & P. E. Blackshaw. "Superior Mesenteric Artery Blood Flow and Gastric Emptying in Humans and the Differential Effects of High Fat and High Carbohydrate Meals." *Gut* (1994), 35, pp. 186-190.
  - c. Vist, G. E. & R. J. Maughan. "The Effect of Osmolality and Carbohydrate Content on the Rate of Gastric Emptying of Liquids in Man." *J. Physiology* (1995), 486.2, pp. 523-531.

Background:

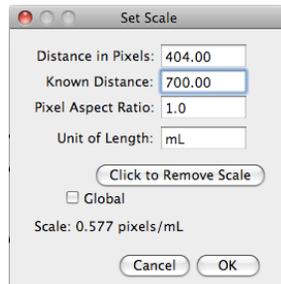
When creating a mathematical model, we need to verify its accuracy by using experimental data. It is often the case that such data is not published in tabular form; rather, the results are represented graphically. To extract this data, we will use ImageJ. Before extracting the data, we should know what the data structures are in the mathematical model.

The mathematical model in question is a model of gastric emptying, or the process by which ingested food moves from the stomach to the duodenum. The model tracks the overall volume of foodstuffs emptying from the stomach, in mL, as well as the amount of the macronutrients, in grams. The articles listed above give graphical results of gastric emptying experiments conducted in humans.

Method:

1. Create an Excel Spreadsheet.
  - a. Label the first cell "Initial Volume Ingested (mL)."
  - b. Leave the next two rows blank.
  - c. Label cell A4 "Time" and cell B4 "Volume (mL)."
2. Rename the sheet "Calbet1997."
  - a. Right click on the tab at the bottom labeled "Sheet 1."
  - b. Select the Rename Option, type the name, and hit enter.
3. Right click on the sheet tab again.
  - a. Select "Copy."
  - b. In the box, select "Move to End" and be sure to check the "Make a copy" box.

- c. Hit “Okay.”
  - d. Rename this sheet “Vist1995.”
4. Repeat step 3. Rename the sheet “Sidery1994.”
5. For each article, determine the initial volume of food ingested, as well as how often the measurements were taken. Document this in the appropriate worksheet; you may have to add additional cells to accommodate the number of solutions administered. Make sure to label your time column with the appropriate units.
6. Open the Calbet article in Adobe Reader. Go to Figure 1.
  - a. Review the graph. How many data sets are represented? Edit your Excel spreadsheet to include a column for each data set.
  - b. Using the Tools menu, go to “Select and Zoom” and select “Snapshot Tool.”
  - c. Position the cursor at the lowest value on the vertical axis. Be sure to note what the maximum and minimum values are on the vertical axis.
  - d. Create a box that captures the scale on the vertical axis and the data points. It is not necessary to capture the scale on the horizontal axis. (Why?)
  - e. Release your mouse button. The image is now placed on the clipboard.
7. Open ImageJ.
  - a. Under the Edit menu, select “Paste.” A new window with your image will appear.
  - b. Select the line tool that appears on the ImageJ icon menu. Line the crosshairs up on the lowest point on the vertical axis. Click the left mouse button and hold; while holding the button, draw a straight line to the top of the vertical axis. Release the button.
  - c. Under the Analyze menu, select “Set Scale.” In the “Known Distance” box, put the distance between the maximum and minimum values on the vertical axis. In the case of Calbet 1997, the distance is 700 units. Then, you can change the units to be “mL.”



- d. Under the Analyze menu, select the “Set Measurements” option. Check the “Invert Y Coordinates” box. This will make the bottom of your picture  $y=0$  (versus making the top  $y=0$ , which is the default). Once this option is selected, it will be saved for all future uses of ImageJ.
  - e. Select the “Wand” option from the toolbar. Using your mouse, hover over and center the crosshairs over each data point. Record the value in the appropriate column in your Excel spreadsheet.
8. Repeat steps 6 and 7 for both the Vist and Sidery articles.
  - a. For the Vist article, analyze Figure 1.
  - b. For the Sidery article, analyze Figure 2. Be careful of what is plotted and the scale used.

9. Compare all of your results. Why are your first data points larger than the initial volumes consumed?