Overview

Fathom statistics software will let you easily input and analyze data. It is especially useful for making graphical representations of the data, such as histograms, graphs, and boxplots. This program will also do statistical analyses such as hypothesis testing, correlation measures, and curve fitting. In this activity, we will limit our scope to the following tasks: entering a data set (or collection of cases), plotting various attributes of the data against each other, and creating a window for easily viewing the data.

Go to the website https://fathom.concord.org/ and follow the directions for downloading the free trial version. It is a fully functional version that you can use for free for 2 weeks. Note that the cost of Fathom for a 1-year license is only $5-10 dollars, so it is relatively inexpensive software.

Getting Started - Entering Data

We create a typical scenario. Suppose a high school has administered a standardized exam to a group of 20 of its students. The student's score on the exam is the total of his or her score on the math portion and on the verbal portion (each portion is measured out of 100). Thus, the highest exam score possible is 200. A report is generated showing the data for each student. This report is given below. The report contains each student's name, class ("1"=freshman,"2"=sophomore, etc.), scores on the exam, and whether or not the student took the school's preparatory course for the exam.

last name	class	math score	verbal score	total score	prep course
Andrews	3	67	56		y
Barrows	3	82	94		y
Block	3	62	51		n
Chu	4	89	88		y
Elders	3	89	93		y
Essex	2	76	62		n
Johnson, A.	4	65	71		y
Johnson, F.	3	64	55		n
Martin	3	55	53		n
Morrow	1	97	94		n
Neuman	3	53	48		n
Orr	4	65	64		y
Phillips	3	93	89		y
Quo	3	87	79		y
Ross	2	73	69		n
Smith	3	76	80		y
Sullivan	4	53	53		y
Tyler	4	72	77		y
Wallis	3	99	90		y
Whitson	3	56	57		n

When you first start Fathom it opens a blank document.

- Click on the Collection icon and drag it into the document. Double click on the name "Collection 1" and rename it "Test Scores". The top left corner of your document should look like the following:
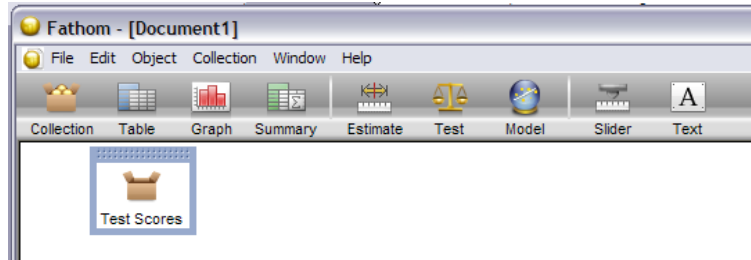
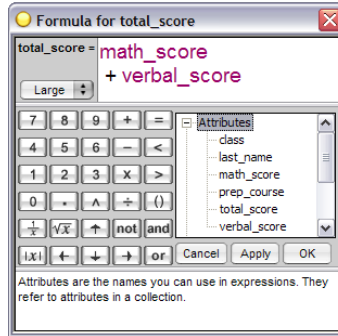- Click on the Table icon and drag it into the blank document. Fathom opens the following table.

We want to use the column headings that appear in our report. *Fathom only allows column headings that begin with a letter and contain only letters, digits, and underscores. Any spaces will automatically be changed to an underscore.*

- Click in the box where "<new>" appears. Type the first column heading (last name) and press tab. Note the underscore appears between the words. Now, continue until all 6 of the column headings in the report are entered. You can enlarge the table by clicking on the bottom right corner of the table and holding down the mouse button as you drag the corner outward. You can also change the width of each column by placing your curser on the vertical line separating the headings and double-clicking. Enlarge your columns and table so that it looks like this:

- Now enter the data for all columns ***except*** for the total_score column just as it appears in the report.

Your table should now be holding all of the data in the report for each student, *except* for the total score. Since the total score is just the sum of the math and verbal score, we can have Fathom calculate it for us.

- Select the total_score column by clicking on its heading (this should highlight the entire column).

- Under the Edit menu, select Edit Formula. This will bring up what appears to be a large calculator. Double click on the word Attributes, to see all of your column headings. We want our formula to consist of the sum of the two attributes math_score and verbal_score. Double click on math_score to paste this into the formula box. Then click on the plus sign, and finally double click on verbal_score. Your formula should look like this:

- Click on the OK button.

The total_score column should now contain the sum of the math and verbal scores.

Making Plots

Let's start by making a histogram of one of our attributes.

- Click on the Graph icon and drag it into the document. Notice that you do not get a graph yet, because Fathom does not know which attribute(s) we want to graph.

- In your case table, select the attribute (column heading) labeled "class". Hold down your mouse button and drag this attribute to the place on the graph where it tells you to "Drop an attribute here". Make sure to drag it far enough so that a black rectangle appears around the "drop attribute here" space before you release the mouse button.

- Now, click on the graph where it says "Dot Plot" and select Histogram. You should have the following graph:
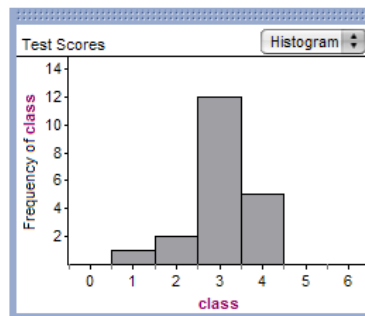
If you do not like where Fathom chooses to put the graph or any other object in your document, you can move each object by grabbing its frame at the top (just as you do on the Windows desktop). Move the graph to another position.

- Now, one at a time, drag each of the other attributes to replace the class attribute in the graph. Note that when your attribute has nonnumeric data (such as names or letters), your graph is called a bar chart instead of a histogram.

Let's examine the histogram in more detail.

- Make a histogram of the total_score attribute.

- Right click on the graph and select Inspect Graph. Move the Inspect Graph of Test Scores box so that it is to the right of your histogram. Select the Cases tab. You should see all the data (Attribute, Value, and Formula) corresponding to the first student, Andrews. At the bottom of this box you can click on the arrow to move to the next case (student). Scroll through several of the cases to see the data.

- Click on the Properties tab and you will see data about the graph itself. Read the graph information and make sure you understand how it corresponds to the histogram.

You can change the properties of the graph here. The bin width is presently set to 5. You can look at each bin in your histogram by moving the cursor over it until the cursor becomes a hand. The information about the bin is displayed at the bottom left hand corner of the screen. Check a few of the bins to confirm that the bin width is 5.

- Change the bin width to 10 and make sure your histogram changes accordingly. If the vertical axis does not adjust automatically, increase yUpper to 3.3 so that your graph looks like the following:
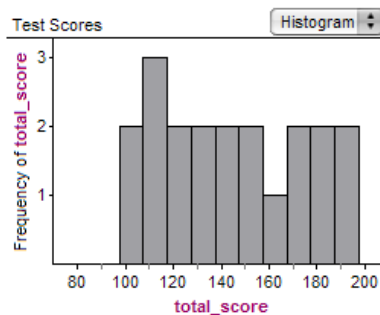
- Move your cursor over the different bins to confirm that the new bin width is 10. You can play around with the other information as well.

- You can also change the scaling on either axes by moving the cursor over the axis until the pointer becomes a hand. With the hand, select the axis and slide it back and forth (or up and down, depending on the axis). Try this now.

Now, let's compare one attribute to another. For instance, let's make a scatterplot of the math score versus the verbal score for the students.

- Drag the verbal_score attribute down to the graph to get a histogram of the verbal scores again.

- Now, drag the math_score attribute down to the vertical axis of the graph where the words "Frequency of verbal_score" is written on its side. You should now have the desired scatterplot.

Note that the Inspect Graph box has updated its information as well. You can see from this scatterplot that the math and verbal scores of these students seem fairly well correlated (that is, a high verbal score seems to go hand in hand with a high math score).

- Click on the graph to select it. The Graph option will now appear in the menu bar. Click outside the graph to deselect it and notice that the Graph option is no longer shown in the menu bar. [***Note:*** *The* Graph *menu is different than the* Graph *icon and the* Graph *menu will only appear if you have a graph selected.*] Click on the graph to select it again. Then from the Graph menu select Least-Squares Line to fit a least-squares regression line to the data.

Note that in addition to giving you the equation of the line at the bottom of the graph, Fathom also gives you (the square of) the correlation coefficient. We can get even more information than this.

- Click on the Model icon and drag it to any blank space in your document. In the box that opens up, click "Empty Model" and choose Simple Regression.

- Drag the verbal_score attribute and drop it in the Predictor Attribute slot. Drag the math_score attribute into the Response Attribute slot. Scroll through the information to see all of the information that Fathom calculates.

Exercises

Note: As with any dataset and software, you may need to format or enter the data differently than it was given to you in order for it to be compatible with the software.

1. Suppose a manager at a grocery store recorded the following data over a particular 24-hour period:

Time Period	# of Cashiers	# of Customers	Total Revenue
midnight - 2 AM	4	60	$2000
2 - 4 AM	4	45	500
4 - 6 AM	8	80	600
6 - 8 AM	12	90	900
8 - 10 AM	14	120	4800
10 - noon	14	160	5600
noon - 2 PM	16	200	6000
2 - 4 PM	20	250	10000
4 - 6 PM	20	240	8400
6 - 8 PM	20	150	3700
8 - 10 PM	8	100	2000
10 - midnight	4	70	1400

a. Create a *new* Fathom worksheet for this exercise. Create a new collection and table of the data above. Resize the table and columns so that it is easy to read.

b. Suppose that 40% of the revenue on the groceries is profit for the store. Insert a column into the chart showing the profit on the groceries during each 2-hour time period.

c. The cashiers are each paid $8.00 per hour. Insert a column that shows the cost of paying the cashiers during each **2-hour** time period. *Note: You can also edit formulas by highlighting the column and then right-clicking.*

d. Insert a column that shows the net profit for the store over each 2-hour time period, taking into consideration only the profit on the groceries and the cost of paying the cashiers.

e. Create a plot showing the net profit versus the number of customers [*Note: The standard convention is to say "y versus x"*]. Fit a least-squares regression line to this scatter plot. What is the value of the slope? Interpret the slope of the line in the context of the situation [*Hint: How would the profit change if you add one more customer?*]. *Create a text box for your answer.* [Note: If you get a slope of 16.7, it is close, but wrong. Go back and make sure you have computed everything correctly and that you have graphed the correct quantities.]

f. Create a separate plot showing the number of cashiers versus the number of customers. Fit a least-squares regression line to this dot plot. What is the value of the slope? Interpret the slope of

the line in the context of the situation and put your answer in a text box. How many more customers would it take for the store to add 1 more cashier*? Note: This will take a little more thought than in part (e).*

[Type your name in the document and save it as **Fathom1_YourLastName.ftm**]

2. Suppose you have the following list of values for x and y:

x	2	5	-1	7	23	-3	10	4	0
y	110	94	127	83	44	135	65	100	125

a. Create a new document and make a fathom chart showing this data.

b. Insert a column into your chart showing $z=x*y$.

c. Create a plot showing z versus x.

d. Use your cursor to select the point on the graph corresponding to $x = 7$ (it will change colors as soon as you do this.) Notice that the corresponding row in your chart becomes highlighted. Move the point around and observe what happens. Is the point free to move wherever you choose or is it restricted to a certain path*? [Put your answer in a text box.]* Note that the corresponding row in your chart continuously updates as you move the point. Then move the point so that x becomes as close to 7 as you can get it.

e. Create a separate plot showing y versus x.

f. Use your cursor to select the point on the graph corresponding to $x = 7$. Move the point around and observe what happens. Is the point free to move wherever you choose or is it restricted to a certain path? What happens to the corresponding point in the first graph? *? [Put your answers in a text box.]*

g. Explain why in part (d) you could only move the point along a fixed path and why in part (f) you could move the point anywhere you wanted. What is the fixed path that the point must travel along in part (d)? [*Hint: Think about how x, y, and z are determined.*]

[Type your name in the document and save it as Fathom2_YourLastName.ftm]

Email both documents to Dr. Crawford (crawford@elmhurst.edu).