8.1b Constructing a Chart of Reasonably Likely Events

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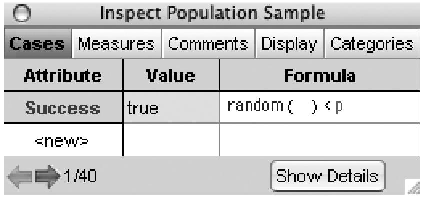
In this activity, you will make a chart that allows you to see the reasonably likely outcomes for all population proportions *p* when the sample size is 40.

Part A: Reasonably Likely Events by Simulation

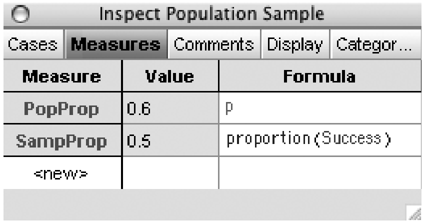
Suppose you take repeated samples of size 40 from a population with 60% success. What proportions of successes would be reasonably likely in your sample? Steps 1–6 help you build a simulation to answer this question.

1. Make a slider named **p** whose range goes from 0 to 1. Set the slider to 0.6 to represent 60% success. (This slider will help you change the population proportion later on.)
2. Create a collection named **Population Sample,** with 40 cases and one attribute, **Success**. Define **Success** to randomly determine whether a case is a success (**true**) based on the population proportion.

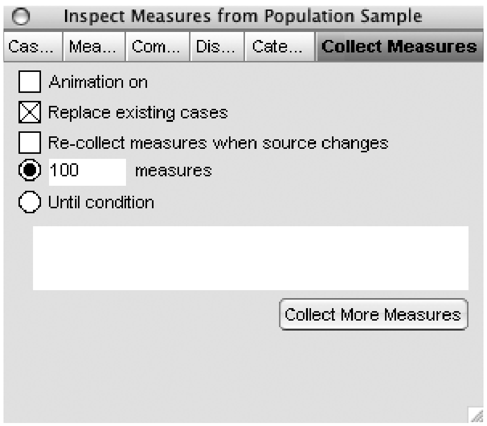


The formula for **SampProp** finds the proportion of cases for which **Success** is **true.** You do not need to include **true** in the formula.

3. Define two measures for the collection, **PopProp** and **SampProp,** as shown here. **PopProp** records the population proportion, and **SampProp** calculates the sample proportion.



4. Select the collection and choose **Collect Measures** from the **Collection** menu. Adjust the measures collection to collect 100 measures with animation off, then collect more measures.



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Although the "segment" is made of discrete points, imagine that it is a solid segment.

5. Make a case table and scatterplot of **Measures from Population Sample**. For the scatterplot, put **SampProp** on the x-axis and **PopProp** on the y-axis and scale both axes for 0 to 1. The scatterplot should be a horizontal "segment" of points. Based on the simulation, what proportions of success would be reasonably likely in your sample?

6. Compare the proportion of students you found to be able to make the Vulcan salute in Activity 8.1a, to your answer in step 5. Is it plausible that 60% of all students are able to make the Vulcan salute? Explain your reasoning.

You now know whether 60% is a plausible population proportion for students able to make the Vulcan salute. You'll use your slider to collect measures and consider the plausibility of other population proportions.

7. In order to build a chart of reasonably likely outcomes, you'll want to add measures for other population proportions to those you collected for 60%. On the Collect Measures panel of the measures collection's inspector, uncheck "Replace existing cases" and check "Re-collect measures when source changes."

☐ Replace existing cases
☒ Re-collect measures when source changes

8. Change the population proportion (slider **p**) to 0.05 by clicking the blue number in the slider and typing in the value 0.05. More measures are automatically collected. Notice that the case table and scatterplot update to include a "segment" of points for 5%.

9. Repeat step 8 for 10%, 15%, 20%, and so on, up to 95%. (Skip 60% because you already did that in step 4.)

You may want to use **Plot Value** from the **Graph** menu to get a vertical line at your sample proportion.

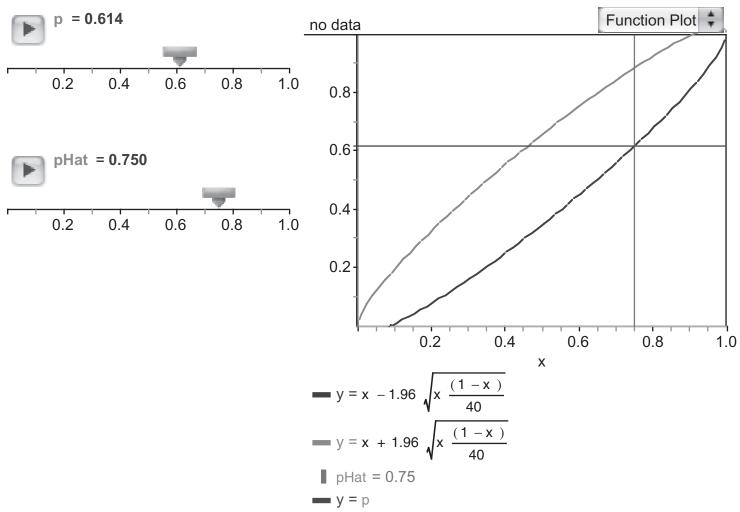
10. Refer to your results from Activity 8.1a. Select your scatterplot, and choose **Plot Value** from the **Graph** menu. Type in the proportion from your sample that were able to do the Vulcan salute. For which population proportions is your sample proportion reasonably likely?

11. Save your Fathom document to use throughout the chapter. With it, you'll be able to approximate confidence intervals for any sample proportion from a sample of size 40.

Part B: Reasonably Likely Events by Theoretical Values

The chart you made in Part A was based on simulation. Because of variability, your chart may look rather ragged. In these steps, you'll make a smoother chart by graphing theoretical lower and upper bounds.

1. Recall that, in theory, about 95% of all sample populations will fall within about 1.96 standard errors of the population proportion. So for any one population proportion p and sample size n, what is the lower bound of the interval? The upper bound?
2. In a new Fathom document, create a new empty graph and change it to a function plot. Adjust the bounds of the x- and y-axes to go from 0 to 1. For this graph, the x-axis represents the sample proportion and the y-axis represents the population proportion.
3. Select the scatterplot and choose **Plot Function** from the **Graph** menu. Enter a function for the theoretical lower bound of all the population proportions, **x**. For now, assume the sample size is 40.
4. Repeat step 3 for the theoretical upper bound. Resize the graph so that it is approximately square, with the same scale on both axes.
5. If you did Part A, explain how this chart relates to the one you created before.
6. Create two new sliders, **p** and **pHat,** whose ranges are both 0 to 1. These allow you to set the value of your population proportion (**p**) and the sample proportion (**pHat**).
7. Select the scatterplot and choose **Plot Value** from the **Graph** menu. Plot **pHat,** which will give you a vertical line.
8. Choose **Plot Function** from the **Graph** menu and plot **p,** which will give you a horizontal line. What does this horizontal line relate to in the chart you created in Part A?
9. Set the slider **pHat** to the value of your sample proportion from Activity 8.1a about the Vulcan salute. Drag the slider **p** until the horizontal and vertical lines intersect at the lower bound curve. What is the approximate value of the theoretical lower bound (the value of slider **p** at the intersection)?



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10. What is the approximate value of the theoretical upper bound?

11. For which population proportions is your sample proportion reasonably likely? How do these theoretical values compare with your results by simulation?

12. Save this Fathom document to use throughout the chapter. With it, you'll be able to approximate confidence intervals for any sample proportion from a sample of size 40.

Extensions

1. Repeat Part B, steps 3 and 4, but do them for the scatterplot from Part A. (You'll need to use one of your attributes instead of **x** for the dependent variable.) You should find that some results from your simulation are not appropriately confined by the lower and upper bounds. Which population proportions seem poorly confined? Explain why your functions might be invalid for these population proportions. Investigate other functions that might remedy this problem.

2. The functions that you graphed in Part B, steps 3 and 4, probably contain 1.96, which determines the interval that contains 95% of sample proportions. How would you change the functions to use the interval that contains 90% or 99% of sample proportions? Explain what happens to the graph when you make this change. (You could try a slider that changes this value.)

3. The functions that you graphed in Part B, steps 3 and 4, contained 40 for the sample size. Create a slider **n** and use it in the functions to dynamically change the sample size. Explain what happens to the graph when you change the sample size.