Section 1.2 Using Technologies to Obtain Reference Distributions

Using Tinkerplots to Repeatedly Flip Coins

To save time and to gather more data quickly, we will use a software package called Tinkerplots® to simulate tossing 20 coins many times. We will then use the data we generate from this simulation to help understand likely outcomes for the number of heads (i.e. the likely outcomes for someone who is guessing).

Setting up the Simulation in Tinkerplots
Open Tinkerkplots® on your computer. Drag a new Sampler from the tool shelf into your blank document, as shown below.

The default sampler is called a Mixer sampler which simply a “hat” that contains three objects (two objects labeled as “a” and one object labeled as “b”. Tinkerplots gives you options on the type of sampler to use for a particular situation. To begin, we will use the Spinner sampler.
The default labeling for the outcomes on the Spinner are \( a \) and \( b \). Relabel the outcomes as **Heads** and **Tails**.

Fair coins have a 50% chance landing on Heads and 50% landing on Tails. Thus, we need to change the proportion for Heads and proportion for Tails. This can be done by selecting **Show Proportion** the drop-down menu to the lower left of the Spinner sampler.

![Spinner Sampler](image)

Your Spinner sampler should look as follows.

![Spinner Sampler](image)

Two additional changes need to be made to the Spinner sampler. Change the **Draw** value from 2 to 1 and the **Repeat** value to 20. This will simulate tossing a single coin 20 times.
Your completed Spinner for tossing a single coin 20 times should look as follows.

Running the Simulation

4. Click the **Run** button in the upper-left corner. A table of the outcomes for 20 fair coin tosses will be generated. What was the outcome from the first coin toss? How about the 10th coin?

5. How many Heads did you get out of the 20 coin tosses?

Next, let’s use Tinkerplots® to plot the 20 outcomes from your first trial of the simulation. This will allow us to more easily count the number of Heads. Start by selecting the variable name of the variable to be plotted, Coin in my case and then select Plot.
Drag a new **Plot** into an open space. The original plot does not separate the Heads from the Tails. You can separate the dots by dragging a dot to the left or right.

Tinkerplots has the ability to automatically count the number of Heads and Tails on your plot. Select the “N” icon from the menu bar.

Click **N** icon to place Counts on your graph.  
Graph with counts shown.
Collecting the Results from Many Trials

Next, we will run many more trials and use Tinkerplots to collect the number of Heads obtained each time. To record the total number of heads for each trial of 20 coin tosses, right-click on the value for the number of Heads in your plot and select Collect Statistic.

To run additional simulations, say 100 total, put 99 in the Collect box and click Collect. This will add 99 additional trials to our initial simulation.

Questions

6. How many heads were obtained on the 47th trial?

7. What is the least number of heads in these 100 trials? How about most?
Plotting the Results from the 100 simulations

Although we can see the individual results in the table shown above, this is not necessarily a good way to organize the results. A better way to organize these results is to plot them. Plot the results from your 100 trials as shown below.

Drag a new Plot onto your workspace. Next, highlight the variable name from your collection in which the outcomes from the 100 trials are stored (count_Coin_Heads) and drag this onto the bottom of the new plot.

In order to count the number of 8’s, 9’s, etc. from each of trail, drag a point all the way to the right so that the plot displays individual columns for each outcome. The vertical Stack button can be used to neatly stack the points. Also, the size of the plotting symbol can be reduced with the slider on the bottom of the plot.
Dotplot showing the outcomes from the 100 trials of this simulation.

The plot above does not display all possible values from flipping 20 coins. This plot should start at 0 and go up to 20. Double click on the smallest axis label, in the Edit Axis box, put 0 in for Axis starts at and set the Bin width to 1. This is shown here.
Next, set the largest axis value to 20. Finally, to obtain a count for each value, simple select the N button on the menu bar.

Sketch your plot on the graphic below.
Questions

8. How many coins were flipped for a single run or trial in this simulation?

9. What does each dot on the graph represent?

10. If an individual is really guessing, what outcomes would be surprising to observe?

11. If an individual is really guessing, what outcomes would not be surprising to observe? That is, what are common values we’d expect to see if an individual is really guessing?

12. What is the smallest value from one trial of your simulation? ________________

   a. Is it possible to obtain a value smaller than this if more simulation were done?

   b. If one additional simulation is done, is this outcome likely to be smaller, larger, or about the same as the previous smallest value? Explain.

13. A statistician might argue that a plot based on 100 trials is better than a plot based on 20 trials. Do you agree? Explain why or why not.
Consider the following graphs, one based on 100 trails and the other based on 1000 trials.

Graph A: 100 trials

Graph B: 1000 trials

Questions

14. What are the similarities between the two graphs? Discuss any differences as well.

15. What would you consider an unusual outcome (i.e. outlier) to be in Graph A? How about Graph B?

16. A statistician might argue that the determination of what constitutes an outlier should not necessarily be influenced by the number of trials. For example, a statistician might say that a value less than 5 would be considered an outlier in either graph. Do you agree? Explain why or why not.