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## Empirical Methods to Determine Probabilities

**Learning Objective: Relate the probability of an event to the likelihood of this event occurring.**

We will now shift our discussion to empirical ways to determine probabilities.

### A Question

A single flip of a coin has an uncertain outcome. So, every time a coin is flipped, the outcome of that flip is unknown until the flip occurs.

**However, if you flip a fair coin over and over again, would you expect  $P(H)$  to be exactly 0.5?** In other words, would you expect there to be the same number of results of "heads" as there are "tails"?

The following activity will allow you to discover the answer.

### Purpose

The purpose of this activity is to experiment with an simulation that simulates flipping a fair coin, and to see if the  $P(H) = 0.5$ .

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### Part (1)

1. Make sure **Coins = 1** and **P(heads) = 0.5**.
2. Press the “**1 Flip**” button 3 times.
3. Notice that for each flip, you will see either heads (1) or tails (0) appear in the histogram count.

### Part (2)

1. Press the **Reset** button so that the count is cleared.
2. Make sure **Coins = 1** and **P(heads) = 0.5**.
3. This time press the “10 Flips” button 3 times so that you have 30 coin flips.

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## Learn By Doing (1/1 point)

Now that you have flipped the coin 30 times, what did you get for  $P(H)$ ? To calculate  $P(H)$  take the total number of heads (the count of the “1’s”) and divide by the total number of flips (30).

Your Answer:

$P(H) = 17/30$

Our Answer:

Since this is a small number of tosses, even though the coin is fair answers will vary and might be substantially different from 0.5.

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### Part (3)

1. Press the **Reset** button so that the count is cleared.
2. Make sure **Coins = 1** and **P(heads) = 0.5**.
3. Press the **Auto** button and watch the count of heads and tails change.
4. Press the **Pause (II)** button once **Total Flips** is over 1,000.

### Learn By Doing (1/1 point)

Describe what happened to the histogram as you flipped the coin at least 1,000 times.

**Your Answer:**

It evens out more and more and gets closer to 0.5!

**Our Answer:**

After 1,000 flips, the total number of heads (1's) should be approximately half the total number of flips meaning P(H) will consistently stay close to the classical probability of 0.5.

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The above Learn by Doing activity was our first example of the second way of determining probability: Empirical (Observational) methods. In the activity, we determined that the probability of getting the result "heads" is 0.5 by flipping a fair coin many, many times.

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