6.2.3 Interactive: Bayesian Updating

Consider a coin whose true probability of Heads, p, is unknown. Our goal is to learn about p, based on data obtained from flipping the coin. Of course, the coin is just a convenient example to think about. More generally, we would like to learn about the probability of success in a sequence of Bernoulli trials, a problem that arises in countless applications, such as looking at wins and losses in a series of games, or looking at successes and failures in a series of medical treatments.

In the *Bayesian* approach, we quantify our uncertainty about p by modeling it as a random variable. We give p a *prior* distribution (reflecting our knowledge or ignorance about p before performing the current experiment), obtain some data, and then use Bayes' rule to *update* our probabilities, obtaining the *posterior* distribution for p. In this interactive, you can choose your own prior by drawing it (in the artistic sense, not the statistical sense of drawing from a distribution!), simulate some data, and explore what happens to the posterior distribution.

Bayesian Updating - Directions for Use

1. Choose your prior PDF for p, by drawing it on the Prior graph (the vertical axis is unlabeled since the scale will automatically be taken to be whatever is needed so that the area under the curve you draw is 1). The outcomes of five prior flips of the coin are shown, to give you some concrete information about the coin (many of the controversies about Bayesian statistics stem from the question of how to choose the prior in the absence of such information).
2. Enter how many times you want to flip the coin, and then press "Go" to flip the coin that many times. The posterior PDF, obtained from Bayes' rule, is plotted in the Posterior graph. Press "Go" repeatedly to accumulate and more more data. Each time "Go" is pressed, the posterior distribution is updated based on the additional data.
3. When you want to have the true value of p revealed, press "Reveal True p".
4. Press "New Coin" to start over with a new coin.

> You Should Try:
>
> - For a variety of coins and priors, check what the posterior PDF looks like, compared to what the true value of p is, as the number of flips grows larger and larger.
> - For a complicated prior with a lot of peaks and valleys, when the number of flips is very small, check how similar the posterior is to the prior. As the number of flips increases, try to get a sense of how influential the prior is vs. how influential the data are, in determining what the posterior PDF looks like.

- Compare a flat prior (Unif(0,1), which is the default) to a "dogmatic" prior (a prior that expresses great confidence that p is close to a particular value, e.g., 1/2), in terms of how quickly the posterior converges to a distribution that is tightly concentrated around the true value of p.

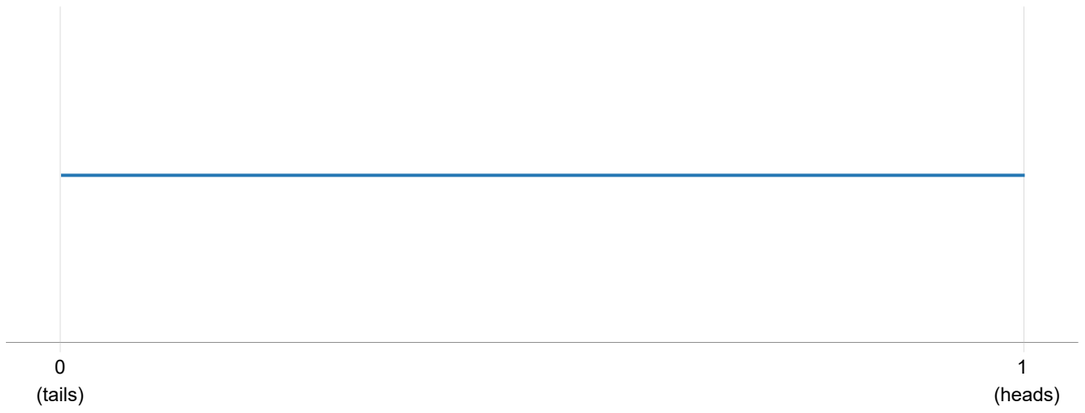
Input

Show screen reader enhancements: ☐

Outcomes of 5 prior flips: Heads, Tails, Heads, Heads, Tails

New Coin

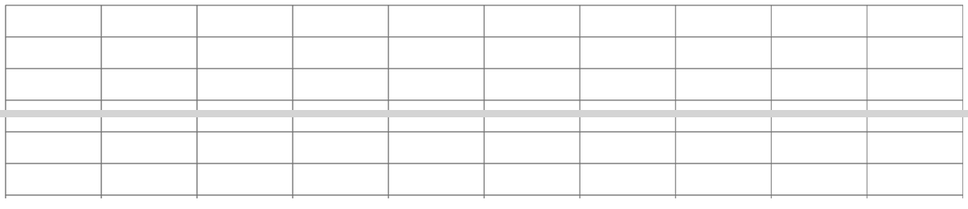
Prior

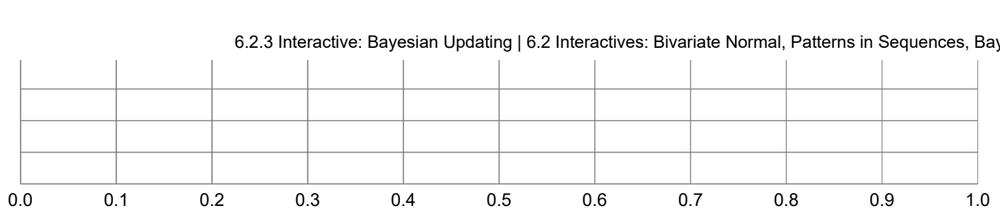


Reveal True p

Flip 100 **more times:** Go

Posterior





Total flips: 0

© All Rights Reserved