20 April 2012
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The graph on the right has more variability, so it has the higher standard deviation.
Some Coin Flipping Data

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We’ll first look at an Excel spreadsheet, Coin Flip Distribution.xlsx.
Excel isn’t the best way to simulate a large amount of data. The following charts were created with the program Maple. We used this program to demonstrate RSA encryption in the beginning of the semester.
Simulation of flipping 100 coins 1,000 times
Simulation of flipping 100 coins 10,000 times
Simulation of flipping 100 coins 100,000 times
Simulation of flipping 100 coins 500,000 times
Simulation of flipping 100 coins 1,000,000 times
As the number of flips gets larger and larger, the graph looks more and more regular.
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Does the shape of the graphs, especially the latter ones, look at all familiar?
The Bell Curve (or Normal Curve)
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The particular shape of the bell curve reflects the mean and the standard deviation. The center of the curve represents the mean. How wide or thin is the curve is an indication of the standard deviation. The larger the standard deviation the wider is the curve.
Bell Curves with Different Standard Deviations

For both of these graphs the mean is 50.
The blue and red graph have mean 0 and the green graph has mean $-2$. The blue graph has the smallest standard deviation, followed by the green graph, and finally by the red graph, which has the largest standard deviation.
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The following graphs represent a simulation of 50,000 people flipping a coin repeatedly. Each person determines the percentages of heads on their flips.

- The first graph represents each person flipping a coin 10 times and recording the percentage of heads.

- The third graph represents each person flipping 100 times.
Clicker Question

Which graph represents the most variability in the data?

A. The first graph
B. The second graph
The first graph has more variability. While nearly all the data of the second graph is between 40 and 60, a lot of the data in the first graph is outside that range.
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- 95% of all data is within 2 standard deviations of the mean.
- 99.7% of all data is within 3 standard deviations of the mean.
The letter \( \sigma \) is an abbreviation for the standard deviation, and \( \mu \) for the mean.
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Finding the area under a curve was one of the problems that led to the development of Calculus in the 17th century.
We’ll use the normal distribution to get some sense on how to tell if a coin is fair. Suppose you flip a coin and get at least 60% heads. Can you conclude the coin is unfair?
Suppose you flip a coin 10 times and get 6 heads. Do you think this is good evidence to conclude the coin is unfair?

A  Yes
B  No
No it really isn’t. If you flip a coin 10 times, you are pretty likely to get 6, or more, heads quite often.
Let’s suppose we flip a coin 100 times and get at least 60% heads. We can ask what is the probability that that happens. Let’s imagine we do this many many times. As our simulations indicate, we can consider the distribution of trials giving us a bell curve.
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Based on the data from Coin Flip Distribution.xlsx, the mean for this curve is 50% and the standard deviation is 5%. Then 60% is two standard deviations to the right of the mean. The amount of data to the right of 60% is then approximately 2.25% of the data.
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So, there is only about a 2% chance that flipping a coin 100 times results in at least 60% heads, but that is not so small. Unless you had a reason to think the coin might be unfair, it would probably be hard to argue from this data that the coin is unfair, even though it is not too likely to get at least 60% heads.
To think a little further about it, suppose a class of 100 students each flipped a coin 100 times. Even if everybody had a fair coin, we’d expect, on average, 2 of the 100 students to get at least 60% heads.
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Therefore, while getting this many heads isn’t too likely for any one person, with enough people it will happen.
Anonymous Poll Questions

The clicker software allows for anonymous poll questions. These work like other clicker questions, except that only the summary of the responses is saved. The data of how each person responded is not saved. Thus, the data is anonymous.
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We may have some anonymous poll questions in the remaining part of the semester. We will do one now.
An iclicker2 costs $44 new, and can be shared. By next semester the iclicker company should have software to allow use of a mobile phone to be used as an iclicker2. Currently a smart phone can be used as an iclicker (but not yet an iclicker2).
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If an instructor allows use of mobile phones in place of clickers, to use a mobile phone in this way a student needs to buy a subscription. A 6 month subscription costs $10.
Purchase **web>clicker** online

Please choose your subscription length:

- 180-day subscription: $10.00
- 1-year subscription (365 days): $16.00
- 2-year subscription (730 days): $22.00
- 4-year subscription (1460 days): $32.00

**Important:** Check with your professor before buying a web>clicker subscription. You will need to make sure your professor allows and has enabled web>clicker use in your course.

See [www.iclicker.com/purchase/](http://www.iclicker.com/purchase/)
If you had a class where clickers were used, which response most accurately represents you and your wishes.

A  I do not have a smart phone
B  I have a smart phone but would prefer to use my iclcker
C  I have a smart phone and would prefer to use it instead of an iclcker
Next week’s topic is interest rates. We’ll see some of the mathematics behind compound interest, loans, and annuities. We’ll also see the affect the interest rate has on a loan payment.
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While it isn’t absolutely required, it would be helpful if you have a scientific calculator or access to the web next week to do interest rate calculations.
For a data point to be more than 3 standard deviations to the right the mean, is this

A Very likely
B Somewhat likely
C Unlikely