# The binomial distribution

**Probability and Statistics**

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## 1 Simulating coin flips

In these exercises, you'll practice using the `rbinom()` function, which generates random "flips" that are either 1 ("heads") or 0 ("tails").

- With one line of code, simulate 10 coin flips, each with a 30% chance of coming up 1 ("heads").
- What kind of values do you see?

## 2 Simulating draws from a binomial

In the last exercise, you simulated 10 separate coin flips, each with a 30% chance of heads. Thus, with `rbinom(10, 1, .3)` you ended up with 10 outcomes that were either 0 ("tails") or 1 ("heads").

But by changing the second argument of `rbinom()` (currently `1`), you can flip multiple coins within each draw. Thus, each outcome will end up being a number between 0 and 10, showing the number of flips that were heads in that trial.

- Use the `rbinom()` function to simulate 100 separate occurrences of flipping 10 coins, where each coin has a 30% chance of coming up heads.
- What kind of values do you see?

## 3 Calculating density of a binomial

If you flip 10 coins each with a 30% probability of coming up heads, what is the probability exactly 2 of them are heads?

- Answer the above question using the `dbinom()` function. This function takes almost the same arguments as `rbinom()`. The second and third arguments are `size` and `prob`, but now the first argument is `x` instead of `n`. Use `x` to specify where you want to evaluate the binomial density.
- Confirm your answer using the `rbinom()` function by creating a simulation of 10,000 trials. Put this all on one line by wrapping the `mean()` function around the `rbinom()` function.

## 4 Calculating cumulative density of a binomial

If you flip ten coins that each have a 30% probability of heads, what is the probability at least five are heads?

- Answer the above question using the pbinom() function. (Note that you can compute the probability that the number of heads is less than or equal to 4, then take 1 - that probability).
- Confirm your answer with a simulation of 10,000 trials by finding the number of trials that result in 5 or more heads.

## 5 Varying the number of trials

In the last exercise you tried flipping ten coins with a 30% probability of heads to find the probability **at least** five are heads. You found that the exact answer was `1 - pbinom(4, 10, .3)` = 0.1502683, then confirmed with 10,000 simulated trials.

Did you need all 10,000 trials to get an accurate answer? Would your answer have been more accurate with more trials?

- Try answering this question with simulations of 100, 1,000, 10,000, 100,000 trials.
- Which is the closest to the exact answer?

## 6 Calculating the expected value

What is the expected value of a binomial distribution where 25 coins are flipped, each having a 30% chance of heads?

- Calculate this using the exact formula you learned in the lecture: the expected value of the binomial is `size * p`. Print this result to the screen.
- Confirm with a simulation of 10,000 draws from the binomial.

## 7 Calculating the variance

What is the variance of a binomial distribution where 25 coins are flipped, each having a 30% chance of heads?

- Calculate this using the exact formula you learned in the lecture: the variance of the binomial is `size * p * (1 - p)`. Print this result to the screen.
- Confirm with a simulation of 10,000 trials.