



Statistical building blocks

PSYC 11: Laboratory in Psychological Science

Jeremy R. Manning
Dartmouth College
Spring 2026

You already know how to *use* statistical tests

The intro-to-stats view

- Want to compare two group means? → t-test or ANOVA
- Want to see if two variables are related? → correlation or regression
- Want to test if categories are associated? → chi-square test
- ...etc.

But...

Where do those tests actually **come from**?

Today: learn to *make* your own statistical tests

The key idea

Every statistical test is built from the same basic recipe:

1. Pick a **distribution** that matches your data type
2. Set parameters to represent your **null hypothesis**
3. **Simulate** many datasets from that null distribution
4. Compare your **actual data** to the simulations and ask how unusual it is

That's it. Every test you learned in intro stats follows this exact recipe!

What kind of data did we collect?

Think about our survey...

On Monday you reported: sleep hours, stress (1—10), happiness (1—10), screen time, exercise days, caffeine, study hours, social activity (1—10).

- Which of these are **real numbers** (could be any value)?
- Which are **counts** (integers only)?
- Which are **bounded ratings** (e.g., 1—10 scale)?

Why does this matter?

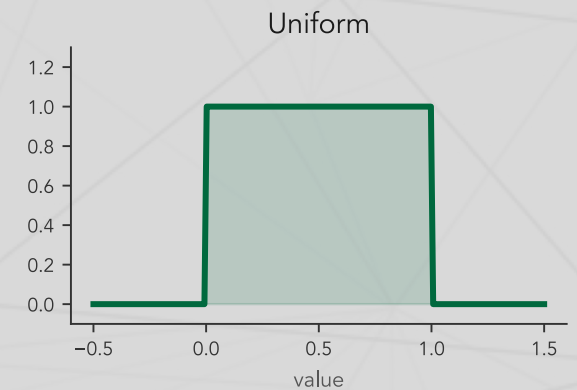
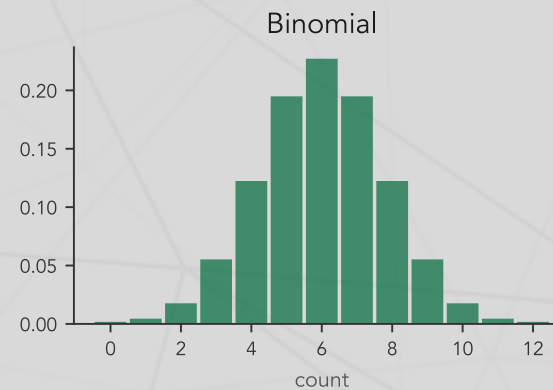
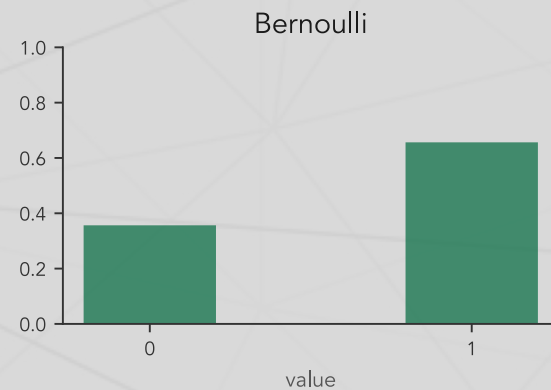
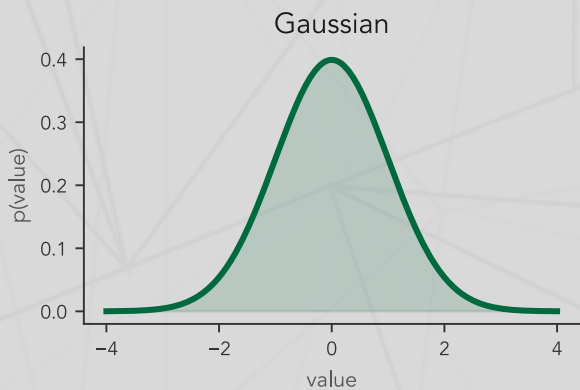
- Different types of data are generated by different **distributions**
- To build a test, you need to pick the right distribution for your data type
- This is the first step in the recipe for building a test!

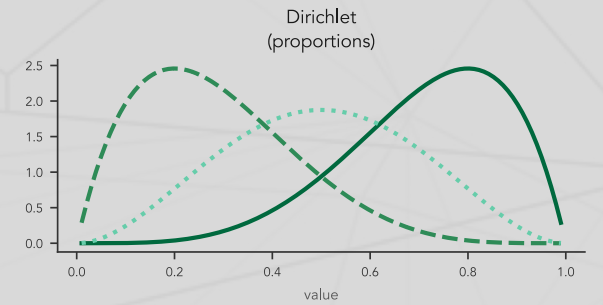
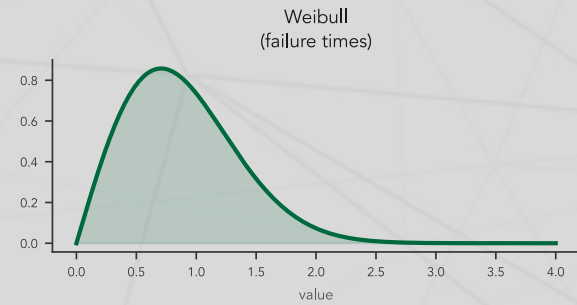
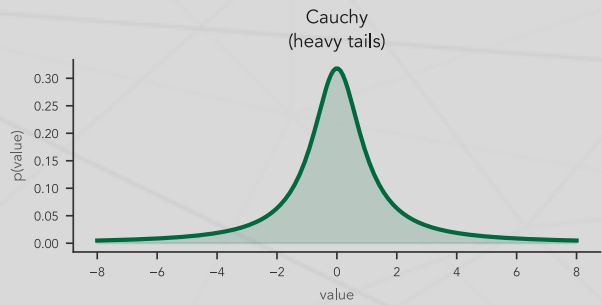
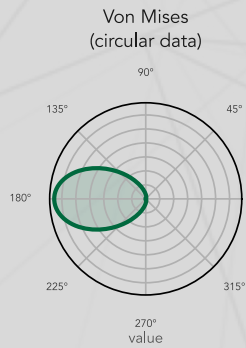
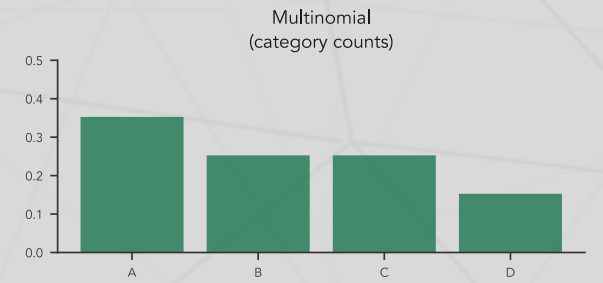
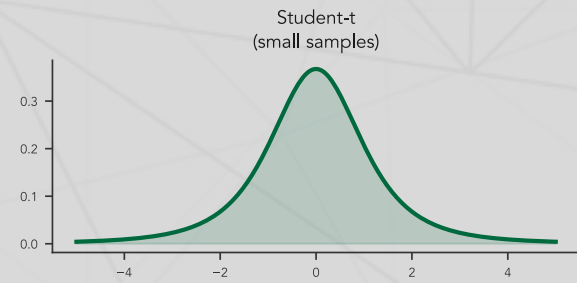
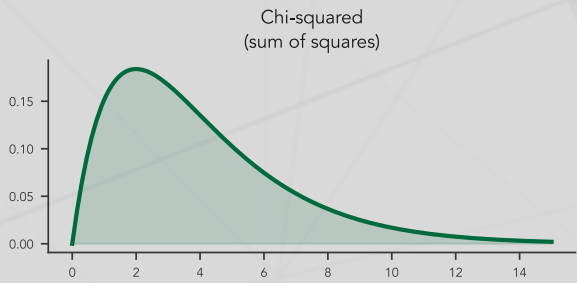
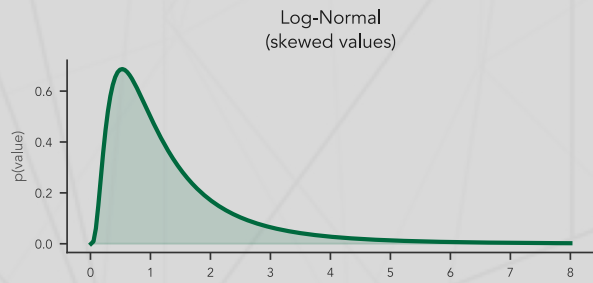
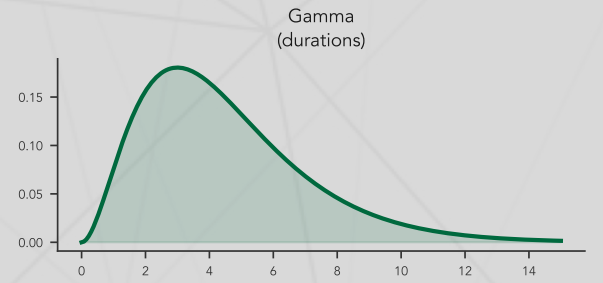
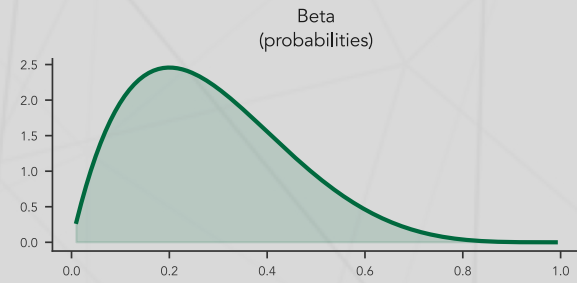
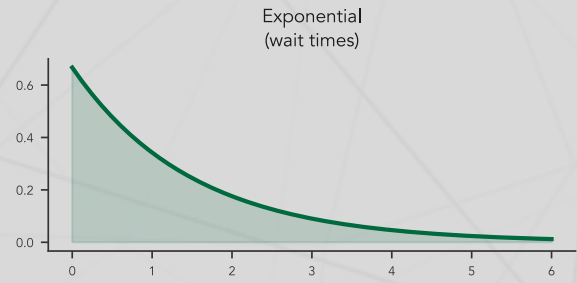
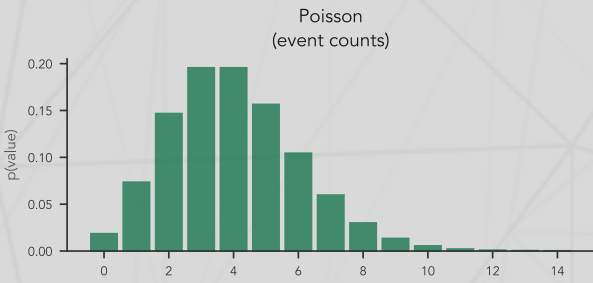
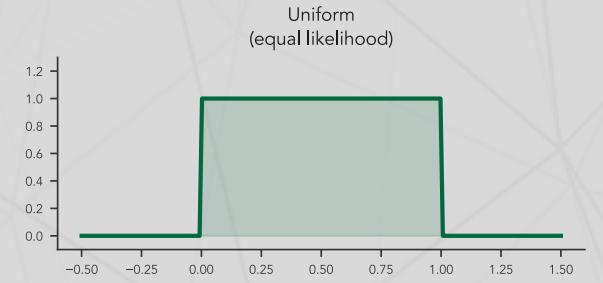
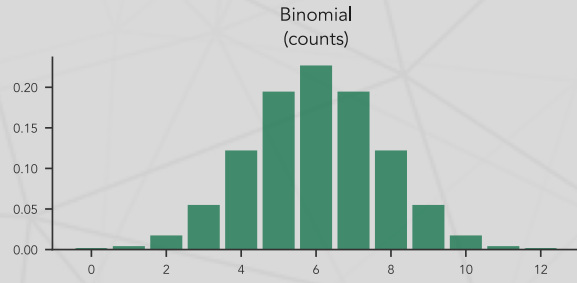
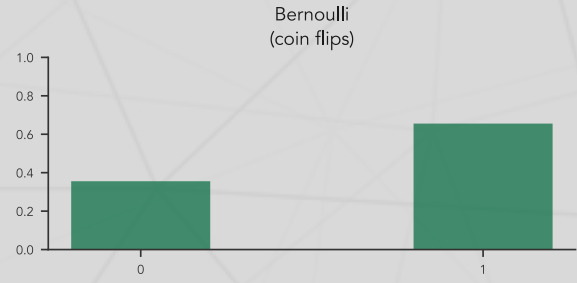
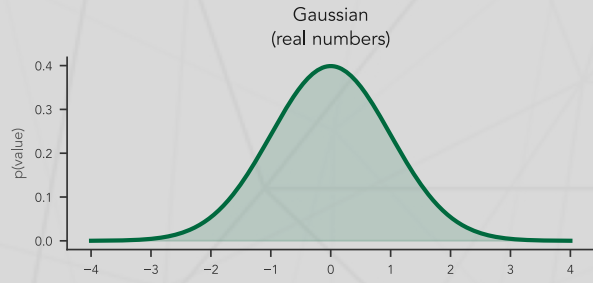
Distributions: the building blocks

What is a distribution?

A distribution is a mathematical object that generates data. Different distributions produce different types of values.

Distribution	Parameters	What you get out	Survey example
Gaussian	Mean, variance	Real numbers	Sleep hours
Bernoulli	Probability	0 or 1 (coin flips)	"Do you exercise?" (yes/no)
Binomial	N trials, probability	Count of successes	How many days/week do you exercise?
Uniform	Start, end	Number in range	If ratings were random





So how do we *build* a test?

The recipe (applied to our survey)

Question: "Do students who sleep more report less stress?"

1. **Pick a distribution:** If there's no relationship, stress scores for high-sleepers and low-sleepers should come from the **same** distribution
2. **Set null parameters:** Both groups have the same mean stress
3. **Simulate:** Randomly shuffle who's in which group 10,000 times, compute the mean difference each time
4. **Compare:** Is the *actual* difference between groups bigger than what we get from shuffling?

You can combine the blocks!

The distributions "work together" to build more sophisticated distributions and tests. For example we could create a distribution of coin flips of different types of coins by combining the multinomial distribution (which picks a coin) with the Bernoulli distribution (which flips the coin).

Let's talk it through: design your own test!

Breakout Groups (5 min)

Pick one of your hypotheses from Monday. For that hypothesis:

- What **distribution** would your data come from if the null hypothesis were true?
- What would you **simulate** to build a null distribution?
- What **statistic** would you compute to compare your actual data to the simulations?

Don't worry about getting it "right" — we'll work through this together!

Why does this matter?

Beyond the cookbook

- In intro stats, you pick from a menu of pre-made tests
- In real research, your question might not fit a standard test
- If you understand the **recipe**, you can build a test for *any* question
- This is also how modern computational statistics works: simulation-based testing

Let's try it with our actual data

Survey analysis notebook

This notebook lets you explore the class survey data and try building your own simulation-based tests!



Survey analysis notebook (Google Colab)

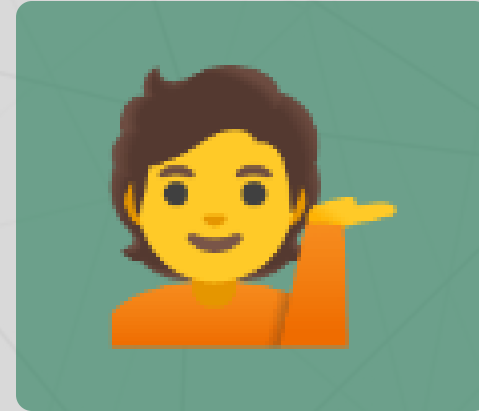
Questions? Want to chat more?



Email me



Join our Slack



Come to office hours

Up next...

- **Today:** play around with the survey data and try building your own tests
- **Thursday and Friday:** no class this week (I'll be away)
- **Next Monday:** Pitch lab starts. Read the lab instructions to prepare!