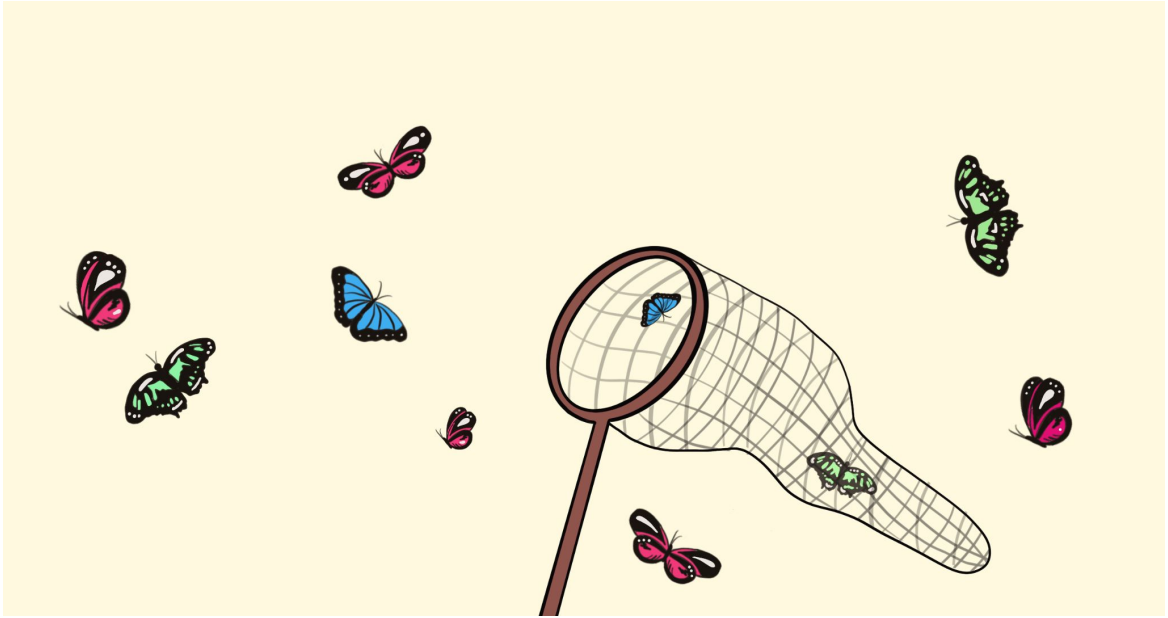
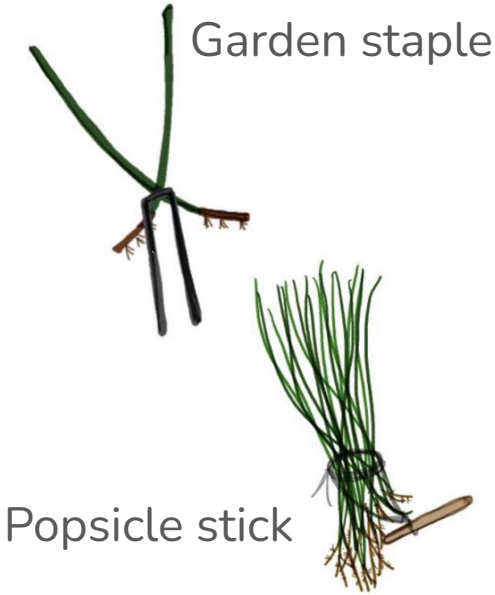
Week 4 Lecture 1:
Permutation and bootstrapping

EDS 222: *Statistics for Environmental Data Science*



Eelgrass restoration

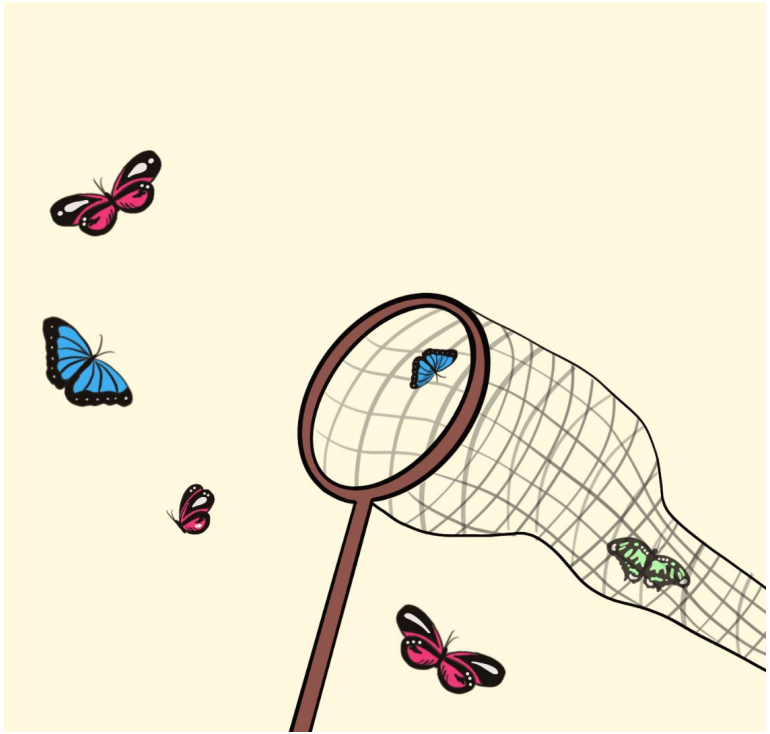
Photo: Hakai Institute



Artwork: Kat Beheshti

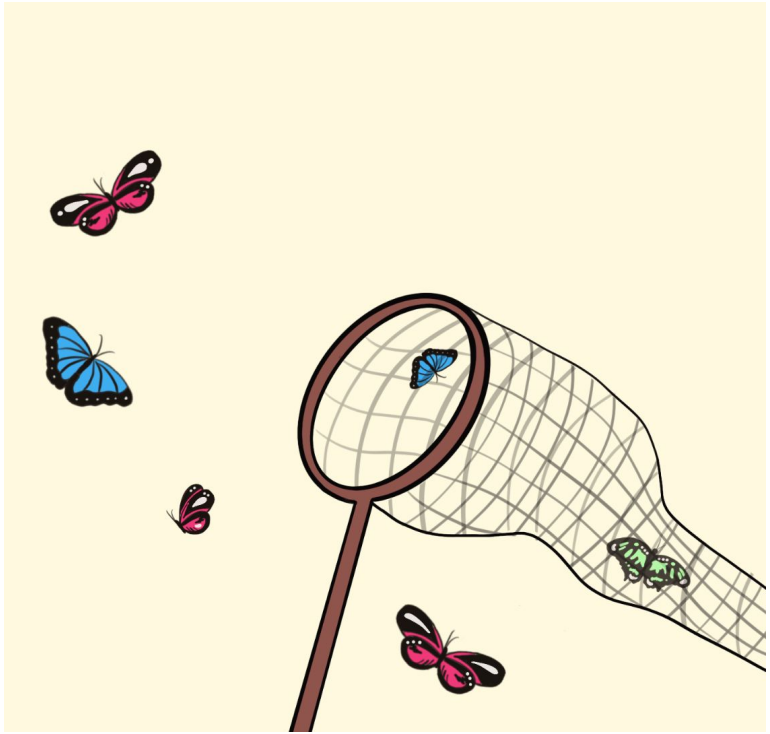
Today’s agenda

- ➔ Answering “yes or no?” questions with permutation
- ➔ Answering “how much?” questions with bootstrapping
- ➔ Permutation vs bootstrap

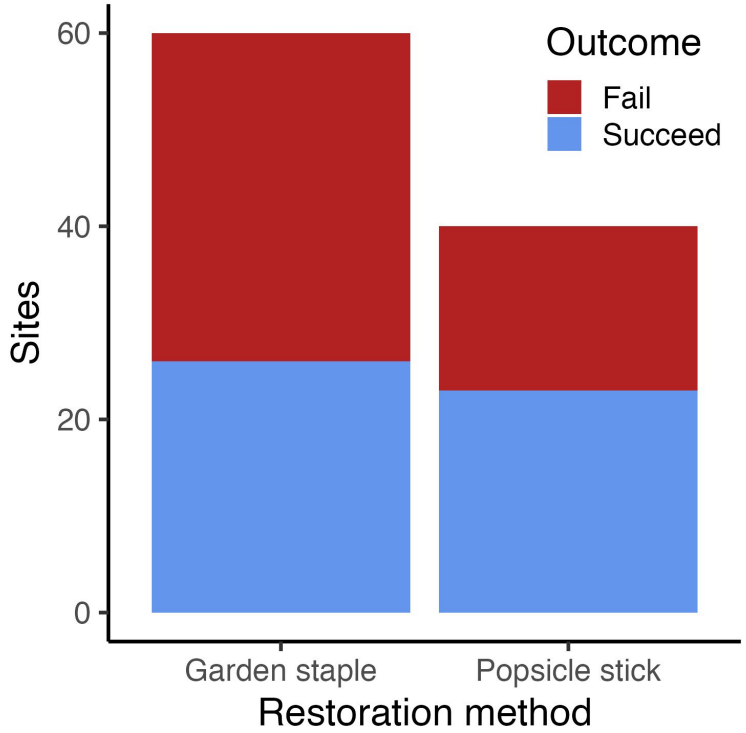


Today's agenda

- ➔ **Answering "yes or no?" questions with permutation**
- ➔ Answering "how much?" questions with bootstrapping
- ➔ Permutation vs bootstrap



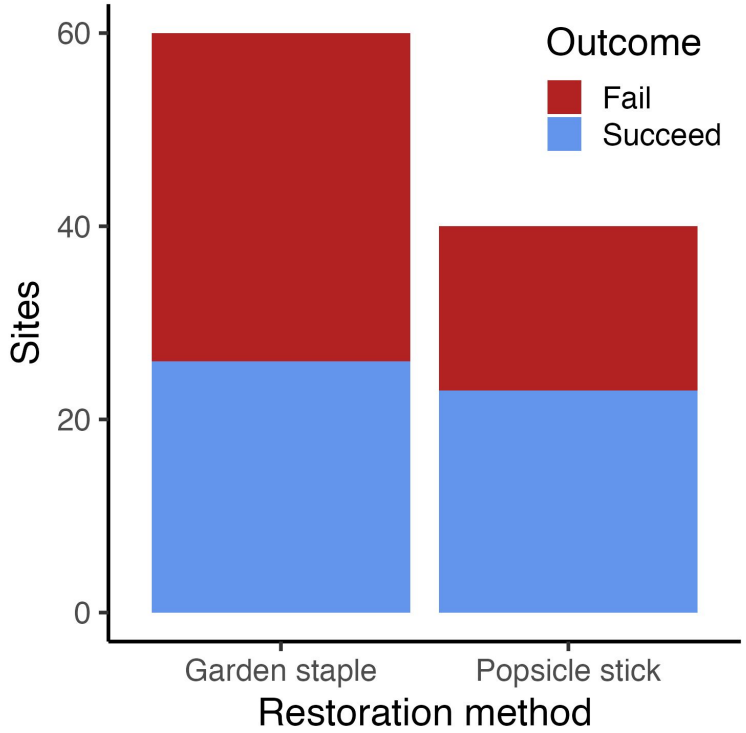
Restoration outcomes



Which method works better?

What statistic would you use to compare them?

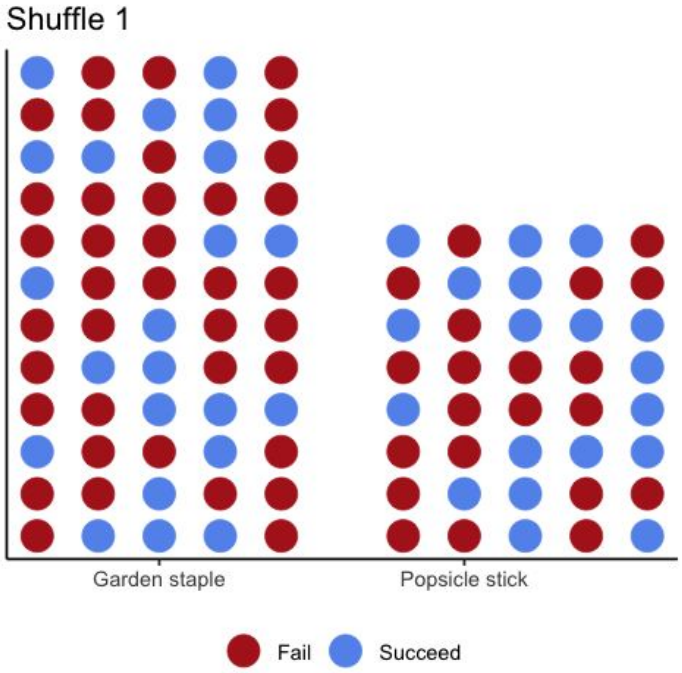
Restoration outcomes

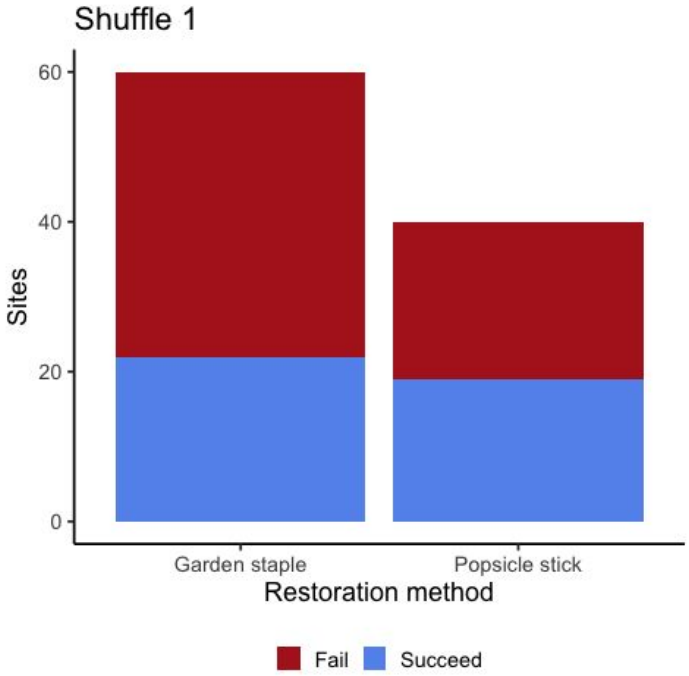


What's the hypothesis?

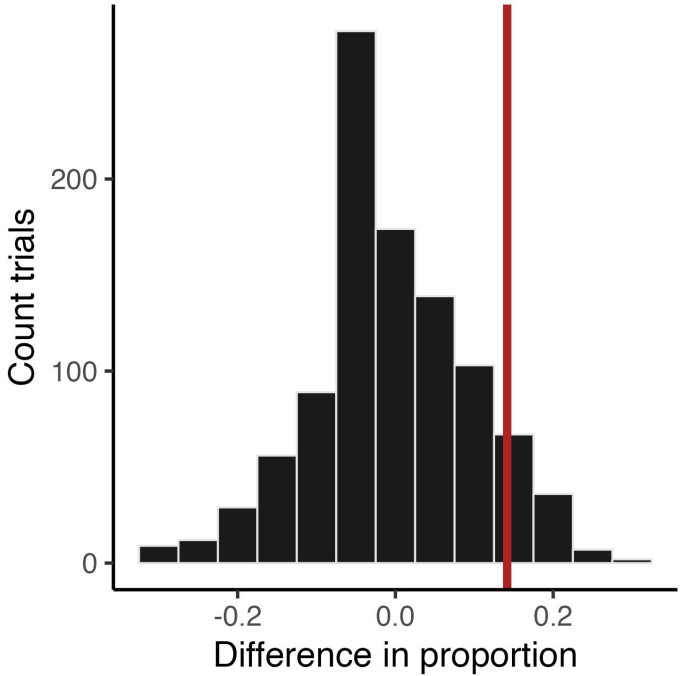
By chance?

By chance?


Shuffle 1
Garden staple
Popsicle stick
Fail
Succeed


Shuffle 1
60
40
20
0
Sites
Garden staple
Popsicle stick
Restoration method
Fail
Succeed

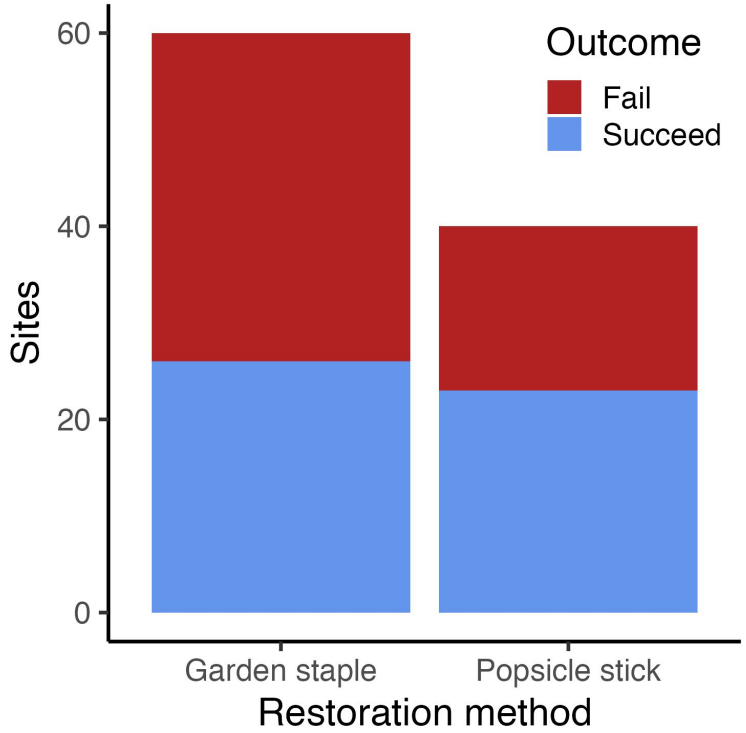
Null distribution and observed



Steps in hypothesis testing

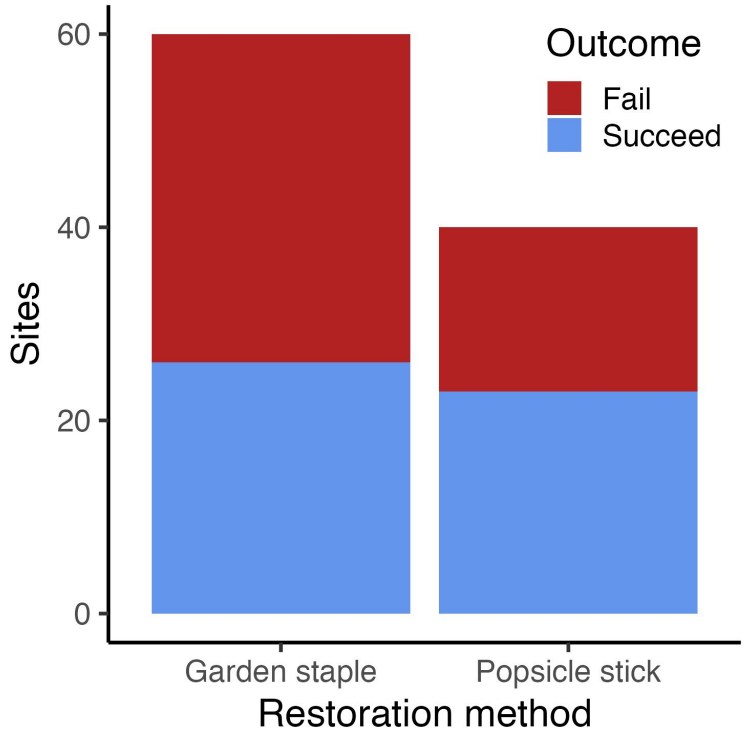
1. Identify the TEST STATISTIC
2. State your NULL and ALTERNATIVE hypotheses
3. Calculate the OBSERVED test statistic
4. Estimate the NULL DISTRIBUTION
5. Calculate P-VALUE
6. Compare p-value to CRITICAL THRESHOLD

Definitions and examples



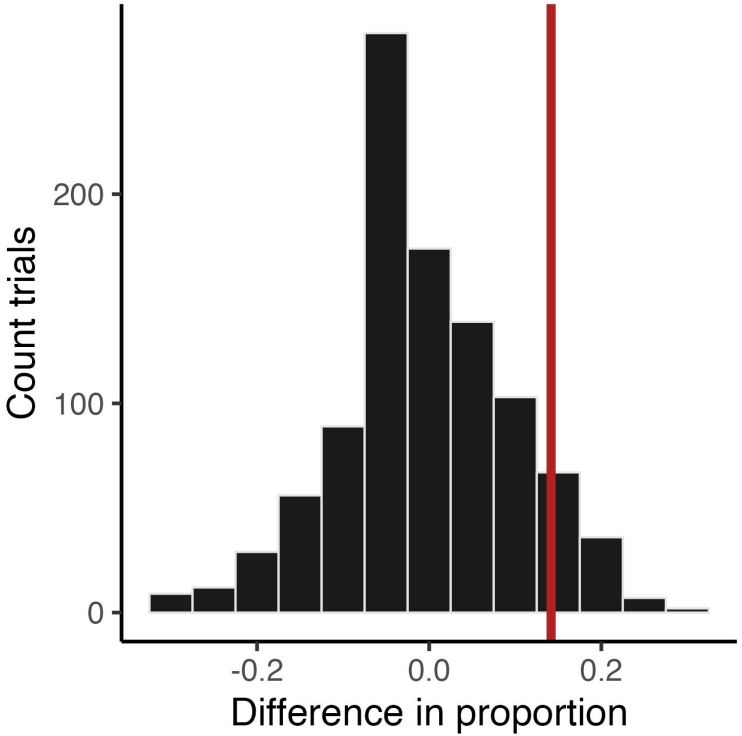
TEST STATISTIC

Definitions and examples



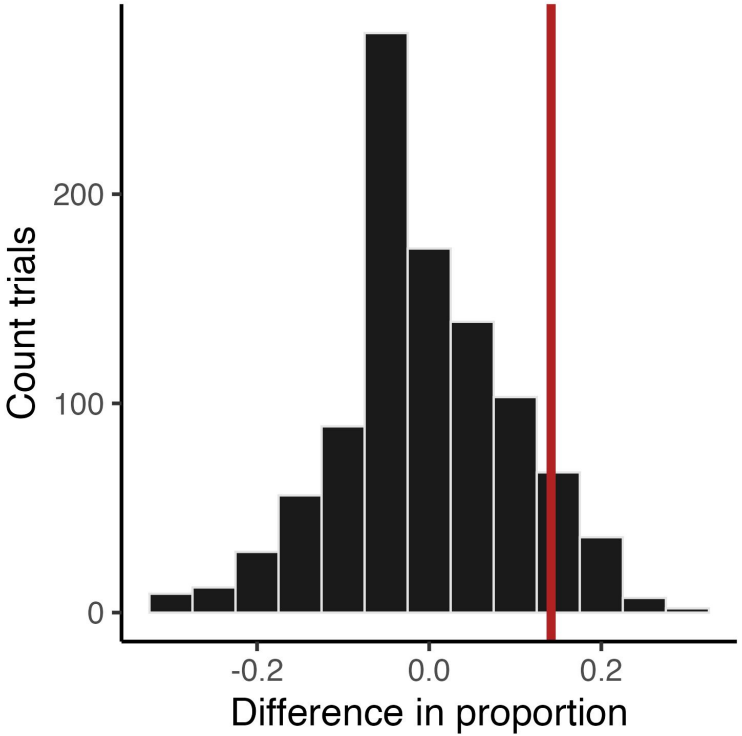
NULL AND ALTERNATIVE HYPOTHESES

Definitions and examples



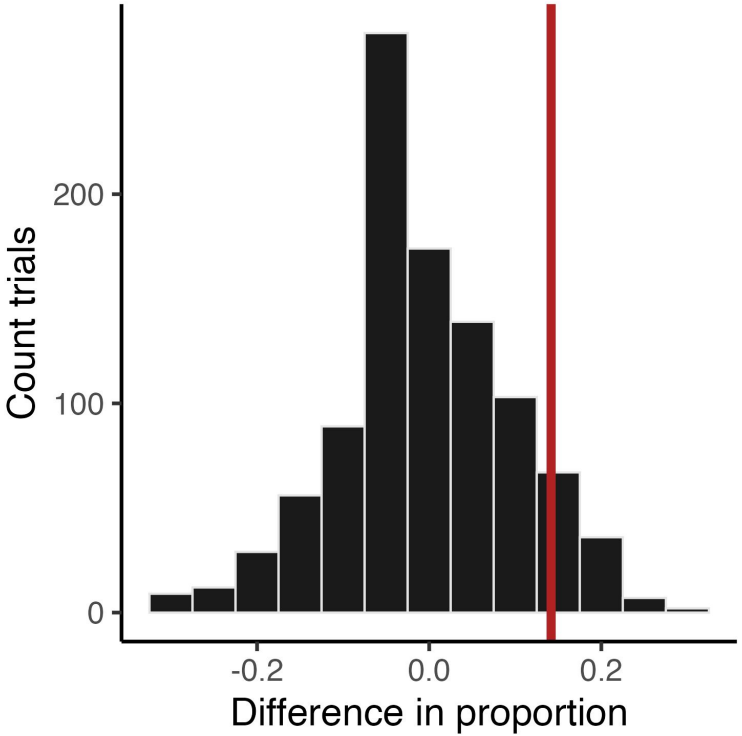
OBSERVED TEST STATISTIC

Definitions and examples



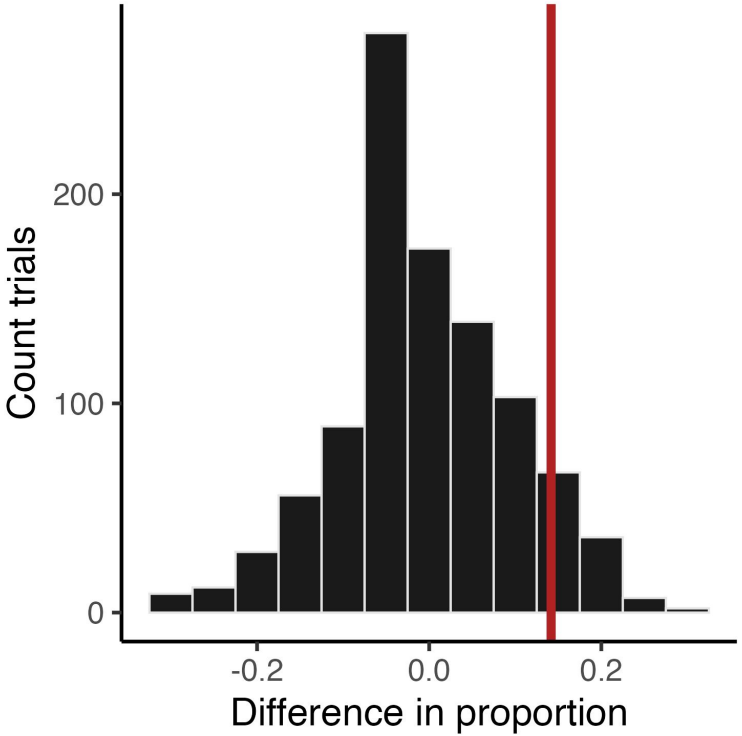
NULL DISTRIBUTION

Definitions and examples



P-VALUE

Interpretation



This is so counterintuitive!

Answering “yes/no?” with permutation

Today’s agenda

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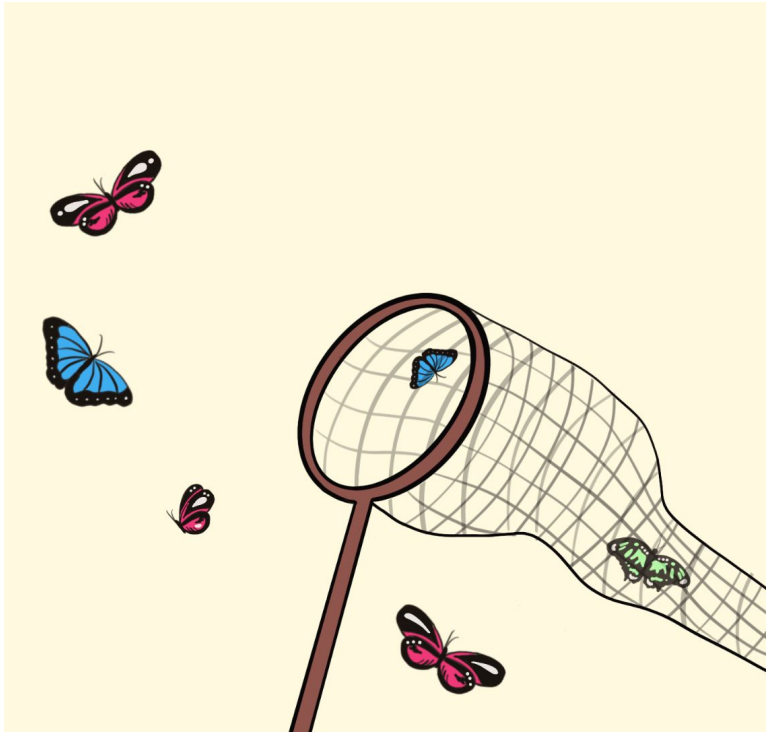
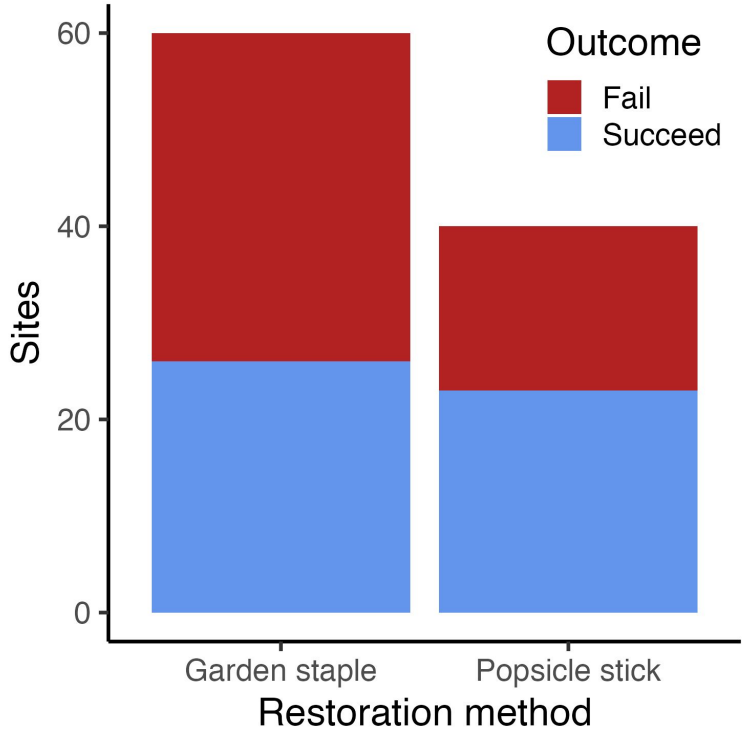
- ➔ **Answering “how much?” questions with bootstrapping**
- ➔ Permutation vs bootstrap

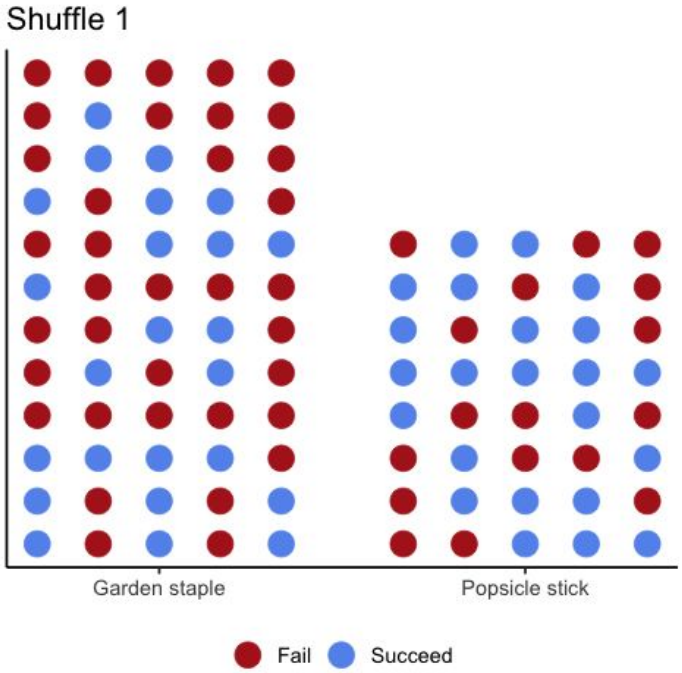


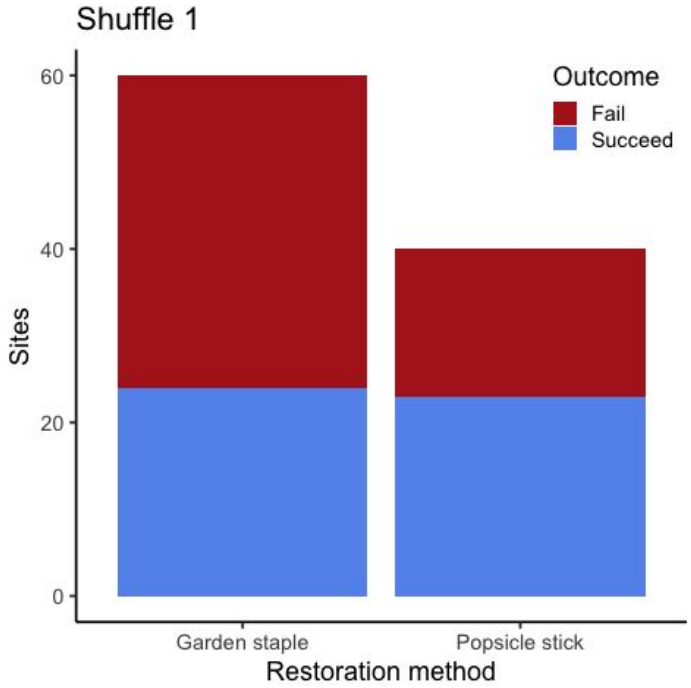
Restoration outcomes



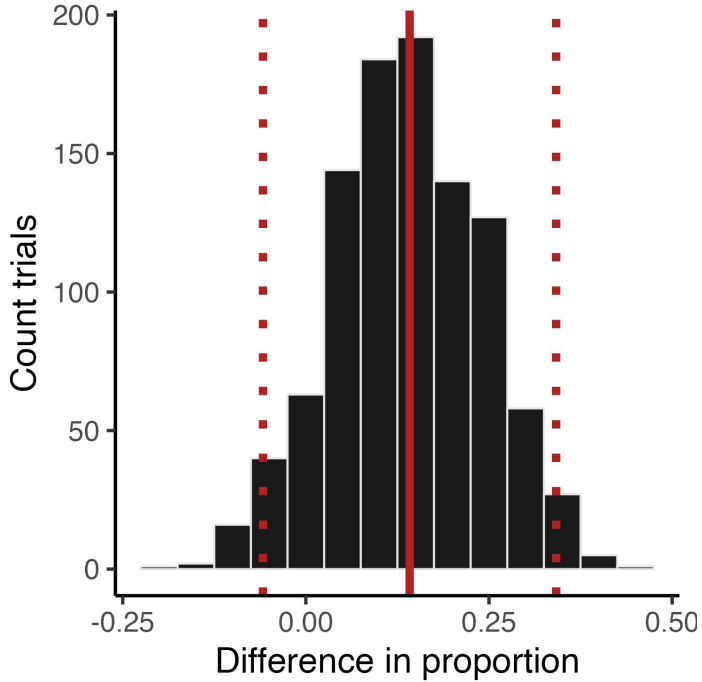
How big is the difference in proportions in the **population**?

Substitute sample for population





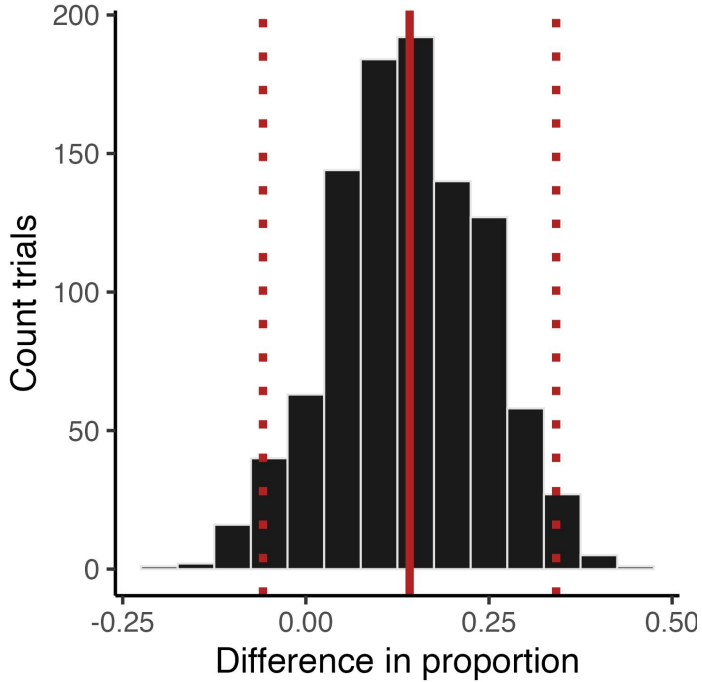
Bootstrapped test statistic



Steps in bootstrapping

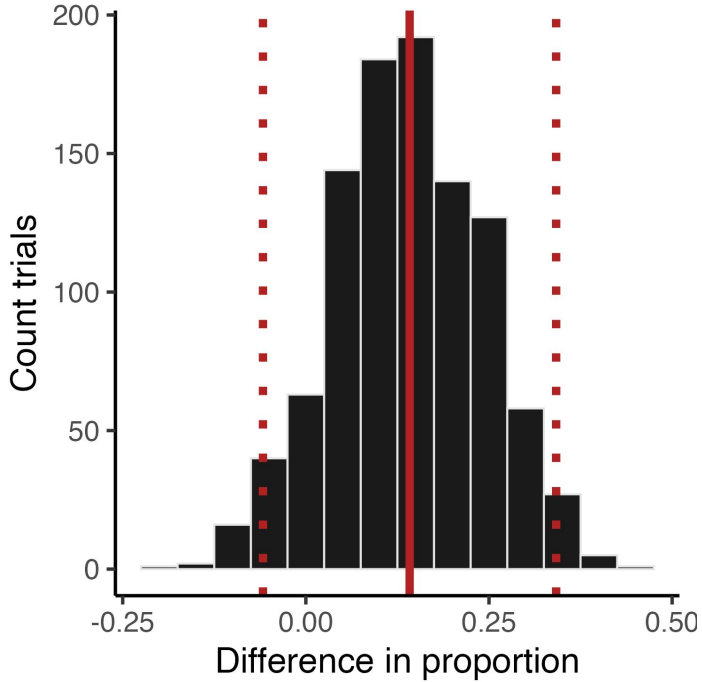
1. Identify the TEST STATISTIC
2. Substitute sample for population and draw BOOTSTRAP SAMPLES
3. Estimate the BOOTSTRAP DISTRIBUTION
4. Calculate CONFIDENCE INTERVAL

Definitions and examples



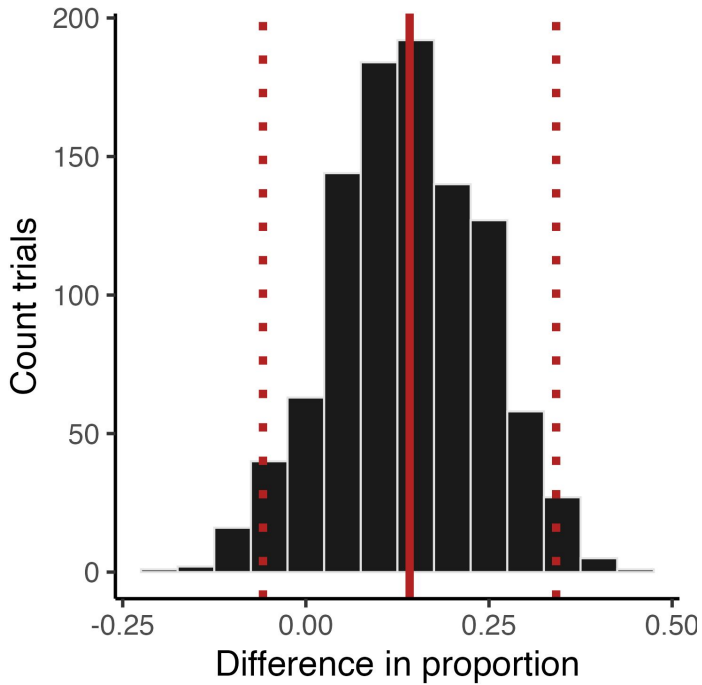
BOOTSTRAP SAMPLES

Definitions and examples



BOOTSTRAP DISTRIBUTION

Definitions and examples



CONFIDENCE INTERVAL

Answering “how much?” with bootstrap

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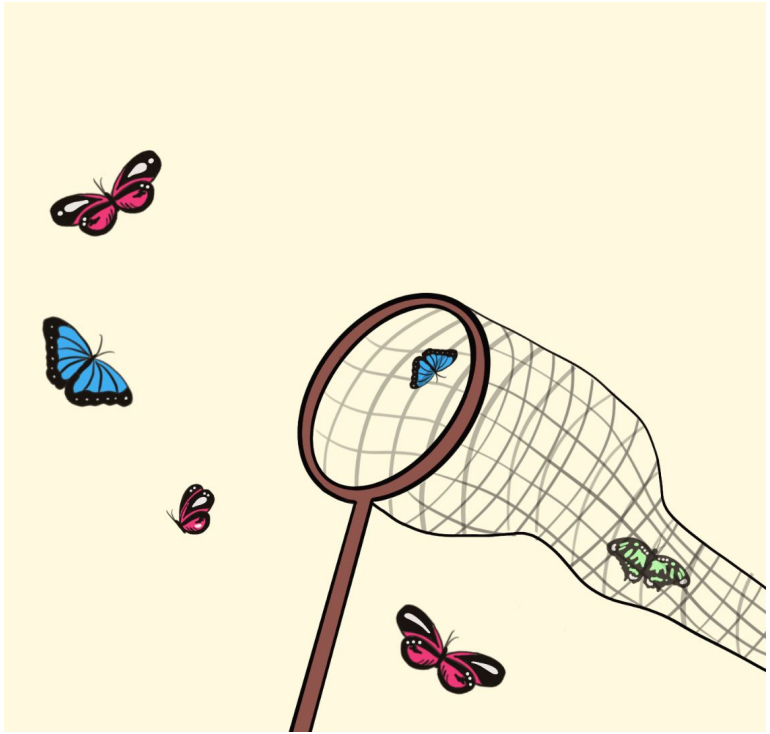
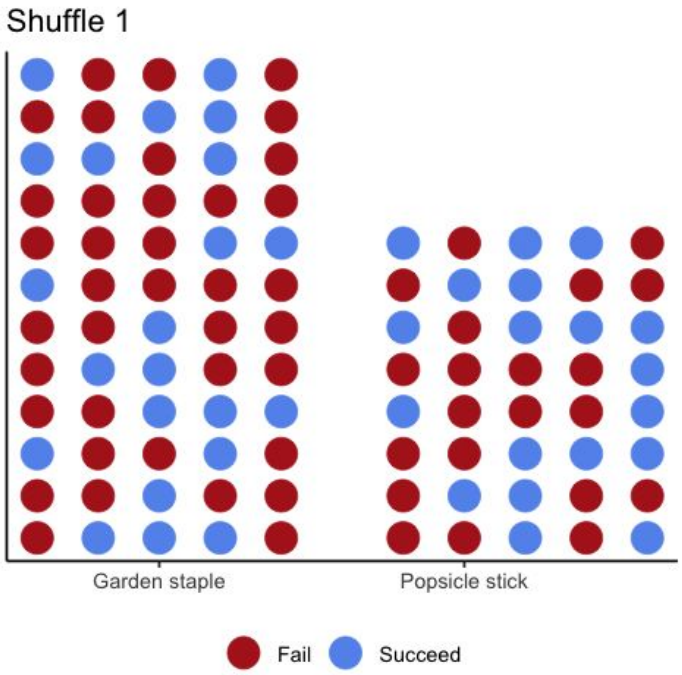
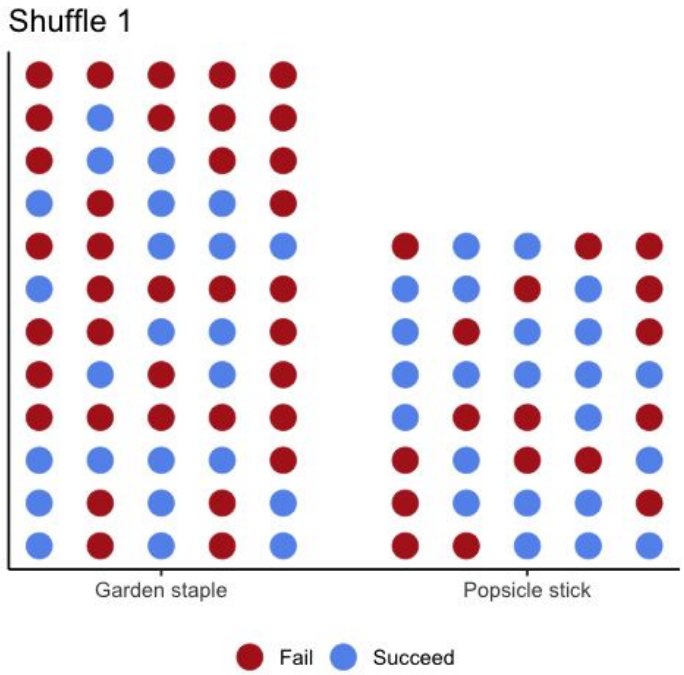
- ➔ **Permutation vs bootstrap**



Permutation vs bootstrap





Permutation vs bootstrap

Permutation vs bootstrap