

# Virtual Tactile Resampling for Permutations and Bootstraps

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## Simulation and Randomization

Tactile demonstrations using a deck of cards can help build intuition for sampling



Drawbacks:

- Limit to how many sets you can reasonably distribute
- Time required to sort / prepare decks
- Shuffling cards during class can be time consuming

## Online Alternatives

Existing online resources were lacking...



- No ability to customize deck composition
- Limited or missing visualizations
- Required user to download and install cumbersome programs

## A solution?

**Goal:** Create a lightweight card shuffler with appropriate visualization that could be used to replicate an in-class simulation activity.

**Tools:** R, ggplot2, shiny



## Activity

The first time I discuss hypothesis testing, I have students perform the following activity:

- Is Yawning contagious? In an experiment conducted on the tv show *Mythbusters*, 50 subjects were divided into two groups:
  - A seed group of 34 who were exposed to a yawn.
  - A control group of 16 who were not.
  - In the seed group, 10 of 34 later yawned. In the control group, 4 of 16 later yawned.
  - This gives a difference in proportion of 0.044 between seed and control.
- Students are asked to investigate how likely it would be to observe this result just due to chance if there were no relationship between exposure to a yawn and later yawning.
- Assume that the assignment of group labels is superfluous. A subject will yawn (or not) regardless of what group they are in.
- To simulate new samples under this hypothesis, we shuffle group labels among all subjects and compute the difference in proportions of the new groups.

To reproduce the activity of card shuffling, I have students use the following shiny app:

[https://chalkboardsonata.shinyapps.io/2\\_sample/](https://chalkboardsonata.shinyapps.io/2_sample/)

## Resampling for a Difference in Proportion

**Sample Options**  
Set the size and number of purple cards in each group

Sample size of group 1:

Sample size of group 2:

Number of purple cards in group 1:

Number of purple cards in group 2:

**Original Sample**  
A deck of 50 cards labeled 1 through 50 is split into 2 groups of sizes 34 and 16 respectively. The first 10 cards in group 1 and the first 4 cards in group 2 are colored purple.

group 1

31	32	33	34		
26	28	27	29	25	30
19	20	21	22	23	24
13	14	15	16	17	18
7	8	9	10	11	12
1	2	3	4	5	6

group 2

47	48	49	50
43	44	45	46
39	40	41	42
35	36	37	38

**Summary**  
Proportion of colors in each group

group	color	number	proportion
group 1	green	24	0.706
group 1	purple	10	0.294
group 2	green	12	0.750
group 2	purple	4	0.250

Pressing the Shuffle button below will shuffle all cards together and then put the first 34 cards into group 1 and the remaining 16 cards into group 2. This corresponds to permuting the group labels of all cards, while preserving each card's color (i.e. card 1 will always be purple, but may be in group 1 or 2 after shuffling).

Difference in proportion of purple cards between groups 1 and 2

**difference**

0.044