

Shuffle Test Lab

Use random reassignments to judge treatment differences.

HIGH SCHOOL • HSS-IC.B.5

CCSS.Math.Content.HSS-IC.B.5 "Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant."

NAME _____

DATE _____

PART 1 PRACTICE: THE SHUFFLE TEST

Find the observed difference in the two treatment rates. Then randomly shuffle the treatment labels many times and count shuffles with an absolute difference at least as large. The p-value is extreme shuffles divided by total shuffles. On this sheet, a p-value of 0.05 or less is significant.

WORKED EXAMPLE

Treatment A had 5 successes out of 7, and treatment B had 2 successes out of 7. In 70 label shuffles, 4 differences were at least $3/7$. Is the result significant?

1. Observed difference: $5/7 - 2/7 = 3/7$.
2. p-value = $4/70 = 2/35$, about 0.057.
3. Because 0.057 is greater than 0.05, the result is not significant.

**Answer: p-value = $2/35$, about 0.057.
The difference is not significant.**

PRACTICE 4 problems

- 1** 1. A randomized test gives treatment C a success rate of $11/15$ and treatment D a success rate of $8/15$. In 60 shuffles, 3 differences are at least as large as the observed difference. Find the p-value and decide whether the result is significant.

ANSWER _____

- 2** 2. Treatment E has 9 successes out of 12. Treatment F has 6 successes out of 12. Find the absolute difference in success rates.

ANSWER _____

- 3** 3. A simulation uses 100 shuffles. Seven shuffled differences are at least as large as the observed difference. Find the p-value and decide whether the result is significant.

ANSWER _____

- 4** 4. Group R has 13 successes out of 20, and group S has 11 successes out of 20. In 50 shuffles, 28 differences are at least as large as the observed difference. Find the p-value and state the conclusion.

ANSWER _____

APPLY IT Show your work

1

Part 2 APPLY: 1. A student club randomly assigns 18 volunteers to study in silence or with nature sounds, 9 students per treatment. Seven students in the silence group and four students in the nature-sounds group report better focus. In 90 shuffles, 8 differences are at least as large as the observed difference. Is there significant evidence that the sound setting affects reported focus?

WORK SPACE

ANSWER _____

2

2. A school randomly assigns 24 students to use either a new homework planner or their usual planner, 12 students per treatment. Ten students using the new planner complete every assignment, compared with five using the usual planner. In 120 shuffles, 3 differences are at least as large as the observed difference. Is the result significant?

WORK SPACE

ANSWER _____

CHALLENGE One step up

Part 3 CHALLENGE: In a randomized experiment, 12 students are split into two groups of 6. Exactly 6 students succeed overall. Group A has 5 successes and group B has 1 success. If all 924 possible random reassignments are considered, 74 give a difference at least as large as the observed difference. Find the exact p-value, decide whether it is significant, and explain why assignments with 0, 1, 5, or 6 successes in group A count as extreme.

WORK SPACE AND ANSWER

PART 1 • PRACTICE

#	PROBLEM	ANSWER
1	1. A randomized test gives treatment C a success rate of $11/15$ and treatment D a success rate of $8/15$. In 60 shuffles, 3 differences are at least as large as the observed difference. Find the p-value and decide whether the result is significant.	p-value = $3/60 = 1/20 = 0.05$. The result is significant.
2	2. Treatment E has 9 successes out of 12. Treatment F has 6 successes out of 12. Find the absolute difference in success rates.	$1/4$
3	3. A simulation uses 100 shuffles. Seven shuffled differences are at least as large as the observed difference. Find the p-value and decide whether the result is significant.	p-value = $7/100 = 0.07$. The result is not significant.
4	4. Group R has 13 successes out of 20, and group S has 11 successes out of 20. In 50 shuffles, 28 differences are at least as large as the observed difference. Find the p-value and state the conclusion.	p-value = $28/50 = 14/25 = 0.56$. There is no significant evidence of a treatment difference.

PART 2 • APPLY IT

1. **The observed difference is $7/9 - 4/9 = 1/3$. The p-value is $8/90 = 4/45$, about 0.089, so there is no significant evidence at 0.05.** Compute the rate difference, then divide 8 extreme shuffles by 90 total shuffles. Since $4/45$ is greater than 0.05, do not call the difference significant.
2. **The observed difference is $10/12 - 5/12 = 5/12$. The p-value is $3/120 = 1/40 = 0.025$, so the result is significant.** Use $3/120$ for the simulated p-value. Because $1/40$ is less than 0.05, the randomized experiment gives significant evidence of a planner effect.

CHALLENGE

p-value = $74/924 = 37/462$, about 0.080. It is not significant. Group A having 0 or 6 successes gives a difference of 1, and having 1 or 5 successes gives a difference of $2/3$, equal to the observed difference.

Accept equivalent fractions, terminating decimals, and correct approximations. For conclusions, accept wording that says there is or is not significant evidence of a treatment difference at the 0.05 cutoff.