

Lesson 25: Ruling Out Chance

Classwork

Opening Exercise

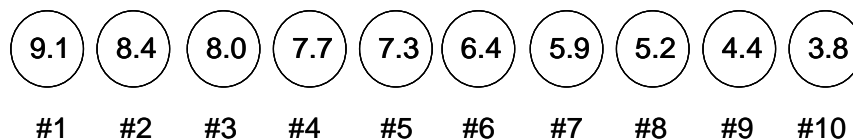
- a. Explain in writing what you learned about randomly divided groups from the last lesson. Share your thoughts with a neighbor.
- b. How could simulation be used to understand the "typical" differences between randomized groups?

Exercises 1–3: Random Assignments and Computing the Difference of the Group Means

Imagine that 10 tomatoes of varying shapes and sizes have been placed in front of you. These 10 tomatoes (all of the same variety) have been part of a nutrient experiment where the application of the nutrient is expected to yield larger tomatoes that weigh more. All 10 tomatoes have been grown under similar conditions regarding soil, water, and sunlight, but 5 of the tomatoes received the additional nutrient supplement. Using the weight data of these 10 tomatoes, you wish to examine the claim that the nutrient yields larger tomatoes on average.

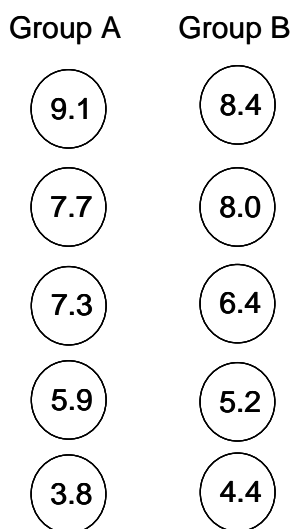
1. Why would it be important in this experiment for the 10 tomatoes to all be of the same variety and grown under the same conditions (except for the treatment applied to 5 of the tomatoes)?

Here are the 10 tomatoes with their weights shown. They have been ordered from largest to smallest based on weight.



For now, do not be concerned about which tomatoes received the additional nutrients. The object here is to randomly assign the tomatoes to two groups.

Imagine that someone assisting you uses a random-number generator or some other impartial selection device and randomly selects Tomatoes #1, 4, 5, 7, and 10 to be in Group A. By default, Tomatoes #2, 3, 6, 8, and 9 will be in Group B. The result is illustrated below.



2. Confirm that the mean for Group A is 6.76 ounces, and calculate the mean for Group B.

3. Calculate the difference between the mean of Group A and the mean of Group B (that is, calculate $\bar{x}_A - \bar{x}_B$).

Exercises 4–6: Interpreting the Value of a Difference

The statistic of interest that you care about is the difference between the mean of the 5 tomatoes in Group A and the mean of the 5 tomatoes in Group B. For now, call that difference “Diff.” $\text{“Diff”} = \bar{x}_A - \bar{x}_B$.

4. Explain what a “Diff” value of “1.64 ounces” would mean in terms of which group has the larger mean weight and the number of ounces by which that group’s mean weight exceeds the other group’s mean weight.
5. Explain what a “Diff” value of “–0.4 ounces” would mean in terms of which group has the larger mean weight and the number of ounces by which that group’s mean weight exceeds the other group’s mean weight.
6. Explain what a “Diff” value of “0 ounces” would mean regarding the difference between the mean weight of the 5 tomatoes in Group A and the mean weight of the 5 tomatoes in Group B.

Exercises 7–8: Additional Random Assignments

7. Below is a second random assignment of the 10 tomatoes to two groups. Calculate the mean of each group, and then calculate the value of “Diff” for this second case. Also, interpret the “Diff” value in context using your responses to the previous questions as a guide.

Group A	Group B
9.1	7.7
8.4	5.9
8.0	5.2
7.3	4.4
6.4	3.8

8. Here is a third random assignment of the 10 tomatoes. Calculate the mean of each group, and then calculate the value of “Diff” for this case. Interpret the “Diff” value in context using your responses to the previous questions as a guide.

Group A	Group B
9.1	8.4
7.7	8.0
7.3	6.4
5.2	5.9
3.8	4.4

Lesson Summary

In this lesson, when the single group of observations was randomly divided into two groups, the means of these two groups differed by chance. These differences have a context based on the purpose of the experiment and the units of the original observations.

The differences varied. In some cases, the difference in the means of these two groups was very small (or "0"), but in other cases, this difference was larger. However, in order to determine which differences were typical and ordinary vs. unusual and rare, a sense of the center, spread, and shape of the distribution of possible differences is needed. In the following lessons, you will develop this distribution by executing repeated random assignments similar to the ones you saw in this lesson.

Problem Set

Six ping-pong balls are labeled as follows: 0, 3, 6, 9, 12, 18. Three ping-pong balls will be randomly assigned to Group A; the rest will be assigned to Group B. "Diff" = $\bar{x}_A - \bar{x}_B$.

In the Exit Ticket problem, 4 of the 20 possible randomizations have been addressed.

- Develop the remaining 16 possible random assignments to two groups, and calculate the "Diff" value for each.
(Note: Avoid redundant cases; selecting "0, 3, and 6" for Group A is NOT a distinct random assignment from selecting "6, 0, and 3" – so do not record both!)

Group A Selection			"A" Mean	"B" Mean	"Diff"	
0	3	6	3	13	-10	Question #4
0	3	9	4	12	-8	
0	3	12	5	11	-6	
0	3	18	7	9	-2	
0	6	9	5	11	-6	
0	6	12	6	10	-4	
0	6	18	8	8	0	
0	9	12	7	9	-2	
0	9	18	9	7	2	Question #1
0	12	18	10	6	4	
3	6	9	6	10	-4	
3	6	12	7	9	-2	
3	6	18	9	7	2	Question #2
3	9	12	8	8	0	
3	9	18	10	6	4	
3	12	18	11	5	6	
6	9	12	9	7	2	Question #3
6	9	18	11	5	6	
6	12	18	12	4	8	
9	12	18	13	3	10	

2. Create a dot plot that shows the 20 "Diff" values obtained from the 20 possible randomizations. By visual inspection, what is the mean and median value of the distribution?
3. Based on your dot plot, what is the probability of obtaining a "Diff" value of "8 or higher"?
4. Would a "Diff" value of "8 or higher" be considered a difference that is likely to happen or one that is unlikely to happen? Explain.
5. Based on your dot plot, what is the probability of obtaining a "Diff" value of " -2 or smaller"?
6. Would a "Diff" value of " -2 or smaller" be considered a difference that is likely to happen or one that is unlikely to happen? Explain.