# WS #3 - Permuted Sampling Distribution
## Math 150, Jo Hardin

Wednesday, January 28, 2026

Your Name: _____

Names of people you worked with: _____

Introduce yourself. What did you do last Saturday? (No need to write down anything.)

**Task:** Consider the Back Pain & Botox example from class. The randomized clinical trial examined whether the drug botulinum toxin A (Botox) is helpful for reducing pain among patients who suffer from chronic low back pain. The 31 subjects who participated in the study were randomly assigned to one of two treatment groups: 16 received a placebo of normal saline and the other 15 received the drug itself. The subjects? pain levels were evaluated at the beginning of the study and again after eight weeks. The researchers found that 2 of the 16 subjects who received the saline experienced a substantial reduction in pain, compared to 9 of the 15 subjects who received the actual drug.

1. What is the null hypothesis in the study? Write it down in words and in symbols (parameters).
2. You have been given 31 cards, what are the red cards and what are the black cards?
3. Please shuffle the cards. Which part of hypothesis testing does "shuffle the cards" correspond to?
4. Deal the shuffled cards into groups of size 15 and 16. What are your two groups?
5. How many of your Botox patients had pain reduction? Is the value you got more extreme than the observed data or less extreme than the observed data?

**Solution:**

1. The null hypothesis is that Botox does not have any impact on back pain relief. In symbols, we write:
$$H_0 : p_{btx} = p_{pl}$$
where $p$ is the true (population) probability of pain relief.

2. Each card represents a single individual in the experiment. The red cards are the individuals who have pain reductions. The black cards are the individuals who did not have pain reduction.

3. When you shuffle the cards you are breaking the connection between the treatment and the response. There will be no connection between the color of the card (the outcome) and the treatment. We are forcing the null hypothesis to be true. (Additionally, we are forcing the groups to be similar on all other confounding variables as well.)

4. The group of size 15 are those who received Botox. The group of 16 are those who received the placebo.

5. I don't know what value you got, but most people in class should have gotten a result that was less extreme than the observed value of 9 Botox patients with pain relief.