

**Problem 1: Simulating the exit poll.**

In this problem we will carry out a simulation using the actual population proportion  $p = 0.54$ , that voted for Tim Walz in the 2018 Minnesota gubernatorial election.

To simulate an exit poll, :

- Go to [https://istats.shinyapps.io/SampDist\\_Prop/](https://istats.shinyapps.io/SampDist_Prop/)
  - On the left side of screen, set **Population Proportion**  $p$  as 0.54.
  - Set sample size  $n$  as 10, which represent a random sample of 10 voters. (Check "Enter Numerical Values for n and p")
  - Click 'Draw sample(s)'. Observe how 'Data distribution' and 'Sampling distribution'. Note that data distribution gives a simulated results of Tim Walz voters (success) among 10.
  - If we draw samples repeatedly, 'Data distribution' shows the most recent experiment result and 'Sampling distribution' shows the distribution of the sample proportion ( $\hat{p}$ ) with its mean and standard deviation.
- a. Simulate a sample of size 10. What is the sample proportion? (This represents (the number of voters vote for Tim Walz in your simulated sample) divided by 10)
- b. Simulate at least 10,000 samples of size  $n=10$ . What are the mean and standard deviation of the sampling distribution of sample proportion?
- c. Use a formula from Chapter 7 to predict/verify the value of the standard deviation of Sample proportion that you generated in part b.
- d. (True or False) Identify each of i, ii, iii is true or false. If false, explain why.

If we increase the sample size from 10 to 500:

- i the mean of sampling distribution of sample proportion increases.
  - ii the standard deviation of sampling distribution increases.
  - iii the shape of the sampling distribution becomes approximately normal.
- e. Simulate 10,000 samples of size  $(n) = 500$ . Based on the sampling distribution of sample proportion, give an interval where approximately the middle 95% of the distribution falls. (Use 68-95-99.7 Rule).

## Problem 2: Simulating customer expense

Zen's All You Can Eat Restaurant charges \$8.95 per customer to eat at the restaurant. Restaurant management finds that its expense per customer, based on how much the customer eats and the expense of labor, has an extremely skewed to the right distribution with a mean of \$8.20 and a standard deviation of \$3.

We will use a Web app (sampling distribution with continuous population distribution) ([https://istats.shinyapps.io/sampdist\\_cont/](https://istats.shinyapps.io/sampdist_cont/)) to simulate random samples from this population.

- GO to [https://istats.shinyapps.io/sampdist\\_cont/](https://istats.shinyapps.io/sampdist_cont/)
- Select "Skewed" under Select population distribution:
- Use the default skewness "Extremely right".
- Check the empty box next to "Enter population mean and st.dev" then enter 8.20 for the population mean, and 3 for population standard deviation.

- Set  $n$  (sample size) 10. Draw one sample. What are mean and standard deviation from your sample of 10 customers? What are the mean and standard deviation from the population of all customers? How are they different (what are they measuring)?
- Let  $\bar{X}_{10}$  the sample mean expense per customer based of a random sample of  $n = 10$  customers. Simulate 50,000 samples with this sample size. What are the mean and the standard deviation of the sampling distribution of  $\bar{X}_{10}$ ? (that is, find the mean of 50,000 sample means, and standard deviation of 50,000 sample means). Is the sampling distribution of sample mean  $\bar{X}_{10}$  approximately normal?
- Let  $\bar{X}_{100}$  be the sample mean expense per customer based of a random sample of  $n = 100$  customers. Find the mean and standard deviation of the sampling distribution of the sample mean expense per customer from 100 customers. Describe the shape of the sampling distribution.
- Suppose on a particular day, the restaurant had 100 customers that have the characteristics of a random sample from their customer base. Find the probability that the restaurant makes a positive profit that day, with the sample mean expense being less than \$8.95. (Hint : Find z-score of sample mean using  $z = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$ )