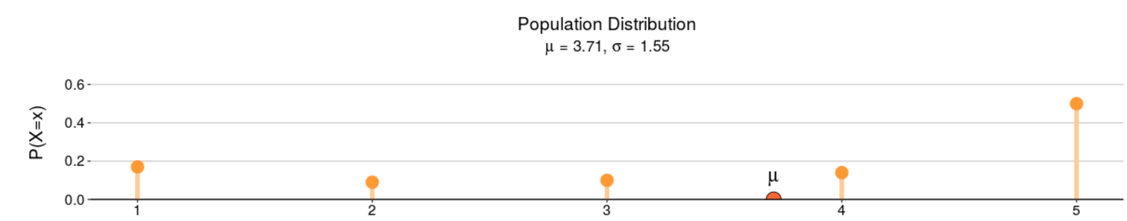
## Five-start Ratings simulation

In this lab handout we will carry out a simulation using our textbook student resource website.

- Click the following link to textbook student resource website. `https://media.pearsoncmg.com/ph/esm/esm_agresti_ast4e_17/cw/ast4e_student.html`)
- Click "Sampling distribution of a sample mean (discrete population distribution)" under Chapter 7.
- By default, "Amazon Star Rating (Fitbit wristband)" is selected.

1. (i) Describe the population distribution. (Shape, center, spread).



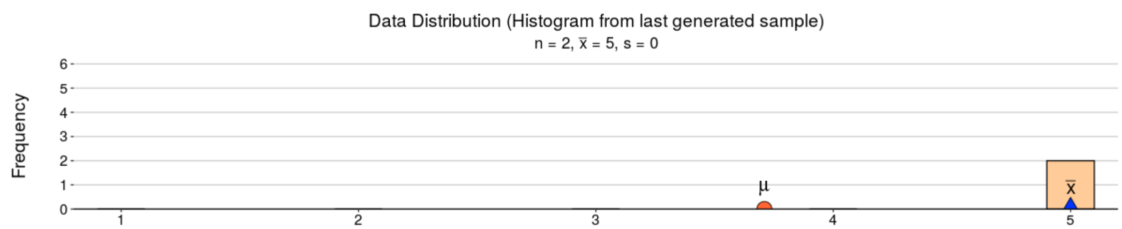

**Mean: 3.71, standard deviation : 1.55. Unimodal/bimodal, overall left-skewed. Most customers give a 5-star rating.**

2. For a randomly selected customer, what is the probability s/he rates the product with at least 4 stars?

**Let $X$ be customer rating.** $P(X \geq 4) = P(X = 4) + P(X = 5) = 0.14 + 0.5 = 0.64$

**Now suppose that a researcher wants to reach out a sample of 2 customers and ask them for their rating. To simulate this result, select sample size (n) 2 and draw 1 sample by clicking "Draw Sample(s)".**

3. What is the result of your simulated sample (Data distribution)? (e.g. 5 and 5). What is your sample mean and sample standard deviation? write them (result, sample mean, standard deviation) down on a piece of paper (we will use it in Part 6 below.) Compare the results with your neighbors. Do your neighbors have the same result as yours?

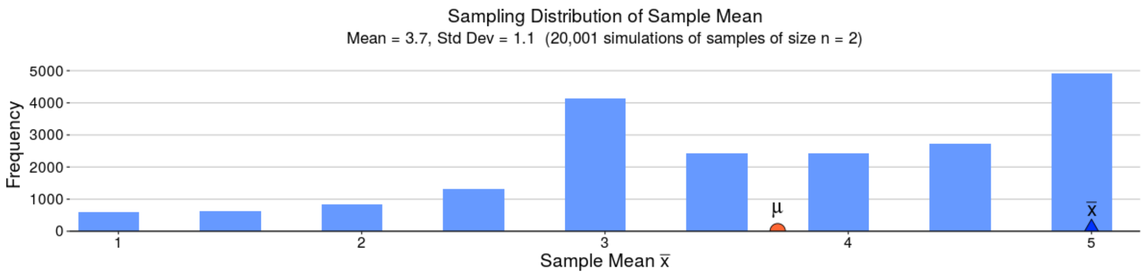



**sample mean =5, sample standard deviation 0. Answer may vary.**

4. Draw a few more samples of sample size n=2. Observe how data distribution and sampling distribution change.

5. Simulate at least 20,000 samples of size n=2. What is the mean and standard deviation of **sampling distribution of sample mean**? What is the shape of the sampling distribution? Is it approximately normal? Compare the result with your neighbors.

**Mean of sampling distribution 3.7, standard deviation of sampling distribution 1.1**
**Shape of distribution is bimodal. High frequency at $\bar{x} = 5$ and $\bar{x} = 3$. Overall slightly left-skewed.**




6. In class, we learned :

- standard deviation of probability distribution (population standard deviation) from Ch 6 $\sigma = \sqrt{\sum(x-\mu)^2 P(X=x)}$
- sample standard deviation $s = \sqrt{\frac{\sum(x-\bar{x})^2}{(n-1)}}$ from Ch 2
- standard deviation of sample proportion $\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}}$ from Ch 7
- standard deviation of sample mean $\sigma_{\bar{x}} = \sigma/\sqrt{n}$ from Ch 7.

Which formula do we use to obtain the standard deviation from Problem 3? Which formula do you use to obtain the standard deviation from Problem 5?

**In Problem 3, we use sample standard deviation $s$.** $\sum(x-\bar{x})^2/1 = (5-5)^2 + (5-5)^2 = 0$
**In Problem 5, we use standard deviation of sample mean** $\sigma_{\bar{x}} = \sigma/\sqrt{n} = 1.55/\sqrt{2} = 1.096$

**Repeat Problem 5 but this time use** $n = 30$.

7. Observe how mean and standard deviation of sample distribution change as sample size changes from $n = 2$ to $n = 30$. Does the shape of sampling distribution change?

**Mean remains the same, standard deviation decreases.**
**Sampling distribution of sample mean is approximately normal for a large sample size for any population distribution (by CLT).**

8. Suppose the researcher surveyed a random sample of 30 customers and found the sample mean rating is 4. Do you think this value of sample mean is usually large? Why or why not?

**Not unusually high according to the sampling distribution of sample mean with** $n = 30$ **from Problem 7**

9. How many standard deviation is this observed sample mean ($\bar{x} = 4$) away from the center of the sampling distribution?

$z = \dfrac{\bar{x} - \mu_{\bar{x}}}{\sigma_{\bar{x}}} = \dfrac{\bar{x} - \mu}{\sigma/\sqrt{n}} = \dfrac{(4 - 3.71)}{1.55/\sqrt{30}} = 1.0247$

**The observed sample mean $\bar{x} = 4$ is 1.02 standard deviations above the mean (center of sampling distribution).**

10. What is the probability a random sample of 30 customers has a sample mean larger than 4?

    $P(\bar{X} > 4) \approx P(Z > 1.0247) =$ `1-pnorm(1.0247)=0.1527`

You may select any different population distribution (fair die, unfair die, or continuous distribution at `https://istats.shinyapps.io/sampdist_cont/`) and repeat.