<u>**In-class Worksheet 11**</u>

Today's worksheet is an in-class activity with the goal of simulating a sampling distribution of sample means. The first part of the activity is for each of you to generate a list of sample means. After the data is gathered, the second part directs you to use the results of the entire class to analyze the outcome.

PART 1

1. Attached to this page is a copy of a random number table for the population of digits {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}. Assuming that this random distribution is uniform:

   (a) What is the population mean of the digits?

   Since the frequency of all digits is equally weighed, $\mu = \frac{0+1+2+3+4+5+6+7+8+9}{10} = 4.5$.

   (b) What is the population standard deviation of the digits?

   This could be done by hand (like the mean just was) or entering $L_1 = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$, `1-VarStats` indicates that $\sigma = 2.872281323$.

2. Repeat the following steps 10 times. In the end, you will have generated 10 different sample means. Please do NOT simply copy a classmate's values on this part, but please do your own work so that you really are generating your own list of sample means.

   (a) *Randomly* select a spot on the random number table.

   (b) Write down the next 10 digits listed from that spot horizontally (if you reach the end of a row, wrap around to the start of the next row to complete your list of 10).

   (c) Compute the mean of that sample of 10 random digits.

Sample	List of 10 digits	Sample mean
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

PART 2

1. Looking at the list of sample means, there should be a variety of values, but they are not uniformly distributed. What is the shape of the distribution for the sample means?

   This will certainly vary from section to section, but the distributions should be roughly single-mound, symmetric.

2. What is the mean of the sample means?

   Again, the specific answers will vary from section to section, but the outcome should be close to the population mean of 4.5.

3. What is the standard deviation of the sample means?

   Again, the specific answers will vary from section to section, but the outcome should not be too far from $\frac{2.872281323}{\sqrt{(10)}} \approx 0.9082951$.

4. In Section 6.5, one of the most critical theorems in statistics is introduced; the Central Limit Theorem. Essentially it says that a sampling distribution for sample means (where the sample size for all samples is n) will have a distribution close to a normal distribution. Further, the mean of the sample means will equal the population mean μ and the standard deviation of the sample means will equal $\frac{\sigma}{\sqrt{(n)}}$.

   How did the simulation the class do match up to the theorem?

   (a) Was the shape of the distribution of sample means approximately normal?
       Answers will vary.

   (b) Was the mean of the sample means close the the population mean μ?
       Answers will vary.

   (c) What was the sample size for our sample means?
       $n = 10$

   (d) Was the standard deviation of the sample means close to the value $\frac{\sigma}{\sqrt{(n)}}$?

       Answers will vary, but $\frac{\sigma}{\sqrt{(n)}} = \frac{2.872281323}{\sqrt{(10)}} \approx 0.9082951$.

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6 1 9 2 5     8 0 2 9 6     8 1 0 4 8     9 7 1 9 1     6 5 1 8 2     6 2 8 2 3     1 0 7 4 2     1 6 8 5 9
9 4 2 9 5     4 0 3 3 9     0 4 5 5 3     1 9 6 5 6     7 7 6 4 5     1 5 0 4 4     7 2 8 1 5     4 2 6 3 8
2 0 4 8 9     3 8 4 5 5     9 5 7 2 4     7 4 6 4 6     7 4 4 4 1     9 0 3 9 7     4 8 6 3 0     5 5 8 4 3
5 0 1 9 6     0 6 3 3 0     7 7 5 6 8     8 7 0 5 4     8 2 8 5 8     5 9 6 9 2     6 2 1 7 1     2 7 8 8 7
2 8 4 0 1     9 7 5 1 0     6 3 5 0 7     1 4 3 9 6     3 9 0 0 5     5 7 0 7 8     7 1 0 0 2     2 4 4 2 5
7 0 1 6 6     5 1 4 2 1     8 4 0 5 5     2 5 1 4 6     8 1 4 7 6     2 7 9 6 3     5 2 3 3 7     4 3 0 0 4
3 6 9 9 0     1 6 5 0 7     1 8 7 6 8     1 3 1 8 6     8 3 1 0 6     4 5 9 1 9     0 7 0 8 8     9 6 3 0 2
8 5 5 3 4     7 1 3 5 5     3 6 0 3 0     2 8 9 5 0     7 2 1 5 4     4 8 4 6 7     4 4 7 7 9     1 6 1 5 2
5 0 4 3 6     3 0 8 7 6     8 0 3 6 7     6 0 4 2 2     2 3 8 0 7     0 9 5 2 4     4 7 1 5 4     8 8 8 2 1
1 5 5 6 3     0 6 0 2 0     0 0 4 4 0     4 7 7 0 8     9 1 4 1 7     3 7 7 2 5     3 3 1 3 2     5 5 4 0 9
0 1 9 9 8     8 9 5 5 8     4 7 1 0 5     1 5 1 9 7     4 5 2 0 9     3 0 9 0 7     0 6 5 5 1     5 0 4 0 0
6 2 5 2 0     9 6 7 0 3     7 9 8 9 6     5 5 3 1 2     0 3 1 5 9     6 6 4 9 5     6 9 8 3 3     9 4 6 6 2
9 1 2 6 9     4 4 0 6 1     7 2 5 8 4     3 9 1 5 8     7 6 5 0 8     1 8 3 3 4     3 9 3 5 7     1 7 9 3 5
0 5 2 6 1     7 3 6 5 5     3 1 7 1 2     4 9 9 9 0     6 2 7 9 0     6 6 2 3 8     9 5 7 3 8     6 8 7 1 2
4 6 8 7 2     8 8 2 9 1     8 8 8 5 3     2 8 2 1 3     0 9 2 3 0     4 3 5 2 2     0 4 3 7 6     0 1 0 9 7
5 7 5 3 7     2 8 7 0 8     5 2 4 5 1     8 1 7 4 0     5 4 8 2 8     8 9 4 4 5     1 5 3 6 8     8 8 2 5 2
9 3 9 6 1     6 4 0 2 7     3 4 4 5 1     8 6 8 7 0     0 3 5 8 0     7 8 0 4 6     5 8 3 2 8     2 5 6 0 6
6 9 0 6 9     4 0 8 9 1     0 0 5 2 4     0 5 6 4 4     9 0 9 4 5     7 3 2 0 6     0 3 5 6 2     8 9 3 0 9
8 6 4 9 8     2 1 2 9 7     7 0 4 8 3     0 3 2 2 2     8 9 1 7 7     4 1 7 6 6     1 2 6 2 3     8 7 1 4 1
6 2 9 5 4     7 9 6 2 9     2 3 9 3 8     4 2 5 0 6     4 9 4 1 7     8 9 0 7 6     1 5 8 4 1     3 9 8 2 2
9 5 3 6 7     6 7 2 6 5     8 2 9 4 7     9 1 6 9 6     7 6 2 3 1     7 5 5 2 3     3 4 7 6 9     3 0 4 9 6
8 0 0 2 0     5 6 4 2 8     8 9 2 9 1     5 6 4 1 3     8 7 5 5 8     5 4 7 8 1     5 9 8 7 7     6 2 3 6 3
0 9 0 4 4     0 2 5 1 1     5 0 6 1 2     7 9 7 1 5     0 2 3 5 0     3 2 7 2 6     0 0 5 5 5     4 5 6 2 8
9 7 0 8 2     3 0 3 0 1     5 6 2 6 6     1 1 6 5 2     4 1 5 4 0     9 3 6 9 3     0 8 7 5 7     9 2 3 4 9
1 2 0 3 5     2 1 9 4 1     6 7 7 3 8     6 7 7 7 9     6 5 0 8 4     0 5 4 5 5     1 9 9 3 1     8 7 5 5 7
9 1 1 2 7     4 3 3 6 4     3 3 0 8 0     4 6 0 8 8     7 4 3 4 1     9 4 2 2 0     4 7 9 9 9     6 2 1 7 5
2 5 9 0 8     6 9 5 1 1     4 7 5 2 4     7 8 6 2 3     7 4 9 1 6     3 9 0 8 3     6 5 5 7 5     6 4 0 5 0
7 8 7 2 2     6 5 8 4 5     1 4 5 7 0     6 5 3 1 6     0 0 2 2 8     4 9 1 1 4     8 6 8 0 1     7 9 8 8 1
7 0 6 1 4     1 5 4 0 7     8 7 4 4 6     9 0 2 9 6     7 6 8 8 6     5 5 7 1 2     9 9 4 7 5     7 8 6 4 0
8 7 3 7 5     7 3 6 4 9     9 0 2 2 4     6 6 0 8 7     9 7 6 7 4     5 1 4 9 0     3 3 6 7 4     3 3 0 6 2
4 9 0 2 0     1 7 4 1 9     4 6 1 8 0     9 2 2 2 3     0 0 4 3 5     4 8 3 1 9     0 5 8 3 5     1 5 2 5 9
1 7 1 6 6     1 1 3 8 1     6 3 5 1 5     3 1 2 8 5     7 9 6 3 7     6 1 0 5 9     5 4 9 2 3     8 7 0 8 8
7 6 8 0 0     5 7 1 8 7     9 3 2 4 8     6 3 7 9 2     1 6 9 9 4     0 7 9 7 2     7 5 3 3 7     2 7 5 5 9
6 4 9 0 8     2 2 9 7 1     7 0 8 3 7     3 0 0 4 0     5 5 4 9 7     6 8 4 9 6     3 1 0 1 7     1 0 3 2 9
9 6 5 4 4     6 0 4 5 3     2 1 9 5 6     5 6 3 8 5     5 3 3 6 6     3 5 7 1 7     4 3 4 0 2     8 0 3 9 7
2 0 7 4 6     0 2 6 5 6     8 2 8 9 0     9 5 2 5 6     7 0 3 4 6     7 8 1 1 8     5 3 8 8 5     6 6 5 9 4
0 9 8 9 2     0 3 8 5 8     7 9 4 6 6     2 5 2 3 0     5 1 6 9 6     2 5 1 9 1     5 1 1 9 2     7 5 9 7 8
8 1 8 5 8     6 7 6 5 3     8 5 1 6 7     0 3 5 5 5     9 9 3 2 7     0 2 3 5 4     2 0 9 4 1     6 7 5 0 9
8 4 7 2 0     3 2 5 2 3     1 7 9 7 9     4 3 3 3 4     1 6 6 9 5     0 8 9 2 1     9 7 8 4 9     8 2 6 5 2
7 2 5 8 7     4 0 1 3 5     6 1 0 6 7     0 3 4 8 6     1 4 8 2 3     2 9 2 0 0     9 2 7 1 9     0 4 4 7 4
5 6 1 8 4     3 4 9 8 3     7 6 3 4 1     1 6 5 5 8     5 4 5 0 1     9 0 5 7 9     3 6 4 2 3     2 1 8 8 5
2 7 4 5 0     9 0 6 8 0     5 8 3 8 8     7 6 5 8 6     1 1 4 6 3     3 5 7 2 9     0 8 4 9 3     7 4 7 9 4
2 2 1 4 5     8 7 1 0 3     2 7 7 3 1     2 7 2 6 5     5 8 0 3 9     8 6 7 8 7     3 9 2 7 2     5 9 7 1 7
4 0 8 9 5     9 2 1 6 0     8 0 2 5 2     2 4 6 2 0     3 2 4 7 1     5 4 7 6 3     4 5 1 1 5     6 7 2 0 2
6 8 7 4 8     5 8 2 2 8     6 1 0 6 1     8 4 6 3 1     7 4 5 2 8     6 5 7 3 4     4 4 9 5 9     4 0 2 1 2
1 9 1 1 3     6 2 3 9 8     1 7 0 3 3     6 2 0 3 9     6 4 8 1 0     3 6 1 4 9     7 2 6 3 2     7 1 2 9 4
8 2 7 3 7     6 6 6 8 8     7 6 9 2 3     5 6 4 1 6     7 6 1 1 6     6 0 8 7 0     9 1 0 6 4     2 6 8 6 7
2 9 1 5 1     0 7 6 8 1     8 7 9 4 7     0 5 5 1 5     1 5 9 9 8     8 5 1 7 4     0 9 1 0 1     6 4 3 3 1
6 6 2 2 2     9 3 9 6 5     4 1 5 8 6     4 8 4 1 7     4 1 7 7 2     2 5 7 8 4     0 5 0 9 4     7 6 4 1 9
1 0 2 3 4     5 9 0 2 0     7 0 8 7 2     7 4 0 9 9     4 5 7 8 8     8 3 1 3 7     6 3 2 2 2     1 2 5 2 2
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