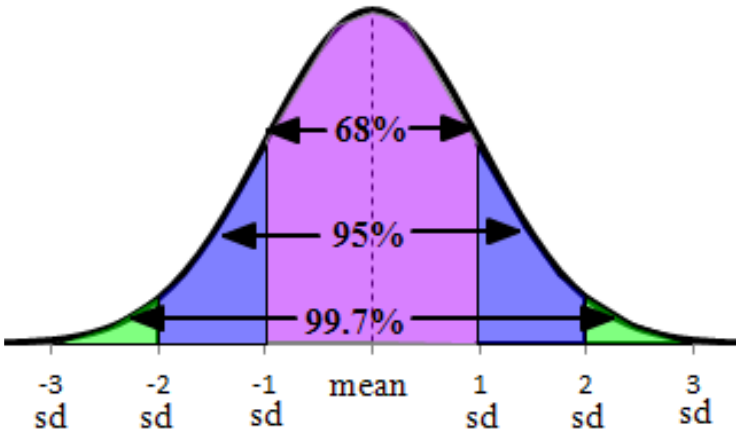
Margin of Error Notes

When we use a simulation to model an event, it is only an approximation of the population parameter. If we were to run the simulation numerous times, each result would be slightly different. However, it is possible to give an interval that the population parameter falls within by finding a margin of error.

A margin of error is not a mistake; rather it refers to the expected range of variation in a survey or simulation if it were to be conducted multiple times under the same procedures. The margin of error is based on the sample size and the confidence level desired. The interval that includes the margin of error is called the **confidence interval** and is usually computed at a 95% **confidence level**. A **confidence level of 95%** means that you can be 95% certain that the actual population parameter falls within the confidence interval.

For example, the student body officers at your school conducted a survey to determine whether or not a majority of the students dislike the music played in the hall during class changes. They randomly interviewed students and determined that 52% of the students disliked the music with a margin of error of 3% that was calculated at a 95% confidence level. Can the student body officers say for certain that over half of the student body dislikes the music? The confidence interval for this situation is or 49% to 55%. The confidence level of 95% allows us to say that we are 95% confident that the true percentage is between 49% and 55%. However, it is plausible that the percentage of students who dislike the music is less than 50%. Therefore, it is probably not wise to approach the administration about changing the music just yet.

When calculating the means from several trials of a simulation, the results are normally distributed. Recall that in a normal distribution 68% of the data falls within 1 standard deviation of the mean, 95% of the data falls within two standard deviations of the mean, and 99.7% of data falls within three standard deviations of the mean. We can use the fact that 95% of the data is within 2 standard deviations of the mean to find a margin of error with a 95% confidence level.



VOCABULARY

The **margin of error** accounts for the variation in results if the study or simulation were to be conducted multiple times under the same conditions. It does account for the random selection of individuals but it does not account for bias.

A **confidence interval** provides a range of plausible values for a population parameter. It can be found by using the sample statistic and the margin of error for the confidence level desired, i.e. sample statistic $\pm$ margin of error.

The **confidence level** determines how likely it is that the actual population parameter falls on the confidence interval that was calculated using the sample statistic and the margin of error.

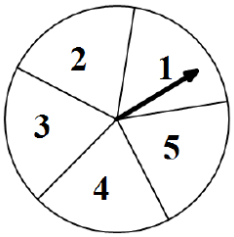
Calculating the Margin of Error

The following formulas can be used to approximate the margin of error with a 95% confidence level:

1. If you are given a sample proportion, then the margin of error can be approximated by: margin of error $= 2 \cdot \sqrt{\frac{\rho(1-\rho)}{n}}$, where ρ is the sample proportion and n is the sample size.
2. If you are given sample mean and standard deviation, then the margin of error can be approximated by: margin of error $= 2 \cdot \frac{s}{\sqrt{n}}$, where s is the sample standard deviation and n is the sample size.

Example 1:

A spinner like the one shown at the right was spun 30 times and the number it landed on was recorded as shown below.



1	2	3	4	5
𝍸 |	𝍸	𝍸 |	𝍸	𝍸 𝍸

For each situation, find:

a. the sample proportion
b. the margin of error for a 95% confidence level
c. the 95% confidence interval for the population proportion
d. Determine if the theoretical proportion would be within the confidence interval.

1. The probability of the spinner landing on 2

2. the probability of the spinner landing on 3

3. the probability of the spinner landing on 5

Example 2:
A fast food restaurant manager wanted to determine the wait times for customers in line. He timed the customers chosen at random.

Wait Time in Minutes		
6.4	9.3	3.9
4.3	6.4	4.8
6.7	3.7	5.4
4.0	3.3	5.9
4.5	8.1	2.6
2.9	4.4	3.1
6.0	5.5	5.9
3.6	8.0	3.7
7.7	8.1	9.4
9.9	9.4	2.6

a. Find the mean and standard deviation for the sample. Use a graphing calculator. (Round answers to the nearest tenth) If you do not have one, ***http://www.numberempire.com/statisticscalculator.php*** works well.

b. Approximate the margin of error for a 95% confidence level and round to the nearest tenth.

c. Find the 95% confidence interval.

d. Interpret the meaning of the interval in terms of wait times for customers.