**Point Estimation & Confidence Intervals**

**Estimator :** A sample statistic (such as the sample mean ) used to approximate a population parameter.

**Point Estimate :** A single value (or point) used to approximate a population parameter. The sample mean  is the best point estimate of the population mean .

**Confidence Interval (or interval estimate) :** A range (or an interval) of values that is likely to contain the true value of the population parameter.

**Degree of confidence :** The probability 100% that the confidence interval contains the true value of the population parameter. (The degree of confidence is also called the level of confidence or the confidence coefficient.)

**Critical Value :** The number on the borderline separating sample statistics that re likely to occur from those that are unlikely to occur. The number  is a critical value that is a z-score with the property that it separates an area of  in the right tail of the standard normal distribution. (The value of - is at the vertical boundary for the area of  in the left tail.)

**Margin of Error (*E*) :** The maximum likely ( with probability  ) difference between the observed sample mean  and the true value of the population mean . Also called the maximum error of the estimate. 

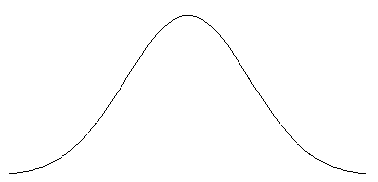
**Calculating *E* when  is known :**

1. If n>30, we can replace  by the sample standard deviation *s*.
2. If n<30, the population must have a normal distribution and we must know .

**Round-Rule for Confidence Intervals used to Estimate** 

1. When using the original set of data to construct a confidence interval, round the confidence interval limits to one more decimal place than is used for the original set of data.
2. When the original set of data is unknown and only the summary statistics ( *n*, , *s* ) are used, round the confidence interval limits to the same number of decimal places used for the sample mean.

**Point Estimation :**



1-







 For the distribution of sample means for sample size n from

an infinite population we have :

Mean = 

Standard Deviation = 







**Margin of Error**

**or**

**Maximum Error**

**of Estimate**

**for n > 30**

 🡨Maximum Error



**Confidence Statements – your conclusion**

With \_\_\_\_\_\_% confidence, the true <*parameter of interest*> is between \_\_\_\_\_ and \_\_\_\_\_ <*units*>.

Recall that a **parameter of interest** can be: population mean, population standard deviation, population proportion, difference in population means, difference in population standard deviations, or difference in population proportions

**Example #1:**

An efficiency expert intends to use the mean of a random sample of size 40 to estimate the average time it takes auto mechanics to perform a certain task. If based on experience, the efficiency expert can assume that minutes, what can we assert with a probability of 99% about the maximum size of his error?

**Confidence Intervals for Means**









We can assert with a probability of 100% confidence that this interval contains the population mean we are trying to estimate based upon large sample ( n > 30). Use .

**Length of Confidence Intervals**

The ultimate goal of determining confidence intervals is that one should strive for a high level of confidence and a narrow interval.



Determining the length of the confidence interval for  does not depend on , but it does depend on  and n, in the following manner :

1. For a given sample size, if the level of confidence is raised, the interval will be wider and estimation will be less precise. On the other hand, if the interval is made narrower so estimation is more precise, then the confidence level must be lowered.
2. The quantity appears in the numerator of the formula listed above. Therefore, the length of the interval will be large if  is large and small if  is small. Notice that  is a population characteristic and the experimenter has no control over its value.
3. Since n appears in the denominator of , then the width will be small if n is large. Thus, if a very high accuracy in estimating  is desired (a narrow confidence interval with a high degree of confidence is desired), then a way to accomplish this is by picking an appropriately large sample.

How large a sample for estimating  ? n > 30

**Example #2:**

The dean of a college wants to use the mean of a random sample to estimate the average amount of time students take to get from one class to the next, and she wants this estimate to be in error by at most .25 minutes with a probability of 95% where minutes. How large a sample will she have to take?

**Example #3:**

From past records, the seasonal rainfall in a county when observed over sixteen randomly picked years yielded a mean rainfall of 20.8 inches. If it can be assumed from past experience that rainfall during a season is normally distributed with inches, construct confidence intervals for the true mean rainfall  with the following confidence intervals :

1. 90 percent
2. 95 percent
3. 98 percent

**Example #4:**

The National Center for Education Statistics surveyed 4400 college graduates about the lengths of time required to earn their bachelor’s degrees. The mean is 5.15 years, and the standard deviation is 1.68 years. Based on these sample data, construct the 99% confidence interval for the mean time required by all college graduates.

**Example #5:**

A psychologist has developed a new test of spatial perception, and she wants to estimate the mean score achieved by male pilots. How many people must she test if she wants the sample mean to be in error by no more than 2.0 points, with 95% confidence? An earlier study suggests that .