

## Measures of Dispersion

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Measures of dispersion are used to describe the amount of scatter around the center of the distribution. They include range, mean deviation, variance, standard deviation, and coefficient of variation.

### Range

This is simply the difference between the largest value and the smallest value.

### Mean deviation

This is the mean absolute difference of each observation and averaged.

$$\overline{dev} = \frac{\sum_{i=1}^n |x_i - \bar{x}|}{n}$$

### Variance

The formula for the population is different than the formula for the sample.

Population variance is calculated as follows:

$$\sigma^2 = \frac{\sum_{i=1}^n (x_i - \mu)^2}{N}$$

Sample variance is estimated as follows:

$$s^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}$$

### Computer Formulation

This formulation is much easier to use when calculating variance on a computer or calculator.

$$\sigma^2 = \frac{\sum_{i=1}^n x_i^2 - \frac{\left(\sum_{i=1}^n x_i\right)^2}{N}}{N}$$

$$s^2 = \frac{\sum_{i=1}^n x_i^2 - \frac{\left(\sum_{i=1}^n x_i\right)^2}{n}}{n-1}$$

### Standard Deviation

The standard deviation is the square root of the variance. This statistics in the units of measurement. The population standard deviation can be calculated as follows:

$$\sigma = \sqrt{\frac{\sum_{i=1}^n x_i^2 - \frac{\left(\sum_{i=1}^n x_i\right)^2}{N}}{N}}$$

The sample standard deviation can be calculated as:

$$s = \sqrt{\frac{\sum_{i=1}^n x_i^2 - \frac{\left(\sum_{i=1}^n x_i\right)^2}{n}}{n-1}}$$

### Coefficient of Variation

Coefficient of variation is a relative measure of dispersion that **removes the units** from the statistic. It can be calculated as:

$$cv = \frac{s}{\bar{x}}$$

$$cv = \frac{s}{\bar{x}} 100$$

### Standard Error

Because the variance on any sample will decrease with increasing  $n$  a method of **comparing samples of different size** is need. This is Standard Error for a sample and is given by:

$$s_{\bar{x}} = \sqrt{\frac{s^2}{n}}$$

**Also See:**

Chapter 3-4, 3-5 Basic Statistical Concepts in:

Husch, B., T. W. Beers, and J. A. Kershaw, Jr. 2003. Forest Mensuration. John Wiley and Sons, Inc. Hoboken, New Jersey. 443 pp. ISBN 0-471-01850-3

Chapter 3 - Measure of Variability pages 35-46 in:

Phillips, J. L. 2000. How to think about statistics. W. H. Freeman and Co. New York. 202 pp. ISBN 0-7167-3654-3

Chapter 4 - Measure of Dispersion and Variability pages 27-32 in:

Zar, J. H. 1984. Biostatistical Analysis. Prentice-Hall, Inc. Englewood Cliffs, New Jersey. 718 pp.