Calculating Averages and Standard Deviations

Andrew J. Pounds, Ph.D.
Department of Chemistry, Mercer University

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1 Introduction

For MANY of the labs you will be completing at Mercer you will need to not only calculate averages, but also standard deviations. While there is vey little confusion about how to calculate averages, there has historically been confusion over how to calculate standard deviations. It is the intent of this document to clarify some of these terms and supply you with the equations you will need for the laboratory.

2 Averages

2.1 Basic Theory

For a variable x, the average (denoted $\bar{x}$) is calculated via Eqn 1

$$\bar{x} = \frac{\sum_{i=0}^{N} x_i}{N} \tag{1}$$

where the x_i denote each member of the set of N items.

2.2 Example

Assume that one has the following set of data shown in Table 1. Then $\bar{x}$ is calculated as...

$$\bar{x} = \frac{\sum_{i=1}^{N} x_i}{N} = \frac{20.02 + 20.11 + 21.05 + 20.66 + 19.59 + 20.87}{6} = 20.38 \tag{2}$$

Table 1: Sample Data

i	x
1	20.02
2	20.11
3	21.05
4	20.66
5	19.59
6	20.87

3 Standard Deviations

3.1 Basic Theory

There are two kinds of standard deviations often used in the sciences. Namely these are the *sample standard deviation* (Eqn. 3) and the *population standard deviation* (Eqn. 4.

$$s = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N-1}} \tag{3}$$

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N}} \tag{4}$$

In CHM 112 we will be dealing mainly with the *sample standard deviation.* This is for several reasons, but primarily because the *population standard deviation* requires that we know the *expected* value of a variable, μ, from the population distribution.

3.2 Example – Sample Standard Deviation

Using Eqn 3, the data from Table 1, and the results from Eqn. 2, one computes the sample standard deviation as follows.

$$\begin{aligned} s &= \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N-1}} \\ &= \sqrt{\frac{(20.02 - 20.38)^2 + \cdots + (20.86 - 20.38)^2}{6-1}} \\ &= \sqrt{\frac{1.594}{5}} \\ &= 0.565 \end{aligned}$$

More on the meaning of all this later...

3.3 Example – Population Standard Deviation

Coming soon!