

Selected Solutions for Exercises in  
Numerical Methods with MATLAB:  
Implementations and Applications

Gerald W. Recktenwald

Chapter 4  
Organizing and Debugging  
MATLAB Programs

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**4.2** Use stepwise refinement to describe all of the steps necessary to compute the average and standard deviation of the elements in a vector  $x$ . Implement these tasks in an m-file, and test your solution. Do not use the built-in `mean` and `std` functions. Rather, develop your solution from the equations for the average and standard deviation of a finite sample.

**Partial Solution:** Given an  $n$ -element vector  $x$ , the formulas for computing the mean  $\bar{x}$  and variance  $\sigma^2$  are

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

The standard deviation is  $\sigma$ .

The tasks necessary for computing  $\bar{x}$  and  $\sigma$  are

- (a) Read the data into  $x$  (or accept  $x$  as input to a function)
- (b) Determine  $n$ , the length of the data set
- (c) Compute  $\bar{x}$  and  $\sigma$  using the formulas given above
- (d) Display the results (or return them to the calling function)

The implementation can be tested with (at least) the following cases

- Data set with  $n = 1$ . Is there an error trap for  $\sigma$ ?
- Data set with  $n = 2$ . Then  $\bar{x} = (x_1 + x_2)/2$ ,  $\sigma = (x_2 - x_1)^2/2$ .
- Data set of arbitrary length with all  $x_i = K$ , where  $K$  is a constant. Then  $\bar{x} = K$  and  $\sigma = 0$ .

Implementation of the code for computing  $\bar{x}$  and  $\sigma$  is complicated in the case where  $n$  is large. For large  $n$

- The available memory (RAM) may not be large enough to hold all the data at once.
- Computation of  $\bar{x}$  and  $\sigma$  may cause overflow errors.
- Computation of both  $\bar{x}$  and  $\sigma$  will suffer loss of significance if the sums are computed as written.