FE 208 Homework 1

Measurements and Measurement Errors

1. Which statistic is best used to describe accuracy?

   The Standard Error

2. Which statistic is best used to describe the variability of the data

   The Standard Deviation

3. What statistic best describes an estimate of the true value

   The Mean

4. Briefly explain why repeated measurements are necessary for an estimate of measurement error

   An estimate of the variability requires replication in order to satisfy the equation for the standard error

$$sd = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$$

5. How does the size of the sample affect the confidence of our calculated mean

   An increase in the size of the sample affects the confidence by reducing the interval of the standard error

6. An distance measurement was repeated 6 times with the following information

   Mean = 115.73'
   STD = 1.22'
   SE   = 0.51

   a. Describe the range of the data

      Approximately 68% of the data are within 114.51' and 116.95, 95% of the data are within 113.29' and 118.17'

b. Describe the true value

**From the data, we are 68% confident that the true mean lies between 115.22'
and 116.24'**

7. Describe accuracy and precision using one short sentence

Accuracy is ... how close to the truth or real value our measurement is

while Precision is… how consistent our repeated measurements are

8. Describe error and mistake using one short sentence

An error is … the difference between a measured value and the true value

While a mistake is … a blunder

9. Toward the end of a long day, a surveyor lays out one of the last remaining angles on a traverse. The theodolite is set up and properly leveled. The instrument height is recorded as 4.9'. The angle is turned between two hubs with tacks and recorded as $23^0 32'00''$. There are at least 5 errors in this procedure. What are they, and what type of error is each?

Errors are numbered and explained below

Toward the end of a long day[1], a surveyor lays out one of the last remaining angles on a traverse. The instrument[2] is set up and properly leveled [3]. The instrument height[4] is recorded as 4.9'[5]. The angle[6] is turned[7] between two hubs with tacks and recorded as $23^0 32'00''$.

1. The first error is fatigue after a long day of working and on the last angle of the day and being more difficult to measure accurately– Personal error
2. Machine error with the instrument – Instrument error
3. Leveling will not be exact – Natural error
4. Instrument height measure not able to be exact with the instrument height– Personal error
5. Tape used to measure instrument height is not exact - instrument error
6. The angle between the two hubs will not be exactly centered on the tacks – Personal error
7. Variation in the instrument compass – Natural error

10. A surveyor measures a horizontal distance 5 times between two points with the following results: 567.32',566.98',567.88',567.51',566.83'. a. What is the recorded distance, b. what is the 1 standard deviation of these measurements, and c. what is the best estimate of the true distance to 1 standard error?

a. The recorded distance is the mean value = 567.30'

b. The 1 standard deviation is 0.42'. The range at 1 standard deviation is 567.30 ± 0.42 or 566.88 to 567.72

c. The standard error is 0.19'. We are 68% confident that the true mean value is between 567.11 and 567.49