CHAPTER

1

Errors and the treatment of Analytical Data

Errors is the numerical difference between a measured value and the true value (or accepted true result)

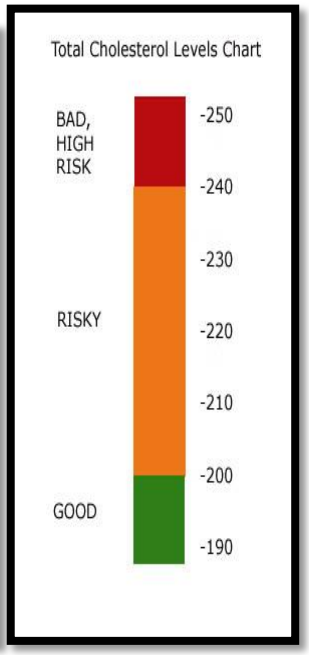
Error = Measured Value - True Value

The best example of the measurement error is, if electronic scales are loaded with 1kg standard weight and the reading is 10002grams, then

The measurement error is = (1002grams-1000grams) =2grams

- In quantitative analysis, when numerical data and numerical results are measured with the greatest exactness, it has been observed that the results of successive determination differ among themselves to a greater or lesser extent
- The reliability of the result depends upon the magnitude of the difference between the average value and the true value.

Example: the quantitative determination of total cholesterol by using spectrophotometer instrument, five equal portion of serum with known concentration of 190 mg\dl were analyzed in exactly the same way: 250, 200, 180, 220,205: find mean and error?



Mean= ∑ Xi \ n
Mean=250+200+ 180+ 220+205\5
Mean= 211 mg\dl
Mean = measured value
Known concentration= true value
Error = Measured Value - True Value
Error = 211 – 190 = + 21 mg\dl

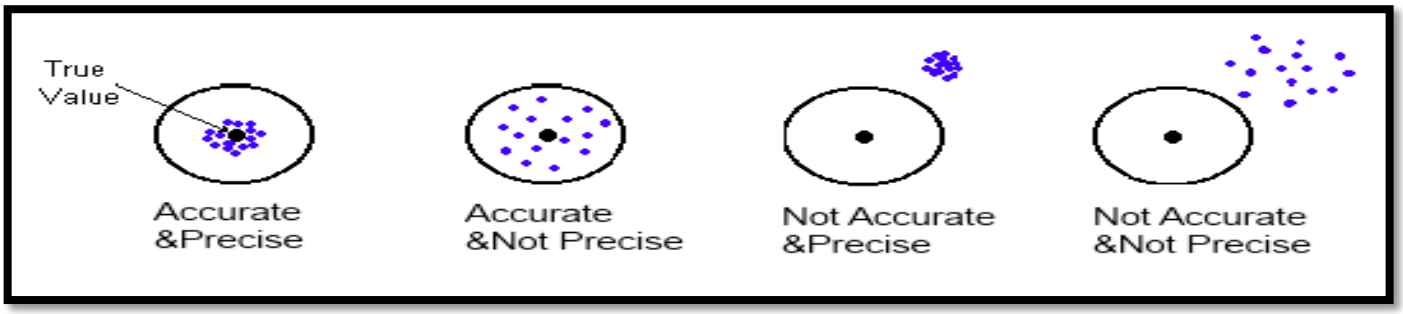
Positive sign indicates that measured value is more than the true value

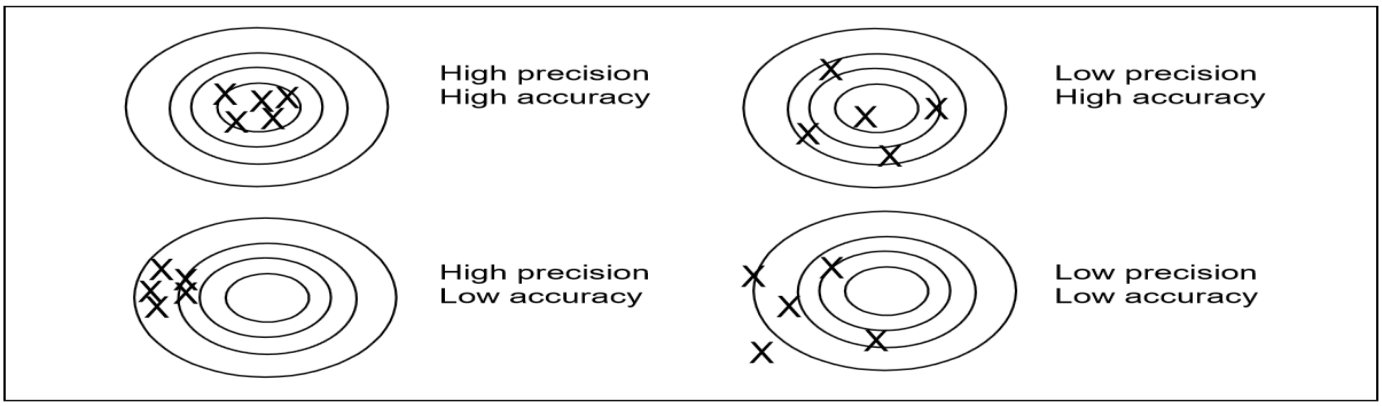
If Negative sign indicates that measured value is less than the true value

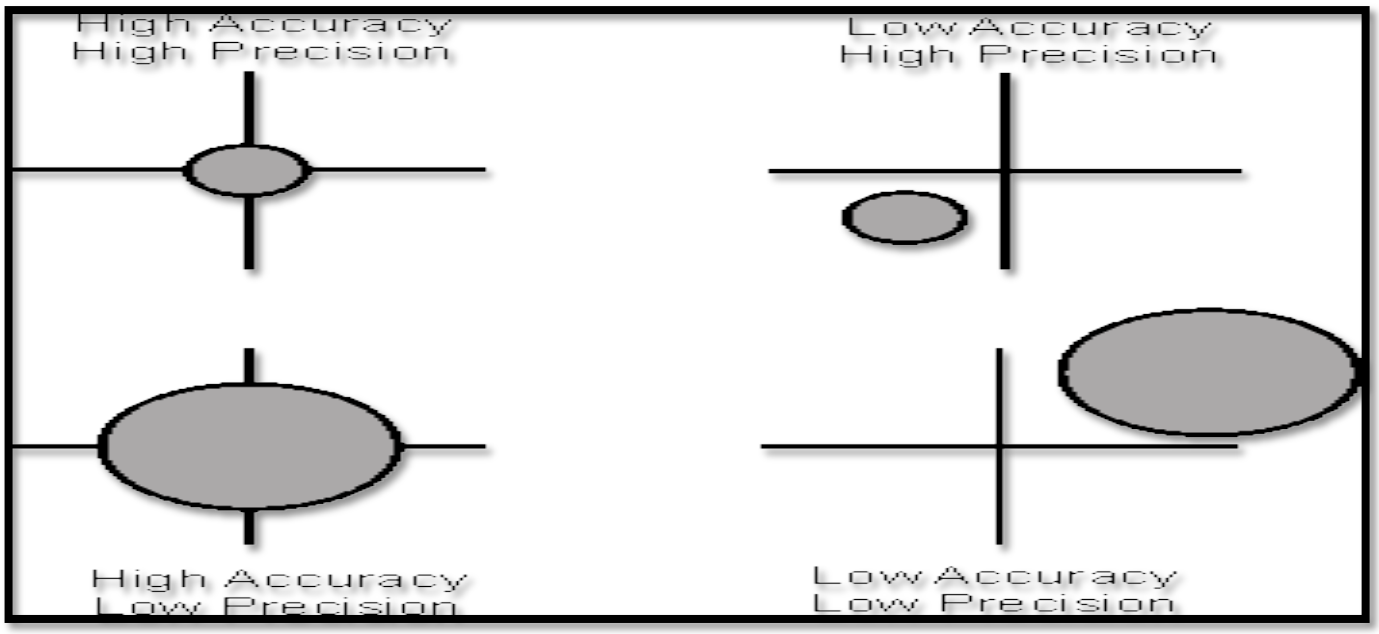
Accuracy & Precision

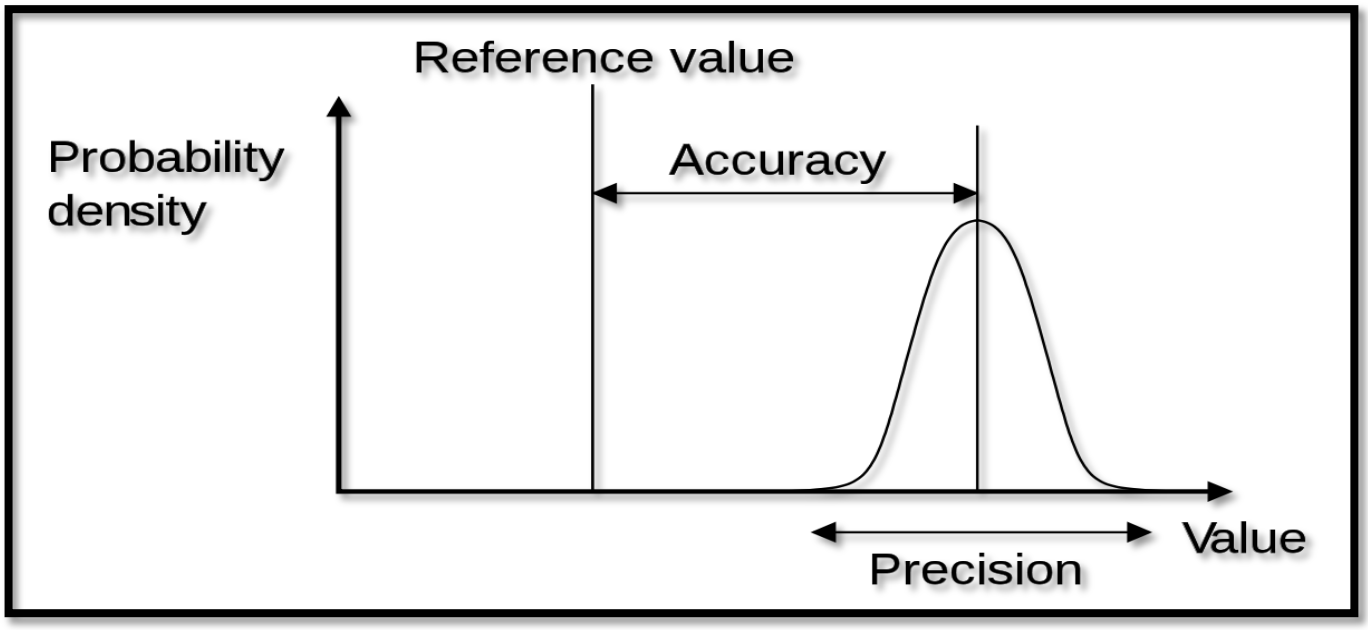
Accuracy: a qualitative term that describes the closeness of result (measured value) to the actual (true) value, it is describe how correct, it determines how much error in the method. Accuracy is **inversely** proportional to the error i.e. **the greater the accuracy, smaller is the error.**

Precision: is the closeness of results to other obtained in exactly the same way
That describes spread of these measurements when repeated. A measurement that has high precision has good repeatability. It is describe how repeat, they have no relationship to true value.




High precision
High accuracy
Low precision
High accuracy
High precision
Low accuracy
Low precision
Low accuracy


High Accuracy
High Precision
Low Accuracy
High Precision
High Accuracy
Low Precision
Low Accuracy
Low Precision


Reference value
Probability density
Accuracy
Precision
Value

Error related to Accuracy

Absolute error: difference between the measured value and the true value.
E = Xi – Xt where Xt is true or accepted value & Xi is measured value

Relative Error: absolute error divided by true value (% error) $\%\, E_r = \frac{x_i - x_t}{x_t} \times 100$

Example: True value is 20.0 ppm and measured value is 19.8 ppm
Relative Error = (19.8 -20) \ 20 X 100 = -1

Measurement = best estimate ± uncertainty
Example: a measurement of salt 5.07 g ± 0.02 g
That it is mean the experimenter is confident that the actual value for the quantity being measured lies between 5.05 g and 5.09 g.
The uncertainty is the experimenter's best estimate of how far an experimental quantity might be from the "true value." (The art of estimating).

Descriptive statistics

1- measures of central tendency 2- measures of dispersion

Measures of central tendency

Central tendency is that single quantity which can represent the whole samples
(Mean – median – mode)

Some important term:
Replicates: are samples of about the same size that are carried through an analysis in exactly the same way.

1. Mean: Average of all the values , is the numerical average obtained by dividing the sum of the individual measurements by the number of measurements

Symbol mean µ if it was for population $\bar{x}$ if it was for sample

Population : collection of all measurements of interest to a experiment .**N more than 30**
Sample : subset of measurement selected from the population **n equal or less than 30**

Sample mean; $\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$ Population mean; $\mu = \frac{\sum_{i=1}^{N} x_i}{N}$

Example:-
Find mean value of fasting blood sugar for the following cases.

Cases	1	2	3	4	5	6	7	8	9	10
FBS (mg/dl)	195	184	138	94	261	191	112	184	94	94

Mean = ∑ Xi \ n X = 1547/10 = 154.7 mg/dl

2. Median : value that splits the data in to two equal parts.

We arrange the numbers given from low to high
For odd number of data middle value represents the median
For even number of data average of two middle values represents the median.

Example :Find median value of fasting blood sugar for the following cases.

Cases	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
FBS (mg/dl)	**195**	**184**	**138**	**94**	**261**	**191**	**112**	**184**	**94**	**94**

Median position (first value) = n/2 = 10/2 = 5

Median position (second value) = (n/2) + 1 = (10/2)+1 = 6

- So in order to find the median of a group of values, we need to arrange the data in order array (from the smallest to the largest value) then we find the position of the median

Obs\ 1 2 3 4 5 6 7 8 9 10

FBS \94, 94, 94, 112, 138, 184, 184, 191, 195, 261)

Median of FBS. = 138+184 \ 2 = 161 mg\dl

Example : age of 19 persons
27,36,27,34,28,32,28,31,28,31,29,30,30,29,30,30,29,30,30. Find the median of age ?