# Chapter2. Error and DataProcession in Analytical Chemistry

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## Section1. The Categories and Representing Methods of Errors

- Types of errors
  - absolute error($\mathrm{E}$)
  - relative error($\mathrm{E}_r$)
- Reasons of systematic error generation and their properties and characteristics
  - Not determined by chances but Caused by an inaccuracy(involving either observation or measurement process) inherent to the system
  - Characteristics: predictable and typically constant or proportional to the true value
- Types of systematic errors
  - Method error
  - Instrument/Reagent error
  - Operation error
  - Subjective error
- What is random error and their properties and characteristics?
  - Random errors are errors in measurement that lead to measurable values being inconsistent when repeated measurements of a constant attribute or quantity are taken
  - Characteristics: unpredictable, unavoidable and show up different results for ostensibly the same repeated measurement
- What is **True Value**($\mathrm{X_T}$)?

  > A value compatible with definition of a given particular quantity

- What is accuracy, precision and the relationship between each other?

  > Accuracy: Closeness of the measurements to true value and measured by Error

  > Precision: Closeness of the measurements to each other and measured by deviation

  > Relationship: High accuracy requests high precision

- What is Error and what is Deviation? How to express them?

  > Error: Measurement of accuracy

$$E = x - x_T$$

$$E_r = \frac{E}{x_T} \times 100\%$$

  > Deviation: Measurement of precision

$$d = x - \bar{x}$$

$$\bar{d} = \frac{1}{n}\sum_{1}^{n}(|d_i|)$$

- How to describe the Central Tendency of data?

$$population\ \ mean: \mu = \lim_{n\to\infty}\frac{1}{n}\sum_{i=1}^{n}$$

$$\delta = \frac{\sum_{i=1}^{n}|x_i - \mu|}{n}$$

- How to describe data's degree of dispersion?

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

$$\delta = 0.797\sigma \approx 0.8\sigma$$

- What is average deviation?How to describe?

  > see above

- What is standard deviation?How to describe?

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

$$S_r = \frac{s}{\bar{x}} \times 100\%$$

- What is population, specimen, population mean, sample mean and degree of freedom?
  - population: a complete set
  - specimen: a subset of population
  - population mean: average value of population
  - sample mean: average value of sample
  - degree of freedom: the number of independent variables or paramenters for a system
- What is population standard deviation(STDEVP) and the relationship between STDEVP and standard deviation of a single sample
  - STDEVP

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

  - 
  - relationship: $n \to \infty$ or not
- Why can we reduce random errors and improve measurement precision via increasing the number of parallel measurements?

  > Random errors obey **Gaussian Distribution**

# Section2. The propagation of error

## 1.Systematic error

- Addition and Subtraction
- Multiplication and Division
- Exponent and Logarithm

## 2.Random error

- Addition and Subtraction
- Multiplication and Division
- Exponent and Logarithm

## 3.Range

$$R = x_{max} - x_{min}$$

# Section3. Significant figure

- Definition of significant figure

  > Banker's rounding

- Rounding data
- How to determine the significant figure during calculation?
  - Addition and subtraction

    According to the which has the smallest decimal number
  - Multiplication and Division

    According to which has the smallest significant figure

# Section4. What I Wanna Say about the Chapter

- There are too many symbols like $E, d, \sigma, \delta, \mu, etc.$ and I am sure they are not so friendly to freshmen at first sight.

  But suggest that if you describe all symbols and their meaning in English instead of just asking students to keep their relationship between Chinese and English in mind, things will be easier because most of abbreviations are original from English words. I hope this advice can help us keep them in mind more cozily.

- You did not proof some statistical theorems. Keeping them in  mind with no proofs seems spending a lot of time.
- The propagation of error is a little difficult when using it because I have to query the formula so should we keep them in mind or derive the formula each time.

To sum up, please allow me to complain... I hate memorizing formulas...