

## **Glossary**

The precise definitions of the terms listed here can be found in the International Vocabulary of Basic and General Terms in Metrology (VIM) and other International Organization for Standardization (ISO) documents (ISO 5725. Accuracy [trueness and precision] of measurement methods and results. ISO 1994).

### **Accuracy**

Closeness of the agreement between the result of the measurement and a true value of the measurand.

Accuracy is a “qualitative” concept (since the true value can never truly be known) and is influenced by both precision (variance) and bias:

$$IA = B(\hat{\theta})^2 + \text{Var}(\hat{\theta})$$

Where IA = inaccuracy indicator

$\hat{\theta}$  = the estimator of a parameter  $\theta$

B = Bias

Var = variance

### **Bias**

Systematic error of the indication of a measuring instrument (see “Error”). The bias of a measuring instrument is normally estimated by averaging the error of indication over an appropriate number of repeated measurements.

### **Calibration**

Set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realised by standards.

### **Coefficient of variation**

The experimental standard deviation divided by the mean.

### **Confidence interval**

A measure of the precision of an estimated value. The interval represents the range of values, consistent with the data, that is believed to encompass the "true" value with high probability (usually 95%). A 95% confidence interval is the range of values between +/- 1.96 standard deviations of the sampling distribution of means. The confidence interval is expressed in the same units as the estimate. Wider intervals indicate lower precision; narrow intervals indicate greater precision.

### **Conventional true value**

Value attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose.

**Correlation coefficient**

A measure of the strength of the relationship between two interval data variables. Most correlation coefficients are normalised so that they have values between +1 (which indicates perfect correlation) and -1 (which indicates perfect inverse correlation); a value of 0 indicates no correlation. As the absolute value of the correlation coefficient increases, so does the strength of correlation.

**Critical difference**

The smallest change in results not due to chance (commonly set at the 95% probability level).

$$CD = 1.414 \times 1.96 \times (CVa^2 + CVwi^2)^{0.5}$$

Where CD = critical difference  
CVa = analytical coefficient of variation  
CVwi = within-person biological variation

**Deviation**

Value minus its reference value.

**Error**

The result of a measurement minus a true value of the measurand.

- Systematic error**      The mean that would result from an infinite number of measurements of the same measurand carried out under repeatability conditions, minus a true value of the measurand. A systematic error is generally caused by an improperly functioning instrument or analyst and leads to “bias.”
  
- Random error**        The result of a measurement minus the mean that would result from an infinite number of measurements of the same measurand carried out under repeatability conditions.
  
- Blunder**                An error that is made unintentionally and went unnoticed (eg transcription error or spilled solution). This term is not included in the VIM, but there is a strong argument that blunders are neither systematic nor random.

**Experimental standard deviation**

For a series of n measurements of the same measurand, the quantity SD characterising the dispersion of the results and given by the formula:

$$SD = [\sum(\theta_i - \chi)^2 / (n-1)]^{0.5}$$

Where                    SD = experimental standard deviation of the mean  
                                  $\theta_i$  = value of the  $i^{th}$  reading

$\chi$  = mean of all readings  
n = number of readings

It should be noted that the experimental standard deviation is the square root of the variance.

### **Experimental standard deviation of the mean**

The experimental standard deviation divided by the square root of the number of readings. This is sometimes incorrectly called “standard error of the mean.”

### **Mean square error**

The *mean square error* of an estimator  $\hat{\theta}$  of a parameter  $\theta$  in a statistical model is defined as:

$$\text{MSE}(\hat{\theta}) = \text{Var}(\hat{\theta}) + \text{Bias}(\hat{\theta}).$$

Where            Var = variance

### **Measurand**

Particular quantity subject to measurement.

### **Precision**

The degree of mutual agreement or repeatability among a series of individual measurements, values or results. A measure of precision is the standard deviation of readings (“experimental standard deviation”).

The International Vocabulary of Basic and General Terms in Metrology (VIM) uses the terms “repeatability” and “reproducibility” instead of the more general term “precision”.

### **Predictive value**

In screening and diagnostic tests, the probability that a person with a positive test is a true positive (i.e. does have the disease; positive predictive value), or that a person with a negative test truly does not have the disease (negative predictive value). The predictive value of a screening test is determined by the sensitivity and specificity of the test, and by the prevalence of the condition for which the test is used.

### **Relative error**

Error of measurement divided by a true value of the measurand.

### **Reference method**

A thoroughly investigated method, in which exact and clear descriptions of the necessary conditions and procedures are given for the accurate determination of one or more property values; the documented accuracy and precision of the method are commensurate with the method’s use for assessing the accuracy of other methods for measuring the same property values or for assigning reference method values to reference materials.

**Reference interval**

The range of values (usually 95% confidence limits) found in an apparently healthy population (i.e. not afflicted with a discernable illness).

**Repeatability**

The closeness of agreement between the results of successive measurements of the same measurand carried out under the same conditions of measurement (called “repeatability conditions”). Repeatability may be expressed quantitatively in terms of the dispersion characteristics of the results.

**Repeatability conditions**

Successive measurements of the same measurand carried out under the same conditions of measurement. Repeatability conditions include:

- the same measurement procedure
- the same observer
- the same measuring instrument, used under the same conditions
- the same location
- repetition over a short period of time.

**Reproducibility**

The closeness of the agreement between the results of measurements of the same measurand carried out under changed conditions of measurement. Reproducibility may be expressed quantitatively in terms of the dispersion characteristics of the results.

**Root mean square error**

The square root of the mean square error.

**Sensitivity**

An operating characteristic of a diagnostic test that measures the ability of a test to detect a disease (or condition) when it is truly present. Sensitivity is the proportion of all diseased patients for whom there is a positive test, determined as the number of true positives divided by the sum of true positives + false negatives. (Contrast with specificity.)

**Specificity**

An operating characteristic of a diagnostic test that measures the ability of a test to exclude the presence of a disease (or condition) when it is truly not present. Specificity is the proportion of nondiseased patients for whom there is a correctly negative test, expressed as the number of true negatives divided by the sum of true negatives + false positives. (Contrast with sensitivity.)

**Standard error of the mean**

The incorrect term for the “experimental standard deviation of the mean.”

**Traceability**

Property of the result of a measurement or the value of a standard whereby it can be related to stated references, usually national or international standards, through an unbroken chain of comparisons all having stated uncertainties.

**True value**

Value consistent with the definition of a given particular quantity.

**Uncertainty of measurement**

Parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand.

**Variance**

The sum of the squares of the differences between each measurement and the arithmetic mean of the measurements divided by the number of measurements minus 1.

$$\text{Var} = \Sigma(\theta_i - \chi)^2 / (n-1)$$

Where Var = variance

$\theta_i$  = value of the  $i^{\text{th}}$  reading

$\chi$  = mean of all readings

n = number of readings