Accuracy

The accuracy of a measurement system is the degree of closeness of measurements of a quantity to that quantity's true value.

The precision of a measurement system, related to reproducibility and repeatability, is the degree to which repeated measurements under unchanged conditions show the same results.

Although the two words precision and accuracy can be synonymous in colloquial use, they are deliberately contrasted in the context of the scientific method.

A measurement system can be accurate but not precise, precise but not accurate, neither, or both. For example, if an experiment contains a systematic error, then increasing the sample size generally increases precision but does not improve accuracy. The result would be a consistent yet inaccurate string of results from the flawed experiment. Eliminating the systematic error improves accuracy but does not change precision.

A measurement system is considered valid if it is both accurate and precise. Related terms include bias (non-random or directed effects caused by a factor or factors unrelated to the independent variable) and error (random variability).

The terminology is also applied to indirect measurements—that is, values obtained by a computational procedure from observed data.

In addition to accuracy and precision, measurements may also have a measurement resolution, which is the smallest change in the underlying physical quantity that produces a response in the measurement.

In numerical analysis, accuracy is also the nearness of a calculation to the true value; while precision is the resolution of the representation, typically defined by the number of decimal or binary digits.

Statistical literature prefers to use the terms bias and variability instead of accuracy and precision. Bias is the amount of inaccuracy and variability is the amount of imprecision.

In the past, the accuracy of surface matching has been shown to be disappointing.

Mongen and Willems aimed to determine whether this had improved over the years by assessing application accuracy of current navigation systems, using either surface matching or point-pair matching.

Eleven patients, scheduled for intracranial surgery, were included in this study after a power analysis had shown this small number to be sufficient. Prior to surgery, one additional fiducial marker was placed on the scalp, the "target marker," where the entry point of surgery was to be expected. Using one of three different navigation systems, two patient-to-image registration procedures were performed: one based on surface matching and one based on point-pair matching. Each registration procedure was followed by the digitization of the target marker's location, allowing calculation of the target registration error. If the system offered surface matching improvement, this was always used; and for the two systems that routinely offer an estimate of neuronavigation accuracy, this was also recorded.

The error in localizing the target marker using point-pair matching or surface matching was respectively 2.49 mm and 5.35 mm, on average ($p < 0.001$). In those four cases where an attempt was made to improve the surface matching, the error increased to 6.35 mm, on average. For the seven cases where the system estimated accuracy, this estimate did not correlate with target registration error ($R2 = 0.04$, $p = 0.67$).

The accuracy of navigation systems has not improved over the last decade, with surface matching consistently yielding errors that are twice as large as when point-pair matching with adhesive markers is used. These errors are not reliably reflected by the systems own prediction, when offered. These results are important to make an informed choice between image-to-patient registration strategies, depending on the type of surgery at hand [1].

Diagnostic accuracy

[Diagnostic accuracy](#)

[1)

Mongen MA, Willems PWA. Current accuracy of surface matching compared to adhesive markers in patient-to-image registration. Acta Neurochir (Wien). 2019 Mar 16. doi: 10.1007/s00701-019-03867-8. [Epub ahead of print] PubMed PMID: 30879130.

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