Error bar’s report

What’s an error bar??

[**Error**](https://en.wikipedia.org/wiki/Error)**bars** are graphical representations of the variability of data and used on graphs to indicate the [error](https://en.wikipedia.org/wiki/Errors_and_residuals) or [uncertainty](https://en.wikipedia.org/wiki/Measurement_uncertainty) in a reported measurement. They give a general idea of how precise a measurement is, or conversely, how far from the reported value the true (error free) value might be. Error bars often represent one [standard deviation](https://en.wikipedia.org/wiki/Standard_deviation) of uncertainty, one [standard error](https://en.wikipedia.org/wiki/Standard_error), or a particular [confidence interval](https://en.wikipedia.org/wiki/Confidence_interval) (e.g., a 95% interval). These quantities are not the same and so the measure selected should be stated explicitly in the graph or supporting text.

Error bars can be used to compare visually two quantities if various other conditions hold. This can determine whether differences are [statistically significant](https://en.wikipedia.org/wiki/Statistically_significant). Error bars can also suggest [goodness of fit](https://en.wikipedia.org/wiki/Goodness_of_fit) of a given function, i.e., how well the function describes the data. Scientific papers in the experimental sciences are expected to include error bars on all graphs, though the practice differs somewhat between sciences, and each journal will have its own [house style](https://en.wikipedia.org/wiki/Style_guide). It has also been shown that error bars can be used as a [direct manipulation interface](https://en.wikipedia.org/wiki/Direct_manipulation_interface) for controlling probabilistic algorithms for approximate computation.[[1]](https://en.wikipedia.org/wiki/Error_bar#cite_note-1) Error bars can also be expressed in a [plus–minus sign](https://en.wikipedia.org/wiki/Plus%E2%80%93minus_sign) (±), plus the upper limit of the error and minus the lower limit of the error.[[2]](https://en.wikipedia.org/wiki/Error_bar#cite_note-stderror-2)

A notorious misconception in elementary statistics is that error bars show whether a statistically significant difference exists, by checking simply for whether the error bars overlap; this is not the case.

Chart, box and whisker chart

Description automatically generated

Error bars may show **confidence intervals, standard errors, standard deviations, or other quantities**. Different types of error bars give quite different information, and so figure legends must make clear what error bars represent.

Types

**Descriptive error bars** show you something about the spread of data. For example:

* The **range**will tell you how spread out the data is, from the lowest to highest values.
* The **standard deviation** tells you a little about how the data is spread out around the mean.

**Inferential error bars** give you information about the results of studies. For example, an author might use error bars to show where the whole population mean probably lies, based on information gleaned from a sample. As it’s not possible to get an exact figure for the population mean (the author is basically taking a good guess), the bars show a range where you can expect to find the mean.

This list isn’t exhaustive; Error bars on a chart could literally mean anything the author wants to communicate: a spread of some kind, a built in equipment error, or something else. **Every graph with error bars should have a key to tell you what they represent.**

**What you can conclude when two error bars overlap (or don't)?**

t is tempting to look at whether two error bars overlap or not, and try to reach a conclusion about whether the difference between means is statistically significant.

**Standard Deviation Error Bars**

SD error bars quantify the scatter among the values. Looking at whether the error bars overlap lets you compare the difference between the mean with the amount of scatter within the groups. But the t test also takes into account sample size. If the samples were larger with the same means and same standard deviations, the P value would be much smaller. If the samples were smaller with the same means and same standard deviations, the P value would be larger.

When the difference between two means is statistically significant (P < 0.05), the two SD error bars may or may not overlap. Likewise, when the difference between two means is not statistically significant (P > 0.05), the two SD error bars may or may not overlap.

Knowing whether SD error bars overlap or not does not let you conclude whether the difference between the means is statistically significant or not.

**Standard Error of the Mean Error Bars**

SEM error bars quantify how precisely you know the mean, taking into account both the SD and sample size. Looking at whether the error bars overlap, therefore, lets you compare the difference between the mean with the precision of those means. This sounds promising. But in fact, you don’t learn much by looking at whether SEM error bars overlap.

By taking into account sample size and considering how far apart two error bars are, Cumming (2007) came up with some rules for deciding when a difference is significant or not. But these rules are hard to remember and apply.

Here is a simpler rule:

If two SEM error bars do overlap, and the sample sizes are equal or nearly equal, then you know that the P value is (much) greater than 0.05, so the difference is not statistically significant. The opposite rule does not apply. If two SEM error bars do not overlap, the P value could be less than 0.05, or it could be greater than 0.05. If the sample sizes are very different, this rule of thumb does not always work.

**Confidence Interval Error Bars**

Error bars that show the 95% confidence interval (CI) are wider than SE error bars. It doesn’t help to observe that two 95% CI error bars overlap, as the difference between the two means may or may not be statistically significant.

A useful rule of thumb: If two 95% CI error bars do not overlap, and the sample sizes are nearly equal, the difference is statistically significant with a P value much less than 0.05 (Payton 2003).

With multiple comparisons following ANOVA, the significance level usually applies to the entire family of comparisons. With many comparisons, it takes a much larger difference to be declared "statistically significant". But the error bars are usually graphed (and calculated) individually for each treatment group, without regard to multiple comparisons. So the rule above regarding overlapping  CI error bars does not apply in the context of multiple comparisons.

Finally ,How do error bars affect the data?

Error bars can communicate the following information about your data: **How spread the data are around the mean value** (small SD bar = low spread, data are clumped around the mean; larger SD bar = larger spread, data are more variable from the mean).