**Margin of Error: Definition, How to Calculate in Easy Steps**

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## **What is a Margin of Error?**

A **margin of error** tells you **how many percentage points your results will differ**from the real population value. For example, a 95% [confidence interval](https://www.statisticshowto.com/probability-and-statistics/confidence-interval/) with a 4 percent margin of error means that your [statistic](https://www.statisticshowto.com/statistic/)will be within 4 percentage points of the real population value 95% of the time.

More technically, the **margin of error**is the [range](https://www.statisticshowto.com/probability-and-statistics/statistics-definitions/range-statistics/) of values below and above the [sample statistic](https://www.statisticshowto.com/sample-statistic-definition-examples/) in a [confidence interval](https://www.statisticshowto.com/probability-and-statistics/confidence-interval/). The confidence interval is a way to show what the [**uncertainty**](https://www.statisticshowto.com/uncertainty-in-statistics/) is with a certain [statistic](https://www.statisticshowto.com/statistic/)(i.e. from a poll or survey).

For example, a poll might state that there is a 98% confidence interval of 4.88 and 5.26. That means if the poll is repeated using the same techniques, 98% of the time the true population parameter ([parameter vs. statistic](https://www.statisticshowto.com/how-to-tell-the-difference-between-a-statistic-and-a-parameter/)) will fall within the interval estimates (i.e. between 4.88 and 5.26) 98% of the time.

## **Statistics Aren’t Always Right!**

The idea behind confidence levels and margins of error is that any survey or poll will differ from the true [population](https://www.statisticshowto.com/what-is-a-population/)by a certain amount. However, [confidence intervals](https://www.statisticshowto.com/probability-and-statistics/confidence-interval/) and margins of error reflect the fact that there *is* room for error, so although 95% or 98% confidence with a 2 percent Margin of Error might sound like a very good statistic, room for error is built in, which means sometimes statistics are wrong. For example, [a Gallup poll](http://www.gallup.com/poll/158519/romney-obama-gallup-final-election-survey.aspx) in 2012 (incorrectly) stated that Romney would win the 2012 election with Romney at 49% and Obama at 48%. The stated confidence level was 95% with a margin of error of +/- 2, which means that the results were calculated to be accurate to within 2 percentages points 95% of the time.

The [real results from the election](http://uselectionatlas.org/RESULTS/national.php)were: Obama 51%, Romney 47%, which was actually even outside the range of the Gallup poll’s margin of error (2 percent), showing that not only can statistics be wrong, but polls can be too.

*Margins of error are commonly used in election polls.*

## **How to Calculate Margin of Error**

Watch the video or read the steps below:

<https://youtu.be/MV_BwPHWGh8>

The margin of error tells you the **range of values** above and below a [confidence interval](https://www.statisticshowto.com/probability-and-statistics/confidence-interval/).

A poll might report that a certain candidate is going to win an election with 51 percent of the vote; The [confidence level](https://www.statisticshowto.com/confidence-level/) is 95 percent and the error is 4 percent. Let’s say the poll was repeated using the same techniques. The pollsters would expect the results to be within 4 percent of the stated result (51 percent) 95 percent of the time. In other words, 95 percent of the time they would expect the results to be between:

* 51 – 4 = 47 percent and
* 51 + 4 = 55 percent.

**The margin of error can be calculated in two ways, depending on whether you have**[**parameters**](https://www.statisticshowto.com/what-is-a-parameter-statisticshowto/)**from a population or**[**statistics**](https://www.statisticshowto.com/statistic/)**from a sample**:

1. Margin of error = Critical value x [Standard deviation](https://www.statisticshowto.com/relative-standard-deviation/) for the population.
2. Margin of error = Critical value x [Standard error](https://www.statisticshowto.com/what-is-the-standard-error-of-a-sample/) of the sample.

## **How to Calculate Margin of Error: Steps**

Step 1: **Find the critical value**. The critical value is either a [**t-score**](https://www.statisticshowto.com/probability-and-statistics/t-distribution/t-score-formula/) or a **z-score**. If you aren’t sure, see: [T-score vs z-score](https://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/t-score-vs-z-score/). In general, for small [sample sizes](https://www.statisticshowto.com/probability-and-statistics/find-sample-size/) (under 30) or when you don’t know the population [standard deviation](https://www.statisticshowto.com/probability-and-statistics/standard-deviation/), use a [t-score](https://www.statisticshowto.com/probability-and-statistics/t-distribution/t-score-formula/). Otherwise, use a [z-score](https://www.statisticshowto.com/probability-and-statistics/z-score/).  
[Click here for a minute video that shows you how to find a critical value.](https://www.youtube.com/watch?v=RAnFyF_6zHk)

Step 2: **Find the**[**Standard Deviation**](https://www.statisticshowto.com/probability-and-statistics/standard-deviation/)**or the**[**Standard Error**](https://www.statisticshowto.com/what-is-the-standard-error-of-a-sample/)**.** These are essentially the same thing, only you must know your population [parameters](https://www.statisticshowto.com/what-is-a-parameter-statisticshowto/)in order to calculate standard deviation. Otherwise, calculate the standard error (see: [What is the Standard Error?](https://www.statisticshowto.com/what-is-the-standard-error-of-a-sample/)).  
[Click here](https://www.youtube.com/watch?v=aBXJnvQ6KFk)for a short video on how to calculate the standard error.

Step 3: **Multiply the**[**critical value**](https://www.statisticshowto.com/probability-and-statistics/t-distribution/t-score-formula/)from Step 1**by the**[**standard deviation**](https://www.statisticshowto.com/probability-and-statistics/standard-deviation/) or [standard error](https://www.statisticshowto.com/what-is-the-standard-error-of-a-sample/) from Step 2. For example, if your CV is 1.95 and your SE is 0.019, then:  
1.95 \* 0.019 = 0.03705

**Example question:** 900 students were surveyed and had an average GPA of 2.7 with a standard deviation of 0.4. Calculate the margin of error for a 90% confidence level:

1. The critical value is 1.645 (see [this video](https://www.youtube.com/watch?v=RAnFyF_6zHk) for the calculation)
2. The standard deviation is 0.4 (from the question), but as this is a sample, we need the standard error for the mean. The formula for the SE of the mean is *standard deviation / √(sample size)*, so: 0.4 / √(900) = 0.013.
3. 1.645 \* 0.013 = 0.021385

*That’s how to calculate margin of error!*  
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**Second example**:[Click here](https://youtu.be/nZjwlCboeV0) to view a second video on YouTube showing calculations for a 95% and 99% Confidence Interval.

**Tip**: You can use the[t-distribution calculator](https://www.statisticshowto.com/calculators/tdist-calculator/) on this site to find the t-score and the [variance and standard deviation calculator](https://www.statisticshowto.com/calculators/variance-and-standard-deviation-calculator/) will calculate the standard deviation from a sample.

## **Margin of Error for a Proportion**

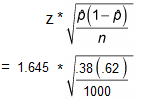
The formula is a little different for proportions:  
[moe](https://www.statisticshowto.com/wp-content/uploads/2013/08/moe.png)  
  
  
Where:

* [phat](https://www.statisticshowto.com/wp-content/uploads/2009/10/phat.bmp)= sample proportion (“P-hat”),
* n = sample size,
* z = z-score.

**Example question:** 1000 people were surveyed and 380 thought that climate change was not caused by human pollution. Find the MoE for a 90% confidence interval.

Step 1: **Find P-hat** by dividing the number of people who responded positively. “Positively” in this sense doesn’t mean that they gave a “Yes” answer; It means that they answered according to the statement in the question. In this case, 380/1000 people (38%) responded positively.

Step 2: **Find the z-score that goes with the given confidence interval.** You’ll need to reference [this chart of common critical values.](https://www.statisticshowto.com/probability-and-statistics/find-critical-values/#CommonCI) A 90% confidence interval has a z-score (a critical value) of 1.645.

Step 3: **Insert the values into the formula and solve:**  
[](https://www.statisticshowto.com/wp-content/uploads/2013/08/moep-2.png)

= 1.645 \* 0.0153

= 0.0252

Step 4: **Turn Step 3 into a percentage**:  
0.0252 = 2.52%  
The margin of error is 2.52%.

## **References**

Moore, D. S. and McCabe G. P. [Introduction to the Practice of Statistics](https://amzn.to/2Tq4V0w). New York: W. H. Freeman, p. 443, 1999.

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