

# How to Calculate Empirical Rule Probabilities in Excel

Authored by  
**stats writer**

December 29, 2025

## RECOMMENDED CITATION

stats writer (2025). *How to Calculate Empirical Rule Probabilities in Excel*.

PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=109783>

Applying statistical concepts efficiently often requires powerful computational tools. When working with large datasets, Microsoft Excel provides robust functions for leveraging core statistical principles like the Empirical Rule. This rule, central to understanding data spread, can be calculated directly in Excel, allowing analysts to quickly determine the percentage of data points that fall within specified ranges of the mean. While the most direct way involves simple arithmetic using the standard deviation, Excel also offers advanced functions. Specifically, the `NORM.DIST` function is essential for calculating the probability that a data point falls within a certain range, and related functions like `NORM.INV` can be utilized to determine the precise boundaries of a range when the desired cumulative probability is known.

## Understanding the Empirical Rule (The 68-95-99.7 Principle)

The Empirical Rule, often referred to as the 68-95-99.7 rule, is a fundamental statistical concept applied exclusively to datasets that follow a normal distribution (bell curve). It provides a quick and reliable estimate of where the majority of data points lie relative to the central tendency. Mastery of this rule is crucial for analysts seeking to understand the spread and variability of their data without complex calculations.

This rule is predicated on the idea that the probability of an observation occurring decreases predictably as its distance from the mean increases. This distance is measured in units of standard deviation. The standard deviation acts as a consistent measure of dispersion, allowing us to define precise intervals that capture specific percentages of the total data population. The rule holds true whether you are examining test scores, manufacturing tolerances, or natural phenomena.

The Empirical Rule defines three critical ranges based on standard deviation multiples:

**68%** of data values are expected to fall within one standard deviation ( $\pm 1\sigma$ ) of the mean. This is the narrowest, most concentrated band.

**95%** of data values are expected to fall within two standard deviations ( $\pm 2\sigma$ ) of the mean. This range is frequently used in quality control and hypothesis testing.

**99.7%** of data values are expected to fall within three standard deviations ( $\pm 3\sigma$ ) of the mean. This wide range captures nearly all data points in a normally distributed set, highlighting the rarity of extreme outliers.

In the following sections, we will demonstrate the practical application of these principles directly within Excel, leveraging its powerful cell-based calculations to automate the discovery of these critical statistical boundaries for any given dataset parameters.

## Setting Up the Empirical Rule Calculation in Excel

To successfully apply the Empirical Rule, we must first clearly define the two defining parameters of our normal distribution: the population mean ( $\mu$ ) and the population standard deviation ( $\sigma$ ). Excel allows for a straightforward setup where these values can be entered into designated cells, making the calculation dynamic and easily adaptable to different scenarios.

The core methodology for calculating the range boundaries relies on simple addition and subtraction. If M represents the Mean and SD represents the Standard Deviation, the calculation for the boundary points (Lower Bound and Upper Bound) for any given multiplier (k, where k=1, 2, or 3) is:

Lower Bound:  $M - (k * SD)$

Upper Bound:  $M + (k * SD)$

By structuring our spreadsheet to reference the mean and standard deviation inputs, we ensure that changing the base data parameters instantly updates all calculated ranges. This efficiency is one of the primary benefits of using Excel for statistical analysis, providing real-time insight into data dispersion characteristics.

### Example 1: Calculating Ranges Using Simple Arithmetic

Let us consider a hypothetical normally-distributed dataset where the central tendency and spread are clearly defined. Suppose our distribution has a mean of **7** and a standard deviation of **2.2**. We aim to apply the 68-95-99.7 rule to determine the specific values between which 68%, 95%, and 99.7% of the data falls.

In Excel, we first designate cells for the input parameters. For instance, we might use cell C2 for the Mean (7) and cell C3 for the Standard Deviation (2.2). We then set up formulas for each level of standard deviation ( $1\sigma$ ,  $2\sigma$ ,  $3\sigma$ ) to calculate the corresponding lower and upper boundaries. The following screenshot illustrates the structure and the formulas used to achieve this result:

	A	B	C	D	E	F	G
1							
2		mean	7				
3		standard deviation	2.2				
4							
5							
6		68% of data falls between:	4.8	9.2		=C2 - C3	=C2 + C3
7		95% of data falls between:	2.6	11.4		=C2 - 2*C3	=C2 + 2*C3
8		99.7% of data falls between:	0.4	13.6		=C2 - 3*C3	=C2 + 3*C3
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							

Analyzing the formulas applied in columns F and G reveals the direct implementation of the standard deviation multiplier:

For the 68% range (1 Standard Deviation): The formulas are  $=C2 - (1 * C3)$  and  $=C2 + (1 * C3)$ , yielding **4.8** and **9.2**.

For the 95% range (2 Standard Deviations): The formulas are  $=C2 - (2 * C3)$  and  $=C2 + (2 * C3)$ , yielding **2.6** and **11.4**.

For the 99.7% range (3 Standard Deviations): The formulas are  $=C2 - (3 * C3)$  and  $=C2 + (3 * C3)$ , yielding **0.4** and **13.6**.

Based on this output, we can definitively state the dispersion characteristics of this dataset:

**68%** of the data falls between **4.8** and **9.2**.

**95%** of the data falls between **2.6** and **11.4**.

**99.7%** of the data falls between **0.4** and **13.6**.

## Flexibility and Adaptability: Rerunning Calculations

One of the strongest advantages of setting up these calculations in Excel is the ease with which parameters can be modified. To apply the Empirical Rule to a completely different dataset, all that is required is updating the values in the mean and standard deviation input cells (C2 and C3). This

dynamic linkage means complex recalculations are unnecessary.

For example, consider a new distribution with a significantly different scale: a mean of **40** and a standard deviation of **3.75**. By simply changing the input values, Excel automatically recalculates the boundaries based on the new parameters, providing immediate statistical insights:

	A	B	C	D	E	F	G
1							
2		mean	40				
3		standard deviation	3.75				
4							
5							
6		68% of data falls between:	36.25	43.75		= \$C\$2 - \$C\$3	= \$C\$2 + \$C\$3
7		95% of data falls between:	32.5	47.5		= \$C\$2 - 2*\$C\$3	= \$C\$2 + 2*\$C\$3
8		99.7% of data falls between:	28.75	51.25		= \$C\$2 - 3*\$C\$3	= \$C\$2 + 3*\$C\$3
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							

The resulting boundaries for this second dataset are:

**68%** of the data falls between **36.25** and **43.75** ( $40 \pm 3.75$ ).

**95%** of the data falls between **32.5** and **47.5** ( $40 \pm 7.5$ ).

**99.7%** of the data falls between **28.75** and **51.25** ( $40 \pm 11.25$ ).

Finally, observing a dataset where the mean is **100** and the standard deviation is **5** illustrates the clear application of the rule to standardized data models. The consistent, symmetrical nature of the Empirical Rule makes it highly intuitive to interpret these results:

	A	B	C	D	E	F	G
1							
2		mean	100				
3		standard deviation	5				
4							
5							
6		68% of data falls between:	95	105		=C\$2 - C\$3	=C\$2 + C\$3
7		95% of data falls between:	90	110		=C\$2 - 2*C\$3	=C\$2 + 2*C\$3
8		99.7% of data falls between:	85	115		=C\$2 - 3*C\$3	=C\$2 + 3*C\$3
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							

**68%** of the data falls between **95** and **105**.

**95%** of the data falls between **90** and **110**.

**99.7%** of the data falls between **85** and **115**.

## Advanced Statistical Analysis: Calculating Probability Between Specific Values

While the standard Empirical Rule provides quick estimates for ranges centered at 1, 2, and 3 standard deviations, sophisticated analysts often require the exact percentage of data that falls between two arbitrary values, X1 and X2. For example, if we have a mean of 100 and a standard deviation of 5, what percentage of data falls between 99 and 105? Answering this requires leveraging Excel's built-in statistical functions, specifically `NORM.DIST`.

The `NORM.DIST` function calculates the cumulative probability for a specified value within a normal distribution. Crucially, to find the area (percentage) between two points, X1 and X2, we must calculate the cumulative probability up to the higher value ( $P(X < X2)$ ) and subtract the cumulative probability up to the lower value ( $P(X < X1)$ ). The result is the percentage of observations that fall within that defined range.

## Utilizing the NORM.DIST Function Syntax

The `NORM.DIST` function is the primary tool for calculating probability density or cumulative distribution values for a normal distribution. Understanding its required arguments is essential for accurate application:

**NORM.DIST**(x, mean, standard\_dev, cumulative)

Each argument serves a specific purpose in defining the desired calculation:

*x*: This is the specific value for which you want to calculate the distribution. In our range calculation (between X1 and X2), we will run the function twice, once for X1 and once for X2.

*mean*: This specifies the arithmetic mean ( $\mu$ ) of the distribution, defining the center of the bell curve.

*standard\_dev*: This specifies the standard deviation ( $\sigma$ ) of the distribution, defining the spread of the data.

*cumulative*: This is a logical value (TRUE or FALSE). Setting this value to **TRUE** returns the Cumulative Distribution Function (CDF), which calculates the probability that an observation is less than or equal to x. Setting it to **FALSE** returns the Probability Density Function (PDF), which provides the probability at a single point (often zero or near zero) and is generally not used for calculating ranges in this context.

For range calculations, we must always set the *cumulative* argument to **TRUE**.

## Applying NORM.DIST to a Specific Range Example

Let's apply this function using our distribution with a mean of 100 and a standard deviation of 5. We want to determine the percentage of data falling between the values **99** (X1) and **105** (X2). We execute the calculation by calculating the difference between the two cumulative probabilities:

The required formula is: `=NORM.DIST(105, 100, 5, TRUE) - NORM.DIST(99, 100, 5, TRUE)`.

This subtracts the area to the left of 99 from the area to the left of 105, isolating the area between the two points. The following screenshot illustrates this implementation in Excel:

	A	B	C	D	E	F	G
1							
2							
3							
4							
5		=NORM.DIST(105, 100, 5, TRUE) - NORM.DIST(99, 100, 5, TRUE)					
6		42.1%					
7							
8							
9							
10							
11							
12							
13							
14							

We see that the resulting probability is 0.421, indicating that **42.1%** of the data falls between the values 99 and 105 for this particular distribution. This powerful technique extends the utility of the Empirical Rule far beyond its standard three ranges, enabling highly precise probability assessments necessary for detailed data modeling.

## Summary and Further Resources

Whether utilizing simple arithmetic based on standard deviations to apply the foundational Empirical Rule, or employing the sophisticated `NORM.DIST` function for custom probability ranges, Excel proves to be an indispensable tool for statistical analysis of normally distributed data. Mastery of these methods allows for rapid calculation and clear visualization of data dispersion, leading to more informed decision-making.

For further study and practical application, consider utilizing these helpful resources:

### Helpful Tools:

[Empirical Rule Calculator](#)

[Empirical Rule \(Practice Problems\)](#)