Z-Score: Definition, Calculation and Interpretation

By Saul McLeod, published May 17, 2019

What is a z-score?

A z-score, also known as a standard score, indicates the number of standard deviations a raw score lays above or below the mean. When the mean of the z-score is calculated it is always 0, and the standard deviation (variance) is always in increments of 1.

A z-score describes the position of a raw score in terms of its distance from the mean when measured in standard deviation units. The z-score is positive if the value lies above the mean, and negative if it lies below the mean.

It is also known as a standard score, because it allows comparison of scores on different kinds of variables by standardizing the distribution. A standard normal distribution (SND) is a normally shaped distribution with a mean of 0 and a standard deviation (SD) of 1 (see Fig. 1).
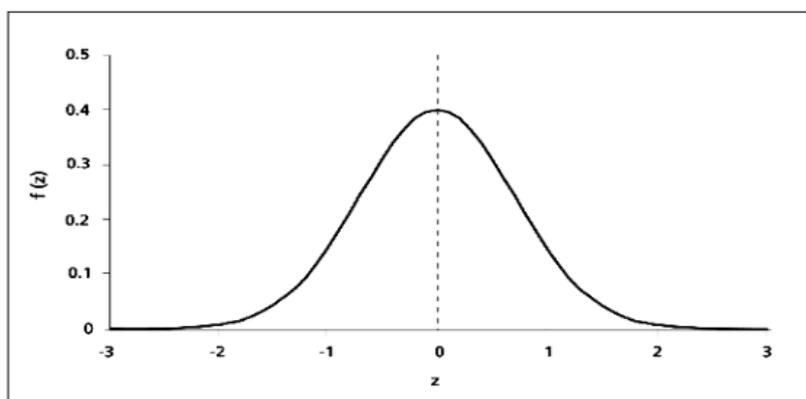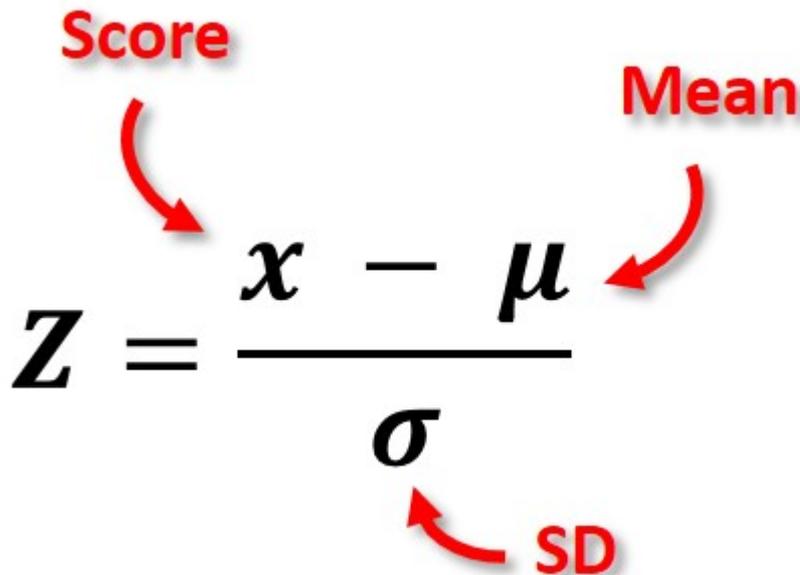

Figure 1. A standard normal distribution (SND).

How do you calculate the z-score?

The formula for calculating a z-score is given below (see Fig. 2): As the formula shows, the z-score is simply the raw score minus the sample mean, divided by the sample standard deviation.

$$Z = \frac{x - \mu}{\sigma}$$

Figure 2. Z-score formula.

How to calculate a raw score when a z-score is known

Sometimes we know a z-score and want to find the corresponding raw score. The formula for calculating a z-score in a sample into a raw score is given below:

X = (z)(SD) + mean

As the formula shows, the z-score and standard deviation are multiplied together, and this figure is added to the mean.

Check your answer makes sense: If we have a negative z-score the corresponding raw score should be less than the mean, and a positive z-score must correspond to a raw score higher than the mean.

How to calculate a z-score using excel

To calculate the z-score of a specific value, x, first you must calculate the mean of the sample by using the AVERAGE formula.

For example, if the range of scores in your sample begin at cell A1 and end at cell A20, the formula =AVERAGE(A1:A20) returns the average of those numbers.

Next, you mush calculate the standard deviation of the sample by using the STDEV.S formula. For example, if the range of scores in your sample begin at cell A1 and end at cell A20, the formula = STDEV.S (A1:A20) returns the standard deviation of those numbers.

Now to calculate the z-score type the following formula in an empty cell: = (x – mean) / [standard deviation].

To make things easier, instead of writing the mean and SD values in the formula you could use the cell values corresponding to these values. For example, = (A12 – B1) / [C1].

Then, to calculate the probability for a SMALLER z-score, which is the probability of observing a value less than x (the area under the curve to the LEFT of x), type the following into a blank cell: = NORMSDIST (and input the z-score you calculated).

To find the probability of LARGER z-score, which is the probability of observing a value greater than x (the area under the curve to the RIGHT of x), type: =1 - NORMSDIST (and input the z-score you calculated).

How do you interpret z score?

The value of the z-score tells you how many standard deviations you are away from the mean. If a z-score is equal to 0, it is on the mean.

A positive z-score indicates the raw score is higher than the mean average. For example, if a z-score is equal to +1, it is 1 standard deviation above the mean.

A negative z-score reveals the raw score is below the mean average. For example, if a z-score is equal to -2, it is 2 standard deviations below the mean.

Another way to interpret z-scores is by creating a standard normal distribution (also known as the z-score distribution or probability distribution). Fig 3 illustrates the important features of any standard normal distribution (SND).
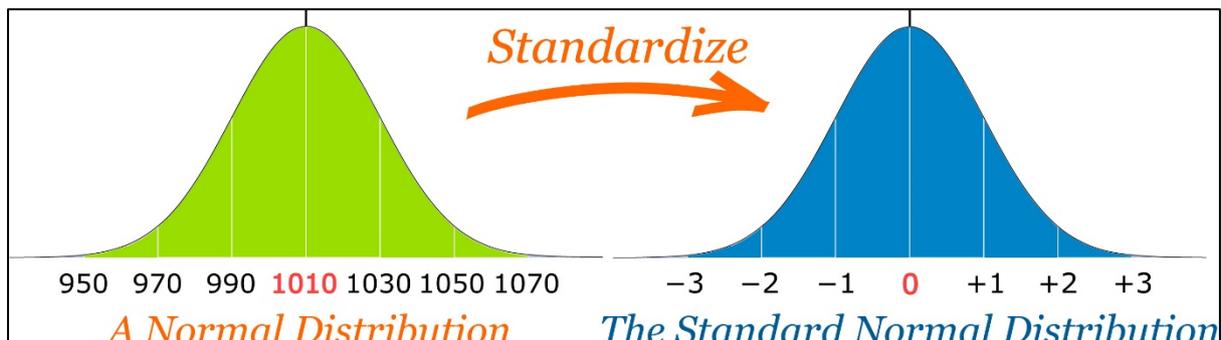

Figure 3. A standard normal distribution (SND) and normal distribution.

1. The SND (i.e. z-distribution) is always the same shape as the raw score distribution. For example, if the distribution of raw scores if normally distributed, so is the distribution of z-scores.
2. The mean of any SND always = 0.
3. The standard deviation of any SND always = 1. Therefore, one standard deviation of the raw score (whatever raw value this is) converts into 1 z-score unit.

The SND allows researchers to calculate the probability of randomly obtaining a score from the distribution (i.e. sample). For example, there is a 68% probability of randomly selecting a score between -1 and +1 standard deviations from the mean (see Fig. 4).
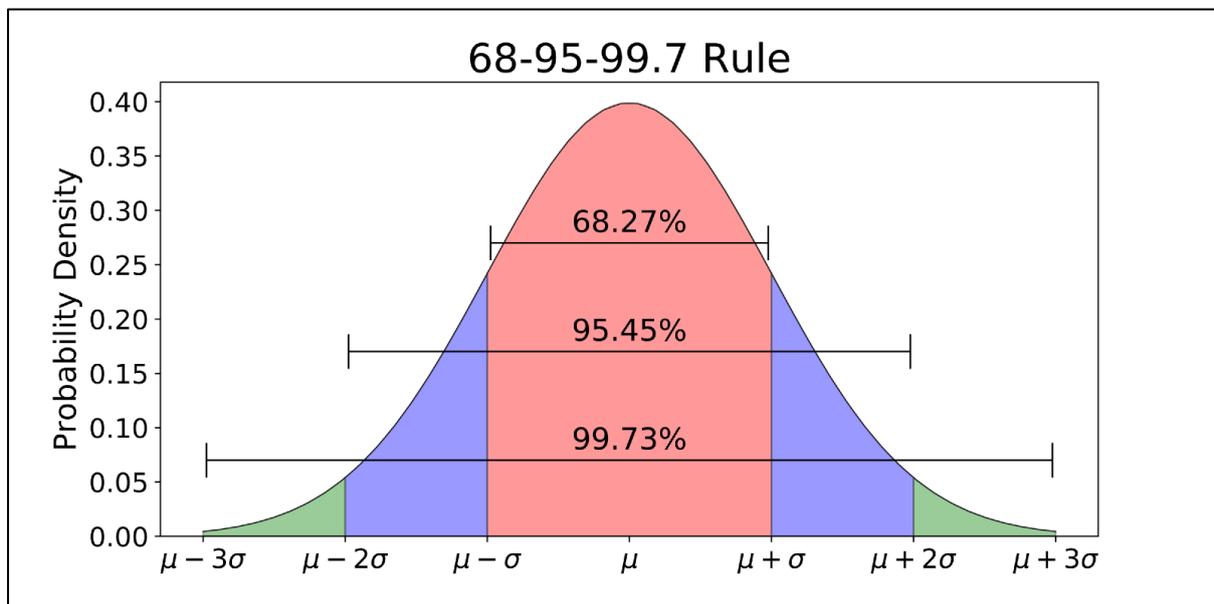

Figure 4. Proportion of a standard normal distribution (SND) in percentages.

The probability of randomly selecting a score between -1.96 and +1.96 standard deviations from the mean is 95% (see Fig. 4). If there is less than a 5% chance of a raw score being selected randomly, then this is a statistically significant result.

How to reference this article:

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Further Information

How to Use a Z-Table