

Z Scores

The **Z score** is a way of measuring the **probability** of something occurring once some initial data has already been established. It does this by using the standard deviation of the original data (the degree to which the data is spread around the mean).

Information on how to calculate **standard deviation** can be found in a separate MVC Guide.

Worked example¹:

A geographer wishes to research the probability that wind will blow at ten knots in a certain location. An automatic data logger records the speed of the wind every fifteen minutes and produces a set of results over the course of a month. From these, the mean speed and standard deviation are calculated.

Mean speed (\bar{x}) = 6.03 knots

Standard deviation (σ) = 4.50

The following formula is used to calculate the Z score:

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

where x is the stated value. In this example, the geographer wishes to know the probability of winds at 10 knots, so $x = 10$.

$$Z = \frac{10 - 6.03}{4.50}$$

$$Z = \frac{3.97}{4.50}$$

$$Z = 0.882$$

Z value	Probability (single) value
± 0.0	0.500
± 0.1	0.460
± 0.2	0.421
± 0.3	0.382
± 0.4	0.345
± 0.5	0.309
± 0.6	0.274
± 0.7	0.242
± 0.8	0.212
± 0.9	0.184
± 1.0	0.159
± 1.1	0.136
± 1.2	0.115
± 1.3	0.097

A Z (single) value table, left, is then used to find the probability. In this case, the probability of winds of 10 knots is seen to be 0.184 or an 18.4% probability.

Worked example²:

A geographer wishes to research the probability that people using a public library on a Saturday were of school age. Data was collected on the age of people using the library on a particular day and their mean age and the standard deviation calculated:

$$\text{Mean age } (\bar{x}) = 30.75 \qquad \text{Standard deviation } (\sigma) = 24.22$$

Z scores were then calculated for each x value at each end of the age range being investigated. In this example, people of school age are deemed to be aged four to eighteen.

The following formula is used to calculate the Z score:

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

$$Z = \frac{4 - 30.75}{24.22}$$

$$Z = \frac{-26.75}{24.22}$$

$$Z = -1.10$$

$$Z = \frac{18 - 30.75}{24.22}$$

$$Z = \frac{-12.75}{24.22}$$

$$Z = -0.53$$

Z value	Probability (range) value
± 0.0	0.000
± 0.1	0.040
± 0.2	0.079
± 0.3	0.119
± 0.4	0.155
± 0.5	0.191
± 0.6	0.226
± 0.7	0.258
± 0.8	0.288
± 0.9	0.316
± 1.0	0.341
± 1.1	0.364
± 1.2	0.385
± 1.3	0.403
± 1.4	0.419
± 1.5	0.433

A Z (range) value table, left, is then used to find the probability for each end of the range scale:

$$\text{Age 4} = 0.364$$

$$\text{Age 18} = 0.191$$

These two values are added together to give the overall probability for the age range.

$$0.364 + 0.191 = 0.555$$

Therefore, there is a 55.5% probability of a library visitor being of school age.