

# What is the method for finding the Standard Deviation of a Probability Distribution?

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April 25, 2024

## RECOMMENDED CITATION

stats writer (2024). *What is the method for finding the Standard Deviation of a Probability Distribution?*. PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=139211>

The method for finding the Standard Deviation of a Probability Distribution is a statistical technique used to measure the amount of variation or spread in a set of data. It involves calculating the average distance of each data point from the mean of the distribution. This is done by taking the square root of the sum of squared deviations from the mean, divided by the total number of data points. A lower standard deviation indicates a more concentrated set of data points around the mean, while a higher standard deviation indicates a more dispersed set of data points. This method is commonly used in various fields such as finance, economics, and psychology to analyze and interpret data.

## Find the Standard Deviation of a Probability Distribution

**A probability distribution tells us the probability that a takes on certain values.**

**For example, the following probability distribution tells us the probability that a certain soccer team scores a certain number of goals in a given game:**

Goals (X)	Probability P(X)
0	0.18
1	0.34
2	0.35
3	0.11
4	0.02

**To find the standard deviation of a probability distribution, we can use the following formula:**

$$\sigma = \sqrt{\sum(x_i - \mu)^2 * P(x_i)}$$

where:

$x_i$ : The  $i$ th value  $\mu$ : The mean of the distribution  $P(x_i)$ : The probability of the  $i$ th value

For example, consider our probability distribution for the soccer team:

Goals (X)	Probability P(X)
0	0.18
1	0.34
2	0.35
3	0.11
4	0.02

The mean number of goals for the soccer team would be calculated as:

$$\mu = 0 \cdot 0.18 + 1 \cdot 0.34 + 2 \cdot 0.35 + 3 \cdot 0.11 + 4 \cdot 0.02 = 1.45 \text{ goals.}$$

We could then calculate the standard deviation as:

Goals (X)	Probability P(X)	$(x_i - \mu)^2 * P(x_i)$
0	0.18	$(0-1.45)^2 * 0.18 = .3785$
1	0.34	$(1-1.45)^2 * 0.34 = .0689$
2	0.35	$(2-1.45)^2 * 0.35 = .1059$
3	0.11	$(3-1.45)^2 * 0.11 = .2643$
4	0.02	$(4-1.45)^2 * 0.02 = .1301$

The standard deviation is the square root of the sum of the values in the third column. Thus, we would calculate it as:

$$\text{Standard deviation} = \sqrt{(.3785 + .0689 + .1059 + .2643 + .1301)} = 0.9734$$

The variance is simply the standard deviation squared, so:

$$\text{Variance} = .9734^2 = 0.9475$$

Example 1: Standard Deviation of Vehicle Failures

The following probability distribution tells us the probability that a given vehicle experiences a certain number of battery failures during a 10-year span:

Failures (X)	Probability P(X)
0	0.24
1	0.57
2	0.16
3	0.03

**Question: What is the standard deviation of the number of failures for this vehicle?**

**Solution: The mean number of expected failures is calculated as:**

$$\mu = 0*0.24 + 1*0.57 + 2*0.16 + 3*0.03 = 0.98 \text{ failures.}$$

**We could then calculate the standard deviation as:**

Failures (X)	Probability P(X)	$(x_i - \mu)^2 * P(x_i)$
0	0.24	$(0 - .98)^2 * 0.24 = .2305$
1	0.57	$(1 - .98)^2 * 0.57 = .0002$
2	0.16	$(2 - .98)^2 * 0.16 = .1665$
3	0.03	$(3 - .98)^2 * 0.03 = .1224$

**The standard deviation is the square root of the sum of the values in the third column. Thus, we would calculate it as:**

**Standard deviation =  $\sqrt{.2305 + .0002 + .1665 + .1224} = 0.7208$**

### Example 2: Standard Deviation of Sales

The following probability distribution tells us the probability that a given salesman will make a certain number of sales in the upcoming month:

Sales (X)	Probability P(X)
10	0.24
20	0.31
30	0.39
40	0.06

**Question:** What is the standard deviation of the number of sales for this salesman in the upcoming month?

**Solution:** The mean number of expected sales is calculated as:

$$\mu = 10 \cdot .24 + 20 \cdot .31 + 30 \cdot 0.39 + 40 \cdot 0.06 = 22.7 \text{ sales.}$$

**We could then calculate the standard deviation as:**

Sales (X)	Probability P(X)	$(x_i - \mu)^2 * P(x_i)$
10	0.24	$(10 - 22.7)^2 * 0.24 = 38.7096$
20	0.31	$(20 - 22.7)^2 * 0.31 = 2.2599$
30	0.39	$(30 - 22.7)^2 * 0.39 = 20.7831$
40	0.06	$(40 - 22.7)^2 * 0.06 = 17.9574$

The standard deviation is the square root of the sum of the values in the third column. Thus, we would calculate it as:

$$\text{Standard deviation} = \sqrt{(38.7096 + 2.2599 + 20.7831 + 17.9574)} = 8.928$$