



## Why

We want a measure of the *spread* of a random variable.

## Definition

The *covariance* (or *variance*) of a random variable  $x : \Omega \rightarrow \mathbf{R}$  is  $\mathbf{E}((x - \mathbf{E}(x))^2)$ , the expectation of the square of the random variable's distance from its mean. The covariance measures the mean square difference from the mean.

## Interpretation

The covariance of  $x$  summarizes how “wide” the induced distribution of  $x$  is. If the covariance is small, then the induced distribution is concentrated around its mean.<sup>1</sup>

## Notation

We denote the covariance of  $x$  by  $\text{cov}(x)$ . Another common notation is  $\text{var}(x)$ .

## Standard deviation

If  $x$  has units meters, then  $\text{cov}(x)$  has units square meters. It can be useful to work instead with the *standard deviation* of  $x$ , defined as  $\sqrt{\text{cov}(x)}$ , which has the same units as  $x$ . We denote the standard deviation of  $x$  by  $\text{std}(x)$ .

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<sup>1</sup>Future editions will give example.



