**Sampling with replacement:**

Consider a population of potato sacks, each of which has either 12, 13, 14, 15, 16, 17, or 18 potatoes, and all the values are equally likely. Suppose that, in this population, there is exactly one sack with each number. So the whole population has seven sacks. If I sample two with replacement, then I first pick one (say 14). I had a 1/7 probability of choosing that one. Then I replace it. Then I pick another. Every one of them still has 1/7 probability of being chosen. And there are exactly 49 different possibilities here (assuming we distinguish between the first and second.) They are: (12,12), (12,13), (12, 14), (12,15), (12,16), (12,17), (12,18), (13,12), (13,13), (13,14), etc.

**Sampling without replacement:**

Consider the same population of potato sacks, each of which has either 12, 13, 14, 15, 16, 17, or 18 potatoes, and all the values are equally likely. Suppose that, in this population, there is exactly one sack with each number. So the whole population has seven sacks. If I sample two without replacement, then I first pick one (say 14). I had a 1/7 probability of choosing that one. Then I pick another. At this point, there are only six possibilities: 12, 13, 15, 16, 17, and 18. So there are only 42 different possibilities here (again assuming that we distinguish between the first and the second.) They are: (12,13), (12,14), (12,15), (12,16), (12,17), (12,18), (13,12), (13,14), (13,15), etc.

**What's the Difference?**

When we sample with replacement, the two sample values are independent. Practically, this means that what we get on the first one doesn't affect what we get on the second. Mathematically, this means that the covariance between the two is zero.

In sampling without replacement, the two sample values aren't independent. Practically, this means that what we got on the for the first one affects what we can get for the second one. Mathematically, this means that the covariance between the two isn't zero.

Sampling with Replacement

Sampling with replacement is used to find **probability with replacement**. In other words, you want to find the [probability](https://www.statisticshowto.com/probability-and-statistics/probability-main-index/)of some event where there’s a number of balls, cards or other objects, and you replace the item each time you choose one.

Let’s say you had a population of 7 people, and you wanted to sample 2. Their names are:

* John
* Jack
* Qiu
* Tina
* Hatty
* Jacques
* Des

[](https://www.statisticshowto.com/wp-content/uploads/2013/12/randomSampling.jpg)

*Image: CSUS.edu*

You could put their names in a hat. If you **sample with replacement**, you would choose one person’s name, put that person’s name back in the hat, and then choose another name. The possibilities for your two-name sample are:

* John, John
* John, Jack
* John, Qui
* Jack, Qui
* Jack Tina
* …and so on.

When you sample with replacement, your two items are [independent](https://www.statisticshowto.com/probability-and-statistics/dependent-events-independent/#or). In other words, one does not affect the outcome of the other. You have a 1 out of 7 (1/7) chance of choosing the first name and a 1/7 chance of choosing the second name.

* P(John, John) = (1/7) \* (1/7) = .02.
* P(John, Jack) = (1/7) \* (1/7) = .02.
* P(John, Qui) = (1/7) \* (1/7) = .02.
* P(Jack, Qui) = (1/7) \* (1/7) = .02.
* P(Jack Tina) = (1/7) \* (1/7) = .02.

Note that P(John, John) just means “the probability of choosing John’s name, and then John’s name again.” You can figure out these probabilities using the [multiplication rule](https://www.statisticshowto.com/multiplication-rule-probability/).

But what happens if you don’t replace the first name before you choose the second? In other words, what happens if you sample without replacement?

Sampling Without Replacement

Sampling without Replacement is a way to figure out **probability without replacement**. In other words, you don’t replace the first item you choose before you choose a second. This dramatically changes the odds of choosing sample items. Taking the above example, you would have the same list of names to choose two people from. And your list of results would similar, except you couldn’t choose the same person twice:

* John, Jack
* John, Qui
* Jack, Qui
* Jack Tina…

But now, your two items are **dependent**, or linked to each other. When you choose the first item, you have a 1/7 probability of picking a name. But then, assuming you don’t replace the name, you only have six names to pick from. That gives you a 1/6 chance of choosing a second name. The odds become:

* P(John, Jack) = (1/7) \* (1/6) = .024.
* P(John, Qui) = (1/7) \* (1/6) = .024.
* P(Jack, Qui) = (1/7) \* (1/6) = .024.
* P(Jack Tina) = (1/7) \* (1/6) = .024…

As you can probably figure out, I’ve only used a few items here, so the odds only change a little. But larger samples taken from small populations can have more dramatic results.

You can tell *how*dramatic these results are by calculating the [covariance](https://www.statisticshowto.com/probability-and-statistics/statistics-definitions/covariance/). That’s a measure of how much probabilities of two items are linked together; the higher the covariance, the more dramatic the results. A covariance of zero would mean there’s no difference between sampling with replacement or sampling without.