simple random sample

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A sample S of size n from a population U of size N is called a *simple random sample* if

1. it is a sample without replacement, and
2. the probability of picking this sample is equal to the probability of picking any other sample of size n from the same population U.

From the first part of the definition, there are $\binom{N}{n}$ samples of n items from a population of N items. From the second part of the definition, the probability of any sample of size n in U is a constant. Therefore, the probability of picking a particular simple random sample of size n from a population of size N is $\binom{N}{n}^{-1}$.

Remarks Suppose $x_1, x_2, \ldots, x_n$ are values representing the items sampled in a simple random sample of size n.

- The sample mean $\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$ is an unbiased estimator of the true population mean μ.
- The sample variance $s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \overline{x})^2$ is an unbiased estimator of S^2, where $(\frac{N-1}{N})S^2 = \sigma^2$ is the true variance of the population given by
$$\sigma^2 := \frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2.$$
- The variance of the sample mean $\overline{x}$ from the true mean μ is
$$\left(\frac{N-n}{nN}\right) S^2.$$
The larger the sample size, the smaller the deviation from the true population mean. When $n = 1$, the variance is the same as the true population variance.