According to the conceptual definition of variance, the sample variance should be calculated as:

$$S_1^2 = \frac{1}{n}\sum_{i=1}^{n}\left(X_i - \bar{X}\right)^2 . \qquad \text{.. (1)}$$

However, when we use the sample to estimate the population, formula (1) is a **biased estimation**, the reason is as follows:

$$\begin{aligned}
E(S_1^2) &= \frac{1}{n}\sum_{i=1}^{n} E\left((X_i-\overline{X})^2\right) = \frac{1}{n}E\left(\sum_{i=1}^{n}(X_i-\mu+\mu-\overline{X})^2\right)\\
&= \frac{1}{n}E\left(\sum_{i=1}^{n}\left((X_i-\mu)^2 - 2(X_i-\mu)(\overline{X}-\mu) + (\overline{X}-\mu)^2\right)\right)\\
&= \frac{1}{n}E\left(\sum_{i=1}^{n}(X_i-\mu)^2 - 2\sum_{i=1}^{n}(X_i-\mu)(\overline{X}-\mu) + n(\overline{X}-\mu)^2\right)\\
&= \frac{1}{n}E\left(\sum_{i=1}^{n}(X_i-\mu)^2 - 2n(\overline{X}-\mu)(\overline{X}-\mu) + n(\overline{X}-\mu)^2\right)\\
&= \frac{1}{n}E\left(\sum_{i=1}^{n}(X_i-\mu)^2 - n(\overline{X}-\mu)^2\right)\\
&= \frac{1}{n}\left(\sum_{i=1}^{n}E\left((X_i-\mu)^2\right) - nE\left((\overline{X}-\mu)^2\right)\right)\\
&= \frac{1}{n}\left(nVar(X) - nVar(\overline{X})\right)\\
&= Var(X) - Var(\overline{X}) = \sigma^2 - \frac{\sigma^2}{n} = \frac{n-1}{n}\sigma^2,
\end{aligned}$$

For this reason, when we calculate a sample variance (S^2) with the purpose to estimate the population variance (**σ^2**), we should take into account that:

$$E(S^2) = \frac{n-1}{n}\,\boldsymbol{\sigma}^2$$

Thus, sample variance (to estimate the population variance) should be calculated as:

$$S^2 = \frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - \bar{X}\right)^2 . \qquad \text{.. (2)}$$

Formula 2 is therefore an **unbiased estimation** of the population variance.