Why sample variance is $n-1$?

Population

$$\mu = \sum_{i=1}^{N} \frac{x_i}{N}$$

$$\sigma^2 = \sum_{i=1}^{N} \frac{(x_i - \mu)^2}{N}$$

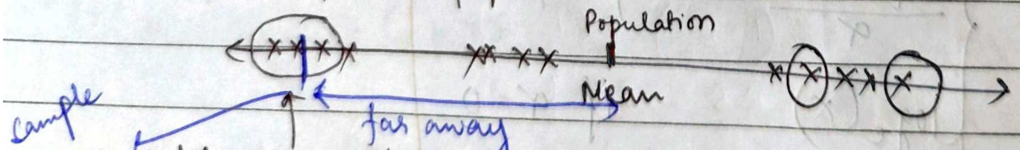
Sample

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n}$$

$$S^2 = \sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n-1} \rightarrow \text{Unbiased estimation}$$

$$s^2 = \sum_{i=1}^{n} \frac{(x_i - \bar{x})^2}{n} \rightarrow \text{It is a biased estimation}$$

let us consider, from a population data we have some sample points



let us consider

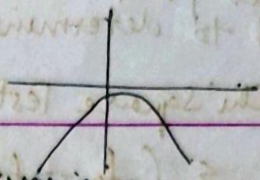
we have ~~seen~~ selected

this data points, then my sample mean will also be located there

In order to overcome the biased estimate, we divide by $(n-1)$

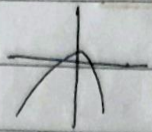
i) when divide by n :-

→ ~~Estimate~~ $\bar{x} << \mu$



Sample ~~mean~~ variance $<<$ Population ~~mean~~ variance

ii) when divide by $(n-1)$:-



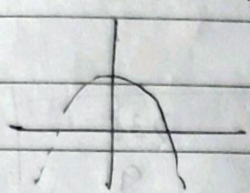
$\bar{x} \approx \mu$

iii) when divide by $(n-2)$:-

$\bar{x} >> \mu$.

$n-3$

$\bar{x} >>> \mu$.



~~When~~ When dividing by $(n-1)$, the sample variance ~~is~~ tends to approach ~~to~~ the ~~p~~ true population variance.