Continuous Mapping Theorem

Let $\hat{\theta}_n$ be an estimator for the parameter θ.

If we have $\hat{\theta}_n \xrightarrow[\text{as } n\to\infty]{p} \theta$, then for a continuous function $g(\hat{\theta}_n)$, the convergence in probability (or distribution) is preserved, i.e we have

$$g(\hat{\theta}_n) \xrightarrow[\text{as } n\to\infty]{p} g(\theta)$$

$g(\hat{\theta}_n)$ will also converge to $g(\theta)$.

$\hat{\theta} = \bar{X}_n$ is an estimator for μ,

$g(x) = x^2$,

So, by the continuous mapping theorem, we have that $(\bar{X}_n)^2 \xrightarrow[\text{as } n\to\infty]{p} (E[X])^2$, here

$$(E[X])^2 \xrightarrow[\text{as } n\to\infty]{} \mu^2.$$