

$$\begin{aligned}
 1.) \text{MSE} &= \mathbb{E}_{p(x|\theta)} [(\hat{\theta}_n - \theta)^2] = \mathbb{E}_{p(x|\theta)} [\hat{\theta}_n^2] + \theta^2 - 2\theta \mathbb{E}_{p(x|\theta)} [\hat{\theta}_n] \\
 &= \mathbb{E}_{p(x|\theta)} [\hat{\theta}_n]^2 + \theta^2 - 2\theta \mathbb{E}_{p(x|\theta)} [\hat{\theta}_n] + \mathbb{E}_{p(x|\theta)} [\hat{\theta}_n^2] - \mathbb{E}_{p(x|\theta)} [\hat{\theta}_n]^2 \\
 &= (\mathbb{E}_{p(x|\theta)} [\hat{\theta}_n] - \theta)^2 + (\mathbb{E}_{p(x|\theta)} [\hat{\theta}_n^2] - \mathbb{E}_{p(x|\theta)} [\hat{\theta}_n]^2) \\
 &= \text{Bias}^2(\hat{\theta}_n) + \text{Var}_{p(x|\theta)}(\hat{\theta}_n)
 \end{aligned}$$