

$$\begin{aligned}
 1.) \text{MSE} &= E_{p(x|\theta)} [(\hat{\theta}_n - \theta)^2] = E_{p(x|\theta)} [\hat{\theta}_n^2] + \theta^2 - 2\theta E_{p(x|\theta)} [\hat{\theta}_n] \\
 &= E_{p(x|\theta)}^2 [\hat{\theta}_n] + \theta^2 - 2\theta E_{p(x|\theta)} [\hat{\theta}_n] + E_{p(x|\theta)} [\hat{\theta}_n^2] - E_{p(x|\theta)}^2 [\hat{\theta}_n] \\
 &= (E_{p(x|\theta)} [\hat{\theta}_n] - \theta)^2 + (E_{p(x|\theta)} [\hat{\theta}_n^2] - E_{p(x|\theta)}^2 [\hat{\theta}_n]) \\
 &= \text{bias}^2(\hat{\theta}_n) + V_{p(x|\theta)}(\hat{\theta}_n)
 \end{aligned}$$