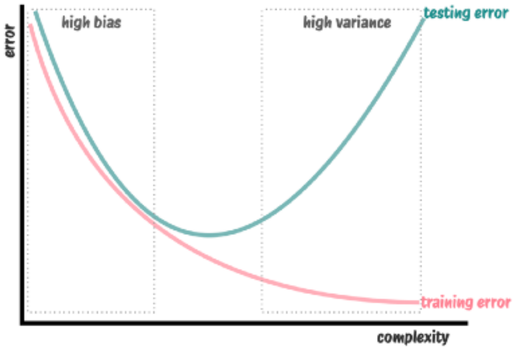
# Formalizing Bias Variance Trade-Off




Expected **test MSE**

$$\underbrace{E\left(y_0 - \hat{f}(x_0)\right)^2}_{} = \text{Var}(\hat{f}(x_0)) + \left[\text{bias}(\hat{f}(x_0))\right]^2 + \underbrace{\text{Var}(\epsilon)}_{}$$

expected MSE at $x_0$ if we repeatedly estimated $f(x)$ with different training sets

irreducible error

[try it out: https://floswald.shinyapps.io/bias_variance/]

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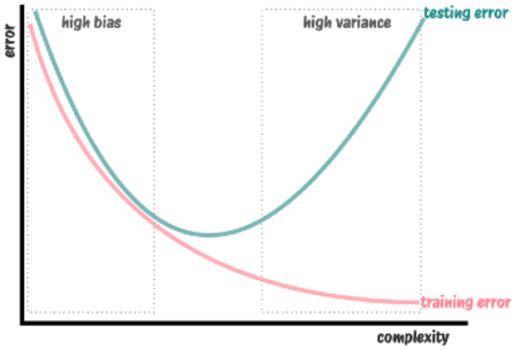


Expected **test MSE**

$$E\left(y_0 - \hat{f}(x_0)\right)^2 = \underbrace{\text{Var}(\hat{f}(x_0))}_{\text{variance increases with complexity}} + \underbrace{\left[\text{bias}(\hat{f}(x_0))\right]^2}_{\text{bias decreases with complexity}} + \text{Var}(\epsilon)$$

[try it out: https://floswald.shinyapps.io/bias_variance/]