$E[\varepsilon_i]=0, \quad Var(\varepsilon_i)=\sigma^2$

$$y_i = \beta x_i + \underline{\varepsilon_i} \qquad \hat{\beta}$$

(x_0, y_0)

$$E[(y_0-\hat{y}_0)^2 \mid x_0] = E[(y_0 - \hat{\beta}x_0)^2 \mid x_0]$$

$$= E[(\underbrace{y_0-\beta x_0}_{\varepsilon_0} + \underline{\beta x_0 - \hat{\beta}x_0})^2 \mid x_0]$$

$$= E[\underline{\varepsilon_0^2} + (\beta x_0 - \hat{\beta}x_0)^2 + \underbrace{2\varepsilon_0(\beta x_0 - \hat{\beta}x_0)}_{3} \mid x_0]$$

$$= \sigma^2 + \underline{E[(\beta x_0 - \hat{\beta}x_0)^2 \mid x_0]} + 0$$

$$= \sigma^2 + E[(\underbrace{\beta x_0 - E[\hat{\beta}]x_0}_{1} + \underbrace{E[\hat{\beta}]x_0 - \hat{\beta}x_0}_{2})^2 \mid x_0]$$

$$= \sigma^2 + \underline{(\beta x_0 - E[\hat{\beta}]x_0)^2} + E[(\hat{\beta}x_0 - E[\hat{\beta}]x_0)^2 \mid x_0]$$

$$= \sigma^2 + [(\underline{\beta - E[\hat{\beta}]})x_0]^2 + E[(\hat{\beta}-E[\hat{\beta}])^2 \mid x_0]\, x_0^2$$

$$= \sigma^2 + \underbrace{(\beta - E[\hat{\beta}])^2}_{\text{bias}} x_0^2 + \underbrace{Var(\hat{\beta})}_{\text{Variance}} x_0^2$$

λ

λ

$1 + 2 + 4 + 5 \longrightarrow \hat{f}_{-3} \longrightarrow \underline{3}$

$\longrightarrow \hat{f}_{-1} \longrightarrow \underline{1}$

$\hat{f}_{-2} \longrightarrow 2$

$\hat{f}_{-4} \longrightarrow 4$

$\hat{f}_{-5} \longrightarrow 5$

$p \qquad x_1, x_2, \ldots, x_p$

$2 \times 2 \times \cdots \times 2 = 2^p$

$p = 10 \qquad 2^p \approx 1{,}000$

$M_0 \qquad 1 \qquad \longrightarrow M_0^*$

$\underline{M_1} \qquad p \qquad \binom{p}{1} \longrightarrow M_1^*$

$M_2 \qquad \binom{p}{2} \longrightarrow M_2^*$

$\vdots$

$M_p \qquad 1 \qquad \binom{p}{p} \longrightarrow M_p^*$

$M_0 \to M_1 \to M_2$ $\qquad M_3$

$\downarrow$ $\qquad \cancel{\binom{p}{2}}$

$\underline{\underline{X_1}}$ $\qquad X_1, X_2$

$\underline{X_1, X_3}$

$\vdots$

X_1, X_p

$p-1$