

Simple regression formulae

$$b_1 = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sum(X_i - \bar{X})^2}$$

$$b_0 = \bar{Y} - b_1 \bar{X}$$

$$\text{Var}(b_1) = \frac{\sigma^2}{\sum(X_i - \bar{X})^2}$$

$$\text{Var}(b_0) = \sigma^2 \left(\frac{1}{n} + \frac{\bar{X}^2}{\sum(X_i - \bar{X})^2} \right)$$

$$\text{Cov}(b_0, b_1) = -\frac{\sigma^2 \bar{X}}{\sum(X_i - \bar{X})^2}$$

$$\text{SSTO} = \sum(Y_i - \bar{Y})^2$$

$$\text{SSE} = \sum(Y_i - \hat{Y}_i)^2$$

$$\text{SSR} = b_1^2 \sum(X_i - \bar{X})^2 = \sum(\hat{Y}_i - \bar{Y})^2$$

$$\begin{aligned} \sigma^2\{\hat{Y}^h\} &= \text{Var}(\hat{Y}^h) \\ &= \sigma^2 \left(\frac{1}{n} + \frac{(X^h - \bar{X})^2}{\sum(X_i - \bar{X})^2} \right) \end{aligned}$$

$$\begin{aligned} \sigma^2\{\text{pred}\} &= \text{Var}(Y^h - \hat{Y}^h) \\ &= \sigma^2 \left(1 + \frac{1}{n} + \frac{(X^h - \bar{X})^2}{\sum(X_i - \bar{X})^2} \right) \end{aligned}$$

$$\begin{aligned} \hat{X}_h &\pm \frac{t_{n-2, 1-\alpha/2}}{|b_1|} * \text{appropriate s.e.} \\ \text{(valid approximation if } \frac{t^2 s^2}{b_1^2 \sum(X_i - \bar{X})^2} \text{ is small)} \end{aligned}$$

Working-Hotelling coefficient:

$$W = \sqrt{2F_{2, n-2; 1-\alpha}}$$

$$\begin{aligned} \text{Cov}(\mathbf{X}) &= \text{E}[(\mathbf{X} - \text{E}\mathbf{X})(\mathbf{X} - \text{E}\mathbf{X})'] \\ &= \text{E}(\mathbf{X}\mathbf{X}') + (\text{E}\mathbf{X})(\text{E}\mathbf{X})' \end{aligned}$$

$$\text{Cov}(\mathbf{A}\mathbf{X}) = \mathbf{A}\text{Cov}(\mathbf{X})\mathbf{A}'$$

$$\mathbf{b} = (\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'\mathbf{Y}$$

$$\text{Cov}(\mathbf{b}) = \sigma^2(\mathbf{X}'\mathbf{X})^{-1}$$

$$\hat{\mathbf{Y}} = \mathbf{X}\mathbf{b} = \mathbf{H}\mathbf{Y}$$

$$\mathbf{e} = \mathbf{Y} - \hat{\mathbf{Y}} = (\mathbf{I} - \mathbf{H})\mathbf{Y}$$

$$\mathbf{H} = \mathbf{X}(\mathbf{X}'\mathbf{X})^{-1}\mathbf{X}'$$

$$\text{SSR} = \mathbf{Y}'(\mathbf{H} - \frac{1}{n}\mathbf{J})\mathbf{Y}$$

$$\text{SSE} = \mathbf{Y}'(\mathbf{I} - \mathbf{H})\mathbf{Y}$$

$$\text{SSTO} = \mathbf{Y}'(\mathbf{I} - \frac{1}{n}\mathbf{J})\mathbf{Y}$$

$$R_{\text{adj}}^2 = 1 - (n-1) \frac{MSE}{\text{SSTO}}$$

$$C_p = \frac{\text{SSE}_p}{\text{MSE}_p} - (n-2p)$$

$$\text{PRESS}_p = \sum(Y_i - \hat{Y}_{i(i)})^2$$