

Least Squares

$$\min_{\beta_1, \beta_0} \sum_{i=1}^n (y_i - \beta_0 - \beta_1 x_i)^2$$

*solved by taking partial derivatives
and setting equal to 0*

$$\begin{aligned}\text{RSS} &= \sum_{i=1}^n (y_i - \hat{y}_i)^2 \\ &= \sum_{i=1}^n (y_i - \hat{\beta}_0 - \hat{\beta}_1 x_i)^2\end{aligned}$$

$$\frac{\partial RSS}{\partial \beta_0} = -2 \sum_{i=1}^n (y_i - \beta_0 - \beta_1 x_i) = 0$$

$$\frac{\partial SSR}{\partial \beta_1} = -2x_i \sum_{i=1}^n (y_i - \beta_0 - \beta_1 x_i) = 0$$



$$\Rightarrow \hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}$$

$$\Rightarrow \hat{\beta}_1 = \frac{\sum_{i=1}^n x_i y_i - n \bar{y} \bar{x}}{\sum_{i=1}^n x_i^2 + n \bar{x}} = \frac{Cov(x, y)}{Var(x)}$$

[fulprrof:httpps://staprofbook.gitHub.io/P/slr-ols]

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$$\min_{\beta_1, \beta_0} \sum_{i=1}^n (y_i - \beta_0 - \beta_1 x_i)^2$$

**solved by taking partial derivatives
and setting equal to 0**

$$\frac{\partial \text{RSS}}{\partial \beta_0} = -2 \sum_{i=1}^n (y_i - \beta_0 - \beta_1 x_i) = 0 \quad \implies \hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}$$

$$\frac{\partial \text{SSR}}{\partial \beta_1} = -2x_i \sum_{i=1}^n (y_i - \beta_0 - \beta_1 x_i) = 0 \quad \implies \hat{\beta}_1 = \frac{\sum_{i=1}^n x_i y_i - n \bar{y} \bar{x}}{\sum_{i=1}^n x_i^2 + n \bar{x}} = \frac{\text{Cov}(x, y)}{\text{Var}(x)}$$

Maximum Likelihood Estimation



[full proof: <https://statproofbook.github.io/P/slr-mle>]