

$$e = \begin{bmatrix} e_1 \\ e_2 \\ \vdots \\ e_n \end{bmatrix} = \begin{bmatrix} \text{Normal}(0, \sigma^2) \\ \text{Normal}(0, \sigma^2) \\ \vdots \\ \text{Normal}(0, \sigma^2) \end{bmatrix}$$

$\text{Cov}(e_1, e_2) = 0$   
 because  
 Independent variables

$$E[e] = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \end{bmatrix} = 0$$

$$\text{Cov}(e) = \begin{bmatrix} \text{Cov}(e_1, e_1) & \text{Cov}(e_1, e_2) & \dots & \text{Cov}(e_1, e_n) \\ \text{Cov}(e_2, e_1) & \text{Cov}(e_2, e_2) & & \\ \vdots & & \ddots & \\ \text{Cov}(e_n, e_1) & \dots & & \text{Cov}(e_n, e_n) \end{bmatrix} = \sigma^2 I$$

(Note: In the matrix above, off-diagonal elements are 0 and diagonal elements are  $\text{Var}(e_i) = \sigma^2$ )