2.31 $R^2 = 1 - \frac{SS_E}{SS_T}$

$SS_E = \sum_i (y_i - \hat{y}_i)^2$

If there are diff values of y, then $SS_E > 0$. Hence $R^2 < 1$ always

2.32-a) $S(\beta_0, \beta_1) = \sum_{i=1}^{n} (y_i - \beta_0 - \beta_1 x_i)^2$ $\hat{\beta}_0 = \beta_0$

$\left.\frac{\partial S}{\partial \beta_0}\right|_{\hat{\beta}_0, \hat{\beta}_1} = -2\sum_{i=1}^{n}(y_i - \hat{\beta}_0 - \hat{\beta}_1 x_i) = 0$

$\left.\frac{\partial S}{\partial \beta_1}\right|_{\hat{\beta}_0, \hat{\beta}_1} = -2\sum_{i=1}^{n} (y_i - \hat{\beta}_0 - \hat{\beta}_1 x_i) x_i = 0$

$\hat{\beta}_1 = \frac{\sum_{i=1}^{n} (y_i - \beta_0) x_i}{\sum_{i=1}^{n} x_i^2}$

$n\hat{\beta}_0 + \hat{\beta}_1 \sum_{i=1}^{n} = \sum_{i=1}^{n} y_i$

b) $Var(\hat{\beta}_1) = \frac{1}{(\sum_{i=1}^{n} x_i)^2} Var(\sum_{i=1}^{n} y_i x_i)$

$= \frac{1}{(\sum_{i=1}^{n} x_i^2)^2} (\sum_{i=1}^{n} x_i^2)\sigma^2$

$= \frac{\sigma^2}{\sum_{i=1}^{n} x_i^2}$

c t_{n-2} is approximately $\frac{\hat{\beta}_1 - \beta_1}{\sqrt{MSE/\sum_{i=1}^{n} x_i^2}}$

We get $\hat{\beta}_1 + t_{\frac{\alpha}{2}, n-2} \sqrt{\frac{MSE}{\sum_{i=1}^{n} x_i^2}}$

In the above equation, the variability is significantly reduced.