For a single Point: (x,y)

Total Deviation = (y - \bar{y})

Explained Deviation = (\hat{y} - \bar{y})

Unexplained Deviation = (y - \hat{y})

(y - \bar{y}) = (\hat{y} - \bar{y}) + (y - \hat{y})

For All Points Together:

Total Variation in y = \sum (y - \bar{y})^2

Explained Variation in y = \sum (\hat{y} - \bar{y})^2

Unexplained Variation in y = \sum (y - \hat{y})^2
Important Relationship #1

Total Variation =
Explained Variation
+ Unexplained Variation

\[ \sum (y - \bar{y})^2 = \sum (\hat{y} - \bar{y})^2 + \sum (y - \hat{y})^2 \]

Important Relationship #2

\[ r = \text{correlation coefficient} \]

\[ r^2 = \frac{\text{Explained Variation}}{\text{Total Variation}} \]

\[ r^2 = \frac{\sum (\hat{y} - \bar{y})^2}{\sum (y - \bar{y})^2} \]

\[ r^2 = \frac{\sum (\hat{y} - \bar{y})^2}{\sum (y - \bar{y})^2} \]

so squaring the correlation
gives the fraction, proportion,
or percentage \((r^2 \times 100\%)\) of
the total variation that can be
explained by the line.
1 - \( r^2 = \frac{\sum (y - \hat{y})^2}{\sum (y - \bar{y})^2} \) = \( \frac{\text{Unexplained}}{\text{Total}} \)
gives the fraction, proportion, or percentage \(((1 - r^2) \times 100\%)\) of the total variation that cannot be explained by the line.

**Useful calculation shortcut**
The total variation in \( y = \sum (y - \bar{y})^2 = s_y^2 (n - 1) \)
Practice doing this on your calculator.

**“x” can be used the same way**
The total variation in \( x = \sum (x - \bar{x})^2 = s_x^2 (n - 1) \)
Practice calculating this starting with \( s_x \) not \( s_y \)
Calculating “Explained Variation”

Approach #1:
Explained variation in $y = r^2 \times \sum (y - \bar{y})^2$

Calculating “Explained Variation”

Approach #2:
Explained variation in $y = (r^2) \text{(total)} - (r^2) \text{(unexplained)} = \sum (y - \bar{y})^2 - \sum (y - \hat{y})^2$

Calculating the “Unexplained Variation”

Approach #1:
Unexplained variation in $y = (1 - r^2)(\text{total variation}) = (1 - r^2) \times \sum (y - \bar{y})^2$
Calculating the “Unexplained Variation”

Approach #2:
Unexplained variation in y = (total) - (explained) = 
\[ \sum (y - \bar{y})^2 - \sum (\hat{y} - \bar{y})^2 \]

The “Standard Error of Estimate”

\[ s_e = \sqrt{\frac{\text{Unexplained variation}}{n - 2}} \]

\[ s_e = \sqrt{\frac{\sum (y - \hat{y})^2}{n - 2}} \]

CI(y|x_0) uses the “Standard Error of Estimate”

\[ \text{CI}(y \mid x_0) = \hat{y} \pm E \]

\[ E = \sqrt{1 + \frac{1}{n} + \frac{(x_0 - \bar{x})^2}{\sum (x - \bar{x})^2}} \]

remember:
\[ \sum (x - \bar{x})^2 = s_x^2(n - 1) \]