response values = fitted value + residual \[ y_i = \hat{y}_i + e_i \]

1. Some properties of linear model fitted by least squares.
   
   (a) The sum of the residuals is 0.
   
   (b) The mean of the fitted values is the mean of response values.
   
   (c) The sum of the squared response values is equal to the sum of the sums of the squares of the fitted values and the squares of the residuals.
   
   (d) The variance of the response values is equal to the sum of the variances of the fitted values and the variance of the residuals.

   \[ \text{variance of response} = \text{variance of fitted} + \text{variance of response} \]

   \[ R^2 = \frac{\text{variance of fitted}}{\text{variance of response}} = 1 - \frac{\text{variance of residuals}}{\text{variance of response}} \]

2. Read \( R^2 \) as a percentage – “the percentage of variation in the observed values that is explained by the model”

3. nels88 data frame in faraway package.

   ```
   > head(nels88)
   sex race ses paredu math
   1 Female White -0.13   hs  48
   2      Male White -0.39   hs  48
   3      Male White -0.80   hs  53
   4      Male White -0.72   hs  42
   5 Female White -0.74   hs  43
   6 Female White -0.58   hs  57
   ```

<table>
<thead>
<tr>
<th>Model</th>
<th>sq obs</th>
<th>sq fit</th>
<th>sq res</th>
<th>var obs</th>
<th>var fit</th>
<th>var res</th>
<th>R^2</th>
</tr>
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<tr>
<td>y~sex</td>
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</tbody>
</table>

4. Special case – one quantitative variable \( y \sim 1 + x \). The correlation coefficient \( r \) is the signed square root of \( R^2 \) (sign of \( r \) is the sign of the slope of the fitted line).