Multiple linear regression example
Recall the multiple linear regression of GRADE on IQ and STUDY TIME data.

<table>
<thead>
<tr>
<th>IQ</th>
<th>Study Time</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>105</td>
<td>10</td>
<td>75</td>
</tr>
<tr>
<td>110</td>
<td>12</td>
<td>79</td>
</tr>
<tr>
<td>120</td>
<td>6</td>
<td>68</td>
</tr>
<tr>
<td>116</td>
<td>13</td>
<td>85</td>
</tr>
<tr>
<td>122</td>
<td>16</td>
<td>91</td>
</tr>
<tr>
<td>130</td>
<td>8</td>
<td>79</td>
</tr>
<tr>
<td>114</td>
<td>20</td>
<td>98</td>
</tr>
<tr>
<td>102</td>
<td>15</td>
<td>76</td>
</tr>
</tbody>
</table>

1. Create a dataset called grades with these three variables. Open this dataset within the SAS/INSIGHT facility: choose Library=WORK and then dataset=GRADES.

2. Within SAS/INSIGHT, obtain a contour plot with Z=GRADE and (X, Y) = (IQ, STUDY).
   - **Analyze,**
     - Contour Plot (Z X Y)
       * Click GRADE into Z, IQ into X and STUDY into Y.
       * Repeat with P into Z, IQ into X and STUDY into Y.

3. Also, obtain a 3D perspective plot of the observed values and fitted surface that you can rotate.
   - **Analyze,**
     - Fit (Y X)
       * Click grade into Y and study IQ into X
       * Click Output before clicking OK. Check the Parametric box under Surface Plots:
4. Carry out a multiple linear regression of grade on IQ and study time.
   
   - Analyze,
     
     - Fit (Y X)
       
       * Click grade into Y and study IQ into X
       * Also, click the Output tab near the bottom and choose Partial Leverage under Plots.
       * Also, investigate the 3D perspective plot similar to the one you did in part 3, but with the fitted surface included.
       * Write these fitted values to a new variable by clicking the Output tab, then the Output Variables tab, then selecting Predicted. Look for this variable in the rightmost column of the data table.

   - In the output from the multiple linear regression, what happens? Is there any evidence of a partial linear association between grade and IQ? This should be apparent from inspecting the Partial Leverage Plots.

5. How about that contour plot from part 2.? Is that the same as a multiple linear regression with $X_1 = IQ$ and $X_2 = STUDY$. To investigate, explore the contour plot with $Z$ as the predicted value from the regression.
6. Do you have any reason to believe that the effect of study time on grade depends on IQ? If so, consider a model with an interaction term, IQ × study time. To create this variable in SAS/INSIGHT,

- **Edit**
  - **Variables**
    - **Other**
      - Click IQ into \( Y \) and study into \( X \) and click the “\( Y \times X \)” transformation, then click \( \text{OK} \), then look for the variable in the rightmost column of your data table in SAS/INSIGHT. You may choose to provide a more descriptive name for the variable than the default.

- **Fit** the interaction model using **Analyze Fit (Y X)** and then clicking terms into the \( Y \) and \( X \) boxes. Note that you can add the cross-product term (IQ×STUDY) in this **Fit (Y X)** facility by clicking on \( \text{CROSS} \). Use the \( t \)-test on the appropriate coefficient in the output to compare the additive model with the multiplicative model. What is the \( p \)-value for the comparison?