The objective of this assignment is to run a MULTIPLE regression with linear and quadratic terms and interaction. You may use the following input statements. Note that if you use power terms or interactions with PROC REG you need to create these terms in the data step.

```
data CornYield; infile input1 missover DSD dlm="," firstobs=2;
   input YEAR YIELD RAINFALL;
   Rainfall2 = Rainfall*Rainfall;   /* rainfall squared */
   Rainfall_Year =  Rainfall*Year;  /* rainfall interaction */
datalines;
run;
```

a) The homework is based on problem 9.15 which is used as an example by your text, and has more detailed explanation in the chapter. The exercise from the book is on the back of this page. The dataset is ex0915.csv.

b) Arrange for the usual comments and title, and HTML output dataset to the C:\temp\ directory.

c) Create a scatter plot following the textbooks instructions for 9.15a and 9.15c.

d) Run 3 regression models as described in sections 9.15b, 9.15d and 9.15e.

e) In addition to the tasks above, include a residual plot and proc univariate of the residuals to check for normality. Do this for the last model only.

The book asks a lot of questions you need not consider. Answer the following questions only. Please attach the answer to your email.

a) Does the quadratic term, fitting curvature to corn yield on rainfall, improve the model (yes or no)? Give the p-value.

b) Does the addition of "year" (supposedly fitting some technological advance) improve the model (yes or no)? Give the p-value.

c) Does the addition of the interaction term (suggesting that the effect of rainfall is not consistent from year to year, figure that one) improve the model (yes or no)? Give the p-value.

d) Do the assumptions of normality and homogeneity appear to be met? Yes or no, no p-values needed (I trust you).

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15. Rainfall and Corn Yield. The data on corn yields and rainfall, discussed in Section 9.3.1, appear in Display 9.18. (Data from M. Ezekiel and K. A. Fox, *Methods of Correlation and Regression Analysis*, New York: John Wiley & Sons, 1959; originally from E. G. Misner, "Studies of the Relationship of Weather to the Production and Price of Farm Products, I. Corn" [mimeographed publication, Cornell University, March 1928].)

Display 9.18 Average corn yield and rainfall in six U.S. states (1890–1927)

Year	Corn Yield (bu/acre)	Rainfall (in/year)	Year	Corn Yield (bu/acre)	Rainfall (in/year)	Year	Corn Yield (bu/acre)	Rainfall (in/year)
1890	24.5	9.6	1903	30.2	14.1	1916	29.7	9.3
1891	33.7	12.9	1904	32.4	10.6	1917	35.0	9.4
1892	27.9	9.9	1905	36.4	10.0	1918	29.9	8.7
1893	27.5	8.7	1906	36.9	11.5	1919	35.2	9.5
1894	21.7	6.8	1907	31.5	13.6	1920	38.3	11.6
1895	31.9	12.5	1908	30.5	12.1	1921	35.2	12.1
1896	36.8	13.0	1909	32.3	12.0	1922	35.5	8.0
1897	29.9	10.1	1910	34.9	9.3	1923	36.7	10.7
1898	30.2	10.1	1911	30.1	7.7	1924	26.8	13.9
1899	32.0	10.1	1912	36.9	11.0	1925	38.0	11.3
1900	34.0	10.8	1913	26.8	6.9	1926	31.7	11.6
1901	19.4	7.8	1914	30.5	9.5	1927	32.6	10.4
1902	36.0	16.2	1915	33.3	16.5			

(a) Plot corn yield versus rainfall.

(b) Fit the multiple regression of corn yield on *rain* and *rain*^{2}.

(c) Plot the residuals versus year. Is there any pattern evident in this plot? What does it mean? (Anything to do, possibly, with advances in technology?)

(d) Fit the multiple regression of corn yield on *rain*, *rain*^{2}, and *year*. Write the estimated model and report standard errors, in parentheses, below estimated coefficients. How do the coefficients of *rain* and *rain*^{2} differ from those in the estimated model in (b)? How does the estimate of σ differ? (larger or smaller?) How do the standard errors of the coefficients differ? (larger or smaller?) Describe the effect of an increase of one inch of rainfall on the mean yield over the range of rainfalls and years.

(e) Fit the multiple regression of corn yield on *rain*, *rain*^{2}, *year*, and *year* × *rain*. Is the coefficient of the interaction term significantly different from zero? Could this term be used to say something about technological improvements regarding irrigation?

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