4.3 Non-Linear Regression

Non-Linear Regression – A technique for finding the <u>curve</u> of best fit.

Coefficient of Determination – $r^2 \rightarrow$ A quantitative measure for the strength of <u>any</u> regression.

Using Excel/ Sheets to Find the Best Regression Line/Curve:

1) Enter the data into two columns and select *Chart > Scatter > Marked Scatter*
2) Right-click on one of the points and select *Add Trendline*
3) Under *Options* click *Display equation on chart* and *Display R-squared value on chart*
4) Under *Type* select a *regression type*
5) Try different regression curves until you find the one with the highest R^2 value

Types of Regression

1) Linear Regression

2) Exponential Regression
   - The curve of best fit with the form <u>$y = ab^x$</u> or <u>$y = ae^{kx}$</u>, where $e = 2.71828...$

3) Polynomial Regression
   - The curve of best fit with descending powers based on the initial degree
   - Example: Degree 2 (Quadratic) $\rightarrow y = ax^2 + bx + c$
             Degree 3 (Cubic) $\rightarrow y = ax^3 + bx^2 + cx + d$

   Don't go beyond degree 4

4) Power Regression
   - The curve of best fit with the form <u>$y = ax^b$</u>

Example 1 – A laboratory monitors the growth of a bacterial culture by scanning it every hour and estimating the number of bacteria. The initial population is unknown.

Time (h)	1	2	3	4	5	6	7
Population	10	21	43	82	168	320	475

a) Use Excel/ Sheets to create a scatterplot.

b) What type of curve does this scatterplot most closely resemble? Polynomial degree 3

c) Generate the most appropriate regression and determine the equation for the curve of best fit and the coefficient of the determination.

$$r^2 = 0.9974 \quad \text{(there are some differences between Excel and Sheets)}$$

$$y = 1.1389x^3 + 3.7619x^2 - 17.091x + 25.429$$

Example 2 – Suppose the lab technician took the following further measurements of the bacterial culture in Example 1.

Time(h)	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Population	10	21	43	82	168	320	475	630	775	830	980	1105	1215	1405

a) Update your graph in Excel/ Sheets.

b) Update the regression that you performed in the last question. What happened to the R^2 value?

c) What type of curve is more appropriate for this scatterplot? Polynomial degree 3

d) Generate the most appropriate regression and determine the equation for the curve of best fit and the coefficient of determination.

$$r^2 = 0.9948$$

$$y = -0.7297x^3 + 20.349x^2 - 46.745x + 25.545$$