12 Curve Fitting

Solve all problems using numerical and scientific python packages and show the solutions in jupyter Notebook. References:

Chapra & Canale. (2010). Numerical Methods for Engineers, 6th edition. Part five: Curve fitting.

Kiusalaas. (2013). Numerical Methods in Engineering with Python 3. Third Edition. Ch. 3. Interpolation and curve fitting.

Johansson. (2015). Numerical Python: A Practical Techniques Approach for Industry. Ch 7. Interpolation.

1. Use least-squares regression to fit a straight line to

x	0	2	4	6	9	11	12	15	17	19
y	5	6	7	6	9	8	7	10	12	12

   Along with the slope and intercept, compute the standard error of the estimate and the correlation coefficient. Plot the data and the regression line. Then repeat the problem, but regress x versus y – that is, switch the variables. Interpret your results.

2. ~~Fit the following data with the power model ($y = ax^b$). Use the resulting power equation to predict y at $x = 9.0$.~~

x	2.5	3.5	5	6	7.5	10	12.5	15	17.5	20
y	13	11	8.5	8.2	7	6.2	5.2	4.8	4.6	4.3

3. Fit an exponential model to

x	0.4	0.8	1.2	1.6	2.0	2.3
y	800	975	1500	1950	2900	3600

   Plot the data and the equation on both standard and semi-logarithmic graph.

4. An investigator has reported the data tabulated below for an experiment to determine the growth rate of bacteria k (per day), as a function of oxygen concentration c (mg/L). It is known that such data can be modeled by the following equation:

$$k = \frac{k_{max} c^2}{c_s + c^2}$$

where c_s and k_{max} are parameters. Use a transformation to linearize this equation. Then use linear reqression to estimate c_s and k_{max} and predict the growth rate at $c = 2$ (mg/L).

c	0.5	0.8	1.5	2.5	4
k	1.1	2.4	5.3	7.6	8.9

5. Use nonlinear regression to fit a parabola to the following data

x	0.2	0.5	0.8	1.2	1.7	2.0	2.3
y	500	700	1000	1200	2200	2650	3750

6. A material is tested for cyclic fatique failure whereby a stress, in MPa, is applied to the material and the number of cycles needed to cause failure is measured. The results are in the table below. When a log-log plot of stress versus cycles is generated, the data trend shows a linear relationship. Use least-squares regression to determing a best-fit equation for this data.

N, cycles	1	10	100	1000	10,000	100,000	1,000,000
Stress, MPa	1100	1000	925	800	625	550	420