

Consider the given dataset (X, Y) obtained experimentally. The theoretical function $Y = f(X | a, b, c, d, h)$ seems to obey the following types of nonlinear ODEs whose solutions are not known.

NLS fit function nonlinear ODEs

- Function 1. $\frac{df(X)}{dX} + a X \sin(h X f(X)) + b \sin(f(X))^2 + c X (f(X))^3 = d \sin(X)$
- Function 2. $\frac{df(X)}{dX} + a \cos(h X f(X)) + b X (f(X))^2 + c \cos(X (f(X))^3) = d \cos(X)$
- Function 3. $\frac{df(X)}{dX} + a \sin(h f(X)) + b \sin(X (f(X))^2) + c \sin((f(X))^3) = d \sin(X)$
- Function 4. $\frac{df(X)}{dX} + a \cos(h f(X)) + b \sin(X (f(X))^2) + c ((f(X))^3) = d \sin(X)$
- Function 5. $\frac{df(X)}{dX} + a \sinh(h f(X)) + b (f(X))^2 + c (f(X))^3 = d \cos(X)$
- Function 6. $\frac{df(X)}{dX} + a \sin(h X f(X)) + b \cos(X (f(X))^2) + c \sin(X (f(X))^3) = d \sin(X^2)$
- Function 7. $\frac{df(X)}{dX} + a X \cos(h f(X)) + b X (f(X))^2 + c \tanh(X (f(X))^3) = d \sin(X^2)$
- Function 8. $\frac{df(X)}{dX} + a \cosh(h f(X)) + b X (f(X))^2 + c \sin(X (f(X))^3) = d \cos(X^3)$
- Function 9. $\frac{df(X)}{dX} + a \tanh(h f(X)) + b \cos((f(X))^2) + c X ((f(X))^3) = d \sin(X^2)$
- Function 10. $\frac{df(X)}{dX} + a \cos(h f(X)) + b \cos(X (f(X))^2) + c X ((f(X))^3) = d X \sin(X)$
- Function 11. $\frac{df(X)}{dX} + a \cosh(h f(X)) + b \sin(X (f(X))^2) + c X ((f(X))^3) = d \sin(X)$

Perform NLS fit using Marquart-Levenberg algorithm and obtain the estimates (5 X 2 = 10 marks), standard errors (5 X 2 = 10 marks) and p-values (5 X 1 = 5 marks) of the parameters (a, b, c, d, h) at alpha = 0.02563.

Use the Marquart-Levenberg settings as initial lambda = 50 with lower and higher limits (10^{-3} , 10^8), tuning parameter = 2, delta X to implement Euler differential = 10^{-6} , initial guess values (a, b, c, d, h) = (1.0, -1.7, 0.5, 1.0, 0.2) and tolerance limit to quit iteration = 10^{-12} .

Find out the total number of iterations (3 marks), final SSE (2 marks), final lambda (5 marks), calculated F value from ANOVA (3 marks), covariance of parameters (I, J) (2 marks).

Note: For the respective function number to be fitted and the parameter indices (I, J) for computing the covariance, check the data file.