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Statistical and Numerical Methods
Exercise 11, HS 2024

10/12/2024

1 Nonlinear Regression - the COVID-19 data of Switzerland (Core)

1. Import the data relative to the COVID-19 pandemics in Switzerland (`covid19_data_switzerland.csv` source: https://corona-data.ch/).
   ```
   data = importdata("covid_19_data_switzerland.csv");
   ```
2. Plot the data and select only those relative to the first wave (day 2 to 25). First, consider the following exponential model:
   $$y = \alpha e^{\beta x} \tag{1}$$
3. Linearize the model and perform a linear regression using `fitlm`. Transform back the obtained regression coefficients to have an initial estimate for α and β.
4. Use the previously regressed coefficients to fit the nonlinear model in Matlab using `fitnlm`.
5. For each model, plot the fitted curves against the data and analyze the TA and QQ plots. How are the two model compared to each other?
6. Consider now the following model:
   $$y = \alpha e^{\beta x} + \gamma \tag{2}$$
   Perform a nonlinear regression using the updated model.
   - Which coefficients are significant?
   - Did the model improve the TA and QQ plots?

2 Nonlinear Regression - the effect of Methionin nutrition supplements (Core)

An experiment was conducted to evaluate the effect of two different methionin nutrition supplements (source A and source B) on the growth of newborn turkeys. The turkeys were separated into 10 experimental units of 15 birds each. For each supplement, the amount fed was varied between 0.04% and 0.44% of the total food. The target variable, the mean body weight of the units, is expressed as a function of the dosage of the two supplements, according to the following nonlinear model:

$$Y_i = \theta_1 + \theta_2 \left[1 - exp\left(-\theta_3 \cdot (\theta_4 x_i^A + x_i^B)\right)\right] + E_i \tag{3}$$

where Y is the mean weight, and x^A and x^B are the dosages of the two supplements, respectively.

The model assumes that the intercept θ_1 and the horizontal asymptote $\theta_1 + \theta_2$ are the same for both supplements and that only the growth rates $\theta_3 \cdot \theta_4$ and θ_3 for supplements A and B, respectively, are different. The question is whether one of the supplements is superior, i.e. whether θ_4 is significantly different from unity.

1. Find the online the data file `turkeyweight.dat` and load the data into Matlab.
   ```
   tdata = load('turkeyweight.dat');
   ```
2. Find suitable initial values for the parameters by linearizing the model.
   - If you cannot solve this, use $\theta_1 = 638$, $\theta_2 = 175$, $\theta_3 = 5$, and $\theta_4 = 1$.
3. Write a model function of the form '`function y = turkeymodel(theta, x)`'.
4. Perform the nonlinear regression, using `nlinfit` or `NonLinearModel`.
5. Are the growth rates for the two supplements significantly different, i.e. is θ_4 significantly different from unity?
   - Use either `nlparci` or `coefCI` to estimate the confidence intervals.