Prompt: "MATLAB code to simulate a ballistics experiment with noise and fit the data with a nonlinear model"

Certainly! Let's break down the task into two steps:

1. **Simulating a Ballistics Experiment with Noise**:  
   To simulate a ballistics experiment, we'll generate synthetic data that mimics the behavior of a projectile. We'll add some noise to make it more realistic. Here's an example of how you can do this in MATLAB:

   ```matlab
   % Parameters
   g = 9.8; % Acceleration due to gravity (m/s^2)
   t = 0:0.1:10; % Time vector (seconds)

   % Simulate projectile motion (parabolic trajectory)
   y_true = -0.5 * g * t.^2;

   % Add random noise
   noise_std = 0.5; % Standard deviation of noise
   y_observed = y_true + noise_std * randn(size(t));

   % Plot the noisy data
   figure;
   plot(t, y_observed, 'o', 'DisplayName', 'Observed Data'); hold on;
   plot(t, y_true, 'r', 'DisplayName', 'True Trajectory'); xlabel('Time (s)');
   ylabel('Height (m)'); legend;
   title('Simulated Ballistics Experiment with Noise');
   ```
2. **Fitting a Nonlinear Model**: 

Now let's fit a nonlinear model to the noisy data. We'll assume a quadratic model for the trajectory:

\[
y = a \cdot t^2 + b \cdot t + c
\]

You can use the `fitnlm` function in MATLAB to estimate the coefficients. Here's an example using the noisy data we generated:

```matlab
% Define the nonlinear model function
modelfun = @(b, t) b(1) * t.^2 + b(2) * t + b(3); % Initial guess for coefficients
beta0 = [1, 1, 1];

% Fit the model
mdl = fitnlm(t, y_observed, modelfun, beta0);

% Display the estimated coefficients
disp(mdl.Coefficients.Estimate);
```
% Plot the fitted model figure;
plot(t, y_observed, 'o', 'DisplayName', 'Observed Data'); hold on;
plot(t, predict(mdl), 'r', 'DisplayName', 'Fitted Model'); xlabel('Time (s)');
ylabel('Height (m)'); legend;
title('Fitted Nonlinear Model');

Adjust the model function ('modelfun') and initial guess ('beta0') based on your specific experiment and data.

Remember to replace the example data with your actual measurements and customize the model accordingly. Good luck with your ballistics experiment! ✨

For more details on 'fitnlm', refer to the [official MATLAB documentation](https://www.mathworks.com/help/stats/fitnlm.html) ¹.

Source: Conversation with Bing, 3/21/2024

