**Matlab Assessment 1b task 3**

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**Results**

The contour plot unveils the parameter values for the speed of light and the offset that minimize the disparities between our model and the experimental data, pinpointing the optimal configuration.

A diagram of a light estimate

Description automatically generated

*Figure 1: This contour plot shows the estimated value for the speed of light from task no. 1 shown on a contour plot.*

**Discussion**

The outcomes of this analysis were successful. The contour plot generated from the data in task 1 aligns with the expectations outlined in the task 3 example. Furthermore, the estimated speed of light value closely matches the expected value, taking into account the offset. I am pleased with the code's performance in producing the contour graph for the speed of light function.

**MATLAB code**

% Clear the workspace and close all open figures

clear;

clf;

% Load the data from the provided file

load('Speed\_of\_light\_data.mat');

% Define the model function for fitting

modelfun = @(b, x) b(1) \* x + b(2);

% Define a range of values for the slope (b1) and intercept (b2)

b1\_range = linspace(2.7e8, 3.1e8, 100); % Adjust the range as needed

b2\_range = linspace(-6000, 6000, 100); % Adjust the range as needed

% Create a grid of b1 and b2 values

[B1, B2] = meshgrid(b1\_range, b2\_range);

% Initialize an array to store chi-squared values

chisq\_values = zeros(size(B1));

% Calculate chi-squared values for different combinations of b1 and b2

for i = 1:numel(B1)

test\_distance = modelfun([B1(i), B2(i)], time);

residuals = (test\_distance - distance) ./ (error \* ones(size(distance)));

chisq\_values(i) = sum(residuals.^2);

end

% Reshape chi-squared values to match the grid

chisq\_values = reshape(chisq\_values, size(B1));

% Create a contour plot of chi-squared values

figure;

contour(B1, B2, chisq\_values, 30); % Adjust the number of contour levels as needed

% Add labels and a title

xlabel('Speed of light estimate');

ylabel('Offset Estimate');

title('∆X^2');

% Find the minimum chi-squared value and its corresponding parameters

[min\_chisq, min\_idx] = min(chisq\_values(:));

[min\_b1, min\_b2] = ind2sub(size(chisq\_values), min\_idx);

% Overlay the minimum chi-squared point on the contour plot

hold on;

plot(B1(min\_b1, min\_b2), B2(min\_b1, min\_b2), 'ro', 'MarkerSize', 10, 'LineWidth', 2);

hold off;

% Display the minimum chi-squared point and its parameters

fprintf('Minimum Chi-Squared Value: %.4f\n', min\_chisq);

fprintf('Best-Fit Slope (b1): %.4f\n', B1(min\_b1, min\_b2));

fprintf('Best-Fit Intercept (b2): %.4f\n', B2(min\_b1, min\_b2));

Notes

Purpose: to use a chi-squared minimization to fit a linear model to some date

Clear + clf : Clear the workspace of variables and closes all figures

Load … loads the data into the workspace

Modelfun … defines the model function fitting a linear function

B1 range … define ranges for the slope b1 and intercept b2

Meshgrid … creates a grid of b1 and b2

Chisq\_values … Initializes an array to store chi-squared values

For loop… iterates through each combination of b1 and b2 and calculates the chi-squared value for each

Contour… creates a contour plot of chi-squared values to show goodness of fit

Labels + titles … adds labels to figure

Min\_shisq …. Find the minimum chi-squared value and its corresponding parameters

Hold on … overlays the minimum chi-squared point on the plot with a red circle

Display …. Printes the minimum chi-squared value, best fit slope and best fit intercept

Chi-squared minimization: a common technique used in data analysis and model fitting to find the best fit parameters for a model. It quantifies how well a model with specific parameters matches the experimental data.

Our model: in this code the model is a linear equation in the for y = b1\*x +b2 where b1 is the slope and b2 is the intercept.

Chi-squared value: chi-squared is a statistical measure that quantifies the difference between the observed data points and the predicted values from the model. As the chi-squared value goes to 0 the model perfectly matches the observed data.