ECE 1395 - Spring 2025

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Homework Assignment 3: Logistic Regression + Non-linear regression

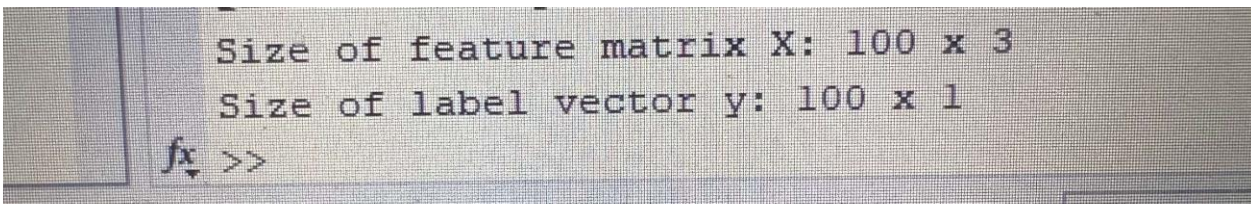
1. Question 1: Logistic Regression

Part a - Feature Matrix and Labels

The feature matrix X and label vector y were created from the input data. The bias term (1) was appended to each feature vector.

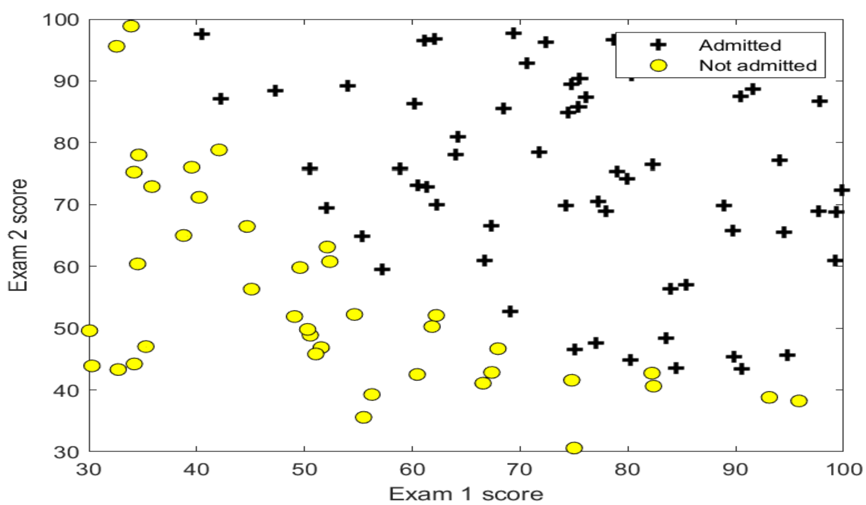
Ther size of feature matrix X: 100 x 3

The size of label vector y: 100 x 1



Part b - Data Visualization

The training data was plotted with different markers for admitted and not admitted students.

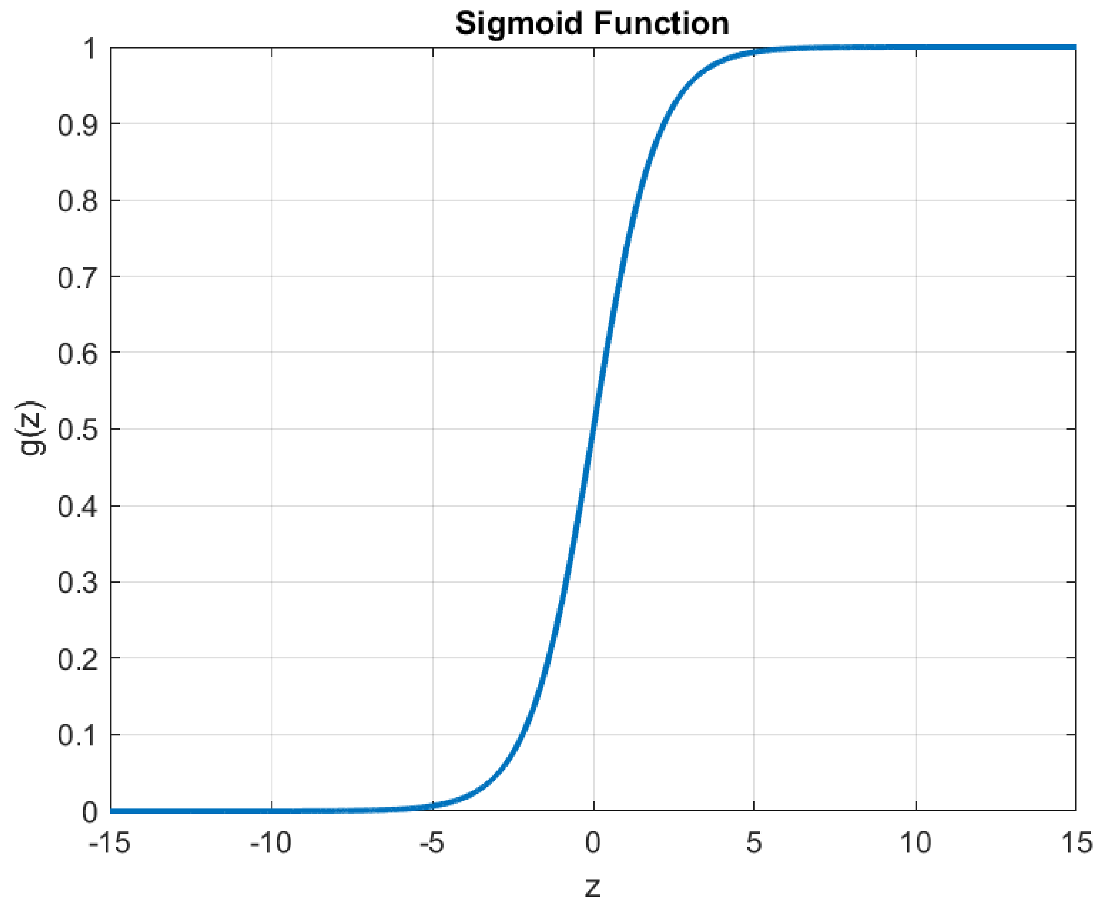


Part c - Data Split

The data was randomly split into training (90%) and testing (10%) sets using a fixed random seed for reproducibility.

Part d - Sigmoid Function

The sigmoid function was implemented and tested over the range [-15, 15].



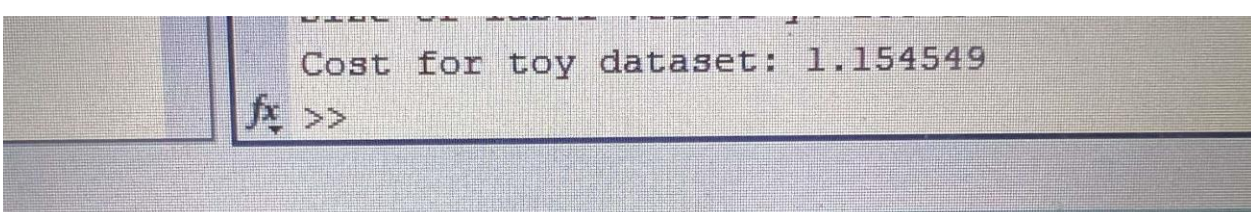
Text response: Looking at the plot, the sigmoid function reaches approximately 0.1 at z = -2.2.

Part e - Cost Function Test

The cost function was tested with the provided toy dataset.

Text output:

Cost for toy dataset: 1.154549



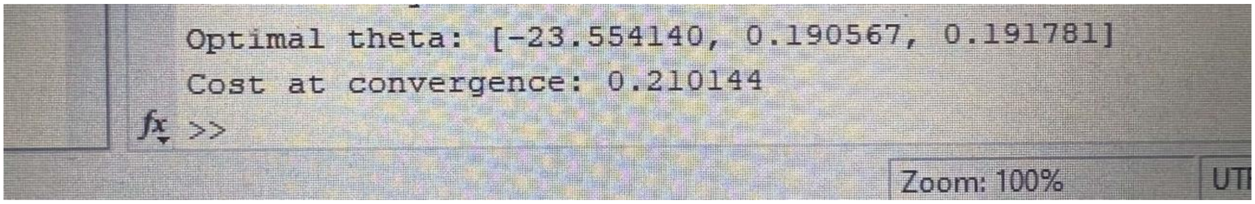
Part f - Model Training

The logistic regression model was trained using fminunc optimization.

Text output:

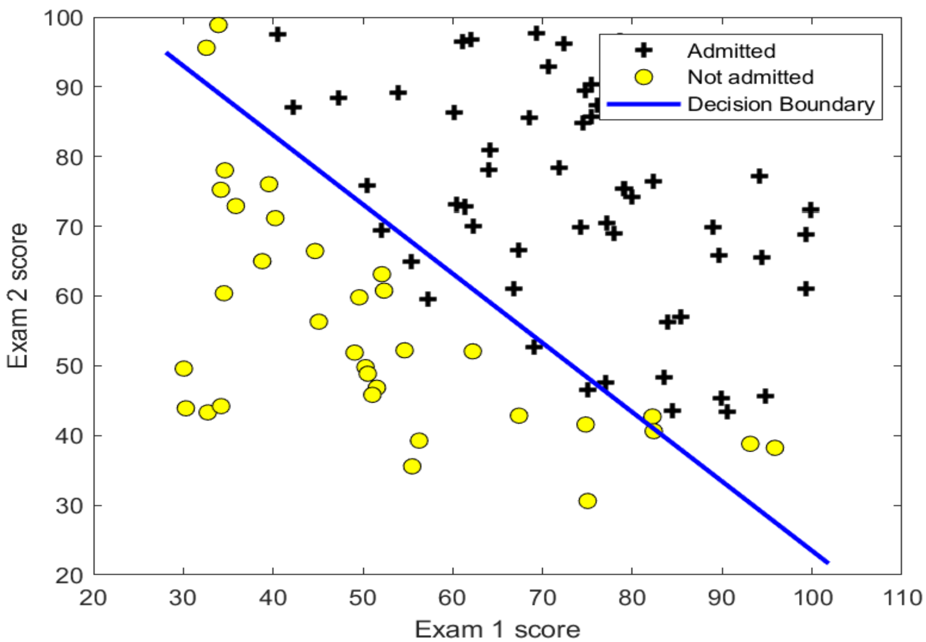
Optimal theta: [-23.554140, 0.190567, 0.191781]

Cost at convergence: 0.210144

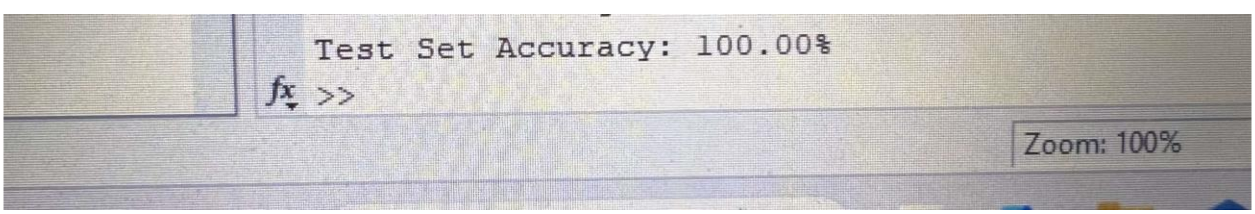


Part g - Decision Boundary

The decision boundary was plotted along with the training data.



Part h - Model Accuracy



Text output:

Test Set Accuracy: 100.00%

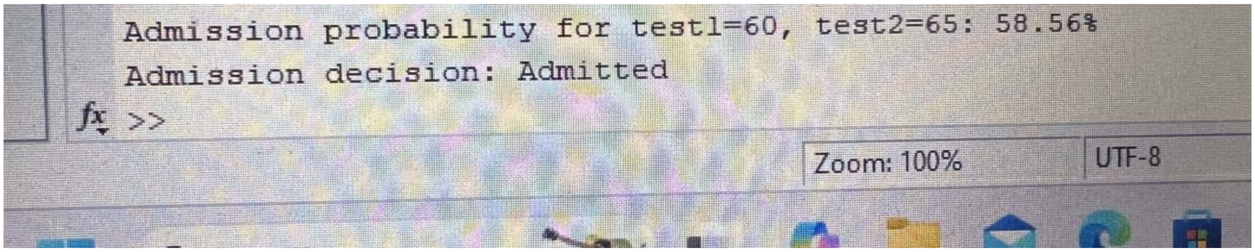
Part i - Sample Prediction

Prediction for a student with test scores: test1 = 60 and test2 = 65

Text output:

Admission probability: 58.56%

Admission decision: Admitted



Part j - Bonus

Starting with cost function: $J(\theta) = (1/m) * \sum[-y^{(i)}\log(h\_\theta(x^{(i)})) - (1-y^{(i)})\log(1-h\_\theta(x^{(i)}))]$

in Derivation: I will Apply Chain Rule then I will need to find $\partial J/\partial\theta_j$

And I will consider sigmoid function $h\_\theta(x) = g(\theta^T x)$

I will use $g'(z) = g(z)(1-g(z))$

I will find derivative of $h\_\theta(x)$: $\partial h\_\theta(x)/\partial\theta_j = h\_\theta(x)(1-h\_\theta(x)) * x_j$

For single example: Iwill take derivative of log terms then substitute sigmoid derivative

Then simplify to: $[h\_\theta(x^{(i)}) - y^{(i)}] * x_j^{(i)}$

And the Final Result: $\partial J/\partial\theta_j = (1/m) * \sum(h\_\theta(x^{(i)}) - y^{(i)})x_j^{(i)}$

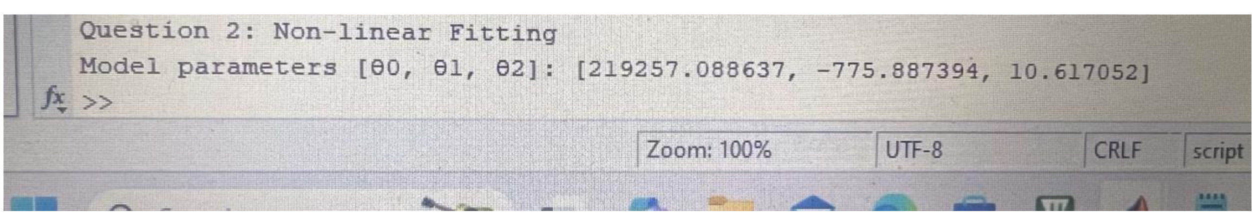
2. Non-linear Fitting

Part a - Model Parameters

The quadratic model parameters were found using the normal equation solution.

Text output:

Model parameters [θ0, θ1, θ2]: [219257.088637, -775.887394, 10.617052]



Part b - Data and Model Visualization