UNIVERSITY OF VICTORIA

Department of Electrical and Computer Engineering

ECE 403/503 Optimization for Machine Learning

LABORATORY REPORT

Experiment No: 03

Title: Predicting Energy Efficiency for Residential Buildings

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To: Mr. J. Zhan

Laboratory Group No.: B01 T 12

Name(s): Alvi Mahadi (V00912845)

1 Introduction and Objectives

In this experiment, we build a multi-output linear model to predict energy efficiency of residential buildings in terms of heating and cooling loads. The database, from which the model in question learns, was created by A. Tsanas and A. Xifara in 2012 [R1] and has since been popular for performance evaluation of various prediction as well as classification techniques [R2]. In [R1], an energy analysis using 12 different building shapes was carried out, where the buildings differ with respect to a total of eight features including relative compactness, surface area, wall area, glazing area, and glazing area distribution, and so on. The data set contains 768 samples, each sample is characterized by a vector x with 8 components which are numerical values of the eight features mentioned above. Also associated with each sample is a 2-component output vector y representing heating and cooling loads of the building. Here we take the term output vector to mean a functional mapping from a set of eight features of a building as seen in a vector x to the buildings heating and cooling loads. Clearly, we are dealing with a dataset of the form $(xn, yn), n = 1, 2, ..., N$ with $x_n \epsilon R^{8\times1}$, $y_n \epsilon R2 \times 1$ and $N = 768$. The objective of the experiment is to develop a 2-output linear model that predicts heating and cooling loads for an "unseen" residential building characterized by a new feature vector x. In this experiment, the above data set was divided into two sets one for training and the other for testing. The train data include 640 samples and the associated outputs while the test data include 128 samples and their outputs, and the division was done at random.

2 Implementation Steps and Results

2.1 Implementation Steps

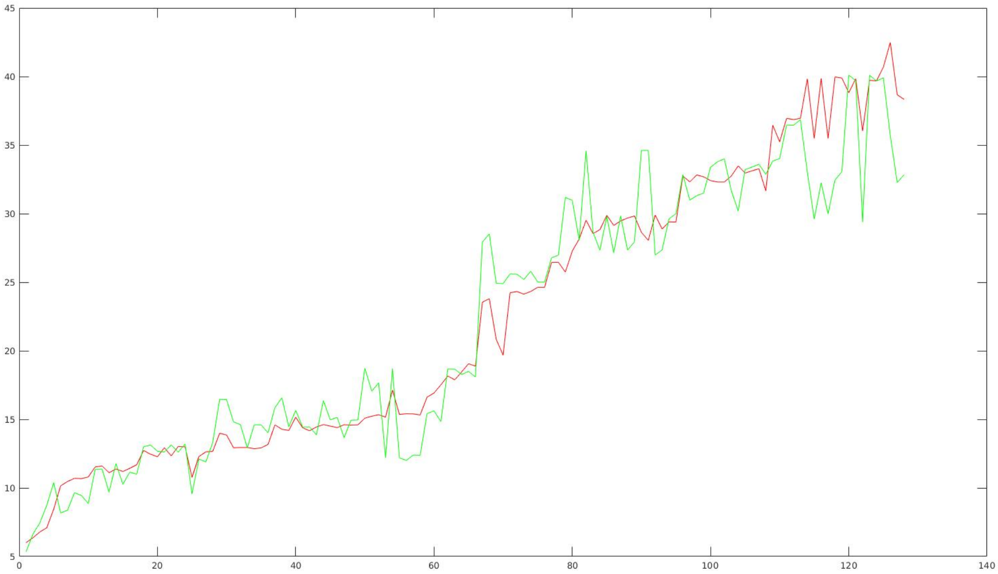
We strictly followed the implementation steps stated in the laboratory manual [3].

2.2 Code

```
clc;
clear all;
close all;
D_tr = load('/home/alvi/Documents/courses/ece503/labs/3/data/D_build_tr.mat');
Xtr = D_tr.D_build_tr(1:8,:);
Ytr = D_tr.D_build_tr(9:10, :);
D_te = load('/home/alvi/Documents/courses/ece503/labs/3/data/D_build_te.mat');
Xte = D_te.D_build_te(1:8,:);
Yte = D_te.D_build_te(9:10, :);
Xtr = [Xtr' ones(640, 1)];
I = eye(9);
W_B = pinv(Xtr' * Xtr + 0.01 * I) * Xtr' * Ytr';
W = [W_B(1:8, 1) W_B(1:8, 2)];
b = W_B(9, :)';
e_p = double.empty();
Y = double.empty();
for i=1:128
y = W' * Xte(:, i) + b;
Y = [Y, y];
end
e_p = norm(Yte - Y, 'fro') / norm(Yte, 'fro');
disp(e_p);
I = 1:128;
plot(I, Yte(1, I), 'r', I, Y(1, I), 'g');
```

```
plot(I, Yte(2, I), 'r', I, Y(2, I), 'g');
```

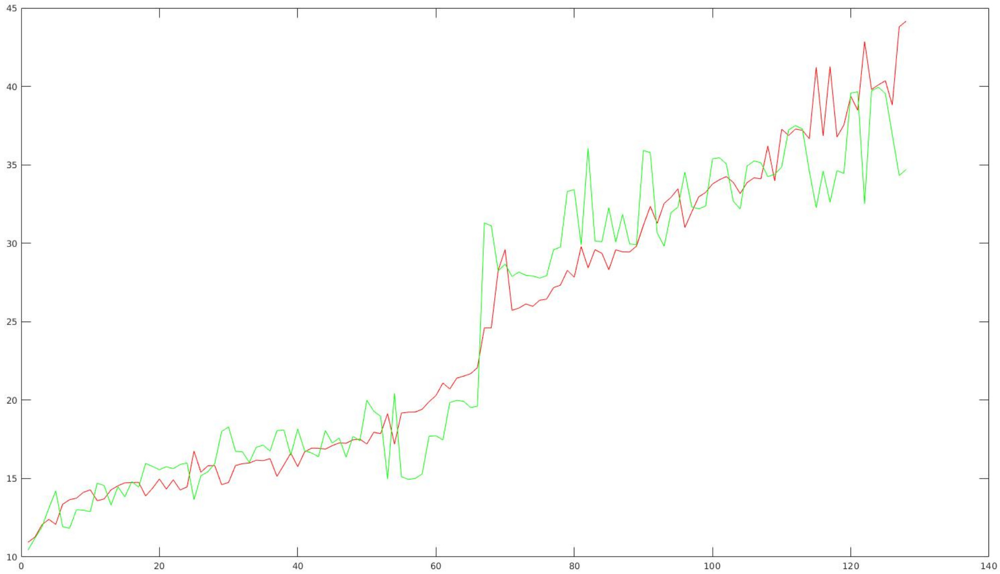
2.3 Result



Figuur 1: First row of Yte and first row of $Y^{(p)}$

3 Discussion

From the generated figure of graphs we can see that, there are not much differences in the test data and the output data as they goes in the same direction wit a little bit of deviations. Thus our experiment does reasonably well in the scenario of the energy efficiency measurement.



Figuur 2: Second row of Yte and second row of $Y^{(p)}$