CS697A – Topic in Computer Science – Machine Learning

Assignment 4

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Q1: Implement the logistic regression (i.e. 1-layer neural network with a single sigmoidal output) algorithm yourself in Python, use adaptive learning rate and momentum for training. Train and test 10 times, each time, start from different random initial weights and use a random subset of 80% of the training data and also start with a different initial learning rate (e.g. 0.0001, 0.005, 0.001, 0.01 etc.) and momentum (0.9, 0.95, 0.99). Report the total training and test errors for each of the 10 runs. Report also the initial learning rate and the momentum you used.

Answer:

Program file: Assignment4Q1.ipynb

- Output for the given 80% of training and testing data:

```
mean training error : 0.0067
mean training error : 0.0075
mean training error : 0.0055
mean training error : 0.0068
mean training error : 0.0070
mean training error : 0.0052
mean training error : 0.0064
mean training error : 0.0069
mean training error : 0.0059
mean training error : 0.0060


mean testing error : 0.0065
mean testing error : 0.0073
mean testing error : 0.0070
mean testing error : 0.0059
mean testing error : 0.0078
mean testing error : 0.0060
mean testing error : 0.0045
mean testing error : 0.0058
mean testing error : 0.0082
mean testing error : 0.0072
```

- Learning rates used are 0.00005, 0.0001, 0.0005, 0.001, 0.005, 0.01, 0.05, 0.1, 0.5, 1.0

Q2: Using the 10 runs in Q1, for each feature compute feature importance as
a) Fa: the average (over 10 runs) increase in the test error when the weight for that feature is set to 0.
For each feature, compute also,
b) Fb: the variance of each feature on the test set and
c) Fc: the mutual information between the feature column and the label column.
Plot x=Fa and y=Fb, Fc
Comment on how your feature importance Fa the other measurements Fb and Fc are related.

Answer:
Program file: Assignment4Q2.ipynb

- Output For the given training and random testing data:

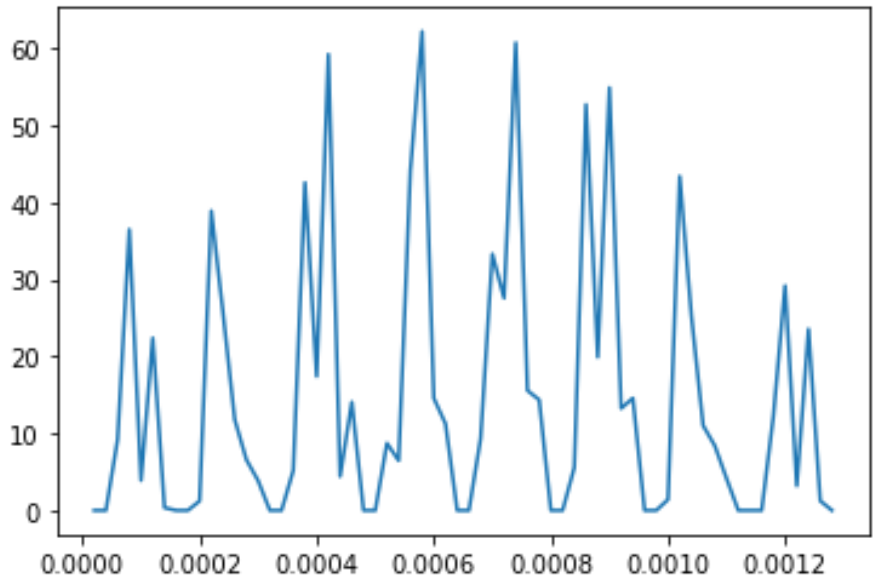
Fa: The average increase in the total test error :
4.9999999999999826e-05

Fb: the variance of each feature on the test set :
[0.0, 0.0, 9.222222222222221, 36.5, 3.888888888888889, 22.38888888888889, 0.3541666666666667, 0.0, 0.0, 1.2222222222222219, 38.90972222222222, 25.6875, 11.805555555555555, 6.576388888888889, 3.8541666666666665, 0.0, 0.0, 5.1875, 42.57638888888889, 17.409722222222218, 59.24305555555555, 4.409722222222222, 14.076388888888891, 0.0, 0.0, 8.722222222222221, 6.472222222222222, 44.1875, 62.22222222222222, 14.576388888888888, 11.25, 0.0, 0.0, 9.354166666666666, 33.30555555555555, 27.576388888888886, 60.743055555555564, 15.576388888888888, 14.354166666666666, 0.0, 0.0, 5.576388888888888, 52.72222222222222, 19.909722222222225, 54.90972222222221, 13.25, 14.576388888888886, 0.0, 0.0, 1.4166666666666667, 43.40972222222223, 25.25, 11.020833333333334, 8.38888888888889, 4.138888888888888, 0.0, 0.0, 0.0, 12.243055555555557, 29.1875, 3.1875, 23.555555555555554, 1.2430555555555554, 0.0]

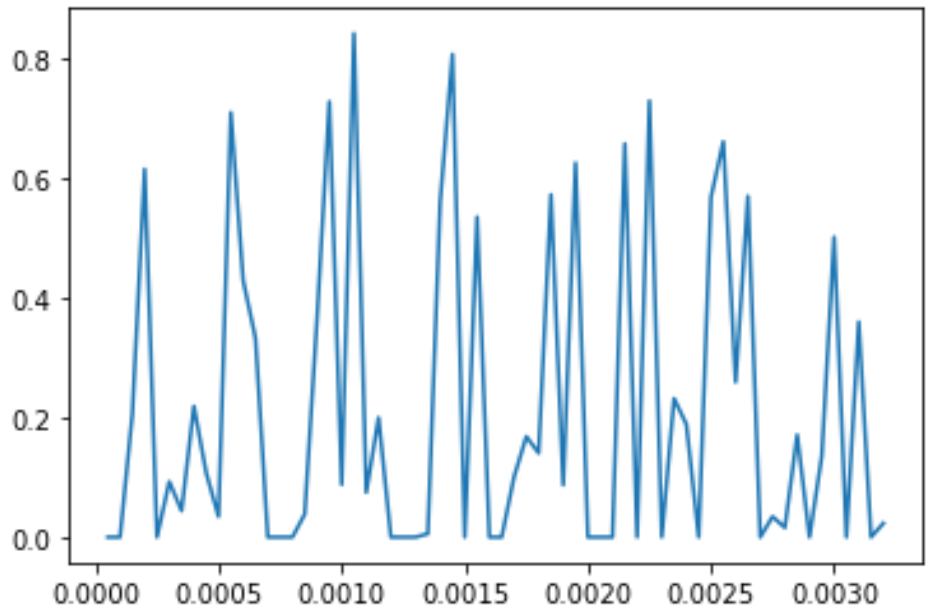
Fc: the mutual information between the feature column and the label column :
[0.0, 0.0, 0.20552248677248697, 0.61432178932179, 0.0, 0.0926286676286685, 0.04401455026455103, 0.21848845598845656, 0.10731120731120813, 0.03439153439153486, 0.7087662337662348, 0.4285744348244356, 0.33217893217893324, 0.0, 0.0, 0.0, 0.038293650793651324, 0.36412337662337757, 0.7268217893217903, 0.08773448773448878, 0.8407106782106792, 0.0746392496392505, 0.19944083694083803, 0.0, 0.0, 0.0, 0.005591630591631258, 0.5586670274170282, 0.8059884559884567, 0.0, 0.5343614718614731, 0.0, 0.0, 0.10033369408369519, 0.16782708032708116, 0.14037698412698463, 0.5716299903799915, 0.08704004329004467, 0.6246392496392501,

0.0, 0.0, 0.0, 0.6565836940836955, 0.0, 0.7282106782106788, 0.0, 0.23138528138528258, 0.18823051948052005, 0.0, 0.5674272486772491, 0.6601551226551237, 0.2587662337662351, 0.5690836940836947, 0.0, 0.034262265512266854, 0.015942159692160063, 0.17067099567099642, 0.0, 0.1355519480519487, 0.500796657046658, 0.0, 0.35949374699374825, 0.0, 0.023250360750361132]

- Plotting x=Fa and y=Fb



- Plotting x=Fa and y=Fc



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Q3: Use the scikit-learn neural network implementation to train a neural network and test it using the same instances as in Q1. Decrease the test error as much as you can through selection of:
-different number of hidden layers and units,
-L1 or L2 regularization/weight decay,
-different optimization algorithms,
-feature selection

Answer:

Program file: Assignment4Q3.ipynb

- Output For the given training and testing data:

Different no. of hidden layers and units:
mean_score for ~100% instances: 0.5046
mean_score for ~78% instances: 0.4236
mean_score for ~39% instances: 0.3711

Feature Selection:
mean_score for ~100% instances: 0.4626
mean_score for ~62% instances: 0.2690
mean_score for ~47% instances: 0.2979

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