CS 6375

ASSIGNMENT 3

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Assumptions:

1) Function used: Sigmoid.
2) Training data is randomly sampled from the dataset.
3) Error used: Mean Square error.
4) Termination condition is either Max number of iteration or error tolerance is met.

Pre-processing

Inputs:

1. File from where the data is to be read.
2. File from where the data is to be stored.

- This information is stored in Arraylist statically. Whenever the program reads the new instance it will match with the values of the list and store its position as its own value. In this way, categorical data is converted into numerical.
- Numerical data is converted using mean and standard deviation.
- If it encounters "?" and " ", it will ignore that row, and read the next line.
- The final output is kept as it is. That is a regression problem. It is not converted to binary variable.

Training:

Inputs:

- File from where the data is stored i.e. the output file from the preprocessing stage.
- Training Size
- Maximum number of iterations
- Number of hidden layers
- For every hidden layer, number of neurons

1) The program will terminate when either it reaches max iteration or error tolerance is met
2) Learning rate is 0.9
3) Accuracy is good when the number of layers are more, but not very large.
4) Also, optimal number of iteration = 200

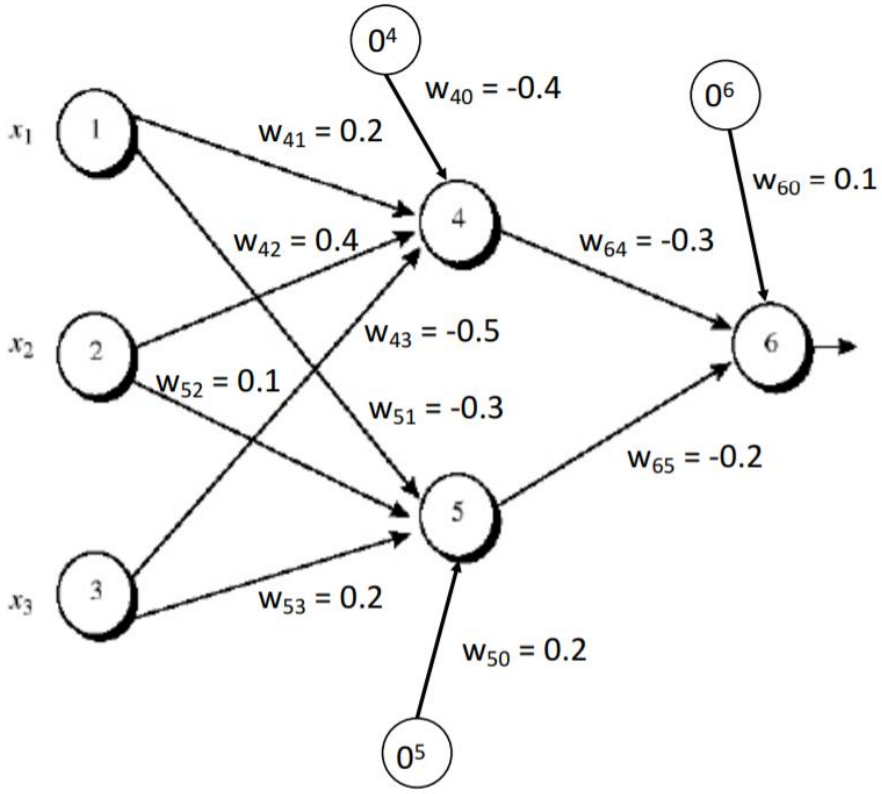
Testing:

- After training given number of instances and iterating for given iterations, a network will be set which contain all the updated weights.
- In this step, attributes of new instance will be taken as input. Also, we know the actual output from the dataset.
- We will predict the final output with our trained network and given new attributes, and find the output. This will be our predicted output.
- Error is calculated using Mean Square Error.

Output:

For every layer (excluding output) it will print

1) The Layer numbers
2) Weights of every neurons in that layer
3) Weight of the bias in that layer (shown in last element of every layer.)



Consider this network (ignore the weights)

Weights will be randomly initialized.

Output will be shown as

Layer 0

Neuron 1 weights: W41, W51

Neuron 2 weights: W42, W52

Neuron 3 weights: W43, W53

Bias Weight: W40, W50

Layer 1

Neuron 1 weights: W64

Neuron 2 weights: W65

Bias Weight: W60

Experiment:

1) Dataset : Car.data.csv
   MaxIteration : 200
   Hidden layers: 2 (5, 3)

```
Layer : 0

Neuron : 1 Weights : 0.6359504311381224   -0.3473749958097137   -0.12087802489925085   0.2189853015605324   0.7463358882703228
Neuron : 2 Weights : -0.8220052123050575   0.8649777620303152   0.6348919713728581   1.0062051433302643   0.9843358090840089
Neuron : 3 Weights : 0.9944271672190855   -0.4953508417373381   -0.96630865306676966   -0.41988950729850927   0.6085300239357543
Neuron : 4 Weights : 0.8412131253882992   0.9488021094701669   0.22871833912568268   -0.5217648141288102   0.9449998282097878
Neuron : 5 Weights : 0.3734433895861672   0.5056962177828296   -0.17578608048527417   -0.7575561979675293   0.24573159522434515
Neuron : 6 Weights : -0.2972272320164232   -0.38512918442216876   -0.43319708085722575   0.14772287430673256   -0.7183003751888721
Neuron : 7 Weights : -0.7108947375089193 0.8053950310201194 -0.6682956541781496 0.9524772225443329 -0.7199943853316032

Layer : 1


Neuron : 1 Weights : -0.11576569823164011   0.2756664286724182   0.3270838388040743
Neuron : 2 Weights : -0.34785189449097575   0.06740132067515173   0.13966168278109117
Neuron : 3 Weights : -0.8566105757797584   -0.69915682680441   -0.9660297656185278
Neuron : 4 Weights : -0.18405497896136785   0.45978802027377674   -0.6713479585212031
Neuron : 5 Weights : -0.5919957716713613   -0.9452352692908267   0.8537763868140366
Neuron : 6 Weights : 0.10844061713081948   -0.8178541369394411   0.30751905071551644

Layer : 2


Neuron : 1 Weights : -0.8885811904694978
Neuron : 2 Weights : 1.0482397028172918
Neuron : 3 Weights : 0.4417132751469188
Neuron : 4 Weights : 0.37371521771729

Total Training Error : 0.007925749318801025
Training Accuracy : 70.50408719346049

Total Testing Error:0.007173076923076926
Testing Accuracy : 72.3076923076923
```

2) Dataset : adult.data.csv
   MaxIteration : 150
   Hidden layers: 2 (8, 5)

```
Layer : 0

Neuron : 1 Weights : -0.42285105658292166   0.6345127554150404   -0.23093125214226157   0.6930687621516081   -0.24209149590630813   -0.12952294182618274   -0.47527567390523334   0.03
Neuron : 2 Weights : -0.4324909367393822   0.363262689338484   -0.884843721062849   0.8767920974976688   -0.9731246756284704   -0.31867065123582217   -0.09919245687190874   0.7161586
Neuron : 3 Weights : 0.023953321641698153   -0.742167957437318   -0.38673198082607985   -0.478055578789871   0.48744193413556225   -0.003580459846839839   -0.8035581138414609   -0.28
Neuron : 4 Weights : 0.6959100045282857   -0.7926095567693802   0.024486765027894777   -0.5634391222415418   -0.08843097607144751   0.22287986293255613   -0.2380790654522143   0.0442
Neuron : 5 Weights : -0.36851288503449686   0.020747971718105968   0.3891989441548114   -0.2894636497240871 7   0.6650451837212068   -0.7433746005296527   0.9911824251048391   0.98842
Neuron : 6 Weights : 0.9749524947159786   -0.2904322084430822   0.7888383098012308   -0.23782564584389787   -0.23984553427367455   -0.15844450816158107   0.5936224278777009   -0.5495
Neuron : 7 Weights : 0.6124797636401501   0.40207211073610555   -0.6280884251708692   0.6968697116666631   0.7448919346921601   0.3287794451919315   0.9309734012772564   -0.249033512
Neuron : 8 Weights : 0.26772364329729037   -0.9486965797077404   -0.1291310274317264   -0.23301262641399023   -0.7197105950257983   0.2499295203177289 7   -0.10419219384537941   0.836
Neuron : 9 Weights : -0.85121298319662 12   0.6020043950616044   -0.6636180059130068   0.2220001487498935   -0.24258589242299117   0.618622875415241   0.3082304560198656   0.465951878
Neuron : 10 Weights : 0.7481418758162696   -0.21982190941966304   -0.6844091728564741   -0.662052158375811   -0.1943971112033525   0.3741357935539589   0.30732177476168004   0.404028
Neuron : 11 Weights : 0.8970670580272454   0.1693913590700 77   0.2008839997282696   -0.08472014156393248   0.043493774684521376   0.8813521389930097   -0.2861055016940495   -0.829318
Neuron : 12 Weights : -0.3238351484763987   -0.2621157043134171   0.9757728577672207   -0.9658555772700996   0.9244184715386434   0.9010488572662663   -0.1588736060958314   -0.624100
Neuron : 13 Weights : 0.2835194141048344   0.4805470733466714   -0.915576843620441   0.3561863267696071   -0.9722826762812606   0.9445806261312883   0.7296314887861743   -0.815315816
Neuron : 14 Weights : 0.4620592180275288   0.33982839292181105   -0.34859362064153254   0.7619161957410177   -0.3524602523517275   0.42702675540759816   0.28353215835071394   -0.0506
Neuron : 15 Weights : 0.5876860668899738 0.057261341078845264 -0.22176646710295544 0.6127132875269959 -0.9693074214305577 -0.4671381714202867 0.28409472954110243 0.5480038408511098
```

```
Layer : 1


Neuron : 1 Weights : -0.9689528876247915   0.1964410568894925   0.1432327693542019   -0.5667847646601557   0.11509860937077344
Neuron : 2 Weights : 0.21952891458545998   0.7641226614601341   -0.5292809302882799   -0.1779943479149909   -0.20587974082207283
Neuron : 3 Weights : 0.6426497665867403   -0.7370295579712455   0.12042823045167747   -0.7995324116441781   0.6732348125848558
Neuron : 4 Weights : 0.19935451346561694   0.41577795690521285   -0.8713257136950607   -0.7729763293701316   0.5603904489236612
Neuron : 5 Weights : 0.8537796414164391   0.5190648259623124   -0.5500608987733673   -0.14999055606510525   -0.6397117363511738
Neuron : 6 Weights : 0.9455788400619949   -0.1431928453919791   -0.14653020552951504   -0.9905344413039959   -0.6744149997039185
Neuron : 7 Weights : 0.25605900536104764   -0.18289362899729514   0.7676944251180926   -0.5235589304364591   -0.4982164636353382
Neuron : 8 Weights : 0.9392009637071808   0.5118702136884977   -0.4274735839083284   0.509961057239657   -0.8483416499393882
Neuron : 9 Weights : 0.46692069607186926   0.9872898272365442   -0.7747113384592262   -0.05964634877532914   0.9749539309660028

Layer : 2


Neuron : 1 Weights : 0.4591708470464758
Neuron : 2 Weights : -0.10083359744449684
Neuron : 3 Weights : 0.6694081171403558
Neuron : 4 Weights : -0.3163844453729009
Neuron : 5 Weights : -0.09670127472907598
Neuron : 6 Weights : 0.42699523250945304

Total Training Error : 0.004969380192689932
Training Accuracy : 75.15309903654874

Total Testing Error:0.004857458563535828
Testing Accuracy : 75.71270718232044
```

3) Dataset : iris.data.csv
   MaxIteration : 150
   Hidden layers: 3 (5, 3, 2)

```
Layer : 0

Neuron : 1 Weights : 0.8980874693051545   0.9696431784638665   0.24344471669044662   -0.6868125213991212   -0.16474968266745119
Neuron : 2 Weights : 0.32386532466823637   0.9590136249589855   -0.6032750957274909   0.9446990256432639   0.16772667822777096
Neuron : 3 Weights : 0.6189911435923904   0.7708566986294049   -0.4054299618349941   0.07041386604271697   0.0029604667831067 87
Neuron : 4 Weights : -0.8682236675013352   0.025874711694425095   -0.950275235934298   0.15988747789848512   -0.7861320295635743
Neuron : 5 Weights : 1.0071260969081846 0.3048471857218805 0.34818365733878553 -0.06857528962523703 0.12577189743914252

Layer : 1


Neuron : 1 Weights : -0.6311925202780356   0.558087797543726   -0.231690722165752
Neuron : 2 Weights : 0.8227075376757668   -0.0356195848780562   -0.5643027776736649
Neuron : 3 Weights : 0.7455612471607759   -0.8904711799987248   -0.3119847331540146
Neuron : 4 Weights : -0.29279634334203775   0.285578762993499   -0.0427715902047001
Neuron : 5 Weights : -0.5563122529209789   -0.7083301749293778   0.8095542445666428
Neuron : 6 Weights : -0.07786499563221237   0.5243400481802402   0.9713588367336866

Layer : 2


Neuron : 1 Weights : -0.12296466626248478   -0.17557001236098133
Neuron : 2 Weights : -0.34460491377879654   0.8147659265915645
Neuron : 3 Weights : -0.5453314870852068   0.04519428057808614
Neuron : 4 Weights : -0.3253475436757736   0.010246840662981475

Layer : 3


Neuron : 1 Weights : 0.8451877061253619
Neuron : 2 Weights : 0.023841020146797558
Neuron : 3 Weights : 2.2145702971850745

Total Training Error : 0.006299212598425202
Training Accuracy : 68.50393700787401

Total Testing Error:0.0034782608695652197
Testing Accuracy : 82.6086956521739
```