

Project 4 Part 3

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Section1:

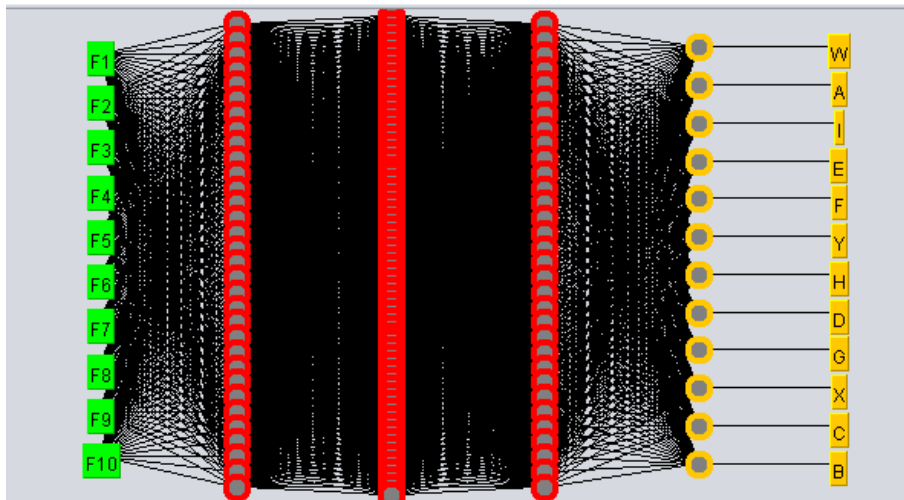
a.

5 layers, there are 3 hidden layers.

First hidden layer: 32

Second hidden layer: 64

Third hidden layer: 32



b.

Training set (DS1): 95.6449%

=== Summary ===

Correctly Classified Instances	15966	95.6449 %
Incorrectly Classified Instances	727	4.3551 %
Kappa statistic	0.9432	
Mean absolute error	0.0099	
Root mean squared error	0.077	
Relative absolute error	7.7517 %	
Root relative squared error	30.4086 %	
Total Number of Instances	16693	

Testing set (DS2): 94.5616%

=== Summary ===

Correctly Classified Instances	3947	94.5616 %
Incorrectly Classified Instances	227	5.4384 %
Kappa statistic	0.9289	
Mean absolute error	0.0117	
Root mean squared error	0.0855	
Total Number of Instances	4174	

c.

Training Set (DS1):

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.338	0.000	1.000	0.338	0.505	0.581	0.770	0.344	W
	0.993	0.014	0.980	0.993	0.987	0.977	0.998	0.997	A
	0.924	0.000	0.997	0.924	0.959	0.956	0.969	0.957	I
	0.957	0.003	0.970	0.957	0.963	0.959	0.977	0.968	E
	0.981	0.013	0.944	0.981	0.962	0.954	0.995	0.988	F
	0.836	0.001	0.965	0.836	0.896	0.895	0.884	0.847	Y
	0.921	0.006	0.890	0.921	0.905	0.900	0.973	0.900	H
	0.855	0.003	0.909	0.855	0.881	0.878	0.946	0.892	D
	0.875	0.005	0.889	0.875	0.882	0.877	0.953	0.921	G
	0.970	0.007	0.883	0.970	0.925	0.922	0.996	0.979	X
	0.667	0.000	0.940	0.667	0.780	0.790	0.866	0.670	C
	0.000	0.000	0.000	0.000	0.000	-0.000	0.982	0.013	B
Weighted Avg.	0.956	0.010	0.957	0.956	0.955	0.949	0.983	0.966	

Class	Accuracy
A	99.3%
B	0.0%
C	66.7%
D	85.5%
E	95.7%
F	98.1%
G	97.5%
H	92.1%
I	92.4%
W	33.8%
X	97.0%
Y	83.6%

Testing Set (DS2):

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.222	0.000	1.000	0.222	0.364	0.471	0.734	0.229	W
	0.988	0.028	0.961	0.988	0.974	0.956	0.994	0.990	A
	0.904	0.000	1.000	0.904	0.949	0.947	0.958	0.941	I
	0.961	0.005	0.961	0.961	0.961	0.957	0.989	0.981	E
	0.961	0.014	0.940	0.961	0.950	0.939	0.992	0.975	F
	0.794	0.001	0.944	0.794	0.863	0.863	0.863	0.804	Y
	0.880	0.003	0.934	0.880	0.906	0.902	0.959	0.919	H
	0.879	0.003	0.899	0.879	0.889	0.885	0.962	0.910	D
	0.894	0.007	0.856	0.894	0.874	0.869	0.960	0.922	G
	0.962	0.007	0.877	0.962	0.917	0.914	0.998	0.980	X
	0.537	0.001	0.880	0.537	0.667	0.685	0.760	0.503	C
	0.000	0.001	0.000	0.000	0.000	-0.001	0.980	0.017	B
Weighted Avg.	0.946	0.016	0.946	0.946	0.944	0.933	0.979	0.960	

Class	Accuracy
A	98.8%
B	0.0%
C	53.7%
D	87.9%
E	96.1%
F	96.1%
G	89.4%
H	88.0%
I	90.4%
W	22.2%
X	96.2%
Y	79.4%

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=== Summary ===

Correctly Classified Instances      2280           68.2839 %
Incorrectly Classified Instances    1059           31.7161 %
Kappa statistic                    0.573
Mean absolute error                 0.0697
Root mean squared error             0.1923
Relative absolute error             54.2159 %
Root relative squared error         75.7412 %
Total Number of Instances          3339

=== Detailed Accuracy By Class ===

      TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Cl
      0.133    0.000    1.000    0.133    0.235     0.364    0.755    0.303    W
      0.850    0.271    0.677    0.850    0.753     0.567    0.871    0.781    A
      0.944    0.000    1.000    0.944    0.971     0.969    0.965    0.953    I
      0.691    0.049    0.634    0.691    0.661     0.618    0.929    0.666    E
      0.444    0.080    0.584    0.444    0.505     0.405    0.857    0.579    F
      0.773    0.001    0.958    0.773    0.855     0.857    0.861    0.840    Y
      0.500    0.012    0.705    0.500    0.585     0.575    0.939    0.629    H
      0.364    0.011    0.541    0.364    0.435     0.428    0.919    0.451    D
      0.144    0.016    0.257    0.144    0.185     0.169    0.787    0.175    G
      0.844    0.008    0.839    0.844    0.841     0.833    0.969    0.831    X
      0.100    0.001    0.500    0.100    0.167     0.221    0.727    0.228    C
      0.000    0.000    ?        0.000    ?         ?        0.039    0.001    B
Weighted Avg.  0.683    0.132    ?        0.683    ?         ?        0.885    0.695

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d.

During building the best network, we found that the number of layers, the number of neurons inside each layer really make a big difference to both the training, testing accuracy, as well as the training speed. At the very beginning we had a 64 neurons one hidden layer network, and it can be trained very fast, but the accuracy can only reach 76%. After adding more layers and more neurons to the hidden layers, the training process got much slower, but the training accuracy goes up in a significant extent. Besides, we also tried different batch size, different learning rate, different momentum, and different epochs. More epochs can make training goes deeper until training loss does not go down further. Learning rate and momentum also play very important roles during the training process, as for the same network we had high learning rate which got converged super quickly without getting more accurate. Overall, there is a paradigm to try different parameters before reaching to an overfitting state, and it also helps to know what is an average or highest accuracy that one can reach through discussion so that we know our target.

Section2:

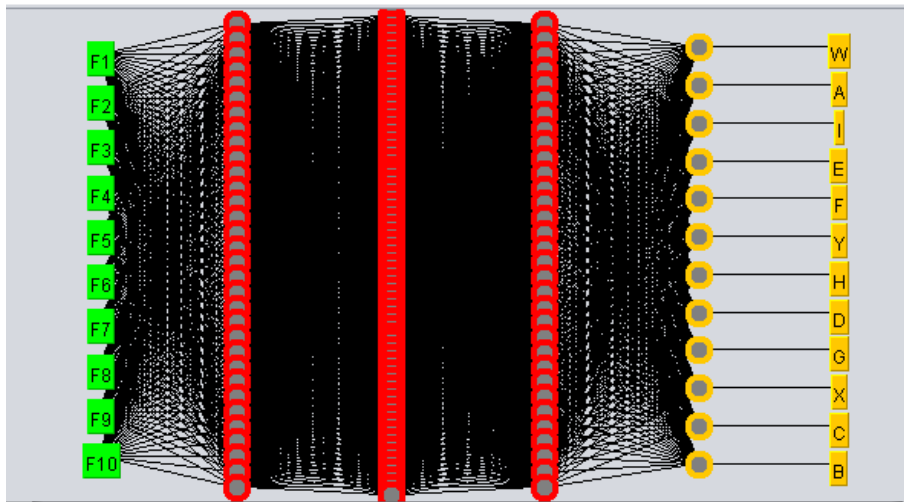
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	0.875	0.005	0.889	0.875	0.882	0.877	0.953	0.921	G
	0.970	0.007	0.883	0.970	0.925	0.922	0.996	0.979	X
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	0.000	0.000	0.000	0.000	0.000	-0.000	0.982	0.013	B
Weighted Avg.	0.956	0.010	0.957	0.956	0.955	0.949	0.983	0.966	

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	0.537	0.001	0.880	0.537	0.667	0.685	0.760	0.503	C
	0.000	0.001	0.000	0.000	0.000	-0.001	0.980	0.017	B
Weighted Avg.	0.946	0.016	0.946	0.946	0.944	0.933	0.979	0.960	

Class	Accuracy
A	98.8%
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	0.850	0.271	0.677	0.850	0.753	0.567	0.871	0.781	A
	0.944	0.000	1.000	0.944	0.971	0.969	0.965	0.953	I
	0.691	0.049	0.634	0.691	0.661	0.618	0.929	0.666	E
	0.444	0.080	0.584	0.444	0.505	0.405	0.857	0.579	F
	0.773	0.001	0.958	0.773	0.855	0.857	0.861	0.840	Y
	0.500	0.012	0.705	0.500	0.585	0.575	0.939	0.629	H
	0.364	0.011	0.541	0.364	0.435	0.428	0.919	0.451	D
	0.144	0.016	0.257	0.144	0.185	0.169	0.787	0.175	G
	0.844	0.008	0.839	0.844	0.841	0.833	0.969	0.831	X
	0.100	0.001	0.500	0.100	0.167	0.221	0.727	0.228	C
	0.000	0.000	?	0.000	?	?	0.039	0.001	B
Weighted Avg.	0.683	0.132	?	0.683	?	?	0.885	0.695	