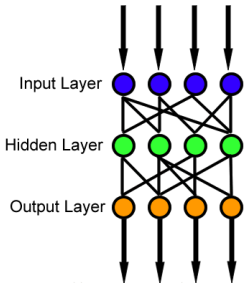
FAI Coursework 2 Report

1) Explain your network structure and parameter setting.

Solution:



● Network structure:

In this coursework, the function “feedforward()” has been applied. As the figure shown, the units inside this network don’t form any cycles or loops. Also, all information move only in one direction, forward, from the input nodes, through the hidden node(s) and to the output nodes.

● Parameter setting:

In this part, this report would introduce the parameter setting in the function “feedforward()” could be shown by command “doc feedforward”. It has two parameters. The first is “hiddenSizes”, which stands for the size of the hidden layer and the default value is 10. The second is “trainFcn”, which stands for the training function and the default value is “trainlm” (Levenberg-Marquardt algorithm). In the demonstration of section 2, this function takes the default settings.

Challenge: Efficient training: Principal Component Analysis (PCA)

Solution:

Here, this report has a succinct explanation about Principal Component Analysis (PCA) in this program. PCA, as an important method for dimension reduction, takes orthogonal transformation to transform a set of co-related variables into a set of linearly irrelevant variables. Here, the program implements this method through the function “pca()”.

As for this function “pca()”, it’s better to illustrate it briefly. Usually, programs use “[Coeff, Scores, latent] = pca(input)” to store all important assets in this process, and this report would like to introduce them individually in short.

“input” is a N*M matrix, which N stands for the number of samples and M stands for the number of features. After reshaping the images, M here is 784 in this situation.

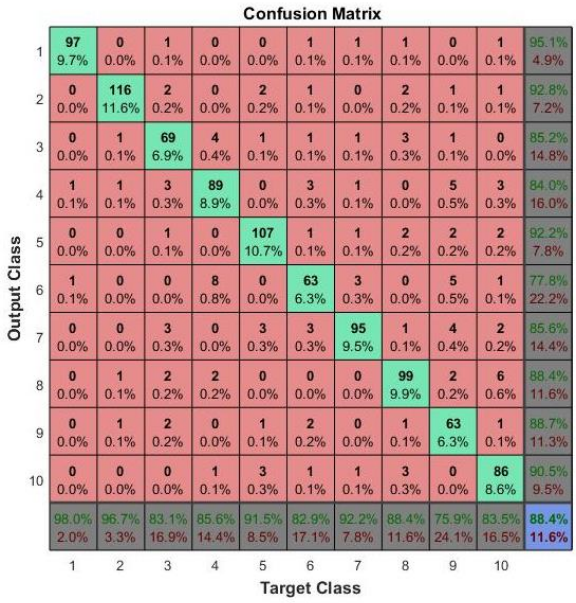
“Coeff” stores an M*M matrix. Each column in it shall contain coefficients for one principal component. The columns are in order of decreasing component variance.

“Score” stores an N*M matrix, and values are the principal component scores. Rows of it correspond to observations, columns to components.

“latent” is a vector which contains the eigenvalues of the covariance matrix of “input”. And it has been applied to calculate the contribution rate(in line 25 to 30) to determine how many dimensions to use.

2) Your testing accuracy and confusion matrix. Explain the meaning of your confusion matrix (what is the row and what is the column). From the confusion matrix, evaluate the ability of your model.

Solution:



With the previous settings and the contribution rate 90%, the testing accuracy and confusion matrix with them are shown on the right figure now.

The row labels show output classes (0 to 9), which means the predicted output according to the trained model. Correspondingly, the column labels show target classes, which means the output should be gained from the prediction according to the model.

And the diagonal shows the situation of right outputs. The right-down corner shows performance. Here accuracy is 88.4%, which is a quite good accuracy value.

3) Explain which parameters you tried and give out a table to show the testing accuracy you got under each group of parameter settings.

Solution:

In the following tables, this reports suspects three variables would affect the accuracy, which are parameters in "pca()" and the contribution rate in data preparations. Different train functions or different size of hidden layer will affect the accuracy. Also, different data set and its splitting situation would do so. Particularly, the contribution rate (highlighted in red) is suspected as a significant factor under the consideration. Here, this report tries to control all variables and make the result more stable, which would be more beneficial to analysis.

Note: Considering the randomized method for splitting train set and test set, in each parameter setting group, this reports offers three different pairs of test and train samples which are schemed as #1, #2 and #3.

trainFcn	hiddenSizes	Testing accuracy								
		0.7 (26 dims)			0.8 (43 dims)			0.9 (84 dims)		
		#1	#2	#3	#1	#2	#3	#1	#2	#3
trainlm	10(default)	85.9%	86.9%	86.9%	85.7%	85.1%	87%	85.4%	87.6%	84.2%
	20	88%	90.1%	90.1%	89.6%	88.1%	89%	89.9%	88.7%	88.8%
	30	90.3%	91.4%	91.4%	91.4%	91.1%	91.6%	91.2%	89.9%	91.2%
	40	92.6%	92.4%	92.4%	91.3%	92.6%	92.8%	90.7%	91.7%	90.8%
	50	92.5%	92.5%	91.8%	92.6%	93.1%	92.5%	91.4%	91.8%	93%
	60	92.6%	93.1%	93.5%	92.9%	91.9%	92.4%	92.6%	93.5%	91.4%
traingdx	10(default)	79%	81.8%	77.7%	80%	81.1%	80.9%	78.6%	82.8%	82%
	20	82.9%	80.1%	81.7%	83.4%	83.1%	83.3%	82.5%	83.2%	83.4%
	30	82.4%	83.7%	82.1%	83.3%	83.9%	84.3%	82.7%	83.5%	82.9%
	40	82.8%	81.8%	81.7%	81.3%	82.9%	83.1%	82.9%	83%	83.9%
	50	83.5%	81.5%	83.5%	82.1%	81.6%	82.4%	81.4%	83.7%	81.7%
	60	82.6%	81.5%	80.9%	83.4%	81.8%	81.2%	82%	82.1%	81.9%
trainrp	10(default)	86%	85.4%	87%	85.8%	86.8%	85.9%	85.2%	86.1%	86.4%
	20	89.2%	88.7%	88.5%	88.7%	88.2%	89.7%	88.1%	88.8%	89.2%
	30	88.9%	90.7%	90.1%	89.6%	90.1%	90.7%	88.8%	90.2%	90.6%
	40	91.6%	91.2%	90.4%	92.3%	90.9%	91.3%	90.3%	91.1%	91.2%
	50	92.2%	91.3%	91.4%	91.1%	90.9%	92.2%	91.9%	92.1%	91.8%
	60	92.8%	92.9%	92.2%	91.5%	92.1%	92.9%	92.2%	91.6%	91.1%
trainscg	10(default)	81.8%	84.4%	85.7%	85.1%	87.3%	86.3%	86%	85.2%	87.2%
	20	88.5%	89.2%	89.5%	88.2%	88.6%	89.2%	89.1%	89.9%	89.3%
	30	89.9%	90.5%	91.4%	91%	91.1%	90.5%	90.6%	89.2%	90.5%
	40	90.6%	90.8%	92%	90.2%	91.9%	91.9%	91.5%	91.7%	90.5%
	50	91.3%	91.5%	91.7%	91%	91%	91.7%	92%	91.5%	92.5%
	60	92%	90.6%	92.6%	91.1%	93.4%	92.9%	91.1%	92.4%	93.5%
trainoss	10(default)	86.5%	86.6%	87.1%	86%	85.3%	85.7%	87.3%	82.8%	87.8%
	20	89.5%	89%	89.4%	88.6%	90%	89.8%	89.8%	89.7%	90.3%
	30	90.2%	90.1%	90.5%	91.3%	90.6%	90.5%	89.8%	89.8%	89.7%
	40	91.4%	91.3%	90.8%	90.5%	91.7%	91.4%	91.7%	91.9%	91.5%
	50	92%	92.8%	89%	90.6%	92%	91.6%	91.1%	91.8%	92.4%
	60	91.1%	92.8%	90.8%	91.8%	92.8%	92.4%	90.1%	93%	92.7%