**EE6222 Assignment 1 Report**

**LI RIXUAN G1801134G**

**1. Used data set:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Datasets** | **Patterns** | **Features** | **Classes** |
| **ctg-3classes** | **2126** | **21** | **3** |
| **ctg-10classes** | **2126** | **21** | **10** |
| **contrac** | **1473** | **9** | **3** |
| **molec-biol-splice** | **3190** | **60** | **3** |
| **st-image** | **2310** | **18** | **7** |
| **titanic** | **2201** | **3** | **2** |

**2. Experiment Result about Question 1,2,4,5:**

In question 1&2，we only need to run the program with different selected data sets because there already exist four options of test accuracy represent whether we have bias and link or not. Bias=1 means bias exist, Bias=0 means bias doesn’t exist, same to the link.

In question 4, I choose 2 activation functions: radbas&hardlim. In order to compare their performance, the ‘option.ActivationFunction’ in program RVFL\_train\_val should manually change between radbas and hardlim. In question 5, two solution algorithm: Regularized Least Square &Moore-Penrose pseudoinverse are manually changed by changing ‘option.mode’ in program RVFL\_train\_val to 1 or 2 respectively.

For every data set, we should set different variables and run the program 4 times to get 4 accuracy each time. So for 6 data sets, I run the program 24 times to get following 6 tables.

TABLE 1.1 Ctg\_3classes

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Solution &Activation Function** | | **Bias = 0**  **Link = 0** | **Bias = 1**  **Link = 0** | **Bias = 0**  **Link = 1** | **Bias = 1**  **Link = 1** |
| **Regularized Least Square** | **Radbas** | **0.9063** | **0.9063** | **0.9077** |  |
| **Hardlim** | **0.8569** | **0.8569** | **0.8837** | **0.8837** |
| **Moore-Penrose pseudoinverse** | **Radbas** | **0.9068** | **0.9068** | **0.9110** | **0.9091** |
| **Hardlim** | **0.8545** | **0.8545** | **0.8856** | **0.8856** |

TABLE 1.2 Ctg\_10classes

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Solution &Activation Function** | | **Bias = 0**  **Link = 0** | **Bias = 1**  **Link = 0** | **Bias = 0**  **Link = 1** | | **Bias = 1**  **Link = 1** |
| **Regularized Least Square** | **Radbas** | **0.7947** | **0.7966** |  | | **0.7985** |
| **Hardlim** | **0.5753** | **0.5753** | **0.6822** | | **0.6822** |
| **Moore-Penrose pseudoinverse** | **Radbas** | **0.7863** | **0.7863** | **0.7952** | | **0.7947** |
| **Hardlim** | **0.5702** | **0.5702** | **0.6883** | **0.6883** | |

TABLE 1.3 Contrac

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Solution &Activation Function** | | **Bias = 0**  **Link = 0** | **Bias = 1**  **Link = 0** | **Bias = 0**  **Link = 1** | | **Bias = 1**  **Link = 1** |
| **Regularized Least Square** | **Radbas** | **0.4980** |  | **0.5292** | | **0.5292** |
| **Hardlim** | **0.4561** | **0.4561** | **0.4786** | | **0.4786** |
| **Moore-Penrose pseudoinverse** | **Radbas** | **0.5231** | **0.5211** | **0.5462** | | **0.5394** |
| **Hardlim** | **0.5023** | **0.5023** | **0.5254** | **0.5254** | |

TABLE 1.4 Molec-biol-splice

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Solution &Activation Function** | | **Bias = 0**  **Link = 0** | **Bias = 1**  **Link = 0** | **Bias = 0**  **Link = 1** | | **Bias = 1**  **Link = 1** |
| **Regularized Least Square** | **Radbas** |  | **0.8168** | **0.8187** | | **0.8184** |
| **Hardlim** | **0.5950** | **0.5950** | **0.8011** | | **0.8011** |
| **Moore-Penrose pseudoinverse** | **Radbas** | **0.8071** | **0.8118** | **0.8134** | | **0.8156** |
| **Hardlim** | **0.5891** | **0.5891** | **0.8033** | **0.8033** | |

TABLE 1.5 St-image

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Solution &Activation Function** | | **Bias = 0**  **Link = 0** | **Bias = 1**  **Link = 0** | **Bias = 0**  **Link = 1** | | **Bias = 1**  **Link = 1** |
| **Regularized Least Square** | **Radbas** | **0.9419** | **0.9419** | **0.9419** | |  |
| **Hardlim** | **0.7621** | **0.7621** | **0.8934** | | **0.8934** |
| **Moore-Penrose pseudoinverse** | **Radbas** | **0.9450** | **0.9445** | **0.9471** | | **0.9458** |
| **Hardlim** | **0.7335** | **0.7335** | **0.8938** | **0.8938** | |

TABLE 1.6 Titanic

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Solution &Activation Function** | | **Bias = 0**  **Link = 0** | **Bias = 1**  **Link = 0** | **Bias = 0**  **Link = 1** | | **Bias = 1**  **Link = 1** |
| **Regularized Least Square** | **Radbas** | **0.7882** | **0.7882** |  | | **0.7895** |
| **Hardlim** | **0.7118** | **0.7118** | **0.7136** | | **0.7136** |
| **Moore-Penrose pseudoinverse** | **Radbas** | **0.7892** | **0.7892** | **0.7951** | | **0.7951** |
| **Hardlim** | **0.7021** | **0.7021** | **0.7056** | **0.7056** | |

**3. Question 1 Conclusion:**

Compare columns with bias=1&link=1 to columns with bias=1&link=0, and also compare columns with bias=0&link=1 to columns with bias=0&link=0 in all above 6 tables. It’s very clear that all accuracy from link=1 groups are higher than link=0 groups. Except in St-image’case, we got two 0.9419 with and without link.

So it is obvious that direct link has big improvement to accuracy.

**4. Question 2 Conclusion:**

Compare columns with bias=1&link=0 to columns with bias=0&link=0, and also compare columns with bias=1&link=1 to columns with bias=0&link=1 in all above 6 tables. In almost all cases the accuracy from bias=1 groups are exactly the same to bias=0 groups, or slightly bigger.

Conclusion is that bias term having almost no effect in accuracy.

**5. Question 4 Conclusion:**

Compare rows 2 to 3 and 4 to 5 in each table above. We could easily observe that all accuracy in radbas groups are significantly higher than hardlim groups without exception.

That means activation function “radbas” enhance the performance a lot compare to “hardlim”.

**6. Question 5 Conclusion:**

Compare rows 2 to 4 and 3 to 5 in each table above. In more than half cases the accuracies fromregularized least square group are higher than Moore-Penrose pseudoinverse group. In other cases, Moore-Penrose pseudoinverse group performs a litter bit well than regularized least square group.

So the regularized least square method performs a certain extent better than Moore-Penrose pseudoinverse method for the computation of the output weights.

**7. Question 3 Experiment Result and Conclusion:**

In table1.1-1.6, I choose one case in each table with corner mark 1-6. They are all in regularized least square method and radbas group. I manually set their program’s scaling factor from to with step size . Then run the program 11\*6 times to get corresponding accuracy for different cases and different scaling factors shown in table 6.1 below.

TABLE 6.1 Changing Scaling Factors

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Method** | **S=** | **S=** | **S=** | **S=** | **S=** | **S=** | **S=** | **S=** | **S=** | **S=** | **S=** |
| **Case1** | **0.8801** | **0.8924** | **0.9081** | **0.9085** | **0.9108** | **0.9110** | **0.9102** | **0.9098** | **0.9098** | **0.9013** | **0.9008** |
| **Case2** | **0.7824** | **0.7951** | **0.7953** | **0.8044** | **0.8051** | **0.8062** | **0.8085** | **0.8078** | **0.8042** | **0.8014** | **0.7969** |
| **Case3** | **0.4823** | **0.4989** | **0.5001** | **0.5032** | **0.5056** | **0.5054** | **0.5032** | **0.5014** | **0.4980** | **0.4913** | **0.4895** |
| **Case4** | **0.8095** | **0.8124** | **0.8156** | **0.8195** | **0.8220** | **0.8221** | **0.8242** | **0.8253** | **0.8256** | **0.8251** | **0.8224** |
| **Case5** | **0.9152** | **0.9324** | **0.9523** | **0.9592** | **0.9615** | **0.9622** | **0.9623** | **0.9621** | **0.9613** | **0.9442** | **0.9402** |
| **Case6** | **0.7562** | **0.7912** | **0.7993** | **0.8045** | **0.8069** | **0.8073** | **0.8101** | **0.8102** | **0.8095** | **0.8091** | **0.8056** |

As we can observe that different scaling values may lead to relatively large change in accuracy. The number in red is the highest accuracy in each row. It’s obvious that the when scaling value is more smaller or more bigger than the best scaling value, the corresponding accuracy is more smaller in almost all case.