2020 Fall EE5183 FinTech - Homework 2

Deep learning Model: Deep Neural Network

Due: Nov 16, 2020

INSTRUCTIONS

1. In this homework, Dataset from kaggle Credit Card Fraud Detection is utilized to build classification models. The datasets were already preprocessed. The features V1, V2, ... V28 are the principal components obtained with PCA, the only features which have not been transformed with PCA are 'Time' and 'Amount'. Feature 'Time' contains the seconds elapsed between each transaction and the first transaction in the dataset. The feature 'Amount' is the transaction Amount, this feature can be used for example-dependant cost-senstive learning. Feature 'Class' is the response variable and it takes value 1 in case of fraud and 0 otherwise.
2. **Please use *Data.csv* to train/test your models**
3. **Please only use TensorFlow, PyTorch, Keras or scikit-learn to build the model.**
4. **You should write your own codes independently. Plagiarism is strictly prohibited.**
5. All the figures are just examples. You do not need to be the same as the figures.
6. Report can only be written in English or Chinese.

PROBLEMS

1. (90%) Classification: In this exercise, you will implement a DNN model for binary classification using *Data.csv*. The objective in this exercise is to create and train a neural network to recognize fraudulent credit card transactions. You need to split the data into training (80%) and validation (20%) data.

   (i) (40%) Please construct a DNN for binary classification according to the cross-entropy error function

   $$E(w) = -\frac{1}{M}\sum_{m=1}^{M}\sum_{i=1}^{C} t_{mi} log S_i,$$

   where t_{mi} is the ith target of the mth batch, M is the batch size, $C = 2$ is the binary class for each sample, S_i is sigmoid activation of neural nets output function. Minimize the error function *E(w)* by running the error backpropagation algorithm using the Adam Optimizer. You should decide the following variables: number of hidden layers, number of hidden units, learning rate, number of iterations and mini-batch size. **Please try to perform grid search over your variables mentioned above and show the best-performing setting for your model in the report. You also have to show your (a) training accuracy, (b) validation accuracy, (c) training loss and (d) validation loss in the report. An example is detailed in Figure 1.**

   (ii) (10%) **Please plot confusion matrices** for (i) as example in Figure 2.

   (iii) (10%) Precision, recall, F1-score are other ways to evaluate model performance. For each class, **please record precision, recall and F1-score as well as the averages of those criteria** over all classes in your report.

   $$Precision = \frac{TruePositive}{TruePositive + FalsePositive}$$

   $$Recall = \frac{TruePositive}{TruePositive + FalseNegative}$$

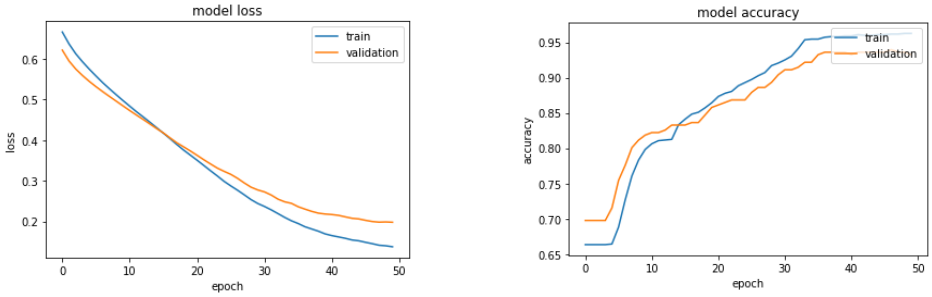


Figure 1: Example of loss and accuracy curve.

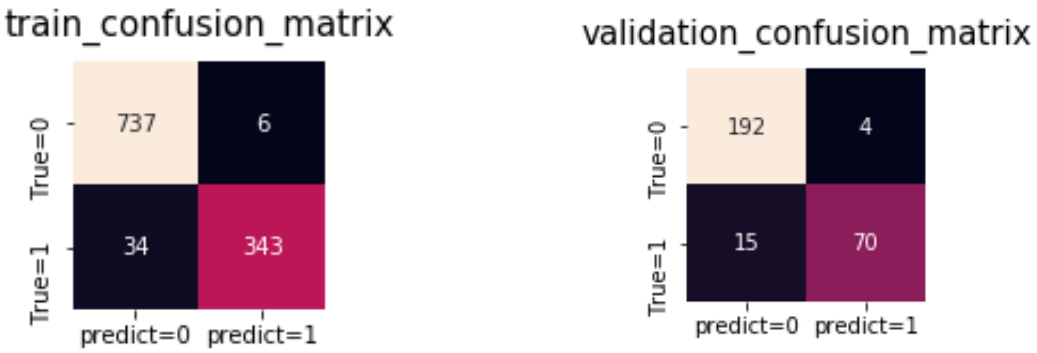


Figure 2: Example confusion matrix.

$$F1 - score = 2 * \frac{Precision * Recall}{Precision + Recall}$$

(iv) (10%) **What is difference between decision tree and random forest?**

(v) (10%) **Please use decision tree and random forest to learn the binary classification task. Calculate the corresponding Accuracy, Precision, Recall and F1-Score**.

(vi) (10%) You have to plot receiver operating characteristic curve (ROC, as shown in Figure 3) and precision-recall curve (PRC, as shown in Figure 3) with their area-under-curve (AUROC and AUPRC) for DNN, decision tree and random forest.

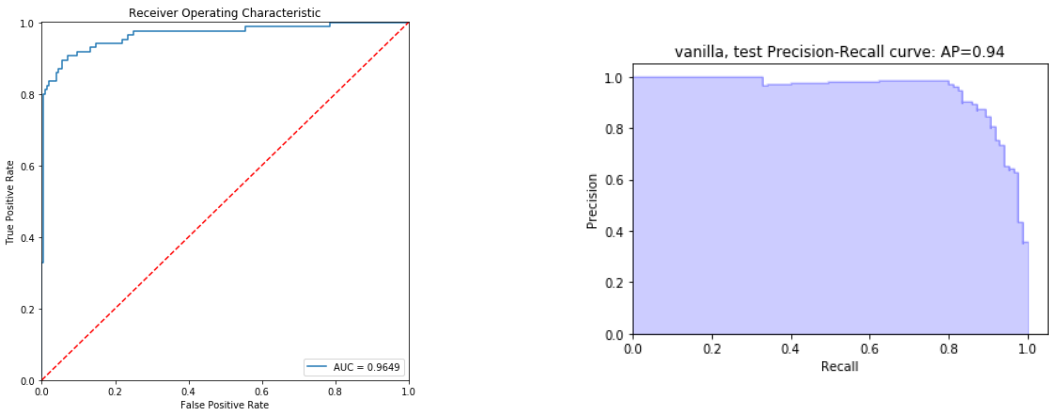
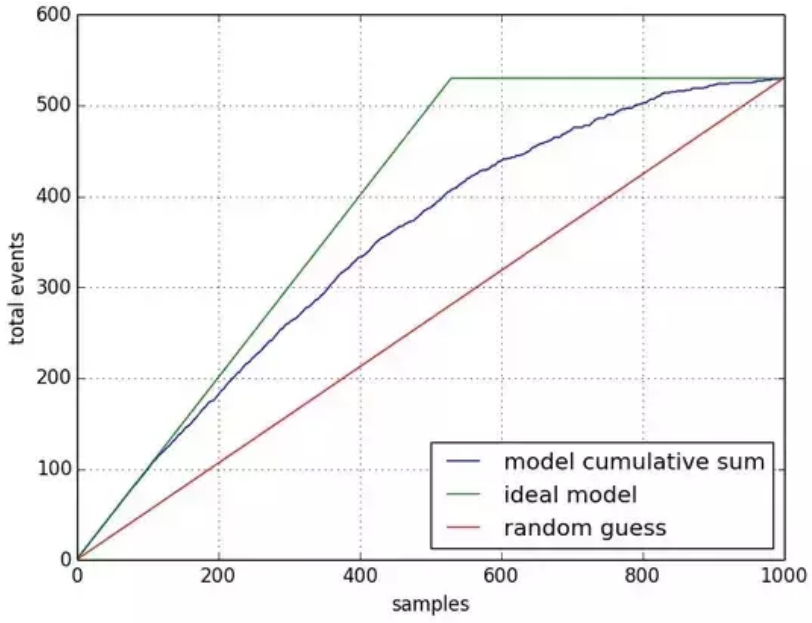


Figure 3: ROC curve and Precision-recall curve.

2. (10%) Lift curve:

Here is an introduction to the concept of lift curve, which is commonly used in marketing analysis. Following is the meaning of each axis: The x-axis sorted all samples from high to low according to the prediction values, which means that closer to origin with higher prediction value; and the y-axis means the accumulated true positives. The following graph is an example of lift curve.



(a) (10%) Please draw the lift curve of models in problem 1: DNN, decision tree and random forest. Please also draw the ideal lift curve and random guess like the above figure.