1.3C - Classification using FFNN

July 27, 2022

Welcome to your assignment this week!

1 Classification task

In this task you are asked to build a simple Feed Forward Neural Network, train it and test it!

After this assignment you will be able to:

- Load a dataset.
- Train a Feed Forward Neural Network.
- Test a Feed Forward Neural Network.

Let's get started! Run the following cell to install all the packages you will need.

[1]:
```
#!pip install numpy
#!pip install keras
#!pip install tensorflow
#!pip install pandas
#!pip install matplotlib
```

if you are using GoogleColab, please install the following packages and mount your Google drive:

[2]:
```
# !apt-get install texlive-xetex texlive-fonts-recommended␣
↪texlive-generic-recommended  2> /dev/null  > /dev/null
# !apt-get install pandoc 2> /dev/null  > /dev/null

# from google.colab import drive
# drive.mount('/content/drive')
```

Run the following cell to load the packages you will need.

[3]:
```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
import keras
from keras.models import Sequential
from keras.layers import Dense
```

The dataset we will use consists of 4500 examples with 512 features. A label is given for each example to indicate positive and negative instances.

Let's read the data.

[4]:
```
df = pd.read_csv('data.csv')
df.set_index('id', inplace=True)
```

Now, let's split the data into training and test sets.

[5]:
```
X_train, X_test, y_train, y_test = train_test_split(
    df.index.values,
    df.label.values,
    test_size=0.15,
    random_state=17,
    stratify=df.label.values
)
df['data_type'] = ['note_set']*df.shape[0]
df.loc[X_train, 'data_type'] = 'train'
df.loc[X_test, 'data_type'] = 'test'

## The data to use:

X_train = df[df['data_type']=='train'].iloc[:,:512].values
X_test = df[df['data_type']=='test'].iloc[:,:512].values
#y_train = df[df['data_type']=='train'].iloc[:,512:513].values
y_train = df[df['data_type']=='train']['label'].to_list()
y_train = np.array(y_train)
#y_test = df[df['data_type']=='test'].iloc[:,512:513].values
y_test = df[df['data_type']=='test']['label'].to_list()
y_test = np.array(y_test)
```

[6]:
```
print(X_train.shape)
print(y_train.shape)
print(X_test.shape)
print(y_test.shape)
```

```
(3825, 512)
(3825,)
(675, 512)
(675,)
```

[7]:
```
X_train.shape
```

[7]:
```
(3825, 512)
```

2 Task 1

Build a Feed Forward Neural Network to address this classification task using the Keras framework.

[8]:
```
# START YOUR CODE HERE
model = Sequential([
  Dense(128, activation='relu', input_shape=(512,)),
  Dense(128, activation='relu'),
  Dense(1, activation='softmax'),
])
model.compile(
  optimizer='adam',
  loss='categorical_crossentropy',
  metrics=['accuracy', 'Precision', 'Recall'],
)
```

3 Training

Now, let's start our training.

[9]:
```
history = model.fit(X_train, y_train, epochs=200, batch_size=64, verbose=1)
```

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Epoch 1/200
60/60 [==============================] - 1s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 2/200
60/60 [==============================] - 0s 3ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
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Epoch 122/200
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Epoch 123/200
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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 130/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 131/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 132/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 133/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 134/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 135/200
60/60 [==============================] - 0s 3ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 136/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 137/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 138/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 139/200
60/60 [==============================] - 0s 3ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 140/200
60/60 [==============================] - 0s 3ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 141/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 142/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 143/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 144/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 145/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 146/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 147/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 148/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 149/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 150/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 151/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 152/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 153/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 154/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
```

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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 155/200
60/60 [==============================] - 0s 3ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 156/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 157/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 158/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 159/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 160/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 161/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 162/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 163/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 164/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 165/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 166/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
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60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 168/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 169/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 170/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 171/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 172/200
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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 173/200
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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 174/200
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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 175/200
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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 176/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 177/200
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accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 178/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 179/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 180/200
60/60 [==============================] - 0s 3ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 181/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 182/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 183/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 184/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 185/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 186/200
60/60 [==============================] - 0s 3ms/step - loss: 0.0000e+00 -
```
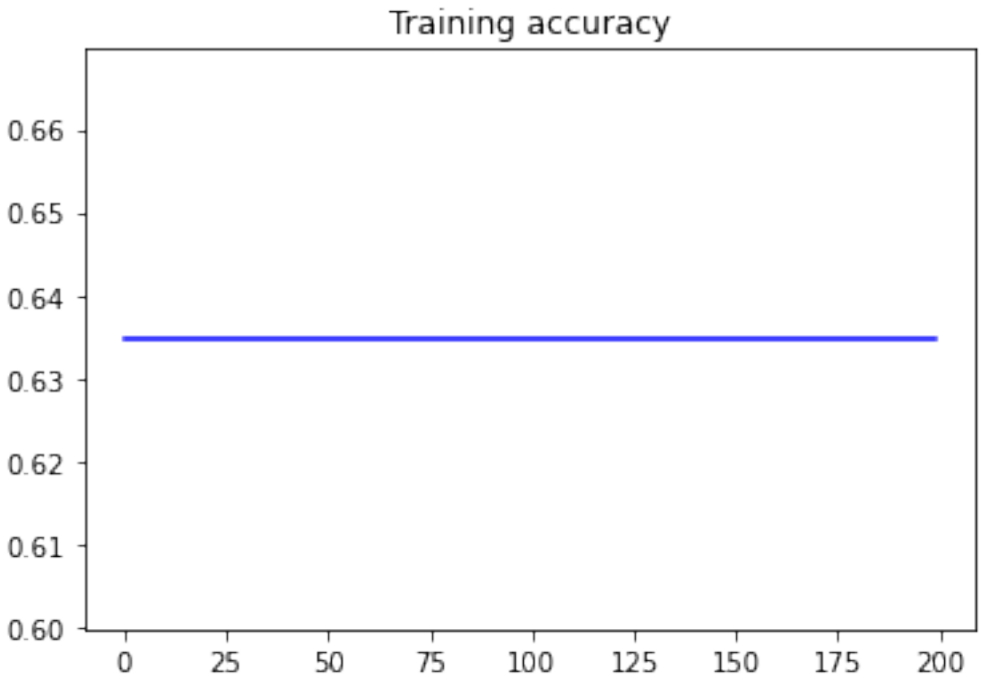
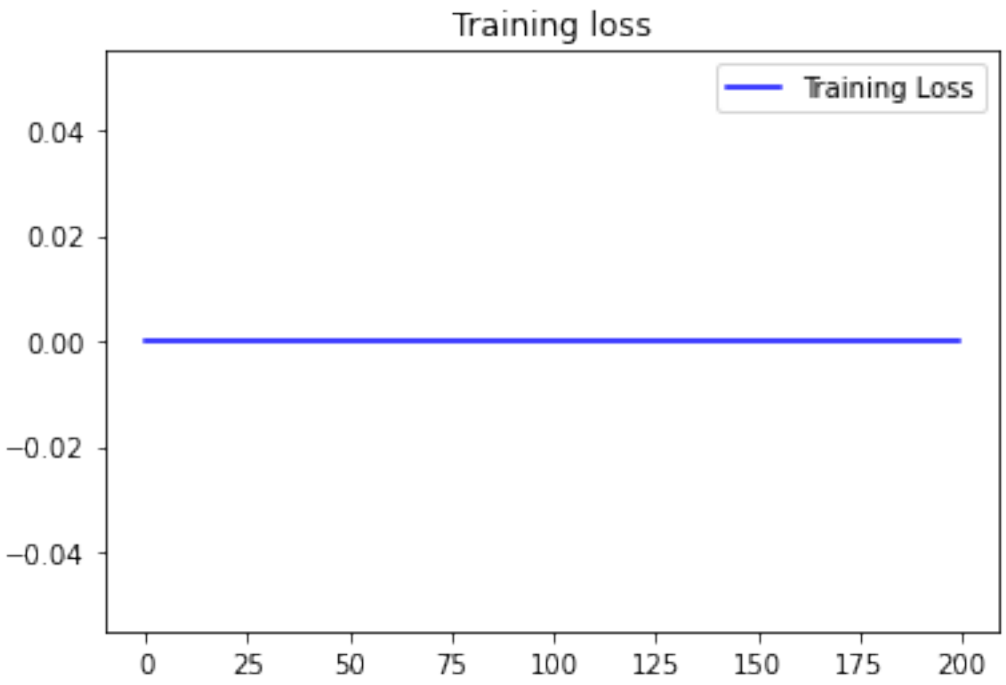

```
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 187/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 188/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 189/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 190/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 191/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 192/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 193/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 194/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 195/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 196/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 197/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 198/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 199/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
Epoch 200/200
60/60 [==============================] - 0s 2ms/step - loss: 0.0000e+00 -
accuracy: 0.6348 - precision: 0.6348 - recall: 1.0000
```

[10]:
```
acc = history.history['accuracy']
loss = history.history['loss']
epochs = range(len(acc))
```

```
plt.plot(epochs, acc, 'b', label='Training accuracy')
plt.title('Training accuracy')
plt.figure()
plt.plot(epochs, loss, 'b', label='Training Loss')
plt.title('Training loss')
plt.legend()
plt.show()
```





4 Task 2

Test the model on the test set and report Precision, Recall, F1-Score, and Accuracy.

[11]:
```
# START YOUR CODE HERE
from sklearn.metrics import classification_report
y_pred = model.predict(X_test, verbose=1)
y_pred_bool = np.argmax(y_pred, axis=1)
print(classification_report(y_test, y_pred_bool, zero_division=1))
```

```
22/22 [==============================] - 0s 2ms/step
              precision    recall  f1-score   support

           0       0.37      1.00      0.54       247
           1       1.00      0.00      0.00       428

    accuracy                           0.37       675
   macro avg       0.68      0.50      0.27       675
weighted avg       0.77      0.37      0.20       675
```

Export your notebook to a pdf document

[12]:
```
!jupyter nbconvert --to pdf "./1.3C - Classification using FFNN.ipynb"
```

```
[NbConvertApp] Converting notebook ./1.3C - Classification using FFNN.ipynb to
pdf
[NbConvertApp] Writing 67513 bytes to 1.3C - Classification using FFNN.pdf
```

5 Congratulations!

You've come to the end of this assignment, and you have built your first neural network.

Congratulations on finishing this notebook!

[ ]: