First I used data with label2, then I tried to use data, whose label1 and label2 are same.

There are no data with label 5 in files.

Shuffling and split the data to 20% for test and 80% for training.

## Label2:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| label | 1 | 2 | 3 | 4 | 6 |
| number | 3899 | 6563 | 363 | 29 | 3401 |

The number of data with label 4 is too less, so I didn’t use it.

XGBoost:

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 3142 | 0 | 0 |  |
| Actual 2 | 0 | 5273 | 0 | 0 |
| Actual 3 | 0 | 0 | 284 | 0 |
| Actual 6 | 0 | 0 | 0 | 2681 |

Test (acc 0.867)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 607 | 103 | 0 | 47 |
| Actual 2 | 70 | 1197 | 1 | 22 |
| Actual 3 | 0 | 38 | 41 | 0 |
| Actual 6 | 60 | 38 | 0 | 622 |

ANN:

Train (acc 0.986)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 3040 | 69 | 0 | 33 |
| Actual 2 | 36 | 5226 | 1 | 10 |
| Actual 3 | 0 | 0 | 284 | 0 |
| Actual 6 | 7 | 0 | 0 | 2674 |

Test (acc 0.878)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 602 | 93 | 1 | 61 |
| Actual 2 | 64 | 1194 | 5 | 27 |
| Actual 3 | 0 | 15 | 64 | 0 |
| Actual 6 | 59 | 22 | 0 | 639 |

## Same label:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| label | 1 | 2 | 3 | 6 |
| number | 2370 | 5348 | 47 | 2941 |

XGBoost:

Train (acc 1.000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 1901 | 0 | 0 |  |
| Actual 2 | 0 | 4265 | 0 | 0 |
| Actual 3 | 0 | 0 | 40 | 0 |
| Actual 6 | 0 | 0 | 0 | 2358 |

Test (acc 0.915)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 377 | 61 | 0 | 31 |
| Actual 2 | 28 | 1027 | 0 | 28 |
| Actual 3 | 1 | 6 | 0 | 0 |
| Actual 6 | 18 | 10 | 0 | 555 |

ANN (without class weight):

Train (acc 0. 994)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 1874 | 27 | 0 | 0 |
| Actual 2 | 5 | 4258 | 0 | 2 |
| Actual 3 | 0 | 14 | 26 | 0 |
| Actual 6 | 0 | 0 | 0 | 2358 |

Test (acc 0. 934)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 407 | 48 | 0 | 14 |
| Actual 2 | 35 | 1027 | 0 | 21 |
| Actual 3 | 1 | 4 | 2 | 0 |
| Actual 6 | 14 | 4 | 0 | 565 |

ANN (with class weight {1:2, 2:1, 3:10, 6:2}):

Train (acc 0.997)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 1893 | 8 | 0 | 0 |
| Actual 2 | 11 | 4253 | 0 | 1 |
| Actual 3 | 0 | 0 | 40 | 0 |
| Actual 6 | 0 | 0 | 0 | 2358 |

Test (acc 0.941)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 426 | 28 | 0 | 15 |
| Actual 2 | 49 | 1022 | 0 | 12 |
| Actual 3 | 0 | 1 | 6 | 0 |
| Actual 6 | 20 | 2 | 0 | 561 |

CNN (without class weight):

Train (acc 0.997)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 1900 | 1 | 0 | 0 |
| Actual 2 | 7 | 4257 | 0 | 1 |
| Actual 3 | 0 | 1 | 39 | 0 |
| Actual 6 | 12 | 3 | 0 | 2343 |

Test (acc 0. .951)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 435 | 26 | 0 | 8 |
| Actual 2 | 22 | 1055 | 0 | 6 |
| Actual 3 | 1 | 2 | 4 | 0 |
| Actual 6 | 26 | 12 | 0 | 545 |

CNN (with class weight {1:2, 2:1, 3:10, 6:2}):

Train (acc 0.993)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 1894 | 6 | 0 | 1 |
| Actual 2 | 32 | 4232 | 0 | 1 |
| Actual 3 | 0 | 0 | 40 | 0 |
| Actual 6 | 4 | 11 | 0 | 2343 |

Test (acc 0.941)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Predicted 1 | Predicted 2 | Predicted 3 | Predicted 6 |
| Actual 1 | 425 | 38 | 0 | 6 |
| Actual 2 | 51 | 1022 | 0 | 10 |
| Actual 3 | 0 | 1 | 6 | 0 |
| Actual 6 | 9 | 12 | 0 | 562 |

## Parameters:

XGBoost:

model = xgb.XGBClassifier(max\_depth=8,

learning\_rate=0.3,

n\_estimators=1000,

objective='multi:softmax',

seed=100,

subsample=0.7,

reg\_lambda = 21,

)

ANN:

l1 = layers.Dense(128,activation='relu')(input\_)

drop1 = layers.Dropout(0.2)(l1)

l2 = layers.Dense(64,activation='relu')(drop1)

drop2 = layers.Dropout(0.2)(l2)

l3 = layers.Dense(32,activation='relu')(drop2)

drop3 = layers.Dropout(0.2)(l3)

output = layers.Dense(4,activation='softmax')(drop3)

CNN:

max\_pool = layers.MaxPooling2D((2,4))(input\_)

conv1 = layers.Conv2D(16,3,strides=(1,1),

kernel\_initializer=TruncatedNormal(),

activation='elu',padding='same')(max\_pool)

max\_pool1 = layers.MaxPooling2D((2,2))(conv1)

conv2 = layers.Conv2D(32,3,strides=(1,1),

kernel\_initializer=TruncatedNormal(),

activation='elu',padding='same')(max\_pool1)

max\_pool2 = layers.MaxPooling2D(2)(conv2)

conv3 = layers.Conv2D(64,3,strides=(1,1),

kernel\_initializer=TruncatedNormal(),

activation='elu',padding='same')(max\_pool2)

max\_pool3 = layers.MaxPooling2D(2)(conv3)

conv4 = layers.Conv2D(128,3,strides=(1,1),

kernel\_initializer=TruncatedNormal(),

activation='elu',padding='same')(max\_pool3)

flatten = layers.Flatten()(conv4)

dropout = layers.Dropout(0.5)(flatten)

layer1 = layers.Dense(256,activation = 'elu')(dropout)

dropout1 = layers.Dropout(0.5)(layer1)

layer2 = layers.Dense(128,activation = 'elu')(dropout1)

dropout2 = layers.Dropout(0.5)(layer2)

output = layers.Dense(4,activation = 'softmax')(dropout2)