In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import os, sys
from PIL import Image
import glob
import cv2
from keras.utils import to_categorical
import keras
from sklearn.model_selection import StratifiedShuffleSplit
```

In [2]:
```
train = pd.read_csv('../input/train-data/traina_3.csv')
```

In [3]:
```
train.head()
```

Out[3]:

	id_code	diagnosis
0	000c1434d8d7	2
1	001639a390f0	4
2	0024cdab0c1e	1
3	002c21358ce6	0
4	005b95c28852	0

In [4]:
```
len(train)
```

Out[4]:
```
3346
```

In [5]:
```
x_train = [cv2.resize(np.asarray(Image.open('../input/aptos2019-blindness-d
```

In [6]:
```
x_train = np.array(x_train)
```

In [7]:
```
x_train = np.array(x_train)
```

In [8]:
```
y_train = train.diagnosis
```

In [9]:
```
y_train = to_categorical(y_train)
y_train
```

Out[9]:
```
array([[0., 0., 1., 0., 0.],
       [0., 0., 0., 0., 1.],
       [0., 1., 0., 0., 0.],
       ...,
       [0., 1., 0., 0., 0.],
       [1., 0., 0., 0., 0.],
       [0., 0., 0., 1., 0.]], dtype=float32)
```

In [10]:
```
s = StratifiedShuffleSplit(n_splits=5, test_size=0.2, random_state=7)
s.get_n_splits(x_train, y_train)
for train_index, test_index in s.split(x_train, y_train):
    x_traino, x_testo = x_train[train_index], x_train[test_index]
    y_traino, y_testo = y_train[train_index], y_train[test_index]
```

In [11]:
```
m1 = keras.applications.densenet.DenseNet121(input_shape=(256,256,3),includ
```

In [12]:
```
m1.summary()
```

...

In [13]:
```
m1.load_weights('../input/densenet-keras/DenseNet-BC-121-32.h5')
```

In [14]:
```
x = m1.layers[-2].output
d = keras.layers.Dense(512,activation='relu')(x)
e = keras.layers.Dense(5,activation='softmax')(d)
```

In [15]:
```
m2 = keras.models.Model(m1.input,e)
```

In [16]:
```
m2.compile(loss='categorical_crossentropy',optimizer='adam',metrics=['accur
```

In [45]:
```
m2.fit(x_traino,y_traino,validation_data=(x_testo,y_testo),epochs=20)
```

```
Epoch 1/20
84/84 [==============================] - 20s 241ms/step - loss: 0.0575 - a
ccuracy: 0.9794 - val_loss: 1.1683 - val_accuracy: 0.7731
Epoch 2/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0579 - a
ccuracy: 0.9780 - val_loss: 1.2271 - val_accuracy: 0.8000
Epoch 3/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0861 - a
ccuracy: 0.9690 - val_loss: 1.1214 - val_accuracy: 0.7955
Epoch 4/20
84/84 [==============================] - 20s 240ms/step - loss: 0.0647 - a
ccuracy: 0.9798 - val_loss: 1.0510 - val_accuracy: 0.8015
Epoch 5/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0673 - a
ccuracy: 0.9753 - val_loss: 1.3983 - val_accuracy: 0.7761
Epoch 6/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0408 - a
ccuracy: 0.9821 - val_loss: 1.1229 - val_accuracy: 0.8104
Epoch 7/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0649 - a
ccuracy: 0.9787 - val_loss: 1.3767 - val_accuracy: 0.7821
Epoch 8/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0930 - a
ccuracy: 0.9679 - val_loss: 1.8301 - val_accuracy: 0.7194
Epoch 9/20
84/84 [==============================] - 20s 240ms/step - loss: 0.0991 - a
ccuracy: 0.9667 - val_loss: 1.2228 - val_accuracy: 0.7687
Epoch 10/20
84/84 [==============================] - 20s 240ms/step - loss: 0.0627 - a
ccuracy: 0.9761 - val_loss: 1.2428 - val_accuracy: 0.7716
Epoch 11/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0469 - a
ccuracy: 0.9828 - val_loss: 1.1095 - val_accuracy: 0.7910
Epoch 12/20
84/84 [==============================] - 20s 240ms/step - loss: 0.0507 - a
ccuracy: 0.9772 - val_loss: 1.3012 - val_accuracy: 0.7806
Epoch 13/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0393 - a
ccuracy: 0.9828 - val_loss: 1.6638 - val_accuracy: 0.7627
Epoch 14/20
84/84 [==============================] - 20s 240ms/step - loss: 0.0872 - a
ccuracy: 0.9656 - val_loss: 2.1922 - val_accuracy: 0.7224
Epoch 15/20
84/84 [==============================] - 20s 240ms/step - loss: 0.1024 - a
ccuracy: 0.9638 - val_loss: 1.6729 - val_accuracy: 0.7821
Epoch 16/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0686 - a
ccuracy: 0.9731 - val_loss: 1.3170 - val_accuracy: 0.7776
Epoch 17/20
84/84 [==============================] - 20s 240ms/step - loss: 0.0476 - a
ccuracy: 0.9806 - val_loss: 1.2885 - val_accuracy: 0.8015
Epoch 18/20
84/84 [==============================] - 20s 240ms/step - loss: 0.0385 - a
ccuracy: 0.9824 - val_loss: 1.1840 - val_accuracy: 0.7985
Epoch 19/20
84/84 [==============================] - 20s 239ms/step - loss: 0.0382 - a
ccuracy: 0.9817 - val_loss: 1.0330 - val_accuracy: 0.7910
Epoch 20/20
84/84 [==============================] - 20s 240ms/step - loss: 0.0268 - a
ccuracy: 0.9884 - val_loss: 1.2125 - val_accuracy: 0.8134
```

Out[45]: <tensorflow.python.keras.callbacks.History at 0x7fb2dc3a4350>

In [46]:
```
test1 = []
test_rd = pd.read_csv('../input/test-data/testa_3.csv')
```

In [47]:
```
for i in test_rd.id_code:
    tp = np.array(cv2.resize(np.array(Image.open('../input/aptos2019-blindn
    test1.append(tp)
```

In [48]:
```
test1 = np.array(test1)
```

In [49]:
```
np.random.seed(42)
res_1 = m2.predict(test1)
```

In [50]:
```
res_2 = []
for i in res_1:
    res_2.append(np.argmax(i))
```

In [51]:
```
test2 = pd.DataFrame({"id_code": test_rd["id_code"].values, "diagnosis": re
test2.head(20)
```

Out[51]:

	id_code	diagnosis
0	e96099b961b4	2
1	e966850247f4	0
2	e9678824215d	0
3	e96bd80a8a53	1
4	e97ecf4355cb	0
5	e9ab8413e771	2
6	e9ce5bf645ab	0
7	e9f3c85a2a02	0
8	e9f82b5bbaf4	2
9	e9faf0296643	0
10	e9ff9352ccb3	1
11	ea05c22d92e9	2
12	ea15a290eb96	0
13	ea1d045f9fea	2
14	ea4ce9516144	0
15	ea4dcb055139	2
16	ea588d1e5d96	2
17	ea5c42a78979	0
18	ea68b58a6e8f	0
19	ea6a53e54d0f	0

In [52]:
```
test2.to_csv('submission.csv',index=False)
```

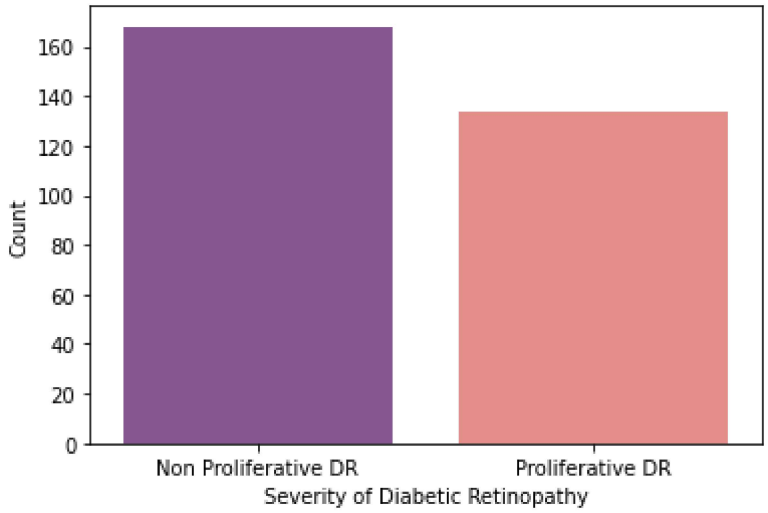
In [53]:
```
dtest = pd.read_csv('../input/test-cmp/traina_testa_compare_3.csv')
```

In [54]:
```
A = test2["diagnosis"]
```

In [55]:
```
B = dtest["diagnosis"]
```

In [56]:
```
import seaborn as sns
clu = ["Non Proliferative DR","Proliferative DR"]
v=0
v1=0
for i in A:
    if (i==0):
        v=v+1
    else:
        v1=v1+1
uo=[v,v1]
V = True
if V:
    sns.barplot(clu, uo, alpha=0.8, palette='magma')
    plt.xlabel("Severity of Diabetic Retinopathy")
    plt.ylabel("Count")
    plt.show()
```

```
/opt/conda/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWa
rning: Pass the following variables as keyword args: x, y. From version 0.
12, the only valid positional argument will be `data`, and passing other a
rguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
```



In [57]:
```
C = []
for i in A:
    if(i==0):
        lu=0
        C.append(lu)
    else:
        lus=1
        C.append(lus)
```

In [58]:
```
D = []
for i in B:
    if(i==0):
        lu=0
        D.append(lu)
    else:
        lus=1
        D.append(lus)
```

In [59]:
```
from sklearn.metrics import accuracy_score
```

In [60]:
```
accuracy_score(C,D)
```

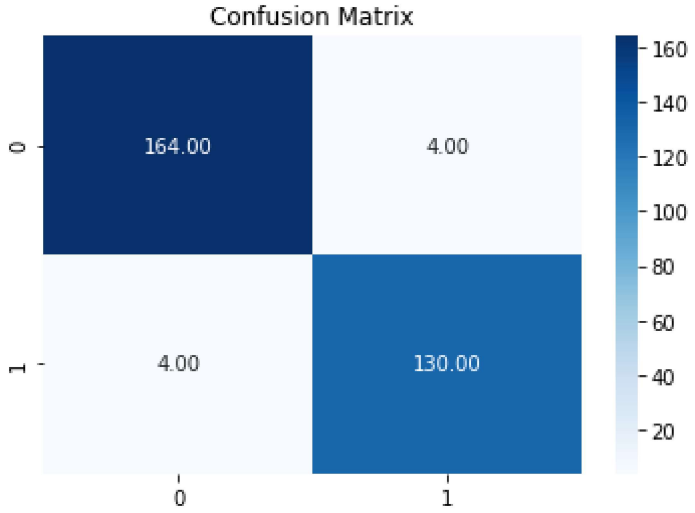
Out[60]:
```
0.9735099337748344
```

In [61]:
```
from sklearn.metrics import confusion_matrix
```

In [62]:
```
C_M = confusion_matrix(C,D)
```

In [63]:
```
import seaborn as sns
```

In [64]:
```
sns.heatmap(C_M, annot=True, fmt='.2f', cmap="Blues").set_title('Confusion M
plt.show()
```



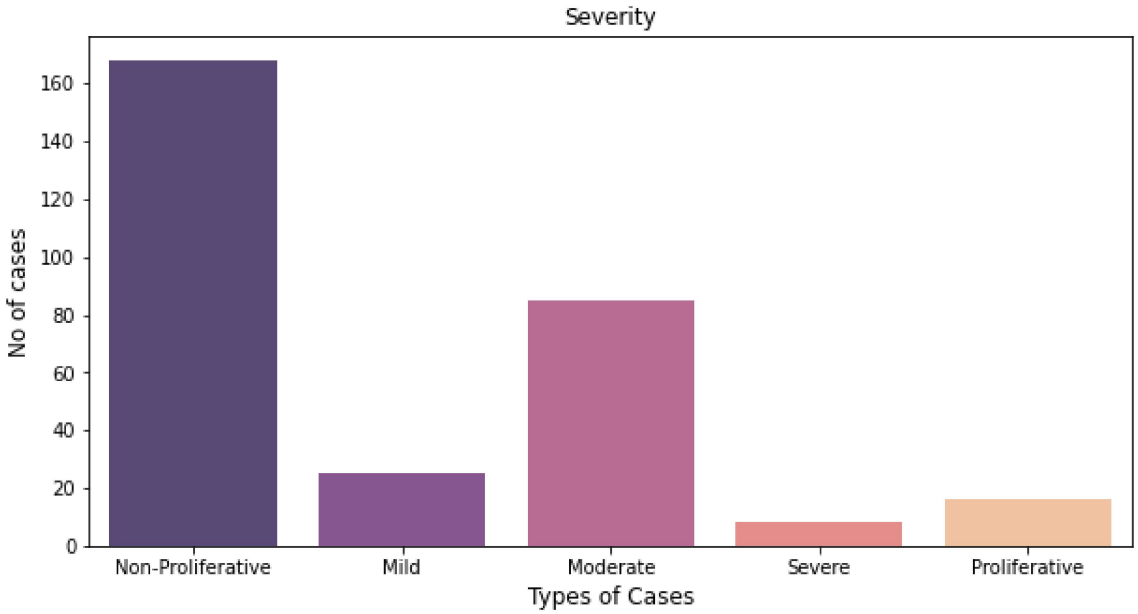
In [65]:
```
from sklearn.metrics import classification_report
```

In [66]:
```
print (classification_report(C,D))
```

```
              precision    recall  f1-score   support

           0       0.98      0.98      0.98       168
           1       0.97      0.97      0.97       134

    accuracy                           0.97       302
   macro avg       0.97      0.97      0.97       302
weighted avg       0.97      0.97      0.97       302
```

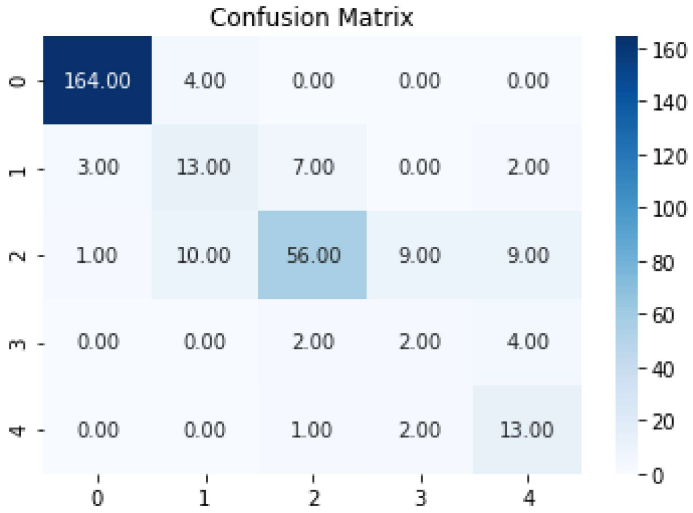
In [67]:
```
clu = ["Non-Proliferative","Mild", "Moderate", "Severe", "Proliferative" ]
ddr=0
ddr1=0
ddr2=0
ddr3=0
ddr4=0
for i in A:
    if (i==0):
        ddr=ddr+1
    elif(i==1):
        ddr1=ddr1+1
    elif(i==2):
        ddr2=ddr2+1
    elif(i==3):
        ddr3=ddr3+1
    elif(i==4):
        ddr4=ddr4+1
uo=[ddr,ddr1,ddr2,ddr3,ddr4]
V = True
if V:

    plt.figure(figsize=(10,5))
    sns.barplot(clu, uo, alpha=0.8, palette='magma')
    plt.title('Severity')
    plt.ylabel('No of cases', fontsize=12)
    plt.xlabel('Types of Cases', fontsize=12)
    plt.show()
```

```
/opt/conda/lib/python3.7/site-packages/seaborn/_decorators.py:43: FutureWa
rning: Pass the following variables as keyword args: x, y. From version 0.
12, the only valid positional argument will be `data`, and passing other a
rguments without an explicit keyword will result in an error or misinterpr
etation.
  FutureWarning
```



In [68]:
```
cf_matrix = confusion_matrix(A,B)
```

In [69]:
```
sns.heatmap(cf_matrix, annot=True, fmt='.2f', cmap="Blues").set_title('Confu
plt.show()
```



In [70]:
```
accuracy_score(A,B)
```

Out[70]:
```
0.8211920529801324
```

In [71]:
```
print (classification_report(A,B))
```

```
              precision    recall  f1-score   support

           0       0.98      0.98      0.98       168
           1       0.48      0.52      0.50        25
           2       0.85      0.66      0.74        85
           3       0.15      0.25      0.19         8
           4       0.46      0.81      0.59        16

    accuracy                           0.82       302
   macro avg       0.58      0.64      0.60       302
weighted avg       0.85      0.82      0.83       302
```