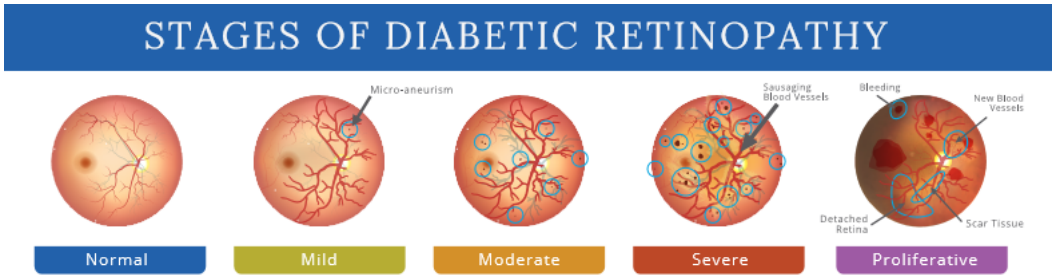
A Deep Learing Approach to

Diabetic Retinopathy Detection




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

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

```
import os
import cv2
import random
import warnings
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix, cohen_kappa_score
from keras.models import Model
from keras import optimizers, applications
from keras.preprocessing.image import ImageDataGenerator
from keras.callbacks import EarlyStopping, ReduceLROnPlateau
from keras.layers import Dense, Dropout, GlobalAveragePooling2D, Input
#from tensorflow import set_random_seed
from tensorflow.random import set_seed
def seed_everything(seed=0):
    random.seed(seed)
    os.environ['PYTHONHASHSEED'] = str(seed)
    np.random.seed(seed)
    set_seed(0)
seed_everything()

%matplotlib inline
sns.set(style="whitegrid")
warnings.filterwarnings("ignore")
```

Load data

```
train = pd.read_csv('/content/drive/MyDrive/rectino/train.csv')
test = pd.read_csv('/content/drive/MyDrive/rectino/test.csv')
print(train)
```

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

EDA

Data overview

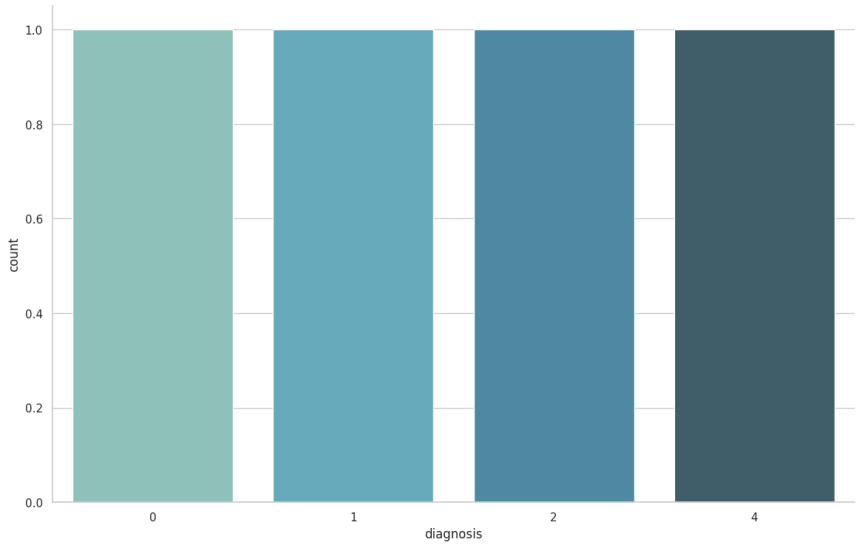
```
print('Number of train samples: ', train.shape[0])
print('Number of test samples: ', test.shape[0])
display(train.head())
```

```
Number of train samples:  4
Number of test samples:  5
```

	id_code	diagnosis
0	000c1434d8d7	2
1	001639a390f0	4

Label class distribution

```
f, ax = plt.subplots(figsize=(14, 8.7))
ax = sns.countplot(x="diagnosis", data=train, palette="GnBu_d")
sns.despine()
plt.show()
```



Legend

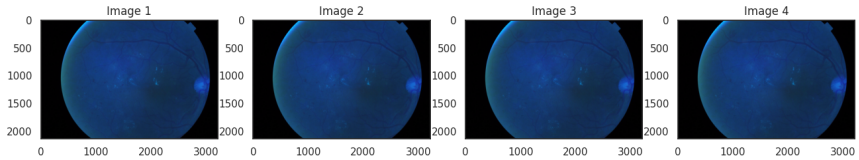
- 0 - No DR
- 1 - Mild
- 2 - Moderate
- 3 - Severe
- 4 - Proliferative DR

Now let's see some of the images

The images have different sizes, they may need resizing or some padding.

```
sns.set_style("white")
count = 1
plt.figure(figsize=[20, 20])
for img_name in train['id_code'][:4]:
    img = cv2.imread("/content/drive/MyDrive/rectino/train_images/000c1434d8d7.png")
    plt.subplot(5, 5, count)
    plt.imshow(img)
    plt.title("Image %s" % count)
    count += 1

plt.show()
```



Model parameters

```
# Model parameters
BATCH_SIZE =32
EPOCHS = 4
WARMUP_EPOCHS = 2
LEARNING_RATE = 1e-4
WARMUP_LEARNING_RATE = 1e-3
HEIGHT = 512
WIDTH = 128
CANAL = 1
N_CLASSES = 64
ES_PATIENCE = 5
RLROP_PATIENCE = 3
DECAY_DROP = 5


# Preprocecss data
train["id_code"] = train["id_code"].apply(lambda x: x + ".png")
test["id_code"] = test["id_code"].apply(lambda x: x + ".png")
train['diagnosis'] = train['diagnosis'].astype('str')
train.head()
```

	id_code	diagnosis
0	000c1434d8d7.png	2
1	001639a390f0.png	4
2	0024cdab0c1e.png	1
3	002c21358ce6.png	0

Data generator

```
train_datagen=ImageDataGenerator(rescale=1./255,
                                 validation_split=0.2,
                                 horizontal_flip=True)

train_generator=train_datagen.flow_from_dataframe(
    dataframe=train,
    directory="/content/drive/MyDrive/rectino/train_images/",
    x_col="id_code",
    y_col="diagnosis",
    batch_size=BATCH_SIZE,
    class_mode="categorical",
    target_size=(HEIGHT, WIDTH),
    subset='training')

valid_generator=train_datagen.flow_from_dataframe(
    dataframe=train,
    directory="/content/drive/MyDrive/rectino/train_images/",
    x_col="id_code",
    y_col="diagnosis",
    batch_size=BATCH_SIZE,
    class_mode="categorical",
    target_size=(HEIGHT, WIDTH),
    subset='validation')

test_datagen = ImageDataGenerator(rescale=1./255)

test_generator = test_datagen.flow_from_dataframe(
        dataframe=test,
        directory = "/content/drive/MyDrive/rectino/test_images/",
        x_col="id_code",
        target_size=(HEIGHT, WIDTH),
        batch_size=1,
        shuffle=False,
        class_mode=None)
```

```
Found 3 validated image filenames belonging to 3 classes.
Found 0 validated image filenames belonging to 3 classes.
Found 5 validated image filenames.
```

Model

```
def create_model(input_shape, n_out):
    input_tensor = Input(shape=input_shape)
    base_model = applications.ResNet50(weights=None,
                                       include_top=False,
                                       input_tensor=input_tensor)
    base_model.load_weights('/content/drive/MyDrive/rectino/resnet50_weights_tf_dim_ordering_tf_kernels_notop.h5')

    x = GlobalAveragePooling2D()(base_model.output)
    x = Dropout(0.5)(x)
    x = Dense(2048, activation='relu')(x)
    x = Dropout(0.5)(x)
    final_output = Dense(n_out, activation='softmax', name='final_output')(x)
    model = Model(input_tensor, final_output)

    return model


model = create_model(input_shape=(HEIGHT, WIDTH, CANAL), n_out=64)
for layer in model.layers:
    layer.trainable =False

for i in range(-5, 0):
    model.layers[i].trainable = True
WARMUP_LEARNING_RATE = 1e-3
metric_list = ["accuracy"]
optimizer = optimizers.Adam(lr=WARMUP_LEARNING_RATE)
model.compile(optimizer=optimizer, loss="categorical_crossentropy",  metrics=metric_list)
model.summary()
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-59-2322f0827cb5> in <cell line: 1>()
----> 1 model = create_model(input_shape=(HEIGHT, WIDTH, CANAL), n_out=64)
      2 for layer in model.layers:
      3     layer.trainable =False
      4
      5 for i in range(-5, 0):

                                  2 frames
/usr/local/lib/python3.10/dist-packages/keras/src/backend.py in _assign_value_to_variable(variable, value)
   4359     else:
   4360         # For the normal tf.Variable assign
-> 4361         variable.assign(value)
   4362
   4363

ValueError: Cannot assign value to variable ' conv1_conv/kernel:0': Shape mismatch.The variable shape (7, 7, 1, 64), and the
assigned value shape (64, 3, 7, 7) are incompatible.

SEARCH STACK OVERFLOW
```

Train top layers

```
STEP_SIZE_TRAIN = train_generator.n//train_generator.batch_size
STEP_SIZE_VALID = valid_generator.n//valid_generator.batch_size

history_warmup = model.fit_generator(generator=train_generator,
                                     steps_per_epoch=STEP_SIZE_TRAIN,
                                     validation_data=valid_generator,
                                     validation_steps=STEP_SIZE_VALID,
                                     epochs=WARMUP_EPOCHS,
                                     verbose=1).history
```

Fine-tune the complete model

```
for layer in model.layers:
    layer.trainable = True

es = EarlyStopping(monitor='val_loss', mode='min', patience=ES_PATIENCE, restore_best_weights=True, verbose=1)
rlrop = ReduceLROnPlateau(monitor='val_loss', mode='min', patience=RLROP_PATIENCE, factor=DECAY_DROP, min_lr=1e-6, verbose=1)

callback_list = [es, rlrop]
optimizer = optimizers.Adam(lr=LEARNING_RATE)
model.compile(optimizer=optimizer, loss="binary_crossentropy",  metrics=metric_list)
model.summary()
```

```
history_finetunning = model.fit_generator(generator=train_generator,
                                          steps_per_epoch=STEP_SIZE_TRAIN,
                                          validation_data=valid_generator,
                                          validation_steps=STEP_SIZE_VALID,
                                          epochs=EPOCHS,
                                          callbacks=callback_list,
                                          verbose=1).history
```

Model loss graph

```
history = {'loss': history_warmup['loss'] + history_finetunning['loss'],
           'val_loss': history_warmup['val_loss'] + history_finetunning['val_loss'],
           'acc': history_warmup['acc'] + history_finetunning['acc'],
           'val_acc': history_warmup['val_acc'] + history_finetunning['val_acc']}

sns.set_style("whitegrid")
fig, (ax1, ax2) = plt.subplots(2, 1, sharex='col', figsize=(20, 14))

ax1.plot(history['loss'], label='Train loss')
ax1.plot(history['val_loss'], label='Validation loss')
ax1.legend(loc='best')
ax1.set_title('Loss')

ax2.plot(history['acc'], label='Train Accuracy')
ax2.plot(history['val_acc'], label='Validation accuracy')
ax2.legend(loc='best')
ax2.set_title('Accuracy')

plt.xlabel('Epochs')
sns.despine()
plt.show()
```

Model Evaluation

```
complete_datagen = ImageDataGenerator(rescale=1./255)
complete_generator = complete_datagen.flow_from_dataframe(
        dataframe=train,
        directory = "../input/aptos2019-blindness-detection/train_images/",
        x_col="id_code",
        target_size=(HEIGHT, WIDTH),
        batch_size=1,
        shuffle=False,
        class_mode=None)

STEP_SIZE_COMPLETE = complete_generator.n//complete_generator.batch_size
train_preds = model.predict_generator(complete_generator, steps=STEP_SIZE_COMPLETE)
train_preds = [np.argmax(pred) for pred in train_preds]
```

Confusion Matrix

```
labels = ['0 - No DR', '1 - Mild', '2 - Moderate', '3 - Severe', '4 - Proliferative DR']
cnf_matrix = confusion_matrix(train['diagnosis'].astype('int'), train_preds)
cnf_matrix_norm = cnf_matrix.astype('float') / cnf_matrix.sum(axis=1)[:, np.newaxis]
df_cm = pd.DataFrame(cnf_matrix_norm, index=labels, columns=labels)
plt.figure(figsize=(16, 7))
sns.heatmap(df_cm, annot=True, fmt='.2f', cmap="Blues")
plt.show()
```

Quadratic Weighted Kappa

```
print("Train Cohen Kappa score: %.3f" % cohen_kappa_score(train_preds, train['diagnosis'].astype('int'), weights='quadratic'))
```

Apply model to test set and output predictions

```
test_generator.reset()
STEP_SIZE_TEST = test_generator.n//test_generator.batch_size
```

```
preds = model.predict_generator(test_generator, steps=STEP_SIZE_TEST)
predictions = [np.argmax(pred) for pred in preds]


filenames = test_generator.filenames
results = pd.DataFrame({'id_code':filenames, 'diagnosis':predictions})
results['id_code'] = results['id_code'].map(lambda x: str(x)[:-4])
results.to_csv('submission.csv',index=False)
results.head(10)
```

Predictions class distribution

```
f, ax = plt.subplots(figsize=(14, 8.7))
ax = sns.countplot(x="diagnosis", data=results, palette="GnBu_d")
sns.despine()
plt.show()
```