OcularCNN-Improvements

In [1]:
```python
import pandas as pd
import random
import numpy as np

theFile = pd.read_csv("../data/full_df.csv")
theFile
```

Out[1]:

	ID	Patient Age	Patient Sex	Left-Fundus	Right-Fundus	Left-Diagnostic Keywords	Right-Diagnostic Keywords	N	D	G	C
0	0	69	Female	0_left.jpg	0_right.jpg	cataract	normal fundus	0	0	0	1
1	1	57	Male	1_left.jpg	1_right.jpg	normal fundus	normal fundus	1	0	0	0
2	2	42	Male	2_left.jpg	2_right.jpg	laser spot, moderate non proliferative retinopathy	moderate non proliferative retinopathy	0	1	0	0
3	4	53	Male	4_left.jpg	4_right.jpg	macular epiretinal membrane	mild nonproliferative retinopathy	0	1	0	0
4	5	50	Female	5_left.jpg	5_right.jpg	moderate non proliferative retinopathy	moderate non proliferative retinopathy	0	1	0	0
...	...	...	...	...	...	...	...	...	...	...	...
6387	4686	63	Male	4686_left.jpg	4686_right.jpg	severe nonproliferative retinopathy	proliferative diabetic retinopathy	0	1	0	0
6388	4688	42	Male	4688_left.jpg	4688_right.jpg	moderate non proliferative retinopathy	moderate non proliferative retinopathy	0	1	0	0
6389	4689	54	Male	4689_left.jpg	4689_right.jpg	mild nonproliferative retinopathy	normal fundus	0	1	0	0
6390	4690	57	Male	4690_left.jpg	4690_right.jpg	mild nonproliferative retinopathy	mild nonproliferative retinopathy	0	1	0	0
6391	4784	58	Male	4784_left.jpg	4784_right.jpg	hypertensive retinopathy, age-related macular d...	hypertensive retinopathy, age-related macular d...	0	0	0	0

6392 rows × 19 columns

In [2]:
```python
theFile.drop(np.linspace(1, 3194, 3193, dtype = int), inplace = True )
target = theFile.loc[(theFile['Left-Diagnostic Keywords'] == 'cataract') | (theFile['L


target = theFile.loc[(theFile['Left-Diagnostic Keywords'] == 'cataract') | (theFile['L
```

In [3]:
```python
print(len(target.loc[target['Left-Diagnostic Keywords'] == 'cataract']))
print(len(target.loc[target['Left-Diagnostic Keywords'] == 'normal fundus']))
```

```
135
1433
```

In [4]:
```python
#As shown above, there are much more normal fundus entries than cataract
#Let's sample the normal fundus to get equivalent numbers of each class
cataract = target.loc[target['Left-Diagnostic Keywords'] == 'cataract']
normal = target.loc[target['Left-Diagnostic Keywords'] == 'normal fundus']
normal = normal.sample(135)
frames = [cataract, normal]
target = pd.concat(frames)

#now shuffle these randomly
# shuffle the DataFrame rows
target= target.sample(frac = 1)
```

In [5]:
```python
pictures = target[['filename']]
```

In [6]:
```python
target
```

Out[6]:

	ID	Patient Age	Patient Sex	Left-Fundus	Right-Fundus	Left-Diagnostic Keywords	Right-Diagnostic Keywords	N	D	G	C	A
4058	990	41	Female	990_left.jpg	990_right.jpg	normal fundus	macular epiretinal membrane	0	0	0	0	0
6232	4496	53	Female	4496_left.jpg	4496_right.jpg	normal fundus	mild nonproliferative retinopathy	0	1	0	0	0
4132	1113	56	Female	1113_left.jpg	1113_right.jpg	normal fundus	mild nonproliferative retinopathy	0	1	0	0	0
4803	2432	45	Female	2432_left.jpg	2432_right.jpg	normal fundus	normal fundus	1	0	0	0	0
4588	2123	47	Male	2123_left.jpg	2123_right.jpg	cataract	refractive media opacity	0	0	0	1	0
...	...	...	...	...	...	...	...	...	...	...	...	...
5080	2740	55	Male	2740_left.jpg	2740_right.jpg	normal fundus	normal fundus	1	0	0	0	0
4574	2109	82	Male	2109_left.jpg	2109_right.jpg	cataract	cataract	0	0	0	1	0
4585	2120	72	Female	2120_left.jpg	2120_right.jpg	cataract	cataract	0	0	0	1	0
5243	2916	61	Male	2916_left.jpg	2916_right.jpg	normal fundus	normal fundus	1	0	0	0	0
4634	2172	73	Male	2172_left.jpg	2172_right.jpg	cataract	normal fundus	0	0	0	1	0

270 rows × 19 columns

In [7]:
```python
classnames = ['[\'N\']', '[\'D\']','[\'G\']','[\'C\']','[\'A\']','[\'H\']','[\'M\']',
classnames
```

Out[7]:
```
["['N']", "['D']", "['G']", "['C']", "['A']", "['H']", "['M']", "['O']"]
```

In [8]:
```python
pictures = pictures.values.tolist()
pictures = sum(pictures, [])
pictures
```

Out[8]:
```
['990_left.jpg',
 '4496_left.jpg',
 '1113_left.jpg',
 '2432_left.jpg',
 '2123_left.jpg',
 '2204_left.jpg',
 '3120_left.jpg',
 '1038_left.jpg',
 '149_left.jpg',
 '2225_left.jpg',
 '2708_left.jpg',
 '448_left.jpg',
 '683_left.jpg',
 '2236_left.jpg',
 '3204_left.jpg',
 '2532_left.jpg',
 '384_left.jpg',
 '3394_left.jpg',
 '2209_left.jpg',
 '2832_left.jpg',
 '2135_left.jpg',
 '2507_left.jpg',
 '4219_left.jpg',
 '2855_left.jpg',
 '2932_left.jpg',
 '2101_left.jpg',
 '3153_left.jpg',
 '2262_left.jpg',
 '2145_left.jpg',
 '2216_left.jpg',
 '2846_left.jpg',
 '2171_left.jpg',
 '2157_left.jpg',
 '2140_left.jpg',
 '3420_left.jpg',
 '3163_left.jpg',
 '85_left.jpg',
 '3183_left.jpg',
 '2117_left.jpg',
 '2744_left.jpg',
 '2134_left.jpg',
 '2166_left.jpg',
 '2098_left.jpg',
 '2774_left.jpg',
 '1484_left.jpg',
 '2232_left.jpg',
 '907_left.jpg',
 '2543_left.jpg',
 '4531_left.jpg',
 '3311_left.jpg',
 '2470_left.jpg',
 '2185_left.jpg',
 '2153_left.jpg',
 '69_left.jpg',
 '2211_left.jpg',
 '2194_left.jpg',
 '2130_left.jpg',
 '2189_left.jpg',
 '2129_left.jpg',
 '2243_left.jpg',
 '3208_left.jpg',
 '2666_left.jpg',
 '999_left.jpg',
 '3172_left.jpg',
 '2452_left.jpg',
 '2872_left.jpg',
 '4209_left.jpg',
 '294_left.jpg',
 '2181_left.jpg',
 '3361_left.jpg',
 '2649_left.jpg',
 '3076_left.jpg',
 '2124_left.jpg',
 '3064_left.jpg',
 '2127_left.jpg',
 '2151_left.jpg',
 '103_left.jpg',
 '2095_left.jpg',
 '2461_left.jpg',
 '0_right.jpg',
 '2178_left.jpg',
 '2179_left.jpg',
 '809_left.jpg',
 '2692_left.jpg',
 '824_left.jpg',
 '2200_left.jpg',
 '1162_left.jpg',
 '477_left.jpg',
 '702_left.jpg',
 '2466_left.jpg',
 '2227_left.jpg',
 '2861_left.jpg',
 '1452_left.jpg',
 '2183_left.jpg',
 '160_left.jpg',
 '2158_left.jpg',
 '2180_left.jpg',
 '2207_left.jpg',
 '1415_left.jpg',
 '333_left.jpg',
 '1166_left.jpg',
 '2152_left.jpg',
 '2529_left.jpg',
 '3379_left.jpg',
 '2184_left.jpg',
 '877_left.jpg',
 '2849_left.jpg',
 '2176_left.jpg',
 '599_left.jpg',
 '2575_left.jpg',
 '2965_left.jpg',
 '2233_left.jpg',
 '2221_left.jpg',
 '1164_left.jpg',
 '2819_left.jpg',
 '2369_left.jpg',
 '691_left.jpg',
 '2150_left.jpg',
 '750_left.jpg',
 '695_left.jpg',
 '3057_left.jpg',
 '3025_left.jpg',
 '3112_left.jpg',
 '1444_left.jpg',
 '2126_left.jpg',
 '2146_left.jpg',
 '2247_left.jpg',
 '3423_left.jpg',
 '2136_left.jpg',
 '2377_left.jpg',
 '2195_left.jpg',
 '2099_left.jpg',
 '2346_left.jpg',
 '629_left.jpg',
 '2154_left.jpg',
 '2167_left.jpg',
 '2144_left.jpg',
 '2155_left.jpg',
 '2122_left.jpg',
 '2514_left.jpg',
 '4230_left.jpg',
 '2110_left.jpg',
 '2107_left.jpg',
 '4224_left.jpg',
 '1008_left.jpg',
 '3173_left.jpg',
 '2993_left.jpg',
 '2441_left.jpg',
 '347_left.jpg',
 '820_left.jpg',
 '2170_left.jpg',
 '2105_left.jpg',
 '2234_left.jpg',
 '2223_left.jpg',
 '1468_left.jpg',
 '4500_left.jpg',
 '2113_left.jpg',
 '2212_left.jpg',
 '553_left.jpg',
 '3102_left.jpg',
 '2480_left.jpg',
 '3128_left.jpg',
 '3121_left.jpg',
 '2722_left.jpg',
 '2375_left.jpg',
 '2876_left.jpg',
 '2448_left.jpg',
 '2121_left.jpg',
 '2163_left.jpg',
 '4577_left.jpg',
 '2215_left.jpg',
 '1102_left.jpg',
 '2434_left.jpg',
 '2138_left.jpg',
 '2175_left.jpg',
 '1200_left.jpg',
 '2206_left.jpg',
 '2235_left.jpg',
 '2169_left.jpg',
 '2931_left.jpg',
 '2446_left.jpg',
 '147_left.jpg',
 '2914_left.jpg',
 '2462_left.jpg',
 '2904_left.jpg',
 '2246_left.jpg',
 '2133_left.jpg',
 '3136_left.jpg',
 '3020_left.jpg',
 '3159_left.jpg',
 '945_left.jpg',
 '3067_left.jpg',
 '2182_left.jpg',
 '2385_left.jpg',
 '2116_left.jpg',
 '2128_left.jpg',
 '2210_left.jpg',
 '2890_left.jpg',
 '173_left.jpg',
 '2132_left.jpg',
 '191_left.jpg',
 '2219_left.jpg',
 '2239_left.jpg',
 '4309_left.jpg',
 '2111_left.jpg',
 '3401_left.jpg',
 '1987_left.jpg',
 '2108_left.jpg',
 '2399_left.jpg',
 '2192_left.jpg',
 '16_left.jpg',
 '2137_left.jpg',
 '1115_left.jpg',
 '3331_left.jpg',
 '2217_left.jpg',
 '2198_left.jpg',
 '439_left.jpg',
 '58_left.jpg',
 '1285_left.jpg',
 '2104_left.jpg',
 '4245_left.jpg',
 '2159_left.jpg',
 '2114_left.jpg',
 '2125_left.jpg',
 '2240_left.jpg',
 '2431_left.jpg',
 '3129_left.jpg',
 '611_left.jpg',
 '2482_left.jpg',
 '425_left.jpg',
 '2349_left.jpg',
 '4489_left.jpg',
 '2242_left.jpg',
 '330_left.jpg',
 '2149_left.jpg',
 '1435_left.jpg',
 '2778_left.jpg',
 '3249_left.jpg',
 '2147_left.jpg',
 '1483_left.jpg',
 '2168_left.jpg',
 '187_left.jpg',
 '2142_left.jpg',
 '2902_left.jpg',
 '1144_left.jpg',
 '3374_left.jpg',
 '119_left.jpg',
 '3075_left.jpg',
 '8_left.jpg',
 '2896_left.jpg',
 '560_left.jpg',
 '2609_left.jpg',
 '2156_left.jpg',
 '3382_left.jpg',
 '3424_left.jpg',
 '317_left.jpg',
 '2987_left.jpg',
 '2398_left.jpg',
 '2226_left.jpg',
 '726_left.jpg',
 '2199_left.jpg',
 '254_left.jpg',
 '3303_left.jpg',
 '2203_left.jpg',
 '3448_left.jpg',
 '2740_left.jpg',
 '2109_left.jpg',
 '2120_left.jpg',
 '2916_left.jpg',
 '2172_left.jpg']
```

In [9]:
```python
#sampling 30 photos
small_pics= random.sample(pictures, 270)
```

In [ ]:

In [10]:
```python
#grab target if label matches
classifications=list()
for pic_name in small_pics:
    intermediate = theFile.loc[theFile['filename'] == pic_name]
    label = intermediate['Left-Diagnostic Keywords'].to_string().replace('\'','').repl
    label = ''.join([i for i in label if not i.isdigit()])
    classifications.append(label)
#classifications contains the "target" corresponding to small_pics
```

In [11]:
```python
classifications
```

Out[11]:
```
['cataract',
 'cataract',
 'normal fundus',
 'normal fundus',
 'normal fundus',
 'normal fundus',
 'normal fundus',
 'cataract',
 'cataract',
 'cataract',
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 'normal fundus',
 'cataract']
```
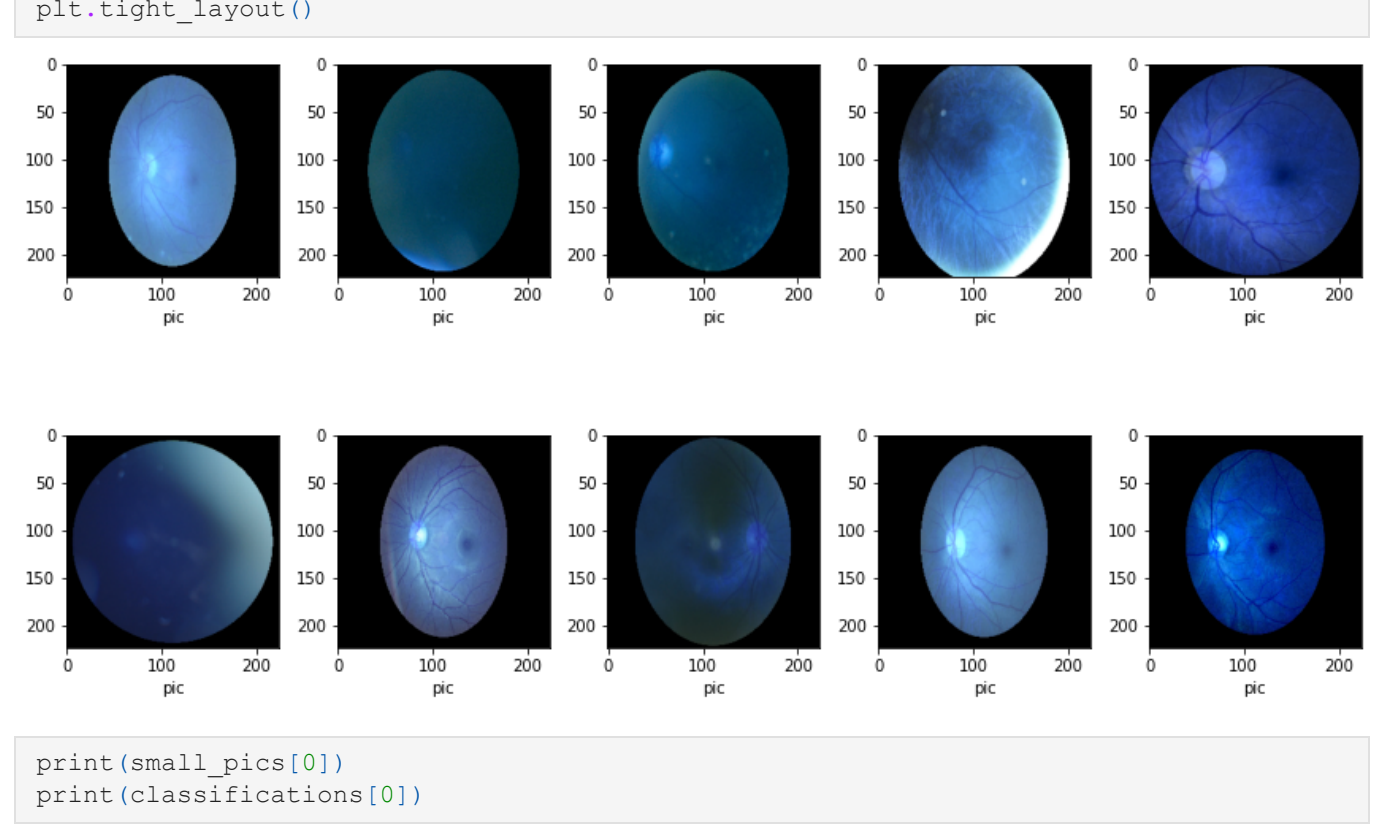

In [12]:
```python
import matplotlib.pyplot as plt
import cv2
actual_pics = []

img_res = 224

for file in small_pics:
    img = cv2.imread('../Challenge/images/' + file) #zero makes it greyscale
    #this is resizing all images
    img = cv2.resize(img, (img_res, img_res))
    actual_pics.append(img)
```

In [13]:
```python
actual_pics[0]
```

Out[13]:
```
array([[[0, 0, 0],
        [0, 0, 0],
        [0, 0, 0],
        ...,
        [0, 0, 0],
        [0, 0, 0],
        [0, 0, 0]],

       [[0, 0, 0],
        [0, 0, 0],
        [0, 0, 0],
        ...,
        [0, 0, 0],
        [0, 0, 0],
        [0, 0, 0]],

       [[0, 0, 0],
        [0, 0, 0],
        [0, 0, 0],
        ...,
        [0, 0, 0],
        [0, 0, 0],
        [0, 0, 0]],

       ...,

       [[0, 0, 0],
        [0, 0, 0],
        [0, 0, 0],
        ...,
        [0, 0, 0],
        [0, 0, 0],
        [0, 0, 0]],

       [[0, 0, 0],
        [0, 0, 0],
        [0, 0, 0],
        ...,
        [0, 0, 0],
        [0, 0, 0],
        [0, 0, 0]],

       [[0, 0, 0],
        [0, 0, 0],
        [0, 0, 0],
        ...,
        [0, 0, 0],
        [0, 0, 0],
        [0, 0, 0]]], dtype=uint8)
```

In [14]:
```python
plt.figure(figsize=(12,7))
for i in range(10):
    sample = random.choice(range(len(actual_pics)))
    image = actual_pics[sample]

    plt.subplot(2,5,i+1)
    plt.imshow(image)
    plt.xlabel('pic')
plt.tight_layout()
```



In [15]:
```python
print(small_pics[0])
print(classifications[0])
```

```
2204_left.jpg
cataract
```

In [16]:
```python
import numpy as np
from sklearn.model_selection import train_test_split
from tensorflow.keras import utils

#normalize our data !!
labels = {
    "cataract": 0,
    "normal fundus": 1
}

labels = np.array(labels)


for i in range(len(classifications)):
        if(classifications[i] == 'cataract'):
                classifications[i] = 0
        elif(classifications[i] == 'normal fundus'):
                 classifications[i] = 1

classifications = utils.to_categorical(classifications)
```

In [17]:
```python
actual_pics = np.array(actual_pics)
classifications = np.array(classifications)

classifications = np.array(classifications)
actual_pics.astype('float32')/255.0

#shuffle = false prevents data split being different everytime
X_train, X_test, y_train, y_test = train_test_split(actual_pics, classifications, test

#split test into validate and test, again making sure the data is always the same for
X_train, xt, y_train, yt = train_test_split(X_train, y_train, test_size=0.1, shuffle =
```

In [18]:
```python
#begin NN
import logging
logging.basicConfig()
import tensorflow as tf
```

In [19]:
```python
import numpy
len(actual_pics[2][0])
```

Out[19]:
```
224
```

In [20]:
```python
print(X_train.shape)
y_train.shape
```

```
(194, 224, 224, 3)
```

Out[20]:
```
(194, 2)
```

In [21]:
```python
# convert to numpy arrays
x = np.array(X_train)
y = np.array(y_train)

X_test = np.array(X_test)
y_test = np.array(y_test)

xt = np.array(xt)
yt = np.array(yt)
```

In [22]:
```python
from tensorflow.keras import datasets, layers, models
import matplotlib.pyplot as plt
from tensorflow.keras.layers import Dropout
from keras.layers.advanced_activations import LeakyReLU

model = models.Sequential()
model.add(layers.Conv2D(32, (3,3), activation = 'linear', input_shape=(img_res, img_re
model.add(LeakyReLU(alpha=0.1))
model.add(layers.MaxPooling2D(2,2))
model.add(Dropout(0.25))
model.add(layers.Conv2D(128, (3,3), activation = 'linear'))
model.add(LeakyReLU(alpha=0.1))
model.add(layers.MaxPooling2D(2,2))
model.add(Dropout(0.25))
model.add(layers.Conv2D(128, (3,3), activation = 'linear'))
model.add(LeakyReLU(alpha=0.1))
model.add(layers.MaxPooling2D(pool_size=(2, 2),padding='same'))
model.add(layers.Flatten())
model.add(layers.Dense(128, activation = 'sigmoid'))
model.add(layers.Dense(2, activation='softmax'))
model.summary()
from tensorflow import keras
opt = keras.optimizers.Adam( learning_rate=0.00001)

#early stopping stuff
# simple early stopping
from keras.callbacks import EarlyStopping
es = EarlyStopping(monitor='val_loss', mode='min', verbose=1, patience=20, min_delta=(

model.compile(loss='binary_crossentropy', optimizer=opt, metrics=['accuracy'])
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 222, 222, 32)      896
_________________________________________________________________
leaky_re_lu (LeakyReLU)      (None, 222, 222, 32)      0
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 111, 111, 32)      0
_________________________________________________________________
dropout (Dropout)            (None, 111, 111, 32)      0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 109, 109, 128)     36992
_________________________________________________________________
leaky_re_lu_1 (LeakyReLU)    (None, 109, 109, 128)     0
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 54, 54, 128)       0
_________________________________________________________________
dropout_1 (Dropout)          (None, 54, 54, 128)       0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 52, 52, 128)       147584
_________________________________________________________________
leaky_re_lu_2 (LeakyReLU)    (None, 52, 52, 128)       0
```

```
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 26, 26, 128)       0
_________________________________________________________________
flatten (Flatten)            (None, 86528)             0
_________________________________________________________________
dense (Dense)                (None, 128)               11075712
_________________________________________________________________
dense_1 (Dense)              (None, 2)                 258
=================================================================
Total params: 11,261,442
Trainable params: 11,261,442
Non-trainable params: 0
_________________________________________________________________
```

In [23]:

```
print(np.size(x))
print(np.shape(x))
print(np.size(y))
print(np.shape(y))
```

```
29202432
(194, 224, 224, 3)
388
(194, 2)
```

In [24]:

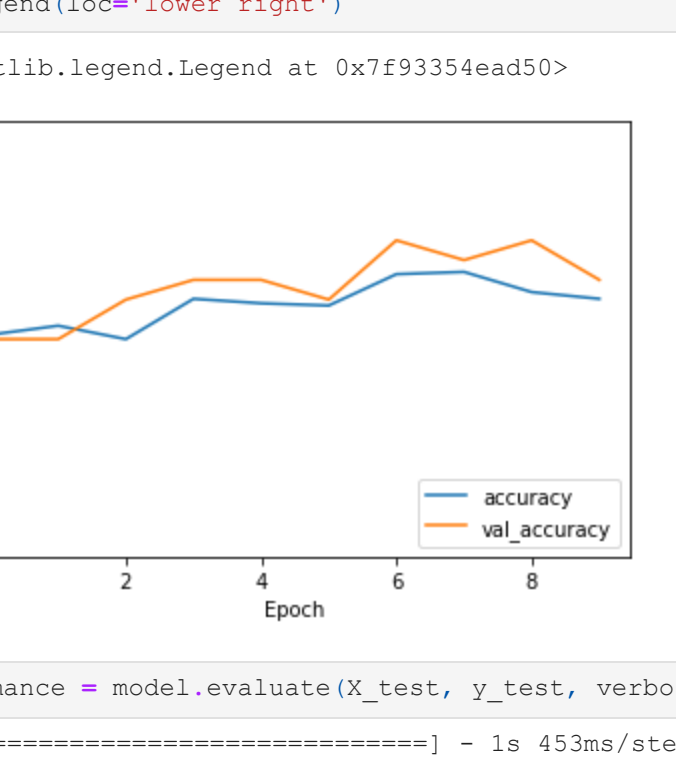
```
#this stores the fitting information
#put in our own data for the images and labelling stuff

history = model.fit(x, y, epochs = 10, validation_data = (xt, yt), callbacks = [es])

#dont forget to keep training until your accuracy becomes bad
```

```
Epoch 1/10
7/7 [==============================] - 19s 3s/step - loss: 0.7603 - accuracy: 0.5463 - val_loss: 0.6945 - val_accuracy: 0.5000
Epoch 2/10
7/7 [==============================] - 13s 2s/step - loss: 0.7005 - accuracy: 0.5379 - val_loss: 0.6847 - val_accuracy: 0.5000
Epoch 3/10
7/7 [==============================] - 14s 2s/step - loss: 0.6844 - accuracy: 0.5163 - val_loss: 0.6784 - val_accuracy: 0.5909
Epoch 4/10
7/7 [==============================] - 14s 2s/step - loss: 0.6737 - accuracy: 0.6050 - val_loss: 0.6769 - val_accuracy: 0.6364
Epoch 5/10
7/7 [==============================] - 14s 2s/step - loss: 0.6700 - accuracy: 0.6041 - val_loss: 0.6708 - val_accuracy: 0.6364
Epoch 6/10
7/7 [==============================] - 13s 2s/step - loss: 0.6632 - accuracy: 0.6111 - val_loss: 0.6727 - val_accuracy: 0.5909
Epoch 7/10
7/7 [==============================] - 14s 2s/step - loss: 0.6718 - accuracy: 0.6098 - val_loss: 0.6675 - val_accuracy: 0.7273
Epoch 8/10
7/7 [==============================] - 13s 2s/step - loss: 0.6511 - accuracy: 0.6498 - val_loss: 0.6688 - val_accuracy: 0.6818
Epoch 9/10
7/7 [==============================] - 13s 2s/step - loss: 0.6641 - accuracy: 0.5980 - val_loss: 0.6722 - val_accuracy: 0.7273
Epoch 10/10
7/7 [==============================] - 14s 2s/step - loss: 0.6652 - accuracy: 0.5865 - val_loss: 0.6655 - val_accuracy: 0.6364
```

In [25]:

```
# Plot the change in accuracy and validation accruacy as a function of epochs

plt.plot(history.history['accuracy'], label='accuracy')
plt.plot(history.history['val_accuracy'], label='val_accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.ylim(0, 1)
plt.legend(loc='lower right')
```

Out[25]: <matplotlib.legend.Legend at 0x7f93354ead50>



In [26]:

```
performance = model.evaluate(X_test, y_test, verbose=1)
```

```
2/2 [==============================] - 1s 453ms/step - loss: 0.6503 - accuracy: 0.6667
```

In [27]:

```
y_pred = model.predict(X_test)
print(y_pred)
```

```
[[0.5788577  0.42114228]
 [0.97771764 0.02228238]
 [0.95906943 0.0409306 ]
 [0.50533015 0.49466982]
 [0.68056893 0.31943107]
 [0.5151514  0.48484862]
 [0.5313143  0.46868566]
 [0.5827789  0.4172211 ]
 [0.58487195 0.4151281 ]
 [0.5960251  0.4039748 ]
 [0.60610163 0.3938983 ]
 [0.5258783  0.47412172]
 [0.536712   0.46328804]
 [0.5292513  0.4707487 ]
 [0.5387855  0.46121445]
 [0.5465227  0.45347735]
 [0.33974645 0.6602535 ]
 [0.5355231  0.46447688]
 [0.58430666 0.41569328]
 [0.57782865 0.42217132]
 [0.7352031  0.26479688]
 [0.6021158  0.39788422]
 [0.57931334 0.4206867 ]
 [0.49606153 0.50393844]
 [0.58762383 0.4123762 ]
 [0.6887743  0.31122577]
 [0.54571277 0.4542873 ]
 [0.45948133 0.54051864]
 [0.6057914  0.39420864]
 [0.4465654  0.55343455]
 [0.60244924 0.39755073]
 [0.57046854 0.4295314 ]
 [0.6301627  0.3698373 ]
 [0.4920884  0.5079116 ]
 [0.4035052  0.5964948 ]
 [0.56033206 0.43966797]
 [0.5877249  0.41227505]
 [0.56644195 0.43355805]
 [0.40571567 0.59428436]
 [0.48935604 0.5106439 ]
 [0.52726674 0.47273326]
 [0.3934633  0.60653675]
 [0.48530552 0.5146944 ]
 [0.4542345  0.5457655 ]
 [0.60464644 0.39535362]
 [0.5187622  0.48123786]
 [0.5898149  0.41018507]
 [0.6575892  0.34241083]
 [0.5853153  0.41468465]
 [0.5554536  0.44454637]
 [0.59884906 0.40115097]
 [0.5957013  0.40429872]
 [0.5611944  0.43880558]
 [0.6112777  0.3887223 ]]
```