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

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947

Enter your authorization code:
··········
Mounted at /content/drive
```

```
import numpy as np
import os
import matplotlib.pyplot as plt
from keras.optimizers import Adam
from numpy import moveaxis
from numpy import asarray
import pandas as pd
from keras.applications.vgg16 import VGG16
from keras.preprocessing import image
from keras.applications.vgg16 import preprocess_input
```

```
Using TensorFlow backend.
```

The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you upgrade now or ensure your notebook will continue to use TensorFlow 1.x via the %tensor

```
def extractThree(x):
  mid = len(x) // 2

  return np.array([ x[mid-1] , x[mid] ,x[mid+1]])


def getTrainingData(type1,type2):

  list = []

  for filename in sorted(os.listdir("/content/drive/My Drive/MINOR PROJECT/Knee MRI Datase
    if(filename != ".DS_Store"):
      trainingExample = np.load("/content/drive/My Drive/MINOR PROJECT/Knee MRI Dataset/MR
      x = image.img_to_array(trainingExample)
      x = np.expand_dims(x, axis=0)
      x = preprocess_input(x)

      list.append(extractThree(trainingExample))

  return list.copy()


sagittalTrainingData = getTrainingData("train","sagittal")
axialTrainingData = getTrainingData("train","axial")
```

```
coronalTrainingData = getTrainingData("train","coronal")

sagittalTestData = getTrainingData("valid","sagittal")
axialTestData = getTrainingData("valid","axial")
coronalTestData = getTrainingData("valid","coronal")



def reshape_data(trainingData):
  data = asarray(trainingData)
  data = moveaxis(data, 1, 3)
  print(data.shape)

  return data




sagittalData  = reshape_data(sagittalTrainingData)
axialData = reshape_data(axialTrainingData)
coronalData = reshape_data(coronalTrainingData)

sagittalTestData = reshape_data(sagittalTestData)
axialTestData = reshape_data(axialTestData)
coronalTestData = reshape_data(coronalTestData)
```

```
(1130, 256, 256, 3)
(1130, 256, 256, 3)
(1130, 256, 256, 3)
(120, 256, 256, 3)
(120, 256, 256, 3)
(120, 256, 256, 3)
```

```
def readLabels(type1,type2):
  path = "/content/drive/My Drive/MINOR PROJECT/Knee MRI Dataset/MRNet-v1.0/"+type1+"-"+ty
  df=pd.read_csv(path, sep=',',header=None)
  labelsValid = df.values
  labelsValid = labelsValid[:,1]
  return labelsValid



abnormalLabels = readLabels('train','abnormal')
aclLabels = readLabels('train','acl')
meniscusLabels = readLabels('train','meniscus')


abnornmalTestLabels = readLabels('valid','abnormal')
aclTestLabels = readLabels('valid','acl')
meniscusTestLabels = readLabels('valid','meniscus')


from keras import models
```

```
from keras import layers
from keras.models import Model
from keras import optimizers
from tensorflow.keras.models import Sequential
from tensorflow.keras.callbacks import EarlyStopping
from keras.applications import VGG16

def buildModel():
  vgg = VGG16(include_top=False, weights='imagenet', input_tensor=None, input_shape=(256,2

  for layer in vgg.layers:
    layer.trainable = False

  x = vgg.output
  x = layers.GlobalAveragePooling2D()(x)
  x = layers.Dropout(0.6)(x)
  predictions = layers.Dense(1, activation= 'sigmoid')(x)
  model = Model(inputs = vgg.input, outputs = predictions)

  model.summary()

  model.compile(loss='binary_crossentropy',optimizer="adam",metrics=['accuracy'])
  return model



model_abnormal_sagittal = buildModel()
history_abnormal_sagittal = model_abnormal_sagittal.fit(sagittalData,abnormalLabels,epochs

model_abnormal_axial = buildModel()
history_abnormal_axial = model_abnormal_axial.fit(axialData,abnormalLabels,epochs=60,valic

model_abnormal_coronal = buildModel()
history_abnormal_coronal = model_abnormal_coronal.fit(coronalData,abnormalLabels,epochs=60
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

Downloading data from https://github.com/fchollet/deep-learning-models/releases/downl
58892288/58889256 [==============================] - 2s 0us/step
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob
WARNING:tensorflow:Large dropout rate: 0.6 (>0.5). In TensorFlow 2.x, dropout() uses
Model: "model_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         (None, 256, 256, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 256, 256, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 256, 256, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 128, 128, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 128, 128, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 64, 64, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 64, 64, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 32, 32, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 32, 32, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 32, 32, 512)       2359808
```

```
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 16, 16, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
_________________________________________________________________
global_average_pooling2d_1 ( (None, 512)               0
_________________________________________________________________
dropout_1 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 513
=================================================================
Total params: 14,715,201
Trainable params: 513
Non-trainable params: 14,714,688
_________________________________________________________________
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:79

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorfl

Train on 1017 samples, validate on 113 samples
Epoch 1/60
1017/1017 [==============================] - 19s 19ms/step - loss: 2.5931 - acc: 0.68
Epoch 2/60
1017/1017 [==============================] - 9s 8ms/step - loss: 2.0369 - acc: 0.7158
Epoch 3/60
1017/1017 [==============================] - 9s 8ms/step - loss: 1.8273 - acc: 0.7188
Epoch 4/60
1017/1017 [==============================] - 9s 8ms/step - loss: 1.4719 - acc: 0.7276
Epoch 5/60
1017/1017 [==============================] - 9s 8ms/step - loss: 1.2744 - acc: 0.7443
Epoch 6/60
1017/1017 [==============================] - 9s 8ms/step - loss: 1.1438 - acc: 0.7493
Epoch 7/60
1017/1017 [==============================] - 9s 8ms/step - loss: 1.0069 - acc: 0.7581
Epoch 8/60
1017/1017 [==============================] - 9s 8ms/step - loss: 0.9453 - acc: 0.7601
Epoch 9/60
1017/1017 [==============================] - 9s 8ms/step - loss: 0.8358 - acc: 0.7660
Epoch 10/60
1017/1017 [==============================] - 9s 8ms/step - loss: 0.7217 - acc: 0.7915
Epoch 11/60
1017/1017 [==============================] - 9s 8ms/step - loss: 0.7564 - acc: 0.7709
Epoch 12/60
```

```
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7136 - acc: 0.7719
Epoch 13/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5840 - acc: 0.7797
Epoch 14/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5988 - acc: 0.7896
Epoch 15/60
1017/1017 [==============================] - 9s 8ms/step - loss: 0.5673 - acc: 0.7906
Epoch 16/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5034 - acc: 0.8161
Epoch 17/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5308 - acc: 0.7925
Epoch 18/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4958 - acc: 0.8014
Epoch 19/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4555 - acc: 0.8171
Epoch 20/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4725 - acc: 0.8122
Epoch 21/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4012 - acc: 0.8338
Epoch 22/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4496 - acc: 0.8142
Epoch 23/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4309 - acc: 0.8210
Epoch 24/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4145 - acc: 0.8132
Epoch 25/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4589 - acc: 0.8063
Epoch 26/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4054 - acc: 0.8269
Epoch 27/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4269 - acc: 0.8220
Epoch 28/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3980 - acc: 0.8181
Epoch 29/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3962 - acc: 0.8269
Epoch 30/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4095 - acc: 0.8210
Epoch 31/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4293 - acc: 0.8132
Epoch 32/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4055 - acc: 0.8142
Epoch 33/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3965 - acc: 0.8112
Epoch 34/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3904 - acc: 0.8417
Epoch 00034: early stopping
WARNING:tensorflow:Large dropout rate: 0.6 (>0.5). In TensorFlow 2.x, dropout() uses
Model: "model_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_2 (InputLayer)         (None, 256, 256, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 256, 256, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 256, 256, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
```

```
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 128, 128, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 128, 128, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 64, 64, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 64, 64, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 32, 32, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 32, 32, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 16, 16, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
_________________________________________________________________
global_average_pooling2d_2 ( (None, 512)               0
_________________________________________________________________
dropout_2 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 513
=================================================================
Total params: 14,715,201
Trainable params: 513
Non-trainable params: 14,714,688
_________________________________________________________________
Train on 1017 samples, validate on 113 samples
Epoch 1/60
1017/1017 [==============================] - 9s 9ms/step - loss: 4.0027 - acc: 0.6057
Epoch 2/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.5296 - acc: 0.7935
Epoch 3/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.4737 - acc: 0.7591
Epoch 4/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.4824 - acc: 0.7453
Epoch 5/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.2891 - acc: 0.7493
Epoch 6/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.9866 - acc: 0.7640
Epoch 7/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.6006 - acc: 0.7630
Epoch 8/60
```

```
1017/1017 [==============================] - 9s 9ms/step - loss: 1.6366 - acc: 0.7778
Epoch 9/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.5042 - acc: 0.7601
Epoch 10/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.3101 - acc: 0.7847
Epoch 11/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.1819 - acc: 0.7699
Epoch 12/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.1095 - acc: 0.7738
Epoch 13/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0879 - acc: 0.7630
Epoch 14/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8955 - acc: 0.7906
Epoch 15/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8209 - acc: 0.7866
Epoch 16/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8155 - acc: 0.7738
Epoch 17/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6888 - acc: 0.7925
Epoch 18/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7093 - acc: 0.7925
Epoch 19/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5315 - acc: 0.8328
Epoch 20/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5794 - acc: 0.8151
Epoch 21/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5408 - acc: 0.8083
Epoch 22/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4959 - acc: 0.8309
Epoch 23/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4549 - acc: 0.8230
Epoch 24/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4933 - acc: 0.8083
Epoch 25/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4736 - acc: 0.8151
Epoch 26/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4456 - acc: 0.8181
Epoch 27/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4172 - acc: 0.8446
Epoch 28/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3998 - acc: 0.8289
Epoch 29/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4181 - acc: 0.8269
Epoch 30/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4015 - acc: 0.8319
Epoch 31/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3777 - acc: 0.8269
Epoch 32/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3879 - acc: 0.8378
Epoch 33/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4089 - acc: 0.8319
Epoch 34/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3997 - acc: 0.8378
Epoch 35/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4008 - acc: 0.8309
Epoch 36/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4060 - acc: 0.8269
Epoch 37/60
```

```
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3782 - acc: 0.8358
Epoch 38/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3942 - acc: 0.8368
Epoch 39/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3598 - acc: 0.8299
Epoch 40/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3630 - acc: 0.8417
Epoch 41/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3845 - acc: 0.8338
Epoch 42/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4086 - acc: 0.8368
Epoch 43/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3641 - acc: 0.8427
Epoch 44/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.3773 - acc: 0.8397
Epoch 00044: early stopping
WARNING:tensorflow:Large dropout rate: 0.6 (>0.5). In TensorFlow 2.x, dropout() uses
Model: "model_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_3 (InputLayer)         (None, 256, 256, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 256, 256, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 256, 256, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 128, 128, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 128, 128, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 64, 64, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 64, 64, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 32, 32, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 32, 32, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 16, 16, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
```

```
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
_________________________________________________________________
global_average_pooling2d_3 ( (None, 512)               0
_________________________________________________________________
dropout_3 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_3 (Dense)              (None, 1)                 513
=================================================================
Total params: 14,715,201
Trainable params: 513
Non-trainable params: 14,714,688
_________________________________________________________________
Train on 1017 samples, validate on 113 samples
Epoch 1/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.5988 - acc: 0.6834
Epoch 2/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.0238 - acc: 0.7168
Epoch 3/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.9579 - acc: 0.6971
Epoch 4/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.8585 - acc: 0.7119
Epoch 5/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.4246 - acc: 0.7414
Epoch 6/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.2365 - acc: 0.7434
Epoch 7/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.1022 - acc: 0.7443
Epoch 8/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.9253 - acc: 0.7571
Epoch 9/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8803 - acc: 0.7502
Epoch 10/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8504 - acc: 0.7581
Epoch 11/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7045 - acc: 0.7876
Epoch 12/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6084 - acc: 0.7876
Epoch 13/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7223 - acc: 0.7463
Epoch 14/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6316 - acc: 0.7788
Epoch 15/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5344 - acc: 0.8004
Epoch 16/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4924 - acc: 0.8092
Epoch 17/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5145 - acc: 0.7984
Epoch 18/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4930 - acc: 0.7935
Epoch 19/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4908 - acc: 0.7955
Epoch 20/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4618 - acc: 0.7994
Epoch 21/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4440 - acc: 0.8250
Epoch 22/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4537 - acc: 0.8083
Epoch 23/60
```

```
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4291 - acc: 0.8250
Epoch 24/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4460 - acc: 0.8053
Epoch 25/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4544 - acc: 0.8024
Epoch 26/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4172 - acc: 0.8181
Epoch 27/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4296 - acc: 0.8191
Epoch 00027: early stopping
```

```
model_acl_sagittal = buildModel()
history_acl_sagittal = model_acl_sagittal.fit(sagittalData,aclLabels,epochs=60,validation_

model_acl_axial = buildModel()
history_acl_axial = model_acl_axial.fit(axialData,aclLabels,epochs=60,validation_split=0.1

model_acl_coronal = buildModel()
history_acl_coronal = model_acl_coronal.fit(coronalData,aclLabels,epochs=60,validation_spl
```

```
WARNING:tensorflow:Large dropout rate: 0.6 (>0.5). In TensorFlow 2.x, dropout() uses
Model: "model_4"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_4 (InputLayer)         (None, 256, 256, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 256, 256, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 256, 256, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 128, 128, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 128, 128, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 64, 64, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 64, 64, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 32, 32, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 32, 32, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 16, 16, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
_________________________________________________________________
global_average_pooling2d_4 ( (None, 512)               0
_________________________________________________________________
dropout_4 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_4 (Dense)              (None, 1)                 513
=================================================================
Total params: 14,715,201
Trainable params: 513
Non-trainable params: 14,714,688
_________________________________________________________________
Train on 1017 samples, validate on 113 samples
Epoch 1/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.5665 - acc: 0.7129
Epoch 2/60
```

```
1017/1017 [==============================] - 9s 9ms/step - loss: 2.2409 - acc: 0.7345
Epoch 3/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.1275 - acc: 0.7404
Epoch 4/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.8957 - acc: 0.7266
Epoch 5/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.6096 - acc: 0.7247
Epoch 6/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.3978 - acc: 0.7247
Epoch 7/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.1037 - acc: 0.7640
Epoch 8/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0836 - acc: 0.7384
Epoch 9/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0187 - acc: 0.7473
Epoch 10/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.9316 - acc: 0.7453
Epoch 11/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8136 - acc: 0.7542
Epoch 12/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7164 - acc: 0.7650
Epoch 13/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7262 - acc: 0.7709
Epoch 14/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6557 - acc: 0.7925
Epoch 15/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5432 - acc: 0.8043
Epoch 16/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5846 - acc: 0.7965
Epoch 17/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5741 - acc: 0.7788
Epoch 18/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5342 - acc: 0.7876
Epoch 19/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5466 - acc: 0.7837
Epoch 20/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4945 - acc: 0.8004
Epoch 21/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4726 - acc: 0.8142
Epoch 22/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4709 - acc: 0.8063
Epoch 23/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4717 - acc: 0.8033
Epoch 24/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4745 - acc: 0.8063
Epoch 25/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4858 - acc: 0.7925
Epoch 26/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4330 - acc: 0.8269
Epoch 27/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4420 - acc: 0.8122
Epoch 28/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4531 - acc: 0.8083
Epoch 29/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4434 - acc: 0.8299
Epoch 30/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4332 - acc: 0.8181
Epoch 31/60
```

```
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4223 - acc: 0.8279
Epoch 32/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4472 - acc: 0.8073
Epoch 33/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4247 - acc: 0.8171
Epoch 34/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4434 - acc: 0.8151
Epoch 00034: early stopping
WARNING:tensorflow:Large dropout rate: 0.6 (>0.5). In TensorFlow 2.x, dropout() uses
Model: "model_5"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_5 (InputLayer)         (None, 256, 256, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 256, 256, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 256, 256, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 128, 128, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 128, 128, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 64, 64, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 64, 64, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 32, 32, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 32, 32, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 16, 16, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
_________________________________________________________________
global_average_pooling2d_5 ( (None, 512)               0
_________________________________________________________________
dropout_5 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 513
=================================================================
Total params: 14,715,201
```

```
Total params: 14,715,201
Trainable params: 513
Non-trainable params: 14,714,688
_________________________________________________________________
Train on 1017 samples, validate on 113 samples
Epoch 1/60
1017/1017 [==============================] - 9s 9ms/step - loss: 3.6328 - acc: 0.6431
Epoch 2/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.6661 - acc: 0.7788
Epoch 3/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.6799 - acc: 0.7729
Epoch 4/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.4891 - acc: 0.7581
Epoch 5/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.3777 - acc: 0.7522
Epoch 6/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.4163 - acc: 0.7601
Epoch 7/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.2253 - acc: 0.7502
Epoch 8/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.9864 - acc: 0.7345
Epoch 9/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.6718 - acc: 0.7453
Epoch 10/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.5611 - acc: 0.7453
Epoch 11/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.4000 - acc: 0.7443
Epoch 12/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.1869 - acc: 0.7355
Epoch 13/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0968 - acc: 0.7512
Epoch 14/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8779 - acc: 0.7719
Epoch 15/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.9211 - acc: 0.7355
Epoch 16/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8584 - acc: 0.7650
Epoch 17/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7018 - acc: 0.7788
Epoch 18/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7174 - acc: 0.7709
Epoch 19/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6628 - acc: 0.7640
Epoch 20/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6106 - acc: 0.7866
Epoch 21/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5286 - acc: 0.7984
Epoch 22/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5240 - acc: 0.7935
Epoch 23/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5662 - acc: 0.7758
Epoch 24/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4860 - acc: 0.7925
Epoch 25/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4808 - acc: 0.8191
Epoch 26/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4978 - acc: 0.8014
Epoch 27/60
```

```
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4598 - acc: 0.8043
Epoch 28/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4628 - acc: 0.8102
Epoch 29/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4819 - acc: 0.7915
Epoch 30/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4741 - acc: 0.8033
Epoch 31/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4423 - acc: 0.8210
Epoch 32/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4736 - acc: 0.8102
Epoch 33/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4753 - acc: 0.7935
Epoch 00033: early stopping
Model: "model_6"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_6 (InputLayer)         (None, 256, 256, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 256, 256, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 256, 256, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 128, 128, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 128, 128, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 64, 64, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 64, 64, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 32, 32, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 32, 32, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 16, 16, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
_________________________________________________________________
global_average_pooling2d_6 ( (None, 512)               0
```

```
_________________________________________________________________
dropout_6 (Dropout)          (None, 512)               0         
_________________________________________________________________
dense_6 (Dense)              (None, 1)                 513       
=================================================================
Total params: 14,715,201
Trainable params: 513
Non-trainable params: 14,714,688
_________________________________________________________________
Train on 1017 samples, validate on 113 samples
Epoch 1/60
1017/1017 [==============================] - 10s 9ms/step - loss: 2.5415 - acc: 0.670
Epoch 2/60
1017/1017 [==============================] - 9s 9ms/step - loss: 2.1024 - acc: 0.7345
Epoch 3/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.9397 - acc: 0.7257
Epoch 4/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.7571 - acc: 0.6991
Epoch 5/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.6469 - acc: 0.7325
Epoch 6/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.3301 - acc: 0.7119
Epoch 7/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.2353 - acc: 0.7355
Epoch 8/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.1618 - acc: 0.7168
Epoch 9/60
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0598 - acc: 0.7257
Epoch 10/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.9405 - acc: 0.7276
Epoch 11/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8500 - acc: 0.7394
Epoch 12/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7726 - acc: 0.7493
Epoch 13/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7250 - acc: 0.7502
Epoch 14/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5868 - acc: 0.7660
Epoch 15/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5662 - acc: 0.7827
Epoch 16/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5778 - acc: 0.7768
Epoch 17/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5969 - acc: 0.7512
Epoch 18/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5336 - acc: 0.7797
Epoch 19/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5240 - acc: 0.7925
Epoch 20/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5091 - acc: 0.7906
Epoch 21/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5165 - acc: 0.7856
Epoch 22/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4727 - acc: 0.7994
Epoch 23/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4691 - acc: 0.8024
Epoch 24/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4628 - acc: 0.8063
Epoch 25/60
```

```
Epoch 25/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4793 - acc: 0.7974
Epoch 26/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4543 - acc: 0.8033
Epoch 27/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4465 - acc: 0.8083
Epoch 28/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4561 - acc: 0.8142
Epoch 29/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4646 - acc: 0.8142
Epoch 30/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4679 - acc: 0.7915
Epoch 31/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4833 - acc: 0.7847
Epoch 32/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4381 - acc: 0.8112
Epoch 33/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4614 - acc: 0.8122
Epoch 34/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4405 - acc: 0.8112
Epoch 35/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4528 - acc: 0.8112
Epoch 36/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4730 - acc: 0.8063
Epoch 37/60
1017/1017 [==============================] - 9s 9ms/step - loss: 0.4148 - acc: 0.8328
Epoch 00037: early stopping
```

```
model_meniscus_sagittal = buildModel()
history_meniscus_sagittal = model_meniscus_sagittal.fit(sagittalData,meniscusLabels,epochs

model_meniscus_axial = buildModel()
history_meniscus_axial = model_meniscus_axial.fit(axialData,meniscusLabels,epochs=30,valic

model_meniscus_coronal = buildModel()
history_meniscus_coronal = model_meniscus_coronal.fit(coronalData,meniscusLabels,epochs=3(
```

```
Model: "model_7"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_7 (InputLayer)         (None, 256, 256, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 256, 256, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 256, 256, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 128, 128, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 128, 128, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 64, 64, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 64, 64, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 32, 32, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 32, 32, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 16, 16, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
_________________________________________________________________
global_average_pooling2d_7 ( (None, 512)               0
_________________________________________________________________
dropout_7 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_7 (Dense)              (None, 1)                 513
=================================================================
Total params: 14,715,201
Trainable params: 513
Non-trainable params: 14,714,688
_________________________________________________________________
Train on 1017 samples, validate on 113 samples
Epoch 1/30
1017/1017 [==============================] - 9s 9ms/step - loss: 3.2587 - acc: 0.5713
Epoch 2/30
1017/1017 [==============================] - 9s 9ms/step - loss: 2.7380 - acc: 0.5723
```

```
Epoch 3/30
1017/1017 [==============================] - 9s 9ms/step - loss: 2.3681 - acc: 0.5742
Epoch 4/30
1017/1017 [==============================] - 9s 8ms/step - loss: 1.9448 - acc: 0.5851
Epoch 5/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.8249 - acc: 0.5949
Epoch 6/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.5809 - acc: 0.6273
Epoch 7/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.3851 - acc: 0.6165
Epoch 8/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.2899 - acc: 0.5998
Epoch 9/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.1432 - acc: 0.6342
Epoch 10/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0181 - acc: 0.6476
Epoch 11/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.9743 - acc: 0.6165
Epoch 12/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.9538 - acc: 0.6372
Epoch 13/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8326 - acc: 0.6509
Epoch 14/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7986 - acc: 0.6529
Epoch 15/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7204 - acc: 0.6716
Epoch 16/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7525 - acc: 0.6735
Epoch 17/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6805 - acc: 0.6814
Epoch 18/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6559 - acc: 0.6794
Epoch 19/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6577 - acc: 0.6834
Epoch 20/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6555 - acc: 0.6824
Epoch 21/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6332 - acc: 0.6942
Epoch 22/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6348 - acc: 0.6755
Epoch 00022: early stopping
Model: "model_8"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_8 (InputLayer)         (None, 256, 256, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 256, 256, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 256, 256, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 128, 128, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 128, 128, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 64, 64, 128)       0
```

```
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 64, 64, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 32, 32, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 32, 32, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 16, 16, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
_________________________________________________________________
global_average_pooling2d_8 ( (None, 512)               0
_________________________________________________________________
dropout_8 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_8 (Dense)              (None, 1)                 513
=================================================================
Total params: 14,715,201
Trainable params: 513
Non-trainable params: 14,714,688
_________________________________________________________________
Train on 1017 samples, validate on 113 samples
Epoch 1/30
1017/1017 [==============================] - 10s 10ms/step - loss: 4.5423 - acc: 0.54
Epoch 2/30
1017/1017 [==============================] - 9s 9ms/step - loss: 3.8048 - acc: 0.5703
Epoch 3/30
1017/1017 [==============================] - 9s 9ms/step - loss: 3.0366 - acc: 0.5703
Epoch 4/30
1017/1017 [==============================] - 9s 9ms/step - loss: 2.6312 - acc: 0.5949
Epoch 5/30
1017/1017 [==============================] - 9s 9ms/step - loss: 2.5107 - acc: 0.5742
Epoch 6/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.9269 - acc: 0.6185
Epoch 7/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.6910 - acc: 0.6293
Epoch 8/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.5053 - acc: 0.6244
Epoch 9/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.3301 - acc: 0.6456
Epoch 10/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.2009 - acc: 0.6509
Epoch 11/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0536 - acc: 0.6506
```

```
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0550 - acc: 0.6506
Epoch 12/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.9415 - acc: 0.6588
Epoch 13/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8974 - acc: 0.6686
Epoch 14/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8536 - acc: 0.6696
Epoch 15/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7811 - acc: 0.6716
Epoch 16/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7774 - acc: 0.6794
Epoch 17/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7442 - acc: 0.6657
Epoch 18/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7143 - acc: 0.6804
Epoch 19/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6601 - acc: 0.6814
Epoch 20/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6659 - acc: 0.6991
Epoch 21/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6914 - acc: 0.6794
Epoch 22/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6163 - acc: 0.6873
Epoch 23/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6658 - acc: 0.6942
Epoch 24/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6127 - acc: 0.6893
Epoch 25/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6014 - acc: 0.7070
Epoch 26/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6176 - acc: 0.6942
Epoch 27/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6056 - acc: 0.6962
Epoch 00027: early stopping
Model: "model_9"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_9 (InputLayer)         (None, 256, 256, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 256, 256, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 256, 256, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 128, 128, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 128, 128, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 128, 128, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 64, 64, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 64, 64, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 64, 64, 256)       590080
_________________________________________________________________
```

```
block3_pool (MaxPooling2D)   (None, 32, 32, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 32, 32, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 32, 32, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 16, 16, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 16, 16, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 8, 8, 512)         0
_________________________________________________________________
global_average_pooling2d_9 ( (None, 512)               0
_________________________________________________________________
dropout_9 (Dropout)          (None, 512)               0
_________________________________________________________________
dense_9 (Dense)              (None, 1)                 513
=================================================================
Total params: 14,715,201
Trainable params: 513
Non-trainable params: 14,714,688
_________________________________________________________________
Train on 1017 samples, validate on 113 samples
Epoch 1/30
1017/1017 [==============================] - 10s 10ms/step - loss: 2.9556 - acc: 0.57
Epoch 2/30
1017/1017 [==============================] - 9s 9ms/step - loss: 2.6406 - acc: 0.5379
Epoch 3/30
1017/1017 [==============================] - 9s 9ms/step - loss: 2.2510 - acc: 0.5713
Epoch 4/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.7053 - acc: 0.5988
Epoch 5/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.7126 - acc: 0.5978
Epoch 6/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.4658 - acc: 0.5900
Epoch 7/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.2280 - acc: 0.6234
Epoch 8/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0151 - acc: 0.6490
Epoch 9/30
1017/1017 [==============================] - 9s 9ms/step - loss: 1.0305 - acc: 0.6254
Epoch 10/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.9652 - acc: 0.6195
Epoch 11/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8340 - acc: 0.6431
Epoch 12/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.8024 - acc: 0.6539
Epoch 13/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7474 - acc: 0.6637
Epoch 14/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.7383 - acc: 0.6549
Epoch 15/30
```

```
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6740 - acc: 0.6824
Epoch 16/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6824 - acc: 0.6676
Epoch 17/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6558 - acc: 0.6863
Epoch 18/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6308 - acc: 0.6785
Epoch 19/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6301 - acc: 0.6794
Epoch 20/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6631 - acc: 0.6735
Epoch 21/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6220 - acc: 0.6853
Epoch 22/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6221 - acc: 0.6932
Epoch 23/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6180 - acc: 0.6726
Epoch 24/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5852 - acc: 0.7089
Epoch 25/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5922 - acc: 0.6962
Epoch 26/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.6202 - acc: 0.6834
Epoch 27/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5790 - acc: 0.7036
Epoch 28/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5822 - acc: 0.6893
Epoch 29/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5681 - acc: 0.7021
Epoch 30/30
1017/1017 [==============================] - 9s 9ms/step - loss: 0.5907 - acc: 0.6991
```

```
from sklearn.metrics import accuracy_score
from sklearn.metrics import f1_score


def getEvaluationScore(labels,predictions):

  my_score = accuracy_score(labels, predictions)
  print("my score: ",my_score)


  fscore = f1_score(labels, predictions)

  print("fscore: ",fscore)

  return my_score



def predictLabels(data,model,threshold):
  labels = model.predict(data)
  for i in labels:
    print(i)
```

```
    labels = list(map(lambda x: 0 if x<threshold else 1, labels))
    print(labels)
    return labels


predictions_abnormal_sagittal = predictLabels(sagittalTestData,model_abnormal_sagittal, 0.
print("-----------------------------------------------------------------------------------")
predictions_abnormal_axial = predictLabels(axialTestData,model_abnormal_axial, 0.75)
print("-----------------------------------------------------------------------------------")
predictions_abnormal_coronal = predictLabels(coronalTestData,model_abnormal_coronal, 0.75)

print("###############################################")
predictions_acl_sagittal = predictLabels(sagittalTestData,model_acl_sagittal, 0.15)
print("-----------------------------------------------------------------------------------")
predictions_acl_axial = predictLabels(axialTestData,model_acl_axial, 0.15)
print("-----------------------------------------------------------------------------------")
predictions_acl_coronal = predictLabels(coronalTestData,model_acl_coronal, 0.15)

print("###############################################")
predictions_meniscus_sagittal = predictLabels(sagittalTestData,model_meniscus_sagittal, 0.
print("-----------------------------------------------------------------------------------")
predictions_meniscus_axial = predictLabels(axialTestData,model_meniscus_axial, 0.4)
print("-----------------------------------------------------------------------------------")
predictions_meniscus_coronal = predictLabels(coronalTestData,model_meniscus_coronal, 0.4)
```

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```
def ensemble(predictions1,predictions2,predictions3):
  list=[]
  for i in range(0,len(predictions1),1):
    total = sum([predictions1[i],predictions2[i],predictions3[i]])
    if total > 1:
      list.append(1)
    else:
      list.append(0)

  return list.copy()

labels_abnormal_ensemble = ensemble(predictions_abnormal_sagittal,predictions_abnormal_axi
print("labels_abnormal_ensemble: ",labels_abnormal_ensemble)
score_abnormal = getEvaluationScore(abnornmalTestLabels, labels_abnormal_ensemble)


labels_acl_ensemble = ensemble(predictions_acl_sagittal,predictions_acl_axial,predictions_
print("labels_acl_ensemble: ",labels_acl_ensemble)
score_acl = getEvaluationScore(aclTestLabels, labels_acl_ensemble)



labels_meniscus_ensemble = ensemble(predictions_meniscus_sagittal,predictions_meniscus_axi
print("labels_meniscus_ensemble: ",labels_meniscus_ensemble)
score_meniscus = getEvaluationScore(meniscusTestLabels, labels_meniscus_ensemble)
```

```
labels_abnormal_ensemble:  [0, 1, 0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1,
my score:  0.85
fscore:  0.911764705882353
labels_acl_ensemble:  [0, 1, 0, 0, 0, 0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 1, 1, 0, 1, 1,
my score:  0.725
fscore:  0.7441860465116279
labels_meniscus_ensemble:  [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
my score:  0.65
fscore:  0.5434782608695652
```

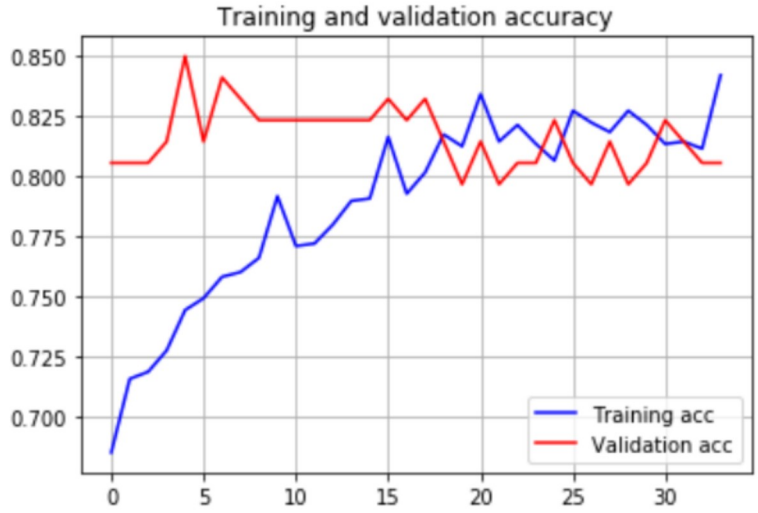
```
def EvaluationScore(labels,predictions):

  score = accuracy_score(labels, predictions)
  return score

score1ab = EvaluationScore(abnornmalTestLabels, predictions_abnormal_sagittal)
score2ab = EvaluationScore(abnornmalTestLabels, predictions_abnormal_axial)
```

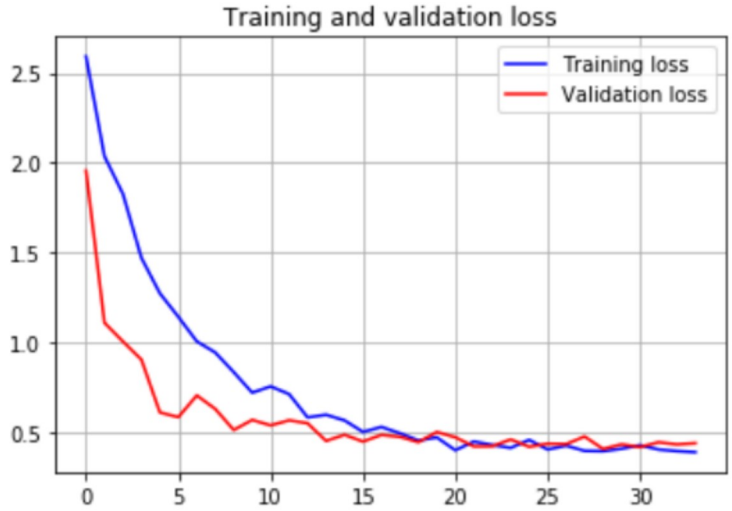
```
score3ab = EvaluationScore(abnornmalTestLabels, predictions_abnormal_coronal)

score1acl = EvaluationScore(abnornmalTestLabels, predictions_acl_sagittal)
score2acl = EvaluationScore(abnornmalTestLabels, predictions_acl_axial)
score3acl = EvaluationScore(abnornmalTestLabels, predictions_acl_coronal)

score1mini = EvaluationScore(abnornmalTestLabels, predictions_meniscus_sagittal)
score2mini = EvaluationScore(abnornmalTestLabels, predictions_meniscus_axial)
score3mini = EvaluationScore(abnornmalTestLabels, predictions_meniscus_coronal)

ab=max(score1ab,score2ab,score3ab)
ac=max(score1acl,score2acl,score3acl)
meni=max(score1mini,score2mini,score3mini)

print("probability of injury type to be \n abnormal = ",ab,"\n acl = ",ac,"\n meniscus = '


'''def maximum(data,model,threshold):
  m=model.predict(data)
  ma=max(m)
  return ma
sagi1max = maximum(sagittalTestData,model_abnormal_sagittal, 0.75)
axi1max = maximum(axialTestData,model_abnormal_axial, 0.75)
coro1max = maximum(coronalTestData,model_abnormal_coronal, 0.75)

sagi2max = maximum(sagittalTestData,model_abnormal_sagittal, 0.15)
axi2max = maximum(axialTestData,model_abnormal_axial, 0.15)
coro2max = maximum(coronalTestData,model_abnormal_coronal, 0.15)

sagi3max = maximum(sagittalTestData,model_abnormal_sagittal, 0.4)
axi3max = maximum(axialTestData,model_abnormal_axial, 0.4)
coro3max = maximum(coronalTestData,model_abnormal_coronal, 0.4)

print(1max)

'''
```

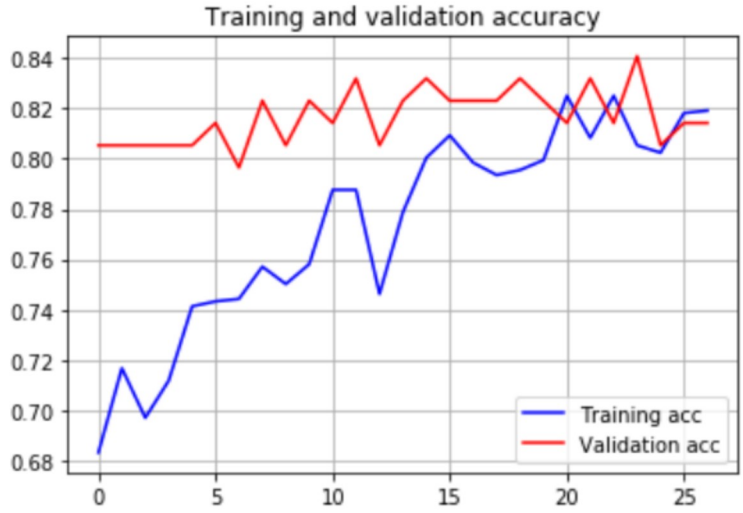
```
 probability of injury type to be
      abnormal =  0.8583333333333333
      acl =  0.7
      meniscus =  0.7666666666666667
     'def maximum(data,model,threshold):\n  m=model.predict(data) \n  ma=max(m)\n  return
```

```
def plot_accuracy(history):
  acc = history.history['acc']
  val_acc = history.history['val_acc']
  loss = history.history['loss']
  val_loss = history.history['val_loss']

  epochs = range(len(acc))
```

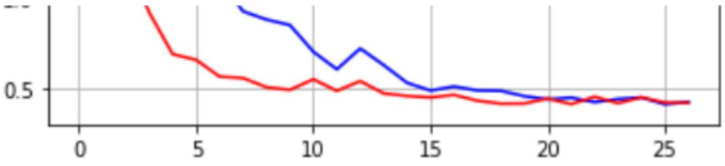
```
    plt.plot(epochs, acc, 'b', label='Training acc')
    plt.plot(epochs, val_acc, 'r', label='Validation acc')
    plt.title('Training and validation accuracy')
    plt.legend()
    plt.grid(True)

    plt.figure()

    plt.plot(epochs, loss, 'b', label='Training loss')
    plt.plot(epochs, val_loss, 'r', label='Validation loss')
    plt.title('Training and validation loss')
    plt.legend()
    plt.grid(True)
    plt.show()



plot_accuracy(history_abnormal_sagittal)
plot_accuracy(history_abnormal_coronal)
plot_accuracy(history_abnormal_axial)

plot_accuracy(history_acl_sagittal)
plot_accuracy(history_acl_coronal)
plot_accuracy(history_acl_axial)

plot_accuracy(history_meniscus_sagittal)
plot_accuracy(history_meniscus_coronal)
plot_accuracy(history_meniscus_axial)
```

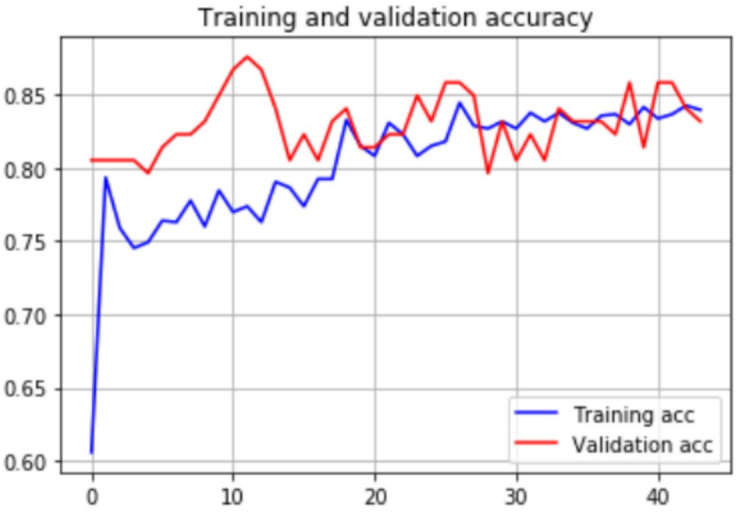

Training and validation accuracy
Training acc
Validation acc

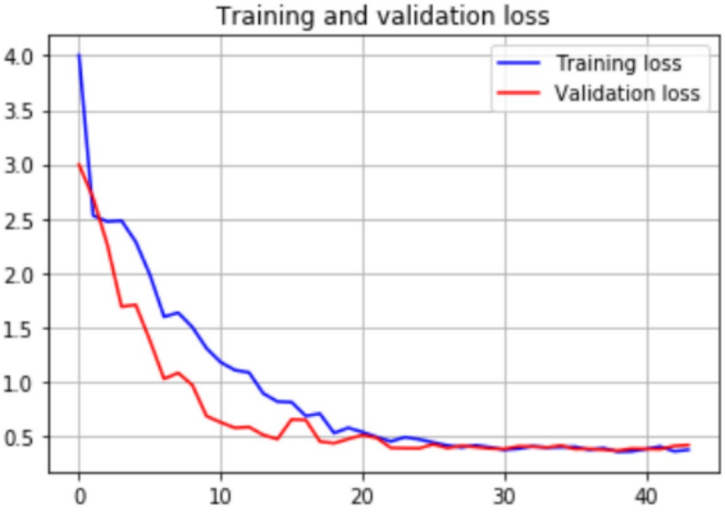

Training and validation loss
Training loss
Validation loss

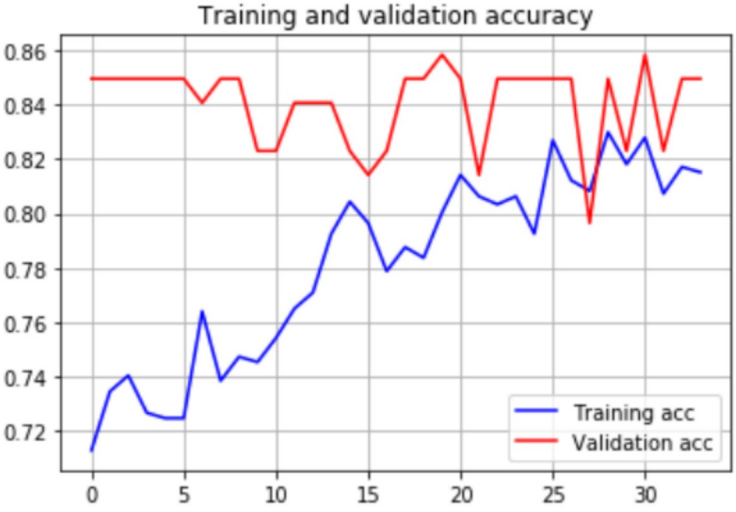

Training and validation accuracy
Training acc
Validation acc

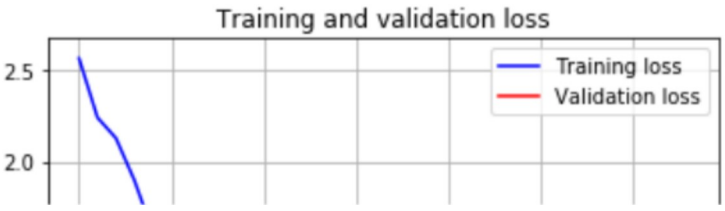

Training and validation loss
Training loss
Validation loss

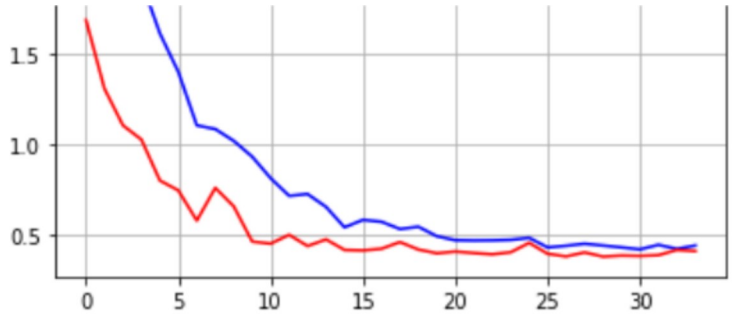

0.5
0
5
10
15
20
25


Training and validation accuracy
0.85
0.80
0.75
0.70
0.65
0.60
0
10
20
30
40
Training acc
Validation acc

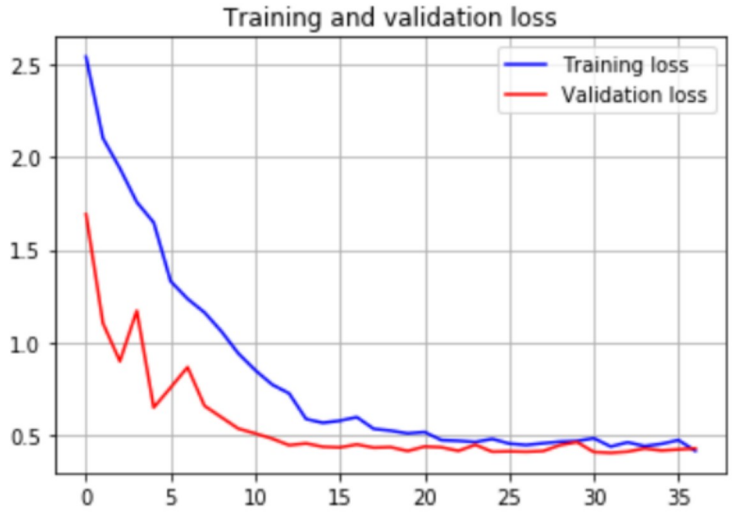

Training and validation loss
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
10
20
30
40
Training loss
Validation loss


Training and validation accuracy
0.86
0.84
0.82
0.80
0.78
0.76
0.74
0.72
0
5
10
15
20
25
30
Training acc
Validation acc

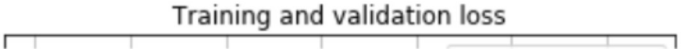

Training and validation loss
2.5
2.0
Training loss
Validation loss

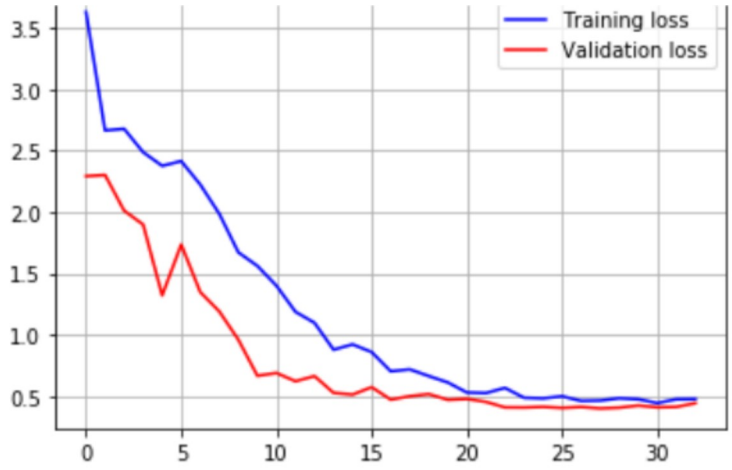

1.5
1.0
0.5
0
5
10
15
20
25
30

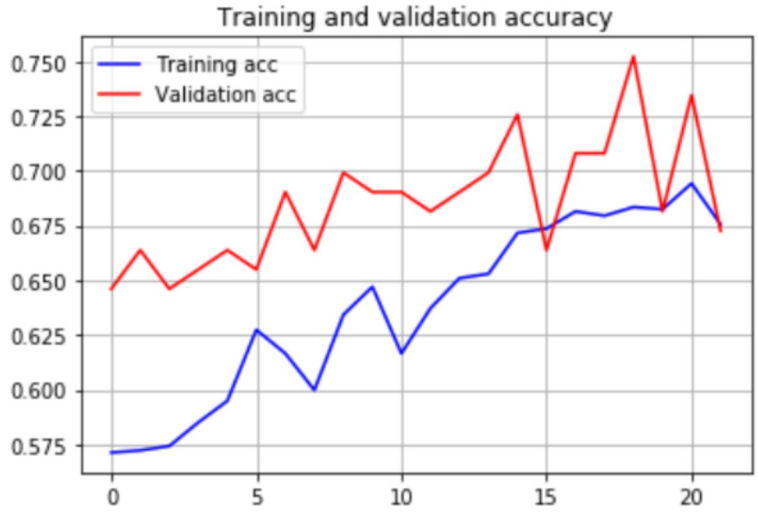

Training and validation accuracy
0.875
0.850
0.825
0.800
0.775
0.750
0.725
0.700
0.675
Training acc
Validation acc
0
5
10
15
20
25
30
35

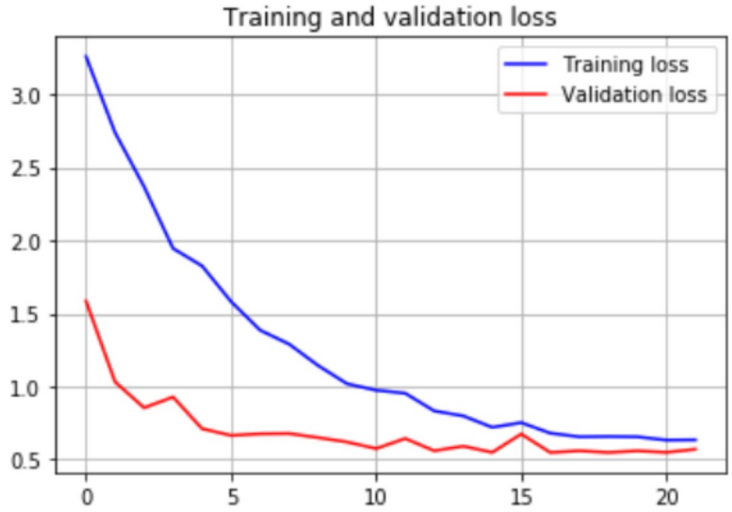

Training and validation loss
Training loss
Validation loss
2.5
2.0
1.5
1.0
0.5
0
5
10
15
20
25
30
35


Training and validation accuracy
0.85
0.80
0.75
0.70
0.65
Training acc
Validation acc
0
5
10
15
20
25
30

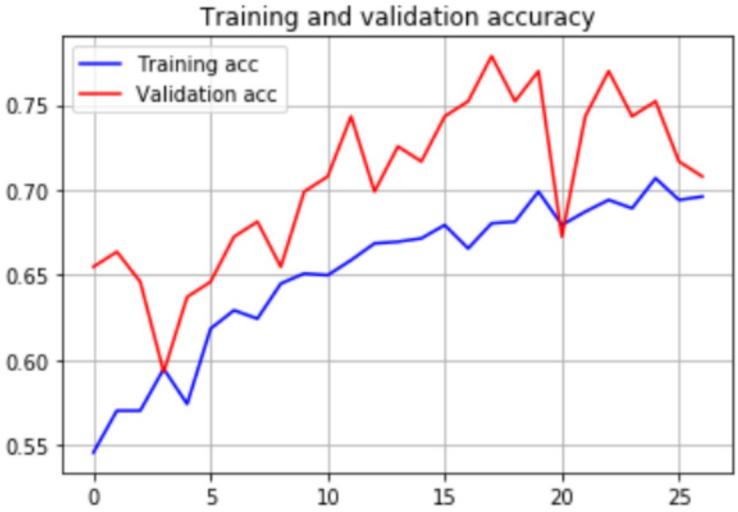

Training and validation loss

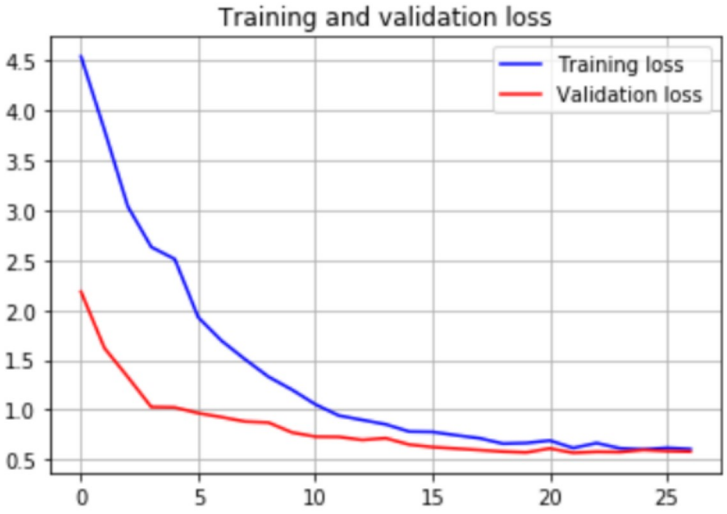

Training loss
Validation loss


Training and validation accuracy
Training acc
Validation acc


Training and validation loss
Training loss
Validation loss


Training and validation accuracy
Training acc

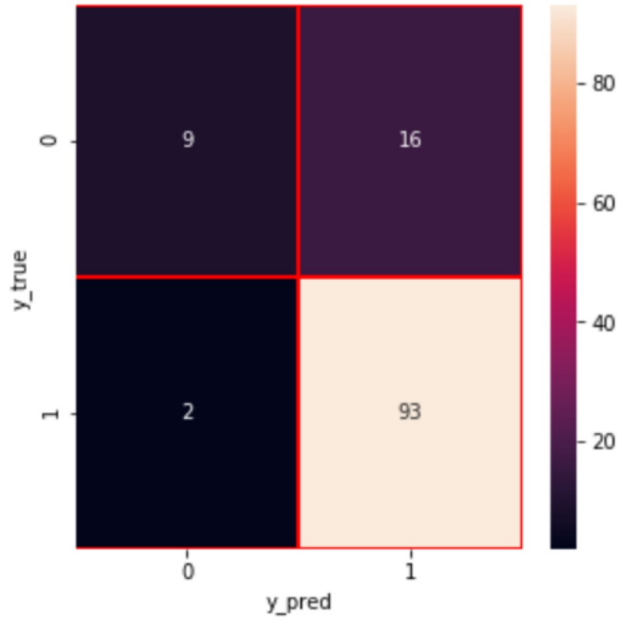


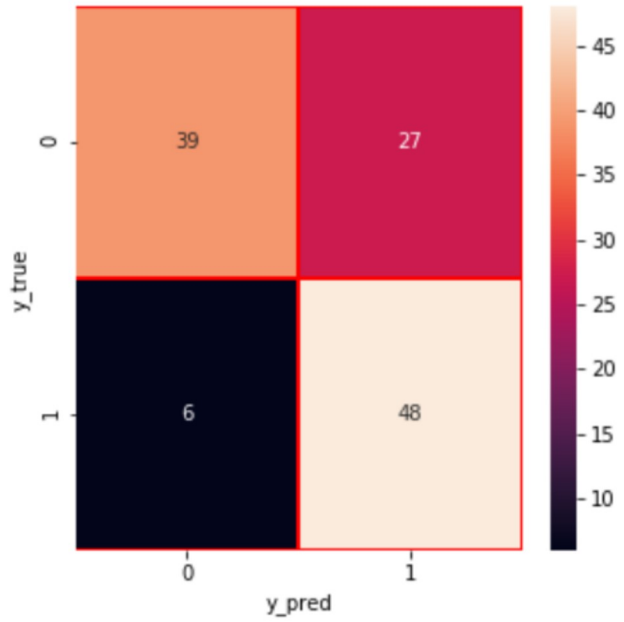


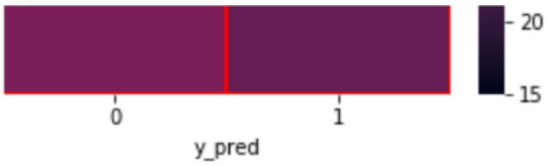

```
from sklearn.metrics import confusion_matrix
from sklearn.metrics import classification_report, roc_auc_score, precision_recall_curve,
import seaborn as sns
import matplotlib.pyplot as plt
```

```
y_pred= [labels_abnormal_ensemble,labels_acl_ensemble,labels_meniscus_ensemble]
y_true=[abnornmalTestLabels,aclTestLabels,meniscusTestLabels]
cm1=confusion_matrix(y_true[0],y_pred[0])
cm2=confusion_matrix(y_true[1],y_pred[1])
cm3=confusion_matrix(y_true[2],y_pred[2])
print(cm1)
print(cm2)
print(cm3)
f, ax=plt.subplots(figsize=(5,5))
sns.heatmap(cm1,annot=True,linewidths=0.5,linecolor="red",fmt=".0f",ax=ax)
plt.xlabel("y_pred")
plt.ylabel("y_true")
plt.show()
f, ax=plt.subplots(figsize=(5,5))
sns.heatmap(cm2,annot=True,linewidths=0.5,linecolor="red",fmt=".0f",ax=ax)
plt.xlabel("y_pred")
plt.ylabel("y_true")
plt.show()
f, ax=plt.subplots(figsize=(5,5))
sns.heatmap(cm3,annot=True,linewidths=0.5,linecolor="red",fmt=".0f",ax=ax)
plt.xlabel("y_pred")
plt.ylabel("y_true")
plt.show()
```

```
[[ 9 16]
 [ 2 93]]
[[39 27]
 [ 6 48]]
[[53 15]
 [27 25]]
```

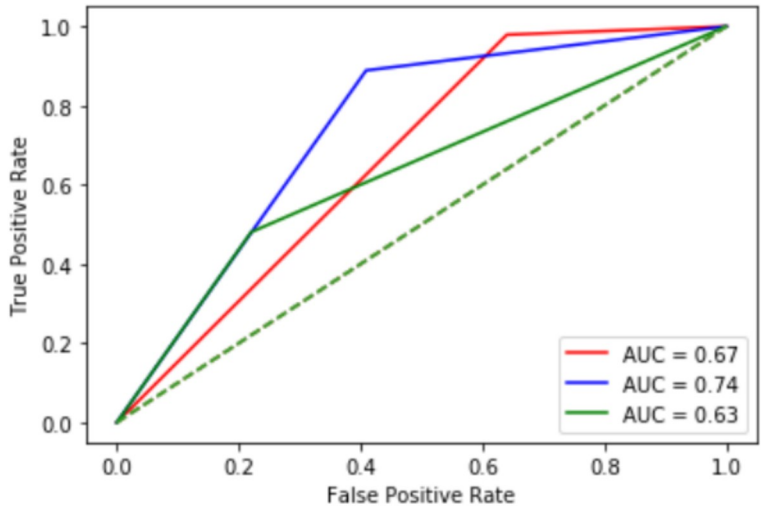







```
auc_roc1=classification_report(y_true[0],y_pred[0])
auc_roc2=classification_report(y_true[1],y_pred[1])
auc_roc3=classification_report(y_true[2],y_pred[2])
print(auc_roc1,auc_roc2,auc_roc3,sep='')
false_positive_rate, true_positive_rate, thresholds = roc_curve(y_true[0], y_pred[0])
roc_auc1 = auc(false_positive_rate, true_positive_rate)
print("roc_auc1 =",roc_auc1)
plt.plot(false_positive_rate,true_positive_rate, color='red',label = 'AUC = %0.2f' % roc_a
plt.legend(loc = 'lower right')
plt.plot([0, 1], [0, 1],linestyle='--')

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_true[1], y_pred[1])
roc_auc2 = auc(false_positive_rate, true_positive_rate)
print("roc_auc2 =",roc_auc2)
plt.plot(false_positive_rate,true_positive_rate, color='blue',label = 'AUC = %0.2f' % roc_
plt.legend(loc = 'lower right')
plt.plot([0, 1], [0, 1],linestyle='--')

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_true[2], y_pred[2])
roc_auc3 = auc(false_positive_rate, true_positive_rate)
print("roc_auc1 =",roc_auc1)
plt.plot(false_positive_rate,true_positive_rate, color='green',label = 'AUC = %0.2f' % roc
plt.legend(loc = 'lower right')
plt.plot([0, 1], [0, 1],linestyle='--')
plt.axis('tight')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
```

```
                  precision    recall  f1-score   support

               0       0.82      0.36      0.50        25
               1       0.85      0.98      0.91        95

        accuracy                           0.85       120
       macro avg       0.84      0.67      0.71       120
    weighted avg       0.85      0.85      0.83       120
                  precision    recall  f1-score   support

               0       0.87      0.59      0.70        66
               1       0.64      0.89      0.74        54

        accuracy                           0.73       120
       macro avg       0.75      0.74      0.72       120
    weighted avg       0.76      0.72      0.72       120
                  precision    recall  f1-score   support

               0       0.66      0.78      0.72        68
               1       0.62      0.48      0.54        52

        accuracy                           0.65       120
       macro avg       0.64      0.63      0.63       120
    weighted avg       0.65      0.65      0.64       120

    roc_auc1 = 0.6694736842105262
    roc_auc2 = 0.7398989898989898
    roc_auc1 = 0.6694736842105262
    Text(0.5, 0, 'False Positive Rate')
```




```
fpr, tpr, thresholds_roc = roc_curve(y_true[0], y_pred[0])
roc_auc1 = auc(fpr,tpr)
print(roc_auc1)
plt.plot(fpr,tpr, lw = 3, alpha = 0.7)


fpr, tpr, thresholds_roc = roc_curve(y_true[1], y_pred[1])
roc_auc2 = auc(fpr,tpr)
print(roc_auc2)
```

```
plt.plot(fpr,tpr, lw = 3, alpha = 0.7)

fpr, tpr, thresholds_roc = roc_curve(y_true[2], y_pred[2])
roc_auc3 = auc(fpr,tpr)
print(roc_auc3)
plt.plot(fpr,tpr, lw = 3, alpha = 0.7)
plt.plot([0,1], [0,1], 'w', linestyle = "--", lw = 2)
plt.xlabel("False Positive Rate", fontsize = 14)
plt.ylabel("True Positive Rate", fontsize = 14)
plt.title("ROC Curve", fontsize = 18)
plt.legend(loc = 'best')
```

```
No handles with labels found to put in legend.
0.6694736842105262
0.7398989898989898
0.6300904977375567
<matplotlib.legend.Legend at 0x7fc5aafc8710>
```