

In [11]:

```
!pip install keras
```

Requirement already satisfied: keras in c:\users\shadm\anaconda3\lib\site-packages (2.8.0)

In [12]:

```
!pip install tensorflow
```

```
Requirement already satisfied: tensorflow in c:\users\shadm\anaconda3\lib\site-packages (2.8.0)
Requirement already satisfied: absl-py>=0.4.0 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (1.0.0)
Requirement already satisfied: tensorboard<2.9,>=2.8 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (2.8.0)
Requirement already satisfied: wrapt>=1.11.0 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (1.12.1)
Requirement already satisfied: termcolor>=1.1.0 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (1.1.0)
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Requirement already satisfied: keras<2.9,>=2.8.0rc0 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (2.8.0)
Requirement already satisfied: h5py>=2.9.0 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (3.6.0)
Requirement already satisfied: keras-preprocessing>=1.1.1 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (1.1.2)
Requirement already satisfied: numpy>=1.20 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (1.21.5)
Requirement already satisfied: astunparse>=1.6.0 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (1.6.3)
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Requirement already satisfied: protobuf>=3.9.2 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (3.19.1)
Requirement already satisfied: libclang>=9.0.1 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (14.0.1)
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Requirement already satisfied: tf-estimator-nightly==2.8.0.dev2021122109 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (2.8.0.dev2021122109)
Requirement already satisfied: six>=1.12.0 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (1.16.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (0.25.0)
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Requirement already satisfied: gast>=0.2.1 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (0.5.3)
Requirement already satisfied: typing-extensions>=3.6.6 in c:\users\shadm\anaconda3\lib\site-packages (from tensorflow) (4.1.1)
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Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in c:\u
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sers\shadm\anaconda3\lib\site-packages (from tensorboard<2.9,>=2.8->tensorflow) (0.6.1)
Requirement already satisfied: google-auth<3,>=1.6.3 in c:\users\shadm\anaco
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Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in c:\users\sha
dm\anaconda3\lib\site-packages (from tensorboard<2.9,>=2.8->tensorflow) (1.
8.1)
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ensorflow) (0.2.8)
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onda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.9,>=2.8->
tensorflow) (4.2.2)
Requirement already satisfied: rsa<5,>=3.1.4 in c:\users\shadm\anaconda3\lib
\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.9,>=2.8->tensorflo
w) (4.7.2)
Requirement already satisfied: requests-oauthlib>=0.7.0 in c:\users\shadm\an
aconda3\lib\site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboar
d<2.9,>=2.8->tensorflow) (1.3.1)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in c:\users\shadm\anac
onda3\lib\site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6.3->te
nsorboard<2.9,>=2.8->tensorflow) (0.4.8)
Requirement already satisfied: idna<4,>=2.5 in c:\users\shadm\anaconda3\lib
\site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->tensorflow)
(3.3)
Requirement already satisfied: charset-normalizer~=2.0.0 in c:\users\shadm\an
aconda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8-
>tensorflow) (2.0.4)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\shadm\anaco
nda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->ten
sorflow) (1.26.9)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\shadm\anaconda
3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->tensor
flow) (2021.10.8)
Requirement already satisfied: oauthlib>=3.0.0 in c:\users\shadm\anaconda3\l
ib\site-packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<0.5,>=
0.4.1->tensorboard<2.9,>=2.8->tensorflow) (3.2.0)

```

In [56]:

```
import os

%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import os
from glob import glob
import seaborn as sns
from PIL import Image
np.random.seed(11)
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split, KFold, cross_val_score, GridSearchCV
from sklearn.metrics import accuracy_score
import itertools

import keras
from keras.utils.np_utils import to_categorical
from keras.models import Sequential, Model
from keras.layers import Dense, Dropout, Flatten, Conv2D, MaxPool2D
from keras import backend as K
from tensorflow.keras.layers import BatchNormalization
from keras.utils.np_utils import to_categorical
from tensorflow.keras.optimizers import Adam, RMSprop
from keras.preprocessing.image import ImageDataGenerator
from keras.callbacks import ReduceLROnPlateau
from keras.wrappers.scikit_learn import KerasClassifier
from tensorflow.keras.applications.resnet50 import ResNet50
from keras import backend as K
```

In [49]:

```

folder_benign_train = r'C:\Users\shadm\Desktop\Project\Biomedical_Image_Processing_using_De
folder_malignant_train = r'C:\Users\shadm\Desktop\Project\Biomedical_Image_Processing_using

folder_benign_test = r'C:\Users\shadm\Desktop\Project\Biomedical_Image_Processing_using_De
folder_malignant_test = r'C:\Users\shadm\Desktop\Project\Biomedical_Image_Processing_using_

read = lambda imname: np.asarray(Image.open(imname).convert("RGB"))

ims_benign = [read(os.path.join(folder_benign_train, filename)) for filename in os.listdir(
X_benign = np.array(ims_benign, dtype='uint8')
ims_malignant = [read(os.path.join(folder_malignant_train, filename)) for filename in os.li
X_malignant = np.array(ims_malignant, dtype='uint8')

ims_benign = [read(os.path.join(folder_benign_test, filename)) for filename in os.listdir(f
X_benign_test = np.array(ims_benign, dtype='uint8')
ims_malignant = [read(os.path.join(folder_malignant_test, filename)) for filename in os.lis
X_malignant_test = np.array(ims_malignant, dtype='uint8')

y_benign = np.zeros(X_benign.shape[0])
y_malignant = np.ones(X_malignant.shape[0])

y_benign_test = np.zeros(X_benign_test.shape[0])
y_malignant_test = np.ones(X_malignant_test.shape[0])

X_train = np.concatenate((X_benign, X_malignant), axis = 0)
y_train = np.concatenate((y_benign, y_malignant), axis = 0)

X_test = np.concatenate((X_benign_test, X_malignant_test), axis = 0)
y_test = np.concatenate((y_benign_test, y_malignant_test), axis = 0)

s = np.arange(X_train.shape[0])
np.random.shuffle(s)
X_train = X_train[s]
y_train = y_train[s]

s = np.arange(X_test.shape[0])
np.random.shuffle(s)
X_test = X_test[s]
y_test = y_test[s]

```

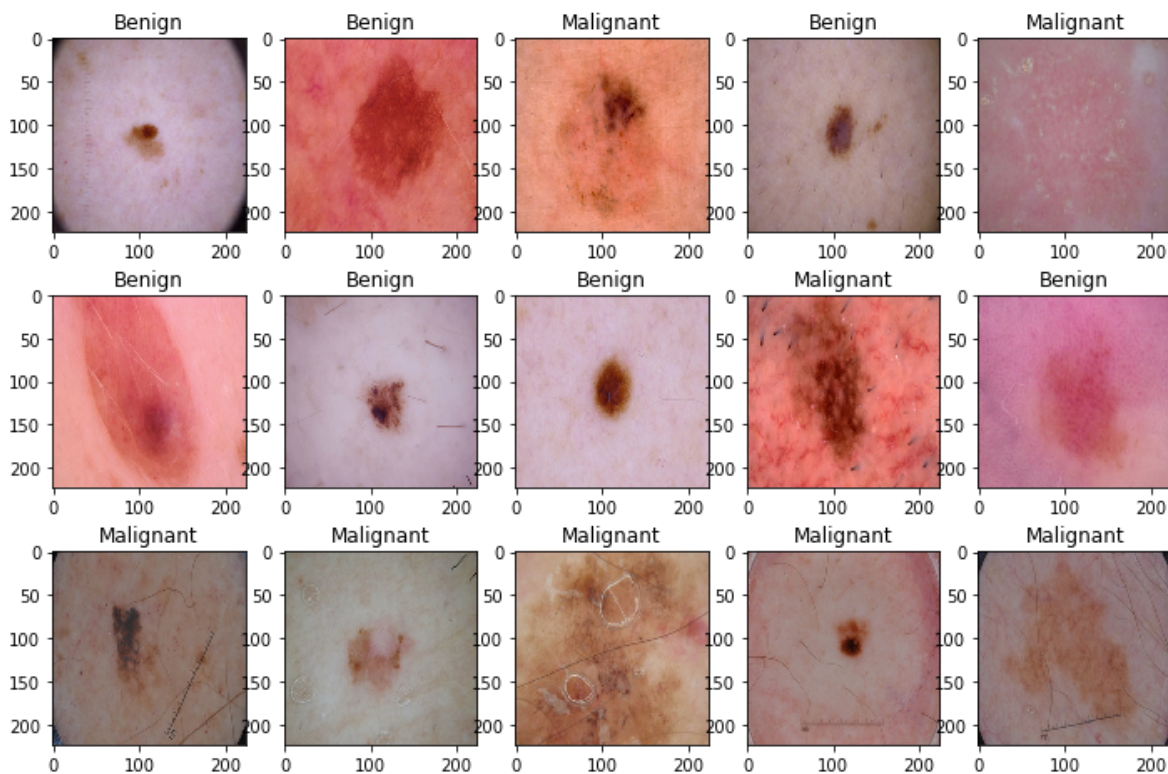
In [50]:

```

w=40
h=30
fig=plt.figure(figsize=(12, 8))
columns = 5
rows = 3

for i in range(1, columns*rows +1):
    ax = fig.add_subplot(rows, columns, i)
    if y_train[i] == 0:
        ax.title.set_text('Benign')
    else:
        ax.title.set_text('Malignant')
    plt.imshow(X_train[i], interpolation='nearest')
plt.show()

```



In [51]:

```
y_train = to_categorical(y_train, num_classes= 2)
y_test = to_categorical(y_test, num_classes= 2)
```

In [52]:

```
X_train = X_train/255.
X_test = X_test/255.
```

In [53]:

```
def build(input_shape= (224,224,3), lr = 1e-3, num_classes= 2,
          init= 'normal', activ= 'relu', optim= 'adam'):
    model = Sequential()
    model.add(Conv2D(64, kernel_size=(3, 3),padding = 'Same',input_shape=input_shape,
                    activation= activ, kernel_initializer='glorot_uniform'))
    model.add(MaxPool2D(pool_size = (2, 2)))
    model.add(Dropout(0.25))

    model.add(Conv2D(64, kernel_size=(3, 3),padding = 'Same',
                    activation =activ, kernel_initializer = 'glorot_uniform'))
    model.add(MaxPool2D(pool_size = (2, 2)))
    model.add(Dropout(0.25))

    model.add(Flatten())
    model.add(Dense(128, activation='relu', kernel_initializer=init))
    model.add(Dense(num_classes, activation='softmax'))
    model.summary()

    if optim == 'rmsprop':
        optimizer = RMSprop(lr=lr)

    else:
        optimizer = Adam(lr=lr)

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

learning_rate_reduction = ReduceLROnPlateau(monitor='val_accuracy',
                                             patience=5,
                                             verbose=1,
                                             factor=0.5,
                                             min_lr=1e-7)
```

In [54]:

```
input_shape = (224,224,3)
learning_rate = 1e-5
init = 'normal'
activ = 'relu'
optim = 'adam'
epochs = 15
batch_size = 64

model = build(lr=lr, init= init, activ= activ, optim=optim, input_shape= input_shape)
```

Model: "sequential_4"

Layer (type)	Output Shape	Param #
=====		
conv2d_8 (Conv2D)	(None, 224, 224, 64)	1792
max_pooling2d_8 (MaxPooling 2D)	(None, 112, 112, 64)	0
dropout_8 (Dropout)	(None, 112, 112, 64)	0
conv2d_9 (Conv2D)	(None, 112, 112, 64)	36928
max_pooling2d_9 (MaxPooling 2D)	(None, 56, 56, 64)	0
dropout_9 (Dropout)	(None, 56, 56, 64)	0
flatten_4 (Flatten)	(None, 200704)	0
dense_8 (Dense)	(None, 128)	25690240
dense_9 (Dense)	(None, 2)	258
=====		
Total params: 25,729,218		
Trainable params: 25,729,218		
Non-trainable params: 0		
=====		

In [55]:

```
history = model.fit(X_train, y_train, validation_split=0.2,
                    epochs= epochs, batch_size= batch_size, verbose=1,
                    callbacks=[learning_rate_reduction]
                    )
```

Epoch 1/15

33/33 [=====] - 134s 4s/step - loss: 1.2189 - accuracy: 0.5107 - val_loss: 0.6853 - val_accuracy: 0.5625 - lr: 1.0000e-05

Epoch 2/15

33/33 [=====] - 163s 5s/step - loss: 0.9583 - accuracy: 0.5557 - val_loss: 0.6646 - val_accuracy: 0.5417 - lr: 1.0000e-05

Epoch 3/15

33/33 [=====] - 168s 5s/step - loss: 0.8987 - accuracy: 0.5728 - val_loss: 0.6283 - val_accuracy: 0.6383 - lr: 1.0000e-05

Epoch 4/15

33/33 [=====] - 182s 6s/step - loss: 0.8567 - accuracy: 0.5785 - val_loss: 0.6137 - val_accuracy: 0.7159 - lr: 1.0000e-05

Epoch 5/15

33/33 [=====] - 182s 6s/step - loss: 0.8017 - accuracy: 0.5936 - val_loss: 0.6023 - val_accuracy: 0.7159 - lr: 1.0000e-05

Epoch 6/15

33/33 [=====] - 204s 6s/step - loss: 0.7720 - accuracy: 0.6069 - val_loss: 0.5995 - val_accuracy: 0.7614 - lr: 1.0000e-05

Epoch 7/15

33/33 [=====] - 198s 6s/step - loss: 0.7242 - accuracy: 0.6377 - val_loss: 0.5895 - val_accuracy: 0.6837 - lr: 1.0000e-05

Epoch 8/15

33/33 [=====] - 184s 6s/step - loss: 0.7000 - accuracy: 0.6515 - val_loss: 0.5819 - val_accuracy: 0.7386 - lr: 1.0000e-05

Epoch 9/15

33/33 [=====] - 183s 6s/step - loss: 0.6944 - accuracy: 0.6472 - val_loss: 0.5845 - val_accuracy: 0.6875 - lr: 1.0000e-05

Epoch 10/15

33/33 [=====] - 194s 6s/step - loss: 0.6499 - accuracy: 0.6610 - val_loss: 0.5772 - val_accuracy: 0.7746 - lr: 1.0000e-05

Epoch 11/15

33/33 [=====] - 551s 17s/step - loss: 0.6500 - accuracy: 0.6515 - val_loss: 0.5771 - val_accuracy: 0.7178 - lr: 1.0000e-05

Epoch 12/15

33/33 [=====] - 166s 5s/step - loss: 0.6400 - accuracy: 0.6610 - val_loss: 0.5680 - val_accuracy: 0.7348 - lr: 1.0000e-05

Epoch 13/15

33/33 [=====] - 139s 4s/step - loss: 0.6208 - accuracy: 0.6799 - val_loss: 0.5648 - val_accuracy: 0.7008 - lr: 1.0000e-05

Epoch 14/15

33/33 [=====] - 137s 4s/step - loss: 0.6237 - accuracy: 0.6804 - val_loss: 0.5627 - val_accuracy: 0.7102 - lr: 1.0000e-05

Epoch 15/15

33/33 [=====] - ETA: 0s - loss: 0.5943 - accuracy: 0.6965

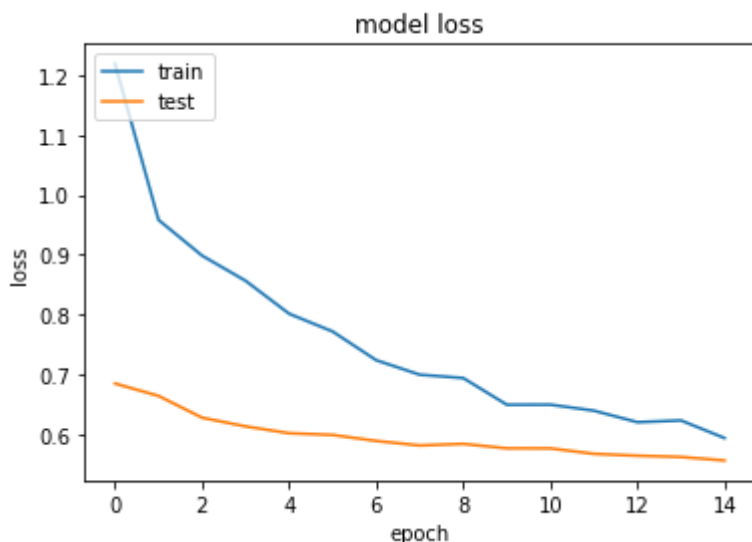
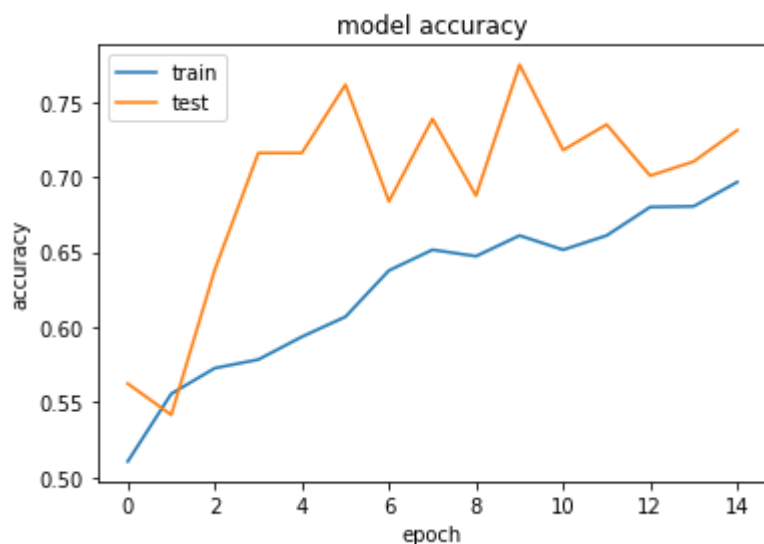
Epoch 15: ReduceLROnPlateau reducing learning rate to 4.999999873689376e-06.

33/33 [=====] - 137s 4s/step - loss: 0.5943 - accuracy: 0.6965 - val_loss: 0.5569 - val_accuracy: 0.7311 - lr: 1.0000e-05

In [57]:

```
print(history.history.keys())
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
```

```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy', 'lr'])
```



In []: