Imports

In [1]:

```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import os
import random
import sys
import gc
%matplotlib inline
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import cv2
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelBinarizer
import PIL
from PIL import Image
from IPython.display import SVG
from keras.utils.vis_utils import model_to_dot

import keras
from keras import layers
from keras import metrics
from keras.models import load_model
from keras.layers import Dense, Flatten, Conv2D, Dropout, MaxPooling2D, GlobalAveragePoolin
g2D, Dropout
from keras import optimizers
from keras import models
from keras.models import Sequential
from keras import preprocessing
from keras.preprocessing import image
from keras.preprocessing.image import ImageDataGenerator, array_to_img, img_to_array, load_
img
from keras.applications import VGG16
from keras.utils import plot_model
```

```
Using TensorFlow backend.
```

Global variables

In [2]:

```
img_size = 224
batch_size = 32
epochs = 120
train_size = 0.7
val_size = 0.2
test_size = 0.1
seed = 4321
channels = 3
learning_rate = 0.00001
```

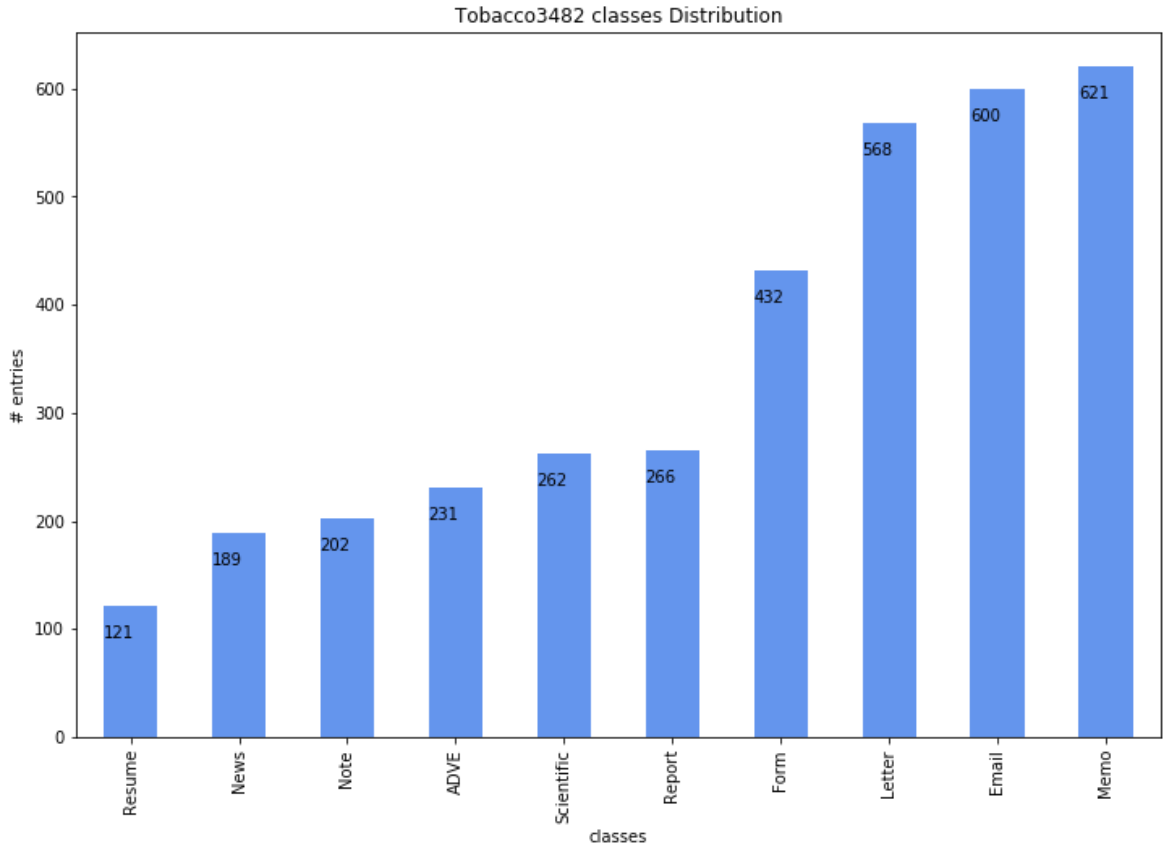
Get classes and entries per classes

In [3]:

```
d = '../input/tobacco3482-jpg/Tobacco3482-jpg/'
PATH = '../'

classes = (os.listdir(d))

paths = [os.path.join(d, o) for o in os.listdir(d)
                    if os.path.isdir(os.path.join(d,o))]

nbEntries = []
```

```
for i in range(len(classes)):
    nbEntries.append(len(os.listdir(paths[i])))

##############################################

print(classes)
print(nbEntries)

df = pd.DataFrame({'classes':classes, 'entries':nbEntries})
ax = df.sort_values(by='entries', ascending=True).plot.bar(x='classes', y='entries', color=
'cornflowerblue',legend=False, figsize=(12,8))
ax.set_title('Tobacco3482 classes Distribution')
ax.set_ylabel("# entries")
for p in ax.patches:
    ax.annotate(str(p.get_height()), xy=(p.get_x(), p.get_height()-30))
```

```
['Letter', 'Resume', 'Scientific', 'ADVE', 'Email', 'Report', 'News', 'Memo', 'Form', 'Note'
]
[568, 121, 262, 231, 600, 266, 189, 621, 432, 202]
```



Get all images

In [4]:

```
total_set = []
total_labels = []


for root, dirs, files in os.walk(d):
    for file in files:
        if file.endswith(".jpg"):
            path = os.path.join(root, file)
            total_set.append(path)
            total_labels.append(root.split(os.path.sep)[-1])


# Return image class based on list entry (path)
def getClass(img):
    return img.split(os.path.sep)[-2]
```

```
print(total_set[0])
print('GetClass : ', getClass(total_set[0]))
print('Label : ', total_labels[0])
```

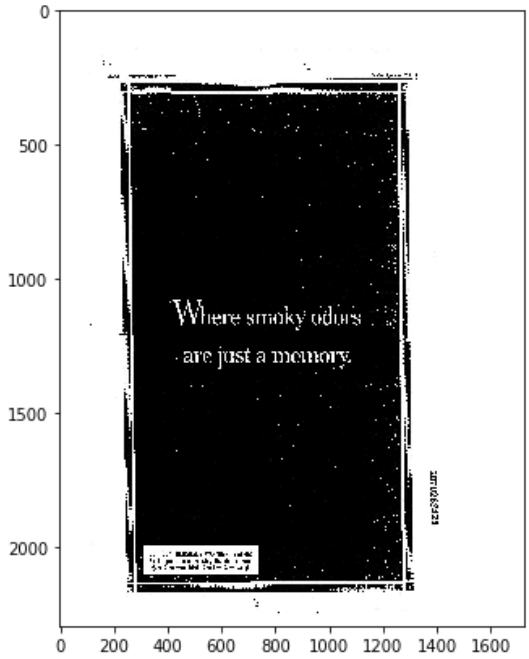
```
../input/tobacco3482-jpg/Tobacco3482-jpg/Letter/507360836+-0837.jpg
GetClass :  Letter
Label :  Letter
```

Plot data

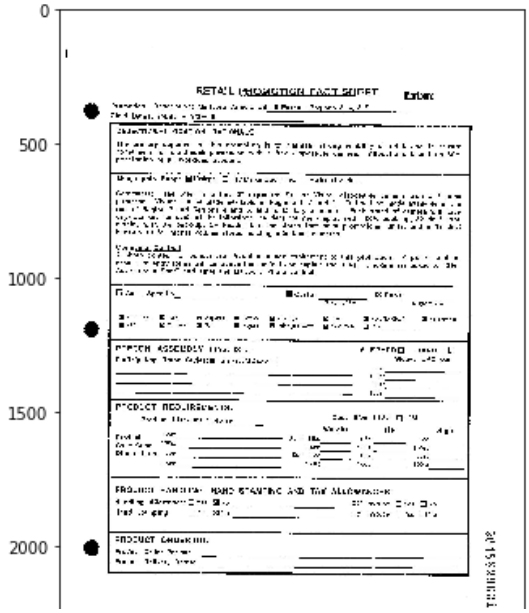
In [5]:

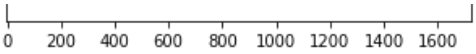
```
random.Random(seed).shuffle(total_set)

for ima in total_set[0:3] :
    print(ima)
    img = mpimg.imread(ima)
    plt.figure(figsize=(7,7))
    imgplot = plt.imshow(img, cmap="gray")
    plt.show()
```

```
../input/tobacco3482-jpg/Tobacco3482-jpg/ADVE/2070262428_2429.jpg
```

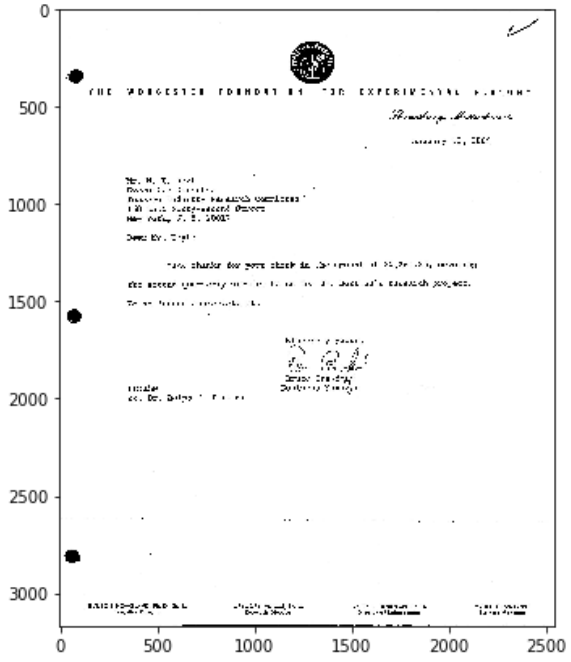



```
../input/tobacco3482-jpg/Tobacco3482-jpg/Form/2045829634_9635.jpg
```

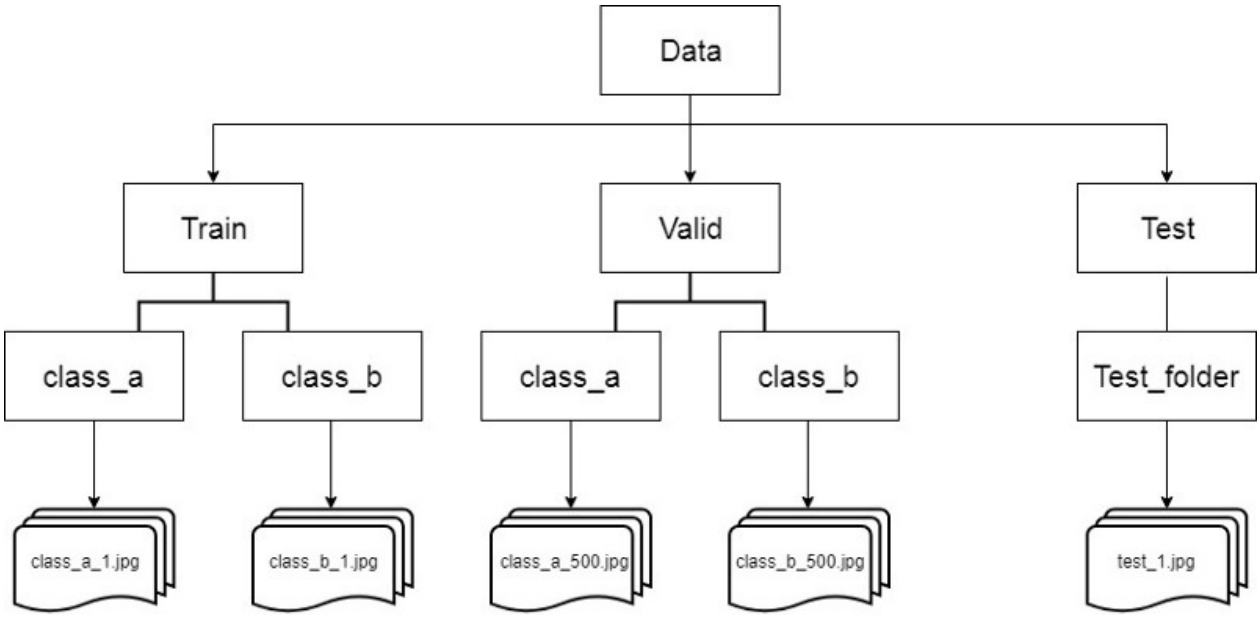





```
../input/tobacco3482-jpg/Tobacco3482-jpg/Letter/50030592.jpg
```



Sorting data in usable sets



In [6]:

```
# Get data and separate it in sets
total_len = len(total_set)
index = 0

train_set = []
train_label = []

val_set = []
val_label = []

test_set = []
test_label = []


for i in total_set[0: int(total_len*train_size)] :
```

```
    train_set.append(i)
    train_label.append(getClass(i))

index = int(total_len*train_size)+1

for i in total_set[index: int(index + total_len*val_size)] :
    val_set.append(i)
    val_label.append(getClass(i))

index = int(index + total_len*val_size)+1

for i in total_set[index: total_len] :
    test_set.append(i)
    test_label.append(getClass(i))

print(val_set[200])
print(val_label[200])
```

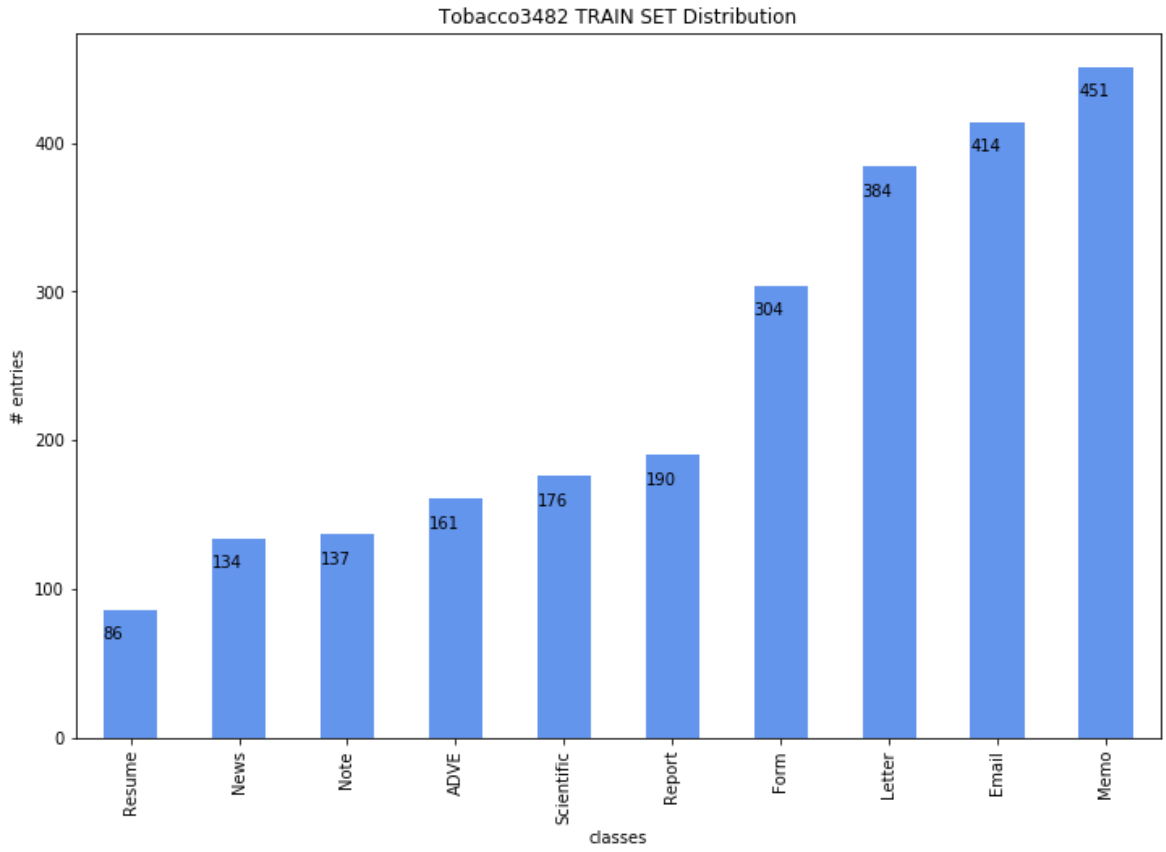
```
../input/tobacco3482-jpg/Tobacco3482-jpg/Memo/1000251492.jpg
Memo
```

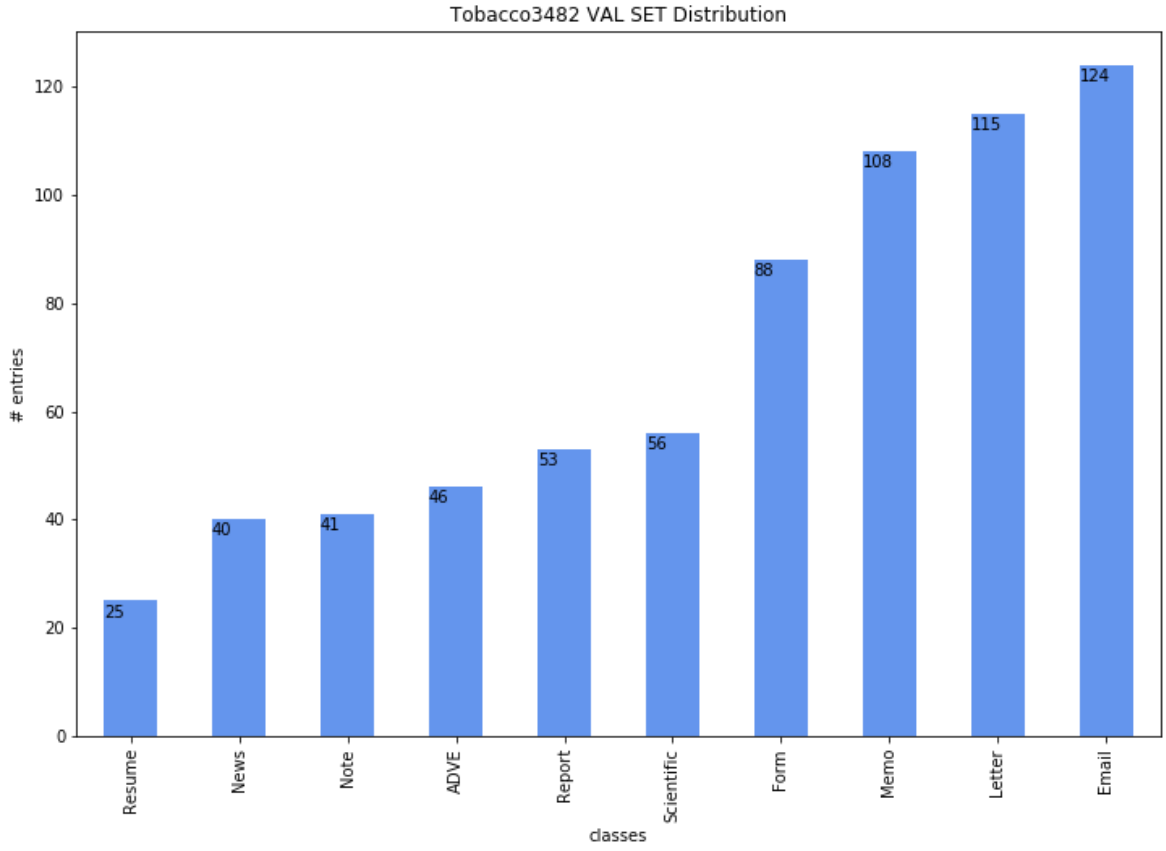
Visualize classes distribution (bar chart)

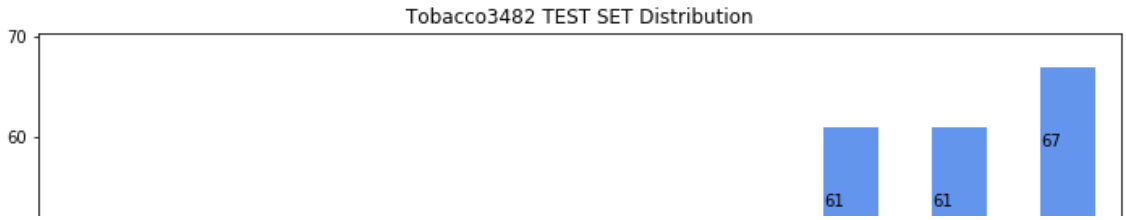
In [7]:

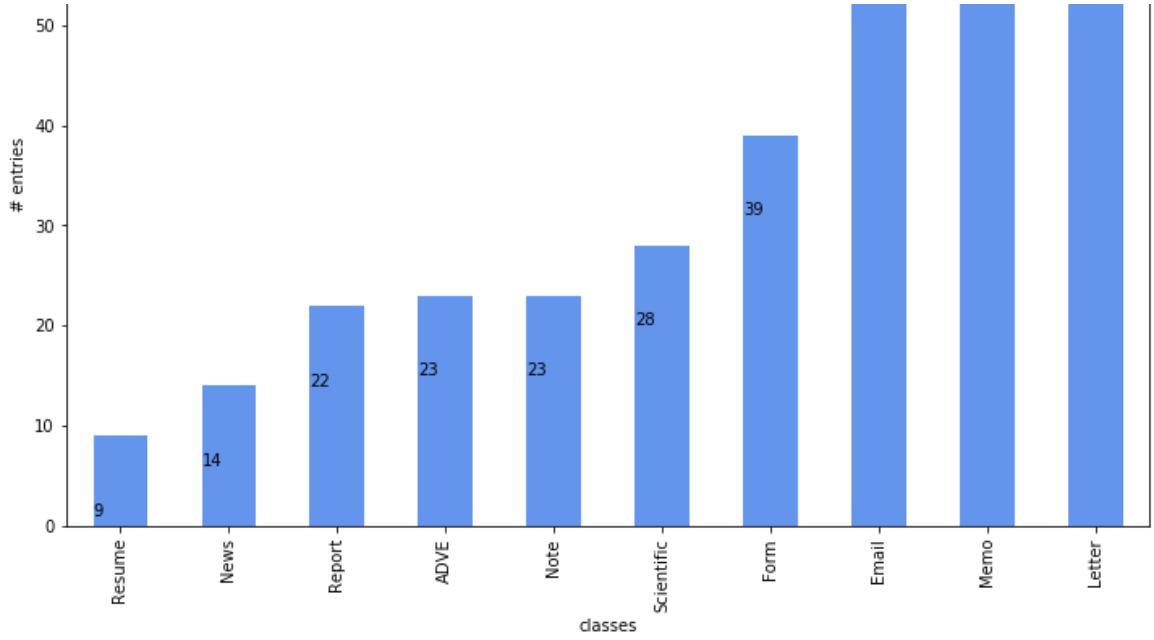
```
################################################
# TRAIN SET
instances = [0] * len(classes)
for index, val in enumerate(classes) :
    for e in train_set :
        if(val == getClass(e)) :
            instances[index] += 1


df = pd.DataFrame({'classes':classes, 'entries':instances})
ax = df.sort_values(by='entries', ascending=True).plot.bar(x='classes', y='entries', color=
'cornflowerblue',legend=False, figsize=(12,8))
ax.set_title('Tobacco3482 TRAIN SET Distribution')
ax.set_ylabel("# entries")
for p in ax.patches:
    ax.annotate(str(p.get_height()), xy=(p.get_x(), p.get_height()-20))

################################################
# VAL SET
instances = [0] * len(classes)
for index, val in enumerate(classes) :
    for e in val_set :
        if(val == getClass(e)) :
            instances[index] += 1


df = pd.DataFrame({'classes':classes, 'entries':instances})
ax = df.sort_values(by='entries', ascending=True).plot.bar(x='classes', y='entries', color=
'cornflowerblue',legend=False, figsize=(12,8))
ax.set_title('Tobacco3482 VAL SET Distribution')
ax.set_ylabel("# entries")
for p in ax.patches:
    ax.annotate(str(p.get_height()), xy=(p.get_x(), p.get_height()-3))

################################################
# TEST SET
instances = [0] * len(classes)
for index, val in enumerate(classes) :
    for e in test_set :
        if(val == getClass(e)) :
            instances[index] += 1


df = pd.DataFrame({'classes':classes, 'entries':instances})
ax = df.sort_values(by='entries', ascending=True).plot.bar(x='classes', y='entries', color=
'cornflowerblue',legend=False, figsize=(12,8))
ax.set_title('Tobacco3482 TEST SET Distribution')
ax.set_ylabel("# entries")
for p in ax.patches:
```

```
    ax.annotate(str(p.get_height()), xy=(p.get_x(), p.get_height()-8))
```









Preprocess data (resize, transform to Numpy array and binarize)

https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.LabelBinarizer.html

In [8]:

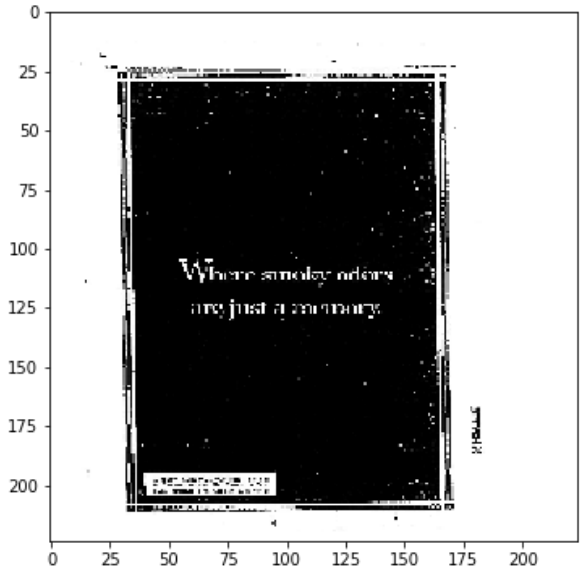
```
def process_images(img_set) :
    processed_img = []

    for i in range(len(img_set)) :
        processed_img.append(cv2.resize(cv2.imread(img_set[i], cv2.IMREAD_COLOR), (img_size
, img_size)))

    return processed_img

data_train = process_images(train_set)
data_test = process_images(test_set)
data_val = process_images(val_set)
```

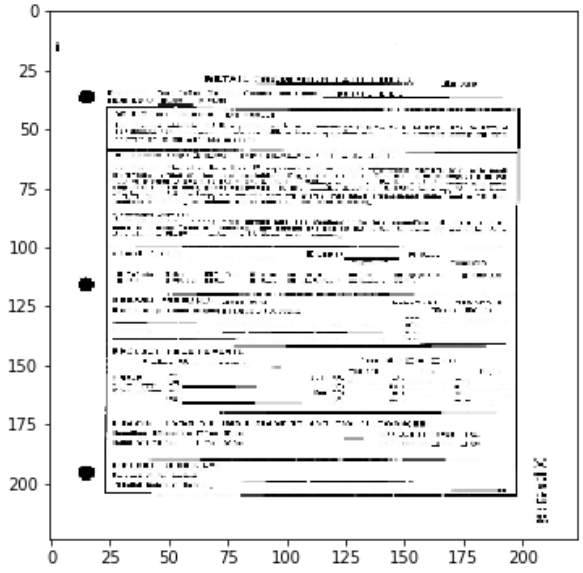
In [9]:

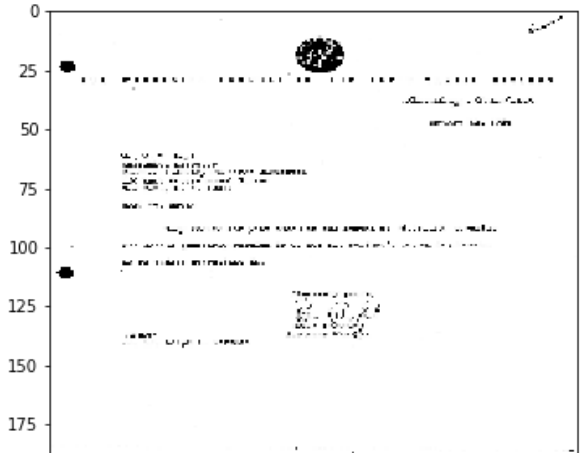
```
lb = LabelBinarizer()
lb.fit(list(classes))

x_train = np.array(data_train)
y_train =lb.transform(np.array(train_label))

x_test = np.array(data_test)
y_test = lb.transform(np.array(test_label))

x_val = np.array(data_val)
y_val = lb.transform(np.array(val_label))

print("train shape : ", x_train.shape)
print(y_train.shape)
print("test shape : ", x_test.shape)
print(y_test.shape)
print("valdiation shape : ", x_val.shape)
print(y_val.shape)


for i in range(3) :
    plt.figure(figsize=(6,6))
    imgplot = plt.imshow(x_train[i])

print(train_label[0])
print(y_train[0])
```

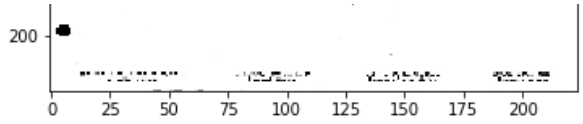
```
# find class with binarizer
print(lb.classes_)
```

```
train shape :  (2437, 224, 224, 3)
(2437, 10)
test shape :  (347, 224, 224, 3)
(347, 10)
valdiation shape :  (696, 224, 224, 3)
(696, 10)
ADVE
[1 0 0 0 0 0 0 0 0 0]
['ADVE' 'Email' 'Form' 'Letter' 'Memo' 'News' 'Note' 'Report' 'Resume'
 'Scientific']
```









Create base model (using pretrained CNN)

https://keras.io/applications/

Trainable weights : TRUE

To "freeze" a layer means to exclude it from training. Allows to train the whole model and not only the last added layers --> 5/10% better accuracy. it takes about three to four times longer for training since there are way more parameters to train.

In [10]:

```
base_model = VGG16(weights = "imagenet", include_top=False, input_shape = (img_size, img_si
ze, channels))

#for layer in base_model.layers:
#    layer.trainable = False

base_model.summary()
```

```
WARNING:tensorflow:From /opt/conda/lib/python3.6/site-packages/tensorflow/python/framework/o
p_def_library.py:263: colocate_with (from tensorflow.python.framework.ops) is deprecated and
will be removed in a future version.
Instructions for updating:
Colocations handled automatically by placer.
Downloading data from https://github.com/fchollet/deep-learning-models/releases/download/v0.
1/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5
58892288/58889256 [==============================] - 2s 0us/step
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_1 (InputLayer)         (None, 224, 224, 3)       0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 224, 224, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 224, 224, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 112, 112, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 112, 112, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 112, 112, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 56, 56, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 56, 56, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 28, 28, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 28, 28, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 14, 14, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 7, 7, 512)         0
```

```
=================================================================
Total params: 14,714,688
Trainable params: 14,714,688
Non-trainable params: 0
_________________________________________________________________
```

Create custom model

Base is VGG16, adding a flatten layer, a Dense layer and a dropout layer. Last Dense layer specify the number of classes

https://keras.io/getting-started/sequential-model-guide/

https://keras.io/layers/core/

In [11]:

```
model = models.Sequential()

model.add(base_model)
model.add(layers.Flatten())
model.add(layers.Dense(128, activation='relu',  name='dense'))
model.add(layers.Dropout(0.5))
model.add(layers.Dense(len(classes), activation='softmax',  name='predictions'))

model.summary()

print('Number of trainable weights : ', len(model.trainable_weights))

plot_model(model, to_file='model.png')
SVG(model_to_dot(model).create(prog='dot', format='svg'))
```

```
WARNING:tensorflow:From /opt/conda/lib/python3.6/site-packages/keras/backend/tensorflow_back
end.py:3445: calling dropout (from tensorflow.python.ops.nn_ops) with keep_prob is deprecate
d and will be removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
vgg16 (Model)                (None, 7, 7, 512)         14714688
_________________________________________________________________
flatten_1 (Flatten)          (None, 25088)             0
_________________________________________________________________
dense (Dense)                (None, 128)               3211392
_________________________________________________________________
dropout_1 (Dropout)          (None, 128)               0
_________________________________________________________________
predictions (Dense)          (None, 10)                1290
=================================================================
Total params: 17,927,370
Trainable params: 17,927,370
Non-trainable params: 0
_________________________________________________________________
Number of trainable weights :  30
```

Out[11]:

Training the model

Compile : Configures the model for training.

Fit : Trains the model for a given number of epochs (iterations on a dataset).

https://keras.io/models/model/

In [12]:

```
model.compile(optimizer=optimizers.Adam(lr=learning_rate), loss='categorical_crossentropy',
metrics=['accuracy'])
```

```
train_model = model.fit(x_train, y_train,
                        batch_size=batch_size,
                        epochs=epochs,
                        verbose=1,
                        validation_data=(x_val, y_val))
```

```
WARNING:tensorflow:From /opt/conda/lib/python3.6/site-packages/tensorflow/python/ops/math_op
s.py:3066: to_int32 (from tensorflow.python.ops.math_ops) is deprecated and will be removed
in a future version.
Instructions for updating:
Use tf.cast instead.
Train on 2437 samples, validate on 696 samples
Epoch 1/120
2437/2437 [==============================] - 26s 11ms/step - loss: 4.7108 - acc: 0.2253 - val
_loss: 1.8169 - val_acc: 0.3664
Epoch 2/120
2437/2437 [==============================] - 19s 8ms/step - loss: 1.9057 - acc: 0.3500 - val_
loss: 1.5234 - val_acc: 0.4971
Epoch 3/120
2437/2437 [==============================] - 19s 8ms/step - loss: 1.6078 - acc: 0.4526 - val_
loss: 1.3149 - val_acc: 0.5675
Epoch 4/120
2437/2437 [==============================] - 19s 8ms/step - loss: 1.4007 - acc: 0.5334 - val_
loss: 1.1195 - val_acc: 0.6710
Epoch 5/120
2437/2437 [==============================] - 19s 8ms/step - loss: 1.2156 - acc: 0.6061 - val_
loss: 1.0012 - val_acc: 0.7011
Epoch 6/120
2437/2437 [==============================] - 19s 8ms/step - loss: 1.0720 - acc: 0.6463 - val_
loss: 0.9526 - val_acc: 0.7055
Epoch 7/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.9813 - acc: 0.6873 - val_
loss: 0.8672 - val_acc: 0.7399
Epoch 8/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.8515 - acc: 0.7259 - val_
loss: 0.8427 - val_acc: 0.7342
Epoch 9/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.7786 - acc: 0.7509 - val_
loss: 0.8440 - val_acc: 0.7543
Epoch 10/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.6765 - acc: 0.7858 - val_
loss: 0.7981 - val_acc: 0.7773
Epoch 11/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.6312 - acc: 0.7928 - val_
loss: 0.8104 - val_acc: 0.7601
Epoch 12/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.5589 - acc: 0.8178 - val_
loss: 0.7747 - val_acc: 0.7701
Epoch 13/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.4897 - acc: 0.8383 - val_
loss: 0.7578 - val_acc: 0.7773
Epoch 14/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.4376 - acc: 0.8662 - val_
loss: 0.7380 - val_acc: 0.7989
Epoch 15/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.3808 - acc: 0.8798 - val_
loss: 0.7504 - val_acc: 0.7989
Epoch 16/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.3535 - acc: 0.8839 - val_
loss: 0.7334 - val_acc: 0.8046
Epoch 17/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.2942 - acc: 0.9027 - val_
loss: 0.7503 - val_acc: 0.8017
Epoch 18/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.2753 - acc: 0.9097 - val_
loss: 0.7814 - val_acc: 0.8075
Epoch 19/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.2483 - acc: 0.9204 - val_
loss: 0.8119 - val_acc: 0.8046
Epoch 20/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.2462 - acc: 0.9179 - val_
loss: 0.7681 - val_acc: 0.8161
Epoch 21/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1979 - acc: 0.9294 - val_
loss: 0.7804 - val_acc: 0.8103
```

```
Epoch 22/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.2270 - acc: 0.9237 - val_
loss: 0.8535 - val_acc: 0.7931
Epoch 23/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1774 - acc: 0.9405 - val_
loss: 0.8505 - val_acc: 0.8060
Epoch 24/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1611 - acc: 0.9384 - val_
loss: 0.7841 - val_acc: 0.8118
Epoch 25/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1540 - acc: 0.9536 - val_
loss: 0.8423 - val_acc: 0.8046
Epoch 26/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1323 - acc: 0.9586 - val_
loss: 0.8930 - val_acc: 0.8204
Epoch 27/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1114 - acc: 0.9631 - val_
loss: 0.8685 - val_acc: 0.8103
Epoch 28/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1120 - acc: 0.9598 - val_
loss: 0.9100 - val_acc: 0.8103
Epoch 29/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1575 - acc: 0.9467 - val_
loss: 0.7924 - val_acc: 0.8204
Epoch 30/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0929 - acc: 0.9680 - val_
loss: 0.9661 - val_acc: 0.8046
Epoch 31/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0888 - acc: 0.9700 - val_
loss: 0.8761 - val_acc: 0.8348
Epoch 32/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0945 - acc: 0.9733 - val_
loss: 0.7872 - val_acc: 0.8290
Epoch 33/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0924 - acc: 0.9692 - val_
loss: 0.8486 - val_acc: 0.8319
Epoch 34/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0679 - acc: 0.9795 - val_
loss: 0.9012 - val_acc: 0.8132
Epoch 35/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0659 - acc: 0.9791 - val_
loss: 0.9066 - val_acc: 0.8261
Epoch 36/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0678 - acc: 0.9783 - val_
loss: 0.9891 - val_acc: 0.8161
Epoch 37/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0909 - acc: 0.9692 - val_
loss: 0.9477 - val_acc: 0.8161
Epoch 38/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0676 - acc: 0.9766 - val_
loss: 0.9571 - val_acc: 0.8348
Epoch 39/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0637 - acc: 0.9799 - val_
loss: 0.9470 - val_acc: 0.8147
Epoch 40/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0649 - acc: 0.9791 - val_
loss: 1.0390 - val_acc: 0.8103
Epoch 41/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0656 - acc: 0.9803 - val_
loss: 0.9323 - val_acc: 0.8204
Epoch 42/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0399 - acc: 0.9897 - val_
loss: 1.0709 - val_acc: 0.8132
Epoch 43/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0506 - acc: 0.9824 - val_
loss: 1.0853 - val_acc: 0.8261
Epoch 44/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0621 - acc: 0.9795 - val_
loss: 1.0891 - val_acc: 0.8032
Epoch 45/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0667 - acc: 0.9774 - val_
loss: 0.9649 - val_acc: 0.8161
Epoch 46/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1060 - acc: 0.9631 - val_
loss: 0.9755 - val_acc: 0.8290
Epoch 47/120
```

2437/2437 [==============================] - 19s 8ms/step - loss: 0.0490 - acc: 0.9856 - val_
loss: 0.9915 - val_acc: 0.8190
Epoch 48/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0439 - acc: 0.9865 - val_
loss: 0.9924 - val_acc: 0.8218
Epoch 49/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0375 - acc: 0.9856 - val_
loss: 0.9514 - val_acc: 0.8204
Epoch 50/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0287 - acc: 0.9914 - val_
loss: 1.0703 - val_acc: 0.8132
Epoch 51/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0435 - acc: 0.9848 - val_
loss: 0.9597 - val_acc: 0.8233
Epoch 52/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0256 - acc: 0.9914 - val_
loss: 0.9600 - val_acc: 0.8319
Epoch 53/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0263 - acc: 0.9897 - val_
loss: 1.0277 - val_acc: 0.8261
Epoch 54/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0578 - acc: 0.9848 - val_
loss: 1.0437 - val_acc: 0.8046
Epoch 55/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.1070 - acc: 0.9684 - val_
loss: 0.9495 - val_acc: 0.8261
Epoch 56/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0694 - acc: 0.9754 - val_
loss: 0.8908 - val_acc: 0.8376
Epoch 57/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0641 - acc: 0.9791 - val_
loss: 0.9252 - val_acc: 0.8132
Epoch 58/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0236 - acc: 0.9926 - val_
loss: 1.0077 - val_acc: 0.8348
Epoch 59/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0367 - acc: 0.9860 - val_
loss: 0.9813 - val_acc: 0.8276
Epoch 60/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0426 - acc: 0.9869 - val_
loss: 1.0047 - val_acc: 0.8348
Epoch 61/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0218 - acc: 0.9930 - val_
loss: 1.0202 - val_acc: 0.8233
Epoch 62/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0181 - acc: 0.9943 - val_
loss: 1.0116 - val_acc: 0.8290
Epoch 63/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0412 - acc: 0.9869 - val_
loss: 1.1317 - val_acc: 0.8032
Epoch 64/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0577 - acc: 0.9799 - val_
loss: 1.0937 - val_acc: 0.8218
Epoch 65/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0451 - acc: 0.9848 - val_
loss: 1.0442 - val_acc: 0.8233
Epoch 66/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0524 - acc: 0.9807 - val_
loss: 0.8870 - val_acc: 0.8276
Epoch 67/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0392 - acc: 0.9844 - val_
loss: 1.0033 - val_acc: 0.8276
Epoch 68/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0260 - acc: 0.9934 - val_
loss: 0.9570 - val_acc: 0.8477
Epoch 69/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0159 - acc: 0.9951 - val_
loss: 0.9665 - val_acc: 0.8290
Epoch 70/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0289 - acc: 0.9914 - val_
loss: 1.0053 - val_acc: 0.8305
Epoch 71/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0292 - acc: 0.9893 - val_
loss: 1.2992 - val_acc: 0.8118
Epoch 72/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0645 - acc: 0.9807 - val_

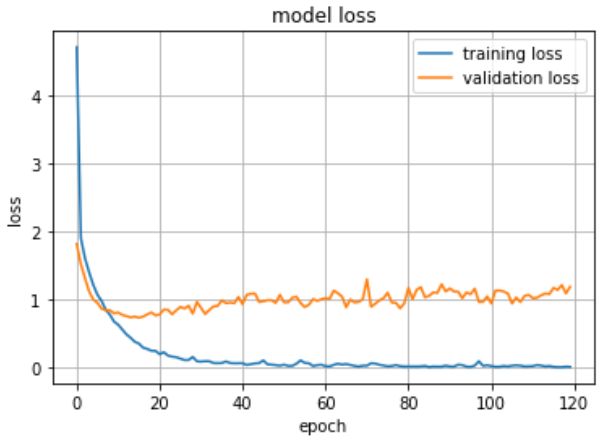
```
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0045 - acc: 0.9867 - val_
loss: 0.8956 - val_acc: 0.8348
Epoch 73/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0596 - acc: 0.9815 - val_
loss: 0.9386 - val_acc: 0.8147
Epoch 74/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0423 - acc: 0.9893 - val_
loss: 0.9880 - val_acc: 0.8376
Epoch 75/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0310 - acc: 0.9902 - val_
loss: 1.0213 - val_acc: 0.8305
Epoch 76/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0195 - acc: 0.9918 - val_
loss: 1.1012 - val_acc: 0.8319
Epoch 77/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0239 - acc: 0.9918 - val_
loss: 0.9567 - val_acc: 0.8391
Epoch 78/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0379 - acc: 0.9889 - val_
loss: 0.9518 - val_acc: 0.8247
Epoch 79/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0218 - acc: 0.9918 - val_
loss: 0.8717 - val_acc: 0.8434
Epoch 80/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0168 - acc: 0.9959 - val_
loss: 0.9435 - val_acc: 0.8405
Epoch 81/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0166 - acc: 0.9959 - val_
loss: 1.1720 - val_acc: 0.8261
Epoch 82/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0176 - acc: 0.9943 - val_
loss: 1.0061 - val_acc: 0.8333
Epoch 83/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0162 - acc: 0.9947 - val_
loss: 1.1447 - val_acc: 0.8362
Epoch 84/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0185 - acc: 0.9938 - val_
loss: 1.1829 - val_acc: 0.8161
Epoch 85/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0255 - acc: 0.9918 - val_
loss: 1.0324 - val_acc: 0.8405
Epoch 86/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0088 - acc: 0.9975 - val_
loss: 1.0558 - val_acc: 0.8376
Epoch 87/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0168 - acc: 0.9930 - val_
loss: 1.1066 - val_acc: 0.8434
Epoch 88/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0148 - acc: 0.9963 - val_
loss: 1.0989 - val_acc: 0.8348
Epoch 89/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0150 - acc: 0.9959 - val_
loss: 1.2252 - val_acc: 0.8420
Epoch 90/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0298 - acc: 0.9889 - val_
loss: 1.1202 - val_acc: 0.8506
Epoch 91/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0166 - acc: 0.9943 - val_
loss: 1.1656 - val_acc: 0.8405
Epoch 92/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0155 - acc: 0.9943 - val_
loss: 1.1181 - val_acc: 0.8420
Epoch 93/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0438 - acc: 0.9832 - val_
loss: 1.1170 - val_acc: 0.8348
Epoch 94/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0369 - acc: 0.9860 - val_
loss: 1.0201 - val_acc: 0.8290
Epoch 95/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0151 - acc: 0.9967 - val_
loss: 1.1043 - val_acc: 0.8376
Epoch 96/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0120 - acc: 0.9967 - val_
loss: 1.0793 - val_acc: 0.8420
Epoch 97/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0296 - acc: 0.9897 - val_
```

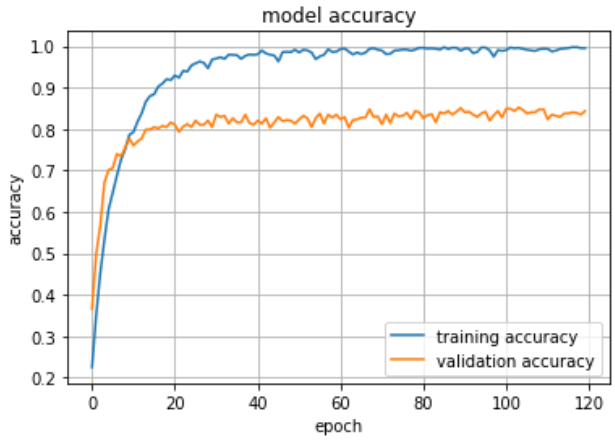
```
loss: 1.1611 - val_acc: 0.8204
Epoch 98/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0948 - acc: 0.9746 - val_
loss: 0.9657 - val_acc: 0.8333
Epoch 99/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0259 - acc: 0.9906 - val_
loss: 0.9671 - val_acc: 0.8434
Epoch 100/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0356 - acc: 0.9885 - val_
loss: 1.0481 - val_acc: 0.8276
Epoch 101/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0231 - acc: 0.9906 - val_
loss: 0.9430 - val_acc: 0.8491
Epoch 102/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0129 - acc: 0.9967 - val_
loss: 1.1331 - val_acc: 0.8491
Epoch 103/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0136 - acc: 0.9951 - val_
loss: 1.1342 - val_acc: 0.8434
Epoch 104/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0244 - acc: 0.9959 - val_
loss: 1.1182 - val_acc: 0.8520
Epoch 105/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0173 - acc: 0.9934 - val_
loss: 1.0894 - val_acc: 0.8463
Epoch 106/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0294 - acc: 0.9914 - val_
loss: 0.9420 - val_acc: 0.8376
Epoch 107/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0333 - acc: 0.9897 - val_
loss: 1.0311 - val_acc: 0.8405
Epoch 108/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0298 - acc: 0.9885 - val_
loss: 0.9637 - val_acc: 0.8405
Epoch 109/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0174 - acc: 0.9926 - val_
loss: 1.0536 - val_acc: 0.8477
Epoch 110/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0193 - acc: 0.9938 - val_
loss: 1.0706 - val_acc: 0.8477
Epoch 111/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0219 - acc: 0.9934 - val_
loss: 1.0209 - val_acc: 0.8233
Epoch 112/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0383 - acc: 0.9873 - val_
loss: 1.0266 - val_acc: 0.8348
Epoch 113/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0305 - acc: 0.9893 - val_
loss: 1.0626 - val_acc: 0.8319
Epoch 114/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0174 - acc: 0.9934 - val_
loss: 1.0890 - val_acc: 0.8290
Epoch 115/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0234 - acc: 0.9943 - val_
loss: 1.0804 - val_acc: 0.8376
Epoch 116/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0122 - acc: 0.9955 - val_
loss: 1.1724 - val_acc: 0.8376
Epoch 117/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0072 - acc: 0.9975 - val_
loss: 1.1420 - val_acc: 0.8405
Epoch 118/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0069 - acc: 0.9975 - val_
loss: 1.2141 - val_acc: 0.8391
Epoch 119/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0145 - acc: 0.9955 - val_
loss: 1.0900 - val_acc: 0.8348
Epoch 120/120
2437/2437 [==============================] - 19s 8ms/step - loss: 0.0107 - acc: 0.9951 - val_
loss: 1.1887 - val_acc: 0.8434
```

Plot accuracy and loss of trained model (line chart)

In [13]:

```
plt.plot(train_model.history['loss'])
plt.plot(train_model.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.grid()
plt.legend(['training loss', 'validation loss'], loc='upper right')
plt.show()

plt.plot(train_model.history['acc'])
plt.plot(train_model.history['val_acc'])
plt.title('model accuracy')
plt.grid()
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['training accuracy', 'validation accuracy'], loc='lower right')
plt.show()
```





Test prediction accuracy on test set

In [14]:

```
# combine predictions + average for better score ?

score = model.evaluate(x_test, y_test, verbose=1)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
347/347 [==============================] - 2s 4ms/step
Test loss: 1.1527481931087262
Test accuracy: 0.8443804056912403
```

Save model

- **the architecture of the model, allowing to re-create the model**
- **the weights of the model**

- **the training configuration (loss, optimizer)**
- **the state of the optimizer, allowing to resume training exactly where you left off.**

In [15]:

```
model.save('trained_model.h5')
```

Use model on test set

In [16]:

```
predictions = model.predict_classes(x_test, verbose=1)
predictions_list = predictions.tolist()
predicted_classes = lb.classes_

count_true = 0;
count_false = 0;

for i, prediction in enumerate(predictions_list):
    state = True
    if (predicted_classes[prediction] != test_label[i]) :
        state = False
        count_false += 1
    else :
        count_true += 1
    print("Prediction : ", predicted_classes[prediction], "   |   Real class : ", test_labe
l[i],  "   |   Result : ", state)

print("\nNumber of success : ", count_true)
print("Number of error : ", count_false)
print("Error rate : ", count_true/len(test_label))
```

```
347/347 [==============================] - 1s 3ms/step
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Form    |   Real class :  Note    |   Result :  False
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Report    |   Result :  False
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Scientific    |   Real class :  Letter    |   Result :  False
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Resume    |   Real class :  Resume    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Form    |   Real class :  Memo    |   Result :  False
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Report    |   Real class :  Resume    |   Result :  False
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Report    |   Real class :  Form    |   Result :  False
```

```
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Report    |   Real class :  Letter    |   Result :  False
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Scientific    |   Result :  False
Prediction :  Letter    |   Real class :  Report    |   Result :  False
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Memo    |   Result :  False
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Form    |   Real class :  Scientific    |   Result :  False
Prediction :  News    |   Real class :  ADVE    |   Result :  False
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Letter    |   Real class :  Scientific    |   Result :  False
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Scientific    |   Real class :  Note    |   Result :  False
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Memo    |   Real class :  Form    |   Result :  False
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Email    |   Result :  False
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Report    |   Real class :  Resume    |   Result :  False
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Scientific    |   Real class :  Letter    |   Result :  False
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Letter    |   Real class :  Memo    |   Result :  False
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Resume    |   Real class :  Resume    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Letter    |   Result :  False
Prediction :  Email    |   Real class :  Email    |   Result :  True
```

```
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Resume    |   Real class :  Resume    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Report    |   Real class :  Letter    |   Result :  False
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  ADVE    |   Real class :  Scientific    |   Result :  False
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Resume    |   Real class :  Resume    |   Result :  True
Prediction :  Report    |   Real class :  Letter    |   Result :  False
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Scientific    |   Real class :  Note    |   Result :  False
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Resume    |   Real class :  Resume    |   Result :  True
Prediction :  Letter    |   Real class :  Report    |   Result :  False
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Report    |   Real class :  Scientific    |   Result :  False
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  News    |   Real class :  Scientific    |   Result :  False
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Form    |   Result :  False
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Resume    |   Real class :  Resume    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  ADVE    |   Real class :  Memo    |   Result :  False
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Form    |   Result :  False
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Report    |   Real class :  Scientific    |   Result :  False
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Letter    |   Real class :  Scientific    |   Result :  False
```

```
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Form    |   Real class :  Scientific    |   Result :  False
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Letter    |   Real class :  Memo    |   Result :  False
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Form    |   Result :  False
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Form    |   Real class :  Memo    |   Result :  False
Prediction :  Form    |   Real class :  Scientific    |   Result :  False
Prediction :  Resume    |   Real class :  Scientific    |   Result :  False
Prediction :  Memo    |   Real class :  Letter    |   Result :  False
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Report    |   Real class :  Letter    |   Result :  False
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Report    |   Real class :  Scientific    |   Result :  False
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Scientific    |   Real class :  Memo    |   Result :  False
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
```

```
Prediction :  Letter    |   Real class :  Memo    |   Result :  False
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Resume    |   Real class :  Report    |   Result :  False
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Note    |   Real class :  Scientific    |   Result :  False
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Report    |   Real class :  Scientific    |   Result :  False
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Memo    |   Real class :  Scientific    |   Result :  False
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Report    |   Real class :  Memo    |   Result :  False
Prediction :  Email    |   Real class :  Memo    |   Result :  False
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Report    |   Real class :  Resume    |   Result :  False
Prediction :  News    |   Real class :  News    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Report    |   Result :  False
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Report    |   Real class :  Report    |   Result :  True
Prediction :  Note    |   Real class :  Note    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Letter    |   Real class :  Report    |   Result :  False
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Scientific    |   Result :  False
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Memo    |   Real class :  Memo    |   Result :  True
Prediction :  Scientific    |   Real class :  Scientific    |   Result :  True
Prediction :  Letter    |   Real class :  Letter    |   Result :  True
Prediction :  Form    |   Real class :  Form    |   Result :  True
```

```
Prediction :  Form    |   Real class :  Form    |   Result :  True
Prediction :  Email    |   Real class :  Email    |   Result :  True
Prediction :  Report    |   Real class :  Letter    |   Result :  False
Prediction :  ADVE    |   Real class :  ADVE    |   Result :  True

Number of success :  293
Number of error :  54
Error rate :  0.8443804034582133
```