In [1]:

```
import numpy as np
import pandas as pd
import cv2
import os
from matplotlib import pyplot as plt

%matplotlib inline

from keras.utils import to_categorical
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import Dropout
from keras.layers import Flatten
from keras.layers import LeakyReLU
from keras.optimizers import *
from keras.layers.normalization import BatchNormalization
from keras.layers.convolutional import Conv2D
from keras.layers.convolutional import MaxPooling2D
from keras.callbacks import ModelCheckpoint
from keras.callbacks import History
```

```
/Library/Frameworks/Python.framework/Versions/3.6/lib/python3.6/site
-packages/h5py/__init__.py:36: FutureWarning: Conversion of the seco
nd argument of issubdtype from `float` to `np.floating` is deprecate
d. In future, it will be treated as `np.float64 == np.dtype(float).t
ype`.
  from ._conv import register_converters as _register_converters
Using TensorFlow backend.
```

In [2]:

```
root = '../'
path_image = root+'Data/DataSubmd/Images/'
path_label = root+'Data/DataSubmd/Label/'
```

In [3]:

```
data = pd.read_csv(path_label+'label_shf.csv')
```

In [4]:

```
name = data['name']
```

In [5]:

```
def data_loader(folder):
    images = []
    foo = []
    for filename in name:
        filename_ = str(filename)+'.jpg'
        img = cv2.imread(os.path.join(folder,filename_))
        if img is not None:
            images.append(img)
            foo.append(filename)
    return (images, foo)
```

In [6]:

```
image, foo = data_loader(path_image)
```

In [7]:

```
image = np.asarray(image)
image.shape
```

Out[7]:

```
(22910, 32, 32, 3)
```

In [8]:

```
label = []
for i in range(len(foo)):
    label.append(data['label'].loc[data['name']==foo[i]].iloc[-1])
```

In [9]:

```
X_train = image[:20000]
```

In [10]:

```
Y = to_categorical(label)
```

In [11]:

```
Y_train = Y[:20000]
```

In [12]:

```
def classification(pretrained_weights = None):
    model = Sequential()
    model.add(Conv2D(16, (5, 5), input_shape=(32, 32, 3), padding='same', activat
    model.add(Conv2D(32, (3, 3), activation='relu', padding='same'))
    model.add(BatchNormalization())
    model.add(Dropout(0.2))
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Conv2D(64, (3, 3), activation='relu', padding='same'))
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Conv2D(128, (3, 3), activation='relu', padding='same'))
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(BatchNormalization())
    model.add(Dropout(0.2))
    model.add(Conv2D(256, (3, 3), activation='relu', padding='same'))
    model.add(Dropout(0.2))
    model.add(Conv2D(512, (3, 3), activation='relu', padding='same'))
    model.add(BatchNormalization())
    model.add(Flatten())
    model.add(Dense(512, activation='relu'))
    model.add(BatchNormalization())
    model.add(Dropout(0.2))
    model.add(Dense(128, activation='relu'))
    model.add(BatchNormalization())
    model.add(Dropout(0.2))
    model.add(Dense(64, activation='relu'))
    model.add(Dense(20, activation='softmax'))
    model.compile(loss='categorical_crossentropy', optimizer=adam(lr=1e-4),    me

    if(pretrained_weights):
        model.load_weights(pretrained_weights)

    return model
```

In [13]:

```
model = classification()
checkpointer = ModelCheckpoint('Model/final_saveall.h5', verbose=1, save_best_onl
results = model.fit(X_train, Y_train, validation_split=0.1, batch_size=32, epochs
```

```
Train on 18000 samples, validate on 2000 samples
Epoch 1/60
17984/18000 [============================>.] - ETA: 0s - loss: 2.529
9 - acc: 0.2549Epoch 00000: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 353s - loss: 2.5294 -
acc: 0.2551 - val_loss: 2.2417 - val_acc: 0.3285
Epoch 2/60
17984/18000 [============================>.] - ETA: 0s - loss: 2.242
3 - acc: 0.3241Epoch 00001: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 331s - loss: 2.2428 -
acc: 0.3241 - val_loss: 2.0953 - val_acc: 0.3615
Epoch 3/60
17984/18000 [============================>.] - ETA: 0s - loss: 2.114
4 - acc: 0.3589Epoch 00002: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 329s - loss: 2.1145 -
acc: 0.3588 - val_loss: 2.0315 - val_acc: 0.3815
```

```
Epoch 4/60
17984/18000 [============================>.] - ETA: 0s - loss: 2.018
5 - acc: 0.3848Epoch 00003: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 330s - loss: 2.0181 -
acc: 0.3849 - val_loss: 1.9804 - val_acc: 0.4015
Epoch 5/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.933
1 - acc: 0.4110Epoch 00004: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 330s - loss: 1.9332 -
acc: 0.4110 - val_loss: 1.9853 - val_acc: 0.3980
Epoch 6/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.857
6 - acc: 0.4326Epoch 00005: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 331s - loss: 1.8573 -
acc: 0.4327 - val_loss: 1.8336 - val_acc: 0.4420
Epoch 7/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.772
5 - acc: 0.4570Epoch 00006: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 331s - loss: 1.7730 -
acc: 0.4569 - val_loss: 1.8155 - val_acc: 0.4385
Epoch 8/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.703
8 - acc: 0.4773Epoch 00007: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 332s - loss: 1.7041 -
acc: 0.4771 - val_loss: 1.7569 - val_acc: 0.4665
Epoch 9/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.628
6 - acc: 0.4985Epoch 00008: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 349s - loss: 1.6285 -
acc: 0.4985 - val_loss: 1.7306 - val_acc: 0.4675
Epoch 10/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.558
8 - acc: 0.5216Epoch 00009: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 329s - loss: 1.5588 -
acc: 0.5216 - val_loss: 1.7813 - val_acc: 0.4685
Epoch 11/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.480
9 - acc: 0.5388Epoch 00010: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 329s - loss: 1.4811 -
acc: 0.5387 - val_loss: 1.6718 - val_acc: 0.4975
Epoch 12/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.423
9 - acc: 0.5558Epoch 00011: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 329s - loss: 1.4237 -
acc: 0.5558 - val_loss: 1.7033 - val_acc: 0.4810
Epoch 13/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.344
0 - acc: 0.5834Epoch 00012: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 328s - loss: 1.3441 -
acc: 0.5835 - val_loss: 1.7772 - val_acc: 0.4720
Epoch 14/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.255
9 - acc: 0.6086Epoch 00013: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 332s - loss: 1.2560 -
acc: 0.6086 - val_loss: 1.6615 - val_acc: 0.5055
Epoch 15/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.190
```

```
5 - acc: 0.6274Epoch 00014: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 329s - loss: 1.1900 -
acc: 0.6275 - val_loss: 1.7121 - val_acc: 0.5080
Epoch 16/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.118
1 - acc: 0.6517Epoch 00015: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 328s - loss: 1.1181 -
acc: 0.6519 - val_loss: 1.6534 - val_acc: 0.5160
Epoch 17/60
17984/18000 [============================>.] - ETA: 0s - loss: 1.051
7 - acc: 0.6682Epoch 00016: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 347s - loss: 1.0515 -
acc: 0.6682 - val_loss: 1.7178 - val_acc: 0.5090
Epoch 18/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.977
9 - acc: 0.6935Epoch 00017: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 361s - loss: 0.9776 -
acc: 0.6937 - val_loss: 1.6002 - val_acc: 0.5430
Epoch 19/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.916
5 - acc: 0.7127Epoch 00018: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 355s - loss: 0.9162 -
acc: 0.7128 - val_loss: 1.6638 - val_acc: 0.5375
Epoch 20/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.856
0 - acc: 0.7320Epoch 00019: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 351s - loss: 0.8559 -
acc: 0.7320 - val_loss: 1.6427 - val_acc: 0.5475
Epoch 21/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.784
2 - acc: 0.7523Epoch 00020: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 347s - loss: 0.7839 -
acc: 0.7524 - val_loss: 1.6247 - val_acc: 0.5690
Epoch 22/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.718
3 - acc: 0.7735Epoch 00021: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 348s - loss: 0.7183 -
acc: 0.7734 - val_loss: 1.7048 - val_acc: 0.5485
Epoch 23/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.674
7 - acc: 0.7868Epoch 00022: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 362s - loss: 0.6754 -
acc: 0.7864 - val_loss: 1.6626 - val_acc: 0.5535
Epoch 24/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.636
2 - acc: 0.7990Epoch 00023: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 357s - loss: 0.6369 -
acc: 0.7989 - val_loss: 1.6517 - val_acc: 0.5735
Epoch 25/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.580
1 - acc: 0.8131Epoch 00024: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 350s - loss: 0.5801 -
acc: 0.8131 - val_loss: 1.7761 - val_acc: 0.5650
Epoch 26/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.544
6 - acc: 0.8250Epoch 00025: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 338s - loss: 0.5445 -
```

```
acc: 0.8251 - val_loss: 1.6922 - val_acc: 0.5710
Epoch 27/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.512
1 - acc: 0.8359Epoch 00026: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 353s - loss: 0.5123 -
acc: 0.8358 - val_loss: 1.8576 - val_acc: 0.5715
Epoch 28/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.471
5 - acc: 0.8485Epoch 00027: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 340s - loss: 0.4721 -
acc: 0.8483 - val_loss: 1.7792 - val_acc: 0.5695
Epoch 29/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.442
8 - acc: 0.8588Epoch 00028: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 376s - loss: 0.4428 -
acc: 0.8589 - val_loss: 1.7415 - val_acc: 0.5885
Epoch 30/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.416
7 - acc: 0.8658Epoch 00029: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 435s - loss: 0.4177 -
acc: 0.8657 - val_loss: 1.8967 - val_acc: 0.5815
Epoch 31/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.392
7 - acc: 0.8745Epoch 00030: saving model to Model/final_saveall.h5

18000/18000 [==============================] - 421s - loss: 0.3927 -
acc: 0.8744 - val_loss: 1.9613 - val_acc: 0.5670
Epoch 32/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.370
3 - acc: 0.8805Epoch 00031: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 442s - loss: 0.3703 -
acc: 0.8805 - val_loss: 1.9323 - val_acc: 0.5670
Epoch 33/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.340
9 - acc: 0.8903Epoch 00032: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 448s - loss: 0.3408 -
acc: 0.8904 - val_loss: 1.8796 - val_acc: 0.5915
Epoch 34/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.335
6 - acc: 0.8912Epoch 00033: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 446s - loss: 0.3357 -
acc: 0.8912 - val_loss: 1.9784 - val_acc: 0.5810
Epoch 35/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.299
2 - acc: 0.9013Epoch 00034: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 431s - loss: 0.2997 -
acc: 0.9012 - val_loss: 1.8764 - val_acc: 0.5900
Epoch 36/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.289
8 - acc: 0.9045Epoch 00035: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 438s - loss: 0.2898 -
acc: 0.9045 - val_loss: 2.0865 - val_acc: 0.5660
Epoch 37/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.278
5 - acc: 0.9122Epoch 00036: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 428s - loss: 0.2785 -
acc: 0.9121 - val_loss: 2.0255 - val_acc: 0.5700
```

```
Epoch 38/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.267
7 - acc: 0.9129Epoch 00037: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 433s - loss: 0.2678 -
acc: 0.9129 - val_loss: 2.1067 - val_acc: 0.5720
Epoch 39/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.252
4 - acc: 0.9178Epoch 00038: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 431s - loss: 0.2530 -
acc: 0.9177 - val_loss: 1.9431 - val_acc: 0.5940
Epoch 40/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.249
5 - acc: 0.9178Epoch 00039: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 429s - loss: 0.2495 -
acc: 0.9178 - val_loss: 1.9673 - val_acc: 0.5895
Epoch 41/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.221
0 - acc: 0.9279Epoch 00040: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 431s - loss: 0.2208 -
acc: 0.9280 - val_loss: 2.0506 - val_acc: 0.5840
Epoch 42/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.229
3 - acc: 0.9268Epoch 00041: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 429s - loss: 0.2293 -
acc: 0.9268 - val_loss: 2.3080 - val_acc: 0.5690
Epoch 43/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.213
9 - acc: 0.9290Epoch 00042: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 434s - loss: 0.2144 -
acc: 0.9288 - val_loss: 2.0489 - val_acc: 0.5910
Epoch 44/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.213
2 - acc: 0.9320Epoch 00043: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 444s - loss: 0.2131 -
acc: 0.9321 - val_loss: 2.1520 - val_acc: 0.5915
Epoch 45/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.189
0 - acc: 0.9383Epoch 00044: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 451s - loss: 0.1889 -
acc: 0.9383 - val_loss: 2.1884 - val_acc: 0.5795
Epoch 46/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.192
1 - acc: 0.9378Epoch 00045: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 436s - loss: 0.1923 -
acc: 0.9378 - val_loss: 2.1648 - val_acc: 0.5705
Epoch 47/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.189
9 - acc: 0.9395Epoch 00046: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 436s - loss: 0.1903 -
acc: 0.9394 - val_loss: 2.1455 - val_acc: 0.5975
Epoch 48/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.185
4 - acc: 0.9408Epoch 00047: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 438s - loss: 0.1858 -
acc: 0.9407 - val_loss: 2.1323 - val_acc: 0.5980
Epoch 49/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.174
```

```
0 - acc: 0.9436Epoch 00048: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 408s - loss: 0.1741 -
acc: 0.9436 - val_loss: 2.2094 - val_acc: 0.5980
Epoch 50/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.170
9 - acc: 0.9427Epoch 00049: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 353s - loss: 0.1713 -
acc: 0.9426 - val_loss: 2.1282 - val_acc: 0.6030
Epoch 51/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.172
6 - acc: 0.9428Epoch 00050: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 351s - loss: 0.1728 -
acc: 0.9427 - val_loss: 2.2370 - val_acc: 0.5880
Epoch 52/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.157
6 - acc: 0.9492Epoch 00051: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 338s - loss: 0.1576 -
acc: 0.9493 - val_loss: 2.2390 - val_acc: 0.5845
Epoch 53/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.154
1 - acc: 0.9498Epoch 00052: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 337s - loss: 0.1543 -
acc: 0.9498 - val_loss: 2.2276 - val_acc: 0.5865
Epoch 54/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.152
9 - acc: 0.9493Epoch 00053: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 348s - loss: 0.1529 -
acc: 0.9492 - val_loss: 2.2426 - val_acc: 0.5880
Epoch 55/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.141
7 - acc: 0.9532Epoch 00054: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 356s - loss: 0.1418 -
acc: 0.9532 - val_loss: 2.2577 - val_acc: 0.5915
Epoch 56/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.138
7 - acc: 0.9540Epoch 00055: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 361s - loss: 0.1389 -
acc: 0.9540 - val_loss: 2.1670 - val_acc: 0.6010
Epoch 57/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.146
4 - acc: 0.9527Epoch 00056: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 357s - loss: 0.1463 -
acc: 0.9528 - val_loss: 2.1588 - val_acc: 0.6020
Epoch 58/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.142
7 - acc: 0.9543Epoch 00057: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 337s - loss: 0.1428 -
acc: 0.9542 - val_loss: 2.1951 - val_acc: 0.5990
Epoch 59/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.143
6 - acc: 0.9548Epoch 00058: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 336s - loss: 0.1436 -
acc: 0.9547 - val_loss: 2.3011 - val_acc: 0.5950
Epoch 60/60
17984/18000 [============================>.] - ETA: 0s - loss: 0.136
4 - acc: 0.9569Epoch 00059: saving model to Model/final_saveall.h5
18000/18000 [==============================] - 337s - loss: 0.1363 -
```

In [ ]:

```

```

In [ ]:

```

```

In [ ]:

```

```

In [14]:

```
model.summary()
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d_1 (Conv2D)            (None, 32, 32, 16)        1216      
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 32, 32, 32)        4640      
_________________________________________________________________
batch_normalization_1 (Batch (None, 32, 32, 32)        128       
_________________________________________________________________
dropout_1 (Dropout)          (None, 32, 32, 32)        0         
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 16, 16, 32)        0         
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 16, 16, 64)        18496     
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 8, 8, 64)          0         
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 8, 8, 128)         73856     
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 4, 4, 128)         0         
_________________________________________________________________
batch_normalization_2 (Batch (None, 4, 4, 128)         512       
_________________________________________________________________
dropout_2 (Dropout)          (None, 4, 4, 128)         0         
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 4, 4, 256)         295168    
_________________________________________________________________
dropout_3 (Dropout)          (None, 4, 4, 256)         0         
_________________________________________________________________
conv2d_6 (Conv2D)            (None, 4, 4, 512)         1180160   
_________________________________________________________________
batch_normalization_3 (Batch (None, 4, 4, 512)         2048      
_________________________________________________________________
flatten_1 (Flatten)          (None, 8192)              0         
_________________________________________________________________
dense_1 (Dense)              (None, 512)               4194816   
_________________________________________________________________
batch_normalization_4 (Batch (None, 512)               2048      
_________________________________________________________________
dropout_4 (Dropout)          (None, 512)               0         
```

```
_________________________________________________________________
dense_2 (Dense)              (None, 128)               65664
_________________________________________________________________
batch_normalization_5 (Batch (None, 128)               512
_________________________________________________________________
dropout_5 (Dropout)          (None, 128)               0
_________________________________________________________________
dense_3 (Dense)              (None, 64)                8256
_________________________________________________________________
dense_4 (Dense)              (None, 20)                1300
=================================================================
Total params: 5,848,820
Trainable params: 5,846,196
Non-trainable params: 2,624
_________________________________________________________________
```

In [15]:

```python
params = list(results.history.keys())
xaxis = []
val_loss = results.history['val_loss']
val_acc = results.history['val_acc']
loss = results.history['loss']
acc = results.history['acc']

for i in range(60):
    xaxis.append(i+1)
```

In [19]:

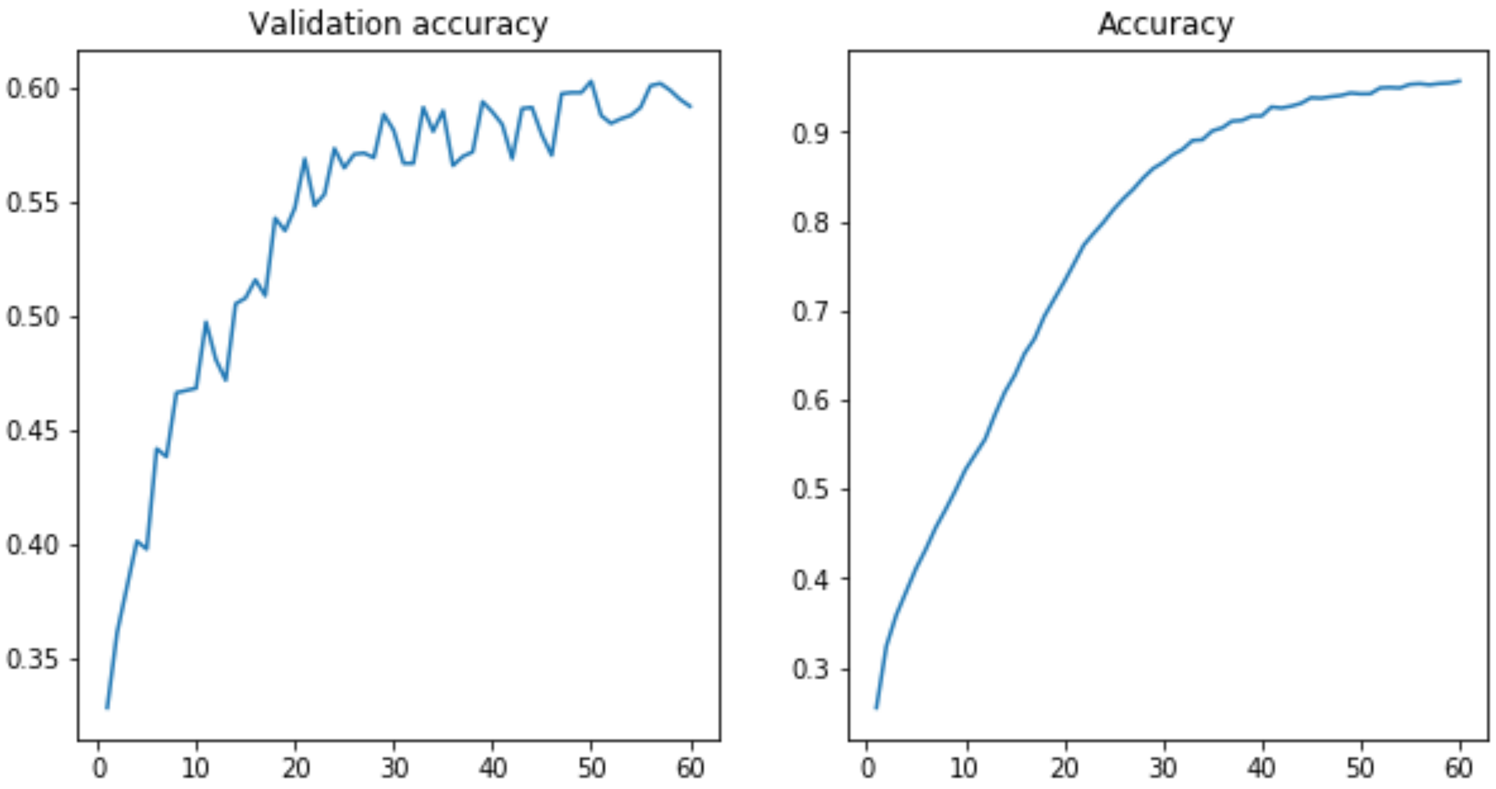
```python
dict_params = {'val_loss' : val_loss, 'val_acc' : val_acc, 'loss' : loss, 'acc' :
df_params = pd.DataFrame(dict_params)
df_params.to_csv('Model/parameters_final.csv')
```

In [20]:

```
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.plot(xaxis, val_acc)
plt.title('Validation accuracy')
plt.subplot(1, 2, 2)
plt.plot(xaxis, acc)
plt.title('Accuracy')
```

Out[20]:

```
<matplotlib.text.Text at 0x135734438>
```



Validation accuracy

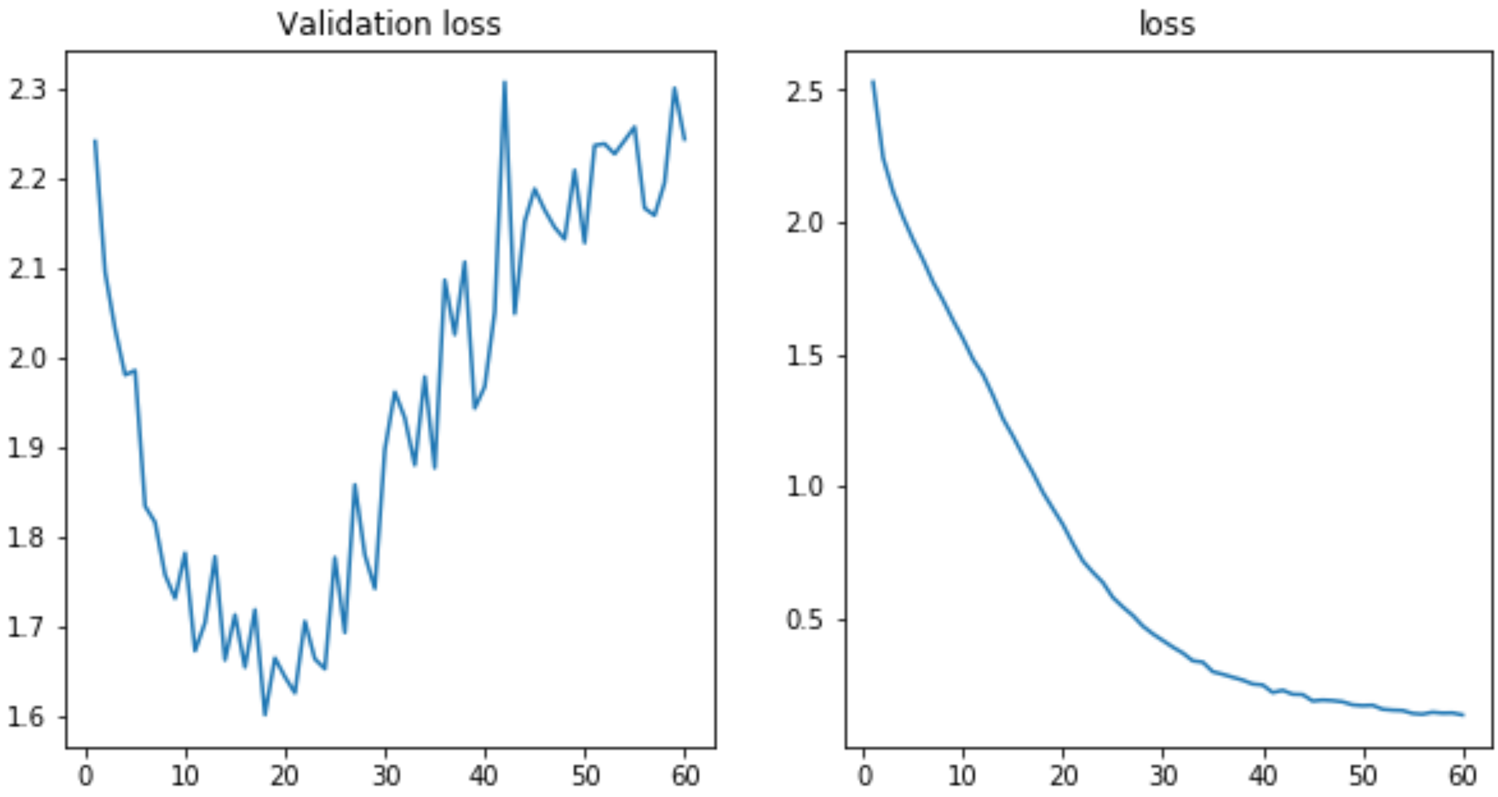
Accuracy

In [21]:

```
plt.figure(figsize=(10, 5))
plt.subplot(1, 2, 1)
plt.plot(xaxis, val_loss)
plt.title('Validation loss')
plt.subplot(1, 2, 2)
plt.plot(xaxis, loss)
plt.title('loss')
```

Out[21]:

```
<matplotlib.text.Text at 0x1353c5e48>
```



In [22]:

```
X_test = image[20000:]
Y_test = Y[20000:]
label_test = label[20000:]
```

In [24]:

```
model = classification('Model/final_saveall.h5')
```

In [25]:

```
score = model.evaluate(X_test, Y_test)
score[1]
```

```
2910/2910 [==============================] - 17s
```

Out[25]:

```
0.5896907215675538
```

In [26]:

```
label_names = ['aquatic mammals',
               'fish',
               'flowers',
               'food containers',
               'fruit and vegetables',
               'household electrical devices',
               'household furniture',
               'insects',
               'large carnivores',
               'large man-made outdoor things',
               'large natural outdoor scenes',
               'large omnivores and herbivores',
               'medium-sized mammals',
               'non-insect invertebrates',
               'human',
               'reptiles',
               'small mammals',
               'trees',
               'vehicles',
               'vehicles']
```

In [27]:

```
pred = model.predict(X_test)
```

In [28]:

```
pred[0]
```

Out[28]:

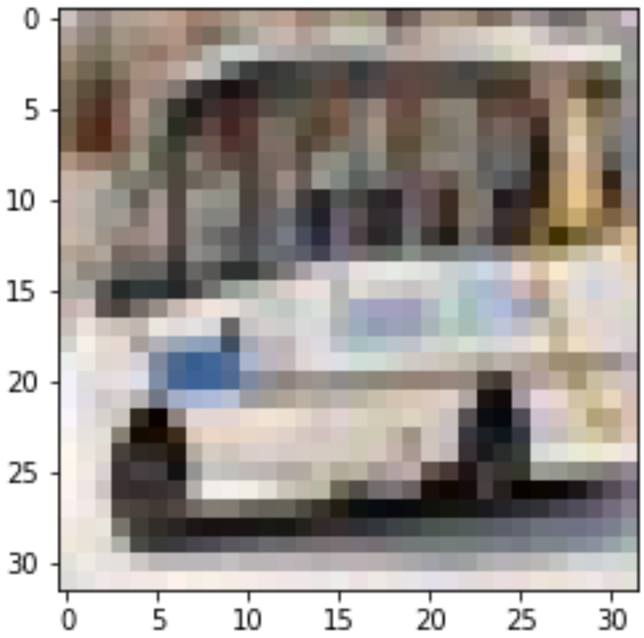
```
array([1.06613095e-06, 4.83985650e-06, 6.09897643e-09, 2.42207789e-0
5,
       9.43731138e-09, 1.67206654e-05, 1.55504182e-04, 1.38480118e-0
6,
       1.11887384e-04, 3.73480289e-04, 9.79136644e-07, 6.47935940e-0
6,
       3.30841181e-06, 5.96883228e-06, 6.58858426e-08, 4.64199729e-0
6,
       1.89576167e-06, 1.96138080e-06, 6.10176772e-02, 9.38267946e-0
1],
      dtype=float32)
```

In [29]:

```
plt.imshow(X_test[0])
```

Out[29]:

```
<matplotlib.image.AxesImage at 0x143f9f668>
```



In [30]:

```
Y_test[0]
```

Out[30]:

```
array([0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0
., 0.,
       0., 1., 0.])
```

In [31]:

```
(pred[0].tolist()).index(max(pred[0]))
```

Out[31]:

```
19
```

In [32]:

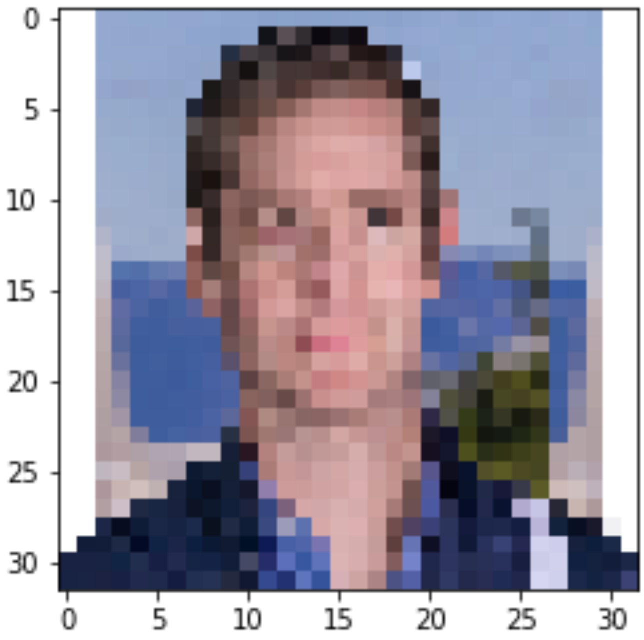
```
def test_on_random(filename):
    path = root+'/Data/Random/'+str(filename)+'.jpg'
    img = cv2.imread(path)
    img = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    #plt.figure(figsize=(7, 7))
    #plt.subplot(1, 2, 1)
    #plt.imshow(img)
    img = cv2.resize(img, (32, 32))
    img = img.reshape(1, 32, 32, 3)
    cnn = model.predict(img[:,:,:])
    #plt.subplot(1, 2, 2)
    plt.imshow(img[0])
    foo = label_names[(cnn[0].tolist()).index(max(cnn[0]))]
    return foo
```

In [33]:

```
test_on_random(2)
```

Out[33]:

```
'human'
```

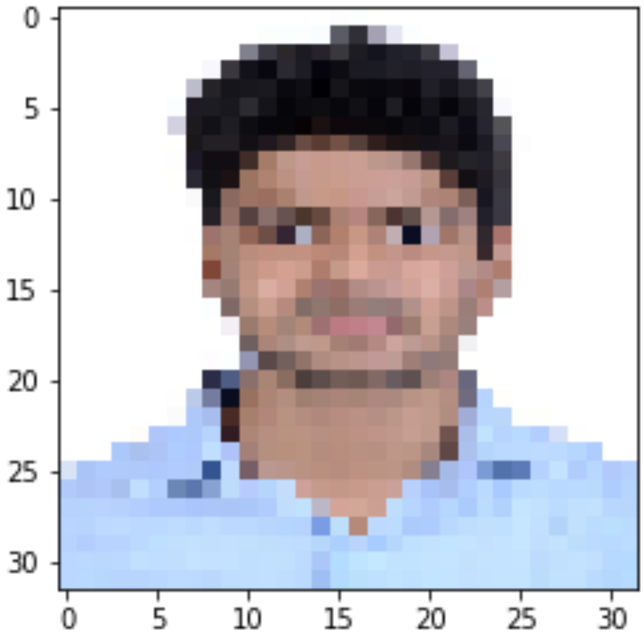


In [34]:

```
test_on_random(4)
```

Out[34]:

```
'human'
```

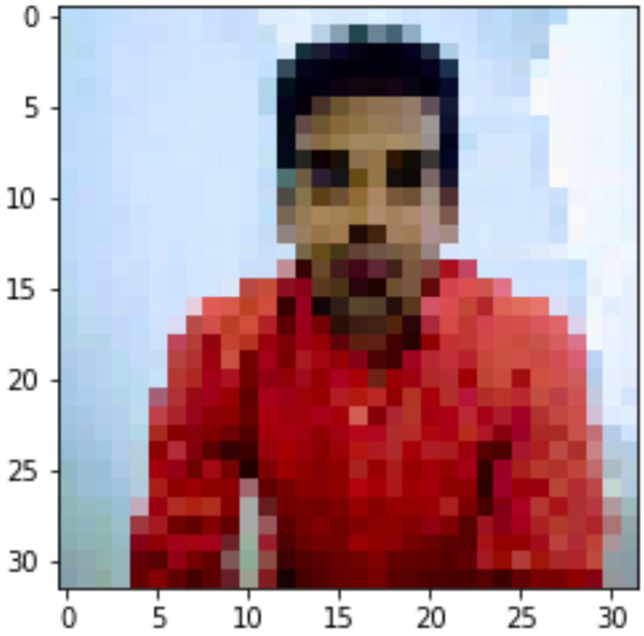


In [35]:

```
test_on_random(3)
```

Out[35]:

```
'human'
```

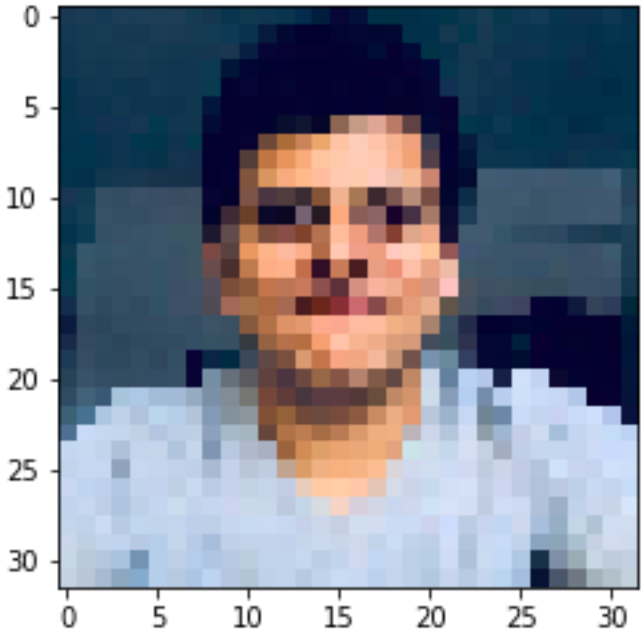


In [36]:

```
test_on_random(5)
```

Out[36]:

```
'human'
```

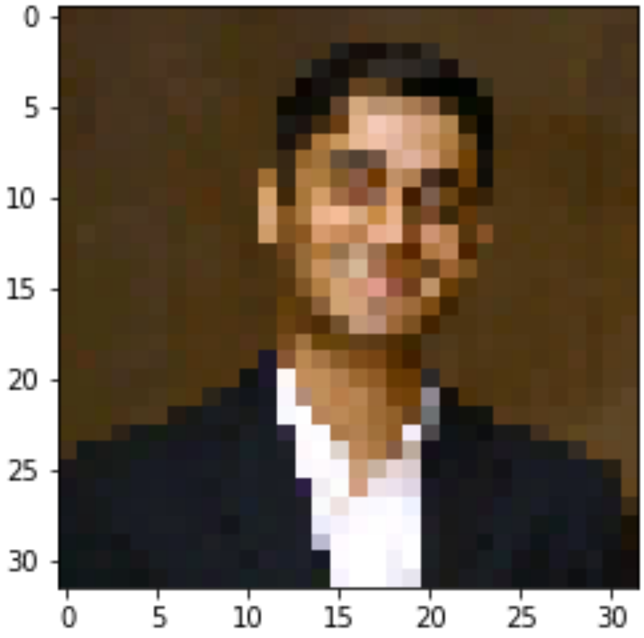


In [37]:

```
test_on_random(6)
```

Out[37]:

```
'fruit and vegetables'
```

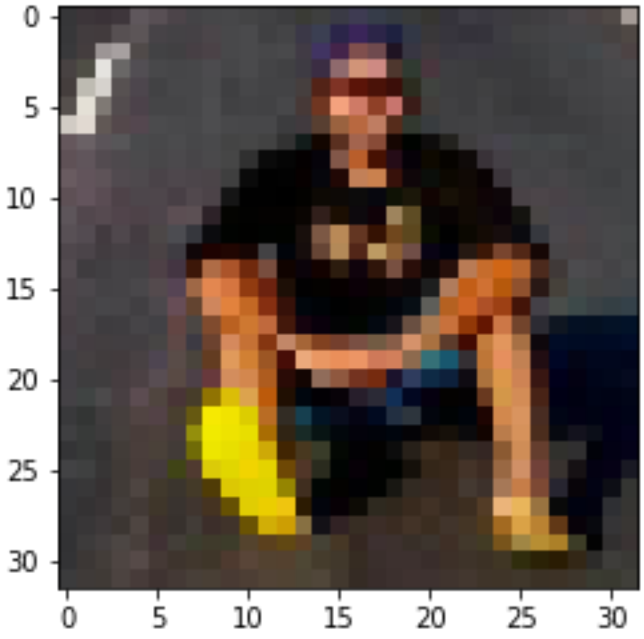


In [38]:

```
test_on_random(7)
```

Out[38]:

```
'vehicles'
```

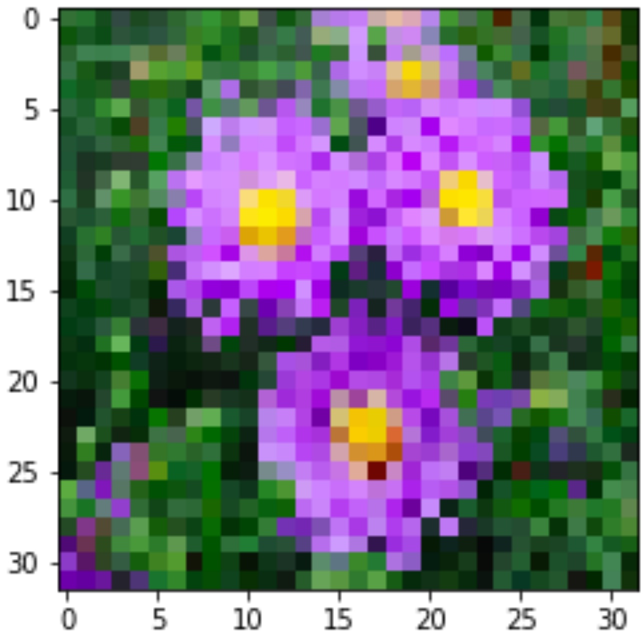


In [39]:

```
test_on_random(9)
```

Out[39]:

```
'flowers'
```

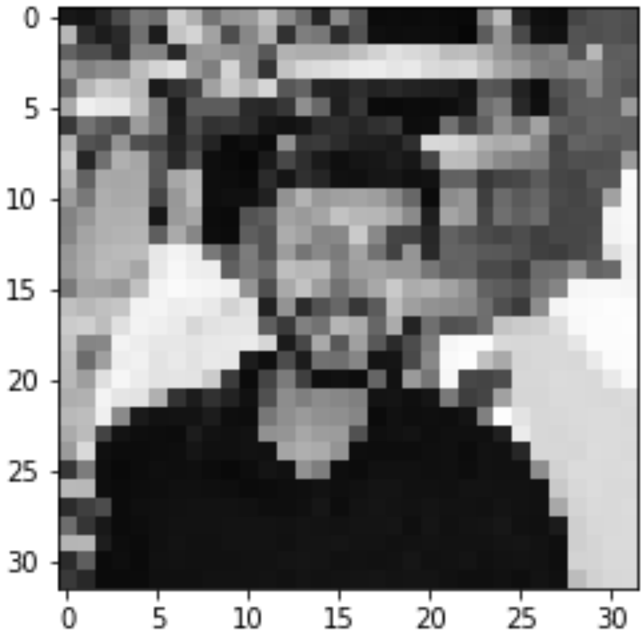


In [40]:

```
test_on_random(10)
```

Out[40]:

```
'vehicles'
```

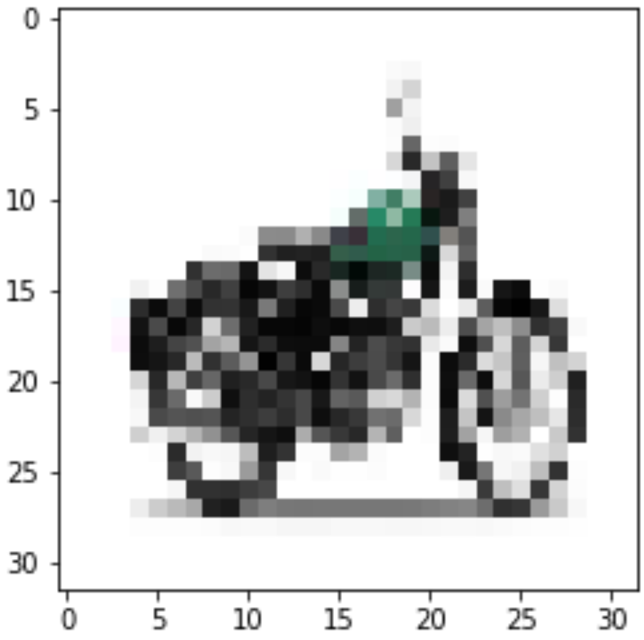


In [41]:

```
test_on_random(11)
```

Out[41]:

```
'vehicles'
```

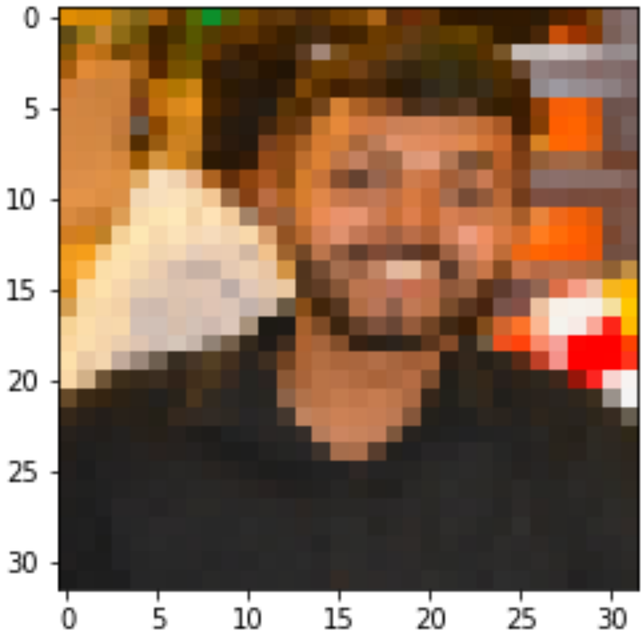


In [42]:

```
test_on_random(16)
```

Out[42]:

```
'non-insect invertebrates'
```

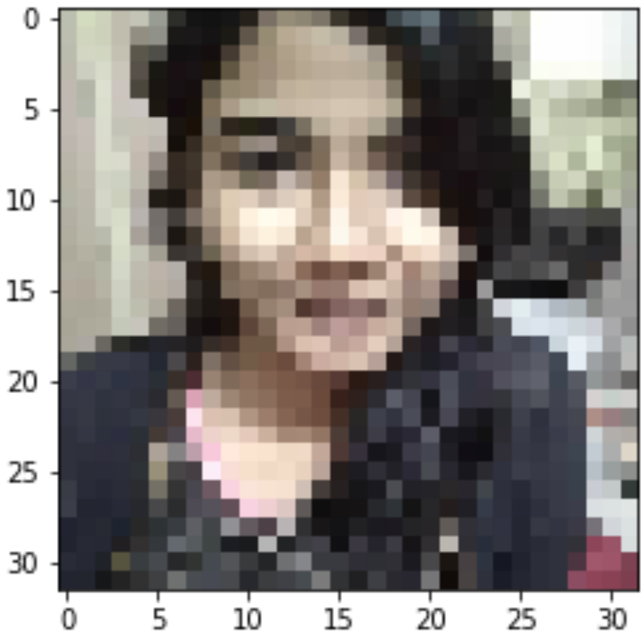


```
In [43]:
```

```
test_on_random(44)
```

```
Out[43]:

'human'
```

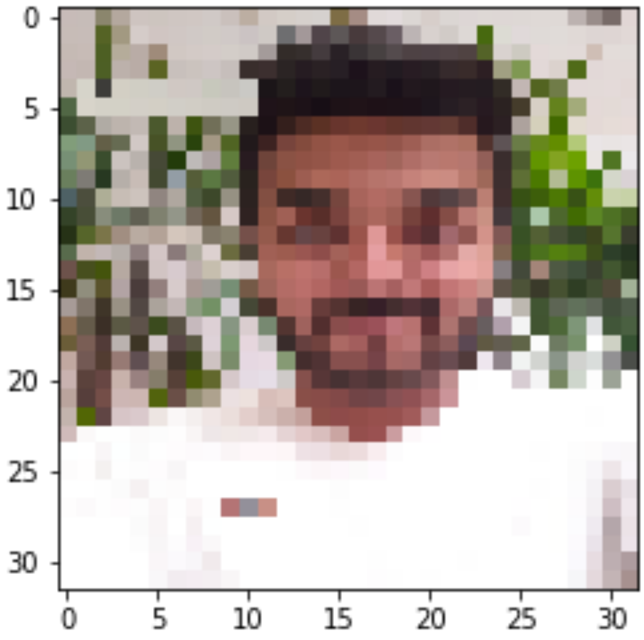


```
In [44]:
```

```
test_on_random(17)
```

```
Out[44]:

'large carnivores'
```

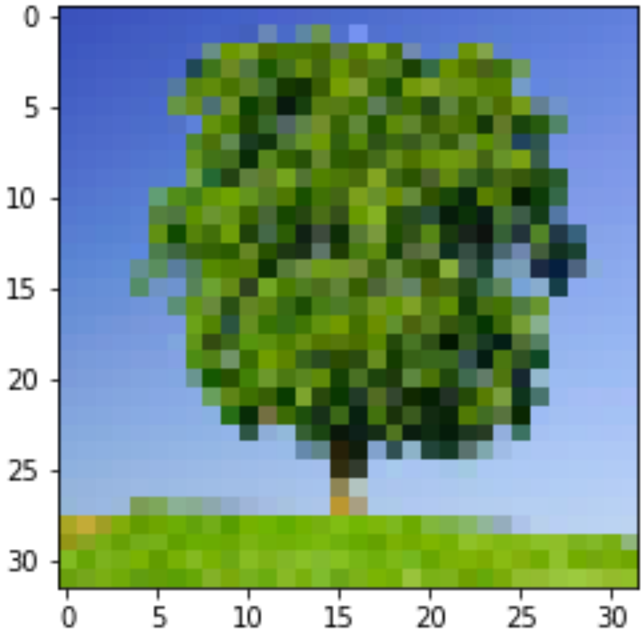


In [46]:

```
test_on_random(19)
```

Out[46]:

```
'trees'
```

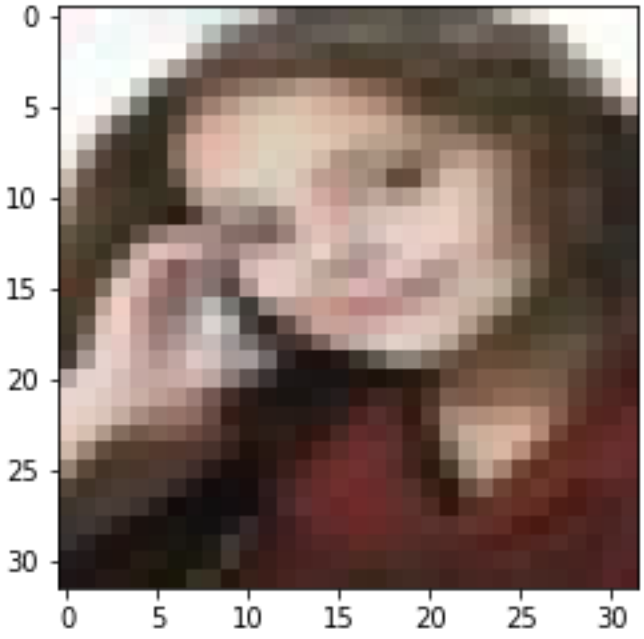


In [47]:

```
plt.imshow(image[0])
```

Out[47]:

```
<matplotlib.image.AxesImage at 0x139cf3da0>
```



In [48]:

```
label[0]
```

Out[48]:

```
14
```

In [49]:

```
Y_train[0]
```

Out[49]:

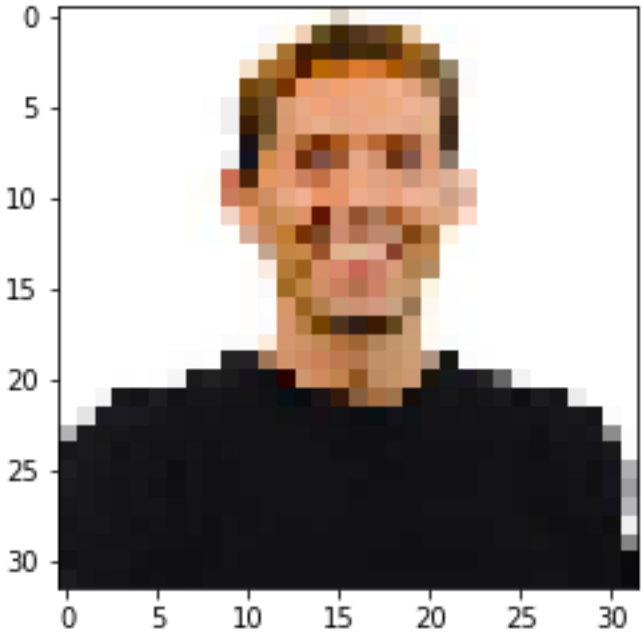
```
array([0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 1., 0
., 0.,
       0., 0., 0.])
```

In [50]:

```
test_on_random(27)
```

Out[50]:

```
'human'
```



In [ ]:

```

```