In [2]:
```
import struct
import numpy as np
import tensorflow as tf
from tensorflow.keras.layers import Conv2D
from tensorflow.keras.layers import Input
from tensorflow.keras.layers import BatchNormalization
from tensorflow.keras.layers import LeakyReLU
from tensorflow.keras.layers import ZeroPadding2D
from tensorflow.keras.layers import UpSampling2D
from tensorflow.keras.layers import add, concatenate
from tensorflow.keras.models import Model
from tensorflow.keras.preprocessing.image import load_img
import matplotlib.pyplot as plt
from matplotlib import pyplot
from matplotlib.patches import Rectangle
from numpy import expand_dims
```

In [4]:
```
def _conv_block(inp, convs, skip=True):
    x = inp
    count = 0
    for conv in convs:
        if count == (len(convs) - 2) and skip:
            skip_connection = x
        count += 1
        if conv['stride'] > 1: x = ZeroPadding2D(((1, 0), (1, 0)))(x)  # peculiar padding as darknet prefer left and top
        x = Conv2D(conv['filter'],
                   conv['kernel'],
                   strides=conv['stride'],
                   padding='valid' if conv['stride'] > 1 else 'same',  # peculiar padding as darknet prefer left and top
                   name='conv_' + str(conv['layer_idx']),
                   use_bias=False if conv['bnorm'] else True)(x)
        if conv['bnorm']: x = BatchNormalization(epsilon=0.001, name='bnorm_' + str(conv['layer_idx']))(x)
        if conv['leaky']: x = LeakyReLU(alpha=0.1, name='leaky_' + str(conv['layer_idx']))(x)
    return add([skip_connection, x]) if skip else x


def make_yolov3_model():
    input_image = Input(shape=(None, None, 3))
    # Layer  0 => 4
    x = _conv_block(input_image,
                    [{'filter': 32, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 0},
                     {'filter': 64, 'kernel': 3, 'stride': 2, 'bnorm': True, 'leaky': True, 'layer_idx': 1},
                     {'filter': 32, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 2},
                     {'filter': 64, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 3}])
    # Layer  5 => 8
    x = _conv_block(x, [{'filter': 128, 'kernel': 3, 'stride': 2, 'bnorm': True, 'leaky': True, 'layer_idx': 5},
                        {'filter': 64, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 6},
                        {'filter': 128, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 7}])
    # Layer  9 => 11
    x = _conv_block(x, [{'filter': 64, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 9},
                        {'filter': 128, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 10}])
    # Layer 12 => 15
    x = _conv_block(x, [{'filter': 256, 'kernel': 3, 'stride': 2, 'bnorm': True, 'leaky': True, 'layer_idx': 12},
                        {'filter': 128, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 13},
                        {'filter': 256, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 14}])
    # Layer 16 => 36
    for i in range(7):
        x = _conv_block(x, [
            {'filter': 128, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 16 + i * 3},
            {'filter': 256, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 17 + i * 3}])
    skip_36 = x
    # Layer 37 => 40
    x = _conv_block(x, [{'filter': 512, 'kernel': 3, 'stride': 2, 'bnorm': True, 'leaky': True, 'layer_idx': 37},
                        {'filter': 256, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 38},
                        {'filter': 512, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 39}])
    # Layer 41 => 61
    for i in range(7):
        x = _conv_block(x, [
            {'filter': 256, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 41 + i * 3},
            {'filter': 512, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 42 + i * 3}])
    skip_61 = x
    # Layer 62 => 65
    x = _conv_block(x, [{'filter': 1024, 'kernel': 3, 'stride': 2, 'bnorm': True, 'leaky': True, 'layer_idx': 62},
                        {'filter': 512, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 63},
                        {'filter': 1024, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 64}])
    # Layer 66 => 74
    for i in range(3):
        x = _conv_block(x, [
            {'filter': 512, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 66 + i * 3},
            {'filter': 1024, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 67 + i * 3}])
    # Layer 75 => 79
    x = _conv_block(x, [{'filter': 512, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 75},
                        {'filter': 1024, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 76},
                        {'filter': 512, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 77},
                        {'filter': 1024, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 78},
                        {'filter': 512, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 79}],
                    skip=False)
    # Layer 80 => 82
    yolo_82 = _conv_block(x, [{'filter': 1024, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 80},
                              {'filter': 255, 'kernel': 1, 'stride': 1, 'bnorm': False, 'leaky': False,
                               'layer_idx': 81}], skip=False)
    # Layer 83 => 86
    x = _conv_block(x, [{'filter': 256, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 84}],
                    skip=False)
    x = UpSampling2D(2)(x)
    x = concatenate([x, skip_61])
    # Layer 87 => 91
```

```
    x = _conv_block(x, [{'filter': 256, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 87},
                        {'filter': 512, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 88},
                        {'filter': 256, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 89},
                        {'filter': 512, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 90},
                        {'filter': 256, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 91}],
                    skip=False)
    # Layer 92 => 94
    yolo_94 = _conv_block(x, [{'filter': 512, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 92},
                              {'filter': 255, 'kernel': 1, 'stride': 1, 'bnorm': False, 'leaky': False,
                               'layer_idx': 93}], skip=False)
    # Layer 95 => 98
    x = _conv_block(x, [{'filter': 128, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 96}],
                    skip=False)
    x = UpSampling2D(2)(x)
    x = concatenate([x, skip_36])
    # Layer 99 => 106
    yolo_106 = _conv_block(x, [{'filter': 128, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True, 'layer_idx': 99},
                               {'filter': 256, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True,
                                'layer_idx': 100},
                               {'filter': 128, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True,
                                'layer_idx': 101},
                               {'filter': 256, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True,
                                'layer_idx': 102},
                               {'filter': 128, 'kernel': 1, 'stride': 1, 'bnorm': True, 'leaky': True,
                                'layer_idx': 103},
                               {'filter': 256, 'kernel': 3, 'stride': 1, 'bnorm': True, 'leaky': True,
                                'layer_idx': 104},
                               {'filter': 255, 'kernel': 1, 'stride': 1, 'bnorm': False, 'leaky': False,
                                'layer_idx': 105}], skip=False)
    model = Model(input_image, [yolo_82, yolo_94, yolo_106])
    return model


class WeightReader:
    def __init__(self, weight_file):
        with open(weight_file, 'rb') as w_f:
            major, = struct.unpack('i', w_f.read(4))
            minor, = struct.unpack('i', w_f.read(4))
            revision, = struct.unpack('i', w_f.read(4))
            if (major * 10 + minor) >= 2 and major < 1000 and minor < 1000:
                w_f.read(8)
            else:
                w_f.read(4)
            transpose = (major > 1000) or (minor > 1000)
            binary = w_f.read()
        self.offset = 0
        self.all_weights = np.frombuffer(binary, dtype='float32')

    def read_bytes(self, size):
        self.offset = self.offset + size
        return self.all_weights[self.offset - size:self.offset]

    def load_weights(self, model):
        for i in range(106):
            try:
                conv_layer = model.get_layer('conv_' + str(i))
                print("loading weights of convolution #" + str(i))
                if i not in [81, 93, 105]:
                    norm_layer = model.get_layer('bnorm_' + str(i))
                    size = np.prod(norm_layer.get_weights()[0].shape)
                    beta = self.read_bytes(size)  # bias
                    gamma = self.read_bytes(size)  # scale
                    mean = self.read_bytes(size)  # mean
                    var = self.read_bytes(size)  # variance
                    weights = norm_layer.set_weights([gamma, beta, mean, var])
                if len(conv_layer.get_weights()) > 1:
                    bias = self.read_bytes(np.prod(conv_layer.get_weights()[1].shape))
                    kernel = self.read_bytes(np.prod(conv_layer.get_weights()[0].shape))
                    kernel = kernel.reshape(list(reversed(conv_layer.get_weights()[0].shape)))
                    kernel = kernel.transpose([2, 3, 1, 0])
                    conv_layer.set_weights([kernel, bias])
                else:
                    kernel = self.read_bytes(np.prod(conv_layer.get_weights()[0].shape))
                    kernel = kernel.reshape(list(reversed(conv_layer.get_weights()[0].shape)))
                    kernel = kernel.transpose([2, 3, 1, 0])
                    conv_layer.set_weights([kernel])
            except ValueError:
                print("no convolution #" + str(i))

    def reset(self):
        self.offset = 0
```

In [24]:

```
# define the model
model = make_yolov3_model()
# load the model weights
weight_reader = WeightReader('./yolov3.weights')
# set the model weights into the model
weight_reader.load_weights(model)
# # save the model to file
# model.save('/content/drive/My Drive/DPprojects/Object Detection - Yolo/model/model.h5')


# model.summary()
```

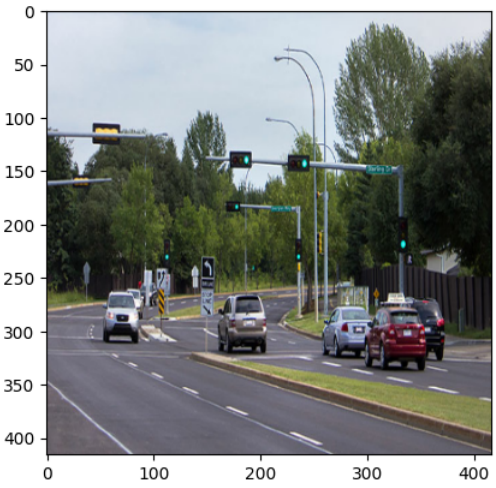
```
loading weights of convolution #0
loading weights of convolution #1
loading weights of convolution #2
loading weights of convolution #3
no convolution #4
loading weights of convolution #5
loading weights of convolution #6
loading weights of convolution #7
no convolution #8
loading weights of convolution #9
loading weights of convolution #10
no convolution #11
loading weights of convolution #12
loading weights of convolution #13
loading weights of convolution #14
no convolution #15
loading weights of convolution #16
loading weights of convolution #17
no convolution #18
loading weights of convolution #19
loading weights of convolution #20
no convolution #21
loading weights of convolution #22
loading weights of convolution #23
no convolution #24
loading weights of convolution #25
loading weights of convolution #26
no convolution #27
loading weights of convolution #28
loading weights of convolution #29
no convolution #30
loading weights of convolution #31
loading weights of convolution #32
no convolution #33
loading weights of convolution #34
loading weights of convolution #35
no convolution #36
loading weights of convolution #37
loading weights of convolution #38
loading weights of convolution #39
no convolution #40
loading weights of convolution #41
loading weights of convolution #42
no convolution #43
loading weights of convolution #44
loading weights of convolution #45
no convolution #46
loading weights of convolution #47
loading weights of convolution #48
no convolution #49
loading weights of convolution #50
loading weights of convolution #51
no convolution #52
loading weights of convolution #53
loading weights of convolution #54
no convolution #55
loading weights of convolution #56
loading weights of convolution #57
no convolution #58
loading weights of convolution #59
loading weights of convolution #60
no convolution #61
loading weights of convolution #62
loading weights of convolution #63
loading weights of convolution #64
no convolution #65
loading weights of convolution #66
loading weights of convolution #67
no convolution #68
loading weights of convolution #69
loading weights of convolution #70
no convolution #71
loading weights of convolution #72
loading weights of convolution #73
no convolution #74
loading weights of convolution #75
loading weights of convolution #76
loading weights of convolution #77
loading weights of convolution #78
loading weights of convolution #79
loading weights of convolution #80
loading weights of convolution #81
no convolution #82
no convolution #83
loading weights of convolution #84
no convolution #85
no convolution #86
loading weights of convolution #87
loading weights of convolution #88
loading weights of convolution #89
loading weights of convolution #90
loading weights of convolution #91
loading weights of convolution #92
loading weights of convolution #93
no convolution #94
no convolution #95
loading weights of convolution #96
no convolution #97
no convolution #98
loading weights of convolution #99
```

```
loading weights of convolution #100
loading weights of convolution #101
loading weights of convolution #102
loading weights of convolution #103
loading weights of convolution #104
loading weights of convolution #105
```

In [8]:
```
labels = ["person", "bicycle", "car", "motorbike", "aeroplane", "bus", "train", "truck",
        "boat", "traffic light", "fire hydrant", "stop sign", "parking meter", "bench",
        "bird", "cat", "dog", "horse", "sheep", "cow", "elephant", "bear", "zebra", "giraffe",
        "backpack", "umbrella", "handbag", "tie", "suitcase", "frisbee", "skis", "snowboard",
        "sports ball", "kite", "baseball bat", "baseball glove", "skateboard", "surfboard",
        "tennis racket", "bottle", "wine glass", "cup", "fork", "knife", "spoon", "bowl", "banana",
        "apple", "sandwich", "orange", "broccoli", "carrot", "hot dog", "pizza", "donut", "cake",
        "chair", "sofa", "pottedplant", "bed", "diningtable", "toilet", "tvmonitor", "laptop", "mouse",
        "remote", "keyboard", "cell phone", "microwave", "oven", "toaster", "sink", "refrigerator",
        "book", "clock", "vase", "scissors", "teddy bear", "hair drier", "toothbrush"]
IMAGE_WIDTH=416
IMAGE_HEIGHT=416
def load_and_preprocess_image(path,shape):
  image=tf.io.read_file(path)
  width,height=load_img(path).size
  image=tf.image.decode_jpeg(image,channels=3)
  image=tf.image.resize(image, shape)
  image/=255
  return image,width,height
```

In [9]:
```
photo_filename='./traffic.jpg'
_image, image_w, image_h=load_and_preprocess_image(photo_filename,[IMAGE_WIDTH,IMAGE_HEIGHT])
plt.imshow(_image)
```

Out[9]: <matplotlib.image.AxesImage at 0x1f3e1dc9d88>



In [10]:
```
image = expand_dims(_image, 0)
yhat = model.predict(image)
print([a.shape for a in yhat])
```

```
1/1 [==============================] - 2s 2s/step
[(1, 13, 13, 255), (1, 26, 26, 255), (1, 52, 52, 255)]
```

In [14]:
```
class BoundBox:
        '''
        Objects of boxes. (xmin,ymin) represents the upleft coordinate of the box while (xmax,ymax) means downright one.
        '''
        def __init__(self, xmin, ymin, xmax, ymax, objness = None, classes = None):
                self.xmin = xmin
                self.ymin = ymin
                self.xmax = xmax
                self.ymax = ymax
                self.objness = objness
                self.classes = classes
                self.label = -1
                self.score = -1

        def get_label(self):
                if self.label == -1:
                        self.label = np.argmax(self.classes)

                return self.label

        def get_score(self):
                if self.score == -1:
                        self.score = self.classes[self.get_label()]

                return self.score

def _sigmoid(x):
        return 1. / (1. + np.exp(-x))

def decode_netout(netout, anchors, net_h, net_w):
        grid_h, grid_w = netout.shape[:2]
        nb_box = 3
        netout = netout.reshape((grid_h, grid_w, nb_box, -1))
        nb_class = netout.shape[-1] - 5
        boxes = []
```

```
        netout[..., :2]  = _sigmoid(netout[..., :2])
        netout[..., 4:]  = _sigmoid(netout[..., 4:])
        netout[..., 5:]  = netout[..., 4][..., np.newaxis] * netout[..., 5:]

        for i in range(grid_h*grid_w):
                row = i / grid_w
                col = i % grid_w
                for b in range(nb_box):
                        # 4th element is objectness score
                        objectness = netout[int(row)][int(col)][b][4]
                        # if(objectness.all() <= obj_thresh): continue
                        # first 4 elements are x, y, w, and h
                        x, y, w, h = netout[int(row)][int(col)][b][:4]
                        x = (col + x) / grid_w # center position, unit: image width
                        y = (row + y) / grid_h # center position, unit: image height
                        w = anchors[2 * b + 0] * np.exp(w) / net_w # unit: image width
                        h = anchors[2 * b + 1] * np.exp(h) / net_h # unit: image height
                        # last elements are class probabilities
                        classes = netout[int(row)][col][b][5:]
                        box = BoundBox(x-w/2, y-h/2, x+w/2, y+h/2, objectness, classes)
                        boxes.append(box)
        return boxes
```

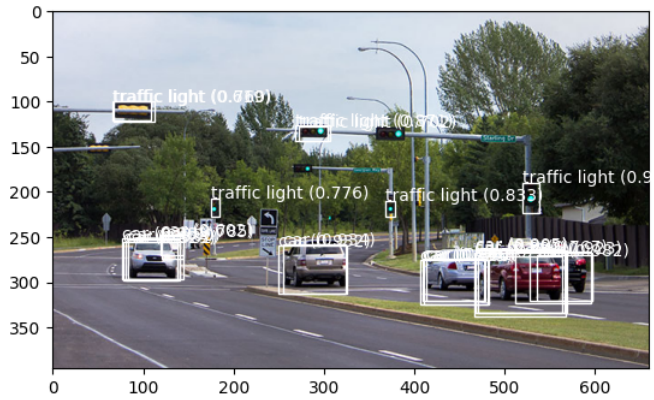
In [15]:
```
anchors = [[116,90, 156,198, 373,326], [30,61, 62,45, 59,119], [10,13, 16,30, 33,23]]
boxes = list()
for i in range(len(yhat)):
        boxes += decode_netout(yhat[i][0], anchors[i], net_h=IMAGE_HEIGHT, net_w=IMAGE_WIDTH)

for i in range(len(boxes)):
        x_offset, x_scale = (IMAGE_WIDTH - IMAGE_WIDTH)/2./IMAGE_HEIGHT, float(IMAGE_WIDTH)/IMAGE_WIDTH
        y_offset, y_scale = (IMAGE_HEIGHT - IMAGE_HEIGHT)/2./IMAGE_HEIGHT, float(IMAGE_HEIGHT)/IMAGE_HEIGHT
        boxes[i].xmin = int((boxes[i].xmin - x_offset) / x_scale * image_w)
        boxes[i].xmax = int((boxes[i].xmax - x_offset) / x_scale * image_w)
        boxes[i].ymin = int((boxes[i].ymin - y_offset) / y_scale * image_h)
        boxes[i].ymax = int((boxes[i].ymax - y_offset) / y_scale * image_h)
len(boxes)
```

Out[15]:
```
10647
```

In [16]:
```
def box_filter(boxes,labels,threshold_socre):
        valid_boxes=[]
        valid_labels=[]
        valid_scores=[]
        for box in boxes:
                for i in range(len(labels)):
                        if box.classes[i] > threshold_socre:
                                valid_boxes.append(box)
                                valid_labels.append(labels[i])
                                valid_scores.append(box.classes[i])

        return (valid_boxes,valid_labels,valid_scores)
valid_data= box_filter(boxes, labels, threshold_socre=0.6)
```

In [17]:
```
def draw_boxes(filename, valid_data):

        data = pyplot.imread(filename)
        pyplot.imshow(data)
        ax = pyplot.gca()
        for i in range(len(valid_data[0])):
                box = valid_data[0][i]
                y1, x1, y2, x2 = box.ymin, box.xmin, box.ymax, box.xmax
                width, height = x2 - x1, y2 - y1
                rect = Rectangle((x1, y1), width, height, fill=False, color='white')
                ax.add_patch(rect)
                print(valid_data[1][i], valid_data[2][i])
                label = "%s (%.3f)" % (valid_data[1][i], valid_data[2][i])
                pyplot.text(x1, y1, label, color='white')
        pyplot.show()
draw_boxes(photo_filename,valid_data)
```

```
car 0.9799808
car 0.90150243
car 0.9822434
car 0.82281214
car 0.9342798
car 0.93157935
car 0.98184437
car 0.9982241
car 0.981548
car 0.9050933
car 0.76686305
car 0.98158294
car 0.92317057
car 0.65974027
car 0.9845722
car 0.98843783
car 0.8808287
traffic light 0.618828
traffic light 0.75971967
traffic light 0.70200676
traffic light 0.87137073
traffic light 0.964606
traffic light 0.77623147
traffic light 0.8328069
car 0.6020881
car 0.78529125
```



In [18]:

```
def encoder_dic(valid_data):
  data_dic={}
  (valid_boxes,valid_labels,valid_scores)=valid_data
  for box, label,score in zip(valid_boxes,valid_labels,valid_scores):
    if label not in data_dic:
      data_dic[label]=[[score,box,'kept']]
    else:
      data_dic[label].append([score,box,'kept'])

  return data_dic
dic=encoder_dic(valid_data)


def decode_box_coor(box):
  return (box.xmin, box.ymin,box.xmax, box.ymax )

def iou(box1, box2):
  (box1_x1, box1_y1, box1_x2, box1_y2) = decode_box_coor(box1)
  (box2_x1, box2_y1, box2_x2, box2_y2) = decode_box_coor(box2)

  xi1 = max(box1_x1,box2_x1)
  yi1 = max(box1_y1,box2_y1)
  xi2 = min(box1_x2,box2_x2)
  yi2 = min(box1_y2,box2_y2)
  inter_width = xi2-xi1
  inter_height = yi2-yi1
  inter_area = max(inter_height,0)*max(inter_width,0)

  box1_area = (box1_x2-box1_x1)*(box1_y2-box1_y1)
  box2_area = (box2_x2-box2_x1)*(box2_y2-box2_y1)
  union_area = box1_area+box2_area-inter_area

  iou = inter_area/union_area

  return iou

def do_nms(data_dic, nms_thresh):
  final_boxes,final_scores,final_labels=list(),list(),list()
  for label in data_dic:
    scores_boxes=sorted(data_dic[label],reverse=True)
    for i in range(len(scores_boxes)):
      if scores_boxes[i][2]=='removed': continue
      for j in range(i+1,len(scores_boxes)):
        if iou(scores_boxes[i][1],scores_boxes[j][1]) >= nms_thresh:
          scores_boxes[j][2]="removed"

    for e in scores_boxes:
      print(label+' '+str(e[0]) + " status: "+ e[2])
      if e[2]=='kept':
        final_boxes.append(e[1])
        final_labels.append(label)
        final_scores.append(e[0])


  return (final_boxes,final_labels,final_scores)
final_data=do_nms(dic, 0.7)
```

```
car 0.9982241 status: kept
car 0.98843783 status: kept
car 0.9845722 status: removed
car 0.9822434 status: kept
car 0.98184437 status: removed
car 0.98158294 status: kept
car 0.981548 status: removed
car 0.9799808 status: removed
car 0.9342798 status: kept
car 0.93157935 status: removed
car 0.92317057 status: removed
car 0.9050933 status: removed
car 0.90150243 status: removed
car 0.8808287 status: removed
car 0.82281214 status: removed
car 0.78529125 status: kept
car 0.76686305 status: kept
car 0.65974027 status: removed
car 0.6020881 status: removed
traffic light 0.964606 status: kept
traffic light 0.87137073 status: kept
traffic light 0.8328069 status: kept
traffic light 0.77623147 status: kept
traffic light 0.75971967 status: kept
traffic light 0.70200676 status: removed
traffic light 0.618828 status: removed
```

In [19]:
```
draw_boxes(photo_filename,final_data)
```

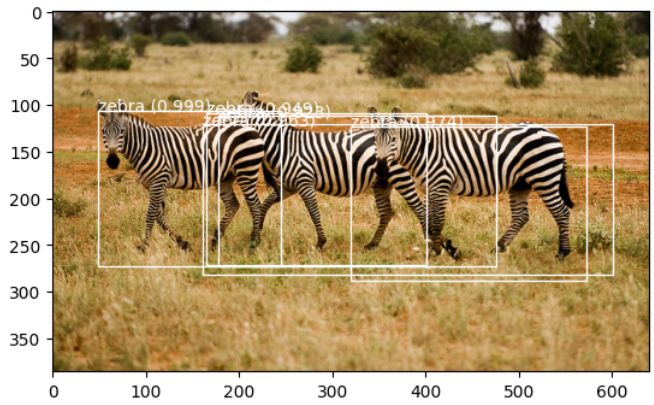
```
car 0.9982241
car 0.98843783
car 0.9822434
car 0.98158294
car 0.9342798
car 0.78529125
car 0.76686305
traffic light 0.964606
traffic light 0.87137073
traffic light 0.8328069
traffic light 0.77623147
traffic light 0.75971967
```

In [20]:
```
def yolo_non_max_suppression(scores, boxes, classes, max_boxes = 10, iou_threshold = 0.5):

    max_boxes_tensor = K.variable(max_boxes, dtype='int32')     # tensor to be used in tf.image.non_max_suppression()
    K.get_session().run(tf.variables_initializer([max_boxes_tensor])) # initialize variable max_boxes_tensor
    nms_indices = tf.image.non_max_suppression(scores=scores,boxes=boxes,max_output_size=max_boxes,iou_threshold=iou_threshold)

    scores = K.gather(scores,nms_indices)
    boxes = K.gather(boxes,nms_indices)
    classes = K.gather(classes,nms_indices)

    return scores, boxes, classes
```

In [21]:
```
def showresults(path):
  _image,width,height=load_and_preprocess_image(path,[IMAGE_WIDTH,IMAGE_HEIGHT])
  image = expand_dims(_image, 0)
  yhat = model.predict(image)
  boxes = list()
  for i in range(len(yhat)):
    boxes += decode_netout(yhat[i][0], anchors[i], net_h=IMAGE_HEIGHT, net_w=IMAGE_WIDTH)
  for i in range(len(boxes)):
    x_offset, x_scale = (IMAGE_WIDTH - IMAGE_WIDTH)/2./IMAGE_HEIGHT, float(IMAGE_WIDTH)/IMAGE_WIDTH
    y_offset, y_scale = (IMAGE_HEIGHT - IMAGE_HEIGHT)/2./IMAGE_HEIGHT, float(IMAGE_HEIGHT)/IMAGE_HEIGHT
    boxes[i].xmin = int((boxes[i].xmin - x_offset) / x_scale * image_w)
    boxes[i].xmax = int((boxes[i].xmax - x_offset) / x_scale * image_w)
    boxes[i].ymin = int((boxes[i].ymin - y_offset) / y_scale * image_h)
    boxes[i].ymax = int((boxes[i].ymax - y_offset) / y_scale * image_h)
  valid_data= box_filter(boxes, labels, threshold_socre=0.6)
  dic=encoder_dic(valid_data)
  final_data=do_nms(dic, 0.7)
  draw_boxes(path,final_data)
```

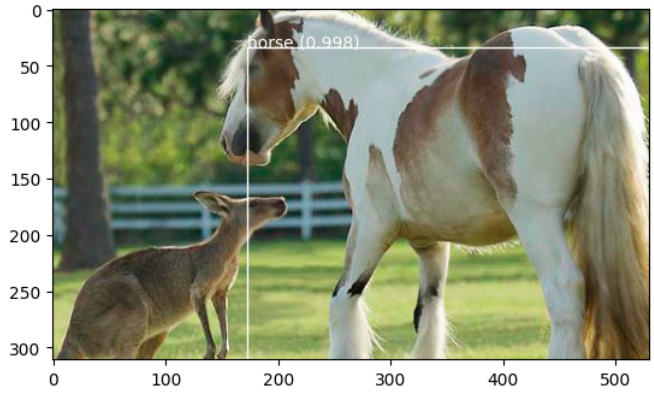
In [22]:
```
showresults('./zebra.jpg')
```

```
1/1 [==============================] - 0s 296ms/step
zebra 0.998504 status: kept
zebra 0.9980972 status: removed
zebra 0.99749166 status: removed
zebra 0.99720335 status: removed
zebra 0.97361505 status: kept
zebra 0.9625324 status: kept
zebra 0.9492128 status: kept
zebra 0.9479591 status: removed
zebra 0.92289144 status: kept
zebra 0.8875617 status: removed
zebra 0.7587733 status: removed
zebra 0.71294904 status: removed
zebra 0.6686954 status: removed
zebra 0.998504
zebra 0.97361505
zebra 0.9625324
zebra 0.9492128
zebra 0.92289144
```



In [23]:
```
showresults('./kangaroo.png')
```

```
1/1 [==============================] - 0s 285ms/step
horse 0.9981355 status: kept
horse 0.9928219 status: removed
horse 0.9498802 status: removed
horse 0.8879705 status: removed
horse 0.79800767 status: removed
horse 0.7887686 status: removed
horse 0.6308995 status: removed
horse 0.9981355
```



In [ ]:
```
```