



([https://colab.research.google.com/github/annulet/CNN\\_NVIDIA/blob/master/hw\\_5\\_object\\_detection.ipynb](https://colab.research.google.com/github/annulet/CNN_NVIDIA/blob/master/hw_5_object_detection.ipynb)).

Обучение и тестирование детектора объектов с использованием сторонней библиотеки

<https://github.com/fizyr/keras-retinanet> (<https://github.com/fizyr/keras-retinanet>).

In [0]:

```
import numpy as np
import time
import imageio
from matplotlib import pyplot as plt
import matplotlib.patches as patches

from keras_retinanet.models import load_model
from keras_retinanet.utils.image import preprocess_image, resize_image
from keras_retinanet.utils.colors import label_color
```

## Загрузка и подготовка библиотеки keras-retinanet

In [2]:

```

if 1:
    !git clone https://github.com/fizyr/keras-retinanet.git
    !cd keras-retinanet \
        && git reset --hard abe89380835bc06dff3b97e69fa2b19dd7fd97a8 \
        && pip install . \
        && python setup.py build_ext --inplace

```

fatal: destination path 'keras-retinanet' already exists and is not an empty directory.

HEAD is now at abe8938 Merge pull request #1326 from fizyr/import\_imagenet\_weights\_effnet

Processing /content/keras-retinanet

Requirement already satisfied: keras in /usr/local/lib/python3.6/dist-packages (from keras-retinanet==0.5.1) (2.3.1)

Requirement already satisfied: keras-resnet==0.1.0 in /usr/local/lib/python3.6/dist-packages (from keras-retinanet==0.5.1) (0.1.0)

Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from keras-retinanet==0.5.1) (1.12.0)

Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from keras-retinanet==0.5.1) (1.4.1)

Requirement already satisfied: cython in /usr/local/lib/python3.6/dist-packages (from keras-retinanet==0.5.1) (0.29.16)

Requirement already satisfied: Pillow in /usr/local/lib/python3.6/dist-packages (from keras-retinanet==0.5.1) (7.0.0)

Requirement already satisfied: opencv-python in /usr/local/lib/python3.6/dist-packages (from keras-retinanet==0.5.1) (4.1.2.30)

Requirement already satisfied: progressbar2 in /usr/local/lib/python3.6/dist-packages (from keras-retinanet==0.5.1) (3.38.0)

Requirement already satisfied: keras-preprocessing>=1.0.5 in /usr/local/lib/python3.6/dist-packages (from keras->keras-retinanet==0.5.1) (1.1.0)

Requirement already satisfied: pyyaml in /usr/local/lib/python3.6/dist-packages (from keras->keras-retinanet==0.5.1) (3.13)

Requirement already satisfied: keras-applications>=1.0.6 in /usr/local/lib/python3.6/dist-packages (from keras->keras-retinanet==0.5.1) (1.0.8)

Requirement already satisfied: numpy>=1.9.1 in /usr/local/lib/python3.6/dist-packages (from keras->keras-retinanet==0.5.1) (1.18.2)

Requirement already satisfied: h5py in /usr/local/lib/python3.6/dist-packages (from keras->keras-retinanet==0.5.1) (2.10.0)

Requirement already satisfied: python-utils>=2.3.0 in /usr/local/lib/python3.6/dist-packages (from progressbar2->keras-retinanet==0.5.1) (2.4.0)

Building wheels for collected packages: keras-retinanet

Building wheel for keras-retinanet (setup.py) ... done

Created wheel for keras-retinanet: filename=keras\_retinanet-0.5.1-cp36m-linux\_x86\_64.whl size=170863 sha256=c4c92cd9748f9d30792990b86071f67bd8b2c19d56be9137b177d01a110b5201

Stored in directory: /root/.cache/pip/wheels/b2/9f/57/cb0305f6f5a41fc3c11ad67b8cedf9127775b563337827ba

Successfully built keras-retinanet

Installing collected packages: keras-retinanet

Found existing installation: keras-retinanet 0.5.1

Uninstalling keras-retinanet-0.5.1:

Successfully uninstalled keras-retinanet-0.5.1

Successfully installed keras-retinanet-0.5.1

running build\_ext

skipping 'keras\_retinanet/utils/compute\_overlap.c' Cython extension (up-to-date)

copying build/lib.linux-x86\_64-3.6/keras\_retinanet/utils/compute\_overlap.cpython-36m-x86\_64-linux-gnu.so -> keras\_retinanet/utils

## Справка по скрипту обучения модели

In [0]:

```
if 0:  
    !python keras-retinanet/keras_retinanet/bin/train.py -h
```

## Загрузка предобученной модели

In [4]:

```
!wget "https://github.com/fizyr/keras-retinanet/releases/download/0.5.1/resnet50_coco_best_
--2020-04-22 15:14:12-- https://github.com/fizyr/keras-retinanet/releases/d
ownload/0.5.1/resnet50_coco_best_v2.1.0.h5 (https://github.com/fizyr/keras-r
etinanet/releases/download/0.5.1/resnet50_coco_best_v2.1.0.h5)
Resolving github.com (github.com)... 140.82.113.3
Connecting to github.com (github.com)|140.82.113.3|:443... connected.
HTTP request sent, awaiting response... 302 Found
Location: https://github-production-release-asset-2e65be.s3.amazonaws.com/10
0249425/b7184a80-9350-11e9-9cc2-454f5c616394?X-Amz-Algorithm=AWS4-HMAC-SHA25
6&X-Amz-Credential=AKIAIWNJYAX4CSVEH53A%2F20200422%2Fus-east-1%2Fs3%2Faws4_r
equest&X-Amz-Date=20200422T151413Z&X-Amz-Expires=300&X-Amz-Signature=76b8b67
96d9bdfa310010073b197fa3558e550858a4a2cacdf2f01088be78e8c&X-Amz-SignedHeader
s=host&actor_id=0&repo_id=100249425&response-content-disposition=attachment%
3B%20filename%3Dresnet50_coco_best_v2.1.0.h5&response-content-type=applicati
on%2Foctet-stream (https://github-production-release-asset-2e65be.s3.amazona
ws.com/100249425/b7184a80-9350-11e9-9cc2-454f5c616394?X-Amz-Algorithm=AWS4-H
MAC-SHA256&X-Amz-Credential=AKIAIWNJYAX4CSVEH53A%2F20200422%2Fus-east-1%2Fs
3%2Faws4_request&X-Amz-Date=20200422T151413Z&X-Amz-Expires=300&X-Amz-Signatu
re=76b8b6796d9bdfa310010073b197fa3558e550858a4a2cacdf2f01088be78e8c&X-Amz-Si
gnedHeaders=host&actor_id=0&repo_id=100249425&response-content-disposition=a
ttachment%3B%20filename%3Dresnet50_coco_best_v2.1.0.h5&response-content-type
=application%2Foctet-stream) [following]
--2020-04-22 15:14:13-- https://github-production-release-asset-2e65be.s3.a
mazonaws.com/100249425/b7184a80-9350-11e9-9cc2-454f5c616394?X-Amz-Algorithm=
AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWNJYAX4CSVEH53A%2F20200422%2Fus-east-
1%2Fs3%2Faws4_request&X-Amz-Date=20200422T151413Z&X-Amz-Expires=300&X-Amz-Si
gnature=76b8b6796d9bdfa310010073b197fa3558e550858a4a2cacdf2f01088be78e8c&X-A
mz-SignedHeaders=host&actor_id=0&repo_id=100249425&response-content-disposit
ion=attachment%3B%20filename%3Dresnet50_coco_best_v2.1.0.h5&response-content
-type=application%2Foctet-stream (https://github-production-release-asset-2e
65be.s3.amazonaws.com/100249425/b7184a80-9350-11e9-9cc2-454f5c616394?X-Amz-A
lgorithm=AWS4-HMAC-SHA256&X-Amz-Credential=AKIAIWNJYAX4CSVEH53A%2F20200422%2
Fus-east-1%2Fs3%2Faws4_request&X-Amz-Date=20200422T151413Z&X-Amz-Expires=300
&X-Amz-Signature=76b8b6796d9bdfa310010073b197fa3558e550858a4a2cacdf2f01088be
78e8c&X-Amz-SignedHeaders=host&actor_id=0&repo_id=100249425&response-content
-disposition=attachment%3B%20filename%3Dresnet50_coco_best_v2.1.0.h5&respons
e-content-type=application%2Foctet-stream)
Resolving github-production-release-asset-2e65be.s3.amazonaws.com (github-pr
oduction-release-asset-2e65be.s3.amazonaws.com)... 52.216.8.3
Connecting to github-production-release-asset-2e65be.s3.amazonaws.com (githu
b-production-release-asset-2e65be.s3.amazonaws.com)|52.216.8.3|:443... conne
cted.
HTTP request sent, awaiting response... 200 OK
Length: 152662144 (146M) [application/octet-stream]
Saving to: 'resnet50_coco_best_v2.1.0.h5.2'

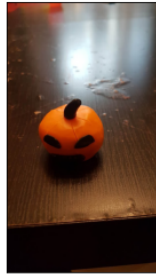
resnet50_coco_best_ 100%[=====>] 145.59M  63.8MB/s   in 2.3s

2020-04-22 15:14:15 (63.8 MB/s) - 'resnet50_coco_best_v2.1.0.h5.2' saved [15
2662144/152662144]
```

##Картинки для обучения

In [5]:

```
imgs = ['1.jpg', '2.jpg', '3.jpg', '4.jpg', '5.jpg', '6.jpg', '7.jpg', '9.jpg']  
  
fig = plt.figure(figsize=(20, 20))  
for i in range(len(imgs)):  
    img = imageio.imread(imgs[i]).astype(np.float32) / 255.  
    ax = fig.add_subplot(4, 3, i+1)  
    ax.imshow(img)  
    plt.xticks([]), plt.yticks([])  
plt.show()
```



## Обучение модели для детектирования объектов

In [6]:

```
!python keras-retinanet/keras_retinanet/bin/train.py \
  --random-transform \
  --weights "./resnet50_coco_best_v2.1.0.h5" \
  --steps 100 \
  --epochs 20 \
  csv "annotations.csv" "classes.csv"
```

Using TensorFlow backend.

```
2020-04-22 15:14:19.866313: I tensorflow/stream_executor/platform/default/dso_loader.cc:44] Successfully opened dynamic library libcudart.so.10.1
Creating model, this may take a second...
2020-04-22 15:14:21.664960: I tensorflow/stream_executor/platform/default/dso_loader.cc:44] Successfully opened dynamic library libcuda.so.1
2020-04-22 15:14:21.684258: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:981] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2020-04-22 15:14:21.684999: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1561] Found device 0 with properties:
pciBusID: 0000:00:04.0 name: Tesla K80 computeCapability: 3.7
coreClock: 0.8235GHz coreCount: 13 deviceMemorySize: 11.17GiB deviceMemoryBandwidth: 223.96GiB/s
2020-04-22 15:14:21.685056: I tensorflow/stream_executor/platform/default/dso_loader.cc:44] Successfully opened dynamic library libcudart.so.10.1
2020-04-22 15:14:21.686944: I tensorflow/stream_executor/platform/default/dso_loader.cc:44] Successfully opened dynamic library libcublas.so.10
2020-04-22 15:14:21.688847: I tensorflow/stream_executor/platform/default/dso_loader.cc:44] Successfully opened dynamic library libcublas.so.10
```

## Конвертация обученной модели для инференса

In [7]:

```
!python keras-retinanet/keras_retinanet/bin/convert_model.py \
  'snapshots/resnet50_csv_20.h5' \
  'snapshots/inference_model.h5'
```

## Загрузка модели для инференса

In [8]:

```
model = load_model('snapshots/inference_model.h5', backbone_name='resnet50')
```

Using TensorFlow backend.

```
tracking <tf.Variable 'Variable:0' shape=(9, 4) dtype=float32, numpy=
array([[ -22.627417, -11.313708,  22.627417,  11.313708],
       [ -28.50876 , -14.25438 ,  28.50876 ,  14.25438 ],
       [ -35.918785, -17.959393,  35.918785,  17.959393],
       [ -16.        , -16.        ,  16.        ,  16.        ],
       [ -20.158737, -20.158737,  20.158737,  20.158737],
       [ -25.398417, -25.398417,  25.398417,  25.398417],
       [ -11.313708, -22.627417,  11.313708,  22.627417],
       [ -14.25438 , -28.50876 ,  14.25438 ,  28.50876 ],
       [ -17.959393, -35.918785,  17.959393,  35.918785]], dtype=float32)> an
```

chors

```
tracking <tf.Variable 'Variable:0' shape=(9, 4) dtype=float32, numpy=
array([[ -45.254833, -22.627417,  45.254833,  22.627417],
       [ -57.01752 , -28.50876 ,  57.01752 ,  28.50876 ],
       [ -71.83757 , -35.918785,  71.83757 ,  35.918785],
       [ -32.        , -32.        ,  32.        ,  32.        ],
       [ -40.317474, -40.317474,  40.317474,  40.317474],
       [ -50.796833, -50.796833,  50.796833,  50.796833],
       [ -22.627417, -45.254833,  22.627417,  45.254833],
       [ -28.50876 , -57.01752 ,  28.50876 ,  57.01752 ],
       [ -35.918785, -71.83757 ,  35.918785,  71.83757 ]], dtype=float32)> an
```

chors

```
tracking <tf.Variable 'Variable:0' shape=(9, 4) dtype=float32, numpy=
array([[ -90.50967 , -45.254833,  90.50967 ,  45.254833],
       [ -114.03504 , -57.01752 ,  114.03504 ,  57.01752 ],
       [ -143.67514 , -71.83757 ,  143.67514 ,  71.83757 ],
       [  -64.        , -64.        ,  64.        ,  64.        ],
       [  -80.63495 , -80.63495 ,  80.63495 ,  80.63495 ],
       [ -101.593666, -101.593666,  101.593666,  101.593666],
       [  -45.254833, -90.50967 ,  45.254833,  90.50967 ],
       [  -57.01752 , -114.03504 ,  57.01752 ,  114.03504 ],
       [  -71.83757 , -143.67514 ,  71.83757 ,  143.67514 ]],
      dtype=float32)> anchors
```

```
tracking <tf.Variable 'Variable:0' shape=(9, 4) dtype=float32, numpy=
array([[ -181.01933, -90.50967,  181.01933,  90.50967],
       [ -228.07008, -114.03504,  228.07008,  114.03504],
       [ -287.35028, -143.67514,  287.35028,  143.67514],
       [ -128.        , -128.        ,  128.        ,  128.        ],
       [ -161.2699 , -161.2699 ,  161.2699 ,  161.2699 ],
       [ -203.18733, -203.18733,  203.18733,  203.18733],
       [  -90.50967, -181.01933,   90.50967,  181.01933],
       [ -114.03504, -228.07008,  114.03504,  228.07008],
       [ -143.67514, -287.35028,  143.67514,  287.35028]], dtype=float32)> an
```

chors

```
tracking <tf.Variable 'Variable:0' shape=(9, 4) dtype=float32, numpy=
array([[ -362.03867, -181.01933,  362.03867,  181.01933],
       [ -456.14017, -228.07008,  456.14017,  228.07008],
       [ -574.70056, -287.35028,  574.70056,  287.35028],
       [ -256.        , -256.        ,  256.        ,  256.        ],
       [ -322.5398 , -322.5398 ,  322.5398 ,  322.5398 ],
       [ -406.37466, -406.37466,  406.37466,  406.37466],
       [ -181.01933, -362.03867,  181.01933,  362.03867],
       [ -228.07008, -456.14017,  228.07008,  456.14017],
       [ -287.35028, -574.70056,  287.35028,  574.70056]], dtype=float32)> an
```

chors

```
/usr/local/lib/python3.6/dist-packages/keras/engine/saving.py:341: UserWarning: No training configuration found in save file: the model was *not* compiled. Compile it manually.
  warnings.warn('No training configuration found in save file: '
```

## Загрузка словаря с метками классов

In [15]:

```
labels_to_names = {}
with open('my_classes.csv') as f:
    for line in f:
        cls_name, cls_id = line.split(',')
        labels_to_names[int(cls_id.strip())] = cls_name.strip()
print(labels_to_names)
```

```
{0: 'pumpkin'}
```

## Функция применения модели для детектирования объектов

In [0]:

```
def detect_objects(image):
    image_processed = preprocess_image(image[:, :, :-1].copy())
    image_processed, scale = resize_image(image_processed)

    start = time.time()
    boxes, scores, labels = model.predict(image_processed[None, ...])
    print("Processing time: ", time.time() - start)
    boxes /= scale
    return boxes[0], scores[0], labels[0]
```

## Функция визуализации результатов детектирования объектов



In [0]:

```

def draw_predictions(image, predictions=None):
    draw = image.copy()
    fig, ax = plt.subplots(1, figsize=(12, 12))
    ax.imshow(draw)

    if predictions is None:
        return

    boxes, scores, labels = predictions
    SCORE_THRESHOLD = 0.5
    for box, score, label in zip(boxes, scores, labels):
        if score < SCORE_THRESHOLD:
            break

        box_y = int(box[1])
        box_x = int(box[0])
        box_h = int(box[3]-box[1])
        box_w = int(box[2]-box[0])
        caption = "{} {:.3f}".format(labels_to_names[label], score)
        if 0:
            color = [x/255 for x in label_color(label)]
        else:
            color = [(0, 1, 0), (1, 1, 0), (1, 0, 1), (1, 0, 0)][label]

        label_size = 20
        plt_scale = float(fig.get_size_inches()[1]) * fig.dpi * draw.shape[0] * label_size
        ax.add_patch(patches.Rectangle((box_x, box_y),
                                       box_w, box_h,
                                       linewidth=2, edgecolor=color, facecolor='none'))
        ax.add_patch(patches.Rectangle((box_x, box_y-round(26*plt_scale)),
                                       round(plt_scale*len(caption)*14), round(26*plt_scale),
                                       linewidth=2, edgecolor=color, facecolor=color))
        ax.text(box_x + round(3*plt_scale), box_y - round(5*plt_scale), caption, fontsize=1

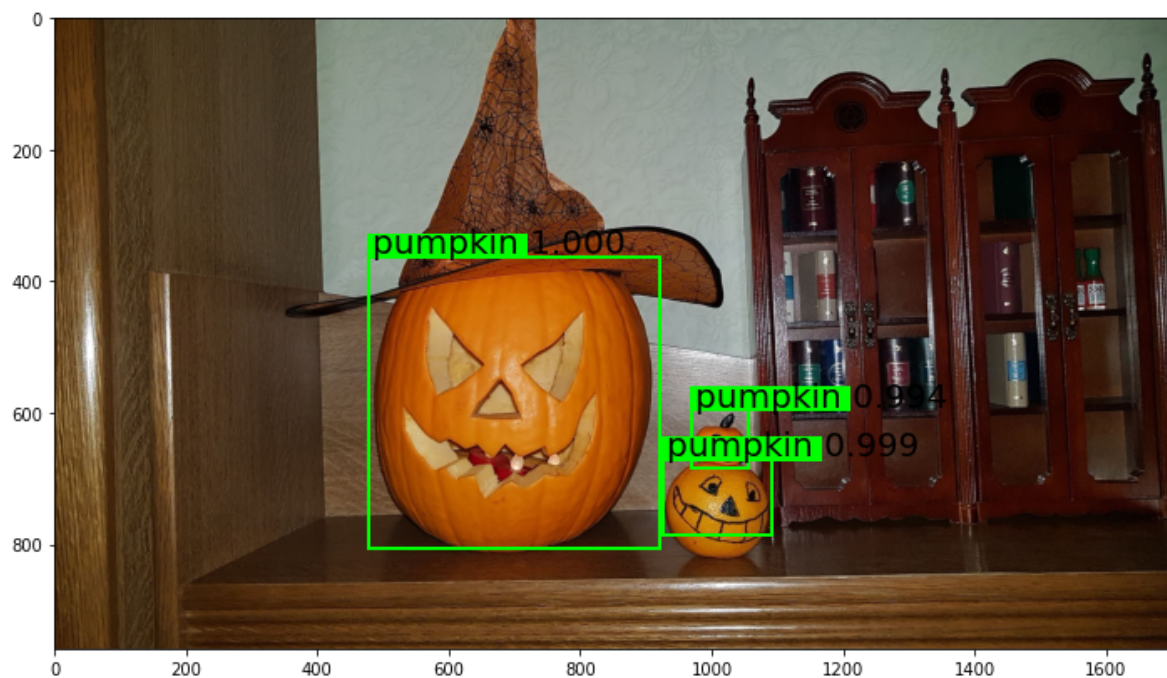
```

## Детектирование объектов на тестовом изображении (1)

In [18]:

```
image = imageio.imread('10.jpg')  
predictions = detect_objects(image)  
draw_predictions(image, predictions)
```

Processing time: 0.3571434020996094

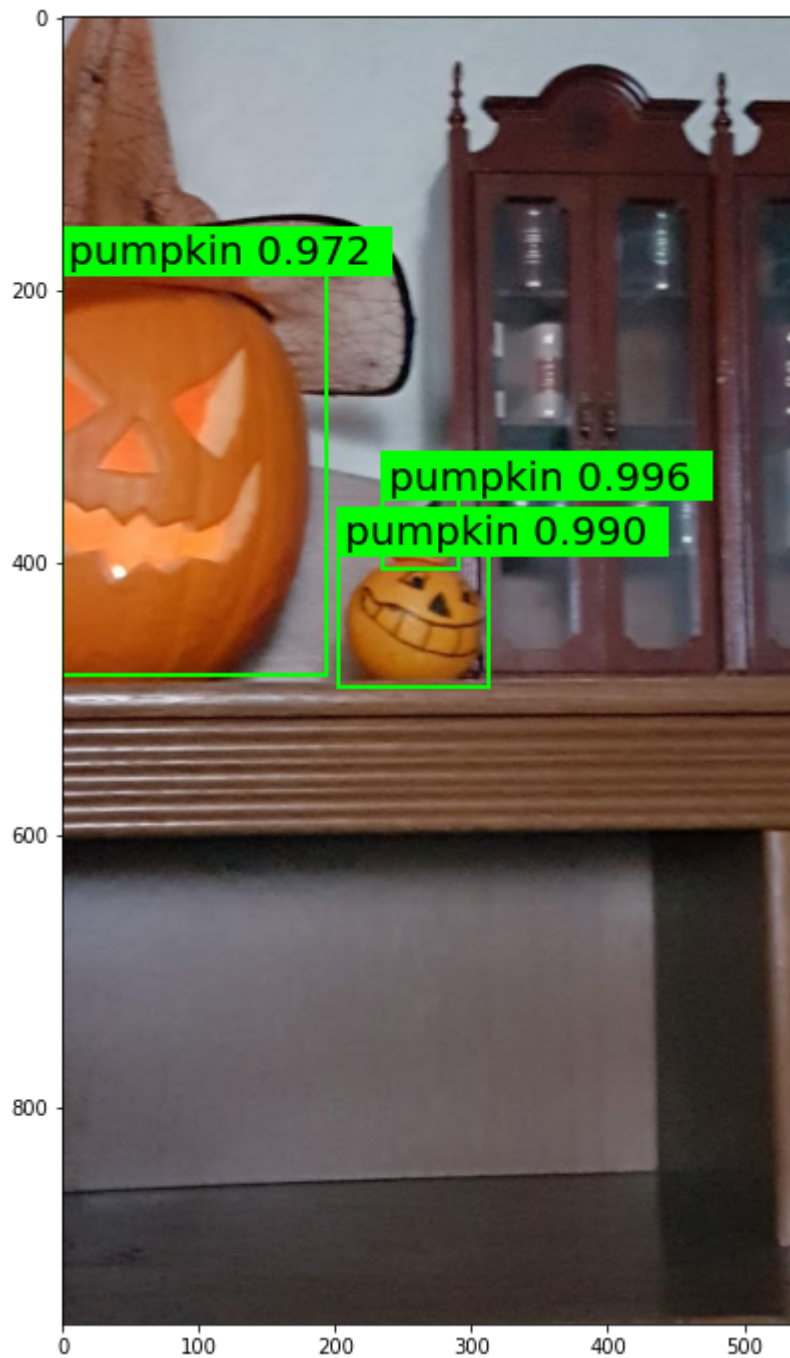


## Детектирование объектов на тестовом изображении (2)

In [19]:

```
image = imageio.imread('8.jpg')  
predictions = detect_objects(image)  
draw_predictions(image, predictions)
```

Processing time: 0.30629801750183105

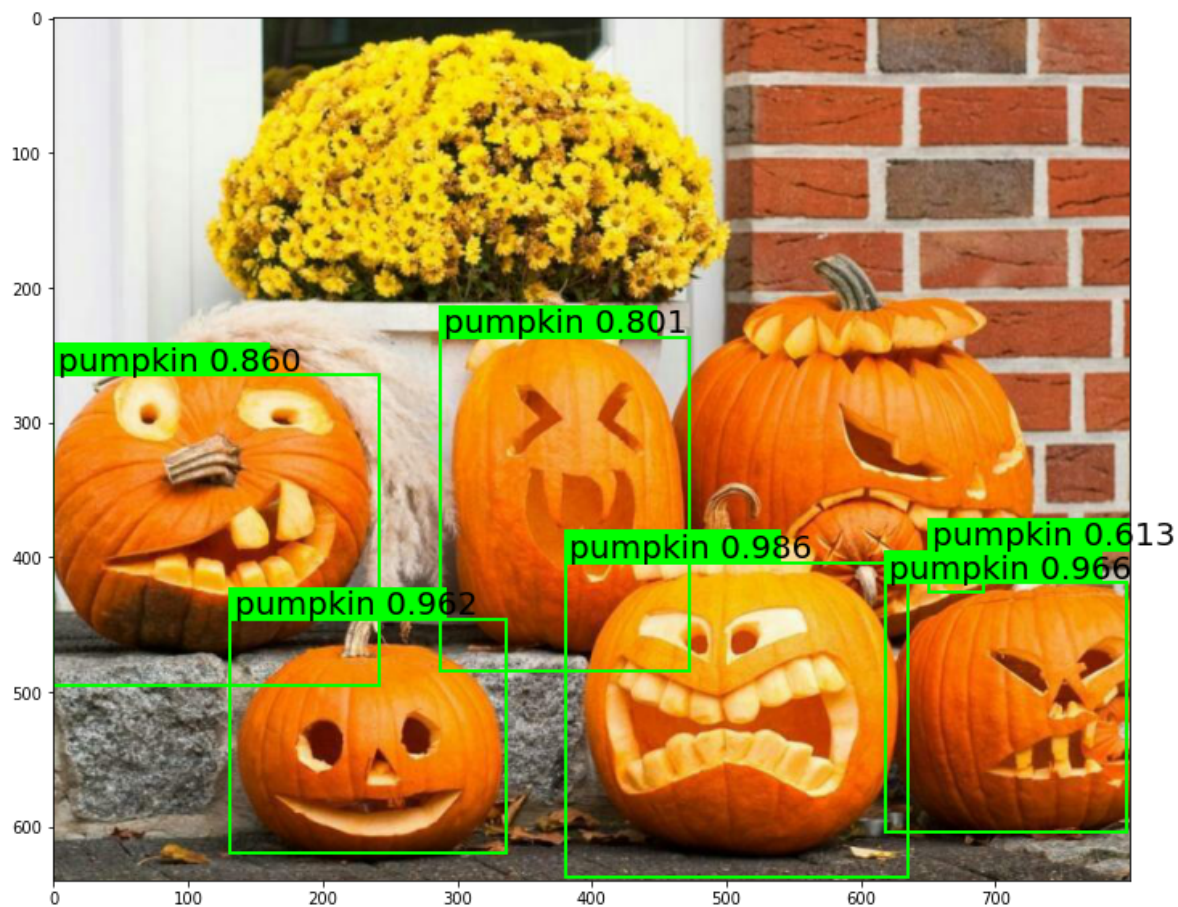


##Детектирование объектов на изображении из интернета

In [20]:

```
image = imageio.imread('test.jpg')
predictions = detect_objects(image)
draw_predictions(image, predictions)
```

Processing time: 0.23968911170959473



In [0]: