Object Detection with Tensorflow

by Anatolii Shkurpylo,

Software Developer

ELIFTECH

Agenda

- Intro
- What is Object Detection
- State of Object Detection
- Tensorflow Object Detection API
- Preparing Data
- Training & Evaluating
- Links

ELIFTECH

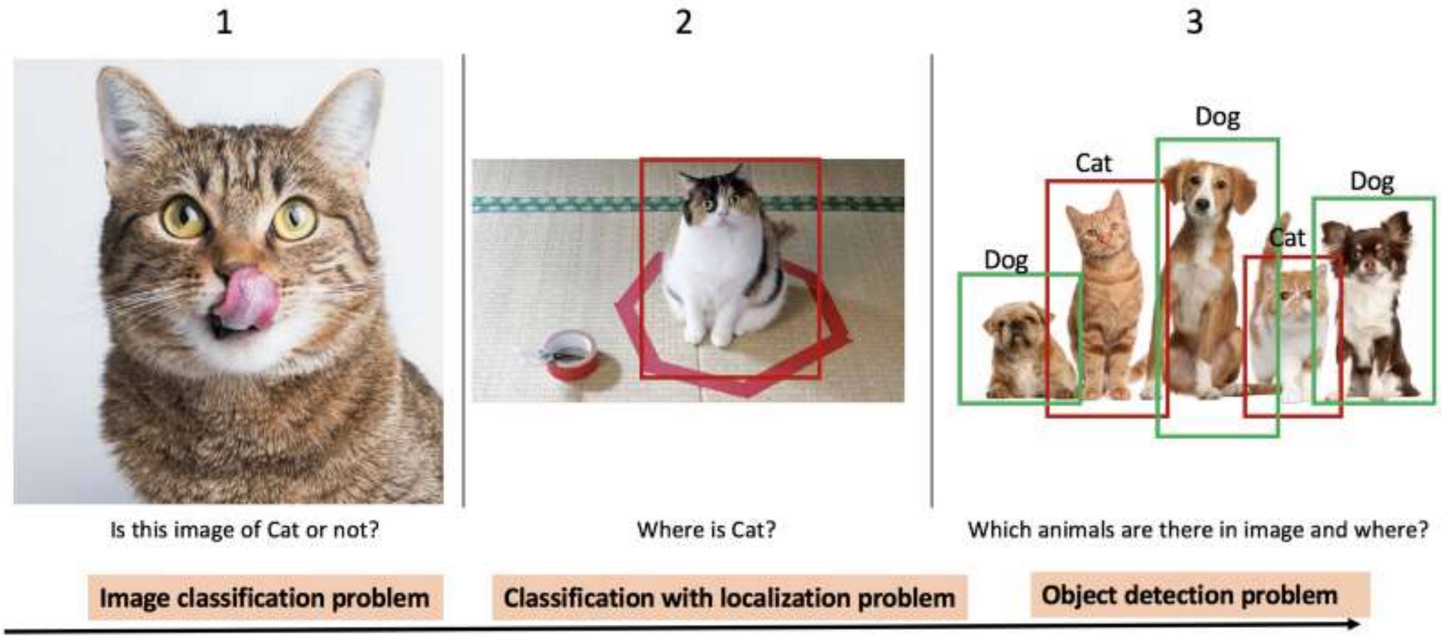
Intro

Use cases

ELIFTECH

What is Object Detection

Object detection =
Object Classification + Object Localization

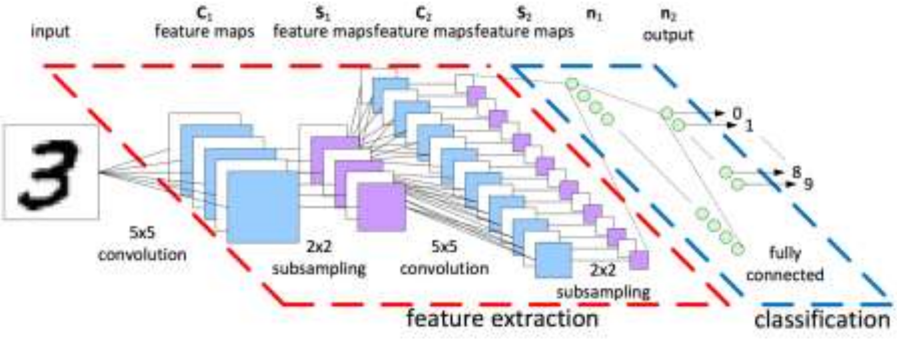


1 — Is this image of Cat or not? — Image classification problem

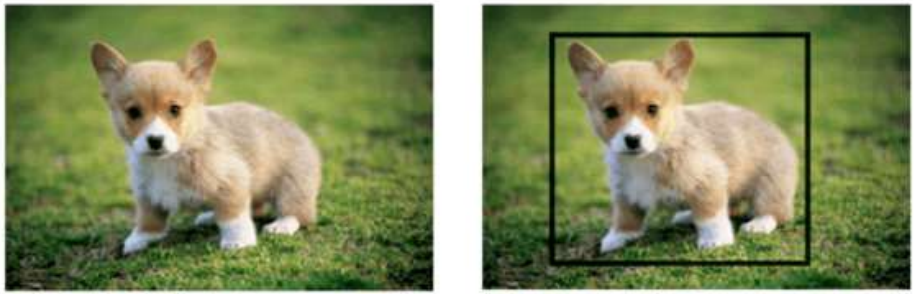
2 — Where is Cat? — Classification with localization problem

3 — Which animals are there in image and where? — Object detection problem

One model for two tasks?



Object detection - output is the one number (index) of a class



Object localization - output is the four numbers - coordinates of bounding box.

Po	- is object exists
bx1 **bx2** **by1** **by2**	- bounding box coordinates
c1 **c2** **c3** **…** **cn**	- object’s variables

State of Object Detection

Approaches

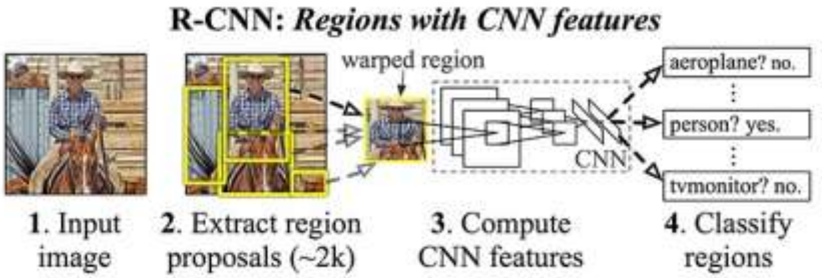
- Classical approach (Haar features) - first OD real time framework (Viola-Jones)
- Deep learning approach - now state of the art in OD
  - OverFeat
  - R-CNN
  - Fast R-CNN
  - YOLO
  - Faster R-CNN
  - SSD and R-FCN

Deep learning approach

OverFeat - published in 2013, multi-scale sliding window algorithm using Convolutional Neural Networks (CNNs).

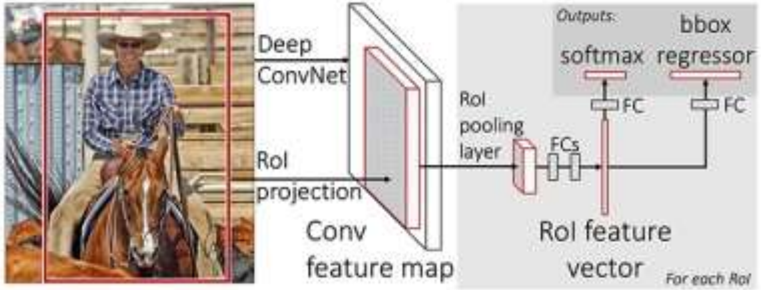
R-CNN - Regions with CNN features. Three stage approach:

- Extract possible objects using a region proposa method (the most popular one being Selective Search).
- Extract features from each region using a CNN.
- Classify each region with SVMs.

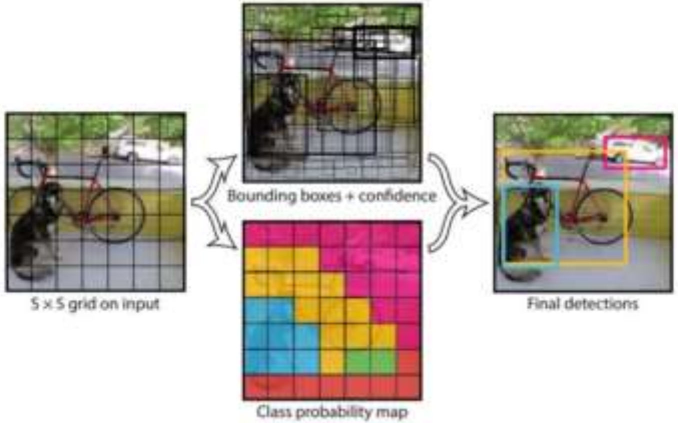


Deep learning approach

Fast R-CNN - Similar to R-CNN, it used Selective Search to generate object proposals, but instead of extracting all of them independently and using SVM classifiers, it applied the CNN on the complete image and then used both Region of Interest (RoI) Pooling on the feature map with a final feed forward network for classification and regression.

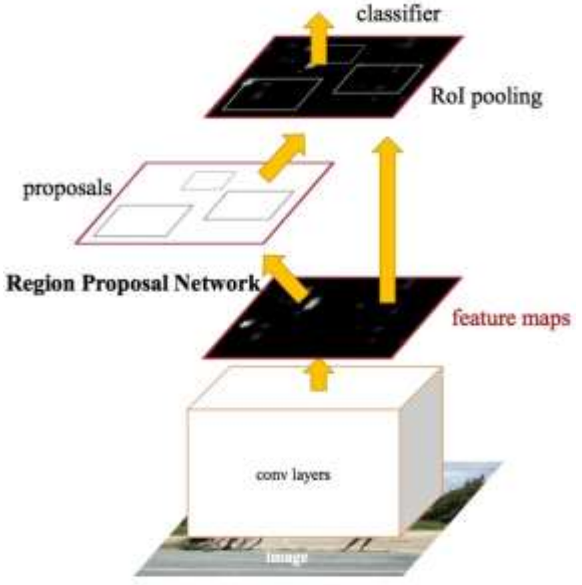


YOLO - You Only Look Once: a simple convolutional neural network approach which has both great results and high speed, allowing for the first time real time object detection.



Deep learning approach

Faster R-CNN - Faster R-CNN added what they called a Region Proposal Network (RPN), in an attempt to get rid of the Selective Search algorithm and make the model completely trainable end-to-end.



SSD and **R-FCN**
Finally, there are two notable papers, Single Shot Detector (SSD) which takes on YOLO by using multiple sized convolutional feature maps achieving better results and speed, and Region-based Fully Convolutional Networks (R-FCN) which takes the architecture of Faster R-CNN but with only convolutional networks.

Tensorflow Object Detection API

TF Object Detection API

- Open Source from 2017-07-15
- Built on top of TensorFlow
- Contains trainable detection models
- Contains frozen weights
- Contains Jupyter Notebook
- Makes easy to construct, train and deploy object detection models

Getting started

Dependencies:

- Protobuf 2.6
- Python-tk
- Pillow 1.0
- lxml
- Tf Slim (included)
- Jupyter notebook
- Matplotlib
- Tensorflow (tensorflow-gpu)
- Cython
- cocoapi

Installation instruction

If model will be trained locally - better to install tensorflow-gpu.

Dependencies for tensorflow-gpu:

- NVIDIA GPU with CUDA Compute Capability 3.0 (list)
- Ubuntu 16.04 at least
- CUDA® Toolkit 9.0
- NVIDIA drivers associated with CUDA Toolkit 9.0.
- cuDNN v7.0
- libcupti-dev

Installation instruction

Latest version of CUDA Toolkit - 9.1 not compatible with tensorflow 1.6, need to install 9.0

Creating a dataset

Dataset

- Tensorflow Object Detection API uses the TFRecord file format
- There is available third-party scripts to convert PASCAL VOC and Oxford Pet Format
- In other case explanation of format available in git repo.
- Input data to create TFRecord - annotated image

Getting images

Grab from internet

- Scrap images from google or Pixabay or whatever
- For batch downloading - Faktun Bulk Image Downloader
- For data mining by multiplying existing images - ImageMagic

Create own images

- Record video with needed object/objects (in 640x480)
- Process video and split on screenshots - ffmpeg

Tips

- Create images with different lights, background and so on.
- If object is able to have different forms - better to catch them all.
- Try to make 30%-50% of images with overlaid object
- Tool for image augmentation

Labeling (Annotation) an images

Tools

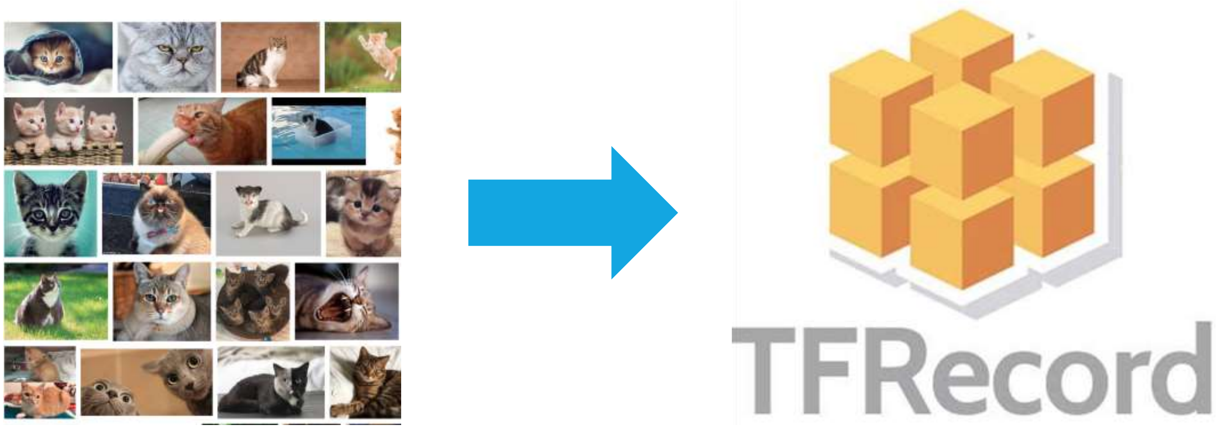
- LabelImg
- FIAT (Fast Image Data Annotation Tool)

- input: images
- output: .xml files with bounding boxes coordinates

Creating TFRecord

- Tensorflow object detection API repo contains folder dataset_tools with scripts to coverts common structures of data in TFRecord.

- If output data has another structure - here is explanation how to convert it



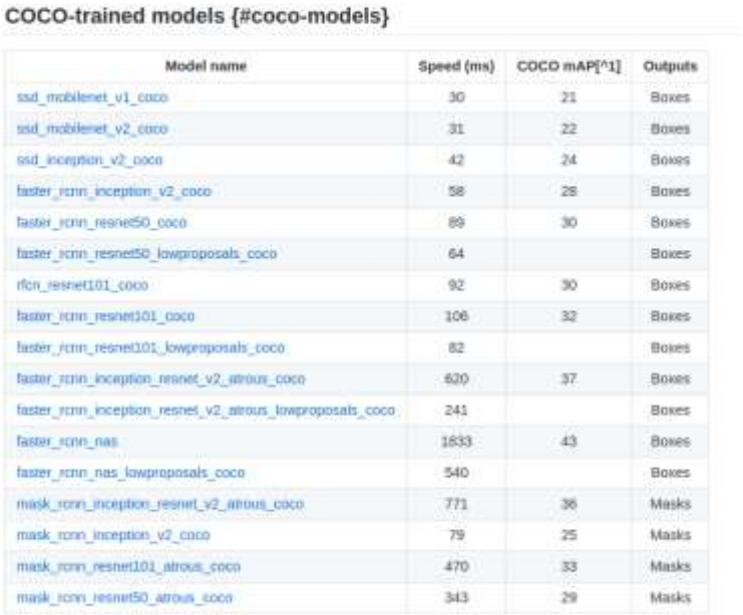
Training

ELIFTECH

Selecting a model

Tensorflow OD API provides a collection of detection models pre-trained on the COCO dataset, the Kitti dataset, and the Open Images dataset.

- **model name** corresponds to a config file that was used to train this model.
- **speed -** running time in ms per 600x600 image
- **mAP** stands for mean average precision, which indicates how well the model performed on the COCO dataset.
- **Outputs** types (Boxes, and Masks if applicable)

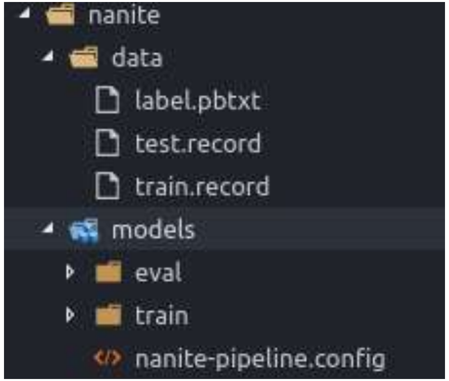


COCO-trained models {#coco-models}

Model name	Speed (ms)	COCO mAP[^1]	Outputs
ssd_mobilenet_v1_coco	30	21	Boxes
ssd_mobilenet_v2_coco	31	22	Boxes
ssd_inception_v2_coco	42	24	Boxes
faster_rcnn_inception_v2_coco	58	28	Boxes
faster_rcnn_resnet50_coco	89	30	Boxes
faster_rcnn_resnet50_lowproposals_coco	64		Boxes
rfcn_resnet101_coco	92	30	Boxes
faster_rcnn_resnet101_coco	106	32	Boxes
faster_rcnn_resnet101_lowproposals_coco	82		Boxes
faster_rcnn_inception_resnet_v2_atrous_coco	620	37	Boxes
faster_rcnn_inception_resnet_v2_atrous_lowproposals_coco	241		Boxes
faster_rcnn_nas	1833	43	Boxes
faster_rcnn_nas_lowproposals_coco	540		Boxes
mask_rcnn_inception_resnet_v2_atrous_coco	771	36	Masks
mask_rcnn_inception_v2_coco	79	25	Masks
mask_rcnn_resnet101_atrous_coco	470	33	Masks
mask_rcnn_resnet50_atrous_coco	343	29	Masks

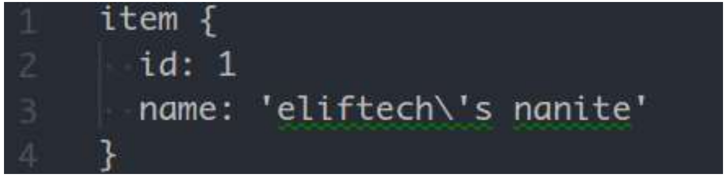
Configuring

- Folders structure



```
nanite
  data
    label.pbtxt
    test.record
    train.record
  models
    eval
    train
  nanite-pipeline.config
```

- label.pbtx



```
item {
  id: 1
  name: 'eliftech\'s nanite'
}
```

- pipeline.config instruction

```
train_config: {
  fine_tune_checkpoint: "<path_to_model.ckpt>"
  num_steps: 200000
}
train_input_reader {
  label_map_path: "<path_to_labels.pbtxt>"
  tf_record_input_reader {
    input_path: "<path_to_train.record>"
  }
}
eval_config {
  num_examples: 8000
  max_evals: 10
  use_moving_averages: false
}
eval_input_reader {
  label_map_path: "<path_to_labels.pbtxt>"
  shuffle: false
  num_readers: 1
  tf_record_input_reader {
    input_path: "<path_to_test.record>"
  }
}
```

Training & Evaluating

```
# From the tensorflow/models/research directory
python object_detection/train.py
--logtostderr
--
pipeline_config_path=/tensorflow/models/object_detection/samples/configs/ssd_mobilenet_v1_p
ets.config
--train_dir=${PATH_TO_ROOT_TRAIN_FOLDER}
```

```
# From the tensorflow/models/research directory
python object_detection/eval.py \
    --logtostderr \
    --pipeline_config_path=${PATH_TO_YOUR_PIPELINE_CONFIG} \
    --checkpoint_dir=${PATH_TO_TRAIN_DIR} \
    --eval_dir=${PATH_TO_EVAL_DIR}
```

Links

- https://towardsdatascience.com/how-to-train-your-own-object-detector-with-tensorflows-object-detector-api-bec72ecfe1d9
- https://www.kdnuggets.com/2017/10/deep-learning-object-detection-comprehensive-review.html
- http://www.machinelearninguru.com/deep_learning/tensorflow/basics/tfrecord/tfrecord.html
- https://www.coursera.org/learn/convolutional-neural-networks
- https://medium.com/comet-app/review-of-deep-learning-algorithms-for-object-detection-c1f3d437b852
- https://towardsdatascience.com/evolution-of-object-detection-and-localization-algorithms-e241021d8bad
- https://medium.freecodecamp.org/how-to-play-quidditch-using-the-tensorflow-object-detection-api-b0742b99065d

Don’t forget to subscribe!

Find us at eliftech.com

Have a question? Contact us:
info@eliftech.com