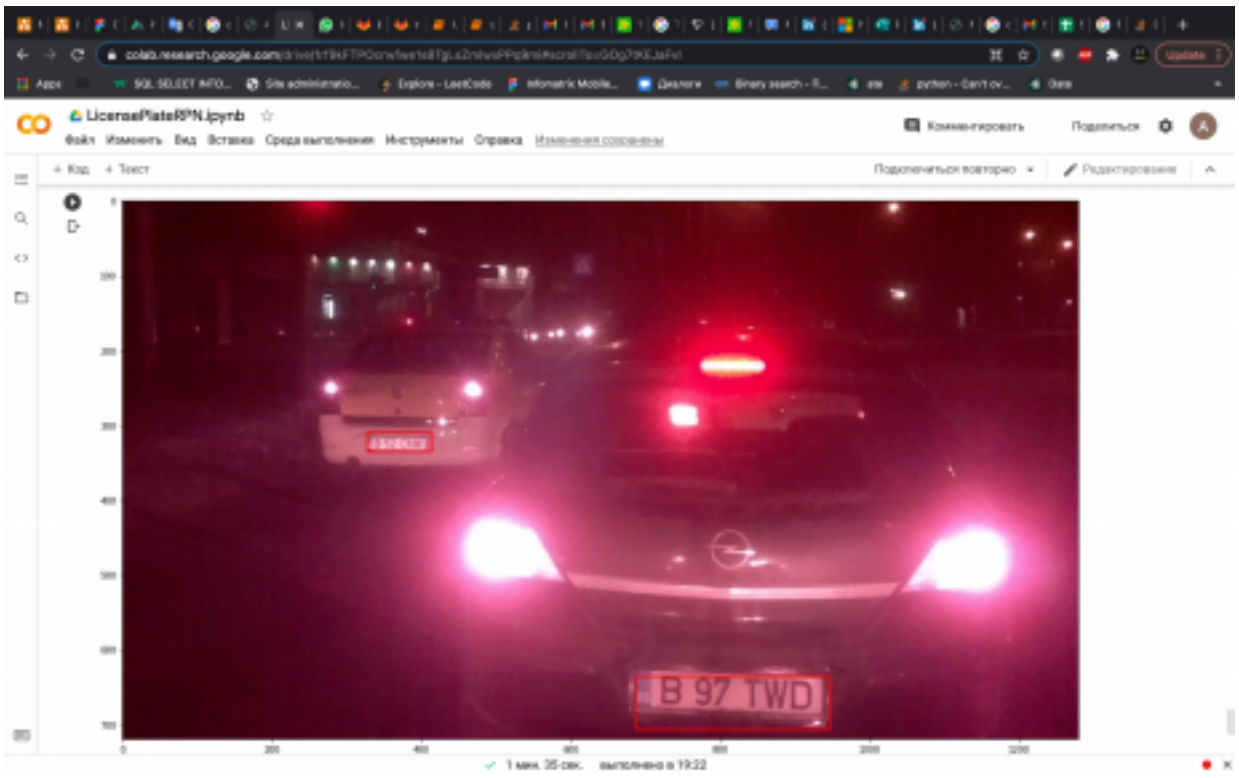
Locating License Plates



Example (screenshot)

Resources

DATASET

Romanian (European Union) Dataset of License Plates

Format

A dataset of Romanian (European Union) license plates in VOC format using

VOTT. **Specs**

The dataset is composed of 534 images of which 80% of them are for training and the rest of 20% is for validation. Since the dataset is rather small, it is encouraged to fine-tune a preexisting model with this dataset.

The dataset was shot in both daytime and nightime.

Source

https://github.com/RobertLucian/license-plate-dataset

LINEAR SUM PROBLEM

Description

The linear sum problem is also known as minimum weight matching in bipartite graphs. A problem instance is described by a matrix C, where each C[i,j] is the cost of matching vertex i of the first partite set (a “worker”) and vertex j of the second set (a “job”).

Source

https://docs.scipy.org/doc/scipy/reference/generated/scipy.optimize.linear_sum_assignment.html

DARKNET53

Source

https://github.com/developer0hye/PyTorch-Darknet53/blob/master/model.py

Basic Idea

FORWARD FUNCTION

Image (**3**x**720**x**1280**)

-

-

Model (DarkNet)

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Output (**5**x**H**x**W**)

-

-

Adding prior values to the output (**5**x**H**x**W**)

-

-

Converting into the format [confidence, xmin, ymin, xmax, ymax]

-

-

Output (**5**x**H**x**W**)

-

-

Reshaping

-

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Output (**H***x**W**x**5**)

- **H** is the height of the tensor
- **W** is the width of the tensor

LOSS FUNCTION

Loss (Output (H*Wx5), Targets (Nx4) **)**
=> Bipartite matching (H*W predictions to N targets)
=> (N) positive losses + **(H*W - N)** negative losses

- **N** is the number of grid cells

Dataset

DATASET HIERARCHY

- train
  - images
    - nightride_type3_001.mp4#t=74.jpg
    - …
  - annots
    - nightride_type3_001.mp4#t=74.xml
    - …
- valid
  - images
    - nightride_type3_001.mp4#t=715.jpg
    - …
  - annots
    - nightride_type3_001.mp4#t=715.xml
    - …

XML SAMPLE

```
<annotation verified="yes">
 <folder>Annotation</folder>
 <filename>nightride_type3_001.mp4#t=74.jpg</filename>
 <path>license-plate-detector-PascalVOC-export/Annotations/nightride_type3_001.mp4#t=74.jpg</path>  <source>
 <database>Unknown</database>
 </source>
 <size>
 <width>1280</width>
 <height>720</height>
 <depth>3</depth>
 </size>
 <segmented>0</segmented>
 <object>
 <name>license-plate</name>
 <pose>Unspecified</pose>
 <truncated>0</truncated>
 <difficult>0</difficult>
 <bndbox>
 <xmin>621.7564468882059</xmin>
 <ymin>300.983606557377</ymin>
```

<xmax>736.233612658471</xmax>
<ymax>334.37703867427626</ymax>
</bndbox>
</object>
</annotation>

Details

FORWARD FUNCTION

- An image, with the size of 3x720x1280, passed throw the darknet53 model. Last classifier layers are removed leaving only convolution layers.

- Here you can add some MaxPool & Convolutions layers at the end in order to decrease the **height** and **width** of the **output tensor**. In practice, **H*W == 50** showed good performance.

- *If the model predicts many anchor boxes, then the network would not be able to be trained due to imbalanced number of positive and negative anchor boxes.*

- The forward function has a tricky moment. For example a given network predicts **5** values { **confidence**, center **x**, center **y**, **height, width** } or { **c, x, y, h, w** } for each grid cell. Here, you have to add some prior values.

Prior values added in the following way

c := sigmoid (c)
x := x * grid_width + dx # **dx** - *center of the grid relative to the image*
y := y * grid_height + dy # **dy** - *center of the grid relative to the image*
h := h * grid_height
w := w * grid_width
output = [c, x - w / 2, y - h / 2, x + w / 2, y + h / 2]
 # Now, the format of the output is [c, xmin, ymin, xmax, ymax]

LOSS FUNCTION

Let's consider a specific case. The model returns 50x5 tensor, where 50 is the number of grid cells and 5 represents an anchor box, { **confidence, xmin, ymin, xmax, ymax** }. For example, a given image contains 2 license plates. So, the target tensor would have the size of 2x4, where 2 is the number of anchor boxes, and 4 represents an anchor box without confidence { **xmin, ymin, xmax, ymax** }.

Now, we have to calculate the loss function. Here, we create Cost Matrix of all combinations in order to calculate the best loss:

a1 a2 a3 … a50

t1 L(t1, a1) L(t1, a2) L(t1, a3) L(t1, a50) t2 L(t2, a1) L(t2, a2) L(t2, a3) L(t2, a50)

L(t[i], a[j]) = confidence_loss (a[j][0]) + location_loss (t[i][:], a[j][1:]) confidence_loss (x) = -log(x +

0.0000000001)

location_loss (a, b) = MSE (a, b)

We have to assign our targets to two anchor boxes in the way to get the minimum cost. This problem is named **bipartite matching**. It can be solved using the Hungarian algorithm. But, for simplicity use already made function from the given source: https://docs.scipy.org/doc/scipy/reference/generated/scipy.optimize.linear_sum_assignment.html .

Now, we marked 2 anchor boxes from 50 as positive ones, but you have to calculate loss function for negative ones, too. Here, you **do not need** to calculate the location loss for negative ones. A simple loss function for negative anchor boxes is given below

```
loss (a) = -log(1 - a[0] + 0.0000000001)
```

Let's summarize

1. We select 2 best anchor boxes (because we have 2 targets) from 50 predicted anchor boxes

2. We calculate total loss

   total_loss = positive_loss (2 best anchor boxes, 2 targets) + negative_loss (48 anchor boxes, no targets)

Loss function is imbalanced !!!!!

1. First case, you have 2 positive anchor boxes and 48 negative ones.

2. Second case, you have 2 different scaled loss functions: **confidence_loss** and **location_loss**. In practice, **confidence_loss** varies from 0 till 24, but **location_loss** varies from 0 till 10000 in average.

The loss function with weights would like

```
positive_loss = W_conf * confidence_loss + W_loc * location_loss
negative_loss = one_minus_confidence_loss = -log(1 - a[0] + 0.0000000001) total_loss =
W_pos * positive_loss + W_neg * negative_loss
```

Submission policy

You have to submit 3 files. Put 2 files, **source.ipynb** and **source.html**, in a single folder named with your **student id**, for example 180102030. The folder should be compressed in ZIP format. Send 3rd file, **model.pt**, in other ways because the size can be large.