THE ANDREW & ERNA VITERBI FACULTY OF ELECTRICAL ENGINEERING

SIPL
Signal and Image Processing Lab

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Tennis ball detection in video
Using neural networks

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In collaboration with Baseline

Introduction

- Object detection is a field in computer vision
- Best object detection algorithms are using neural networks
- Object detection requires a big amount of data to train the network

Example for object detection

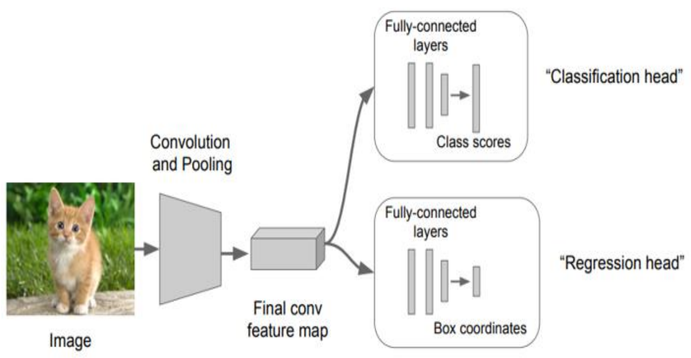
Goals

- Detect a tennis ball within a video
  - Train a NN with small training set
  - Short inference time
  - High mAP

Challenges

- Small dataset
- Small object
- Changing backgrounds
- Different lighting conditions
- Over fitting

Object detection



- Input image goes into the net
- Convolution networks extract features out of the image
- Features correlated often together are recognized to belong to a certain class
- Localizion of an object inside a bounding box

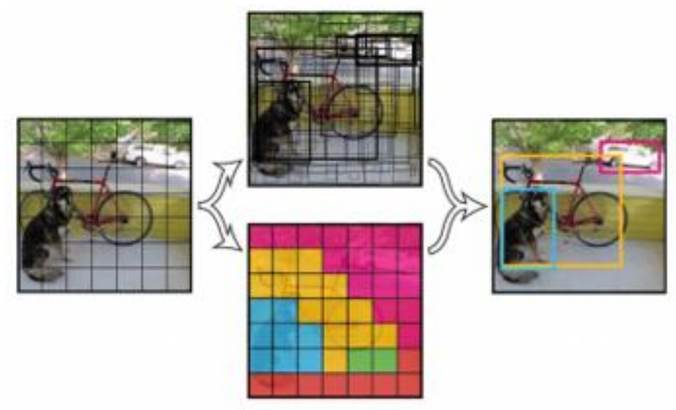
Transfer learning

- Getting a big dataset that is similar to the task
- Training the net on the big dataset

COCO dataset example

- Training the last few layers of the net with the small dataset to adapt it
- Get good results with little training

YOLOv5



Simplification of YOLO method

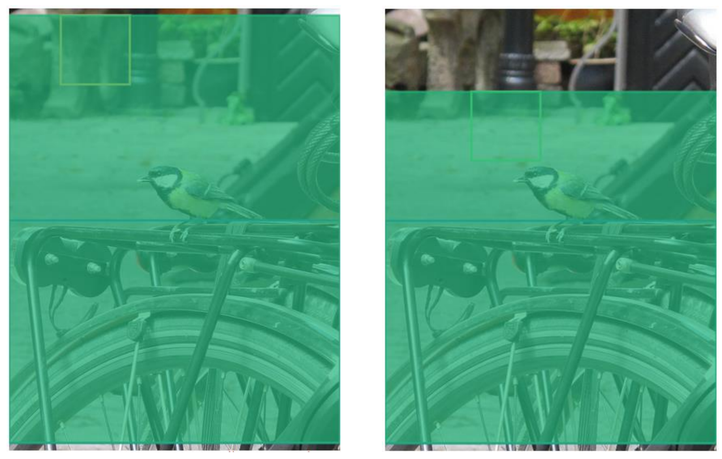
- You only look once deep neural network
  - yolov5 was released on June 25th 2020
  - Extracts features with CNNs
  - Use features to predict bounding boxes (BB)
  - Use features to predict class
  - Get the best fit with regards to BB and class

Results from YOLO network

- YOLOv5 has fast inference time, fast enough for real time detection

GIoU

- Loss function to determine BB pred. quality
- Expands IoU loss function

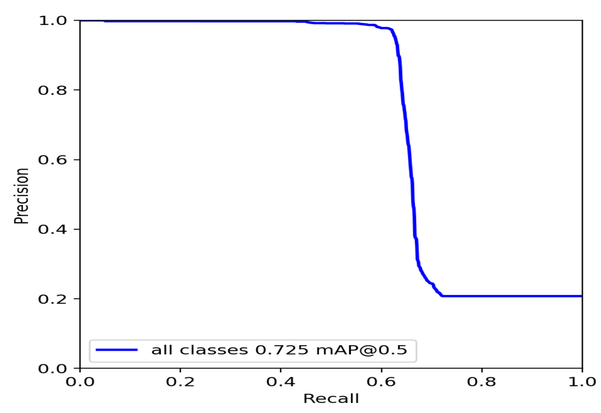


Even bad prediction can be useful

$$GIoU = \frac{|A \cap B|}{|A \cup B|} - \frac{|C \setminus (A \cup B)|}{|C|}$$

Results

- High confidence tennis ball detection



Final net outcome

- Gets result a wide variety of scenarios

Conclusions

- Successful object detection
  - Can be trained with relatively small dataset
  - Transfer learning can be helpful with the right initial database

November 2020