Object Classification and Instance Segmentation of Images

Rosa Gradilla
Machine Learning
Final Project

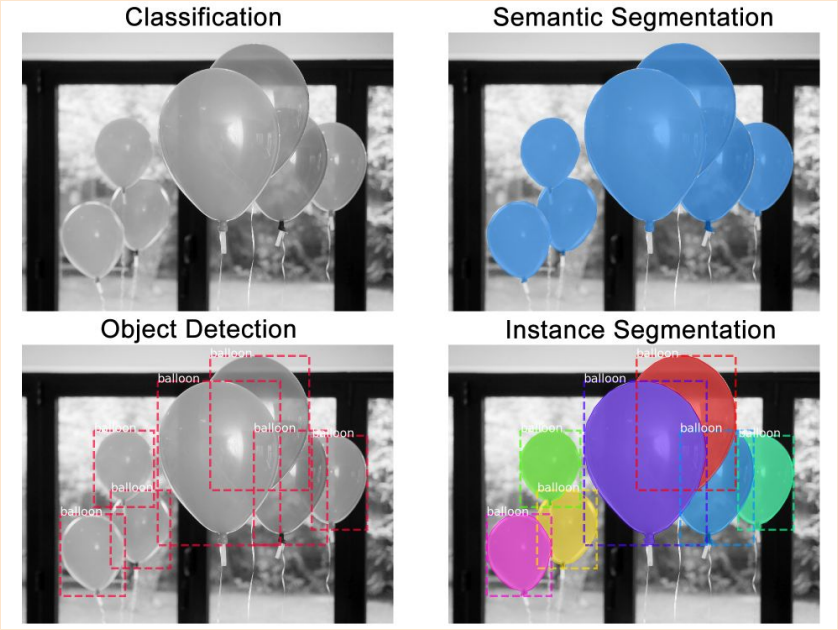
Problem Statement

To identify instances in an image using instance segmentation by assigning segmentation and attribute labels to fashion images.

Used an open source library that implements a method called **Mask R-CNN**, on top of Keras/Tensorflow

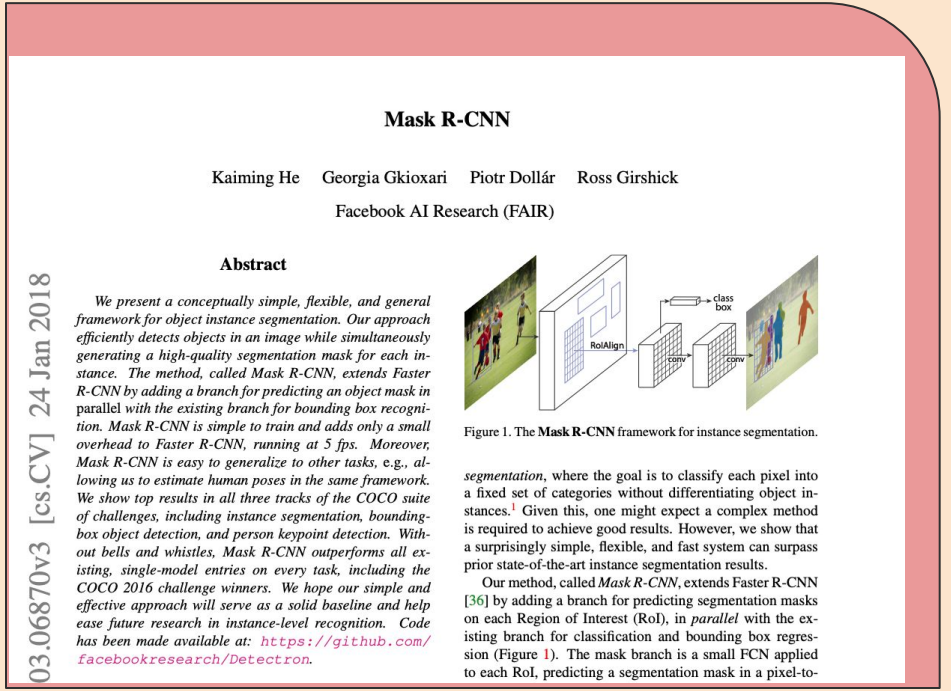
Data: from a Kaggle competition: iMaterialist (Fashion) 2020.

Test: 3200 images
Train: 45623 images



Instance Segmentation

- **Classification:** There is a balloon in this image
- **Semantic Segmentation:** These are all the balloon pixels
- **Object Detection:** There are 7 balloons in this image at these locations. Accounts for objects that overlap.
- **Instance Segmentation:** There are 7 balloons at these locations, and these are the pixels that belong to each one.



Mask R-CNN

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Facebook AI Research (FAIR)

03.06870v3 [cs.CV] 24 Jan 2018

Abstract

We present a conceptually simple, flexible, and general framework for object instance segmentation. Our approach efficiently detects objects in an image while simultaneously generating a high-quality segmentation mask for each instance. The method, called Mask R-CNN, extends Faster R-CNN by adding a branch for predicting an object mask in parallel *with the existing branch for bounding box recognition. Mask R-CNN is simple to train and adds only a small overhead to Faster R-CNN, running at 5 fps. Moreover, Mask R-CNN is easy to generalize to other tasks, e.g., allowing us to estimate human poses in the same framework. We show top results in all three tracks of the COCO suite of challenges, including instance segmentation, bounding-box object detection, and person keypoint detection. Without bells and whistles, Mask R-CNN outperforms all existing, single-model entries on every task, including the COCO 2016 challenge winners. We hope our simple and effective approach will serve as a solid baseline and help ease future research in instance-level recognition. Code has been made available at: https://github.com/facebookresearch/Detectron.*

Figure 1. The **Mask R-CNN** framework for instance segmentation.

segmentation, where the goal is to classify each pixel into a fixed set of categories without differentiating object instances.[1] Given this, one might expect a complex method is required to achieve good results. However, we show that a surprisingly simple, flexible, and fast system can surpass prior state-of-the-art instance segmentation results.

Our method, called *Mask R-CNN*, extends Faster R-CNN [36] by adding a branch for predicting segmentation masks on each Region of Interest (RoI), in *parallel* with the existing branch for classification and bounding box regression (Figure 1). The mask branch is a small FCN applied to each RoI, predicting a segmentation mask in a pixel-to-

K. He, G. Gkioxari, P. Dollár and R. Girshick, "Mask R-CNN," *2017 IEEE International Conference on Computer Vision (ICCV)*, Venice, 2017, pp. 2980-2988.

Technology

- ➔ Python
- ➔ Jupyter Notebook
- ➔ Packages: NumPy, SciPy, Matplotlib, etc
- ➔ Keras(v2.3.1)/Tensorflow(v1.6)
- ➔ OpenCV
- ➔ Mask_RCNN
- ➔ Pycocotools
- ➔ Imaug

Each mask can be 1 out of 46 classes.

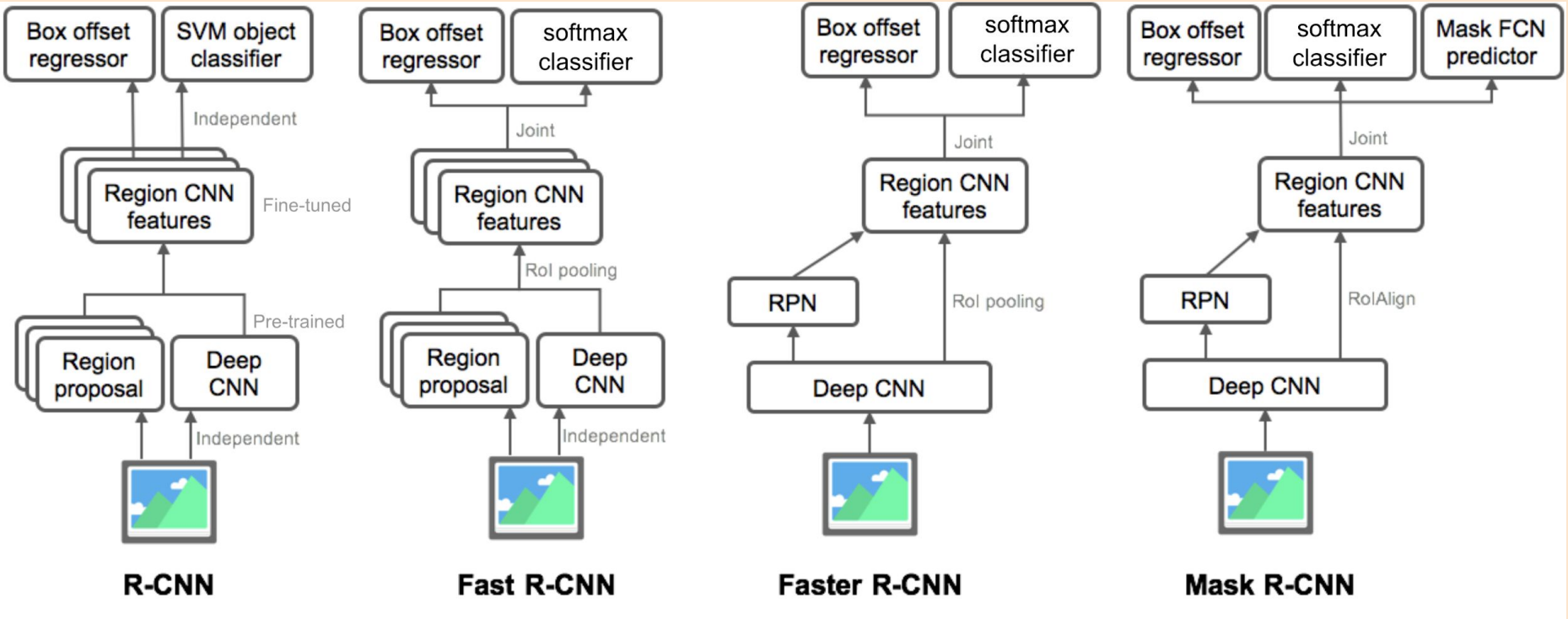
Classes: ['shirt, blouse', 'top, t-shirt, sweatshirt', 'sweater', 'cardigan', 'jacket', 'vest', 'pants', 'shorts', 'skirt', 'coat', 'dress','jumpsuit', 'cape', 'glasses', 'hat', 'headband, head covering, hair accessory', 'tie', 'glove', 'watch','belt', 'leg warmer', 'tights, stockings', 'sock', 'shoe','bag, wallet', 'scarf', 'umbrella', 'hood', 'collar', 'lapel','**epaulette**', 'sleeve', 'pocket', 'neckline', 'buckle', 'zipper','**applique**', 'bead', 'bow', '**flower**', 'fringe', 'ribbon', 'rivet','ruffle', '**sequin**', 'tassel']

Visualizing masks on training set

The Data Annotations

ImageId	EncodedPixels	ClassId	Height	Width
00000663ed1ff0c4e0132b9b9ac53f6e	[6068157 7 6073371 20 6078584 34 6083797 48 60...	[6, 0, 28, 31, 32, 32, 31, 29, 4]	5214	3676
0000fe7c9191fba733c8a69cfaf962b7	[2201176 1 2203623 3 2206071 5 2208518 8 22109...	[33, 1]	2448	2448
0002ec21ddb8477e98b2cbb87ea2e269	[2673735 2 2676734 8 2679734 13 2682733 19 268...	[33, 10, 23, 23]	3000	1997
0002f5a0ebc162ecfb73e2c91e3b8f62	[435 132 1002 132 1569 132 2136 132 2703 132 3...	[10, 33, 15]	567	400
0004467156e47b0eb6de4aa6479cbd15	[132663 8 133396 25 134130 41 134868 53 135611...	[10, 33, 31, 31, 15]	750	500
00048c3a2fb9c29340473c4cfc06424a	[239016 3 239989 6 240963 7 241938 8 242913 9 ...	[13, 1, 33, 8, 35, 24, 23, 23]	975	650
0006ea84499fd9a06fefbdf47a5eb4c0	[73327 6 74328 18 75330 37 76335 63 77340 88 7...	[1, 33, 8, 23, 23]	1000	667

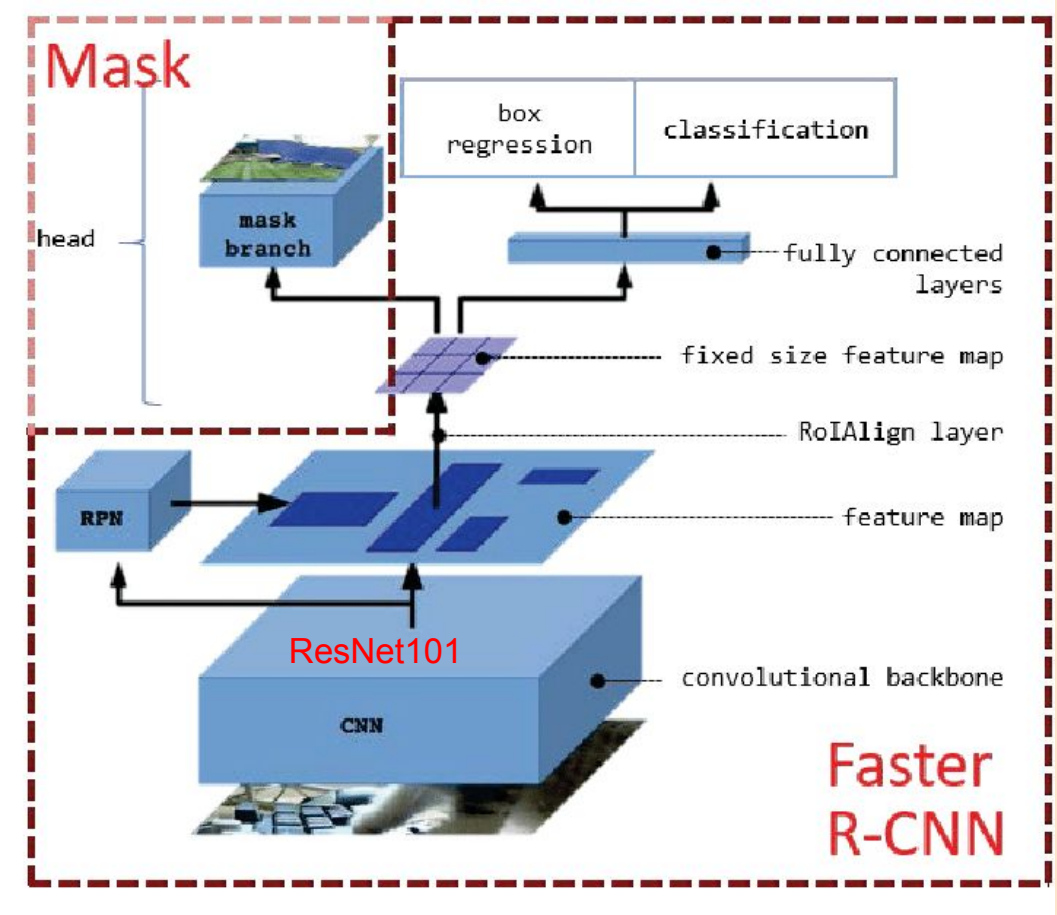
The R-CNN Family



Mask R-CNN architecture

Two stage framework:

1. Generate region proposals
2. Classify proposals and generate bounding boxes and masks.



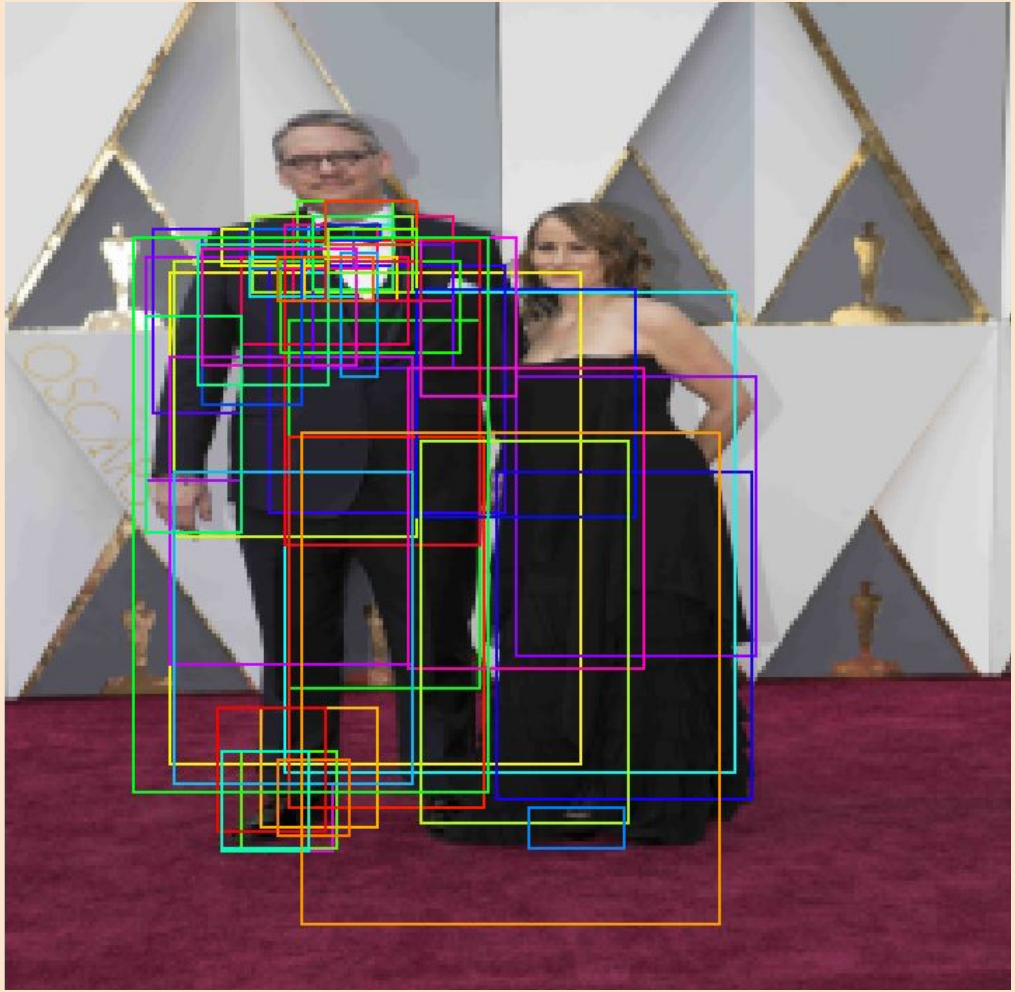
Step by Step Prediction

1. Region Proposal Network (RPN)
2. Proposal Classification
3. Generating the masks

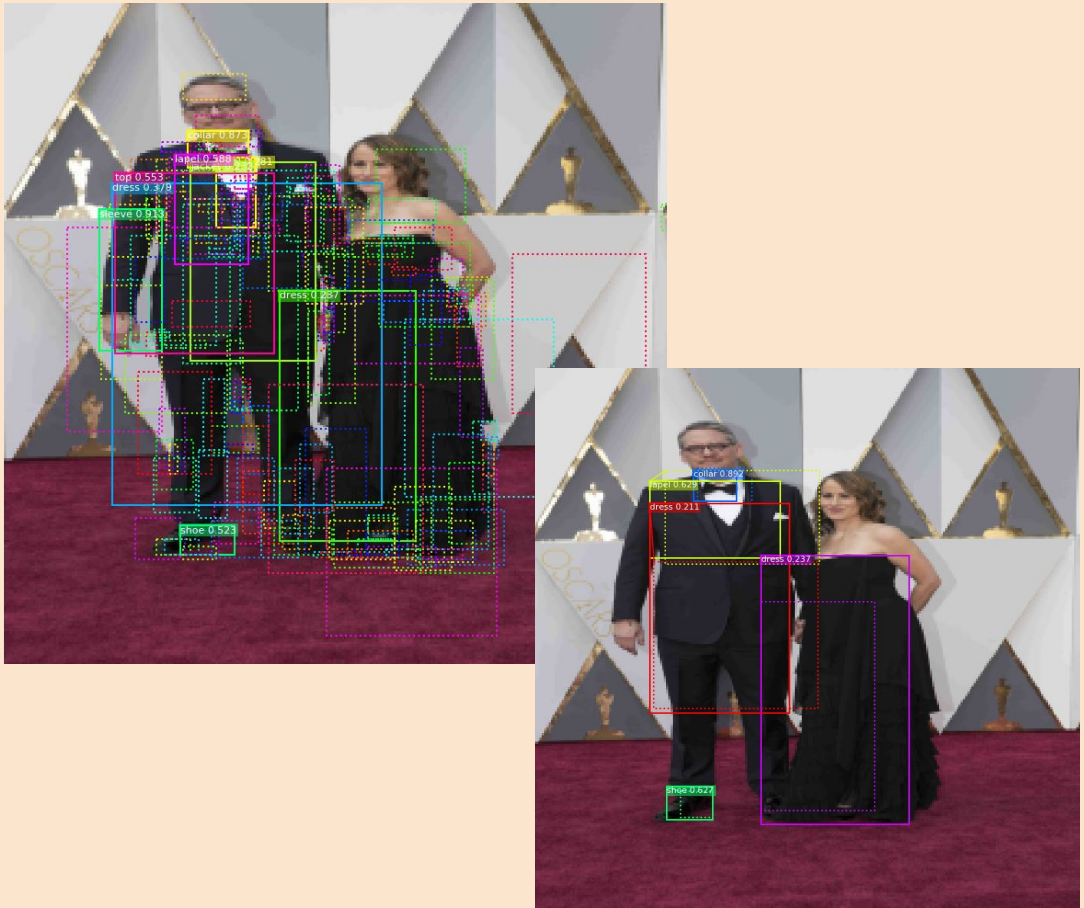
The RPN

Generates two outputs for each anchor:

1. **Anchor Class:** Foreground or background
2. **Bounding box refinement:** To refine the anchor box to fit the object better



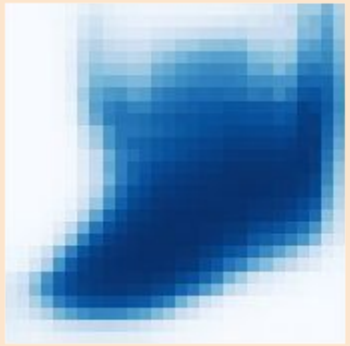
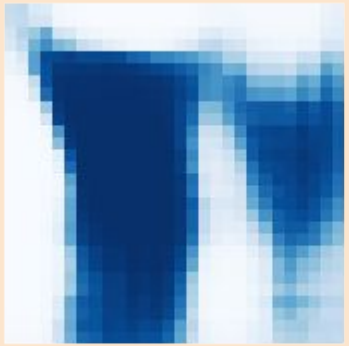
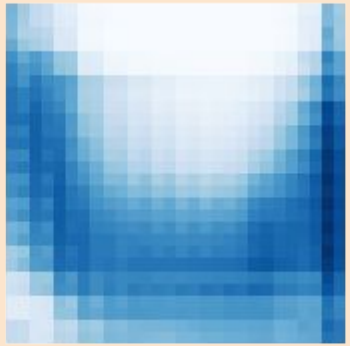
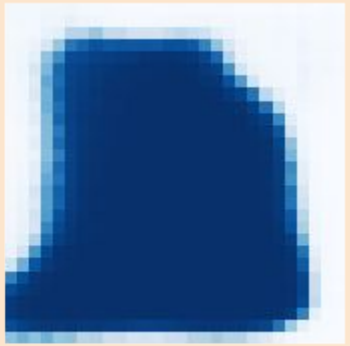
The ROI Classifier & Bounding Box Regressor



Class: the class of the object in the ROI. Unlike the RPN, which has 2 classes(FG/BG), this network is deeper and has the capacity to classify regions to specific classes (shoe, tshirt, sleeve etc).

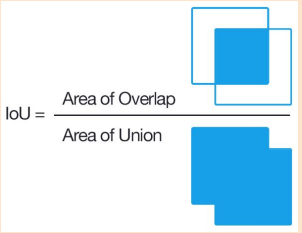
Bounding Box Refinement: to further refine the location and size of the bounding box to encapsulate the object.

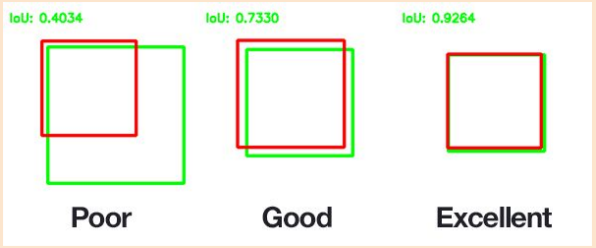
Segmentation Masks

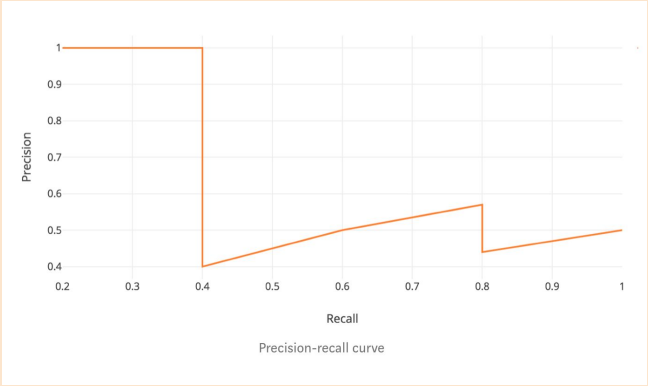
Evaluating the model

IoU: Intersection over Union:





Precision & Recall:



$$Precision = \frac{TP}{TP + FP}$$ ← Predicted boxes

$$Recall = \frac{TP}{TP + FN}$$ ← ALL objects

TP = True positive

TN = True negative

FP = False positive

FN = False negative

AP (Average Precision)

$$\mathrm{AP} = \int_0^1 p(r)dr$$

mAP (mean Average Precision)

0.17

Predictions

Predictions

Predictions

Predictions


THANK YOU
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