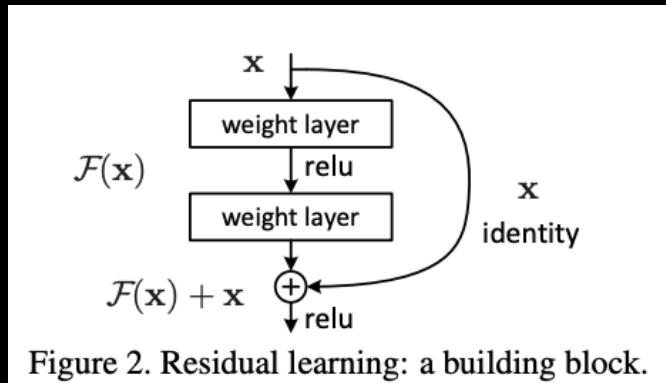


# Today's Agenda

RESNET → Residual Learning



Vanish Speed  
Accuracy Degrad

$x \rightarrow$  Input  
 $F(x) \rightarrow$  Info loss Skip Connection

$F(x) + x$

Identity Mapping Operation

GoogleNet → Auxiliary Classifiers  
Softmax 0, 1

\* { DenseNet  
MobileNet } \*

## Object Detection

What?

Where?

Location of the object

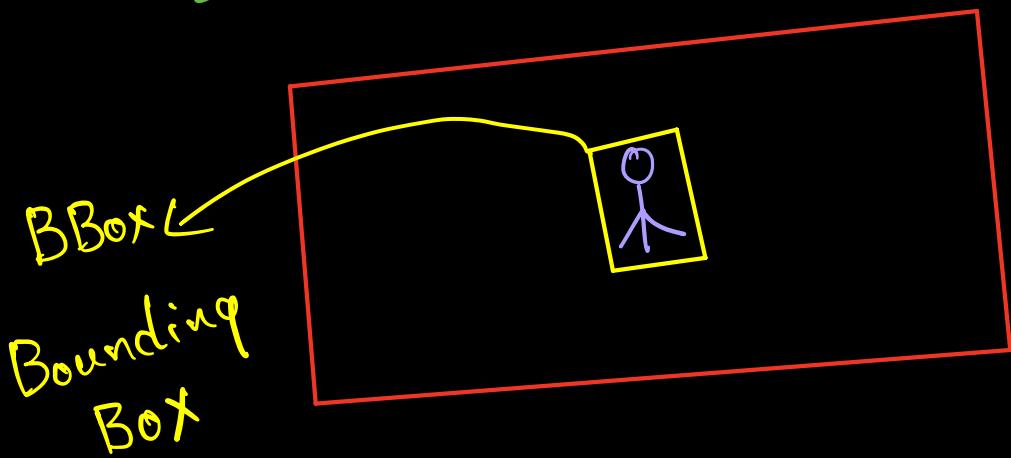
What + Where

{ Classification + Regression }

Identification & Location

Classify each object

Localization of the object



# Working of Obj Detect

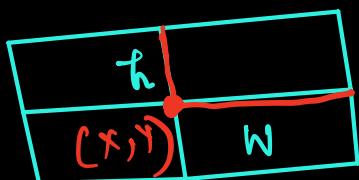
- 1) Input Image
- 2) CNN Backbone  $\rightarrow$  VGG, Resnet, Inception
- 3) Classification + Regression

Output :-

- 1) Class Label
- 2) BBox Coordinates
- 3) Confidence Scores
- \*(4) Total no of objects \*

## BBOX Co-ordinates

$$(x, y, w, h)$$



$(x, y) \rightarrow$  mid/center  
 $(w) \rightarrow$  width  
 $(h) \rightarrow$  height

$(x, y)$   
 $(x + w, y + h)$

## loss Functions

$C.L = \text{Classification Loss}$	$\text{Loss}$	$(\text{Cross Entropy})$
$R.L = \text{Regression Loss}$	$\text{Loss}$	$(\text{Smooth L1 / L2})$

Combined Loss =  $C.L + R.L$

Regression loss

$$\lambda_{\text{coord}} \sum_{i=0}^{S^2} \sum_{j=0}^B \mathbb{1}_{ij}^{\text{obj}} \left[ (x_i - \hat{x}_i)^2 + (y_i - \hat{y}_i)^2 \right]$$

$$+ \lambda_{\text{coord}} \sum_{i=0}^{S^2} \sum_{j=0}^B \mathbb{1}_{ij}^{\text{obj}} \left[ (\sqrt{w_i} - \sqrt{\hat{w}_i})^2 + (\sqrt{h_i} - \sqrt{\hat{h}_i})^2 \right]$$

Confidence loss

$$+ \sum_{i=0}^{S^2} \sum_{j=0}^B \mathbb{1}_{ij}^{\text{obj}} (C_i - \hat{C}_i)^2$$

$$+ \lambda_{\text{noobj}} \sum_{i=0}^{S^2} \sum_{j=0}^B \mathbb{1}_{ij}^{\text{noobj}} (C_i - \hat{C}_i)^2$$

Classification loss

$$+ \sum_{i=0}^{S^2} \mathbb{1}_i^{\text{obj}} \sum_{c \in \text{classes}} (p_i(c) - \hat{p}_i(c))^2$$

Common	Challenged
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- 1) Small Object
- 2) Class Imbalance
- 3) Overlapping Objects

## Evaluation Metrics

IOU → Intersection Over Union  
MAP → Mean Average Precision

Object	Detection Family
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Single Stage

2016

YOLO

SSD

Two Stage

2014 RCNN Family

RCNN  
FAST RCNN  
FASTER RCNN  
MASK RCNN

Very Fast

Low Accuracy

30 ~ 60 FPS

High Acc

Slow

5 - 15 FPS