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CHENNAI

You Only Look Once (YOLO)

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Contents

You Only Look Once (YOLO)

The Object Detection Challenge

THE PROBLEM WE FACE:

- Find + Classify + Localize ALL objects in image
- Real-time speed required (30+ FPS)
- Multiple objects, varying sizes, overlapping

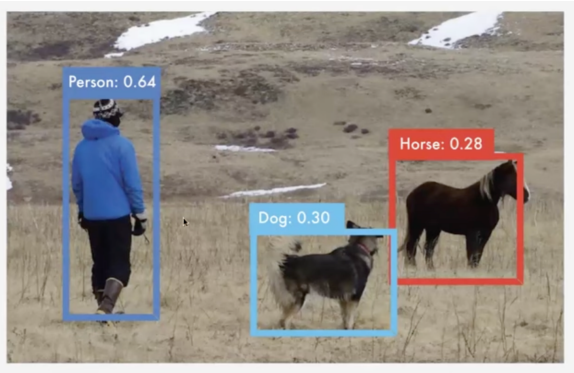
Traditional Pipeline (R-CNN family):

1. Region Proposals $\rightarrow$ 2000+ boxes
2. CNN Feature Extraction $\rightarrow$ Per box
3. Classification $\rightarrow$ Per box
4. Bounding Box Regression $\rightarrow$ Per box

2-5 SECONDS per image!

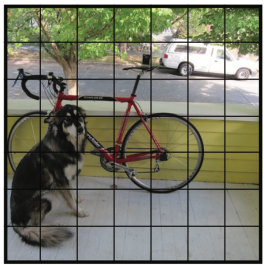
Object Detection

Object detection is a task that involves identifying the location and class of objects in an image or video stream.



- The output of an object detector is a set of bounding boxes that enclose the objects in the image, along with class labels and confidence scores for each box.
- Object detection is a good choice when you need to identify objects of interest in a scene, but don't need to know exactly where the object is or its exact shape.

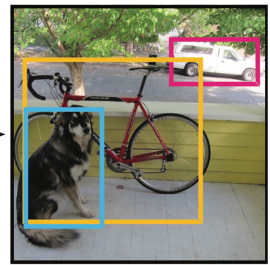
Real-Time Detectors	Train	mAP	FPS
100Hz DPM [31]	2007	16.0	100
30Hz DPM [31]	2007	26.1	30
Fast YOLO	2007+2012	52.7	**155**
YOLO	2007+2012	**63.4**	45
Less Than Real-Time			
Fastest DPM [38]	2007	30.4	15
R-CNN Minus R [20]	2007	53.5	6
Fast R-CNN [14]	2007+2012	70.0	0.5
Faster R-CNN VGG-16[28]	2007+2012	73.2	7
Faster R-CNN ZF [28]	2007+2012	62.1	18
YOLO VGG-16	2007+2012	66.4	21



S × S grid on input

Bounding boxes + confidence

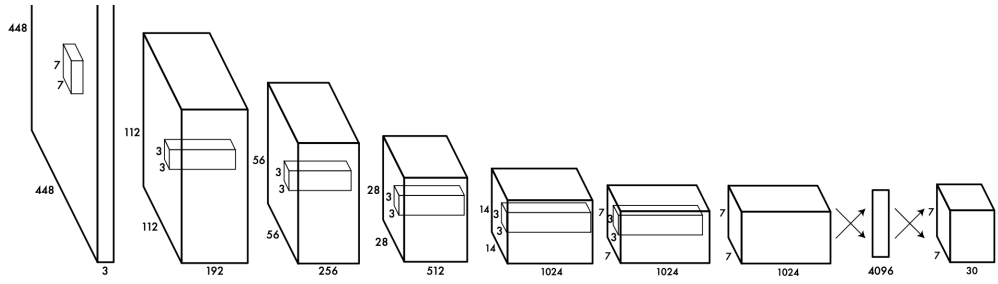
Class probability map



Final detections

YOLO v1 Architecture

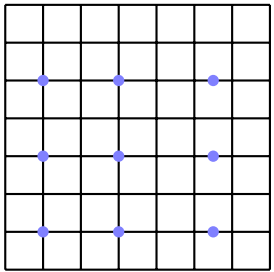
24 Conv Layers + 2 FC Layers



Input Image (448×448)

↓

7×7 Grid



Each cell predicts 2 boxes + 20 classes

↓

NMS (Non-Max Suppression)

↓

Final Detections with Boxes!

YOLO vs Traditional Methods

Metric	**R-CNN**	**Fast R-CNN**	**YOLO v1**
mAP (Accuracy)	66.0%	70.0%	63.4%
Speed (FPS)	0.5-15	17	**45**
Pipeline Steps	4 stages	3 stages	**1 stage**

YOLO TRADES slight accuracy for 3-10x SPEED!

Generalizations

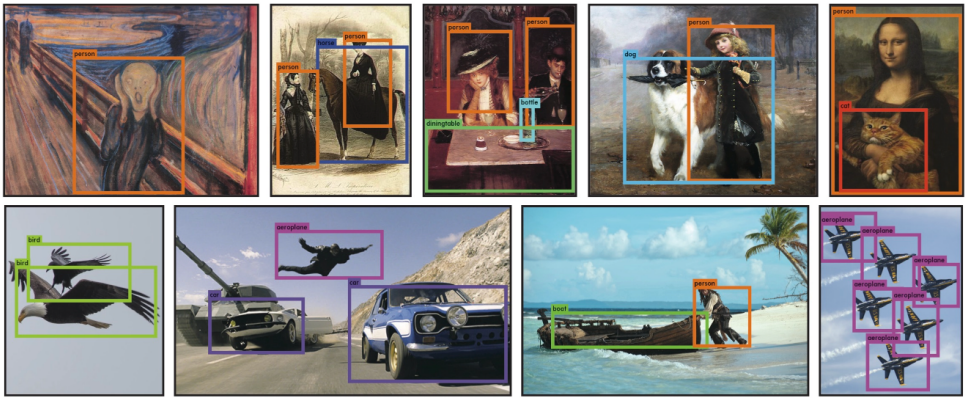


Figure 6: Qualitative Results. YOLO running on sample artwork and natural images from the internet. It is mostly accurate although it does think one person is an airplane.

Why YOLO Wins

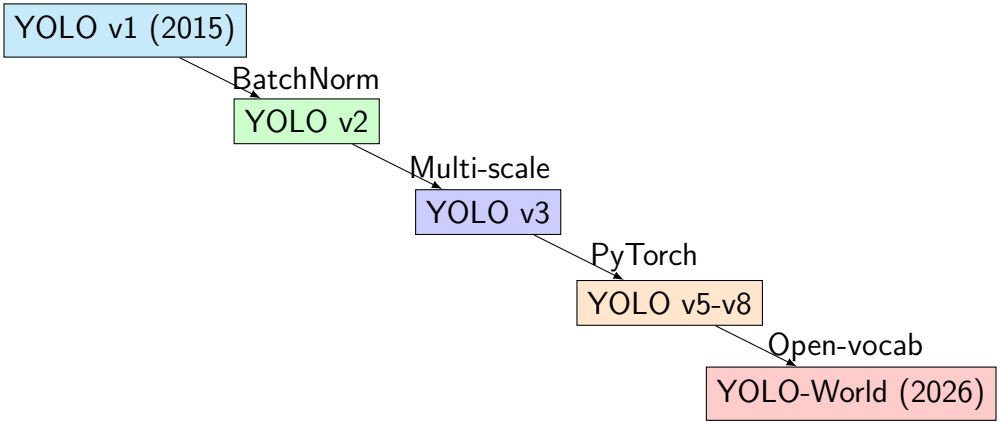
- **SINGLE** neural network (end-to-end)
- Real-time inference **(45+ FPS)**
- Global context (sees entire image)
- Simple to train/deploy
- Scales to video

Tradeoffs:

- Struggles with small objects
- Fewer bounding boxes per cell

PROVEN: Speed > Perfection for real-world!

YOLO Evolution Path



45 FPS → Production Ready

Ready for LIVE Demo?

Next: YOLOv8 in Action!

1. `ultralytics/yolov8n.pt` (2MB model)
2. Webcam $\rightarrow$ Real-time detection
3. Custom training on YOUR data

Questions before we code?

References I

[1] Christopher M Bishop. *Neural networks for pattern recognition*. Oxford university press, 1995.

[2] Ian Goodfellow, Yoshua Bengio, and Aaron Courville. *Deep learning*. MIT press, 2016.

[3] Joseph Redmon et al. "You Only Look Once: Unified, Real-Time Object Detection". In: *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*. 2016, pp. 779–788. URL: http://pjreddie.com/media/files/papers/YOLO_1.pdf.