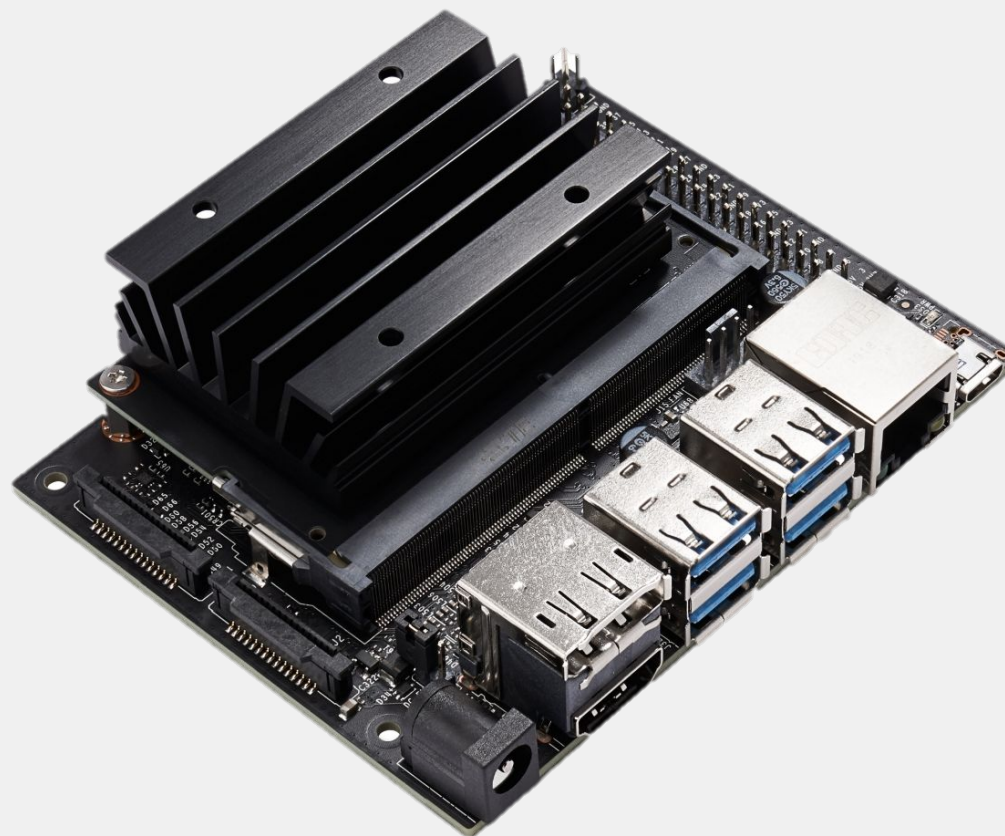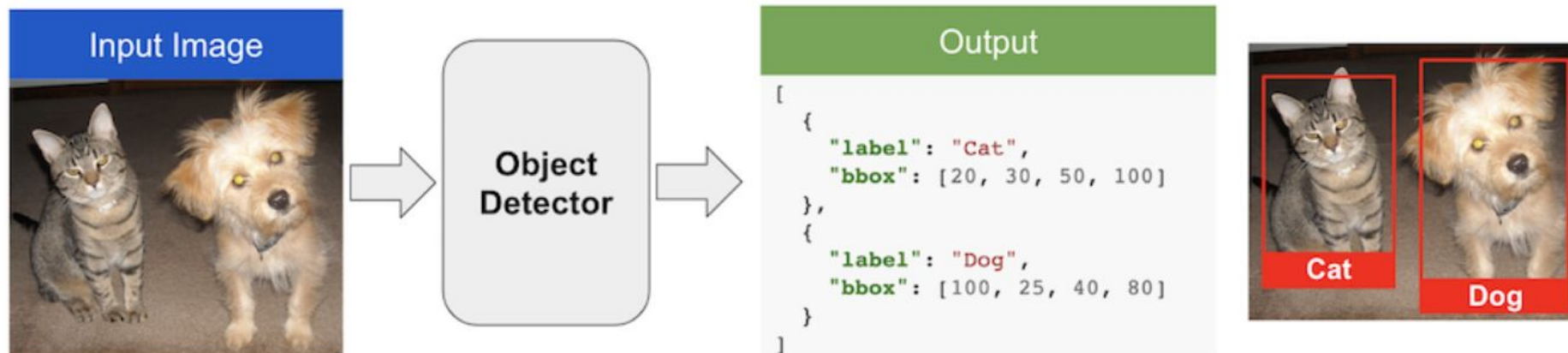# Object Detection
NVIDIA JETSON

Content

- **Image Classification** vs **Object Detection**

- **Different methods of Object Detection**

- **Brief about YOLO**

- **How YOLO performs Object Detection**

- **Comparison of different YOLO Versions**

Image Classification vs Object Detection

Object Detection Methods

- **Sliding Window** approach

- **Two Stage** method
  - **RCNN, Fast-RCNN, Faster-RCNN**

- **One Stage** method
  - **YOLO**

You Only Look Once (YOLO)

- **Introduced in 2015**

- **Outperformed all the previous methods**
  - **Speed and Accuracy**

- **Single CNN**

- **Iterate Once through the whole Image**

- **Many versions proposed after first release**
  - **YOLOv1, v2, v3, v4, v5, and the latest one YOLOX**

YOLO Object Detection

Bounding boxes + confidence

S × S grid on input

Class probability map

Final detections
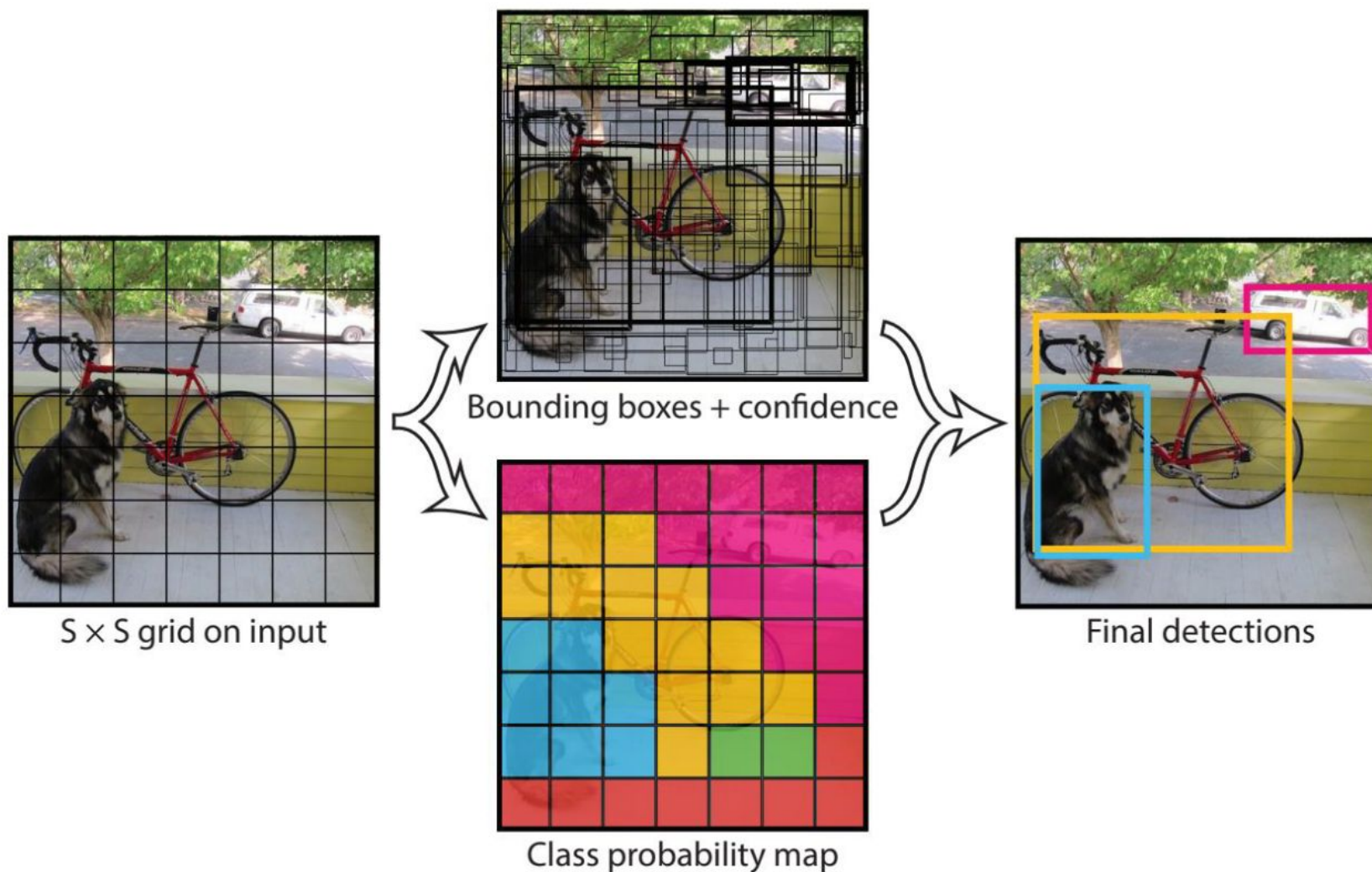
Evolution of YOLO

- **YOLOv1**

- **YOLOv2**

- **YOLOv3**

- **YOLOv4**

- **YOLOv5**

- **YOLOX**

Evolution of YOLO

- **YOLOv1**

  - YOLOv2

  - YOLOv3

  - YOLOv4

  - YOLOv5

  - YOLOX

- **Features:**
  - **Extremely Fast**
  - **Single CNN**
  - **24 Conv. + 2 FC Layers**
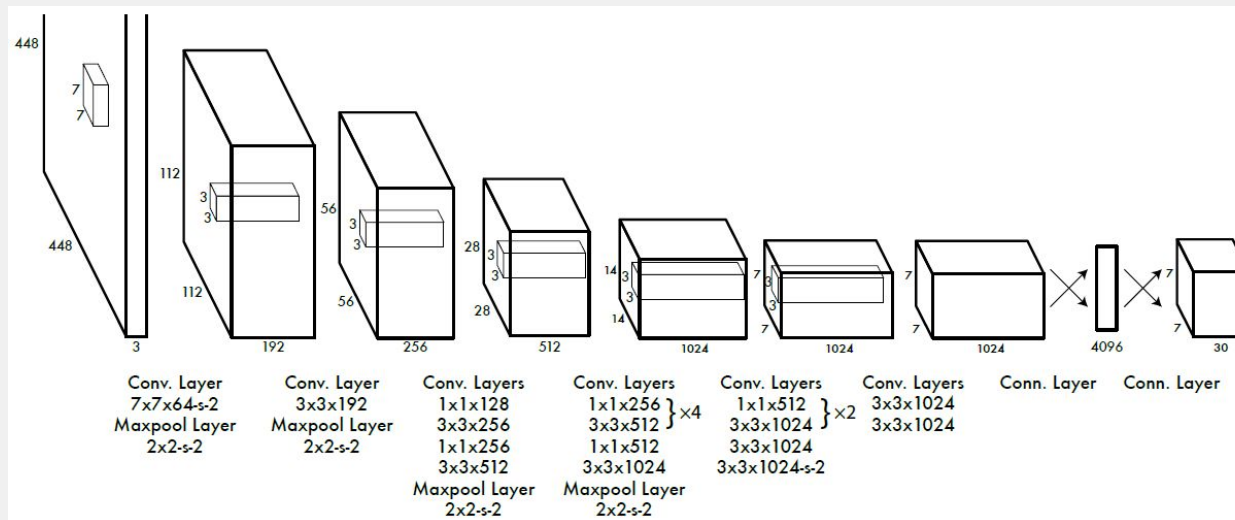
Evolution of YOLO

- **YOLOv1**
  - YOLOv2
  - YOLOv3
  - YOLOv4
  - YOLOv5
  - YOLOX

- **Limitations:**
 - **Ignore Small Objects**
  - **Resolution Restriction**
  - **Low Accuracy**

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

Evolution of YOLO

- YOLOv1
- **YOLOv2**
- YOLOv3
- YOLOv4
- YOLOv5
- YOLOX

●Improvements:
- ○ **Batch Normalization**
- ○ **Resolution Independent**
- ○ **Anchor Boxes for Prediction**
- ○ **mAP increased by 4%**
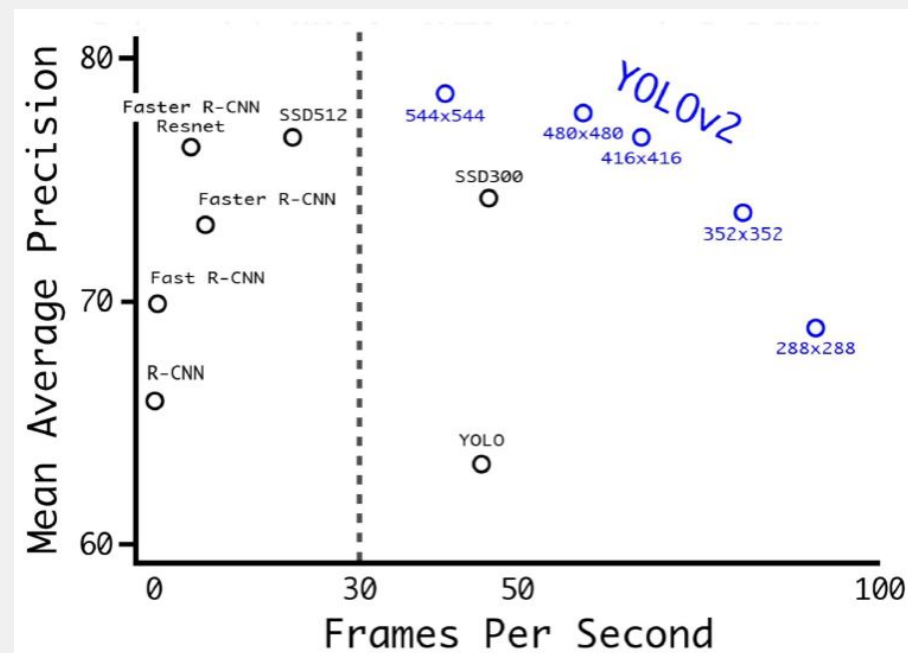
Evolution of YOLO

- YOLOv1

- YOLOv2

- **YOLOv3**

- YOLOv4

- YOLOv5

- YOLOX

● **Improvements:**
  ○ **Multi-label Classification**
  ○ **Predictions**
  ○ **Deeper Network**

Evolution of **YOLO**

- **YOLOv1**

- **YOLOv2**

- **YOLOv3**

- **YOLOv4**

- **YOLOv5**

- **YOLOX**

● **Improvements:**
○ **Mosaic, SAT**
○ **Speed Increased by 12%**
○ **mAP increased by 10%**

MS COCO Object Detection

- YOLOv4 (ours)
- YOLOv3 [63]
- EfficientDet [77]
- ATSS [94]
- ASFF* [48]
- CenterMask* [40]

EfficientDet (D0~D4) real-time

YOLOv4 (ours)

ASFF*

YOLOv3

AP vs FPS (V100)
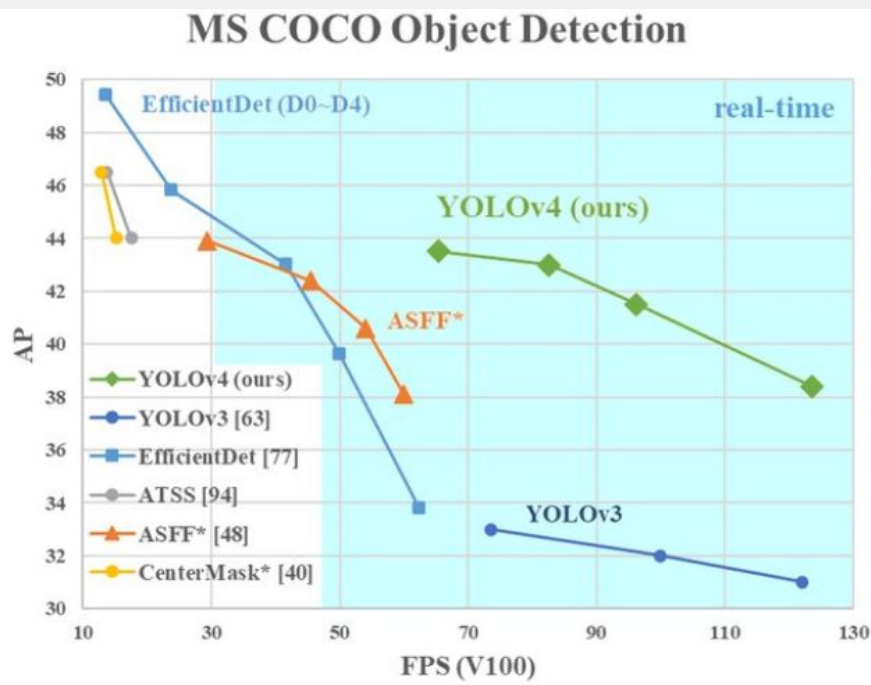
Evolution of YOLO

- YOLOv1
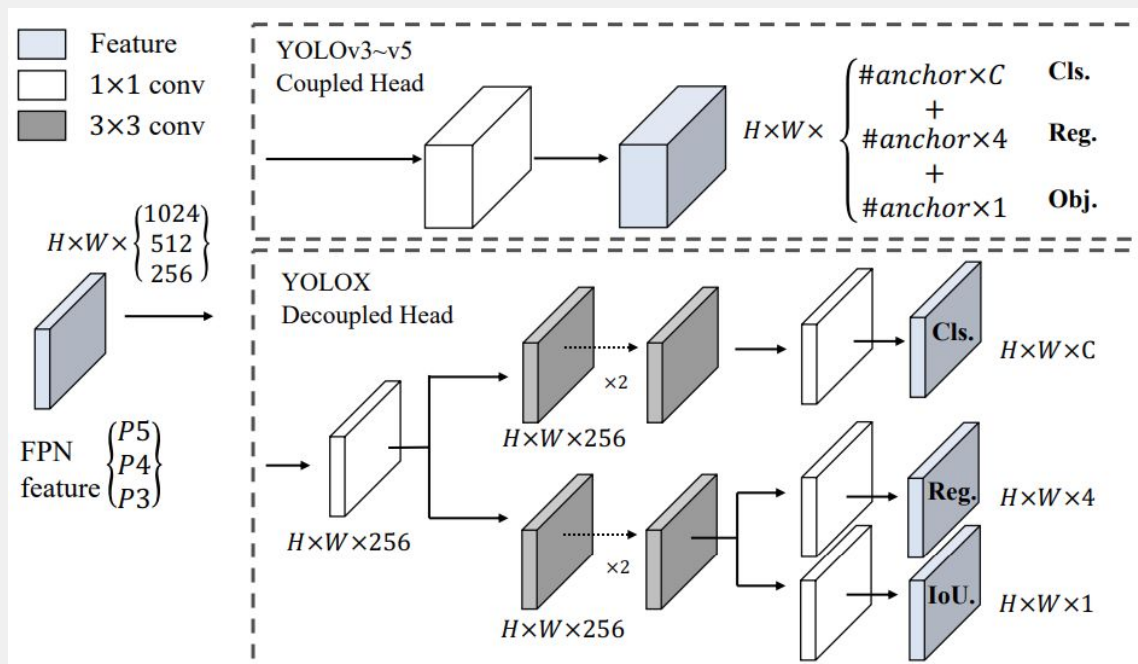- YOLOv2
- YOLOv3
- YOLOv4

- **YOLOv5**

- YOLOX

- **Improvements:**
  - ○ Similar to YOLOv4
  - ○ Improvement in Speed and Accuracy

Evolution of YOLO

- YOLOv1
- YOLOv2
- YOLOv3
- YOLOv4
- YOLOv5
- **YOLOX**

- **Improvements:**
  - Improved Architecture
  - Anchor Free
  - Decoupled Head

Thank You