N2E Robotics Workshop

Taqiya Ehsan

YOLO + OC-SORT for Object Detection and Tracking

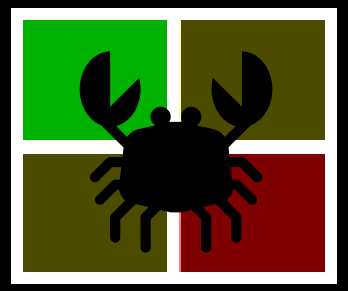
Agenda

1. YOLOv8 Overview & Hands-On Demo
2. YOLOv8 with OC-SORT Tutorial
3. Student Challenge

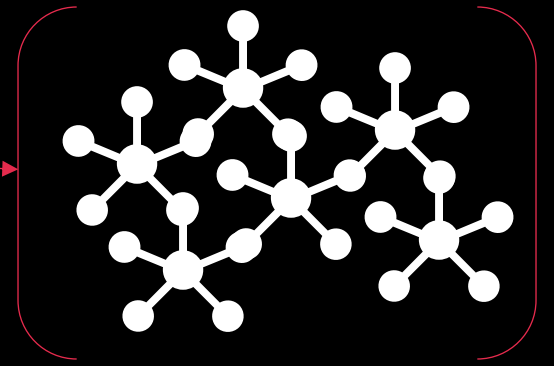
Object Detection

Identify and Locate Objects

Wide Range of Applications

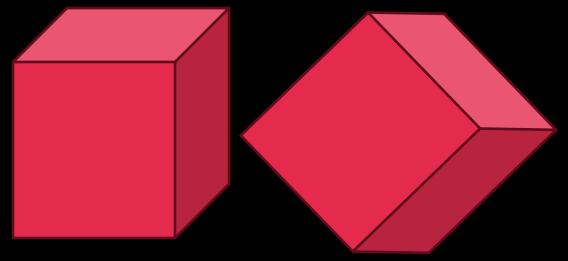


Bounding Boxes

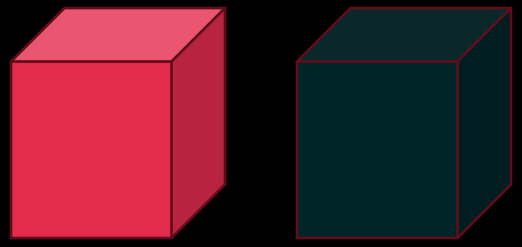


Uses Deep Learning techniques

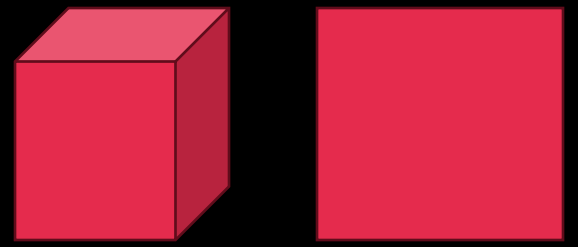
Challenges with Object Detection



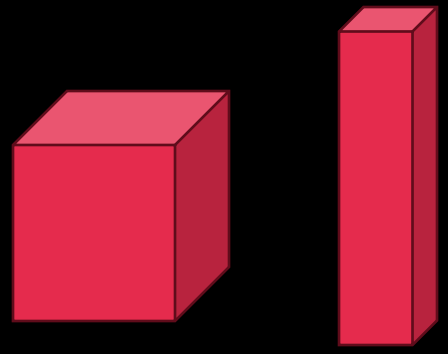
Viewpoint Variation



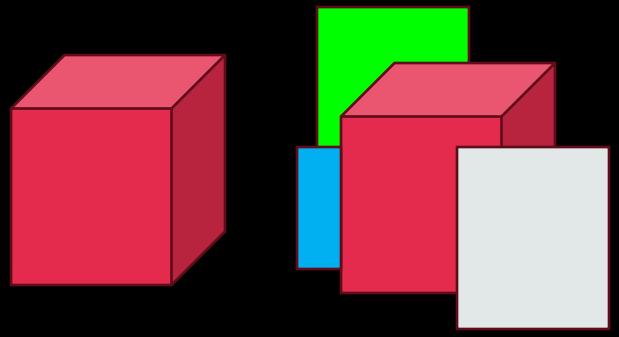
Occlusion/Lighting



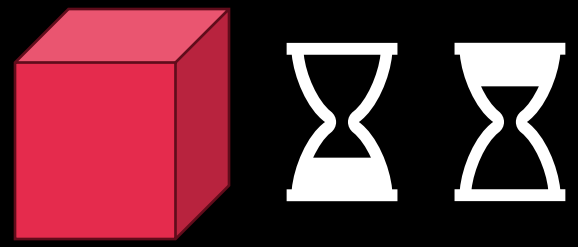
Object Variation



Deformation

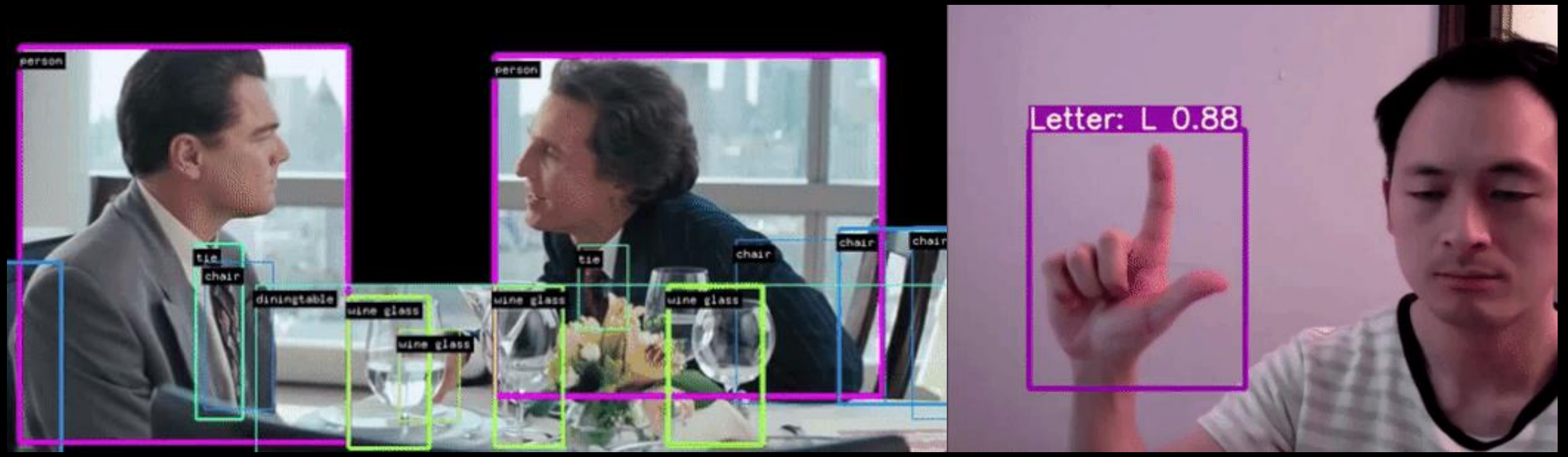


Cluttered Background



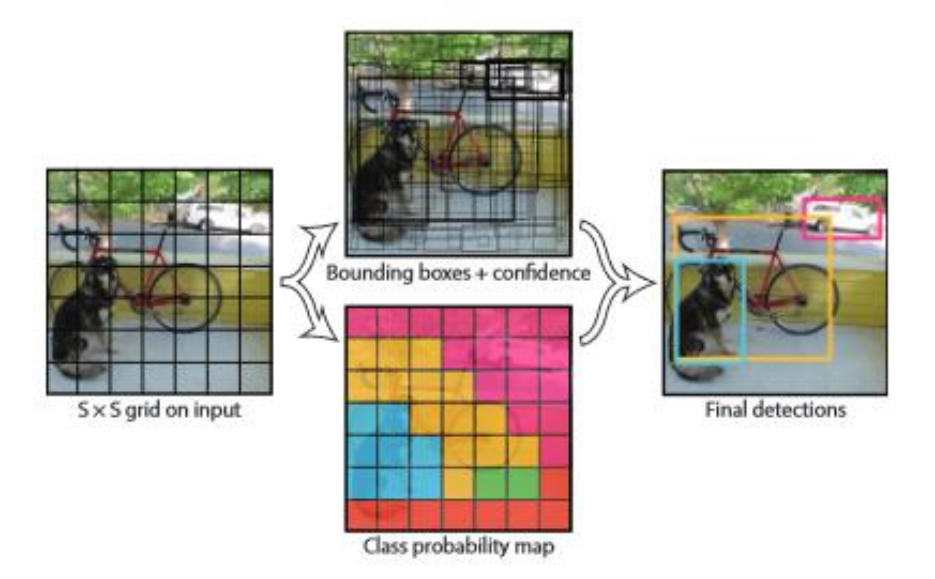
Speed

YOLO: Real-time Object Detection *(2015)*

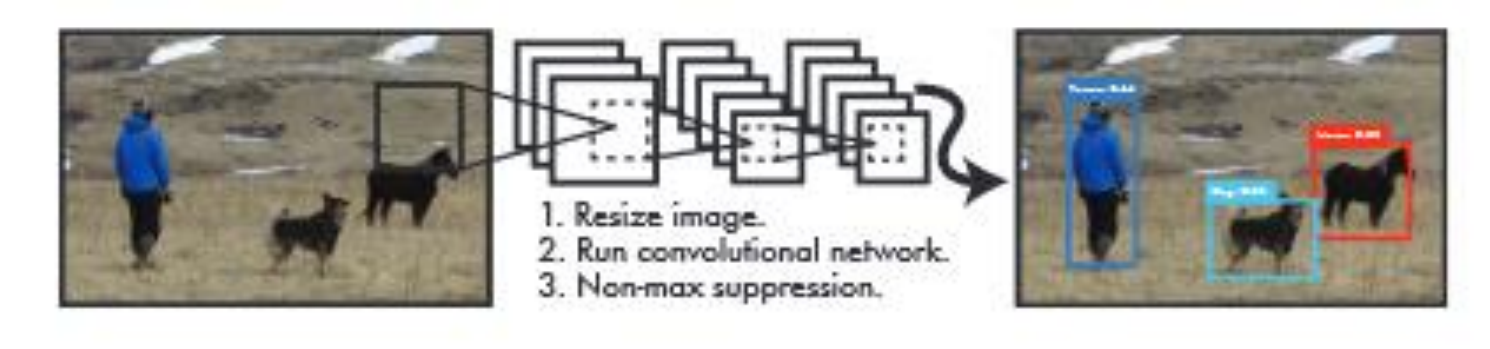


You Only Look Once: Unified, Real-Time Object Detection (2015), Joseph Redmon, Santosh Divvala, Ross Girshick, Ali Farhadi, https://arxiv.org/abs/1506.02640

YOLOv1 (2015)

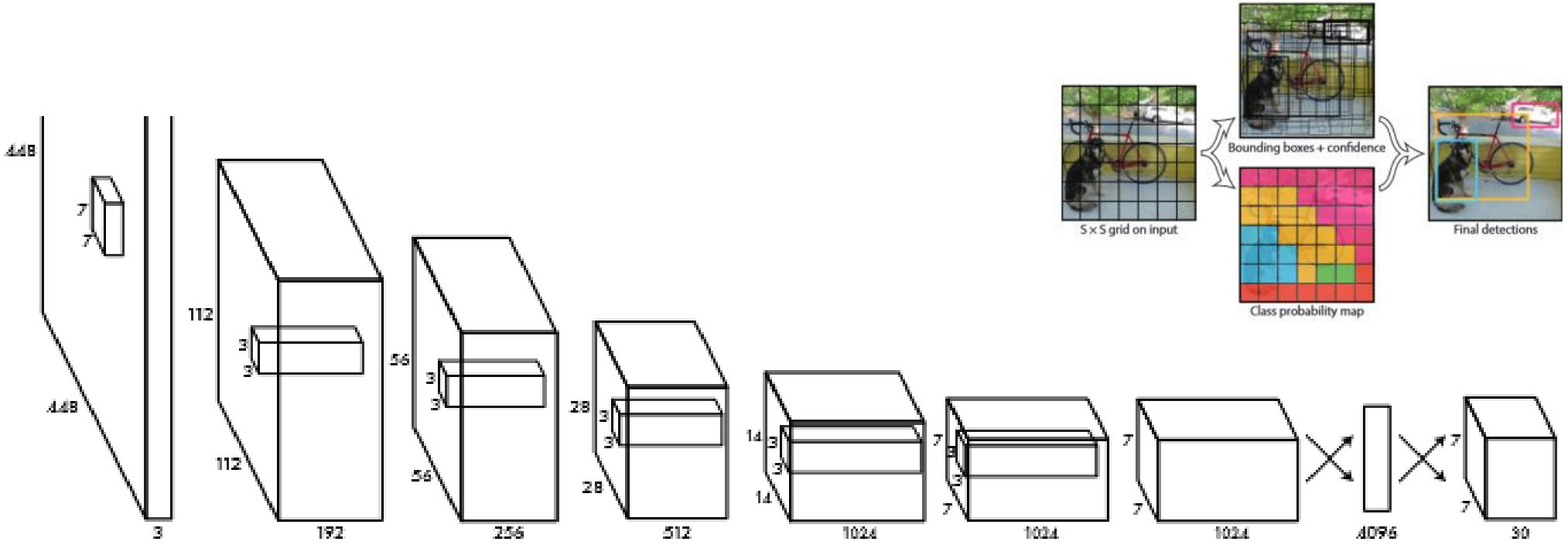


Bounding Boxes



YOLO Overview

Model	Parameters
YOLOv1	40,960



Conv. Layer
7x7x64-s-2
Maxpool Layer
2x2-s-2

Conv. Layer
3x3x192
Maxpool Layer
2x2-s-2

Conv. Layers
1x1x128
3x3x256
1x1x256
3x3x512
Maxpool Layer
2x2-s-2

Conv. Layers
1x1x256
3x3x512
} ×4
1x1x512
3x3x1024
Maxpool Layer
2x2-s-2

Conv. Layers
1x1x512
3x3x1024
} ×2
3x3x1024
3x3x1024-s-2

Conv. Layers
3x3x1024
3x3x1024

Conn. Layer Conn. Layer

YOLOv1 Architecture

YOLOv8 (2023)

Key Features:

+ Anchor-Free Detection
+ C2f Module
+ Decoupled Head
+ Modified Loss Function
+ *Quick implementation on CLI and Python IDE*

Model	# Param.
YOLOv8n	3.2M
YOLOv8s	11.2M
YOLOv8m	25.9M
YOLOv8l	70.4M
YOLOv8x	68.2M

DEMO

Object Tracking

- Follow detected objects across multiple frames in a video.
- Common tracking challenges: occlusions, motion blur, fast-moving objects.
- YOLO detects objects in each frame but does not inherently track them.
- **Real-World Applications**: Object tracking is used in autonomous vehicles, surveillance, sports analytics, AR/VR, retail analytics, healthcare, drones, and robotics to monitor, analyze, and interact with dynamic environments.

Observation-Centric SORT (OC-SORT)

- An advanced tracking algorithm that improves upon SORT (Simple Online and Realtime Tracker).
- Designed to handle object **occlusions** and **motion discontinuities** more effectively.
- Uses Kalman filters, motion models, and re-identification techniques.
- Key feature:

  + **Handles occlusions** better than traditional SORT.

  + **Improved motion prediction** using optical flow features.

  + **Lightweight & real-time**, making it ideal for applications like autonomous driving and surveillance.

Observation-Centric SORT: Rethinking SORT for Robust Multi-Object Tracking, Cao et al., 2023. https://arxiv.org/abs/2203.14360

DEMO

Student Challenge: Track Your Own Objects

Choose One:

- **Filter by Object Class:** Track only a specific object (e.g., people or cars).
- **Track Objects by Color:** Track objects based on a specific color (e.g., red).
- **Experiment with Confidence Threshold:** Ignore low-confidence detections and track only high-confidence objects.
- ** **Display Object Count:** Count and display the number of detected objects of each class.
- ** **Display Object Tracking History:** Show a history of tracked objects with movement paths.
- *** **Object Speed Estimation:** Estimate and display the speed of each tracked object.
- *** **Multi-Object Interaction Highlight:** Change the color when two objects are in close proximity.