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# Computer Vision for Visual Perception

## 2D & 3D Object Detection and Tracking

# Learning Objectives

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- **Object Detection**
  - Definition
  - Why it matters?
  - 2D & 3D Concepts
  - Techniques Used
- **Object Tracking**
  - Definition
  - Types and Uses
  - Techniques Used
  - Working Principle
  - Applications
- **3D Object Detection & Tracking**
- **Object Detection & Tracking in SDC**
- **Summary**
- **References**

# Object Detection – Definition

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- **A computer vision technique for locating instances of objects in images or videos.**

- **The goal of object detection is to replicate this intelligence using a computer.**

# Object Detection – Why it matters

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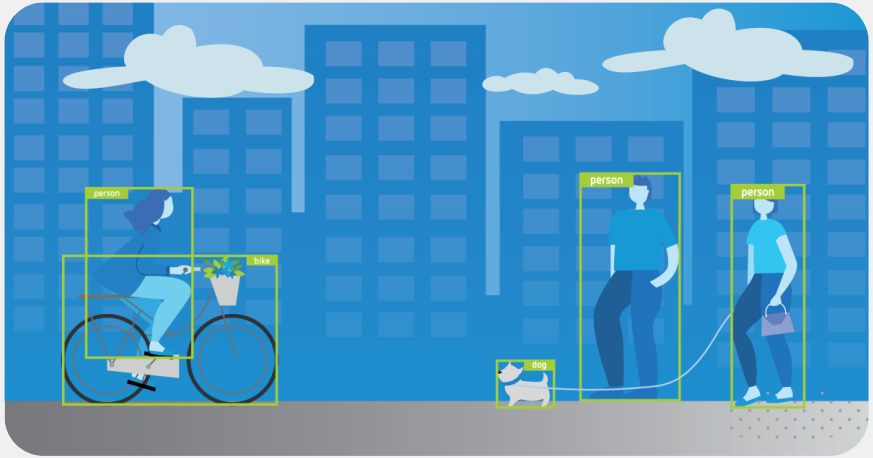
- **Key technology behind Advanced Driver Assistance Systems (ADAS) that enable cars to detect driving lanes.**



# Object Detection – 3D & 2D

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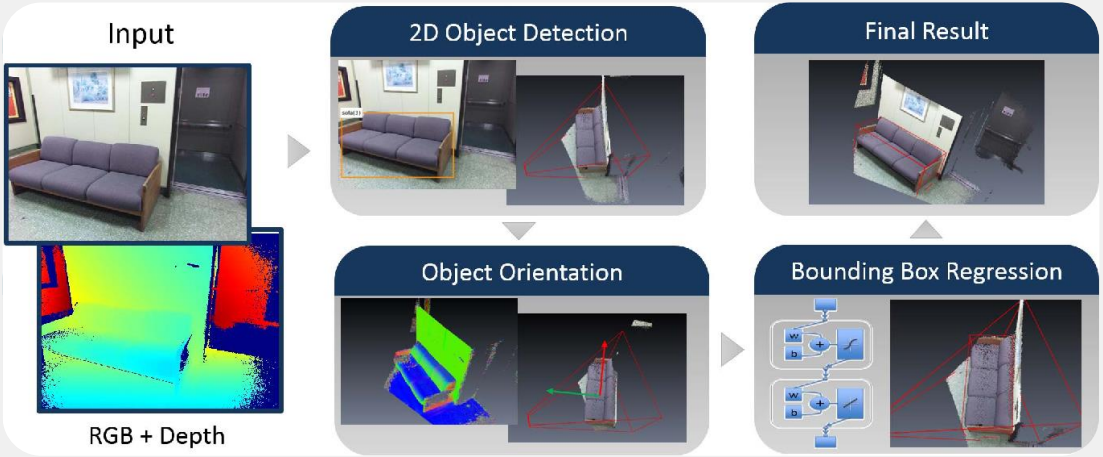
- **2D object detection methods cannot provide enough understanding of the 3D world that a robot (or agent) operate in.**



# Object Detection – Techniques Used

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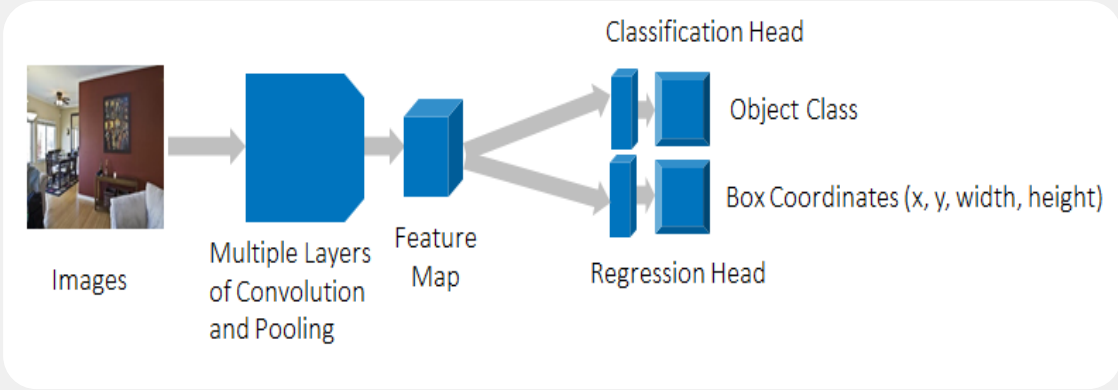
- Object detection using Deep Learning
- Two Stage Networks
- Single Stage Networks
- Object detection using Machine Learning



# 2D Object Detection Techniques

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- YOLOv7
- YOLOv6.5
- YOLOv5
- YOLOX
- YOLOR

# 3D Object Detection Techniques

AUGMENTED STARTUPS
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- YOLO v7
- YOLO v5
- YOLOv4
- YOLOv3

OR YOLOv5

# Object Detection Using Deep Learning

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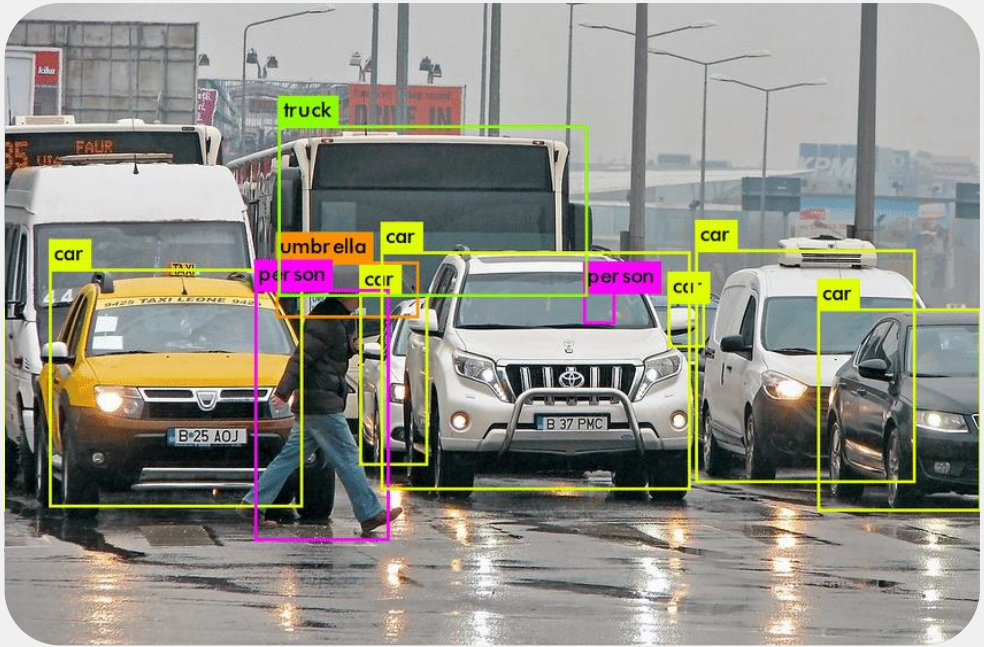
- Create and train a custom object detector
- Use a pretrained object detector



# Object Detection Using Two Stage Networks

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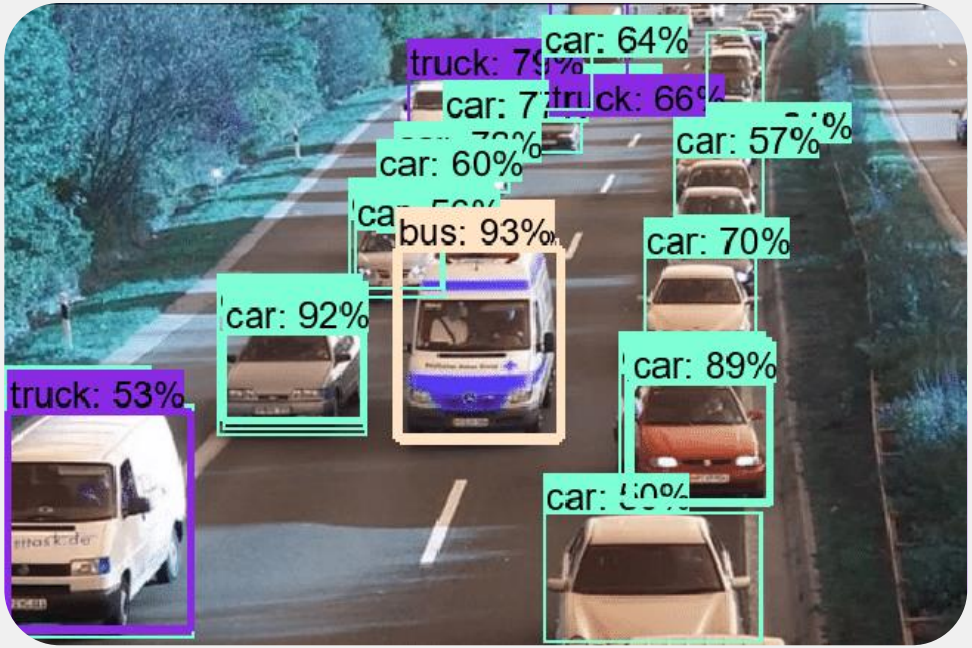
- 1st stage identifies region proposals or subsets of the image that might contain an object.
- 2nd stage classifies the objects within region proposals.



# Object Detection Using Single Stage Networks

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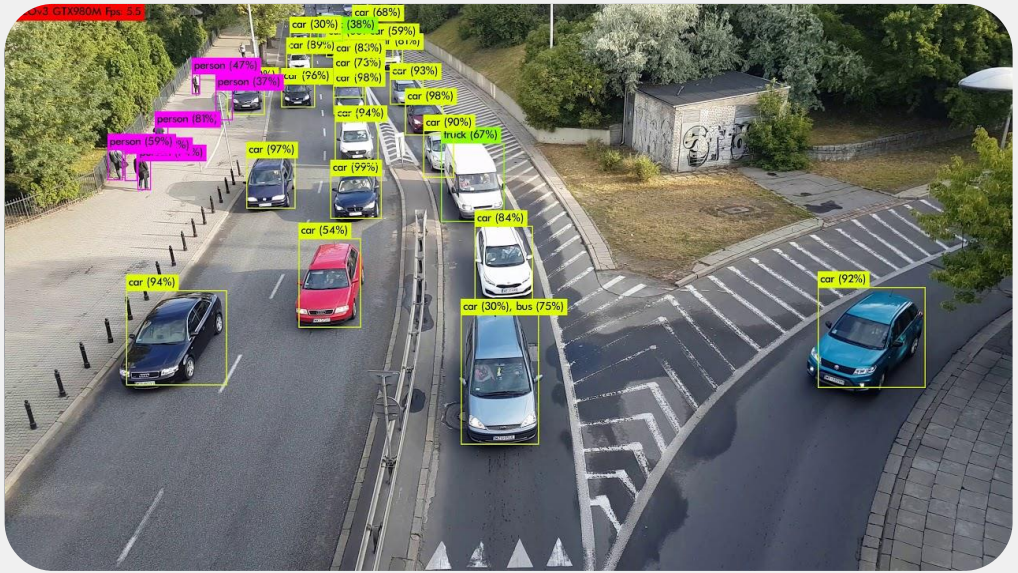
- **Single stage networks such as YOLO v2, the CNN produces network predictions for regions across the entire image using anchor boxes.**

- **Much faster than two-stage networks.**



# Object Detection Using Machine Learning

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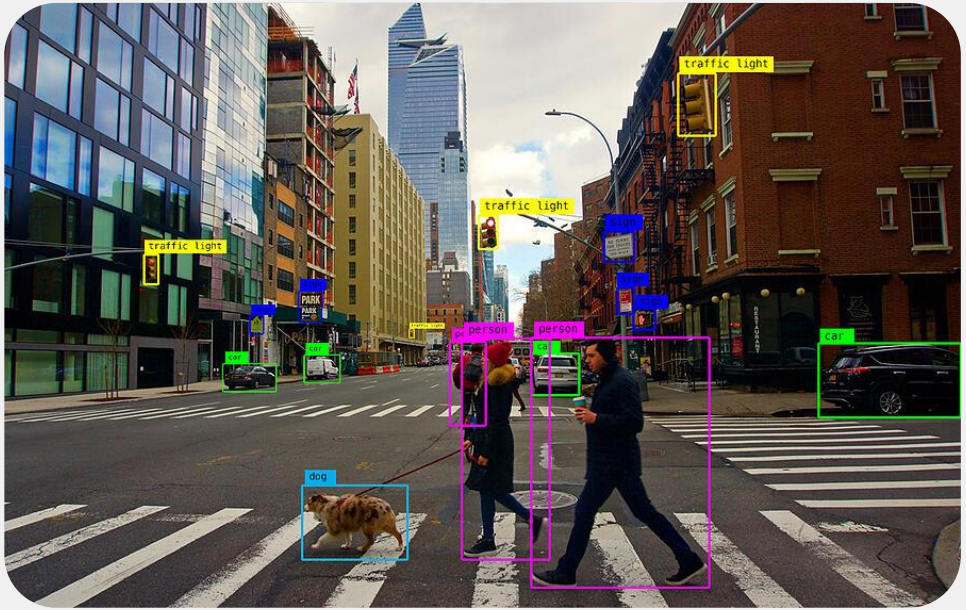
- Aggregate Channel Features (ACF)
- SVM Classification using HOG features
- The Viola-Jones algorithm for human face or upper body detection



# Object Tracking – Definition

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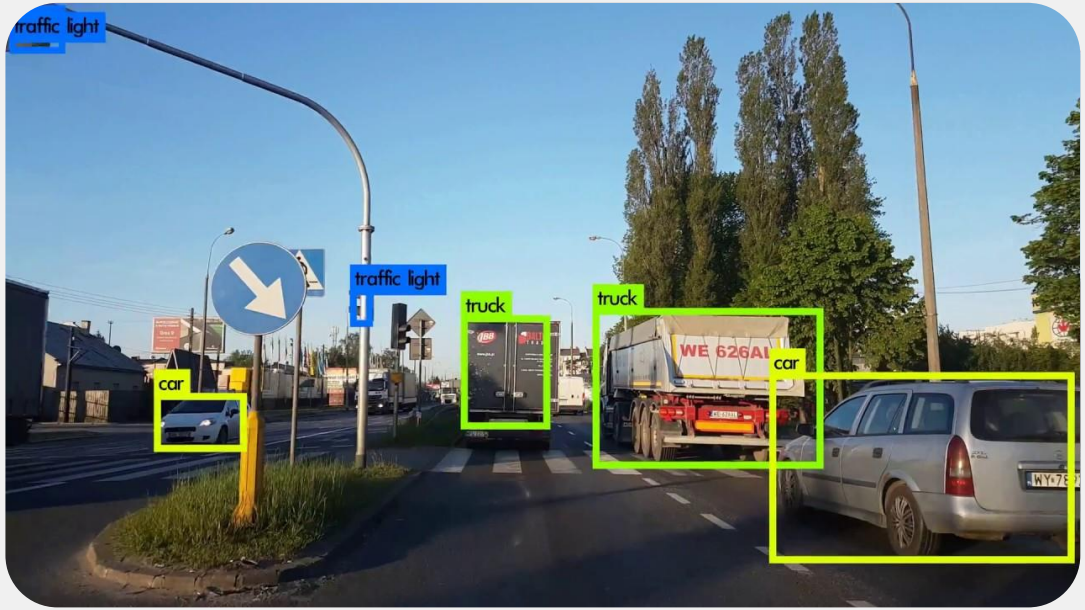
- The process of locating a moving object or multiple objects over time.

- Tracking associates detections of an object across multiple frames.



# Object Tracking – Uses Types

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- **Image Tracking**
  - **Detecting two-dimensional images of interest in a given input.**
- **Video Tracking**
  - **Object tracking where moving objects are located within video.**

# Object Tracking – Uses & Types

AUGMENTED STARTUPS
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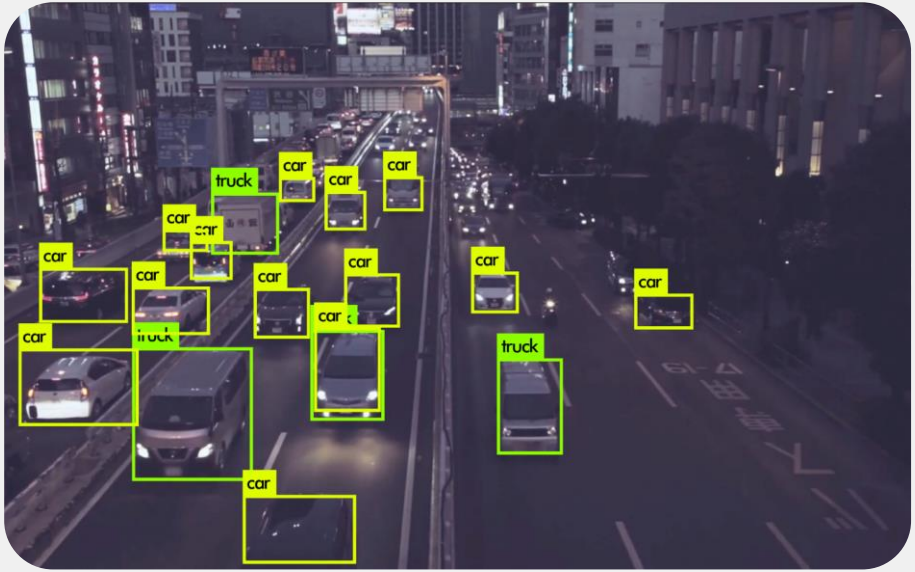
- **Image Tracking**
  - **Detecting 2D images of interest in a given input.**
- **Video Tracking**
  - **Tracking where moving objects are located within video.**



# Object Tracking – Uses & Types

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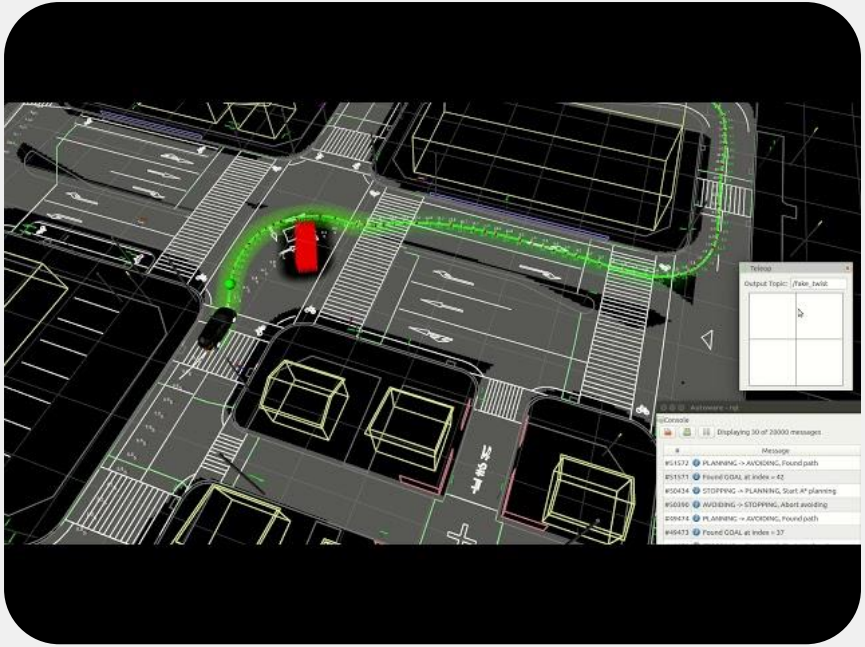
- **Visual Tracking**
  - **Goal of visual tracking is to estimate the future position of a visual target that was initialized without availability of rest of the video.**



# Object Tracking – Techniques Used

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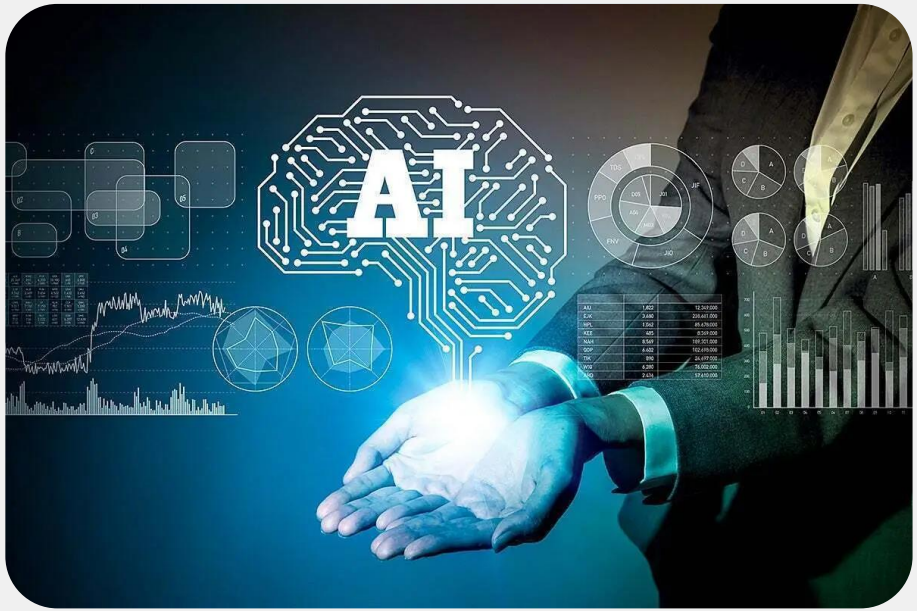
- Machine Learning
- Artificial Intelligence
- Deep Learning



# 2D Object Tracking Techniques

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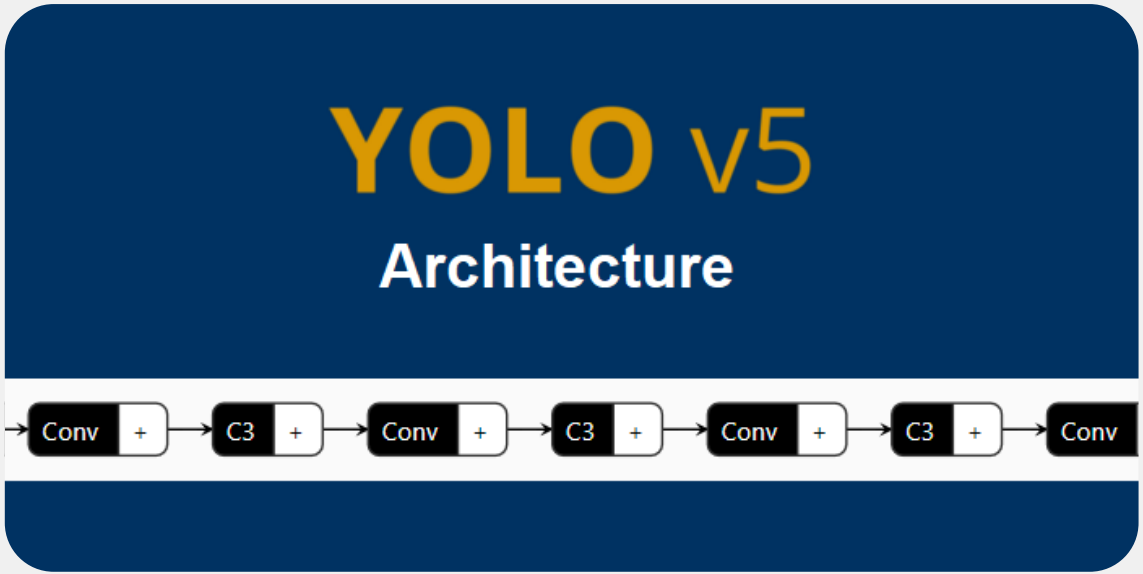
- YOLO v7
- YOLO v6.5
- YOLO X
- YOLO R



# 3D Object Tracking Techniques

AUGMENTED STARTUPS
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- YOLO R

# Object Tracking – Working Principle

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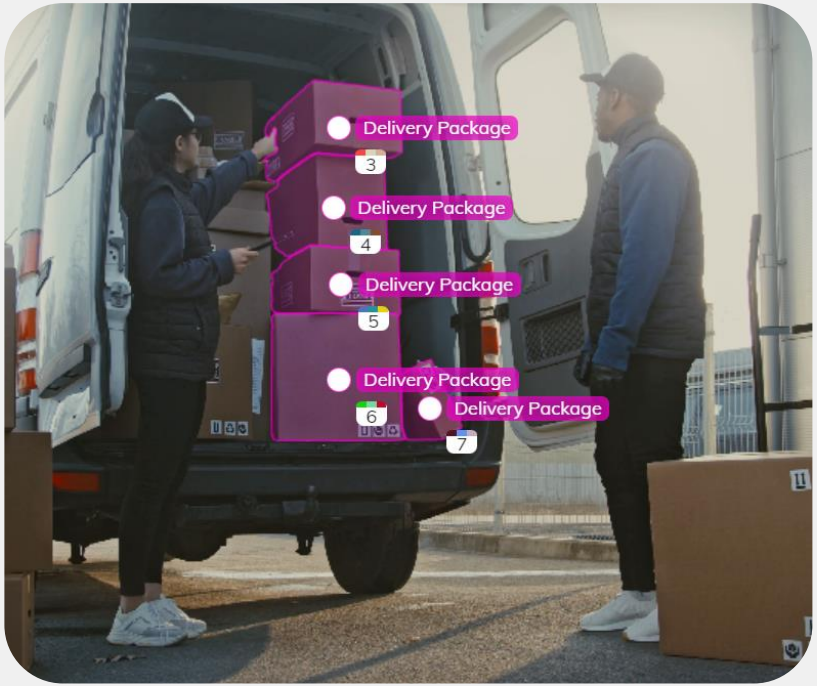
- **Tracking objects requires:**
  - **Detection**
  - **Prediction**
  - **Data Association**



# Object Tracking – Working Principle

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- **Detection**
  - **Object Detection using Stationary Camera**
  - **Object Detection using Moving Camera**

# Object Tracking – Working Principle

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- **Prediction**
  - **To track an object over time means that you must predict its location in the next frame.**
  - **Kalman Filter predicts the next location of an object.**

# Object Tracking – Working Principle

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- **Data Association**
  - **The process of associating detections corresponding to the same physical object across frames.**
  - **Temporal history of a particular object consists of multiple detections is called Track.**

# Object Tracking – Applications

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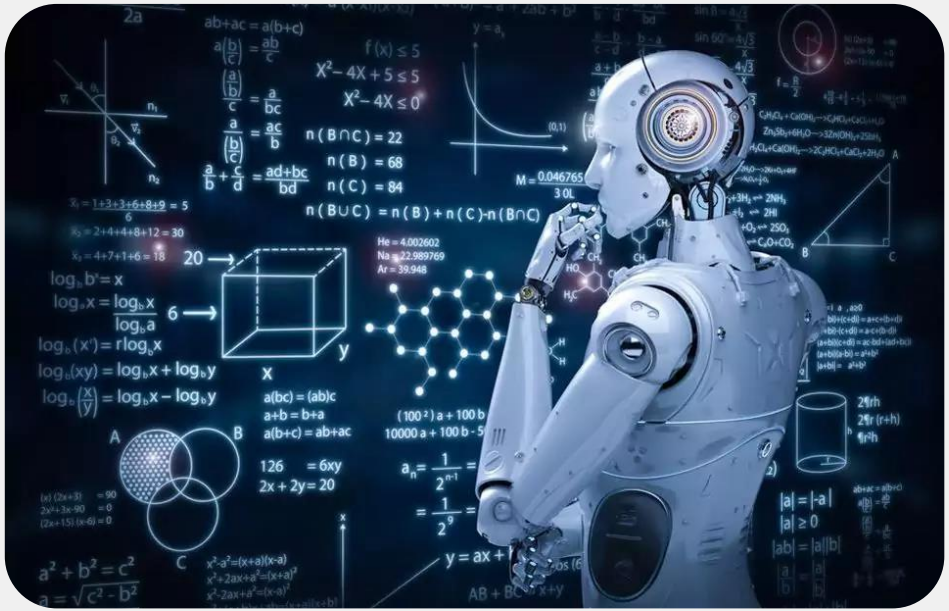
- Surveillance
- Retail Use
- Driverless Vehicles
- Healthcare



# 3D Object Detection & Tracking

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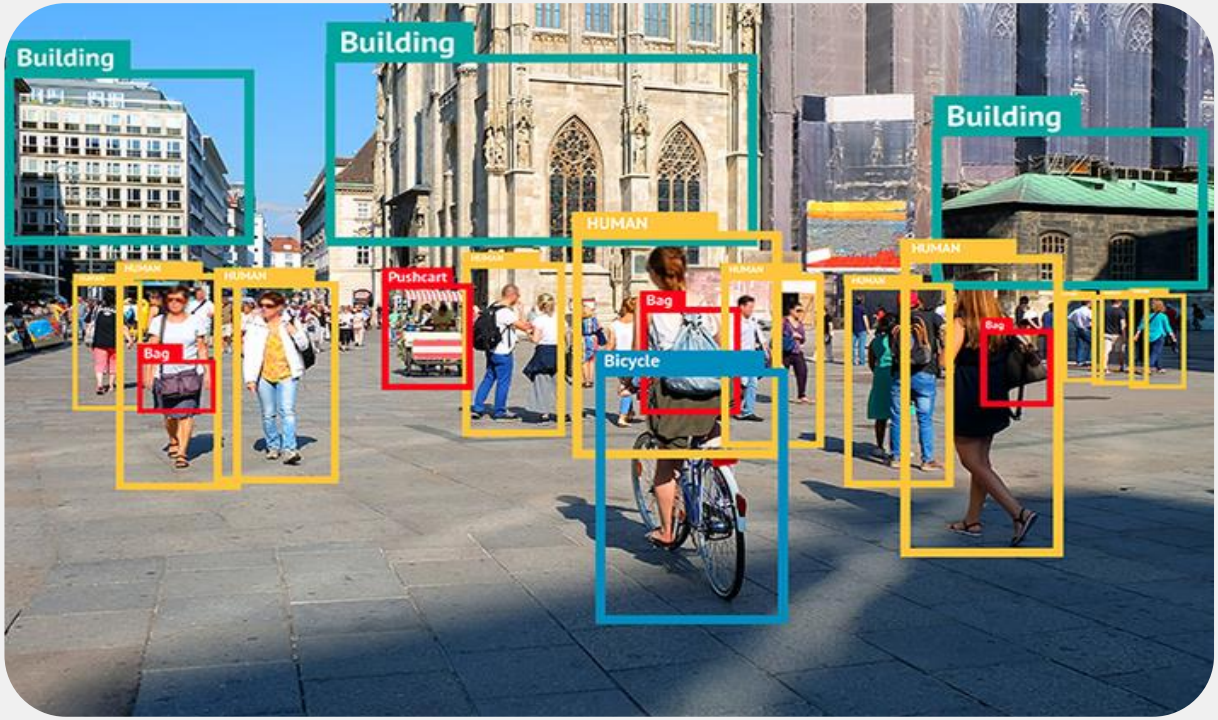

# Object Detection & Tracking in SDC

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# Summary

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  - Applications

# References

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# Thanks