



Simulation-Based Autonomous Driving in Crowded City





Thread

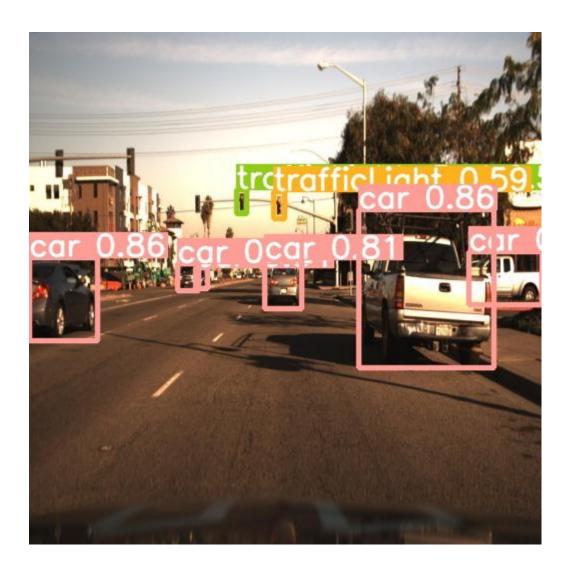
Vehicle Detection Traffic Light Detection Lane Detection Create Thread? Send Image Image Callback Function Simulator





Object Detection

- Classes
 - Traffic light
 - Other Vehicles

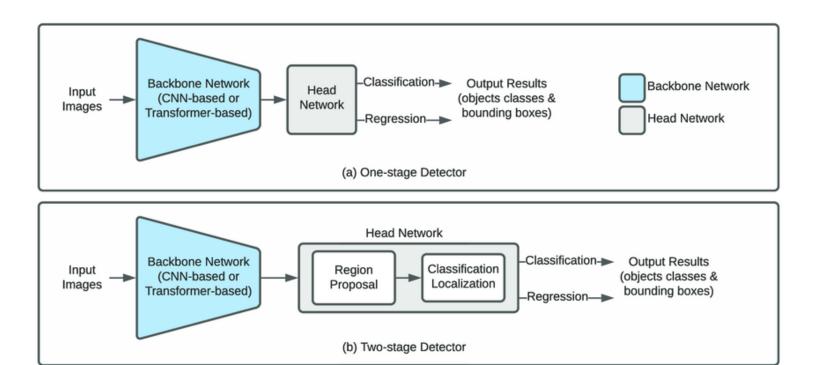






Choosing a Model

- R-CNN
 - Slow Inference ~10 seconds
 - Two-stage Detector
- YOLOv8
 - One-Stage Detector
 - Wrong Traffic Light Detections

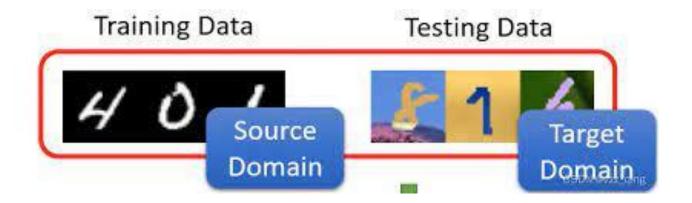






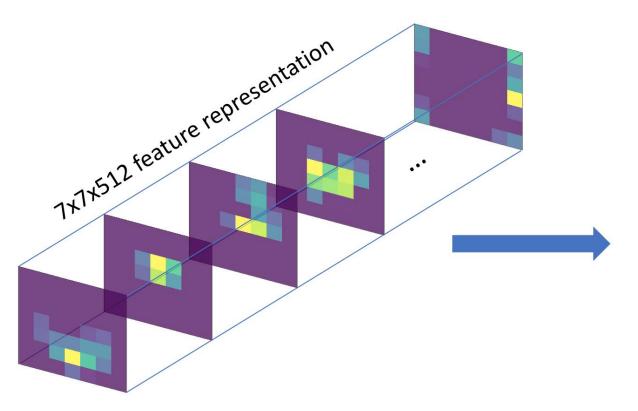
Fine Tuning

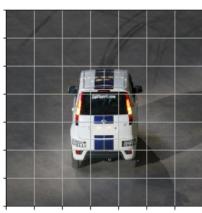
- To Fix Wrong Traffic Light Detections
- Domain Change
- Fine tuned on a dataset
- Removed some classes bikes, ...







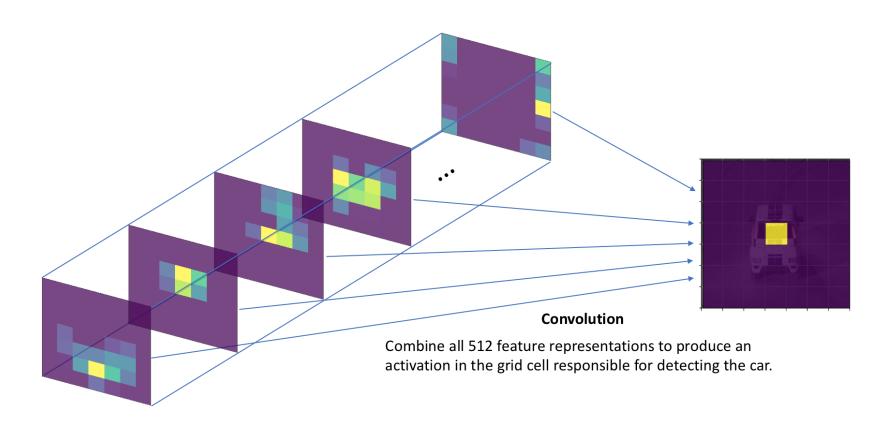




Visualizing the corresponding regions of each "pixel" in the 7x7 feature maps with the original 224x224 image

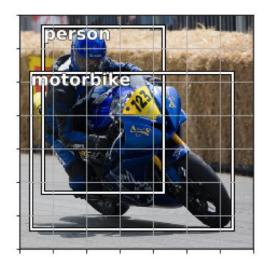


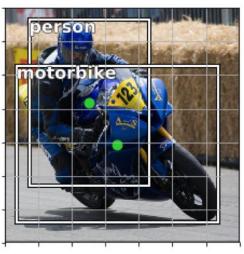


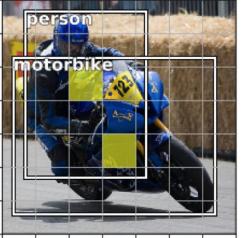


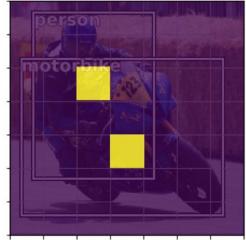






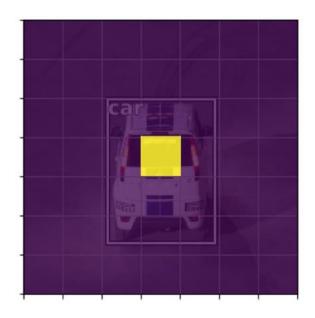


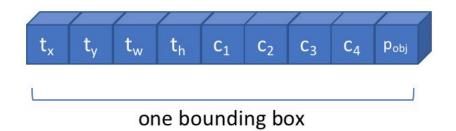








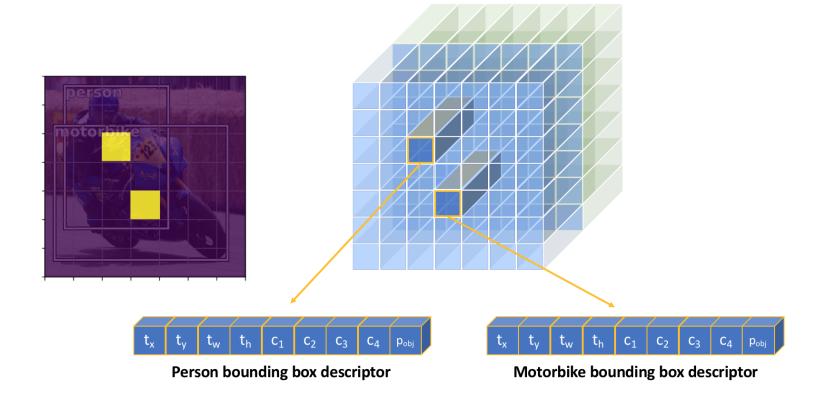








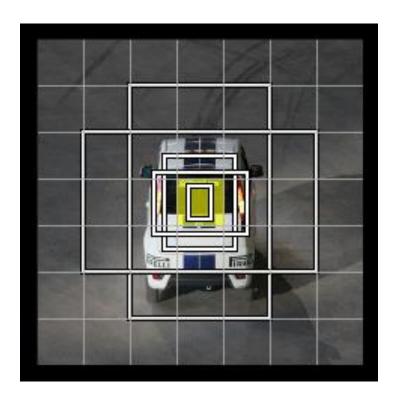
A fixed number of multiple objects can be detected in parallel







Anchors

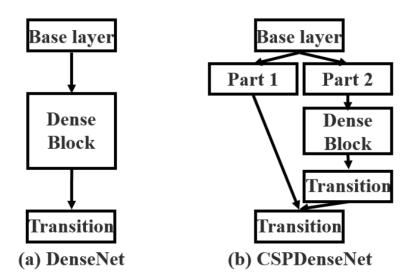


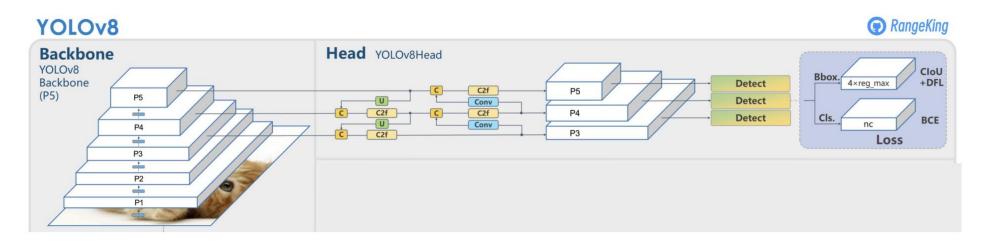
- YOLO uses anchors
- YOLOv8 does not
- Predicts directly the center of an object
- Produces fewer predictions
- NMS is faster





- Cross Stage Partial Network
- Used with Dense Net, ResNet blocks
- FPN
- Path Aggregation
 - Skip connections









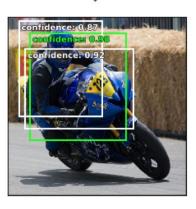
NMS

Repeat with next highest confidence prediction until no more boxes are being suppressed

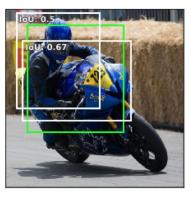
For each class...



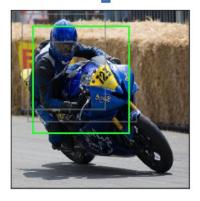
After filtering out low confidence predictions, we may still be left with **redundant** detections



Select the bounding box prediction with the **highest confidence**



Calculate the IoU between the **selected box** and all remaining predictions



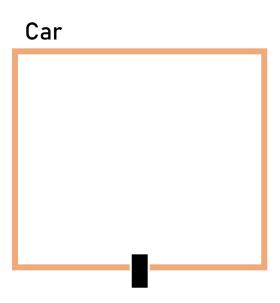
Remove any boxes which have an IoU score above some defined threshold

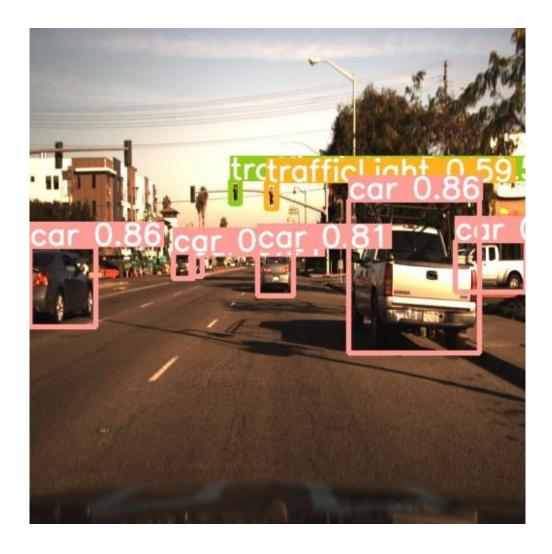
YOLOv8 uses Soft NMS – reduces confidence instead of removing





Decision to Brake



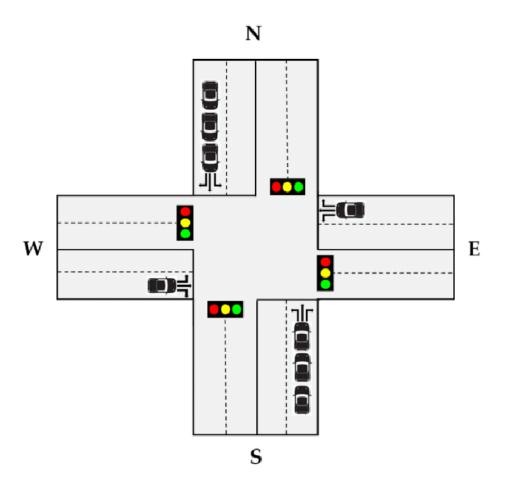






Decision to Brake

Multiple detections?







Intersection

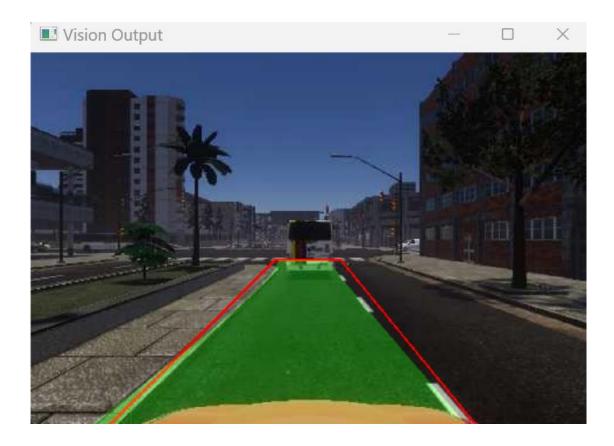
- Need to Detect Intersections
- Car stops at wrong place
- SegFormer model for Road Segmentation
 - Too Slow
 - Couldn't make it accurate enough





Lane Detection

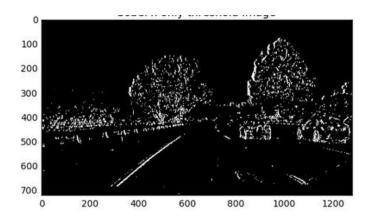
- CNN based
 - Problem with Low FPS
- Traditional Method

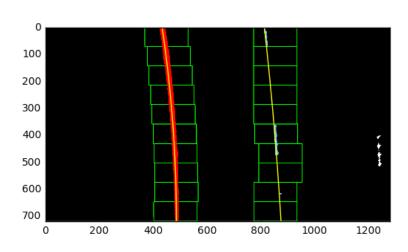


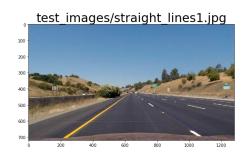


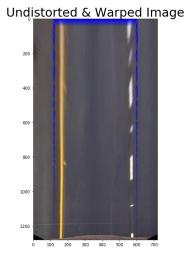


Lane Detection













FPS

- Reduced Speed Limit
- Use of probability
- Start one Thread per Decision
- Ignore new images in callback temporarily