Object Detection in Adverse Weather and Low Light Conditions

Danica Fliss, Jon Van Veen, Han Wang

Problem Statement and Significance

- Adverse weather and low light conditions pose a fundamental challenge to computer vision systems

Region-based CNN (R-CNN)

Object Detection Pipeline

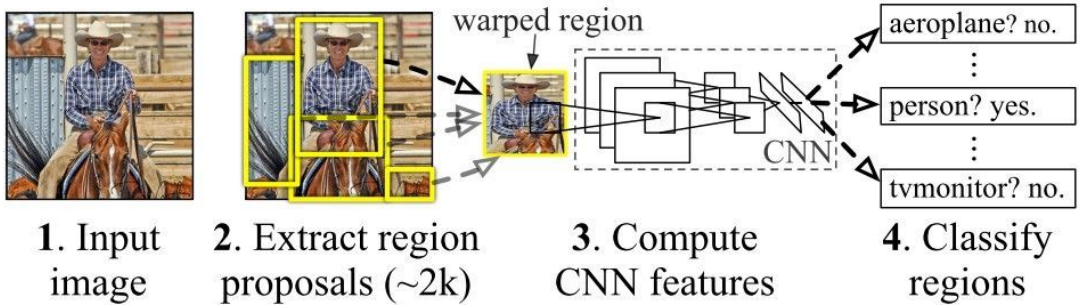
Region Proposal Generator

↓

Feature Extraction

↓

Classification



“You Only Look Once” (YOLO)

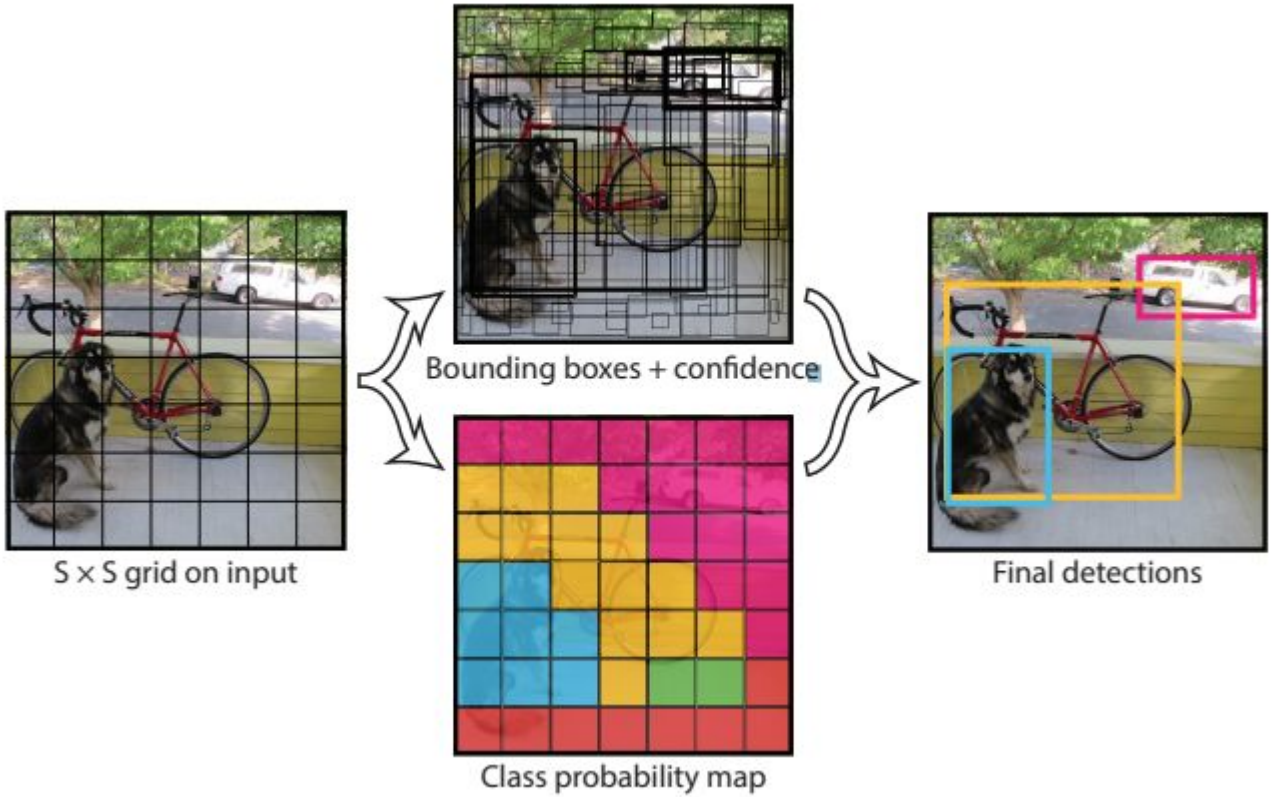
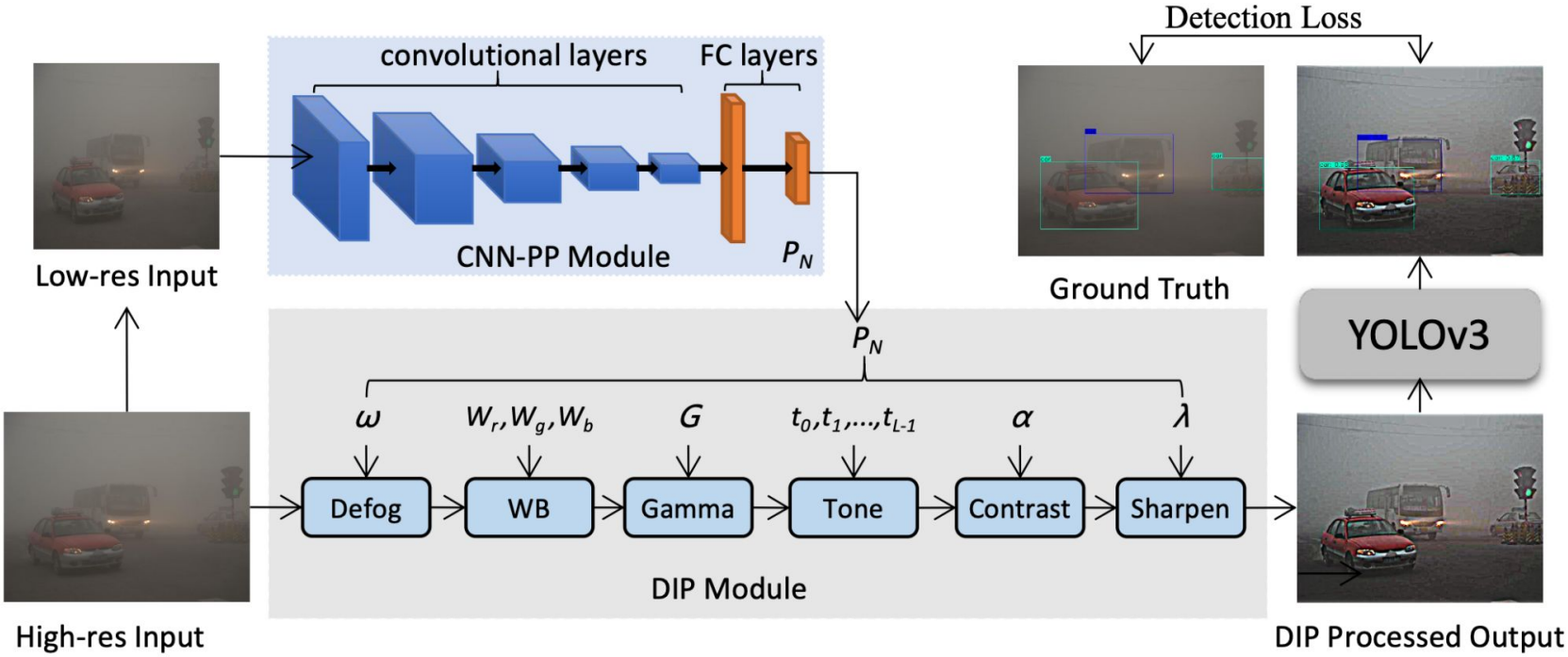


Image-Adaptive YOLO (IA-YOLO)



BDD100K Dataset

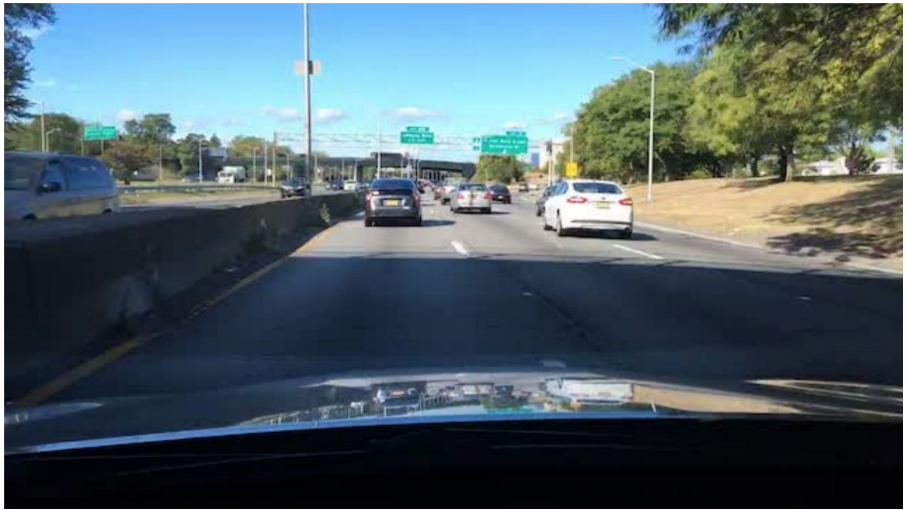
- Diverse scenes and weather
- 100k videos
- 40s frames
- 30 fps

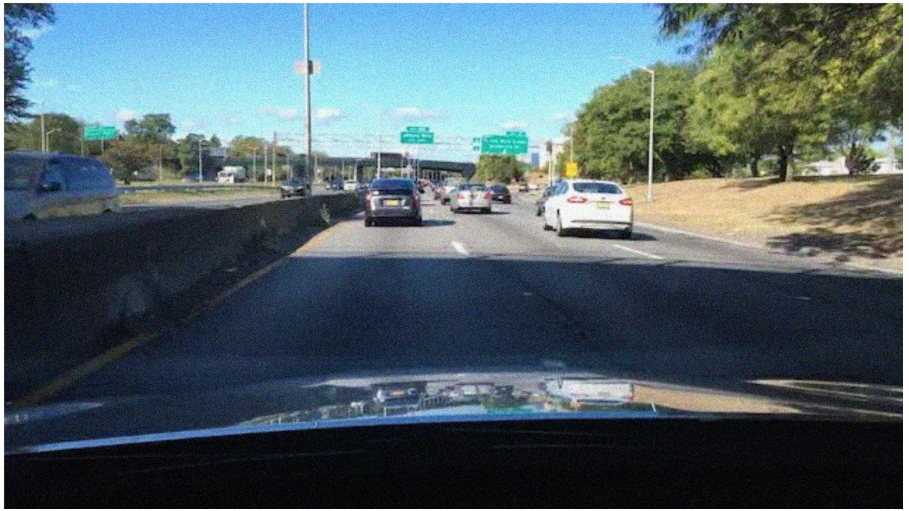
CADC Dataset

- Adverse weather conditions, mainly snow
- 75 scenes
- 50-100 frames per scene
- 8 angles

Data Modifications

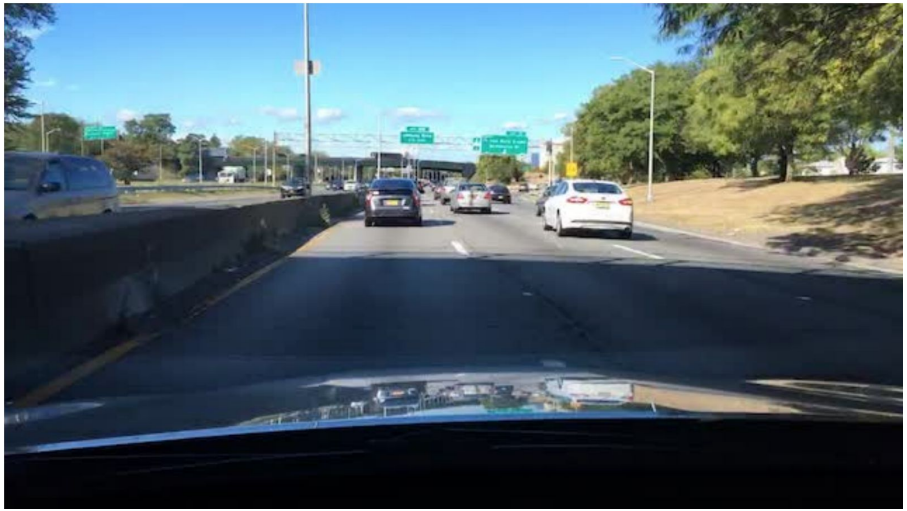
Additive Gaussian Noise





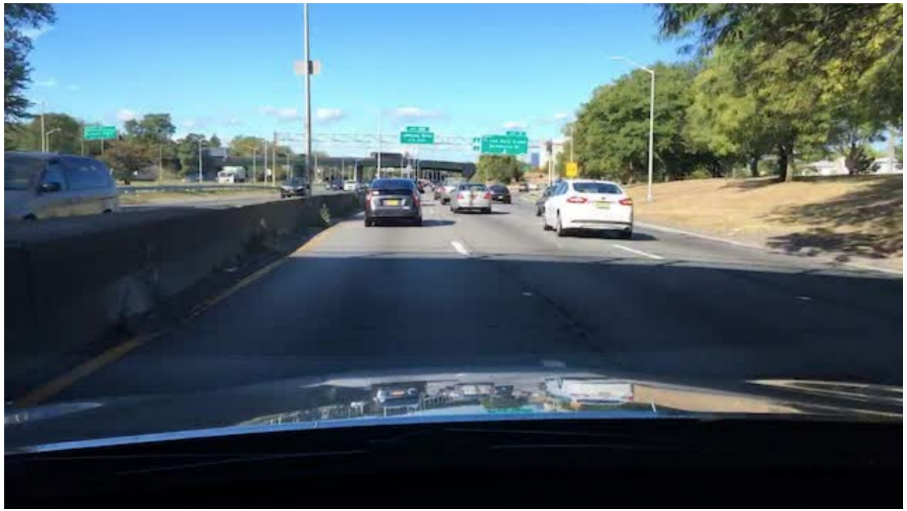
Data Modifications

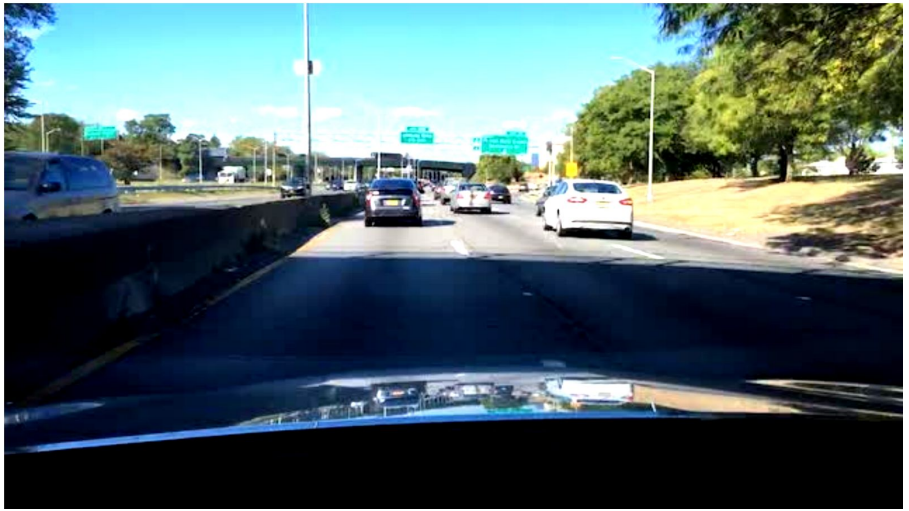
Illumination



Data Modifications

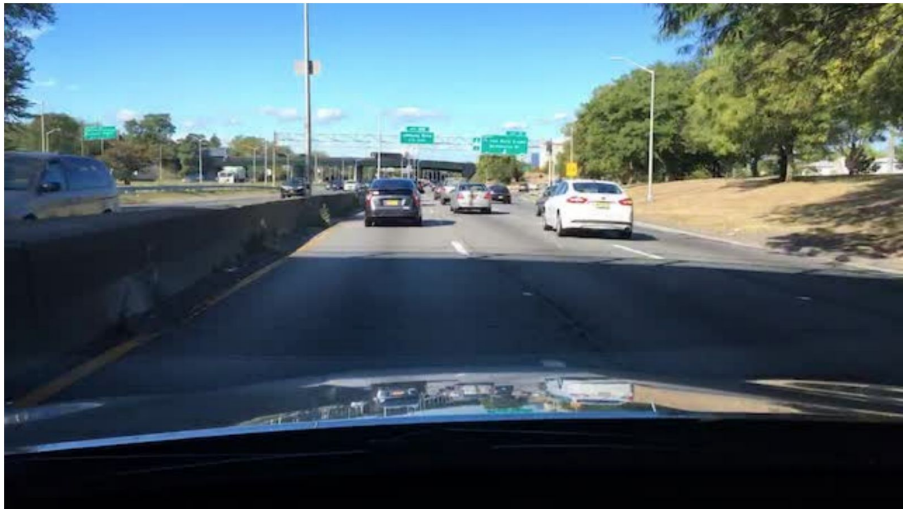
Contrast

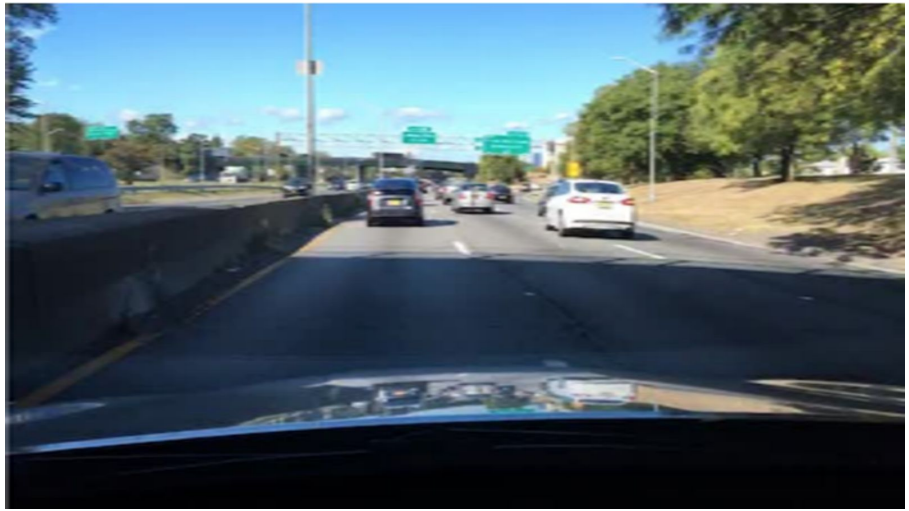




Data Modifications

Downsample - Upsample





Domain Adaptation with GAN

- Contrastive Unpaired Translation (CUT)

Night → Day

Dusk → Day

Experiment Setup

- Trained a detection model on NuImages to test augmentation
  - 1.2 million images
  - 2 classes: vehicles and pedestrians

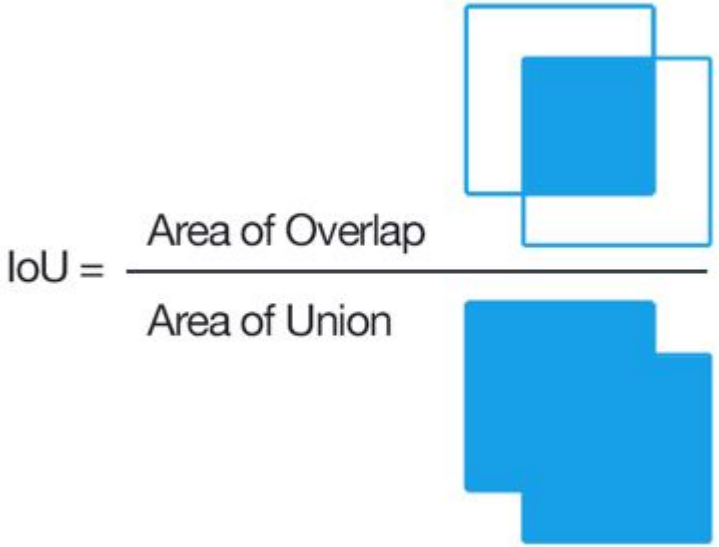
- Augmented images on BDD100K for testing
  - Increase Illumination
  - CUT model to convert night to day

Evaluation Metric

- The goal is to see how augmentation helps detection

- Average Precision (AP)
- Intersection over Union Threshold (IoU)
  - Overlap area / total joint area

- APx

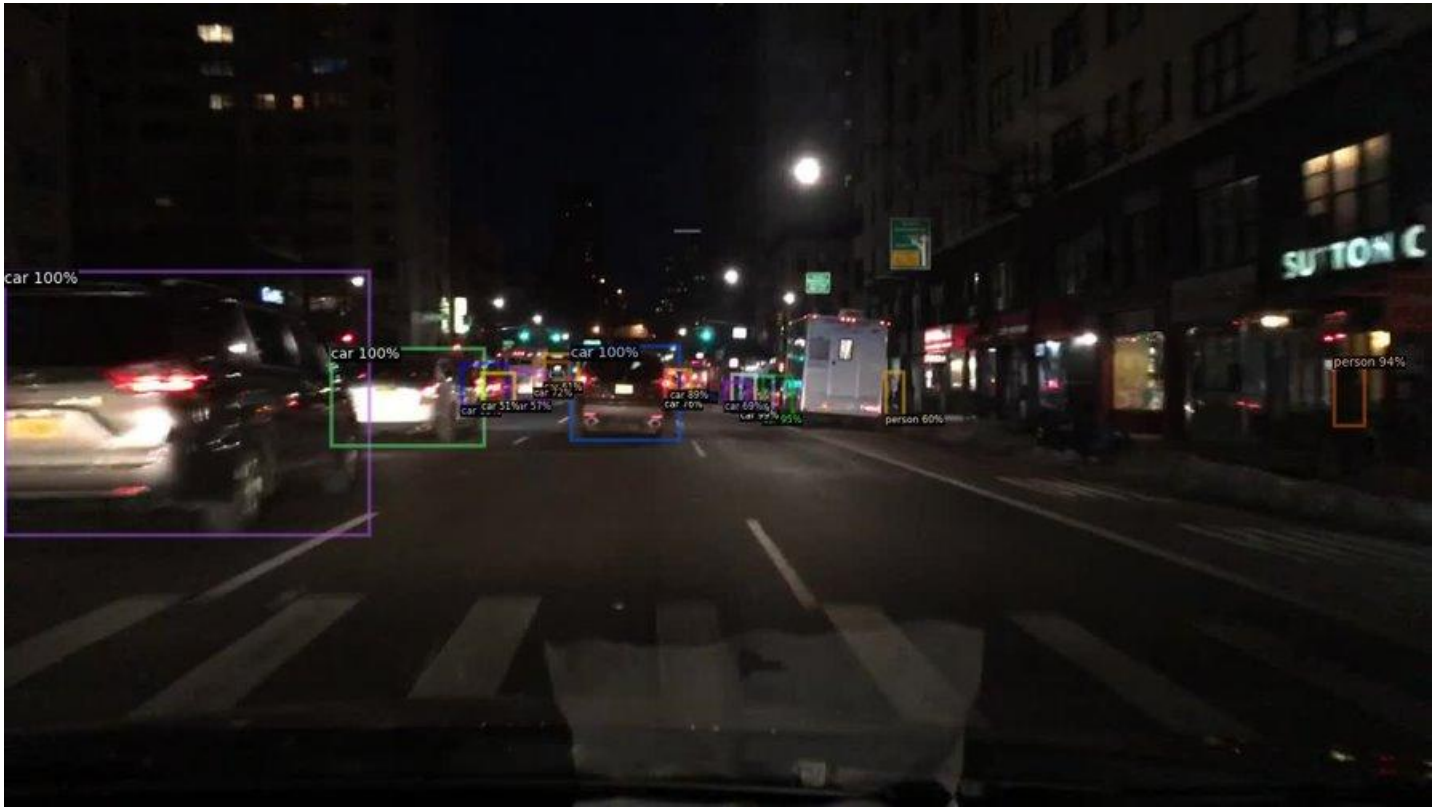


Results

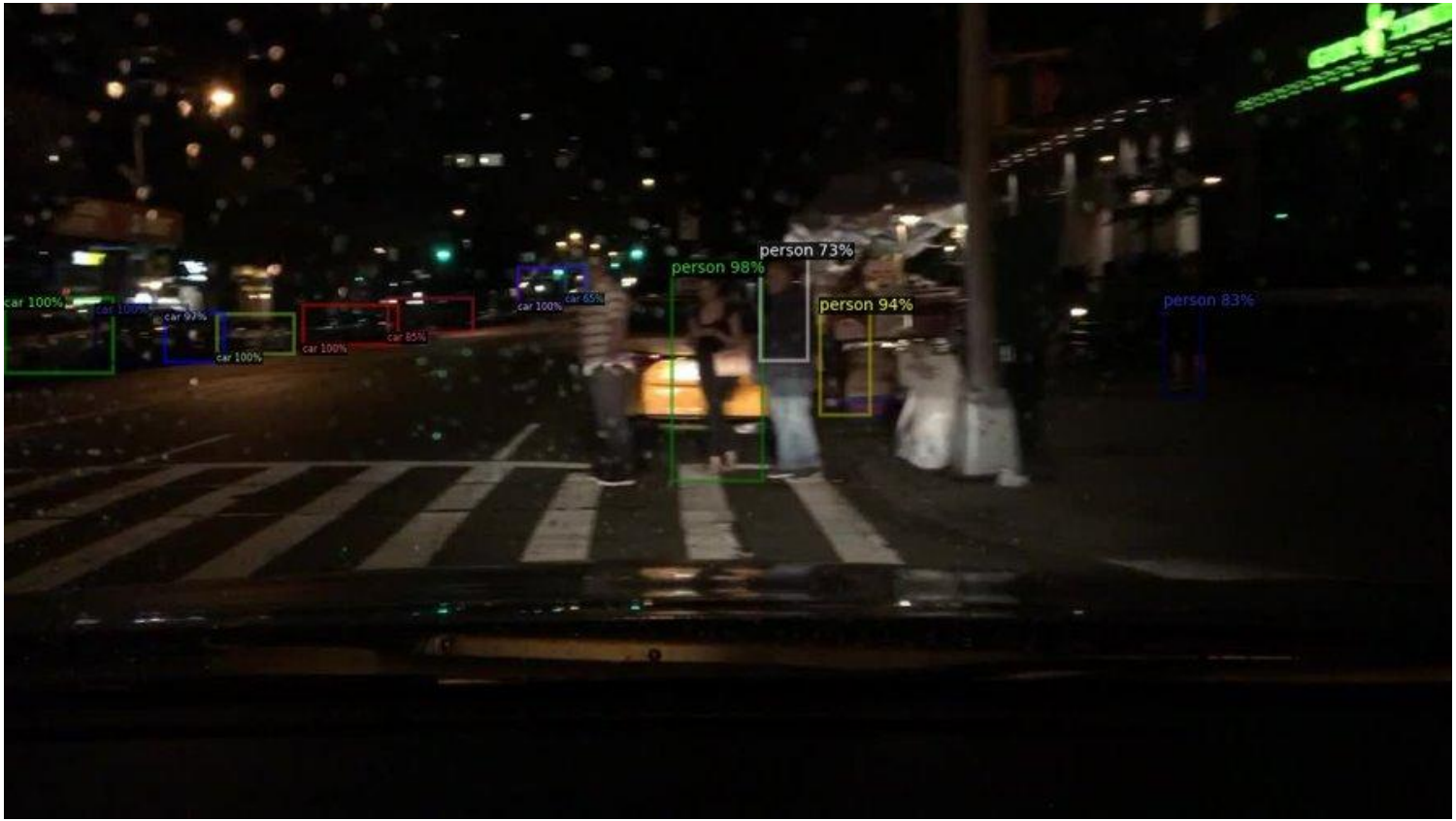
Cars	IAYOLO			YOLOv5			RCNN		
	AP	AP50	AP75	AP	AP50	AP75	AP	AP50	AP75
Night -> Day (CUT)	39.3	38.7	65.8	40.2	39.5	67.3	41.3	40.2	66.3
Illumination	36.9	38.2	63.5	40.1	38.9	64.5	39.9	39.8	65.8
No Modification	39.3	38.1	63.4	39.8	39.6	64.2	39.8	40.1	64.9

Pedestrians	IAYOLO			YOLOv5			RCNN		
	AP	AP50	AP75	AP	AP50	AP75	AP	AP50	AP75
Night -> Day (CUT)	14.6	6.9	37.5	15.8	7.4	38.6	14.6	7.7	39.5
Illumination	11.9	6.2	36.9	14.9	6.9	38.2	15.2	7.3	39.2
No Modification	14.6	6.8	37.2	14.6	6.8	37.2	14.9	7,0	37.5

Nighttime



Nighttime


car 100%
car 100%
car 92%
car 100%
car 100%
car 85%
car 100%
car 65%
person 98%
person 73%
person 94%
person 83%

Nighttime

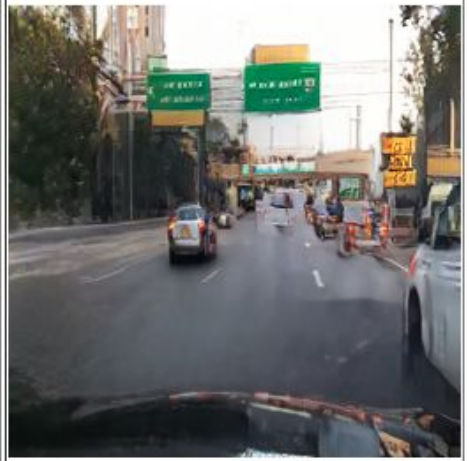

car 99%
car 92%
car 76%
car 93%
car 99%
car 100%
person 64%
car 100%
car 100%

Contributions

- Showed that using GANs, we can improve detection in night time
- A pipeline that can be deployed to detect objects in low light conditions

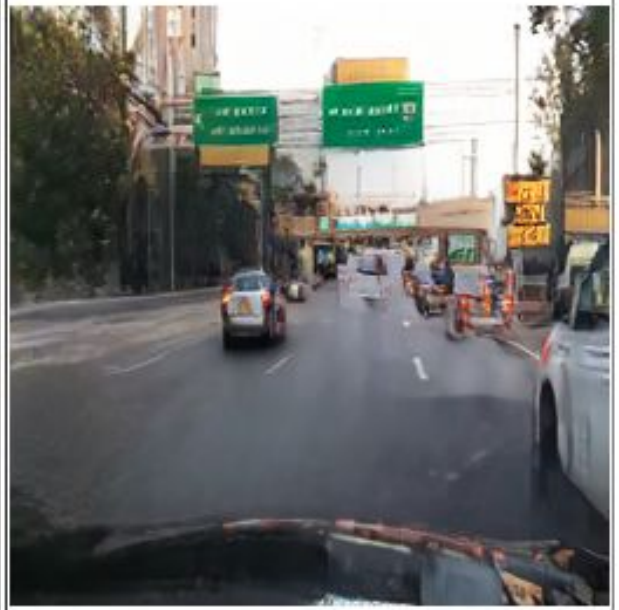
Conclusions

real_A



fake_B

	
real_A	fake_B

	
real_A	fake_B