



MUNET: Multi-task Unified Network For On-Device Autonomous Driving

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IMVC 2018

Our Mission | Solve the Problem of Car Collisions at Scale



1.3M

Road Death in 2017

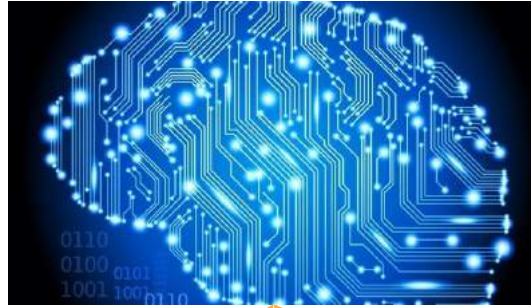


95%

Human Error

Our Approach | Solve the Problem of Car Collisions at Scale

Deep Learning



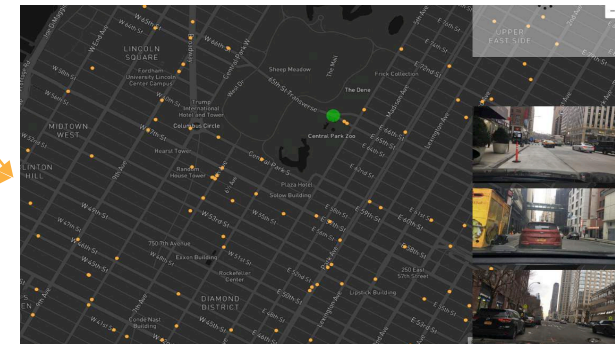
+100m

Road video miles/year

Sensing



V2V Network



Today | Multi-task unified Network for Advanced Driver Assistant System



Driver Assist Data | it is all about “corner cases” – rare events

+10m

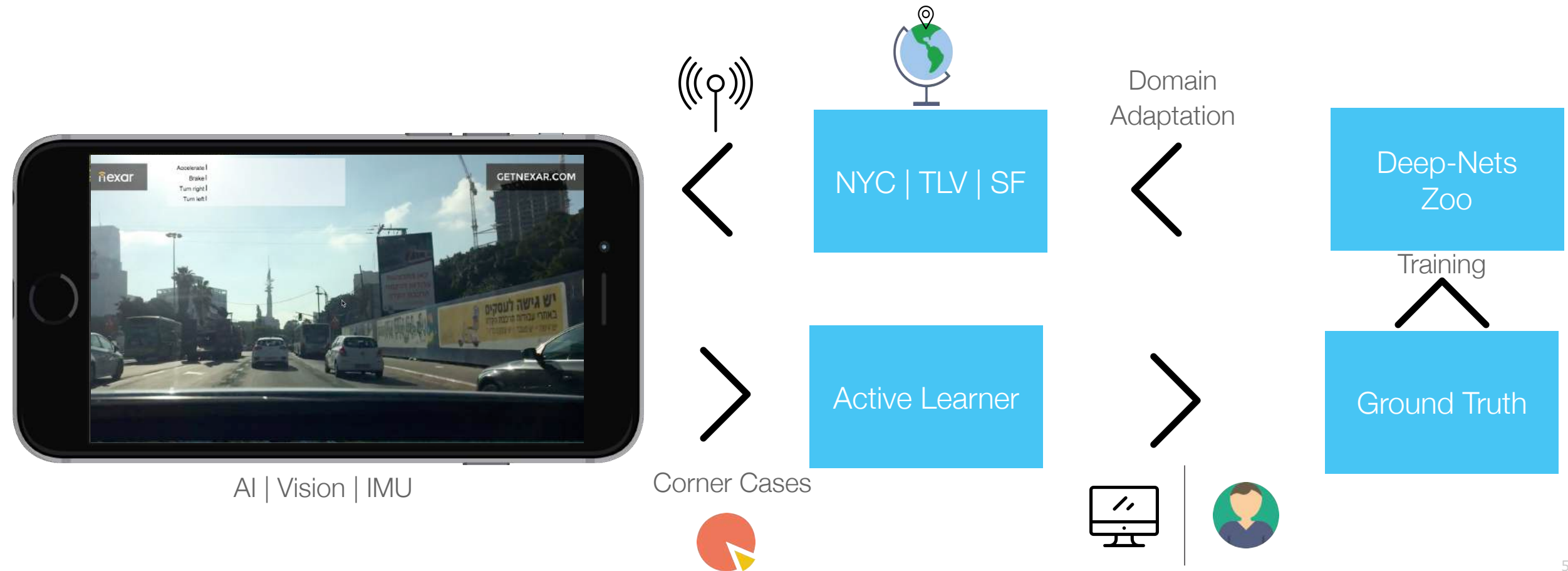
corner cases of driving

+10m

annotated images

+80

countries



NEXET | Dataset and Benchmark (ICCV17)



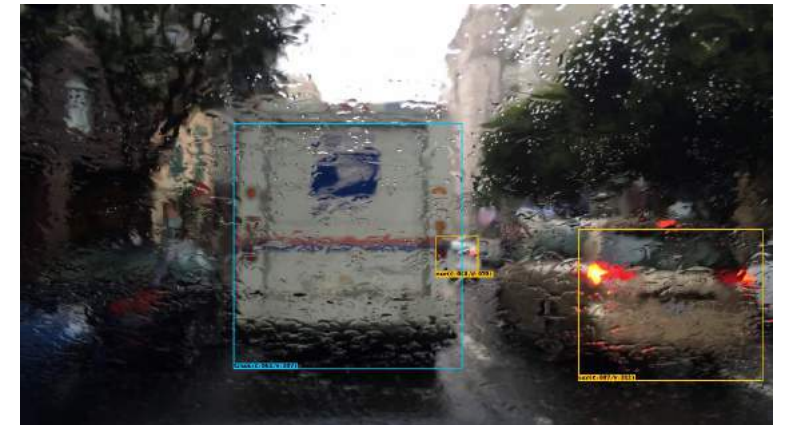
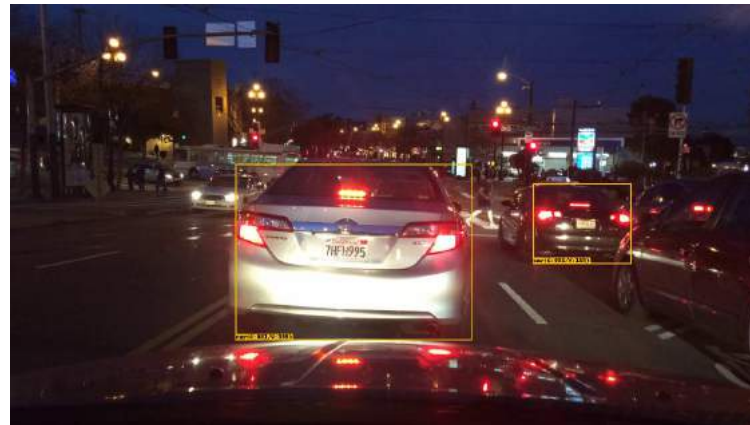
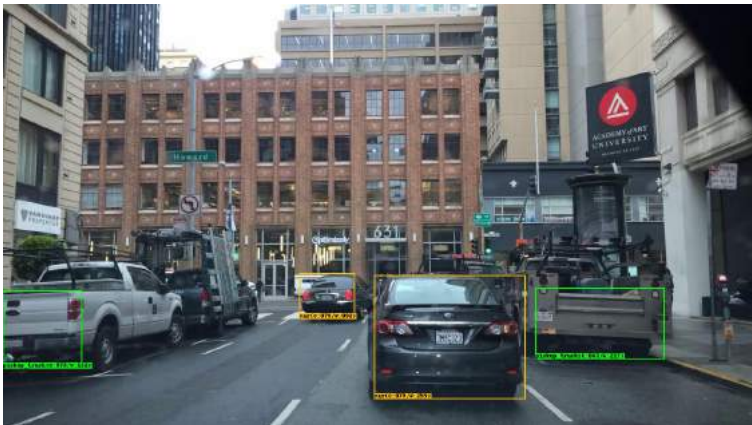
- ★ Road scene understanding requires diverse datasets with corner cases
- ★ Largest and the most diverse annotated **open-sourced** dataset

50,000

Annotated images

77

Countries



Driver Assist on Mobile | Challenges

- ★ Efficient Deep-Net Architecture | low latency, small model size
 - ★ SqueezeDet | YOLO9000 | MobileNet | ShuffleNet
- ★ Efficient and Accurate Multi-tasking inference | single-shot multitasking
 - ★ Object Detection at various scales | truck ,bus, car, traffic lights
 - ★ Object Attributes Recognition | lane-level localization, relevancy
 - ★ Object Tracking

MUNET | Efficient and Accurate Multi-tasking Inference

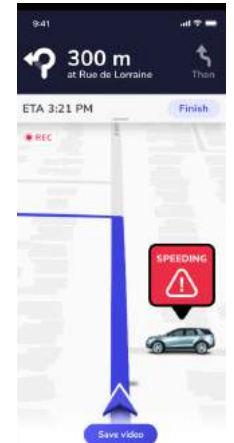
ADAS L1



ADAS L2

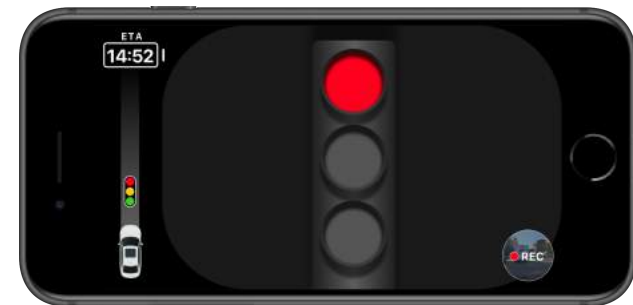


ADAS L3 (Complex Scenarios)



MUNET | Unified Network for Holistic Driver Assistant System

 Flexar's Forward Collision Warnings



Forward Collision Warning Challenges | Detection & Drivable-Path

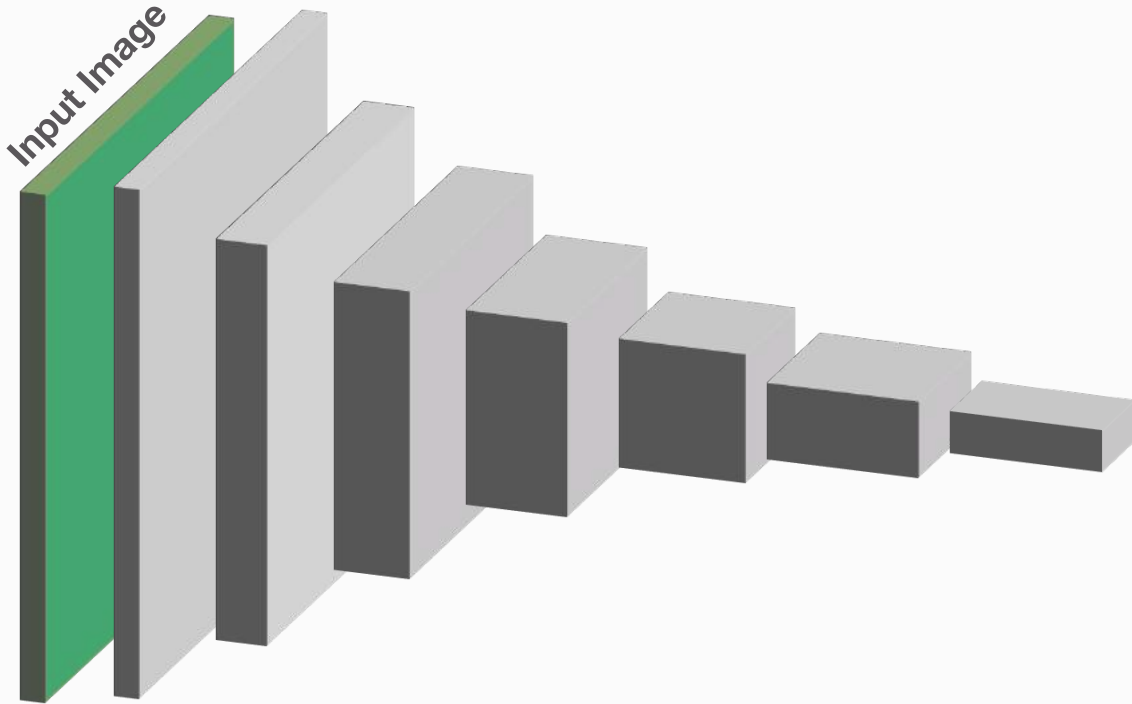
- ★ Vehicle detection & classification | car | bus | truck | pickup-truck
- ★ Relative lane position of detected vehicle | lane-level understanding

Define Classification Tasks for **Scalable** Annotation and **Efficient** Inference



MUNET v.1 | Vehicle Detection | Classification | Relative Lane

Feature Maps



Single-Shot
Road Understanding

Detection

Classification

Relative Lane

Network Output

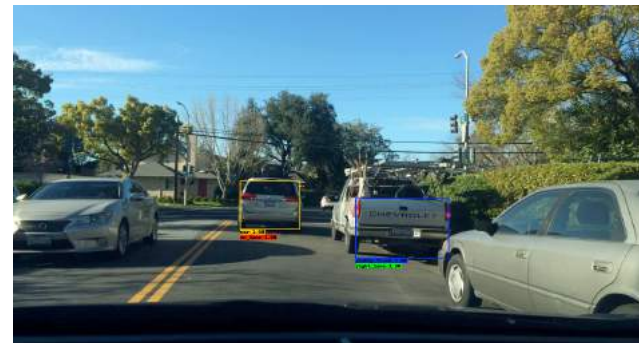
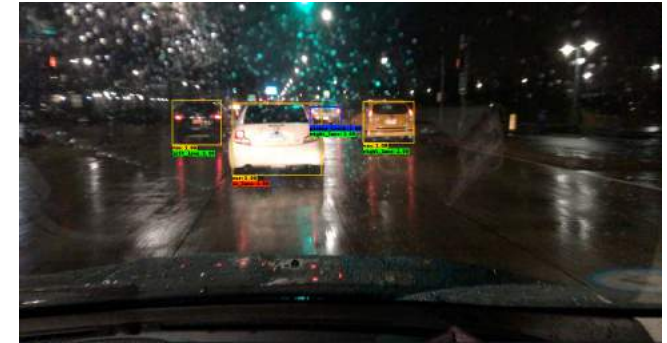
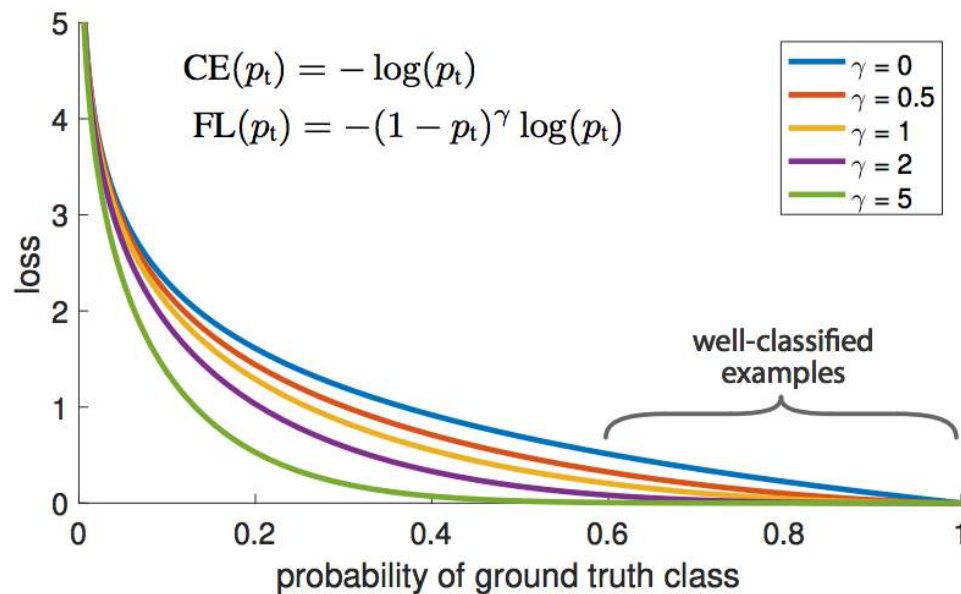


Model Size: 5.7MB | #Flops: 1.78G | Latency (mobile): 50ms

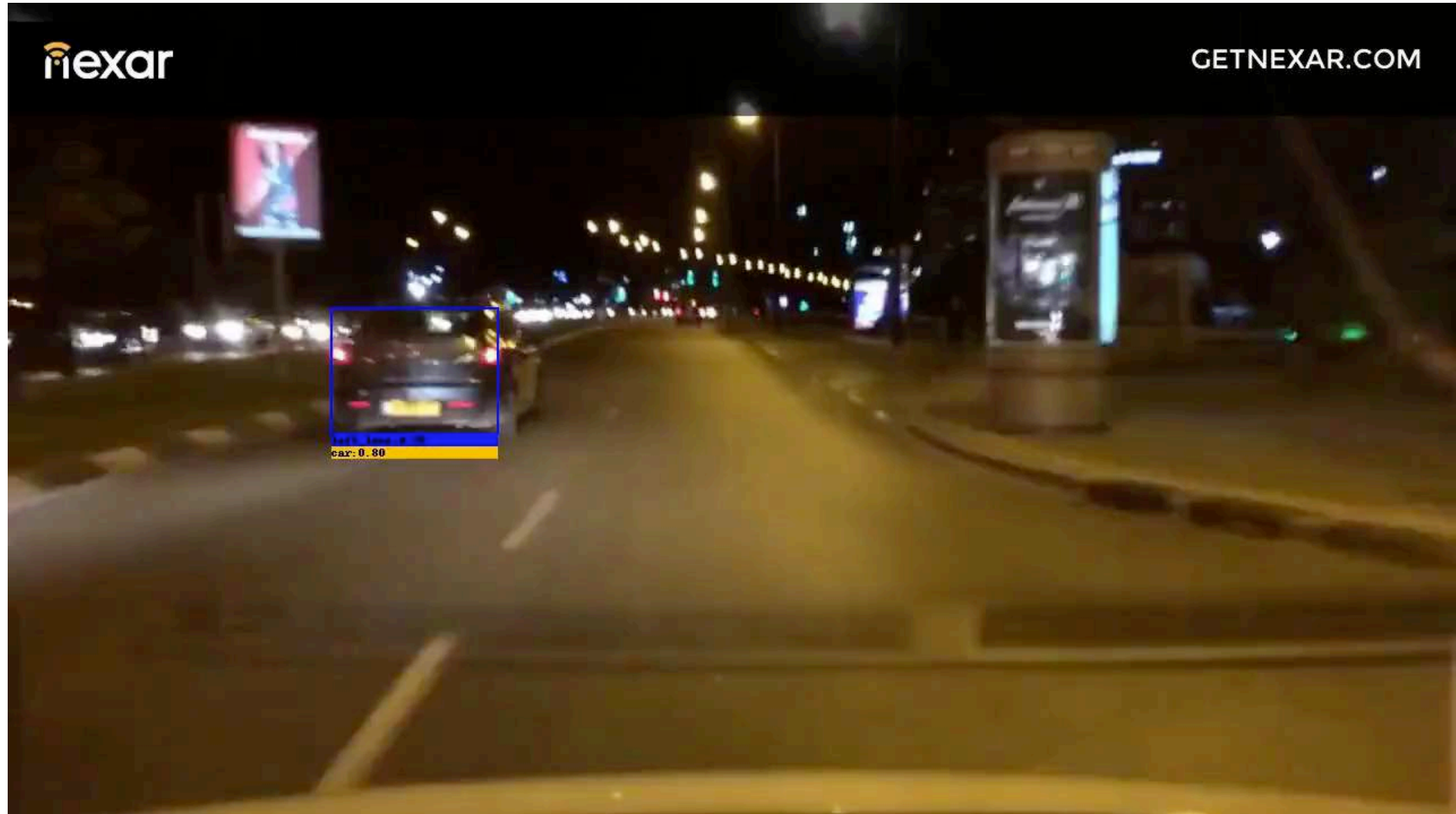


What About Corner Cases ? | Focal Loss (ICCV17 Best Paper)

★ Focus on Hard Examples

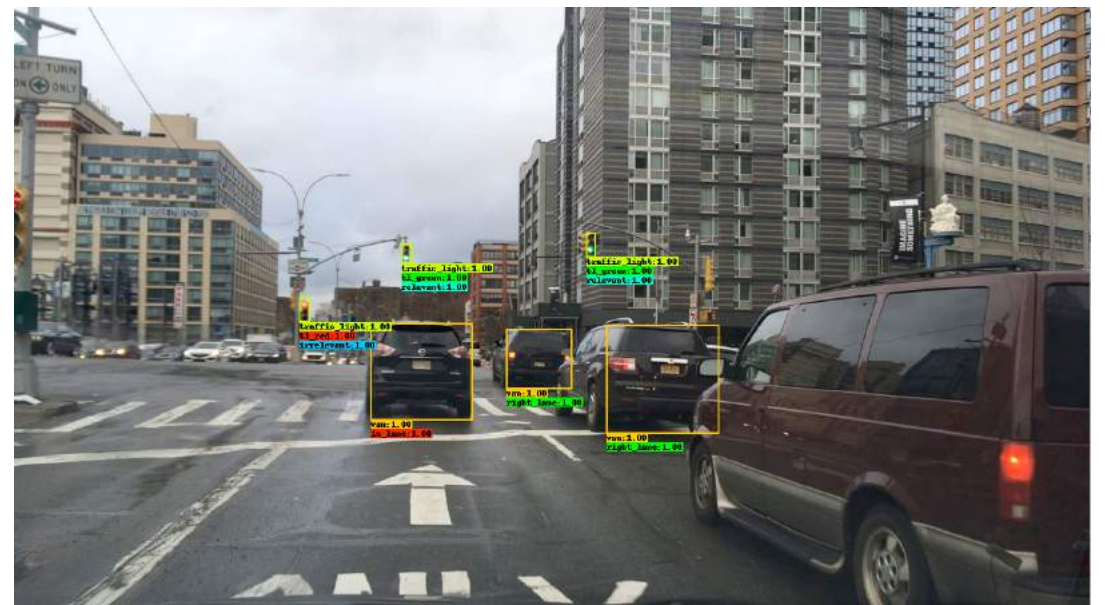


MUNET v.1 | 50ms/frame | iOS (CoreML) | Android (SNPE)



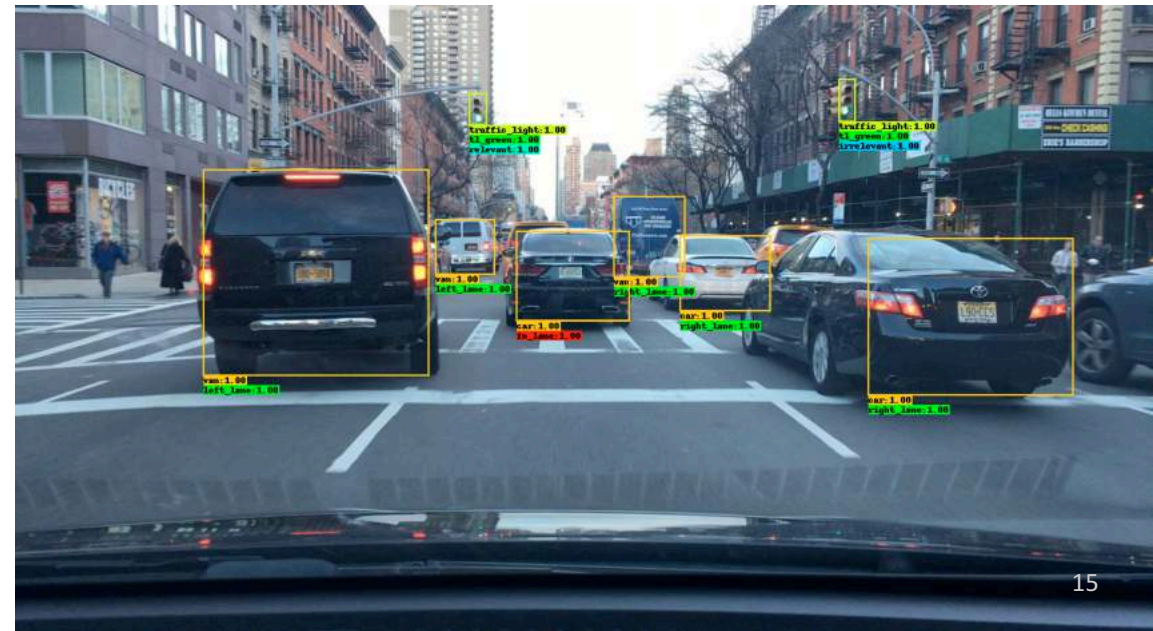
Traffic Light Challenges | Local vs. Global

- ★ Traffic Light Detection | Small scale object detection (local)
- ★ Traffic Light Relevancy | Road context is important (global)

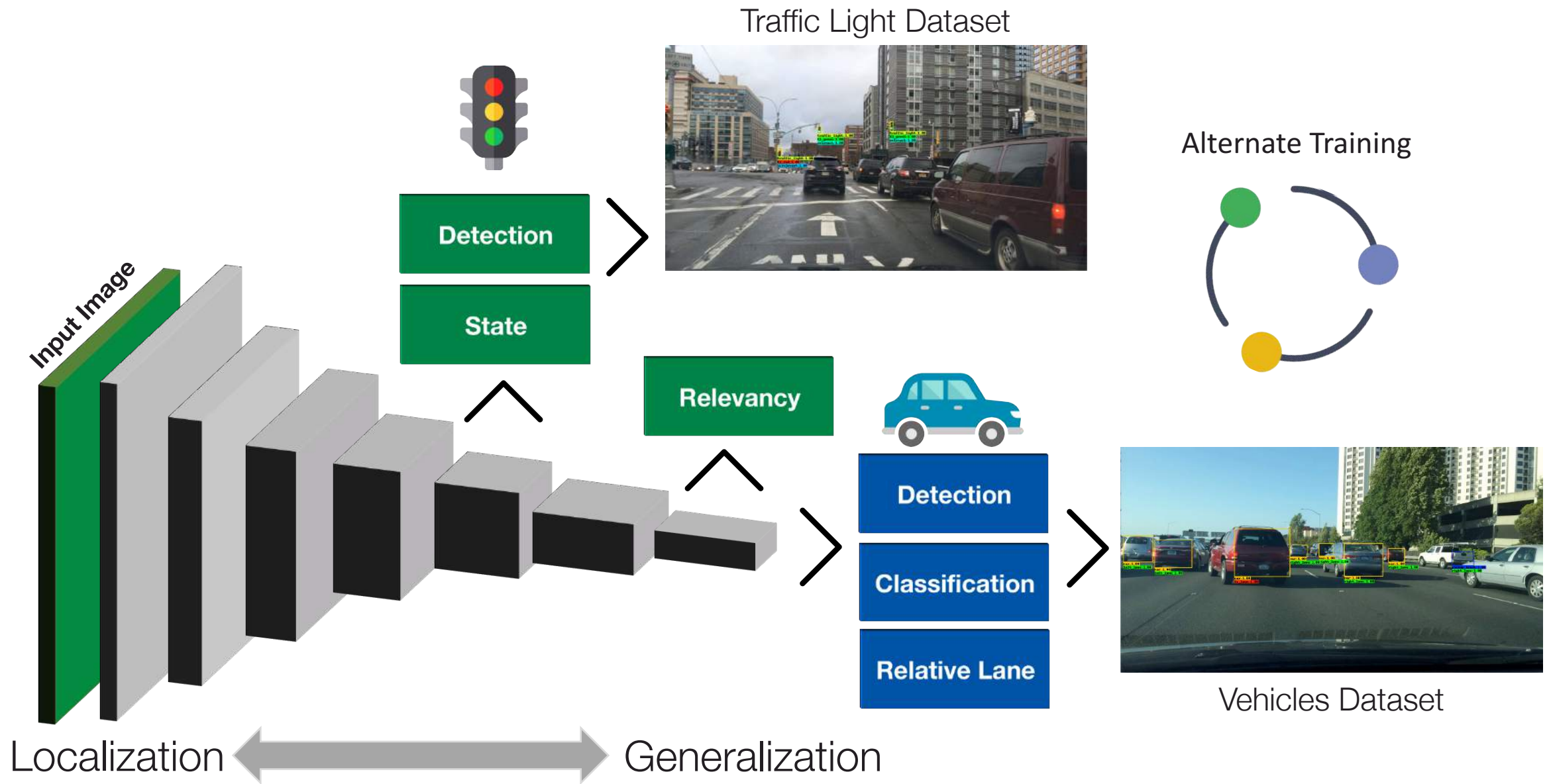


MUNET v.2 | Efficient Multi-Tasking Challenges

- ★ Efficiency | share computation resources across tasks
- ★ Multi-scale objects | traffic light can be extremely small
- ★ Multi-attribute recognition
- ★ Training with Multiple Datasets



MUNET v.2 | Efficient Multi-tasking Architecture



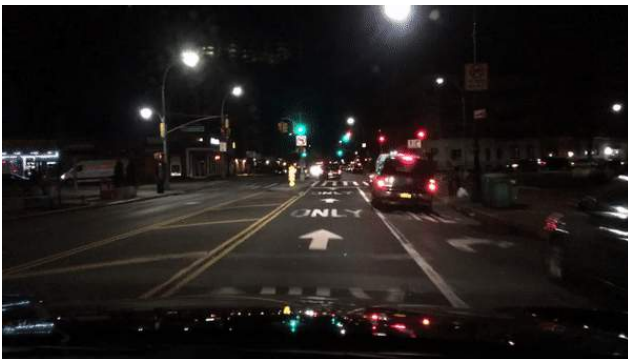
What About Corner Cases? Augment Vision with Active Mapping



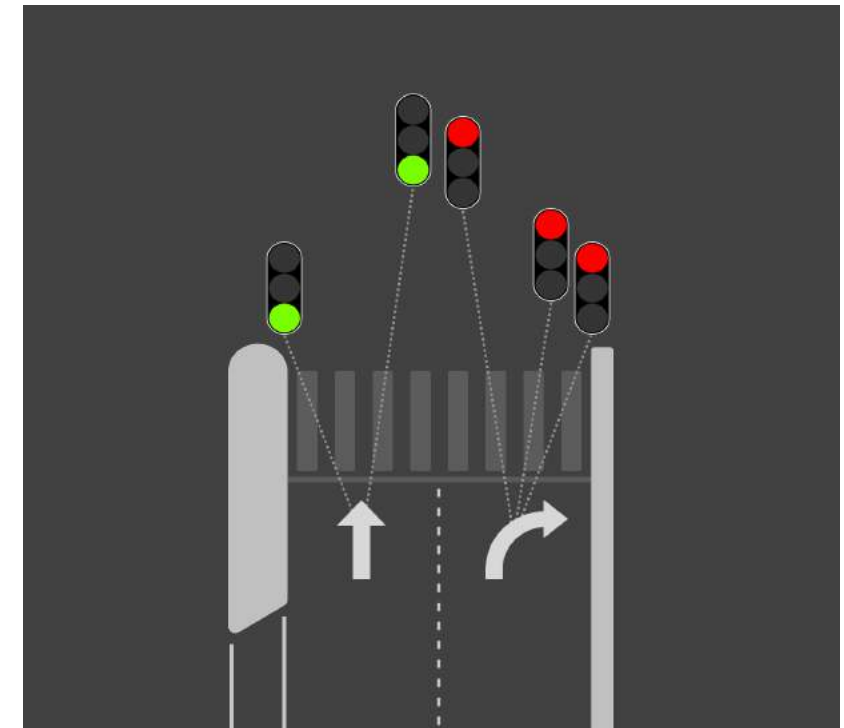
MUNET v.3 | Augment Vision with Active Mapping



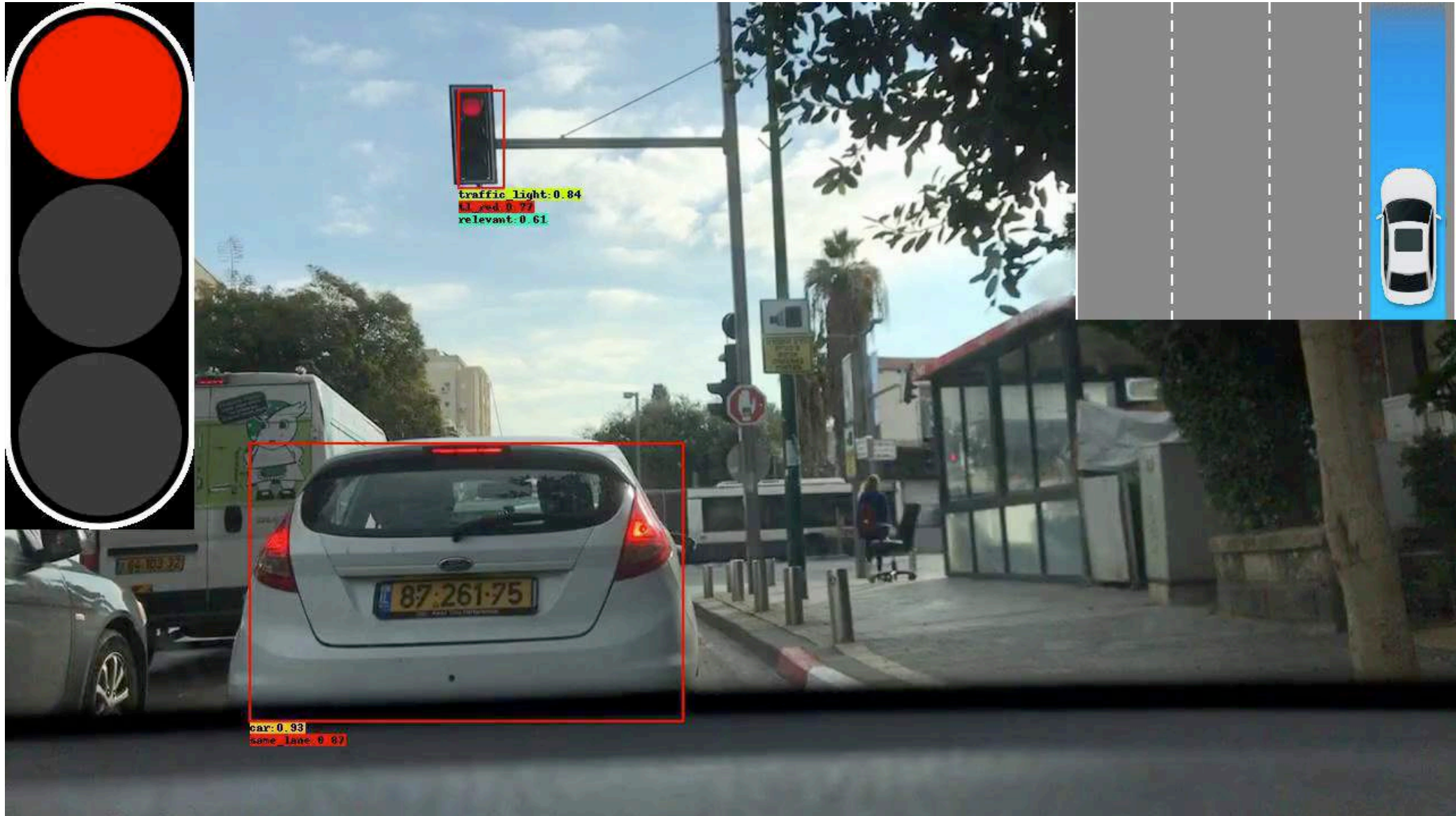
Map Intersections based on Historical Rides
+1M Intersection Videos in NYC



Traffic Lights and Lanes Mapping



MUNET v.3 | Ride to Work (iPhone7)

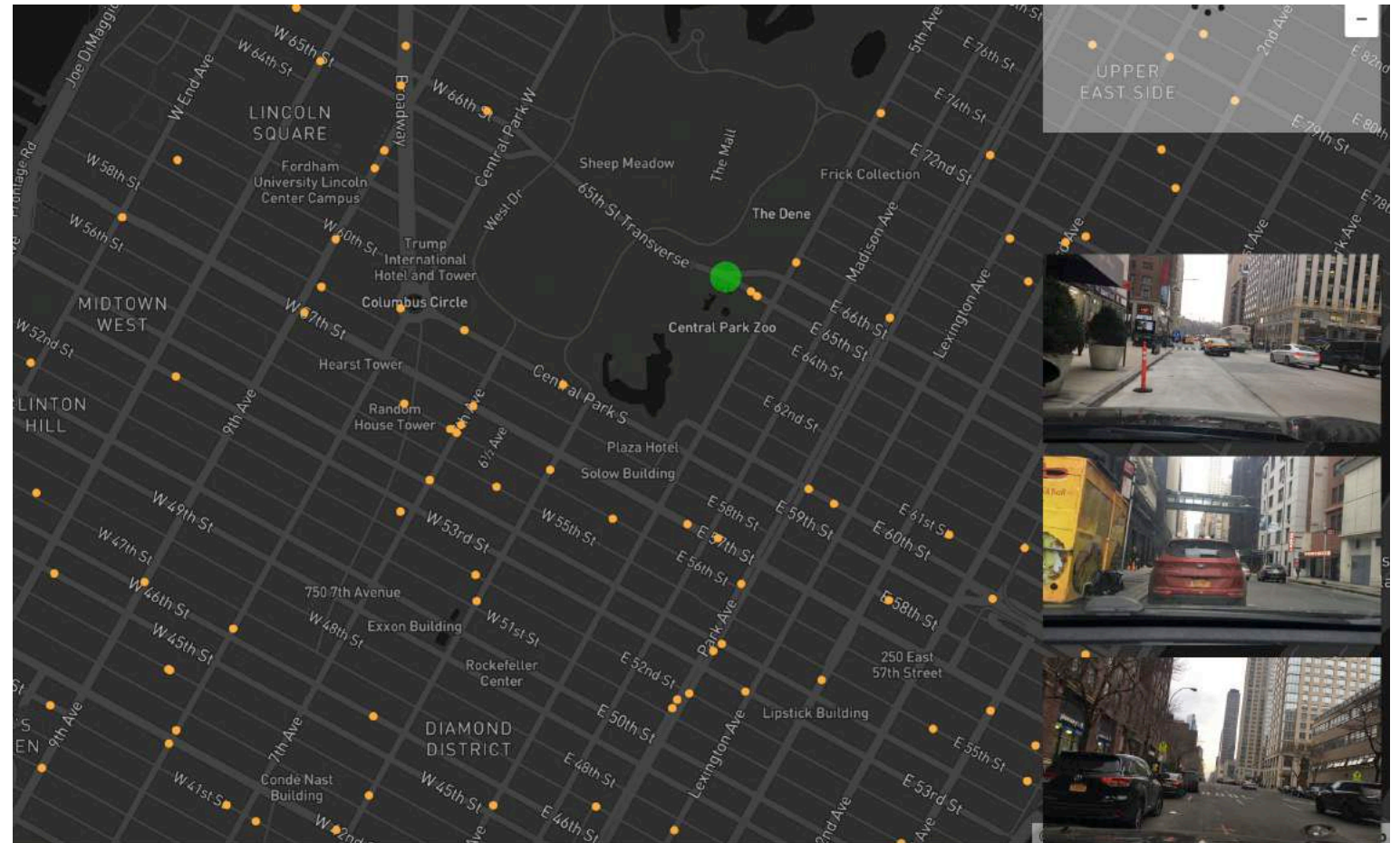


Our Vision | Solve the Problem of Car Collisions at Scale

Nexar's Vehicle-to-Vehicle Network



1.3M
Lives Saved



Nexar Team

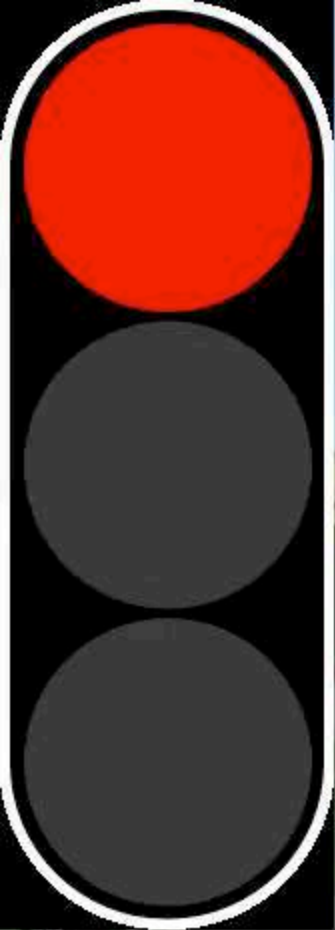


Nexar Team



Join us to make the road safer!

Thank You!



traffic light: 0.84
is red: 0.77
relevant: 0.61



car: 0.93
same lane: 0.87

