nexar

Continuous Deep-Learning
at the Edge

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IMVC 2019

Our Mission | Solve the Problem of Car Collisions at Scale

1,300,000
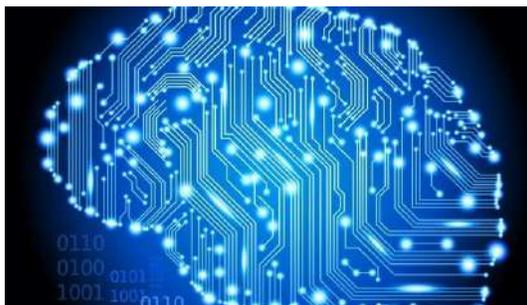**Fatalities Worldwide**

$270B
Collisions Costs in US

$125B
Traffic Costs in the US

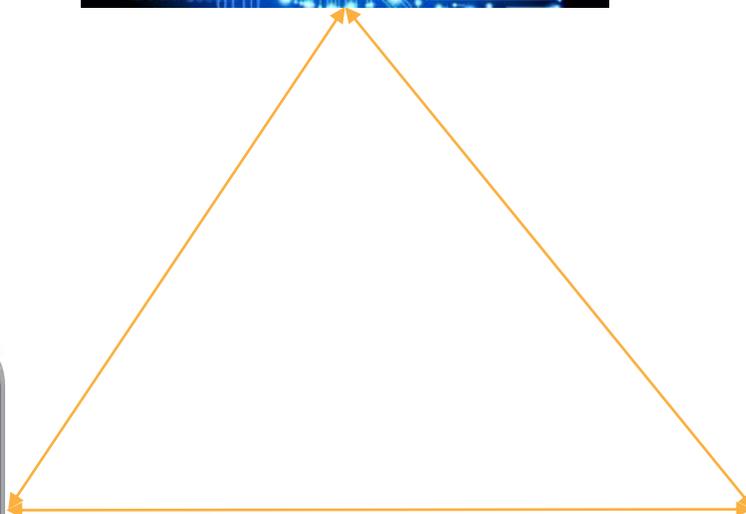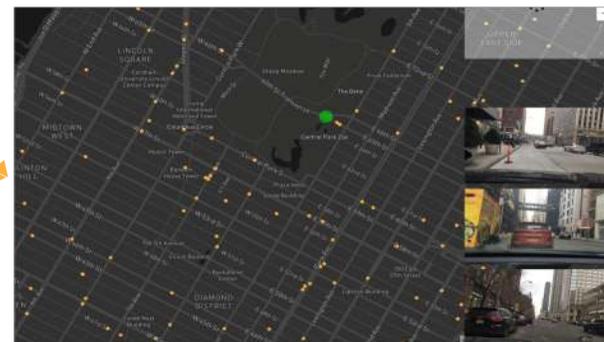# Our Approach | Solve the Problem of Car Collisions at Scale
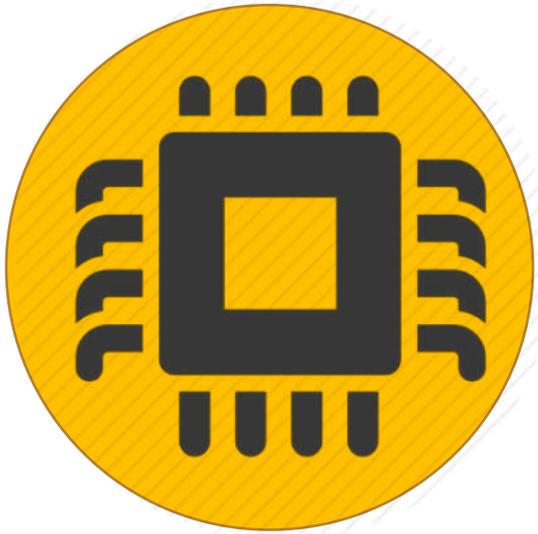

Deep Learning

+500m

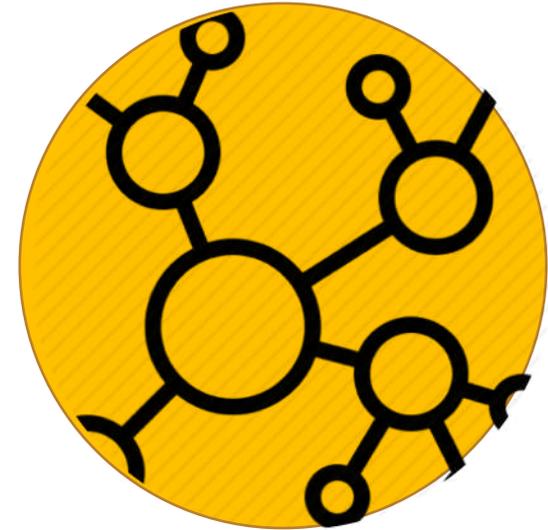Road seen km

Sensing

V2V Network

Models
Limited compute
at the edge

**Data**
Limited exposure
to corner cases

V2V Network
Safer Driving
Experience

Challenges | Limited Compute on the Edge

★ Efficient Deep-Net Architecture | low latency, small model size

★ Efficient and Accurate Multi-Tasking Inference | MUNET

    ★ Object Detection at various scales | truck, bus, car, traffic lights

    ★ Object Attributes Recognition | lane-level localization, relevancy

    ★ Object Tracking

    ★ Single Shot Inference without Compromising the High Accuracy Level

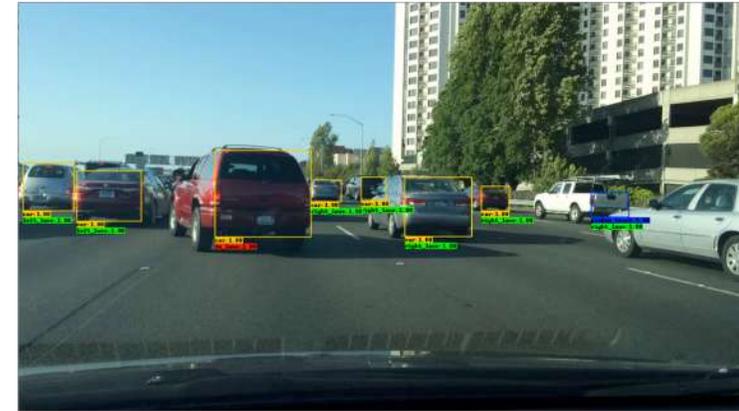# MUNET | Vehicle Detection | Classification | Relative Lane

Feature Maps

Input Image
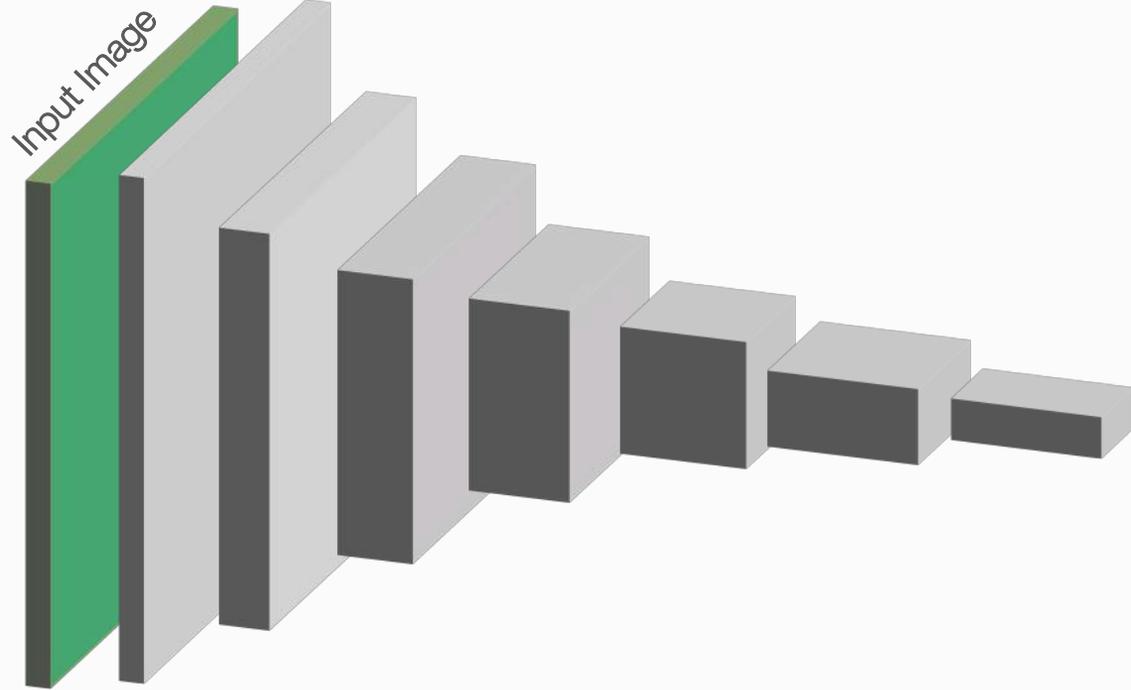
Single-Shot
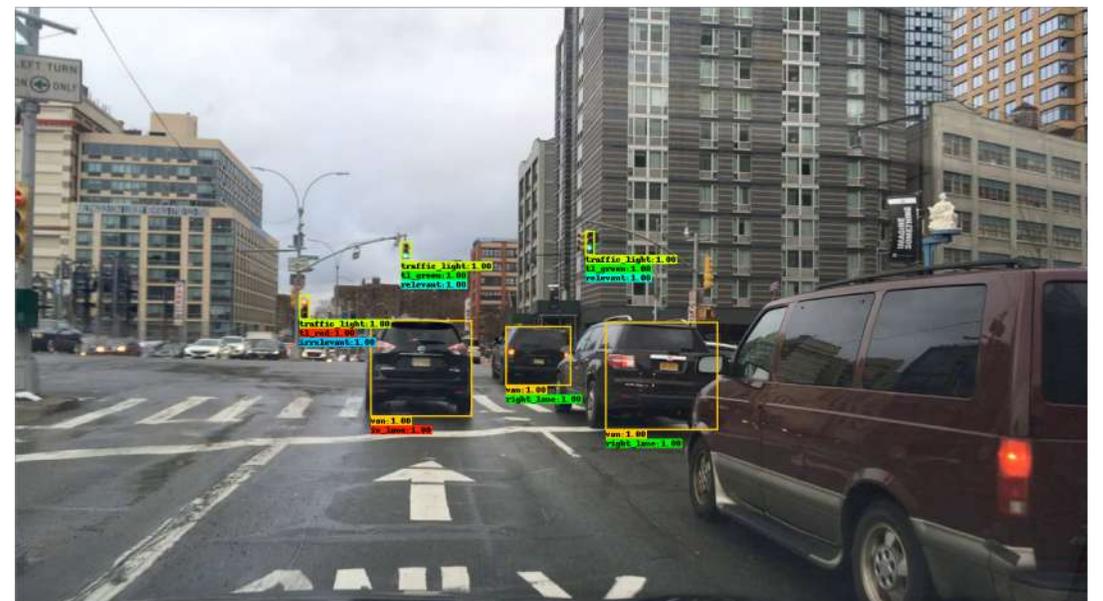Road Understanding

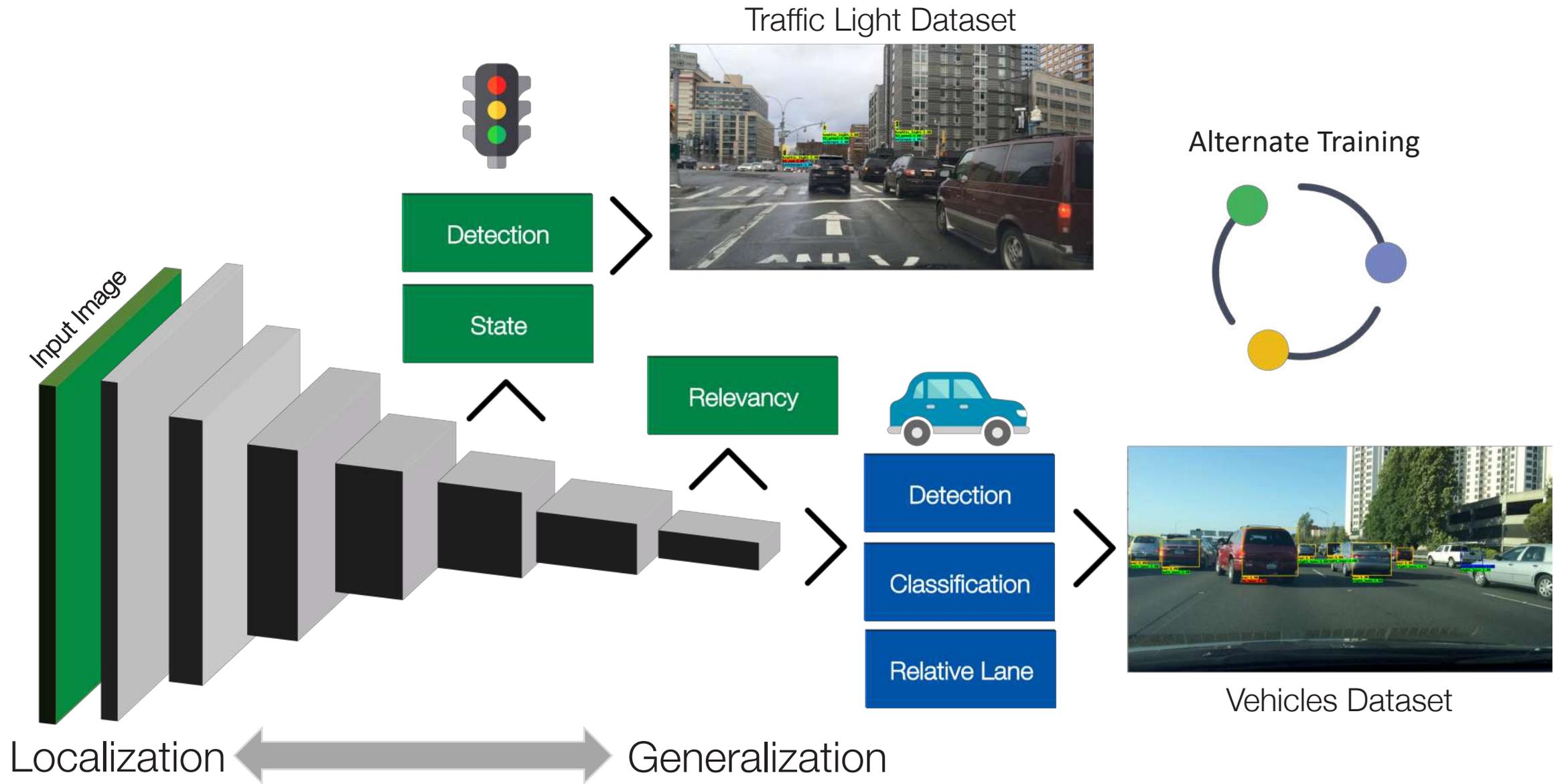Detection

Classification

Relative Lane
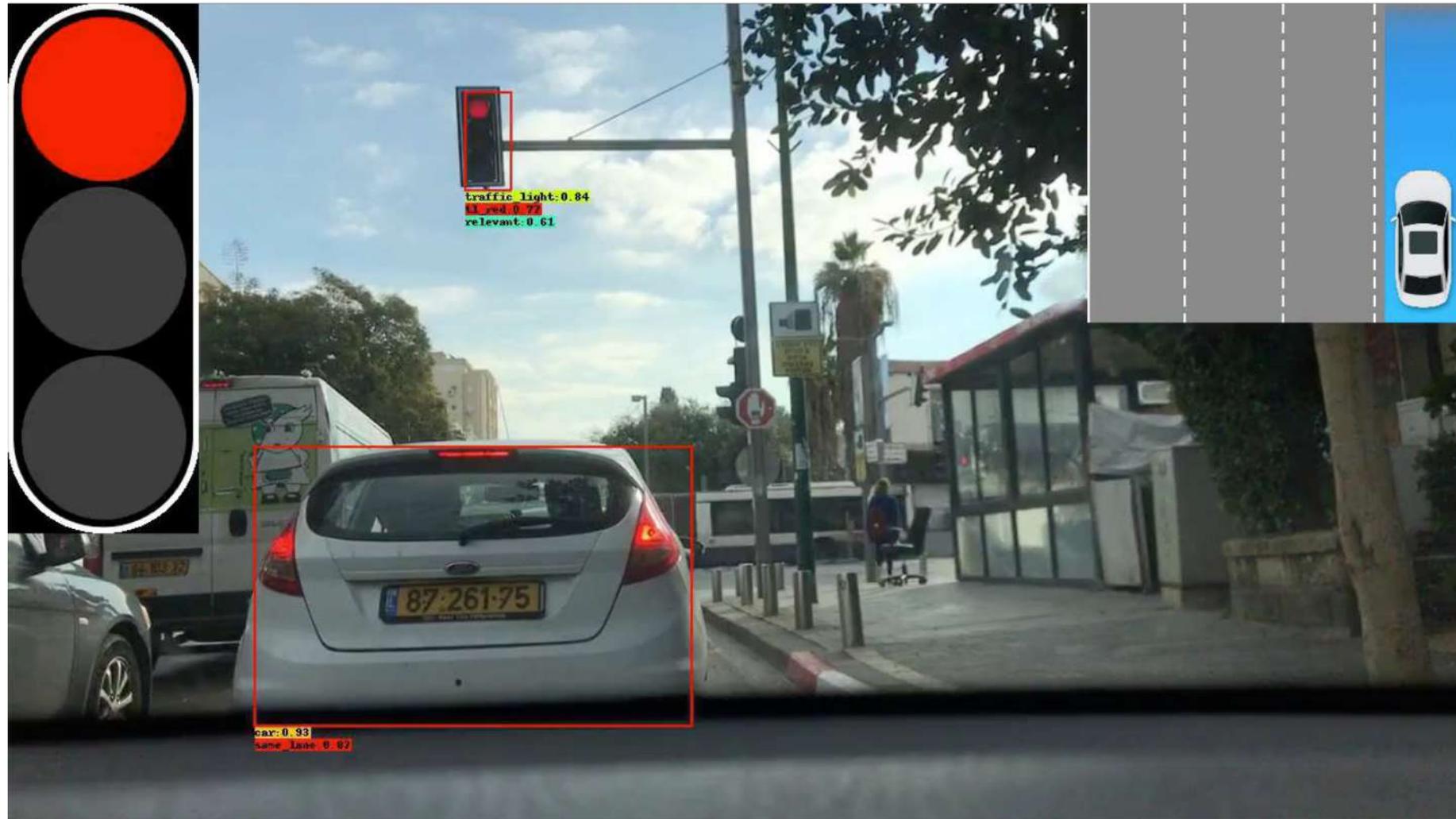
Network Output

MUNET| Traffic Light Recognition

★   Traffic Light Detection | Small scale object detection (local)

★   Traffic Light Relevancy | Road context is important (global)

MUNET | Efficient Multi-tasking Architecture

Traffic Light Dataset

Alternate Training

Detection

State

Relevancy

Detection

Classification

Relative Lane

Vehicles Dataset

Input Image

Localization ⟷ Generalization

Model Size: 5.7MB | #Flops: 1.78G | Latency (iPhone 7): 50ms

Challenge | Running Deep-Learning as Background Task (CPU)

★ Scalable Solution: turn simple dashcam into AI connected dashcam

★ Pair external camera to the phone and run Nexar's app in the background

★ Deploy efficient deep-nets running as a background task on mobile CPU

★ One of the first companies to run vision-based deep-nets in the background

App Background | Deep-Net Results in the Background (CPU)

★ Running Nexar's in the background with external camera

★ Performance | iPhone 7 CPU:

    ★ Runtime: 3.19ms | CPU Usage: 0.53% | Model Size: 20K

Traffic Lights	Obstacles (cones)	Police Cars

Addressing Limited Exposure to Corner Cases

Corner-Cases Challenges | Roads Are Unpredictable

It's All about Corner Cases | Traffic Lights Relevancy

Continuous Learning Pipeline | it is all about "corner cases"

+20m
corner cases of driving

+100m
annotated images

+80
countries

AI | Vision | IMU

Any City in the World

Domain Adaptation

Deep-Nets Zoo

Training

Corner Cases

Active Learner

Ground Truth

Self-Supervised Learning | Temporal Hard-Example Mining

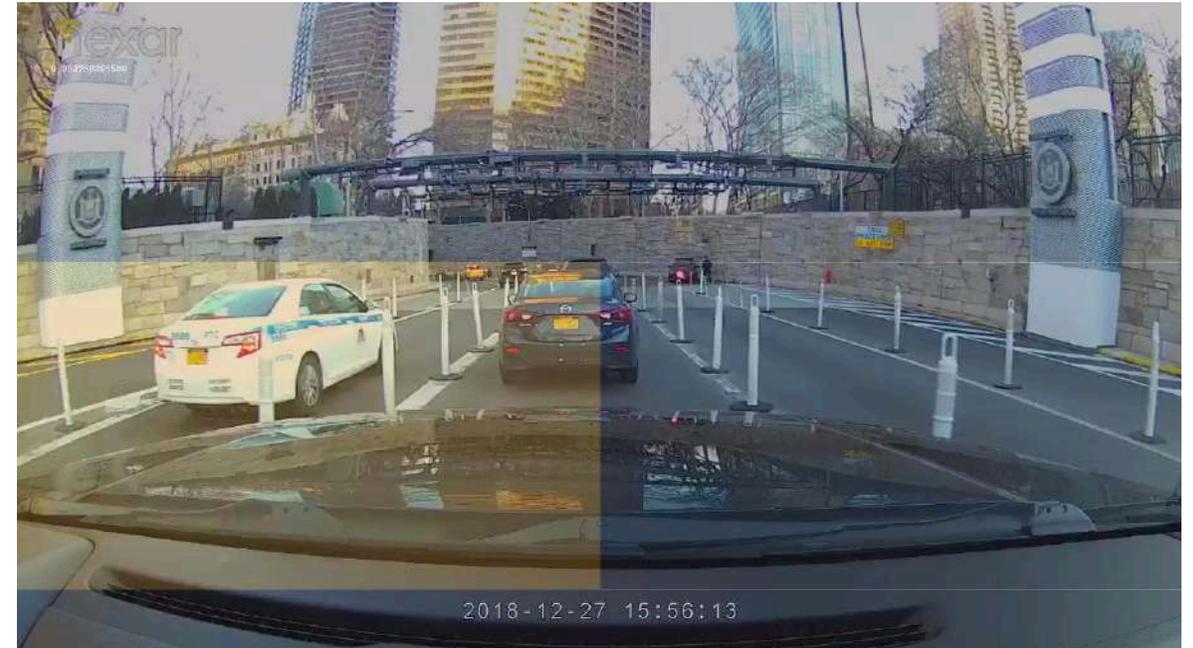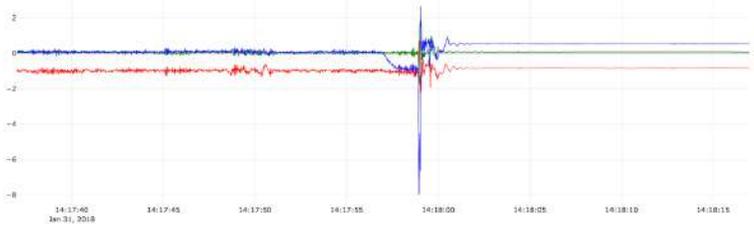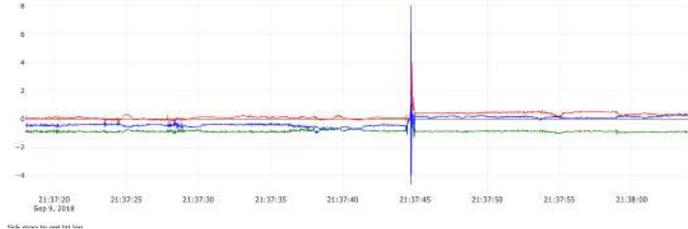| Mis-Detection	Mis-Detection	Detection	Mis-Detection	Mis-Detection
t_{-2}	t_{-1}	t_0	t_1	t_2

Negative Cones Example
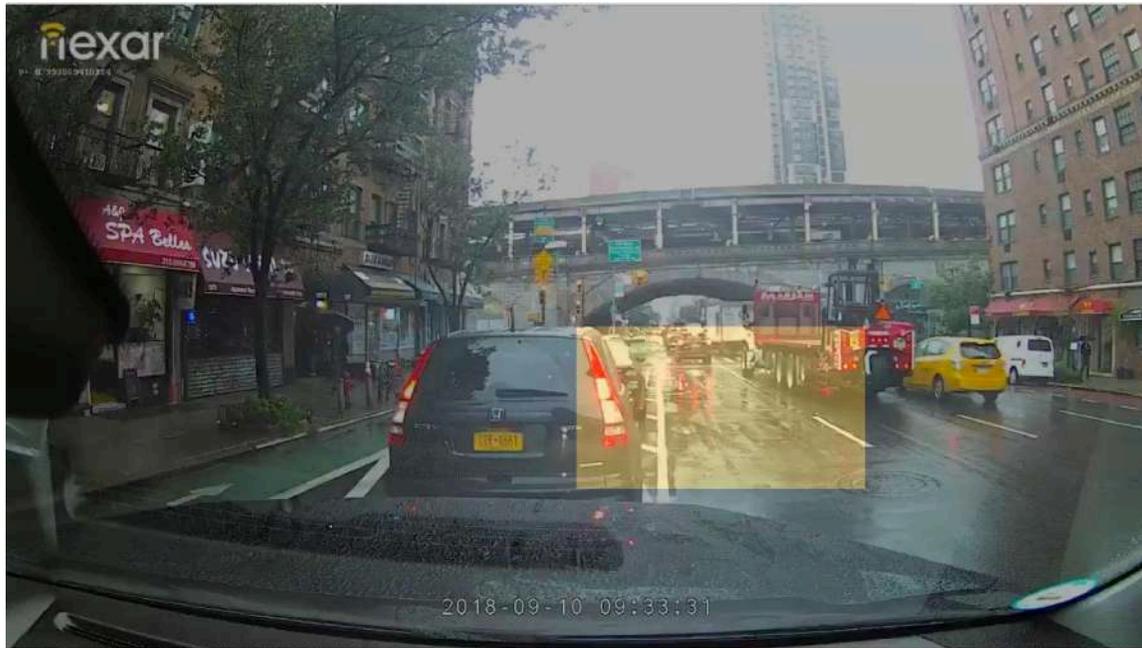
Negative Police Example

Cross-Modality Collision Detection | Augment Sensor with Vision
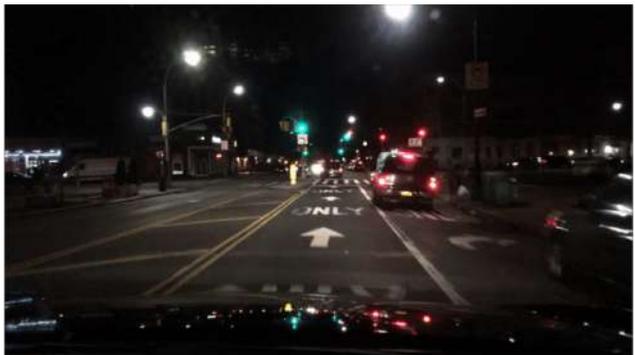

Collision: True Sensor Spike
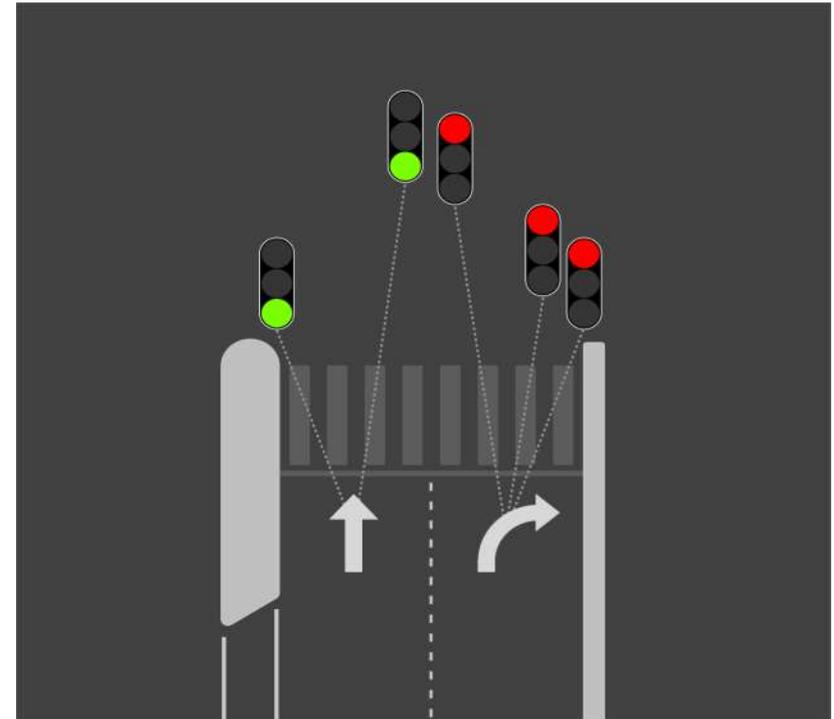
Not Collision: False Sensor Spike

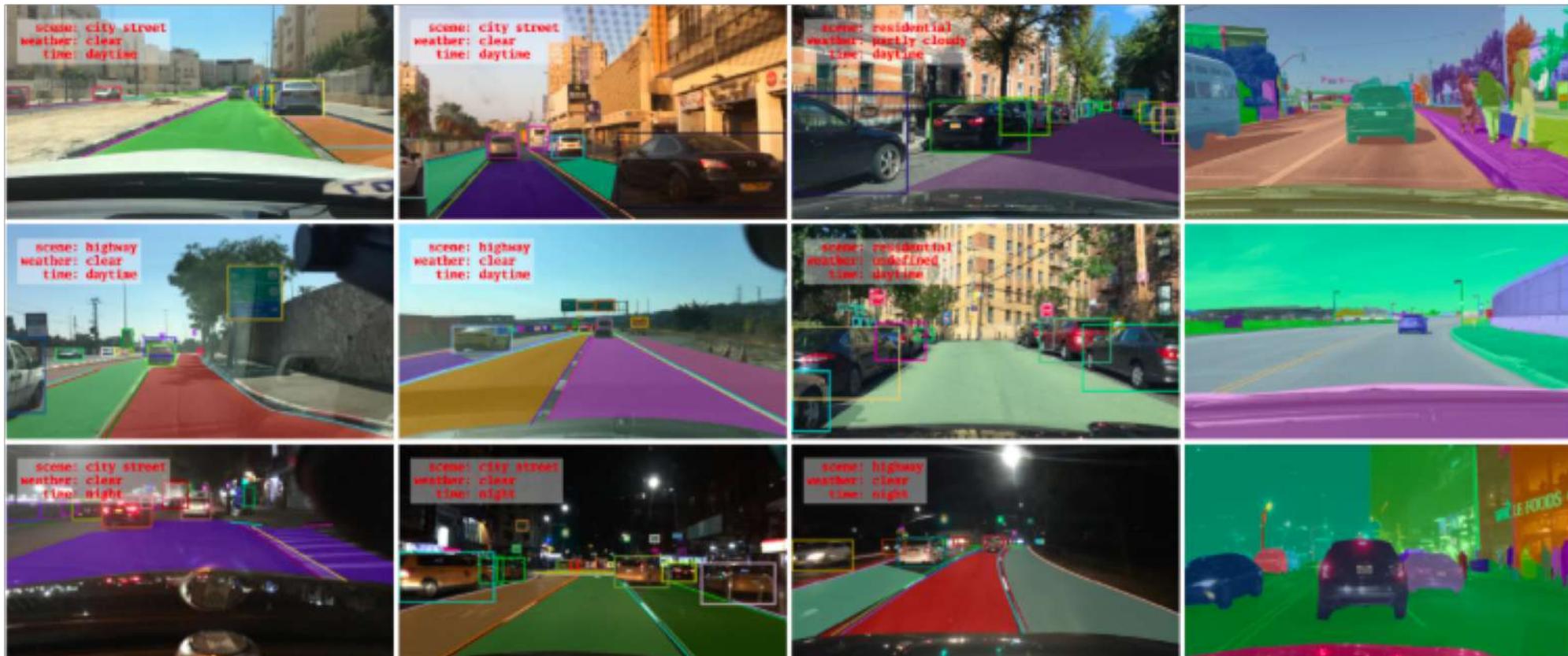# Corner Cases | Augment Vision with Active Mapping

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

Traffic Lights and Lanes Mapping

# BDD100K | Largest Dataset for Road Scene Understanding

Multiple cities, multiple countries, multiple weathers, multiple times of day, multiple scene types, images, video sequences, image tags, road object bounding boxes, drivable area, lane markings, full-frame instance segmentation

Leverage Machine Vision & V2V Network for Safer Driving Experience

Nexar's App | Traffic Light Countdown in NYC&SF
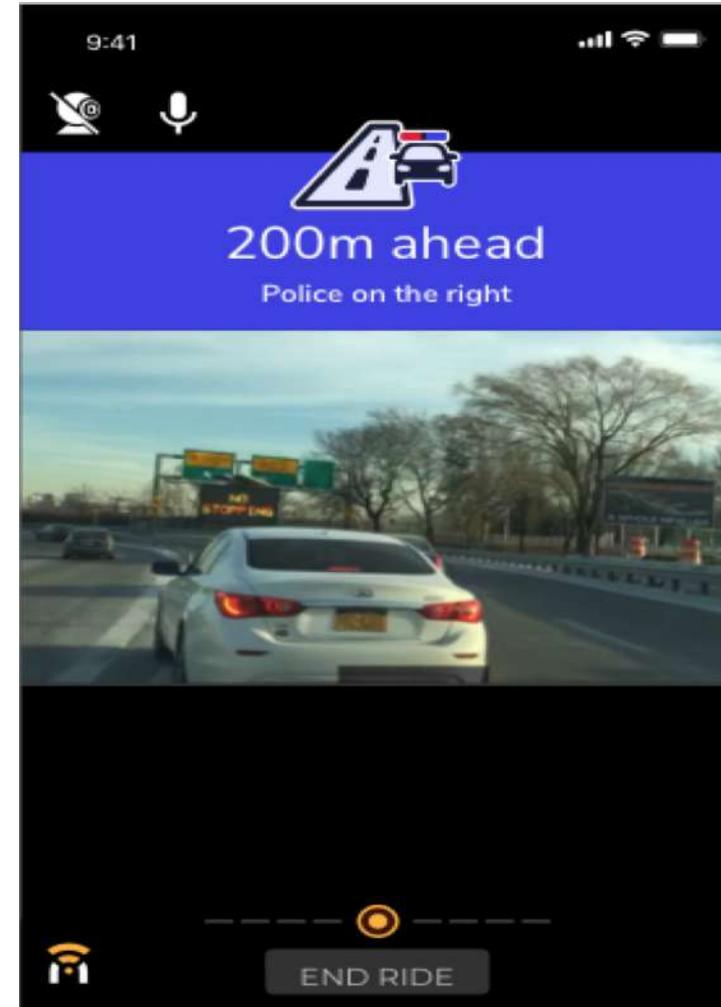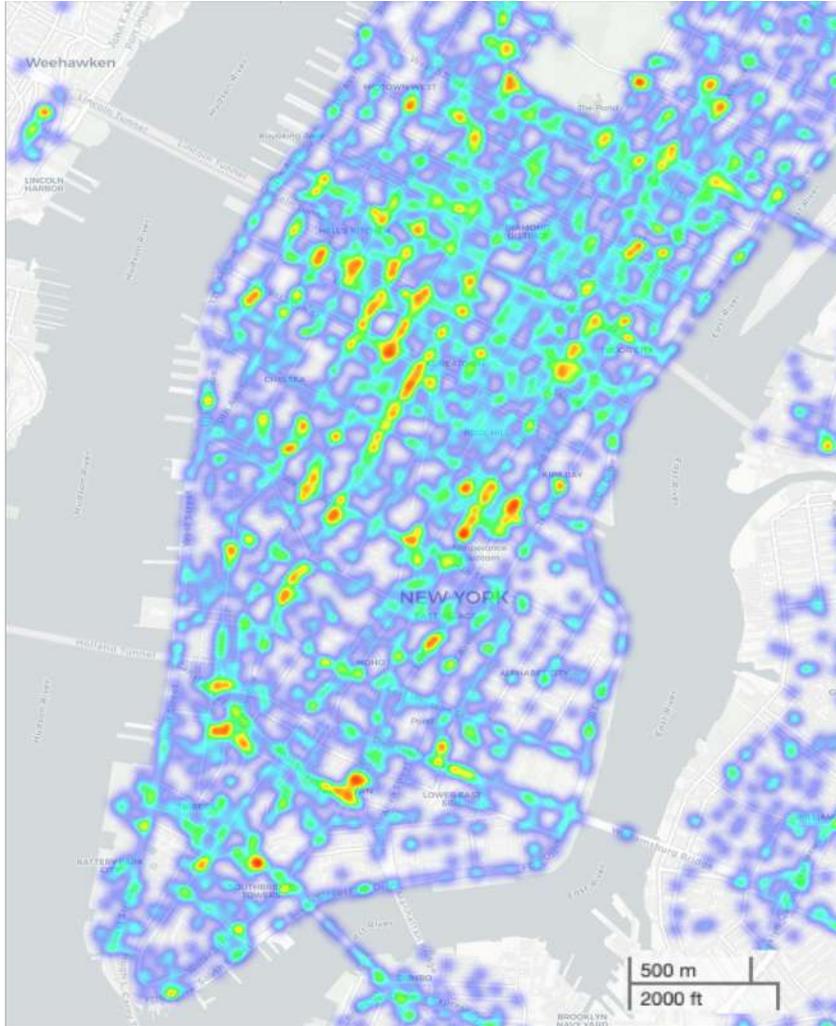
Nexar's V2V Live Map
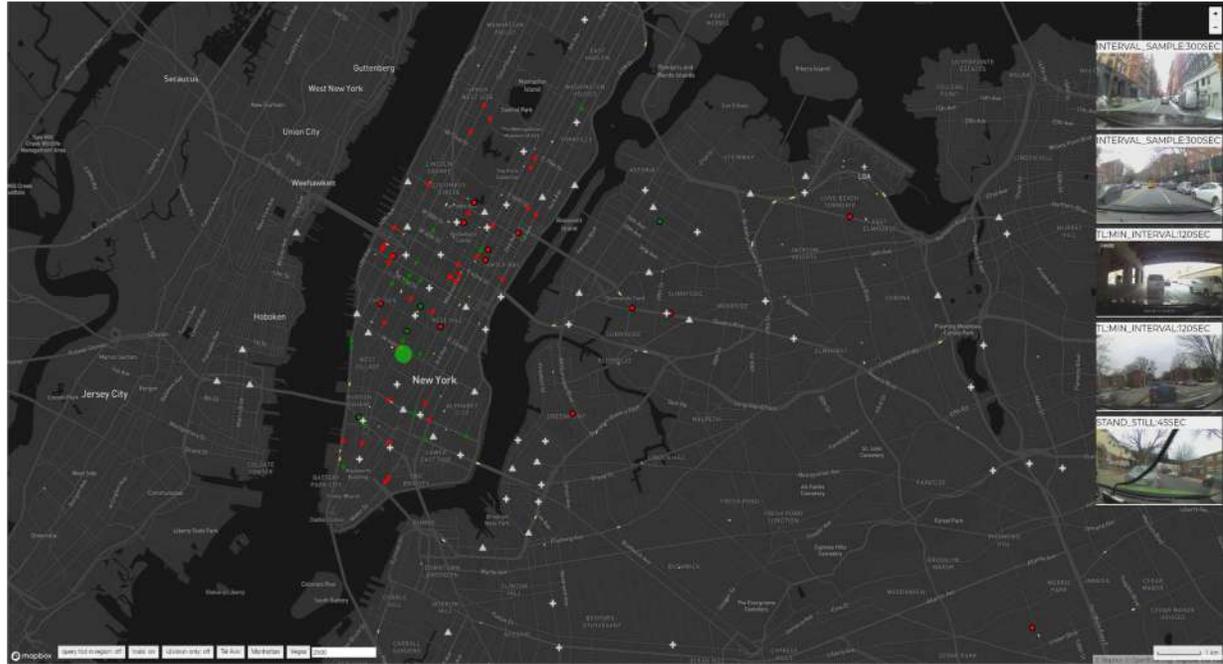
Traffic Light Countdown Feature

Nexar's App | Police Ahead Alerts in NYC

Nexar's CityStream | Turning Every City into Smart City

Road Blockage

What's Next | See through cars with NX-Ray
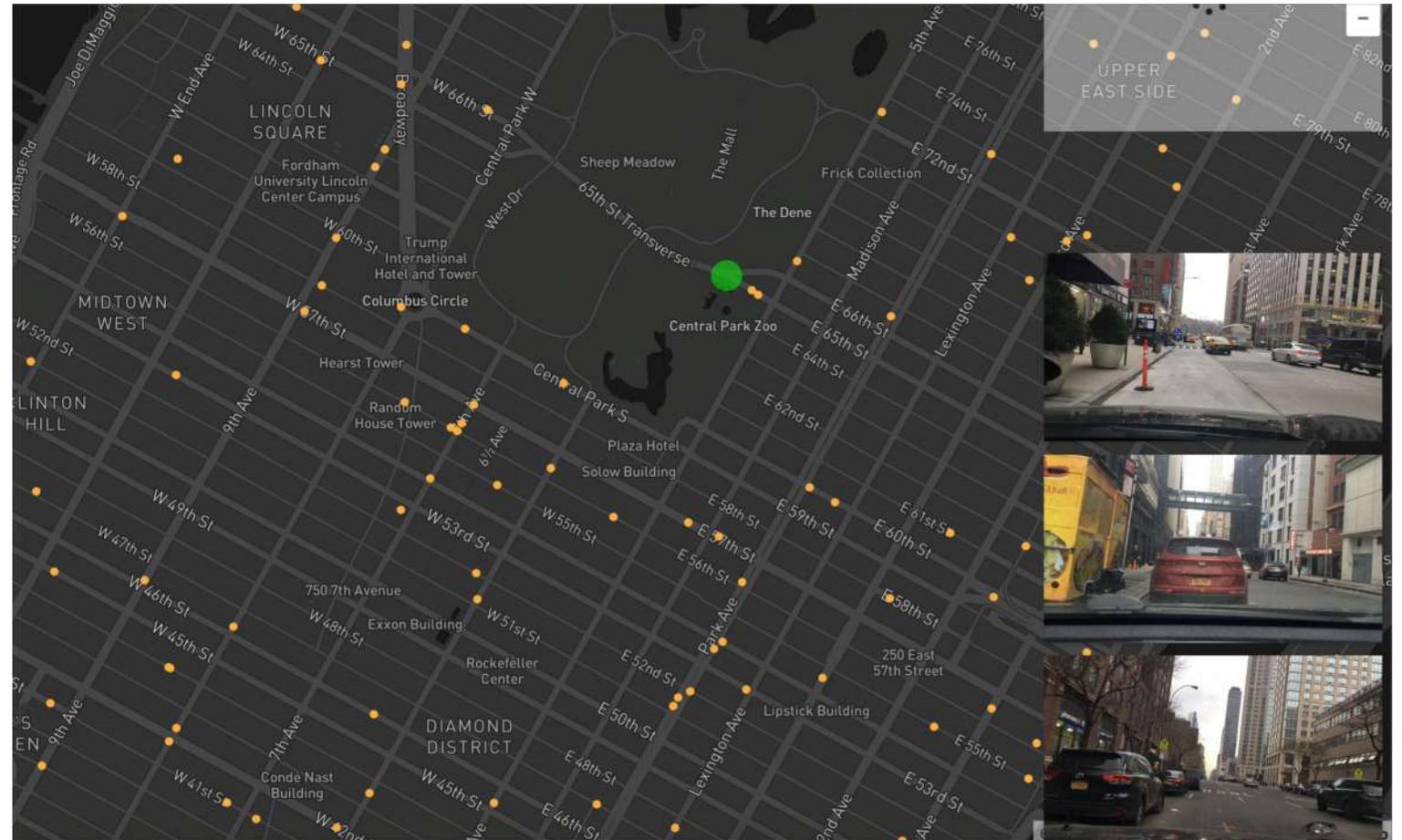
Machine Vision & V2V Network

Our Vision | Solve the Problem of Car Collisions at Scale

Nexar's Vehicle-to-Vehicle Network

Saving Lives

Nexar Team

Join us to make the road safer!

Thank You!