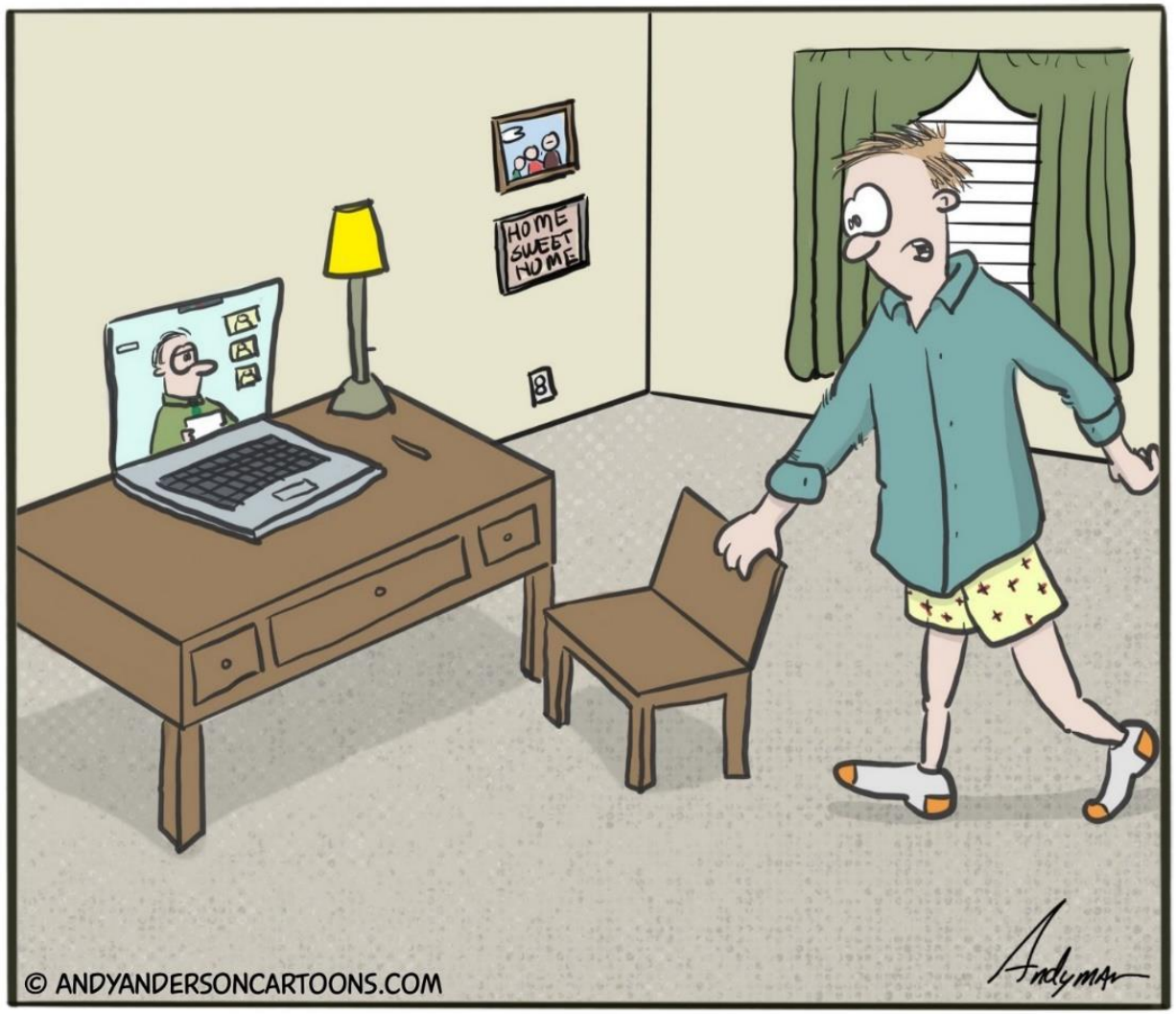
Computer Vision for Traffic Density Estimation

24-678: Computer Vision for Engineers

Overview

Web based mapping platforms can be unreliable!

- **Estimated Time of Arrival (ETA)** is never accurate!
- Heavy reliance on the **applications ability to track location accurately.**
- **Current solutions are not as robust** - real-time traffic prediction and navigation planning.



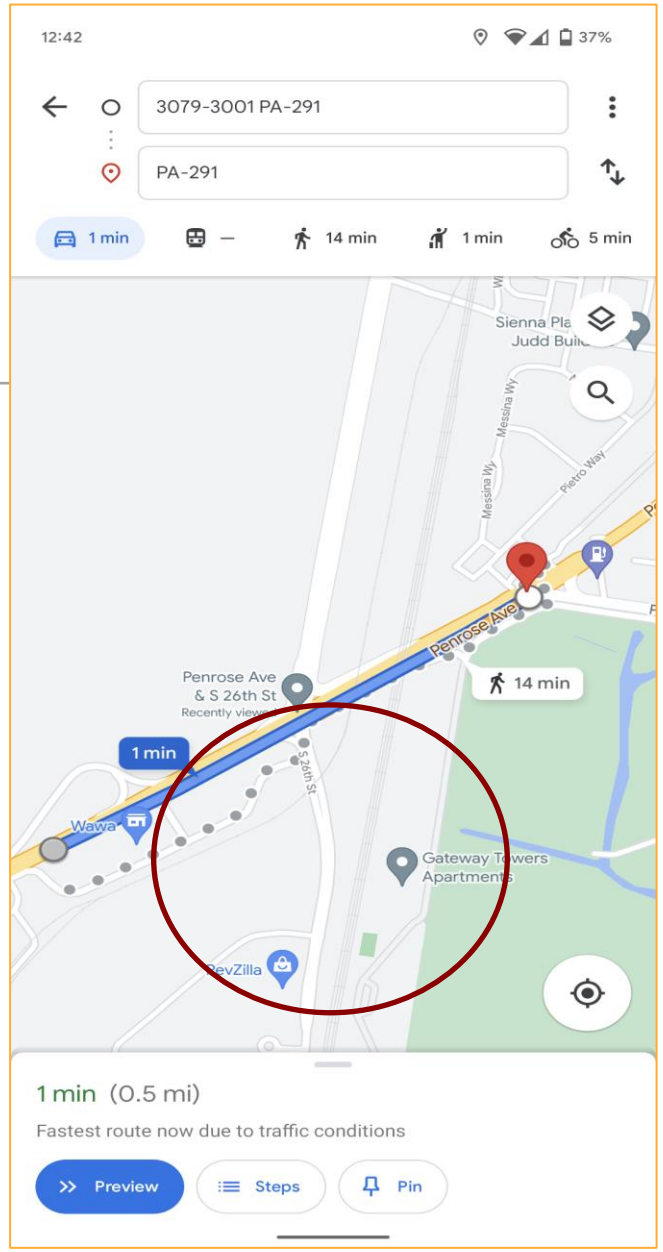
SORRY I'M LATE FOR WORK. TRAFFIC ON THE STAIRS WAS BRUTAL.

⚠ Existing Gaps

What are the current Issues?

- Efficient use of resources – **at the cost of accuracy** ☹
- **Urban development** presents a technical problem!
- **Technological advancements** (5G) still have **hiccups.**
- Inability to distinguish between **real and fake data-points.**

Existing Gaps



📌 Impact

User Groups & Pain Points

- **Professional workers** (Uber / Lyft / Delivery driver) :

  # Frequent navigation to different location

  - What are the shortest routes?
  - How can I get there in the quickest manner?

- **Local users** :

  # Looking for directions to travel locally

  - Navigation routes that adapt to real time traffic data

Product Opportunity

Where do we come in?

- Solution already exists!
- Augment the algorithm by providing reliable data points
- Account for real-time discrepancies

Goal

- Organize information and make it more useful
- Focus is on Customer Engagement

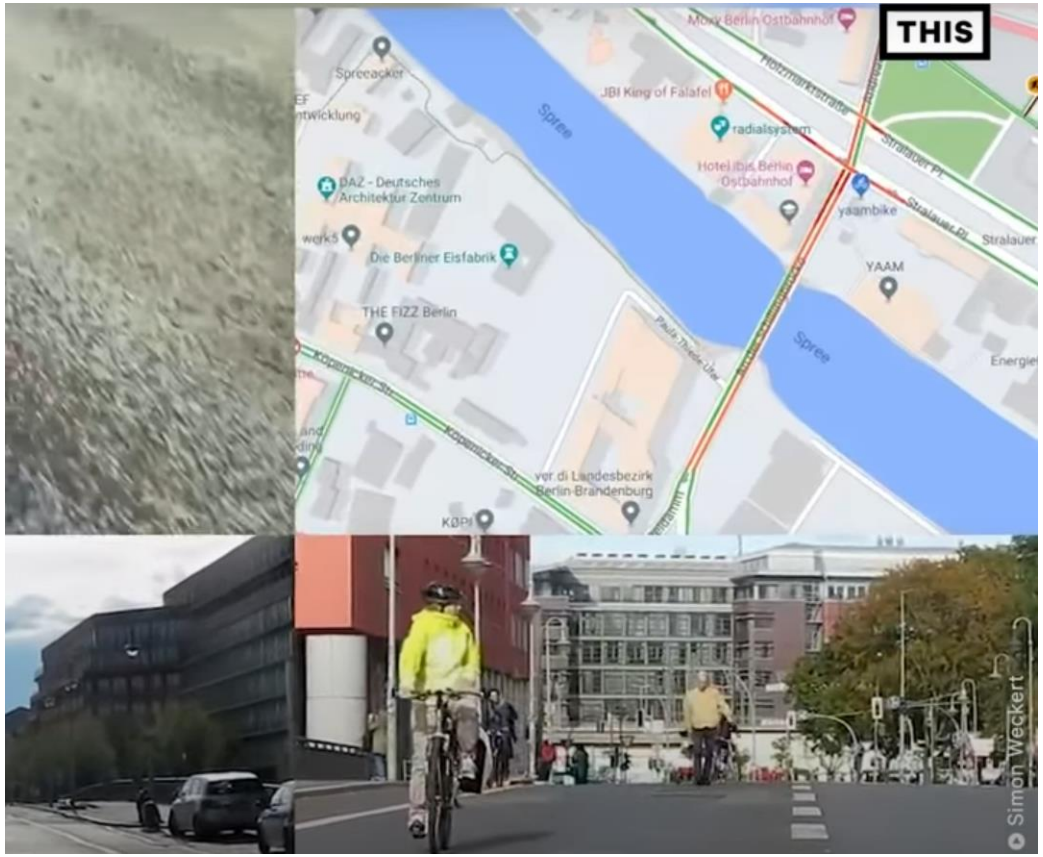
  -> Revenue

  -> Impact

Previous Work

- **Area mapping** algorithm based on OpenCV and SURF.
- **Image Matching Using SIFT, SURF, BRIEF and ORB**: Performance Comparison for Distorted Images
- **Automatic traffic density estimation** using Single Shot Detection (SSD)
- **Optical Flow Based Moving Object Detection** and Tracking for Traffic Surveillance

Study shows how Google Maps can be tricked!



Source:
https://www.youtube.com/watch?v=HbJGTKQ2NII

Our Process

Flowchart for Traffic Density Estimation:

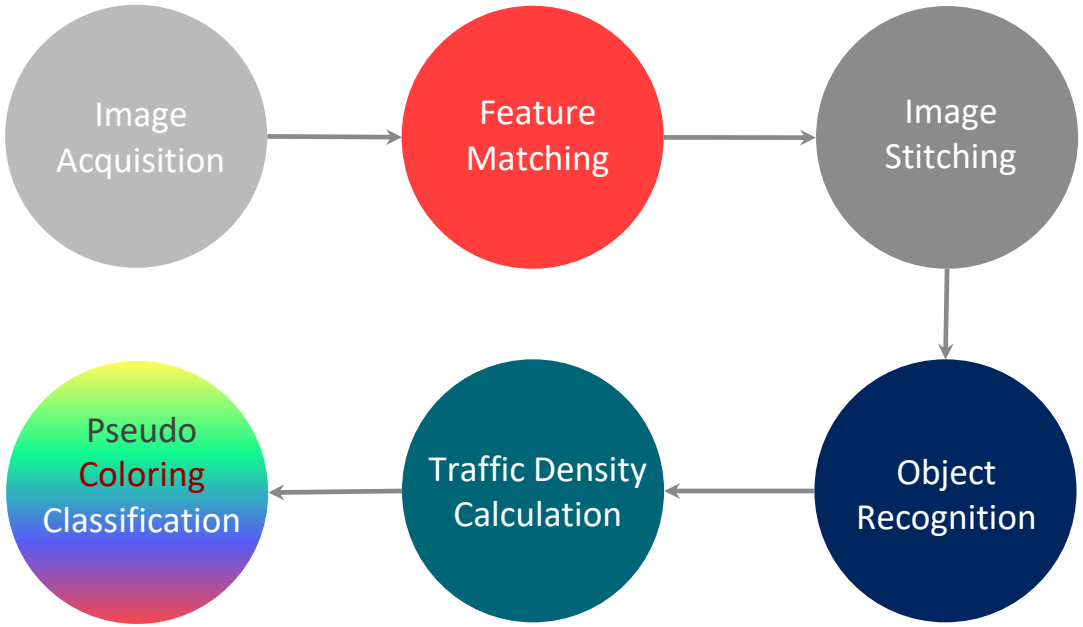


Image Acquisition

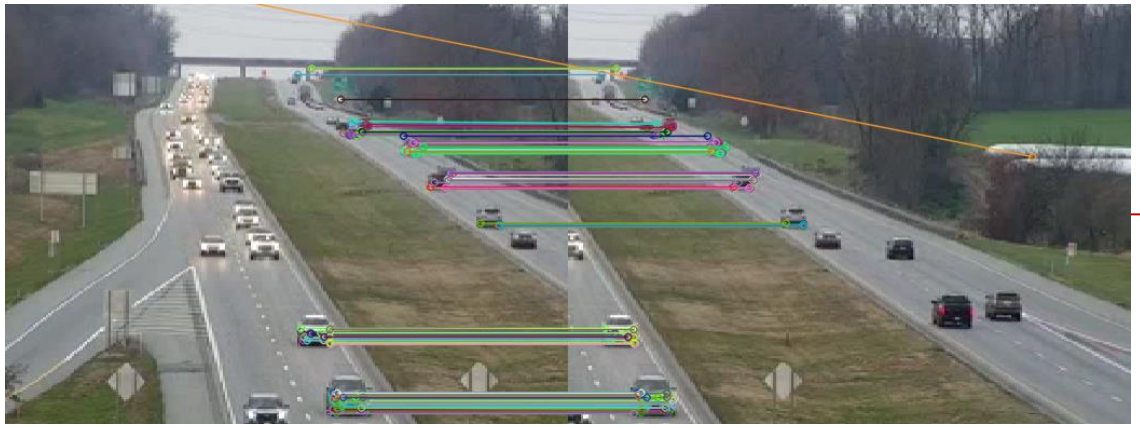
ORB Feature Matching

- **Compute Keypoints** : corner/edge/contour detection
- **Extract features** : Brute Force ORB
- **Compute distances** : between every descriptor pair

  Hamming Distance (ORB uses binary string based descriptors)
- **Select best matches**

ORB Feature Matching

Test Case 1



Test Case 2

Image Stitching

- **Estimation of Homography Matrix**
- **Warp source images** : Realignment for stitching
- **Stitch wrapped Images** : about every descriptor pair

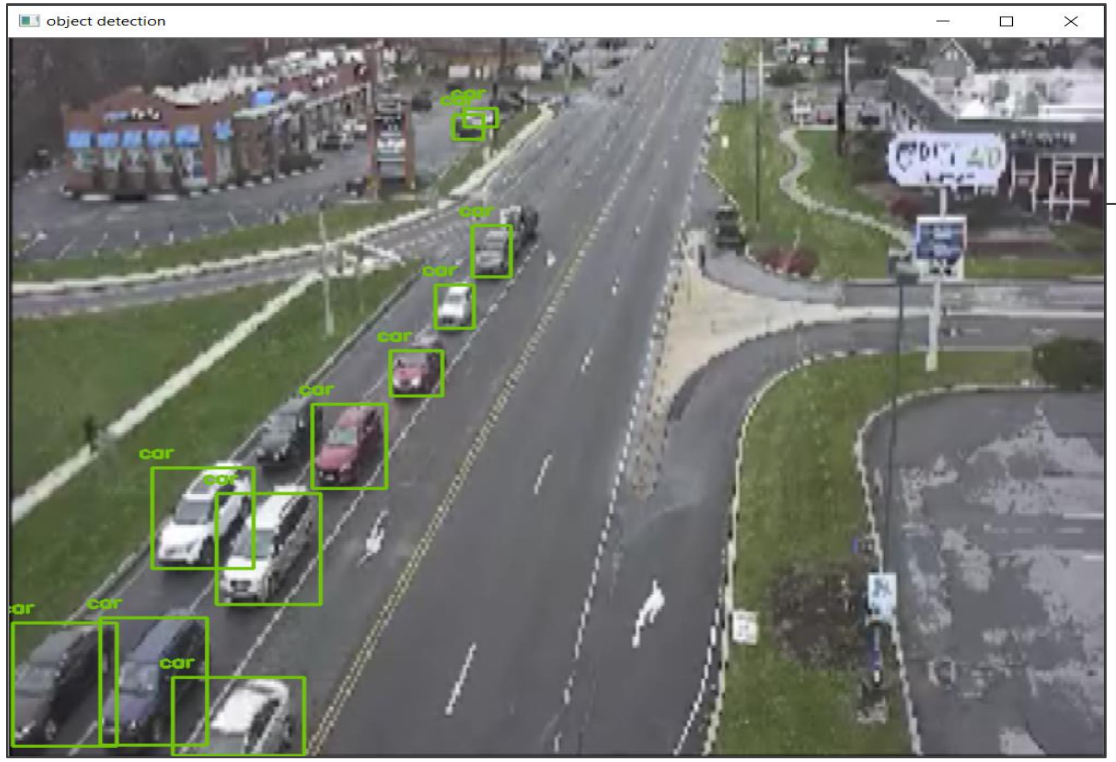
Image Stitching

Test Case 1

Test Case 2

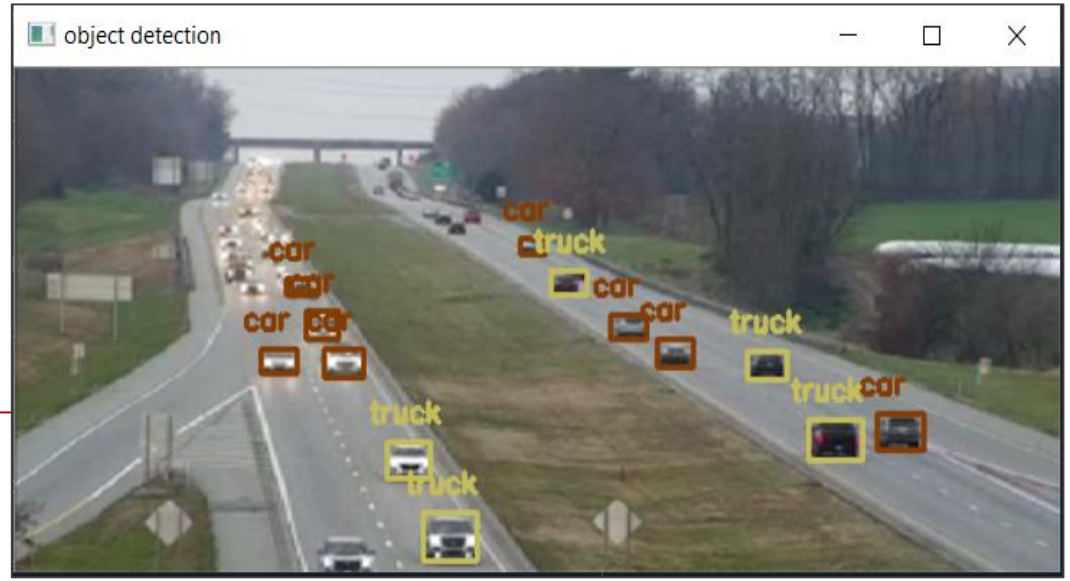
Object Recognition

- **YOLO** : Deep learning based Object detection algorithm.
- **Dataset** : Microsoft Common Objects in Context (COCO Dataset)
- **Train Algorithm** : to detect various vehicle classes in a given image
- **Classify and Store** : the number of vehicles found in the image



Test Case 1

Test Case 2



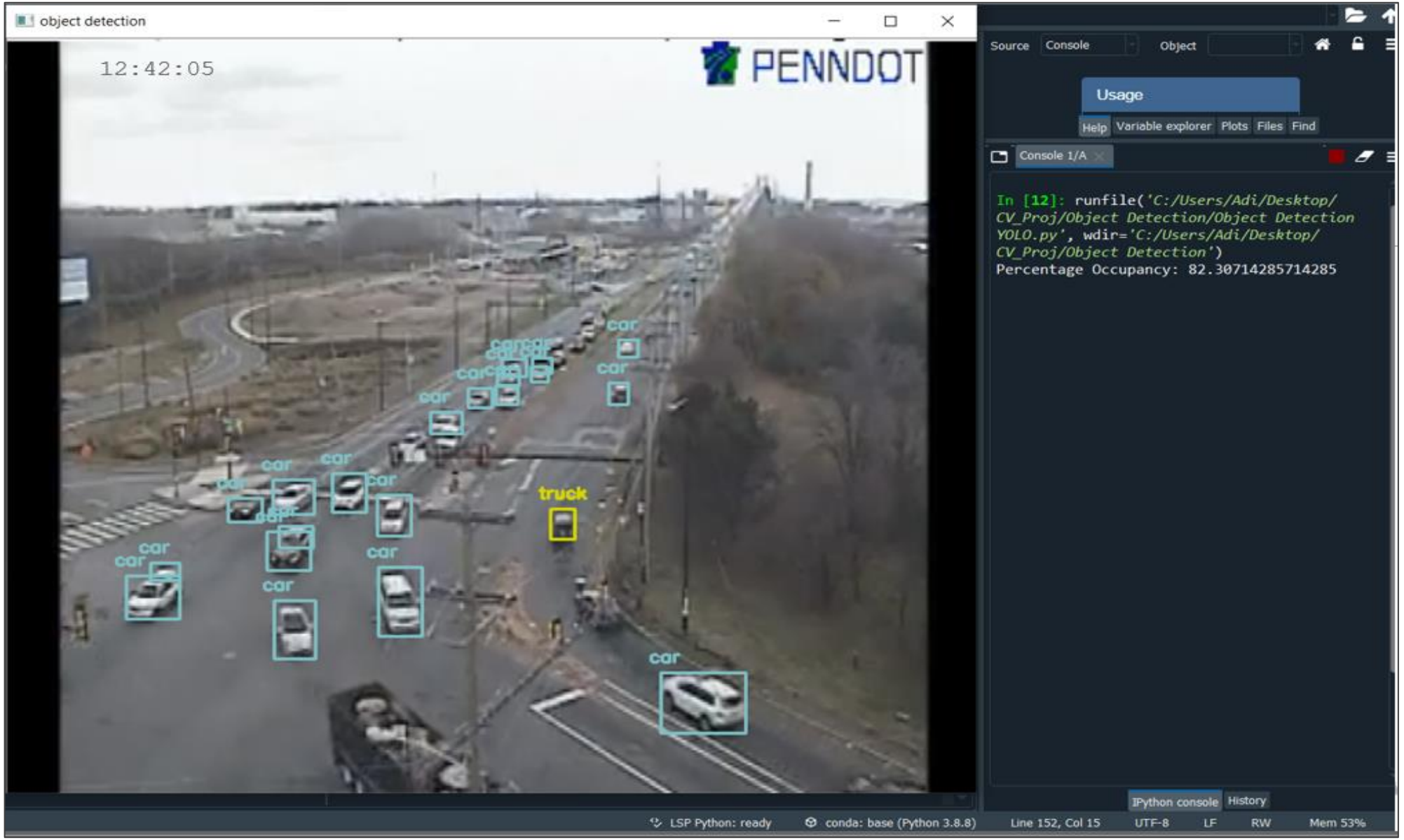
Test Case 3

Traffic Density Calculation

- **Calculate road_area :** the area of road with respect to the input image
- **Calculate Total_vehicle_area :** the sum of individual vehicle areas
- **Compute percentage occupancy:** by dividing the two areas

$$Road\ Percent\ Occupancy = \frac{Total\_vehicle\_area}{Road\ Area}$$

- Note: The Road area may differ based on the type of road (single lane, multi-lane, incoming, and outgoing traffic)


object detection
12:42:05
PENNDOT
car
truck
Source
Console
Object
Usage
Help
Variable explorer
Plots
Files
Find
Console 1/A
In [12]: runfile('C:/Users/Adi/Desktop/CV_Proj/Object Detection/Object Detection YOLO.py', wdir='C:/Users/Adi/Desktop/CV_Proj/Object Detection')
Percentage Occupancy: 82.30714285714285
IPython console
History
LSP Python: ready
conda: base (Python 3.8.8)
Line 152, Col 15
UTF-8
LF
RW
Mem 53%

Future Scope

- **Pseudo-coloring (Mobility Heatmap)**
  - Dataset showing the volume of traffic flow

- **Data-driven city planning**
  - Dataset measuring street speeds of traffic.

Motion Detection

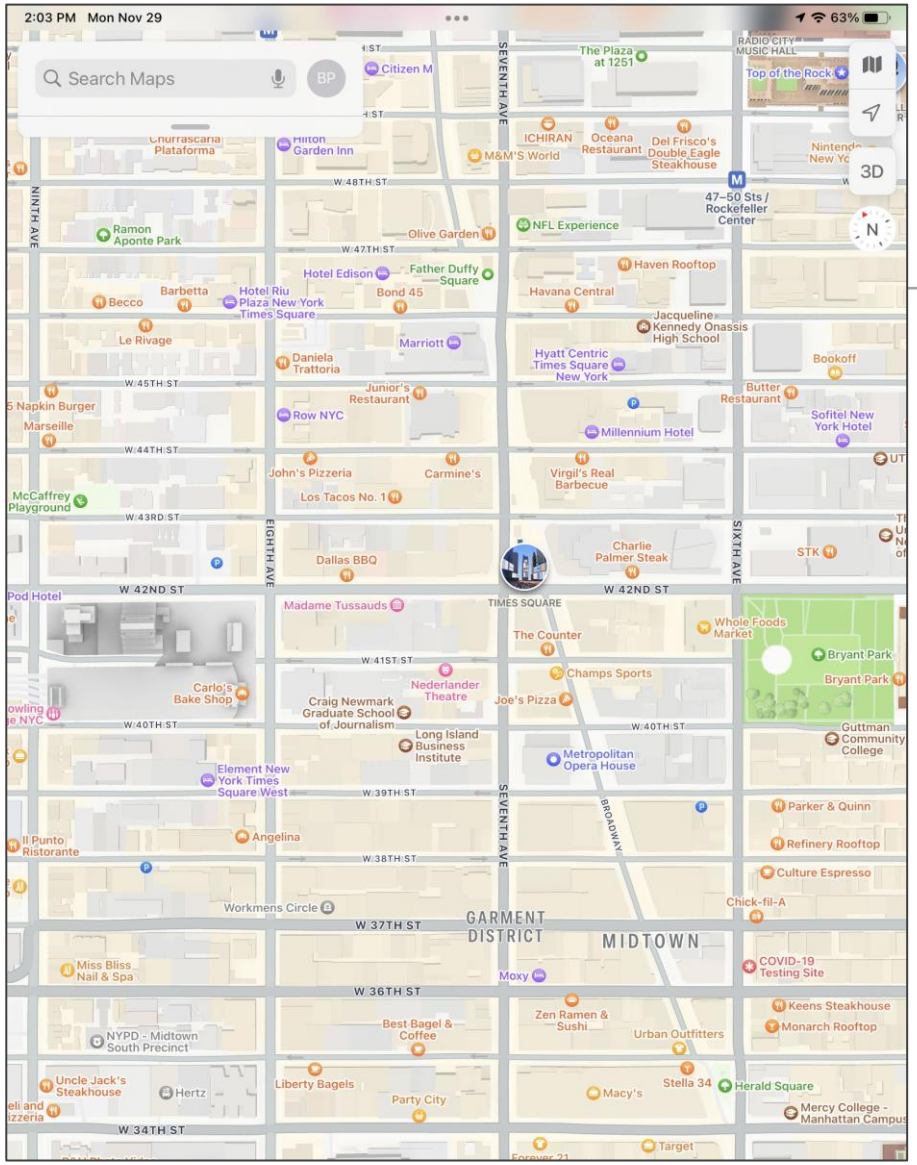
Image 1

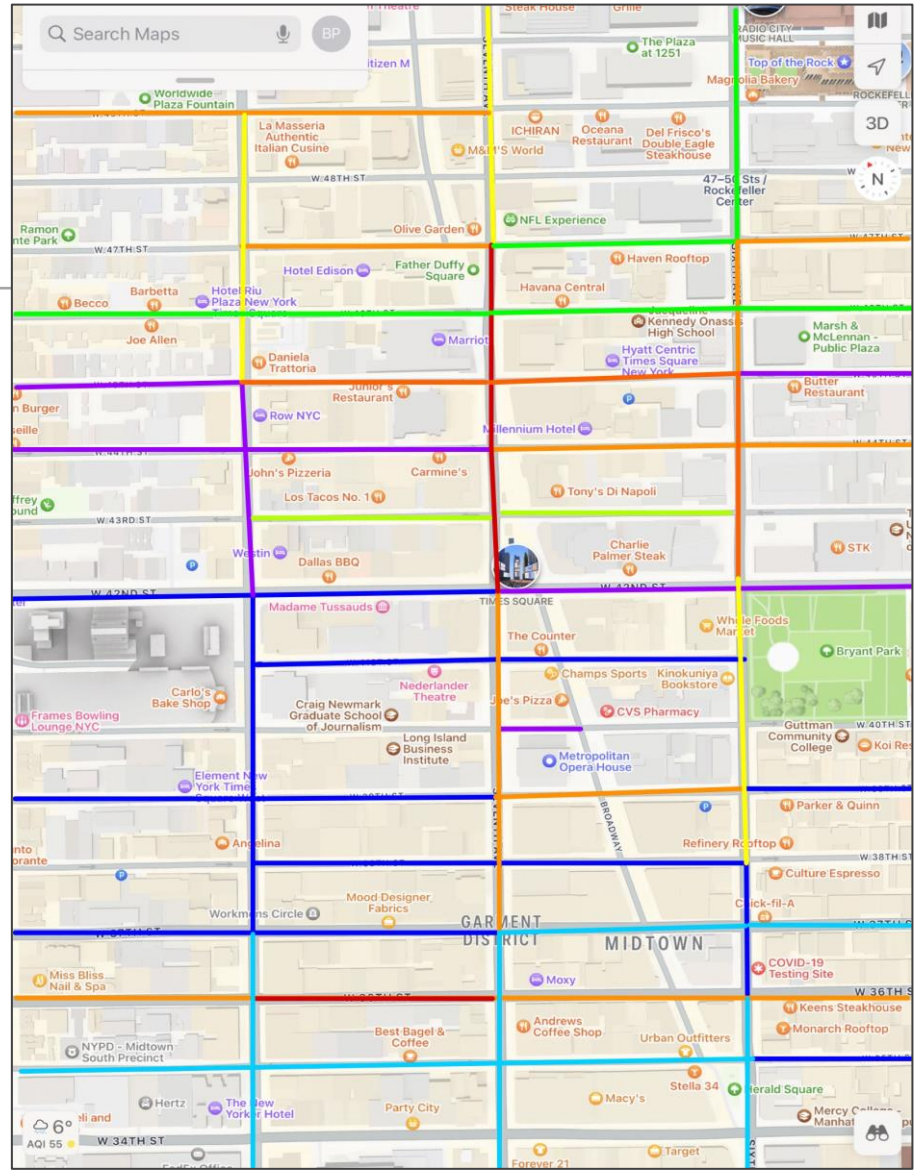
Substraction (1-2)

Image 3

Substraction (2-3)

Pseudo-Coloring





Value proposition

Customers Satisfaction

- Reliable traffic density data
- Privacy protection (Big Brother data harvesting)

Economic Impact

- Increase in productivity and business revenue generation for local and professional consumers

Urban Infrastructure Planning

- Highways, Parking Lots, Metro Lines, Malls …

Thank You!

- Any Questions?
- Please don't forget to provide your scores and any feedback! ☺