

Stay In Your Lane!

Automated Bike Lane Enforcement
With Neural Network Image
Classification

Jesse Markowitz
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Outline:



- The problem
- Business Understanding
- Purpose of Analysis
- Data & Methods
- Results
- Recommendations
- Next Steps

What's the problem?



Insufficient enforcement of bike lane traffic laws creates serious safety issues for cyclists.

- Cars parked in bike lanes force cyclists to weave through traffic
- From 2019–2020, increase in bike lanes but also an increase in cyclists killed by drivers



Business Understanding:



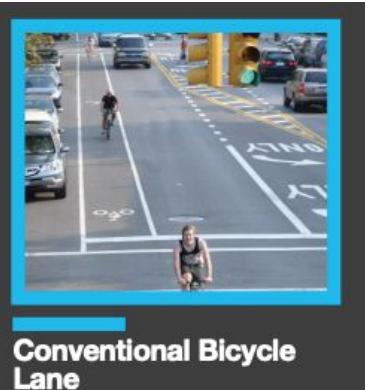
NYC Bike Lanes

- Focus on “Protected” and “Conventional” lanes
- Bike lanes are considered “no stopping zones”

<https://nybc.net/education/bike-law/2-uncategorised/68-a-summary-of-ny-state-bike-laws#blocking>



**Protected Bicycle Lane
with Access Point**



**Conventional Bicycle
Lane**

<https://www1.nyc.gov/html/dot/downloads/pdf/nyc-bike-map-2021.pdf>



Business Understanding:



Intent for automated bike lane enforcement:

- NYC Dept. of Transportation: “Request for Expressions of Interest” announced September 15, 2021
- Reduce police involvement while increasing enforcement
- Automation can target problem areas efficiently
- Similar to ABLE system for bus lanes (see Appendix)

Purpose of Analysis



Image classification: Is there a car in the bike lane?

- Simple image *classification*
 - Empty bike lane vs Vehicle in bike lane
- First step toward automation
- Easy for humans, but time consuming



Data & Methods



Data collected via:

- Manual collection
- Google Maps Street View
- Reported NYC app
 - Twitter account
 - Ryan Gravener



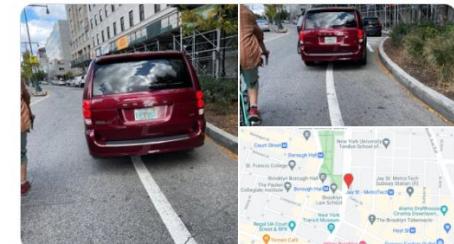
Reported @Reported_NYC · 5h

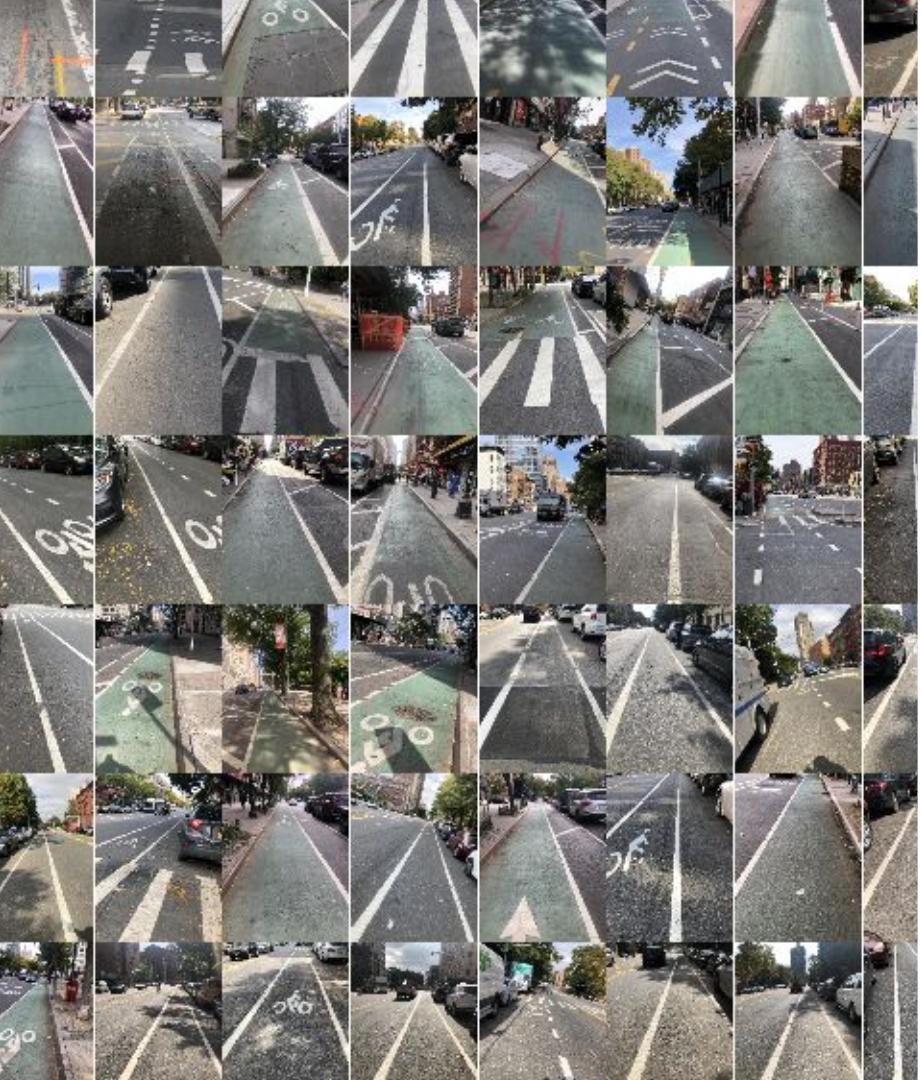
The uber driver T788306C blocked the bike lane near 10A Christopher St on October 17 and has been reported to #nyctaxi. This is in Manhattan Community Board 02 & #NYPD6. #VisionZero #BlockedBikeNYC



Reported @Reported_NYC · 5h

The driver EPH65 blocked the bike lane near 357 Adams St on October 17. This is in Brooklyn Community Board 02 & #NYPD84. #VisionZero #BlockedBikeNYC





Data & Methods

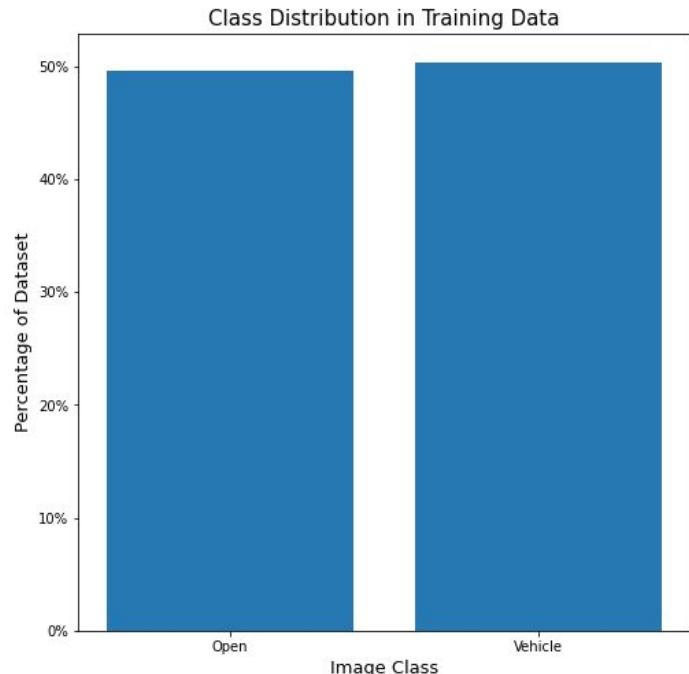


Over 1,600 images in total

- Even class balance
- 100 set aside for final valuation
- 10% validation split during model training

Limitations/Specifications:

- Daytime only
- All photos contain a bike lane
- Looking up or down bike lane
- Both lines of lane are visible (can see that it is a lane)



First Simple Model

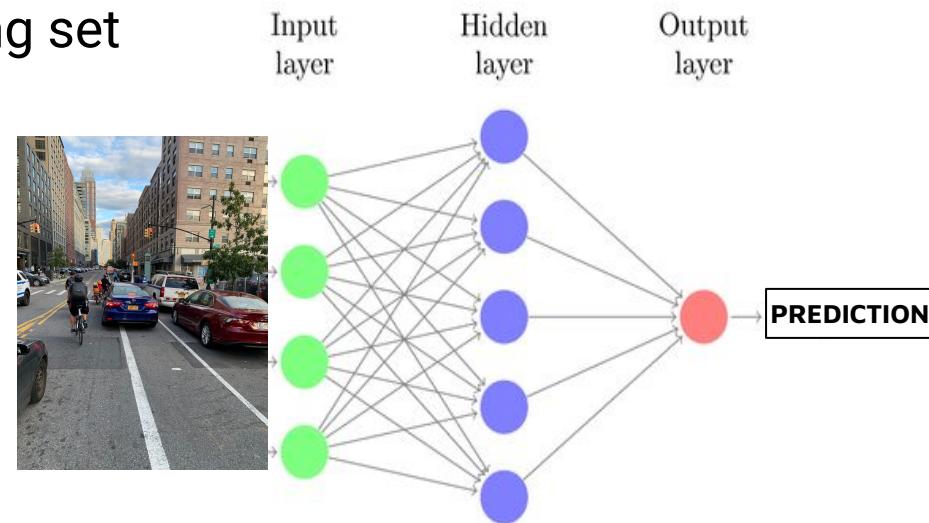


Fully Connected Dense Neural Network

- Single layer
- Evaluated on smaller initial training set

Validation accuracy: 70.63%

Validation precision: 65.3%



Improvements



Convolutional Neural Network

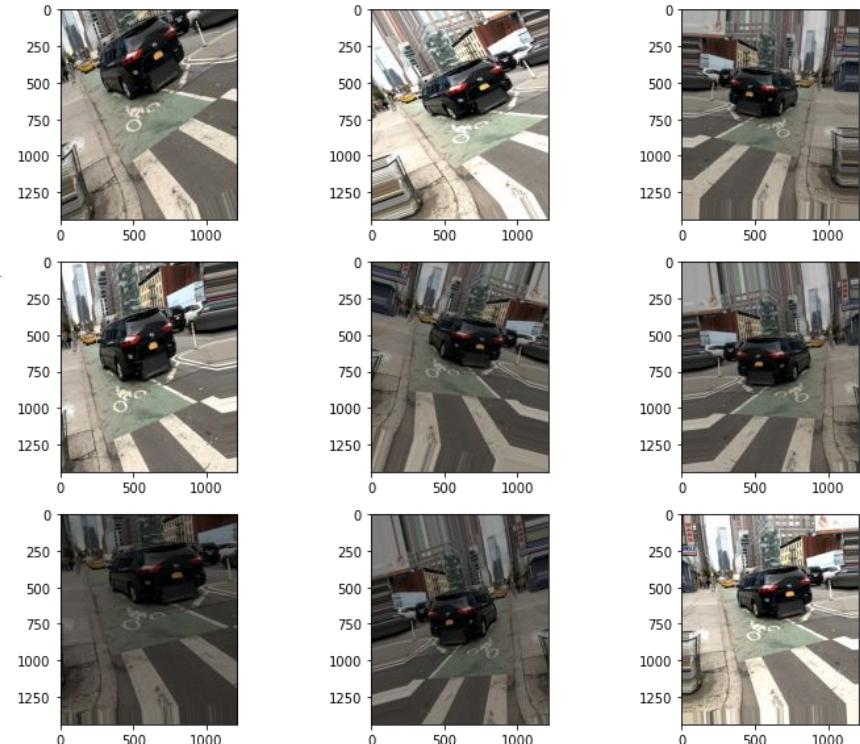
- Multiple layers
- Regularization to avoid overfitting
- Image augmentation



Validation accuracy: 94.07%

Validation precision: 96.88%

Misclassified only 11/135 images

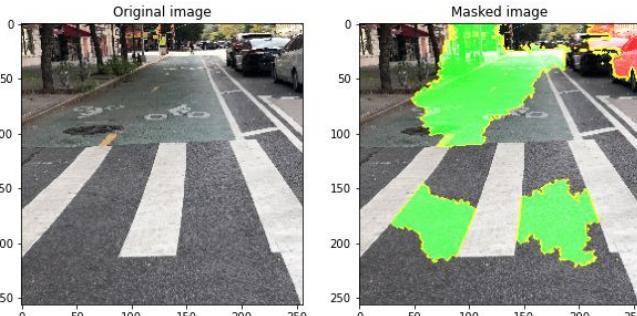
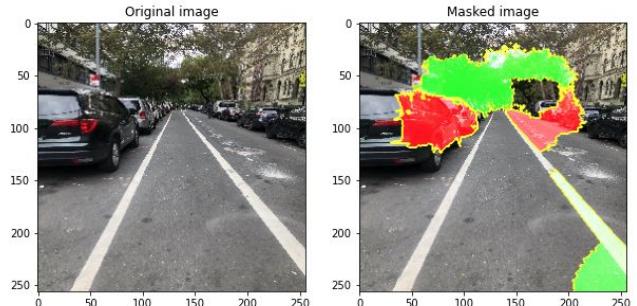


Evaluation: What is the model doing?



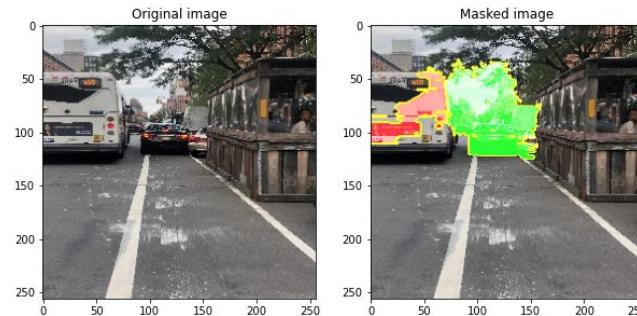
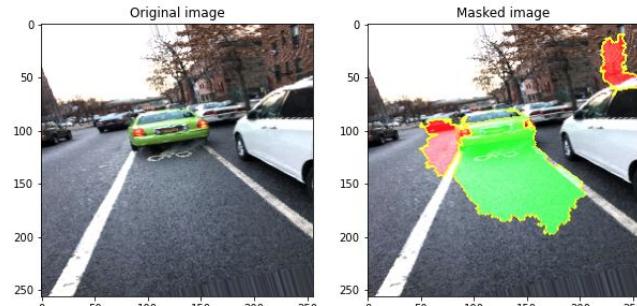
Empty bike lanes:

- Lane lines
- Convergence at horizon line



Bike lanes blocked by vehicles:

- Vehicle located within lane lines
- “Close-up” and at a distance



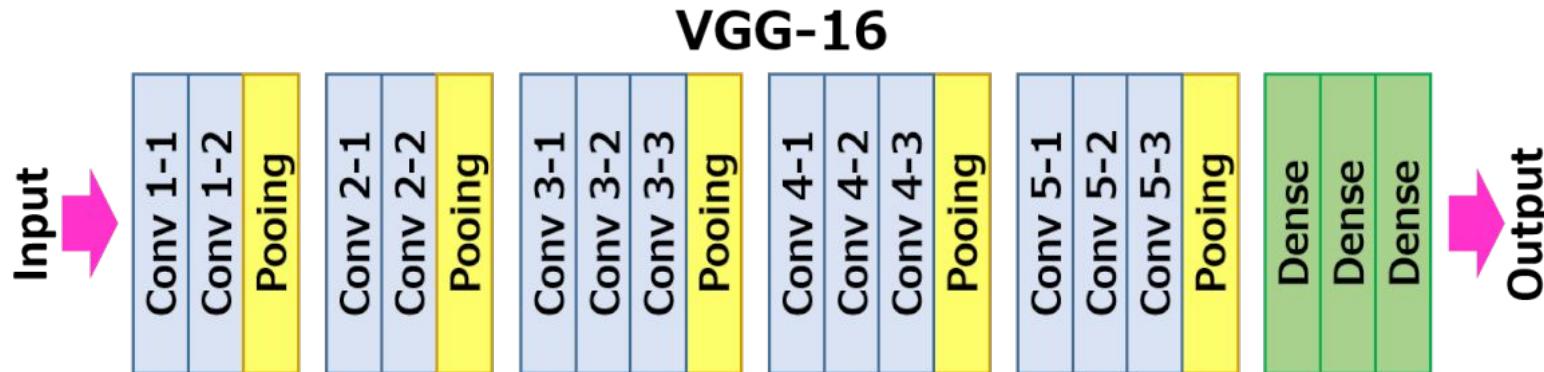
<https://github.com/marcotcr/lime>

Final Model: Architecture



Transfer learning from pre-trained model

- VGG-16 base model
- Dense layers added on top
- Image augmentation as before



Final Model: Evaluation

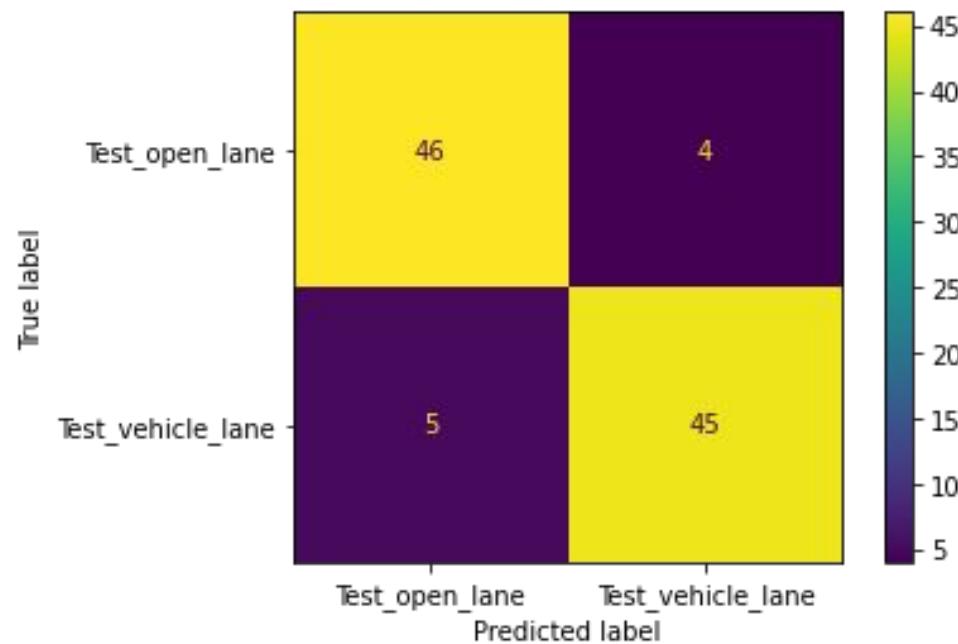


Validation accuracy: 94%

Validation precision: 100%

Testing accuracy: 91%

Testing precision: 92%



Recommendations



Automated enforcement will make streets safer for cyclists

- Increase efficiency and consistency of ticketing
- Reduce the need for traffic police to engage
- Location data from Reported NYC app submissions to ID problematic areas
- Stationary cameras pointing down bike lanes



Next Steps



- More data, additional classes (bike, motorbike, types of vehicles)
- Move to *detection*
 - Identify and locate vehicle in the image/video
- Incorporate Automatic License Plate Recognition for ticketing (APLR)
 - Connect to existing enforcement systems
- Add nighttime photos
- Connect to Reported app

Thank you!



Jesse Markowitz

EMAIL:
jess.markowitz@gmail.com

GITHUB:
[@jmarkowi](https://github.com/jmarkowi)

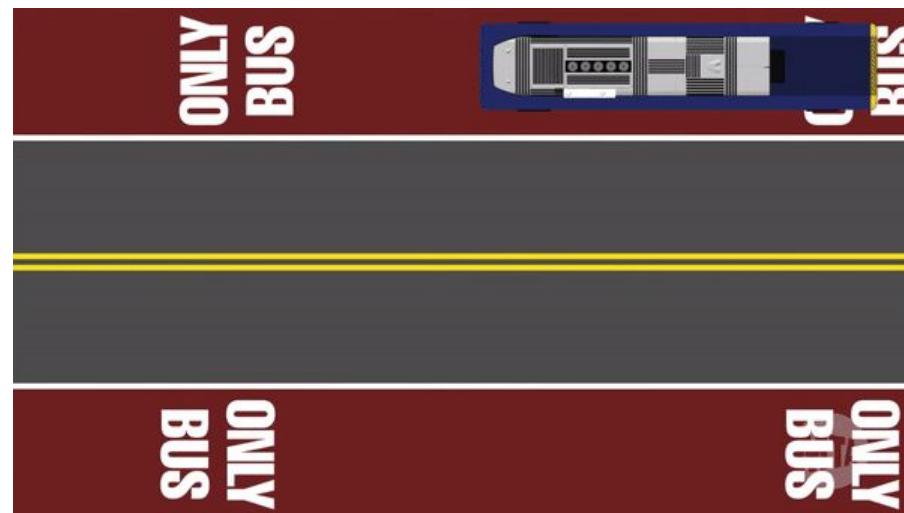
LINKEDIN:
www.linkedin.com/in/jmarkowi

Appendix: ABLE



“Automated Bus Lane Enforcement” (ABLE) system:

- Implemented by Siemens Mobility starting in 2010
- Expanded to several routes
- Cameras on buses automatically capture violators
- Increase in routes' speed and ridership



Appendix: ABLE



“Automated Bus Lane Enforcement” (ABLE) system:

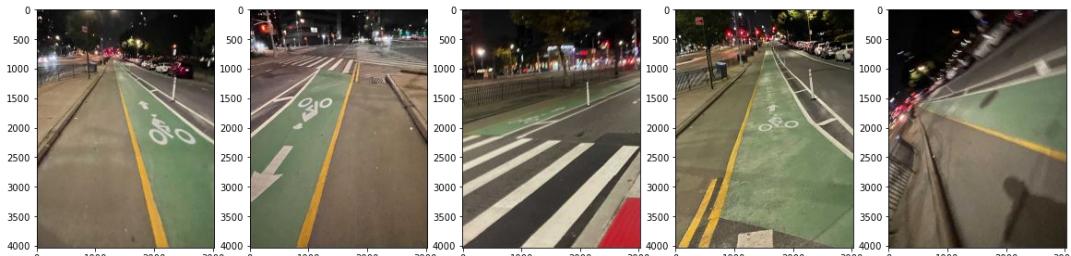


Appendix: Bike Lanes at Night



Final model was also tested on an imbalanced dataset of nighttime images:

Open Bike Lanes: Night

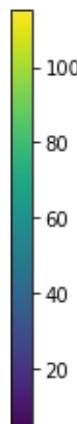
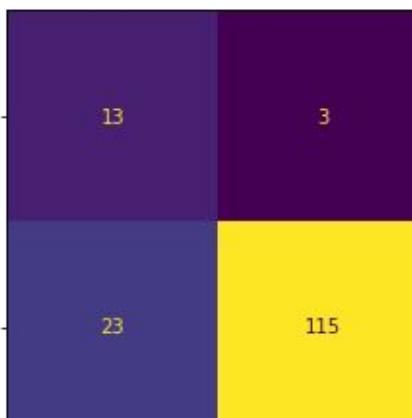


Blocked Bike Lanes: Night



True label

Night_open_lane



Night_open_lane Night_vehicle_lane
Predicted label