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- The Impact of New Bike Lanes on Urban Transportation Dynami

Introduction

Urban Transportation Challenges:

Traffic congestion

Environmental sustainability

Public safety concerns

Objective: To assess how new bike lanes affect:

Bike usage

Car dependency

Pedestrian safety

Study Areas: New York City (NYC) and San Francisco (SF)

Research Significance

Quality of Life: Current citywide congestion can be unbearable

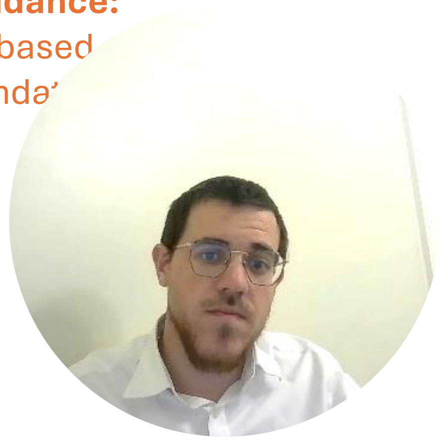
Sustainability: Bike lanes reduce reliance on motor vehicles.

Safety: Fewer accidents and enhanced pedestrian confidence.

Economic Gains: Alleviating congestion can boost productivity (Hartgen and Fields, 2009).

Health Benefits: Increasingly sedentary lifestyles would benefit from increased cycling

Policy Guidance: Evidence-based recommenda planners.



Prior Research

Impact of Bike Lanes on Cycling Rates	Kraus & Koch (2021): Temporary bike lanes led to cycling increases of 11–48% during COVID-19. Buck & Buehler (2011): Bike lanes near bike-share stations increase bike-sharing utilization.
Economic Impacts of Bike Lanes	Arancibia et al. (2019): Replacing parking with bike lanes increased customer spending and foot traffic in Toronto.
Congestion & Productivity	Hartgen & Fields (2009): Mitigating congestion boosts productivity by up to 1%. Prud'homme & Lee (1999): Shorter commutes correlate with economic growth.
Safety Benefits	Buehler & Dill (2015): Dedicated bike lanes reduce pedestrian injuries by improving traffic organization.
Research Gap	Limited studies on bike lane effects on pedestrian and cyclist accidents across cities. Limited studies focusing on multiple cities and on finding quantifiable frameworks for untested cities.

Methodology

Data Sources:

- Bike-sharing data: Citi Bike (NYC), Bay Wheels (SF)
- Traffic volume and accident data from public datasets
- Bike lane network from city open portals
- Demographic data from U.S. Census
- NYC data ranged from 6/2013 until 6/2024
- SF data ranged from 6/2017 until 5/2023

Key Data Variables:

- Bike count usage
- Bike lane network
- Motor vehicle usage
- Pedestrian accident and deaths

Feature Engineered Variables:

- Cumulative bike lanes
- Bike usage trend (seasonality extracted)
- Bike trend to car usage ratio

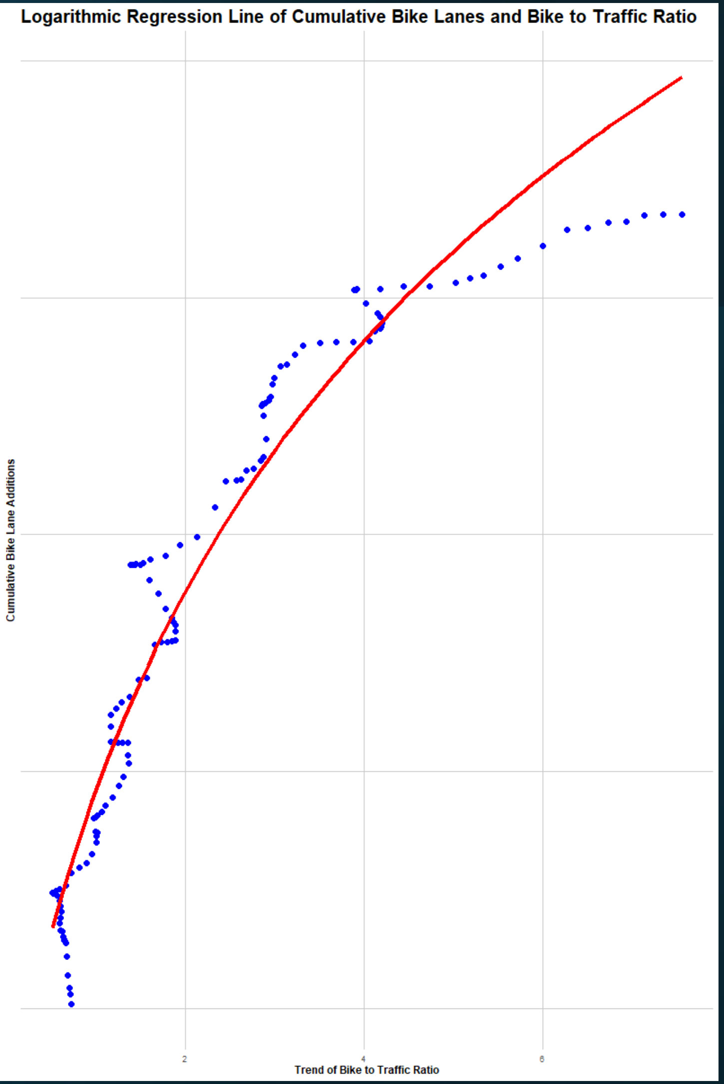
Methodology

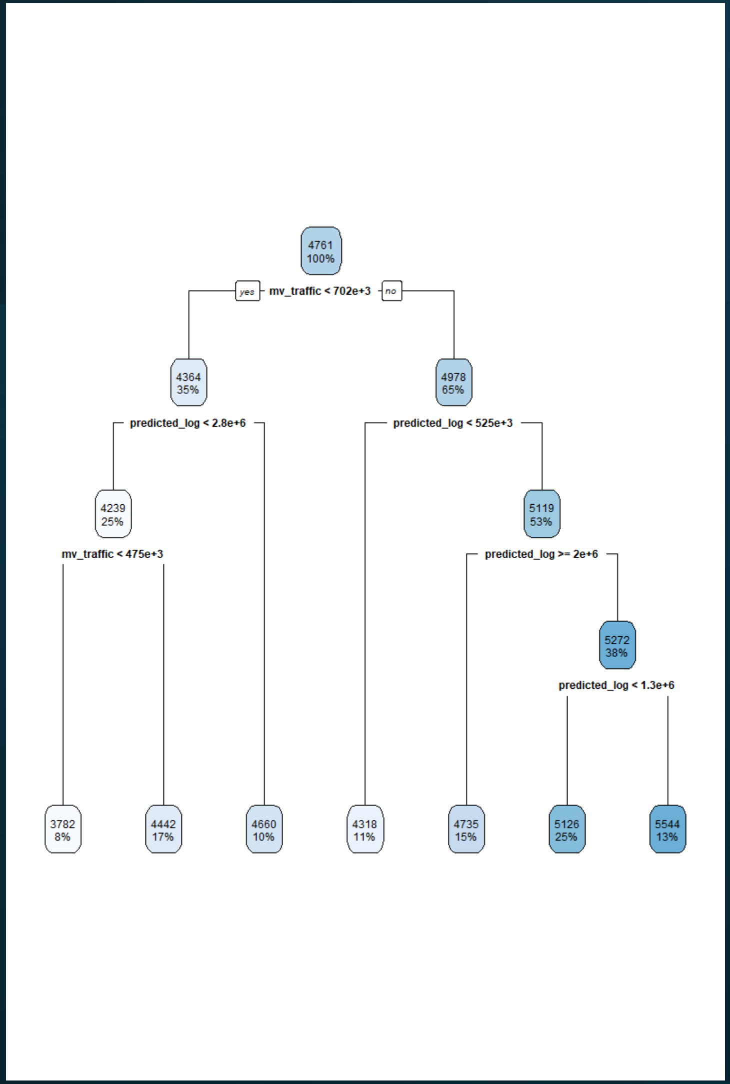
Modelling Techniques:

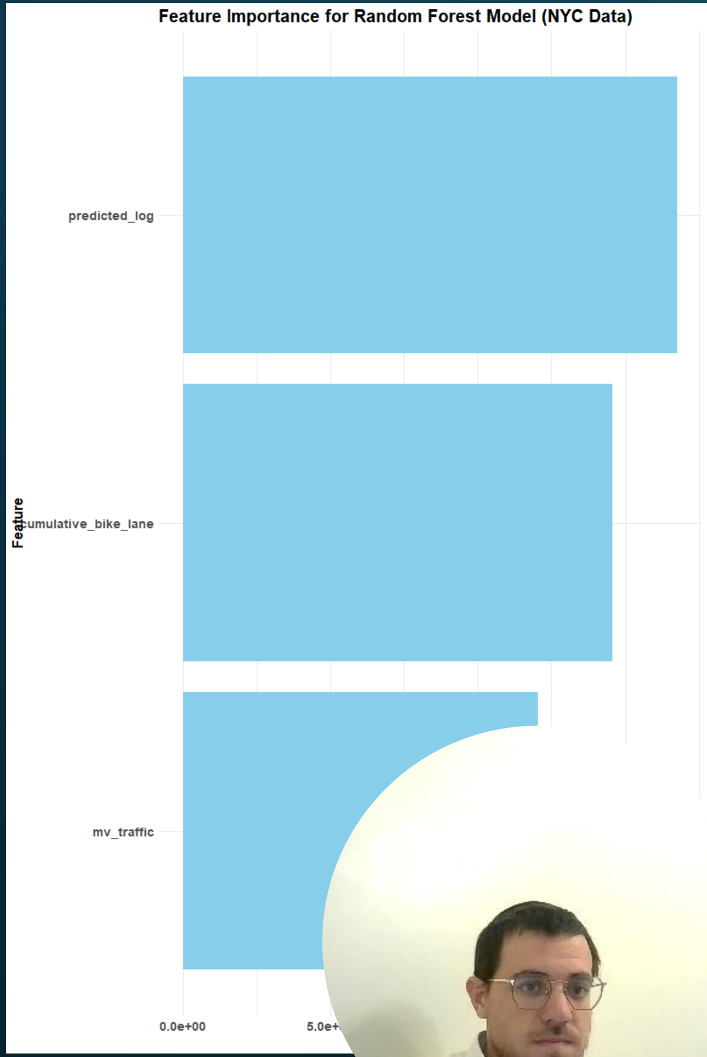
- **Logarithmic Regression:** Captures the logarithmic relationship between bike lane additions and bike-to-traffic ratios.
- **Decision Trees**: Identifies nonlinear interactions and thresholds, highlighting areas where bike lanes have the greatest impact.
- **Random Forest:** Aggregates decision trees for robust predictions, focusing on key variables like bike lane length and traffic volume.
- **XGBoost:** Utilizes advanced ensemble learning to uncover subtle patterns, offering high accuracy in predicting safety outcomes.
- **Support Vector Machines:** Explored but ultimately excluded due to suboptimal performance for this dataset

Seasonal adjustments to account for variati
bike usage

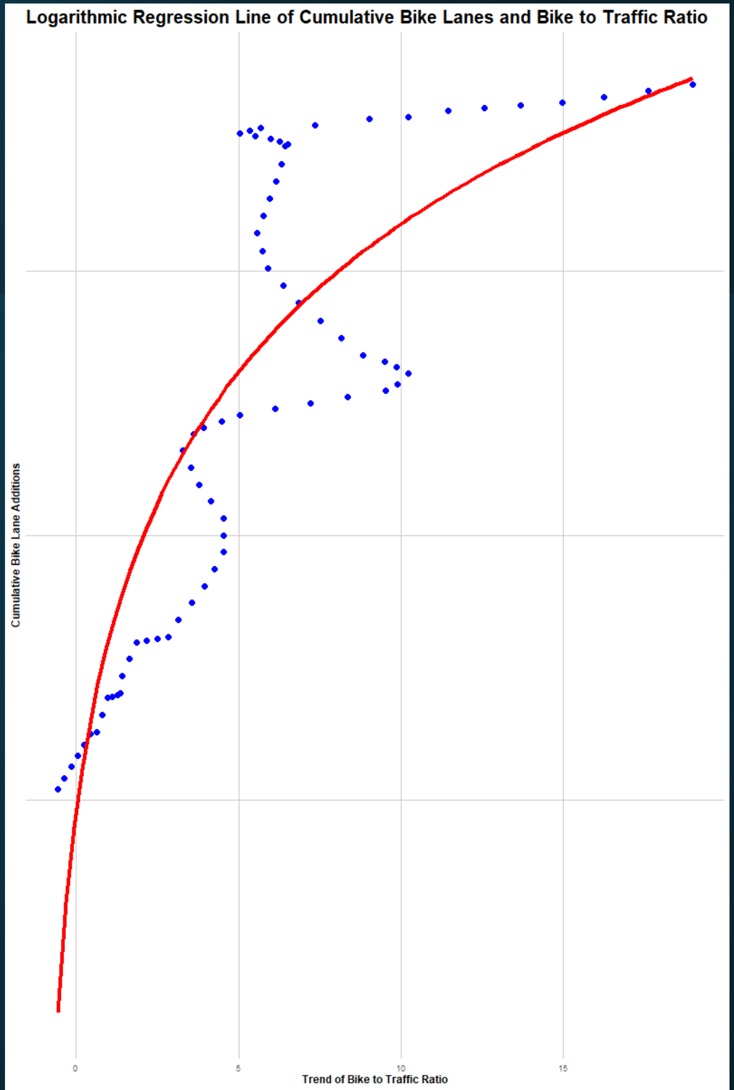
NYC Model Visuals

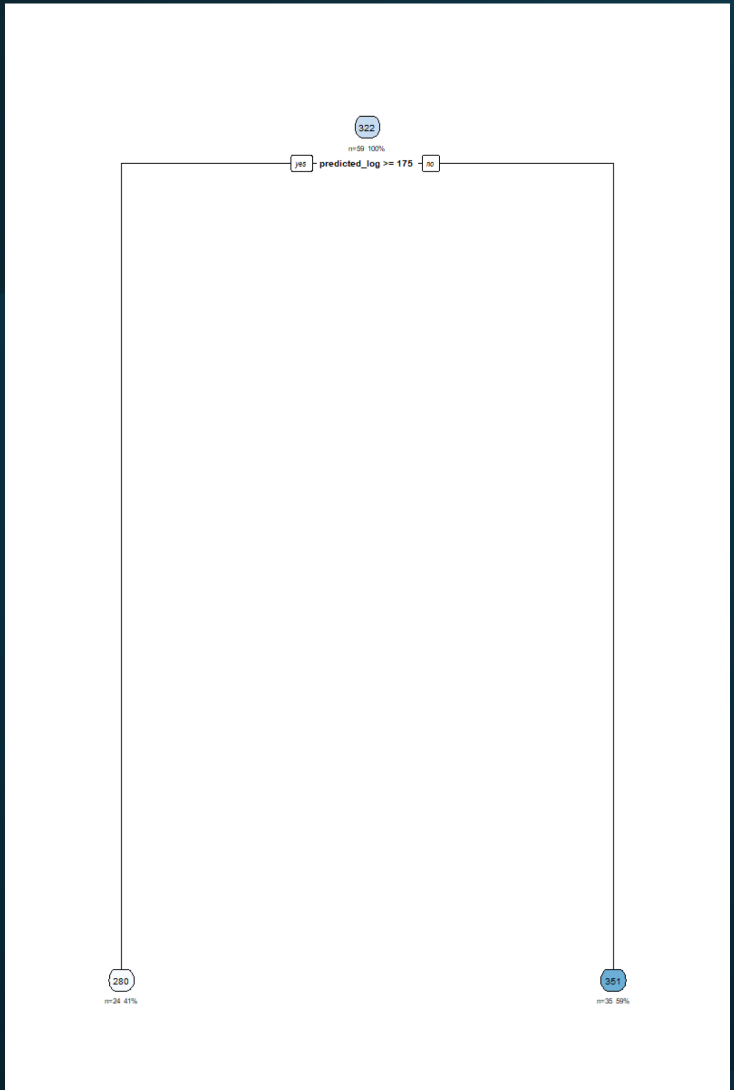


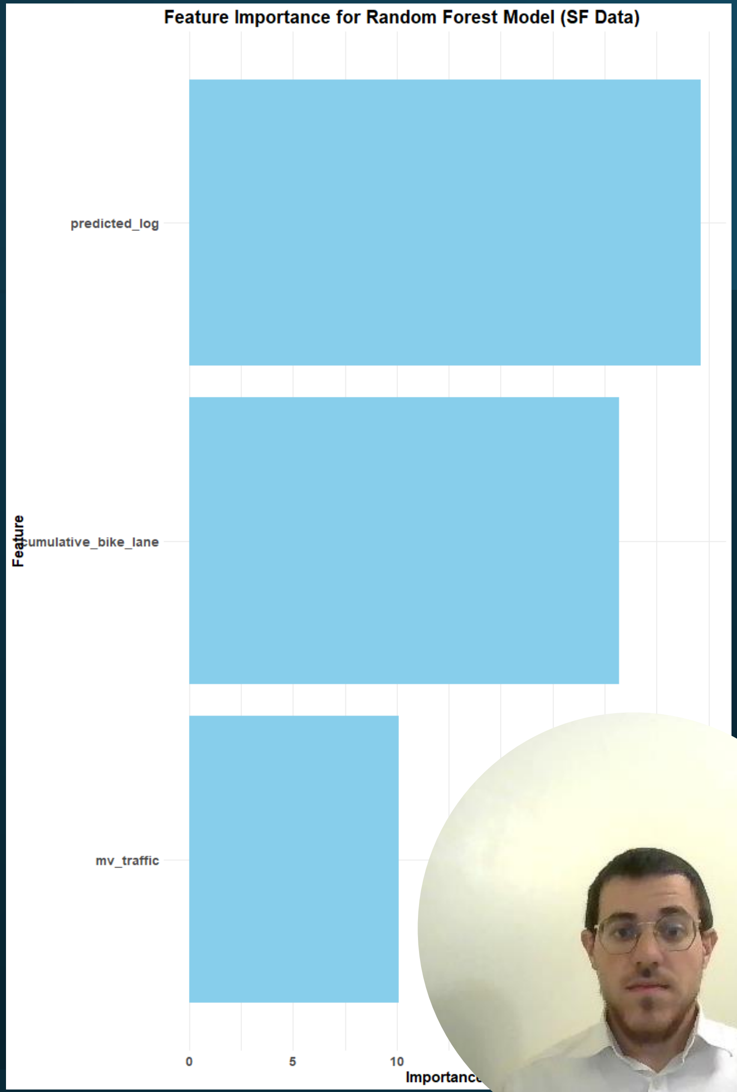




San Francisco Model Visuals







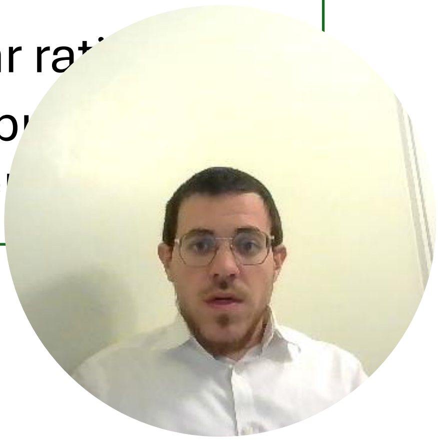
Key Findings - Relationships

Bike-to-Car Usage Ratio:

- Positive correlation with cumulative bike lane mileage.
- Relationship follows a logarithmic trend, indicating diminishing returns over time.

Traffic Volume and Accidents:

- Higher traffic volume correlates with increased accidents.
- Lower traffic areas see greater safety improvements with increased bike-to-car rat
- In lower traffic volume areas and times, b
more bike lanes should decrease accide



NYC vs. SF

Common Finding: Bike lane expansion drives increased safety and bike usage in both cities.

NYC:

- High traffic volume (≥700,000 vehicles/month) diminishes the effectiveness of bike lanes.
- Motor vehicle traffic is the dominant predictor of accidents.
- At lower traffic volumes, bike-to-car ratio is a significant predictor

SF:

- Smaller datasets show bike-to-car ratio as the key
- Bike lanes show stronger impacts in areas with l
dependency.

Models and Insights

Logarithmic Regression:

- Identifies a simple and accurate relationship between additional bike lanes and bike-to-car ratios
- Allows for easy forecasting for bike count and bike-to-car ratio for use in city planning and in other models.

Decision Trees:

- Identifies actionable thresholds (e.g., traffic volume <700,000 vehicles/month).
- Simple and interpretable for policymakers.

Random Forest:

- Balances model complexity with generalizability.
- Variable importance: Bike-to-car ratio, traffic volume, and cumulative bike lanes.

XGBoost:

- Best performance in NYC dataset (RMSE = 0.70).
- Captures nuanced interactions but requires more data fo

Policy Recommendations

Prioritize Bike Lane Additions:

- Focus on areas with traffic volumes <700,000 vehicles/month.

Supplementary Measures:

- High-traffic areas need additional interventions:
  - Protected bike lanes
  - Traffic calming measures

Data-Driven Thresholds:

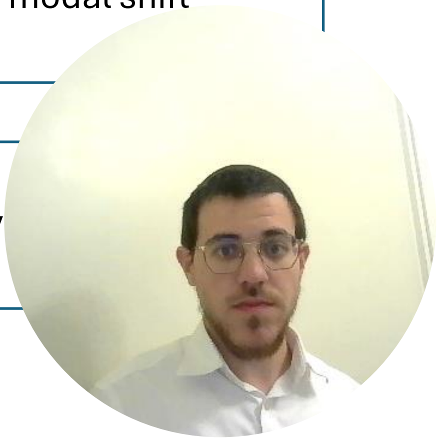
- Identify and address city-specific thresholds for maximizing bike lane effectiveness.

General Guidelines:

- Invest in cumulative bike lane infrastructure to encourage a modal shift toward cycling.

Use the General Framework for Additional Cities:

- While unseen cities might have varying thresholds, the prov framework can be utilized to find them.



Limitations

- **Data Constraints:**
  - Limited temporal scope (data covers only a decade).
  - Smaller dataset for SF limits generalizability.
- **Geographic Focus:**
  - Findings from NYC and SF may not directly apply to cities with different dynamics.
- **Data Consistency:**
  - Variability in data sources introduces potential biases.
- **Omitted Variables:**
  - Factors like weather, road quality, and enforcement of traffic laws not included.

Conclusion

- **Key Takeaways:**
  - Bike lane expansion correlates with increased bike usage and improved safety.
  - Impact varies across cities due to traffic volume, population density, and infrastructure.
- **Scalable Framework:**
  - Analytical tools and models can be adapted for other cities.
- **Actionable Insights:**
  - Invest strategically in bike lane infrastructure to promote sustainable and safer urban environments, particularly in areas with fewer than 700,000 motor vehicles per month.

Referenced Papers

- Hartgen and Fields (2009): Congestion's impact on economic productivity.
- Kraus and Koch (2021): Temporary bike lanes and lasting shifts in bike usage.
- Arancibia et al. (2019): Economic benefits of bike lane infrastructure.
- Github Repository with Code(link: https://github.com/Shayaeng/Data698).