DRIVING EFFICIENCY

FOR BOSTON'S PARKING ENFORCEMENT

City of Boston

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Problem Statement

Boston currently relies on static patrol routes, which have not been updated in recent history, and individual officer discretion to guide parking enforcement. There is no formal strategy to ensure patrol coverage is equitable, efficient, or data-driven.

- Some neighborhoods may receive more frequent patrols, while others may be underrepresented
- Potential violations in less-patrolled areas may go unnoticed
- There are opportunities to improve the equity and efficiency of enforcement city-wide

Objective

Use data to guide strategic enforcement across Boston

Data

- Historical Violations
- Officer GPS Pings
- 311 Reports
- Street Segments

Methodology

Adjusted Violation Score

Estimates true violation activity by adjusting for patrol patterns and highlights where enforcement can have the greatest impact.

$$\text{Score}_i = \frac{\text{Weighted Violations}_i}{\text{Officer Presence}_i + \varepsilon} + 0.2\,\frac{\text{311 Complaints}_i}{\text{Total Days}}$$

Where:

Weighted Violations = total violations on segment *i*, weighted by severity based on enforcement priorities

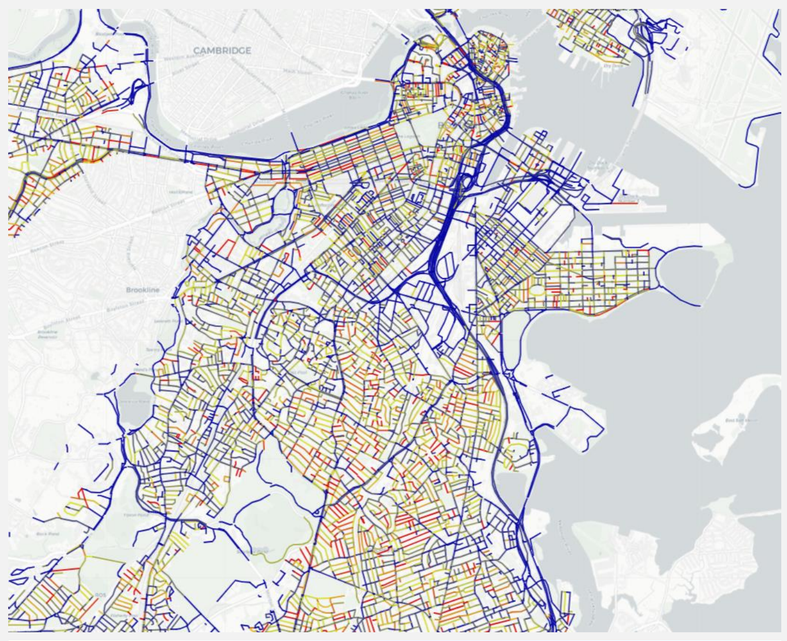
Officer Presence = total number of patrols on segment *i*

311 Complaints = total complaints on segment

Observed Days = number of days in data set

Provides a decensored estimate of how many violations an officer might expect to find when patrolling a street, accounting for historical enforcement, community-reported activity, and safety priorities

Scoring Map



Low Score — High Score

Score Validation & Experiment

Test whether directing officers to high-scoring street segments increases enforcement outcomes, compared to usual patrol patterns

Method: Difference-In-Differences

Treatment: Officers assigned to high-scoring segments

Sample Route: Dorchester

Findings:

- Officer Efficiency: treatment officers issued +3.2 more citations per hour, a 25% increase over the control group baseline
- Findings were directionally aligned with expectations, but not statistically significant due to limited sample size

Monte Carlo Simulation Architecture

100 Randomly Simulated Days → Select Route List and Desired Dispatcher Strategy → Simulate the Patrols with Time Constrained Allocation → Analyze Results

Dispatcher Strategies

Greedy Efficiency	Focus solely on high-scoring segments
Balanced Scores	40% focus on high-scoring segments, 60% on coverage
Greedy Violations	Focus solely on historical high-violation segments
Balanced Violations	40% focus on high-violation segments, 60% on coverage
Coverage First	Focus solely on coverage during patrol

Key Features

Common Random Numbers
Eliminates comparison bias

Partial Route Modeling
Realistic time constraints

Efficiency vs. Equity
Policy-relevant comparison

Patrol Effectiveness Modeling
Realistic capture of diminishing returns on a segment

Poisson Distribution
Officer attendance (Target 70)

Simulation Benefits

Simulates patrol outcomes under uncertainty to quantitively compare strategies.

Traditional Route Planning:

- ✗ Static, outdated routes
- ✗ Inconsistent performance
- ✗ Subjective decisions

Simulation Approach:

- ✓ Data-driven optimization
- ✓ Quantified performance
- ✓ Evidence-based decisions

Business Impact & Value

Expected Results

- +150% Adjusted Violation Scores Found Per Day
- +8.8 Violation Scores Per Hour
- +63% More City Coverage
- Larger Focus on Safety

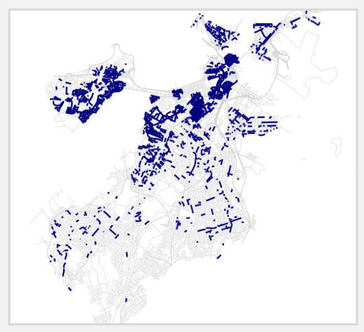
Recommendations

1. Shift Dispatcher Decision-Strategy From Balanced Violations to Balanced Scores
2. 20 Static Routes → 78 Flexible Routes

Baseline Proxy
20 Routes Dispatched Using Balanced Violations

Performance
2,354 scores per day
5.9 scores per hour
13.6% city coverage

→



Recommended Strategy
78 Routes Dispatched Using Balanced Scores

Performance
5,880 scores per day
14.7 scores per hour
22.2% city coverage