"Smart-Enforce: Data-Driven Solutions for Optimizing Urban Parking Enforcement."

CAPESTONE PROJECT

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1) Introduction:

Problem Background:

Urban Content and Challenges in New York City: New York City (NYC) stands as one of the world's most densely populated major cities, with a complex urban landscape that presents unique challenges for transportation management and urban planning. The city's infrastructure must accommodate millions of residents, commuters, and tourists daily, which puts immense pressure on the available road and parking spaces.

Impact of Parking Violations: In NYC, parking violations are not merely a nuisance but a significant issue affecting daily life and urban functionality. These violations can lead to severe traffic congestion, reduced availability of crucial parking spaces, and can even impact emergency services by obstructing roads and access points. Moreover, improperly parked vehicles can impede street cleaning and snow removal, contributing to urban decay and decreased quality of life.

Administrative and Economic Burdens: The enforcement of parking regulations places a substantial administrative burden on local government, including the NYPD and the Department of Transportation. The process of monitoring, ticketing, and processing violations is resource-intensive and costly. Additionally, unresolved parking violations lead to significant financial losses in uncollected fines each year, which could otherwise support public services.

Need for Data-Driven Strategies: With the advent of big data and advanced analytics, there is a compelling opportunity to enhance the efficiency and effectiveness of parking violation management in NYC. Data-driven strategies can identify patterns and trends in parking violations. This approach not only supports more proactive management of parking regulations but also helps in formulating policies that can alleviate the core issues leading to high incidences of violations.

Justification for Startup: Smart-Enforce aims to harness this data-driven approach by offering analytical services and tools to NYC's law enforcement and urban planning bodies. The startup will leverage historical and real-time data to provide insights that can improve decision-making, enhance compliance with parking regulations, and ultimately contribute to a smoother urban flow and reduced administrative costs. The startup's services will not only aid in better enforcement strategies but also in public communication and engagement, helping to inform residents and visitors about parking regulations and reducing unintentional violations.

2) Objective:

Analyse Historical Parking and Camera Violation Data to Identify Trends, Patterns, and Hotspots:

Goal: Utilize comprehensive dataset of historical parking and camera violations to uncover underlying trends, recurring patterns, and geographical hotspots of infractions.

Methodology:

- **Temporal Analysis:** Examine data over various timeframes to identify peak periods for violations, understanding hoe these correlates with events, seasonal changes, or policy shifts.
- **Pattern Recognition:** Deploy machine learning algorithms to detect less obvious patterns in the data, such as the likelihood of violations based on combinations of factors like time-of-day, Vehicle type, and specific enforcement policies.

Impact:

- This objective aims to transform raw data into a clear narrative that informs strategic decisions, helping NYC's transportation and law enforcement agencies understand where and when resources should be focused to maximize compliance and minimize disruptions.

Provide Actionable Insights to Law Enforcement Agencies for Targeted Enforcement and Resource Allocation:

Goal: Translate analytical findings into practical strategies and recommendations that law enforcement can use to optimize enforcement efforts and resource distribution.

Methodology:

- Data-Driven deployment: based on identified hotspots and peak times, recommend optimal deployment schedules for traffic wardens and patrol units.
- Resource Optimization: Suggest allocation of technology resources, such as mobile surveillance units and automated ticketing systems, in areas where there would have the most significant impact.

Impact:

- By providing targeted insights based on robust data analysis, this objective supports more efficient use of personnel and technology, potentially reducing the frequency of violations and enhancing overall traffic management.

3) Data Extraction:

Overview of Data Source: The data for this project was sourced from the NYC Open Data portal, which offers a diverse array of datasets produced by various agencies and organizations within New York City. The dataset specifically utilized in this analysis contains detailed records of parking and camera violations and is publicly accessible through the portal. This comprehensive dataset is crucial for understanding patterns of non-compliance and aiding in the development of targeted strategies for improving parking regulation enforcement. The dataset can be accessed at the following URL: Open Parking and Camera Violations Dataset.

API Data Access: Programmatic access to the dataset was achieved via an API endpoint provided by the NYC Open Data portal. This method ensures real-time access to the most up-to-date and complete records available, utilizing a robust and structured approach to efficiently retrieve large volumes of data.

Authentication and Authorization: Accessing the data through the API required authentication, which was managed by obtaining an API token. This token was secured by registering on the NYC Open Data portal and requesting access to this specific dataset. The use of an API token helps regulate access, preventing unauthorized data retrieval and ensuring that all data requests are properly tracked and managed in accordance with the portal's usage policies.

Data Extraction Process: The extraction involved the use of Python and the request library to make HTTP requests to the API endpoint. The data, typically received in JSON format, includes a range of data points such as dates, times, violation types, fines, and geographical coordinates, among others.

Data Conversation and Cleaning: After fetching the data, it was processed and converted from JSON to a structured comma-separated values (CSV) file using Python's panda's library. The initial cleaning steps involved removing incomplete records, correcting any inconsistencies, and standardizing the formats of date and time entries.

Data Storage and Reuse: Upon extraction and initial processing, the cleaned data was stored in a CSV file to ensure it was readily accessible for future analysis without the need to re-run the extraction process. This practice enhances the efficiency of the project by reducing the need for repeated data retrieval operations.

Conclusion: This methodical approach to data extraction and preparation not only provides a reliable and repeatable framework for data access but also ensures the integrity and confidentiality of the data through secure authentication practices. The resultant dataset is comprehensive and well-suited for the analytical objectives of this project, providing a solid foundation for exploring key insights and developing effective parking violate on enforcement strategies.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	plate	state	license_typ	summons_	issue_date	violation_ti	violation	fine_amou	penalty_an	interest_ar	reduction_	payment_a	amount_d	precinct	county	issuing_ag	summons_	violation_status	
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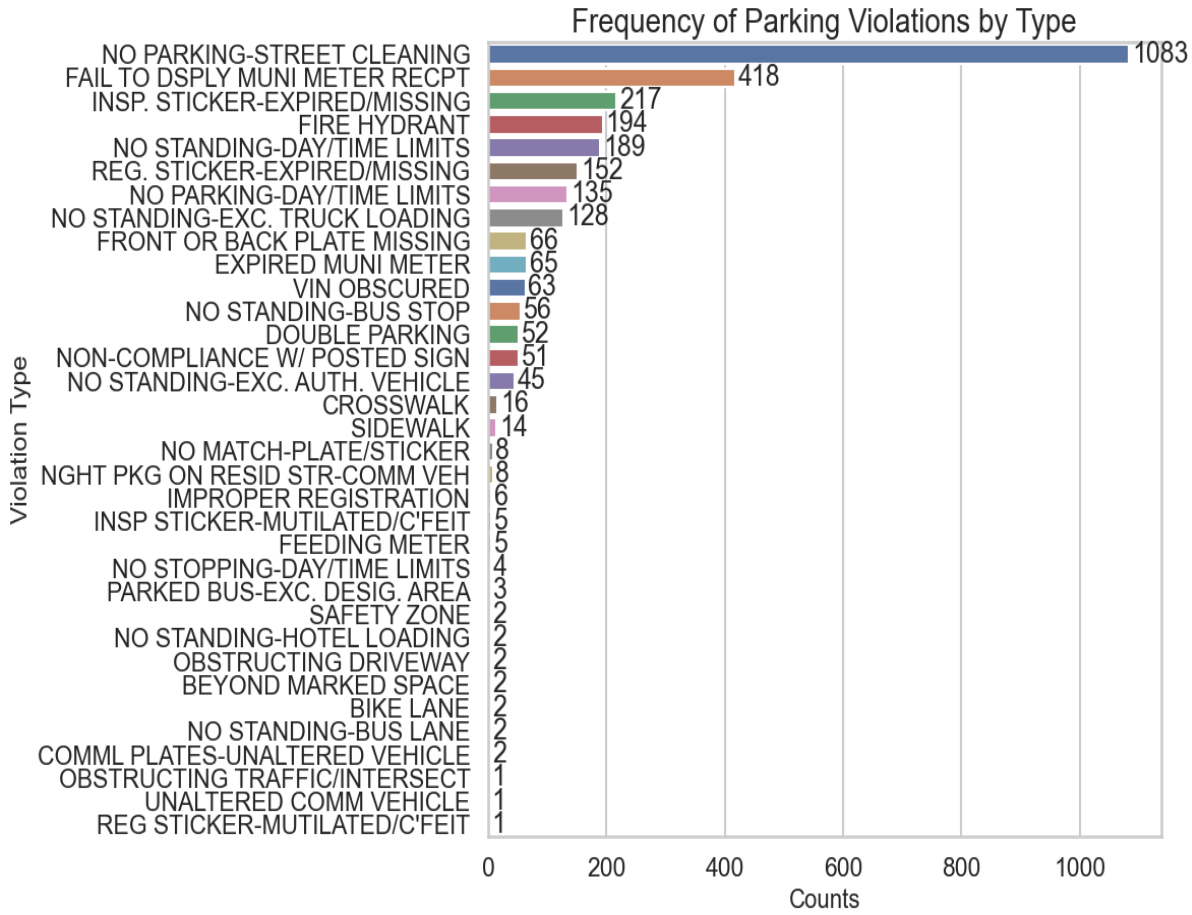
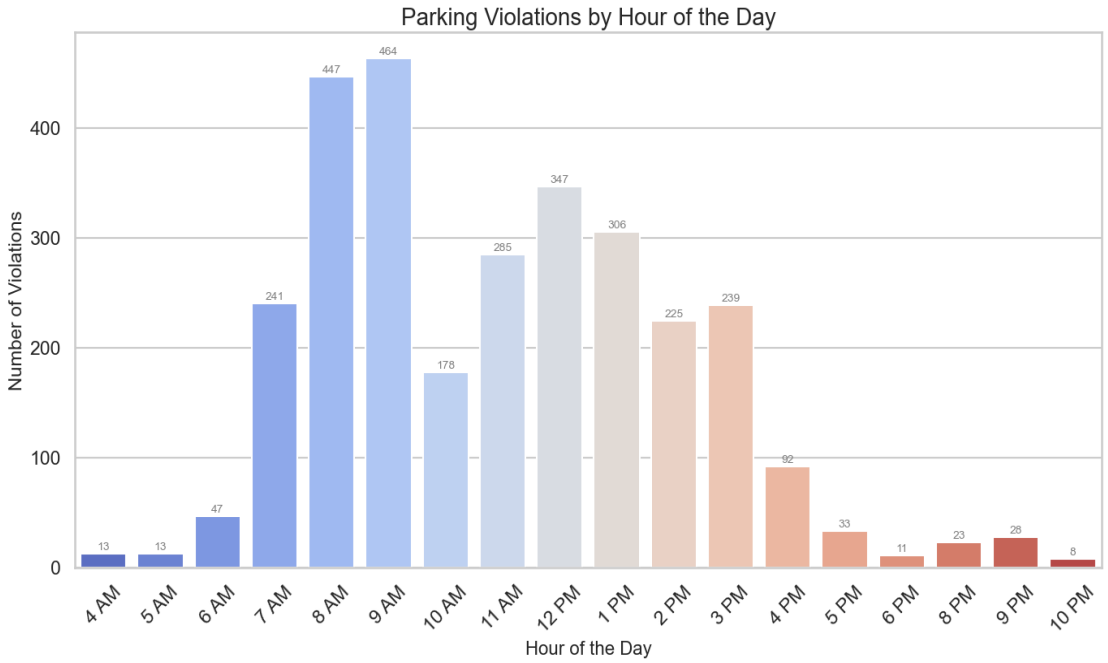
4) Data Exploration:

Analysis of Violation Types and Their frequencies:

This bar graph illustrates a ranking of parking violations, with "NO PARKING-STREET CLEANING" being the most frequent at 1,083 occurrences, and infractions like "REG STICKER-MUTILATED/C'FEIT" and "UNALTERED COMM VEHICLE" being the least common, each recorded only once. To address this, the NYPD could concentrate efforts on the most frequent violations by increasing patrols and signage clarity during street cleaning hours and educating the public about the importance of compliance with parking regulations, particularly in high-violation areas.



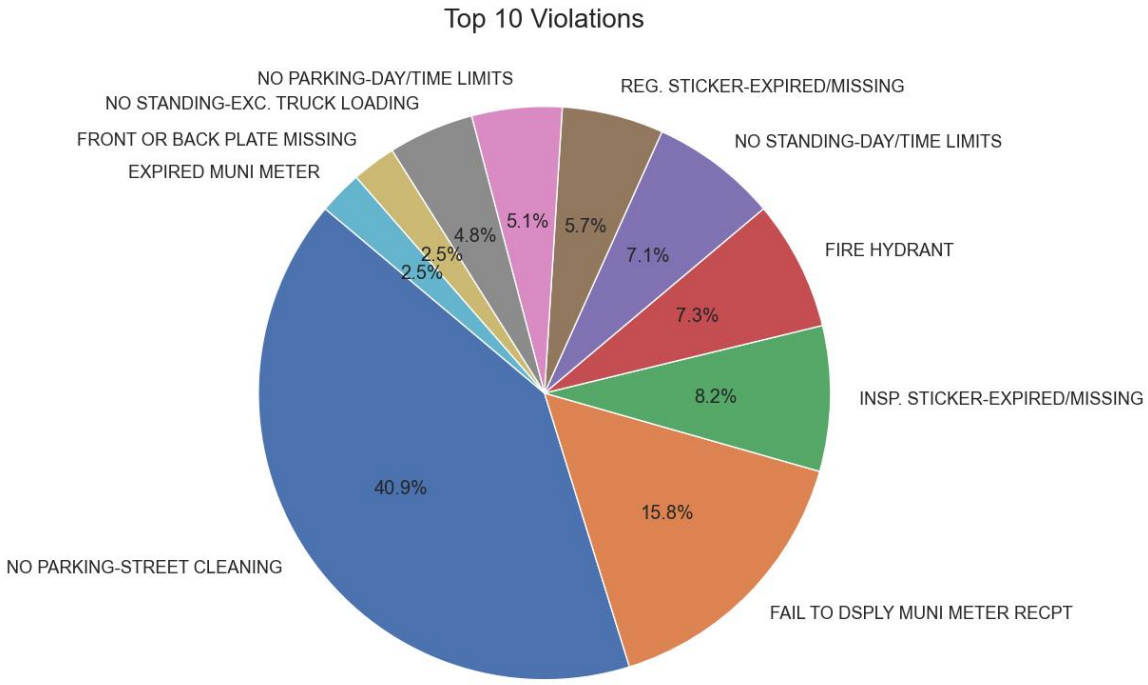


This bar chart shows the number of parking violations in New York City by hour of the day, with a clear peak in violations occurring during the morning hours, specifically between 8 AM and 9 AM. The hours between 10 AM and 3 PM also show high violation numbers, while the frequency drops significantly in the evening after 6 PM. To reduce these violations, the NYPD could allocate more parking enforcement officers during the morning and early afternoon hours, apply stricter penalties during peak violation times, and initiate awareness campaigns about the consequences of parking illegally at these times.

Daily Parking Violations:

Top 10 Violations:

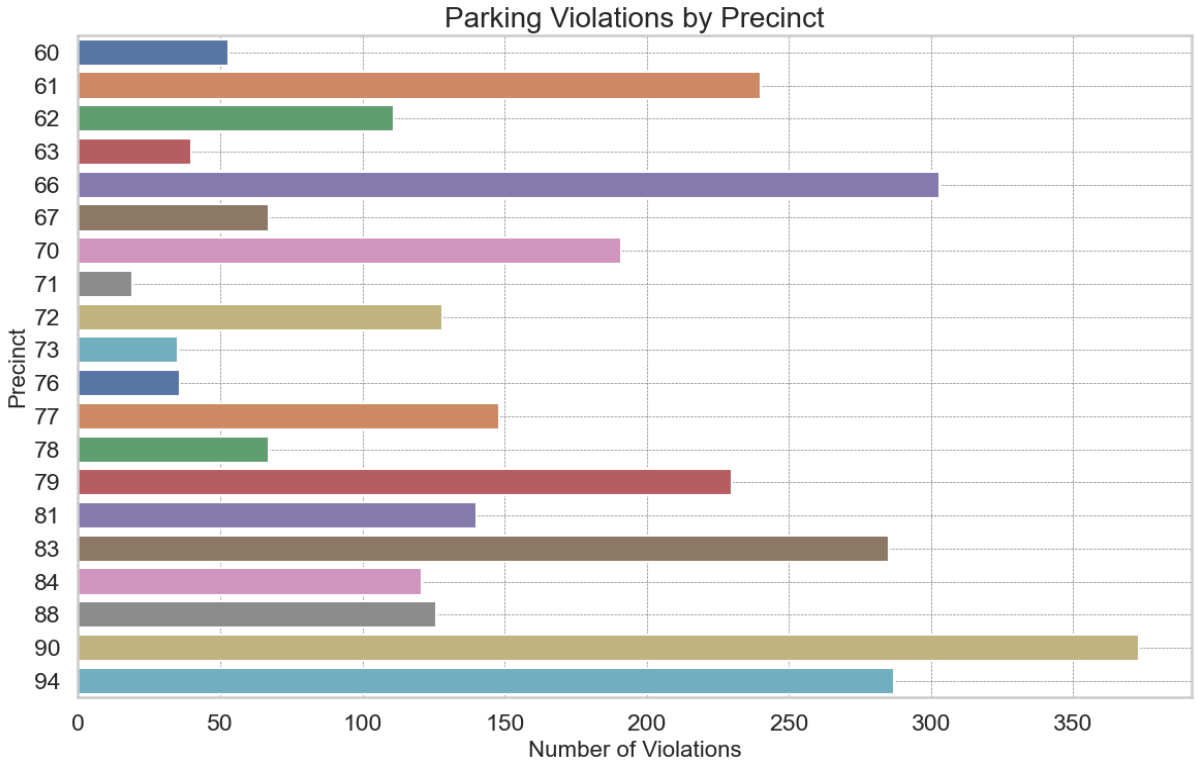
This pie chart below represents the top 10 parking violations, showing that "NO PARKING-STREET CLEANING" accounts for the largest portion at 40.9%, followed by "FAIL TO DSPLY MUNI METER RECPT" at 15.8%, and "REG. STICKER-EXPIRED/MISSING" at 8.2%. The chart indicates that a small number of violation types constitute most offenses, suggesting that efforts to enhance compliance should be focused on these areas. Strategies may include educational outreach on street cleaning schedules, installing more visible signage for metered parking, and reminders for vehicle registration and inspection sticker renewals.



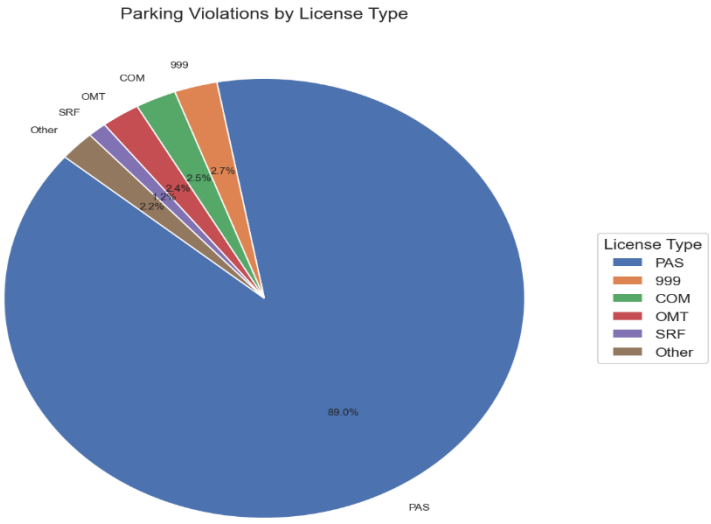
Geographic Analysis: Aggregated Violations by Precinct

The bar chart displays the distribution of parking violations across different NYPD precincts, revealing significant variability in the number of violations per precinct, with some precincts such as 66 and 94 encountering notably higher incidences. This suggests targeted enforcement and resource allocation could be beneficial; the NYPD

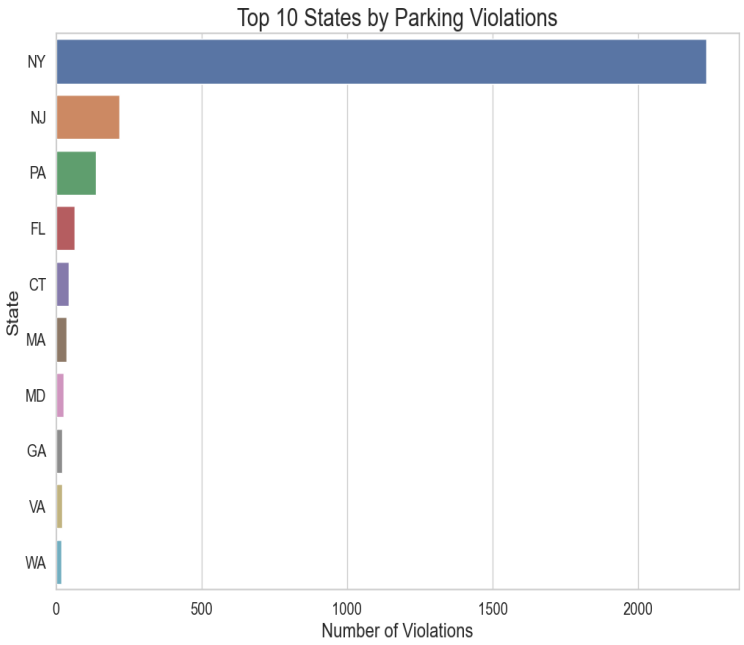
might consider deploying additional patrols or surveillance technology in precincts with higher violation frequencies to deter and manage parking violations more efficiently.



Parking Violations by License Type: This pie chart illustrates that most parking violations are associated with passenger vehicles (PAS), which account for 89% of all tickets. Given this information, a strategic approach for the NYC Police Department could include initiatives specifically aimed at passenger vehicle drivers, such as educational campaigns about parking regulations and the increased visibility of enforcement measures in high-traffic areas to reduce violations.



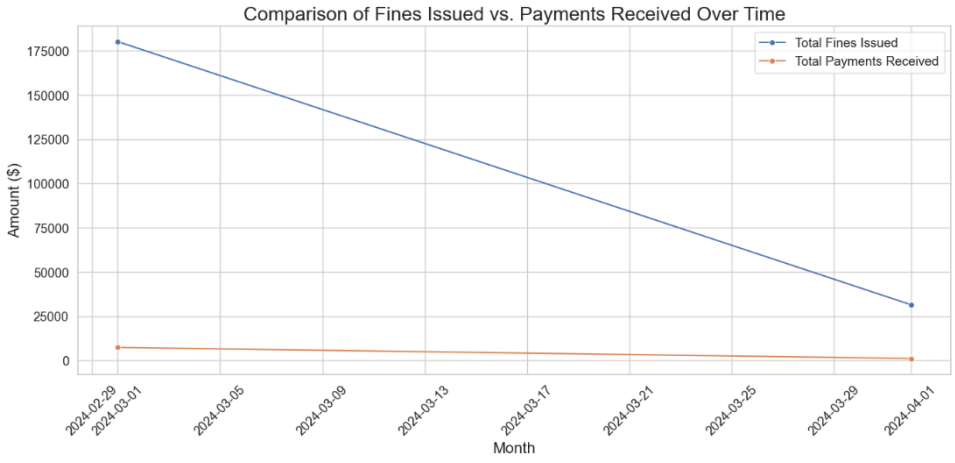
State-Origin-Analysis:



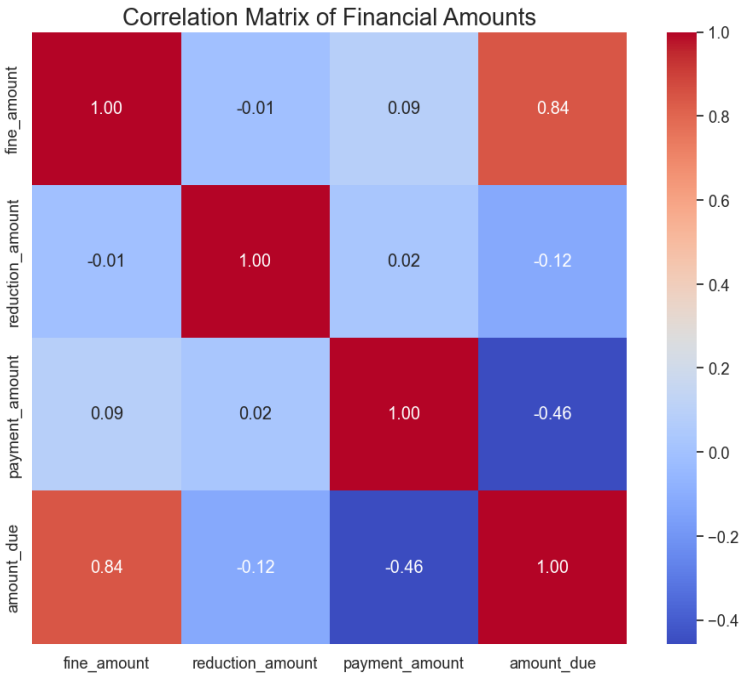
The bar graph indicates New York (NY) leads in parking violations by a significant margin compared to other states, with New Jersey (NJ) and Pennsylvania (PA) following as the second and third most common states for violations. For the NYC Police Department, focusing enforcement efforts and policy measures to address out-of-state vehicles, particularly those from nearby states, could mitigate the number of parking infractions, as these vehicles contribute substantially to the total number of violations.

Payment Analysis:

The line chart depicts a marked discrepancy between the total amount of fines issued and the total payments received over time, indicating a significant gap in fine collection. To address this shortfall, the NYC Police Department could benefit from improving fine collection mechanisms, potentially through more effective follow-up procedures or the implementation of additional payment options to facilitate easier compliance.



Correlation Analysis:



The correlation heatmap reveals a strong positive correlation between fine amounts issued and the total amount due, indicating a direct impact of fines on revenue. Strategically, the NYC Police Department could use this relationship to forecast revenue and enhance fine collection methods, particularly for larger fines which currently show a trend of lower payment completion.

5) Data Analysis:

Predictive Analysis: Random Forest Model

"The predictive model achieved an accuracy of 63%, which reflects a substantial potential to correctly identify the precincts where parking violations are most likely to occur. This level of accuracy indicates that the model is a valuable tool for guiding NYPD's strategic decisions, enabling more effective allocation of enforcement resources and contributing to better traffic management across the city."

Precincts	Precision	Recall	F1-Score	Support
60	0.51	0.55	0.52	11
61	0.58	0.54	0.56	82
62	0.57	0.48	0.52	27
Accuracy	0.63	0.62	0.63	900
Macro Average	0.63	0.53	0.55	900
Weighted Average	0.63	0.62	0.61	900

6) Recommendations:

- **Targeted Enforcement:** Focus enforcement on precincts with the highest number of violations to deter future infractions.
- **Resource Allocation:** Prioritize resource deployment, such as additional officers or traffic cameras, in areas with frequent violations, particularly during peak violation hours identified in the EDA.
- **Out-Of-State Focus:** Given the significant number of violations from non-NY vehicles, consider implementing measures to ensure out-of-state drivers are aware of local parking regulations.
- **Fine Collection Strategies:** Address the gap between fines issued and payments received by exploring new collection strategies, like online payment options or increased fines for late payments.
- **Educational Campaigns:** Develop public information campaigns focused on the most common types of violations and target these campaigns to the driver demographics most represented in the violation data.
- **Data-Driven Patrols:** Use the predictive model's output to inform patrol schedules and routes, emphasizing times and locations with a high likelihood of violations.
- **Review Fine Structures:** Analyse the relationship between fine amounts and actual payments to adjust fine structures, if necessary, to improve compliance.
- **Compliance Incentives:** Create incentive programs for timely payment or compliance, such as reduced fines for early payment or first-time offender forgiveness.

  In essence, these recommendations leverage data insights to optimize the NYPD's parking enforcement efforts and can serve to improve compliance with parking regulations and enhance overall traffic conditions.

7) References:

Dataset Source:
https://data.cityofnewyork.us/City-Government/Open-Parking-and-Camera-Violations/nc67-uf89/about_data

Api Token Access:
https://dev.socrata.com/foundry/data.cityofnewyork.us/nc67-uf89. Used to scrape the data using the API-endpoint from NYC open data.