Analyzing Boston 311 Service Requests: Efficiency, Equity, and Seasonality

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Introduction:

The dataset used for this project is the "311 Service Requests" dataset, obtained from the Boston Data Portal. The dataset contains detailed records of 311 service requests submitted by residents of Boston from 2018 to 2023. The merged dataset includes over one million records with variables capturing request details such as case title, neighborhood, and time-to-close metrics.

Research Questions:

The analysis aims to address the following questions:

1. What are the most common service request types, and how do they vary by season?
2. How do neighborhoods differ in their average time to close service requests?
3. What factors predict the time it takes to close a service request?

Outcome Variables:

1. **Time to Close Requests**: The time (in days) between the open date and closed date for each service request.
2. **Seasonal Distribution of Request Types**: Frequency of service requests by season and type.

Predictor Variables:

Using the dataset columns, the following predictors are most relevant:

1. **Case Title (case_title)**: Type of service requested.
2. **Closure Reason (closure_reason)**: Provides context for request resolution.
3. **Neighborhood (neighborhood_services_district)**: Geographic location of requests.
4. **Department (department)**: Responsible department.
5. **Source (source)**: Submission method.
6. **Season (open_dt)**: Derived variable (Winter, Spring, Summer, Fall).
7. **Day of the Week (open_dt)**: Weekday or weekend.
8. **Days to Acknowledge (target_dt - open_dt)**: Time before acknowledgment.
9. **Volume of Requests**: Aggregate daily/seasonal requests.

Feature Engineering:

1. **Season Variable**: Derived from the open_dt variable using the month to categorize requests into Winter, Spring, Summer, and Fall.
2. **Cleaned Case Titles**: Grouped infrequent case titles into "Other" and combined similar categories (e.g., "Street Light Outages" and "Street Light Knockdowns" were grouped into "Street Lights").
3. **Binary Variables**: Future analysis may include converting continuous variables such as time_to_close into binary categories (e.g., requests resolved quickly vs. not).

Sub-Groups for Analysis:

1. **By Season**: Analyze trends for request types and frequencies.
2. **By Neighborhood**: Compare average time to close and frequencies of request types.
3. **By Source**: Evaluate differences in time-to-close metrics based on submission channels.

Descriptive Statistics Tables:

Table 1: Summary Statistics by neighborhood

neighborhood	mean_time_to_close	median_time_to_close
South Boston	50.08068	0.3356308
Charlestown	38.21812	0.6473090
Boston	32.91186	0.4553009
Fenway / Kenmore / Audubon Circle / Longwood	32.75324	0.5854167
South Boston / South Boston Waterfront	32.36812	0.2490162
Downtown / Financial District	30.33602	0.3183449
Jamaica Plain	29.39188	0.7737384
West Roxbury	28.59652	1.1990104
Allston	28.17908	0.7383449
Back Bay	28.04876	0.4204167
Greater Mattapan	26.28508	0.8659086
Hyde Park	26.18937	0.9127546
Brighton	26.08055	0.6471644
Mattapan	24.53408	0.9169850

neighborhood	mean_time_to_close	median_time_to_close
Mission Hill	24.20384	0.5315394
Beacon Hill	24.12336	0.2719850
Roslindale	23.25524	0.8534259
Allston / Brighton	22.73853	0.5909086
South End	22.43589	0.2298495
East Boston	22.33916	0.5215336
Roxbury	20.26923	0.5614236
Dorchester	20.09554	0.6931134
Chestnut Hill	10.32684	0.6470312

Table 2: Grouped Descriptive Statistics by Season

season	mean_time_to_close	median_time_to_close	total_requests
Winter	24.72728	0.5614583	320,866
Spring	28.62248	0.5914815	353,614
Summer	26.45733	0.5834838	408,275
Fall	23.77183	0.5578588	369,738

Table 2: Grouped Descriptive Statistics by Season

year	mean_time_to_close	median_time_to_close	total_requests
2,018	38.17743	0.6589236	239,680
2,019	35.20734	0.6481134	232,615
2,020	33.85252	0.5222222	228,343
2,021	22.69980	0.4671759	251,578
2,022	13.46532	0.5452778	253,456
2,023	13.98960	0.5803819	246,821

Analytical Plans and Methods:

1. **Linear Regression**

- Model 1: Time to Close Requests (Outcome 1)

- Predictors: Case Title, Neighborhood, Source, Season
- Objective: Identify significant predictors of time-to-close metrics.

- Model 2: Seasonal Distribution of Service Request Types (Outcome 2)
  - Predictors: Season, Case Title, Neighborhood, Source
  - Objective: Understand how request types vary seasonally.

2. **Chi-Square Test**

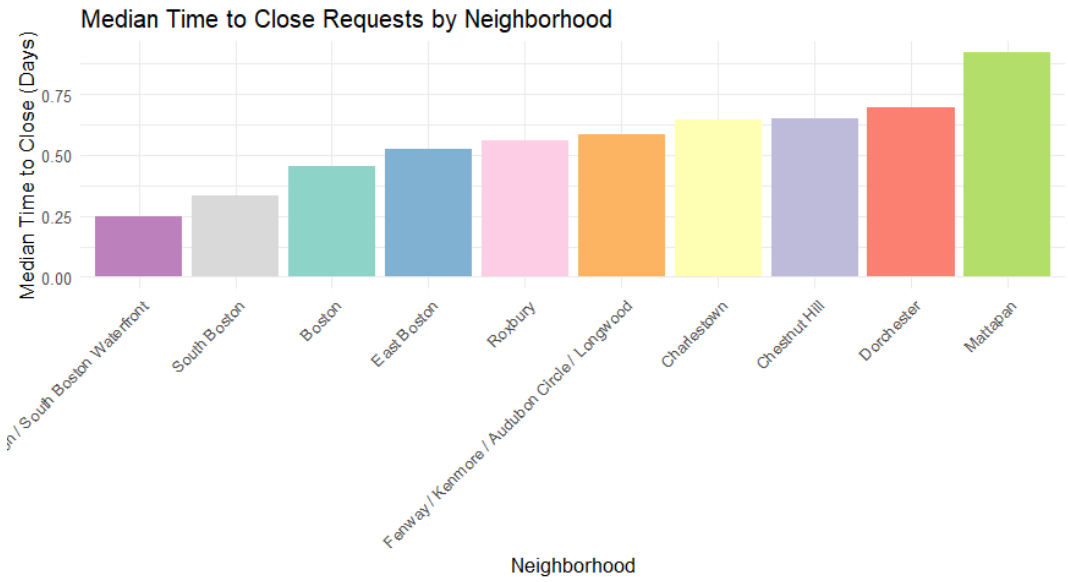
- Used to evaluate the relationship between case_title and season.

3. **Visualization Methods**

- Seasonal trends for top request types using bar charts.
- Neighborhood disparities in time-to-close metrics using grouped bar plots.
- Interactive facets to compare service types across seasons.

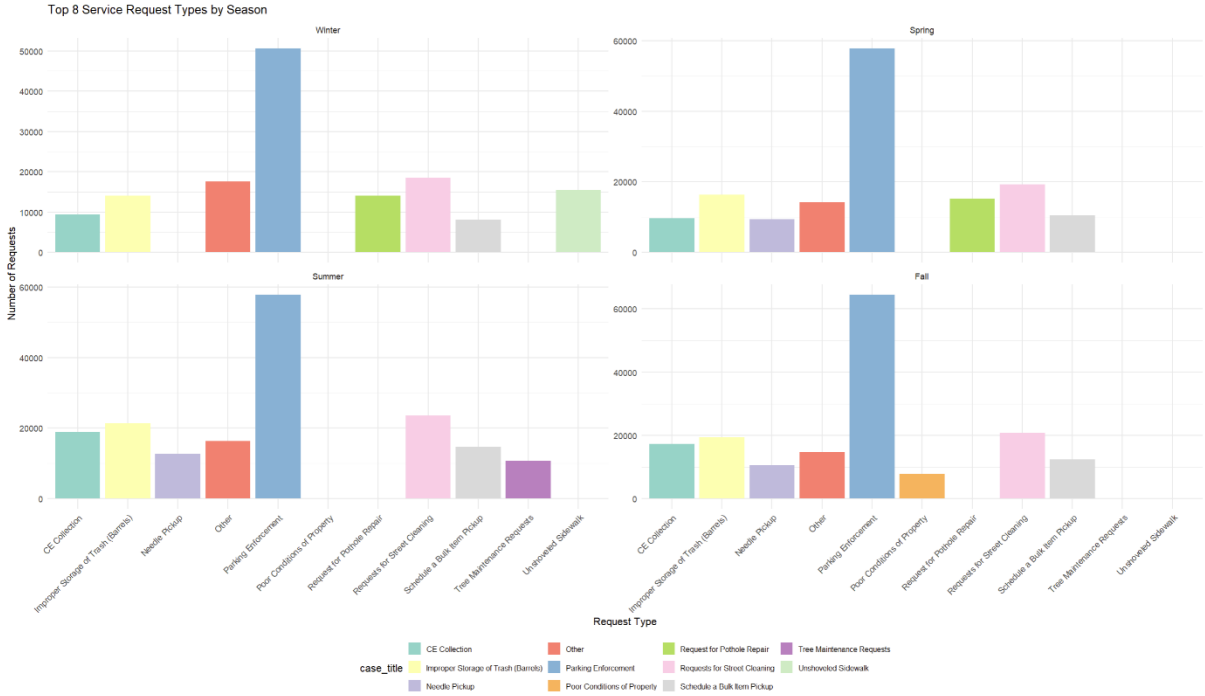
Visualization and Analysis:

Neighborhood Disparity in Time to Close



The bar chart titled **"Median Time to Close Requests by Neighborhood"** displays the median time taken to close service requests across various neighborhoods. The x-axis represents different neighborhoods, while the y-axis shows the median time to close in days. The chart reveals that **Mattapan** has the longest closure times. Other neighborhoods, such as South Boston and Boston, have relatively shorter closure times compared to areas like Dorchester and Chestnut Hill, which experience longer delays. This visualization provides insights into the efficiency of service request handling across different neighborhoods.

Top 8 Service Request Based Seasonally



The bar chart titled **"Top 8 Service Request Types by Season"** presents the distribution of service requests across Winter, Spring, Summer, and Fall. The x-axis represents different service request types, while the y-axis shows the number of requests. **Parking Enforcement** consistently has the highest number of requests across all seasons, significantly surpassing other categories. Other commonly reported issues include **Improper Storage of Trash (Barrels), Requests for Street Cleaning, and CE Collection**, which maintain relatively steady numbers across seasons. Seasonal variations are also observed, with **Unshoveled Sidewalk** requests peaking in Winter and maintenance-related requests showing consistency throughout the year. The chart provides insight into the demand trends for various municipal services across different times of the year.

Conclusion and Recommendations:

Findings:

- *Seasonal Trends*: Service request patterns vary by season. Parking Enforcement dominates year-round, while unsholved sidewalks peak especially in the winter. Street cleaning requests rise in summer and fall, indicating necessary seasonal cleanups.
- Neighborhood Disparities: Median time to close service requests across neighborhoods. The South Boston Waterfront records the fastest response times, while Mattapan has the slowest with closure times more than triple those of the most efficient neighborhoods.

Recommendations:

- Increasing staff and resources during peak seasons for specific service types. For instance, deploy additional groups for unshoveled sidewalks in winter and street cleaning in summer and fall.
- Investigate the causes of delays in Mattapan and other slower neighborhoods. Implement strategies such as improved workflow systems, increased funding to reduce response times, or better workforce distribution.
- Set baseline performance standards for request solution times across neighborhoods as a metric to deliver more equitable services.

Wrap-Up:

- These insights show the essential of adapting resource allocation to seasonal and geographic demands. Tackling disparities in response times will improve service equity and efficiency. This will enhance customer satisfaction in Boston's 311 Service Request system.

References

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https://www.boston.gov/departments/boston-311

https://github.com/CityOfBoston/opendatachallenge