

AIRCRAFT NOISE PATTERNS AROUND SAN FRANCISCO

INTERNATIONAL AIRPORT ANALYSIS



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1. INTRODUCTION

Introduction :

- Aircraft noise is a significant concern for communities living near San Francisco International Airport.
- Night-time flights (8 PM–7 AM) are especially disruptive because they affect sleep and overall well-being.
- Residents frequently file noise complaints, but it is not always clear which neighborhoods are most affected or what flight factors contribute to these disturbances.

Key Questions We Address :

- Which neighborhoods report the most night-time aircraft noise complaints?
- How do aircraft type, altitude, operation type, and time of night influence complaint levels?
- Can a predictive model help estimate complaint patterns and test potential mitigation strategies?

2. DATA SOURCE

Data Description

Type of Data

- Table of noise complaints reported by people living near SFO
- Extra ZIP code data with location and population information

Dataset Size

- 7.09 million rows and 14 columns
- CSV file

Data Sources

- SFO Aircraft Noise Reports from Data.gov (2018–present)
- US ZIP Code Database from SimpleMaps

Data Quality

- The raw data had issues, such as mixed date formats, missing values, and complaints outside night-time hours
- We cleaned the data to remove incorrect or incomplete records

Data Processing

- Kept only night-time complaints (8 PM–7 AM)
- Used key fields like date/time, ZIP code, aircraft type, altitude, and operation type
- Joined ZIP code data to calculate distance to SFO and to include population

Privacy & Consent

- Both datasets are public and anonymous
- No personal details are included, so consent is not required

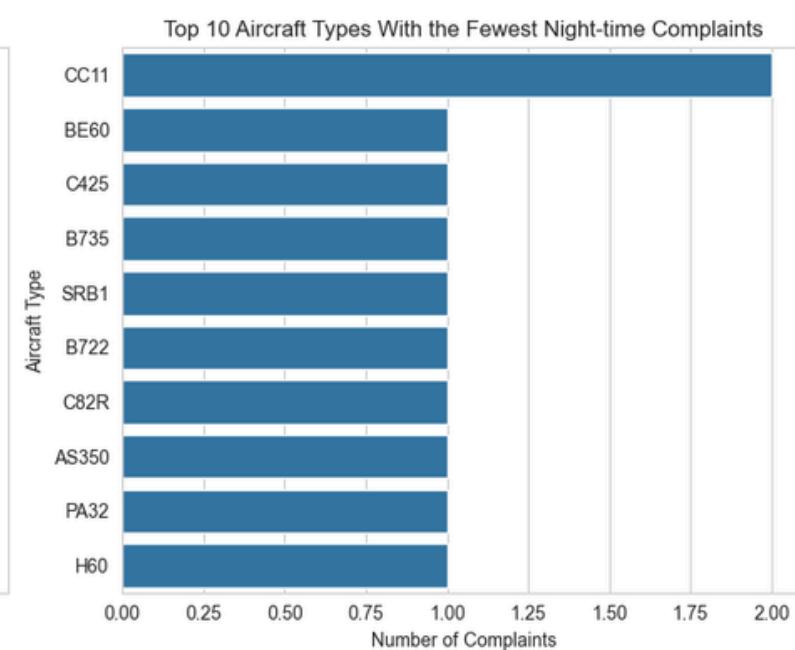
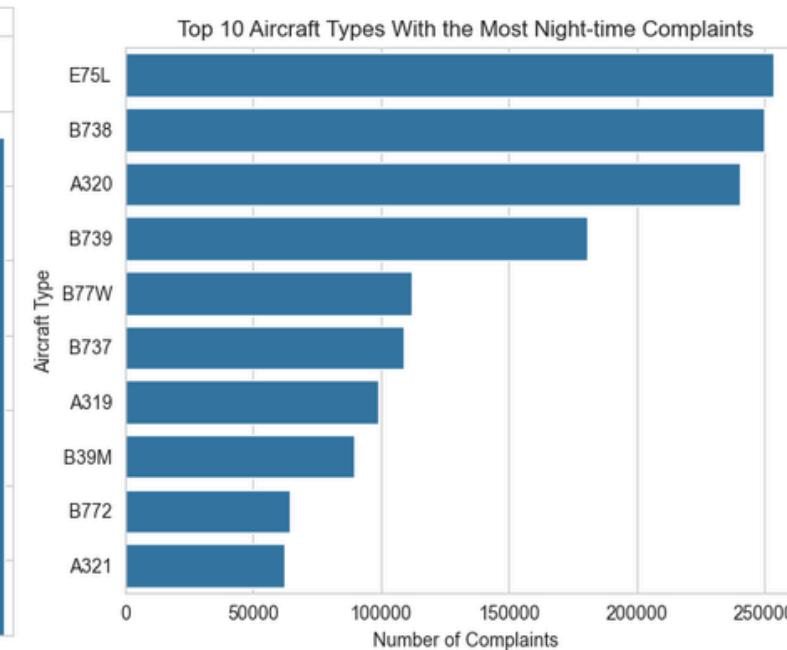
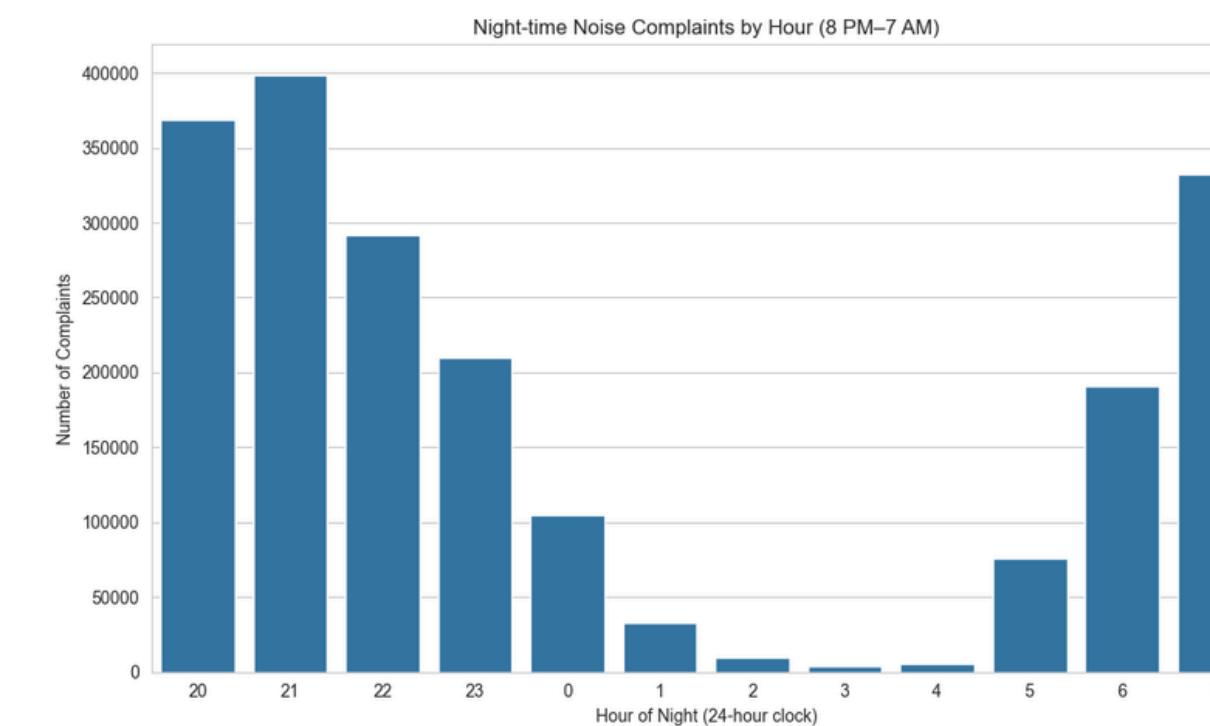
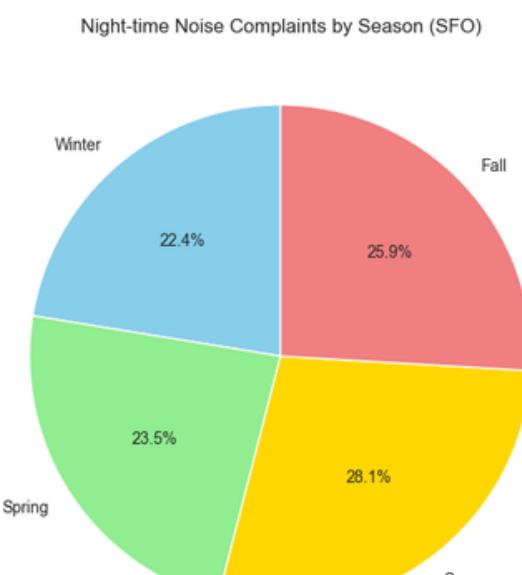
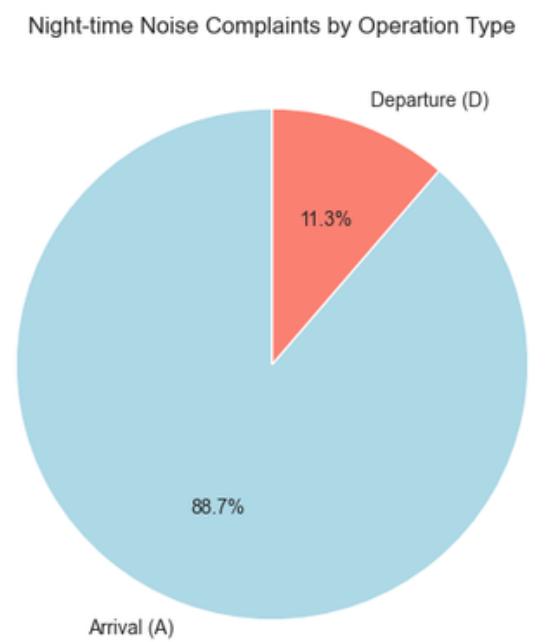
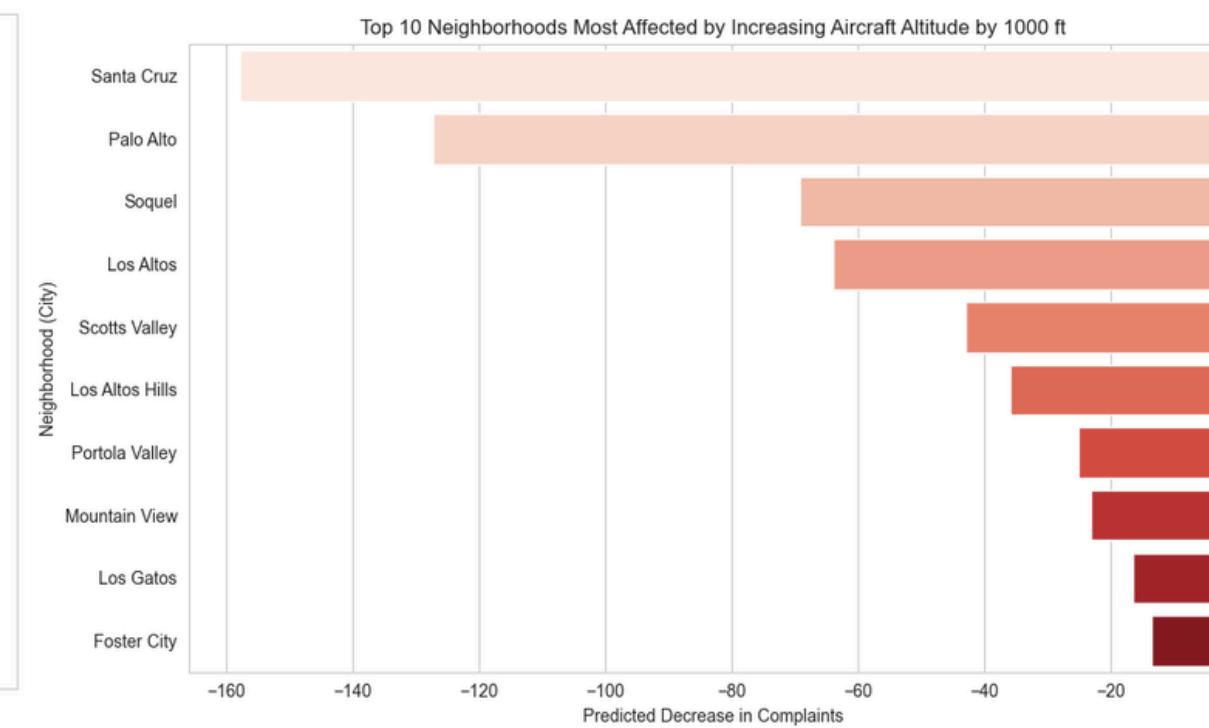
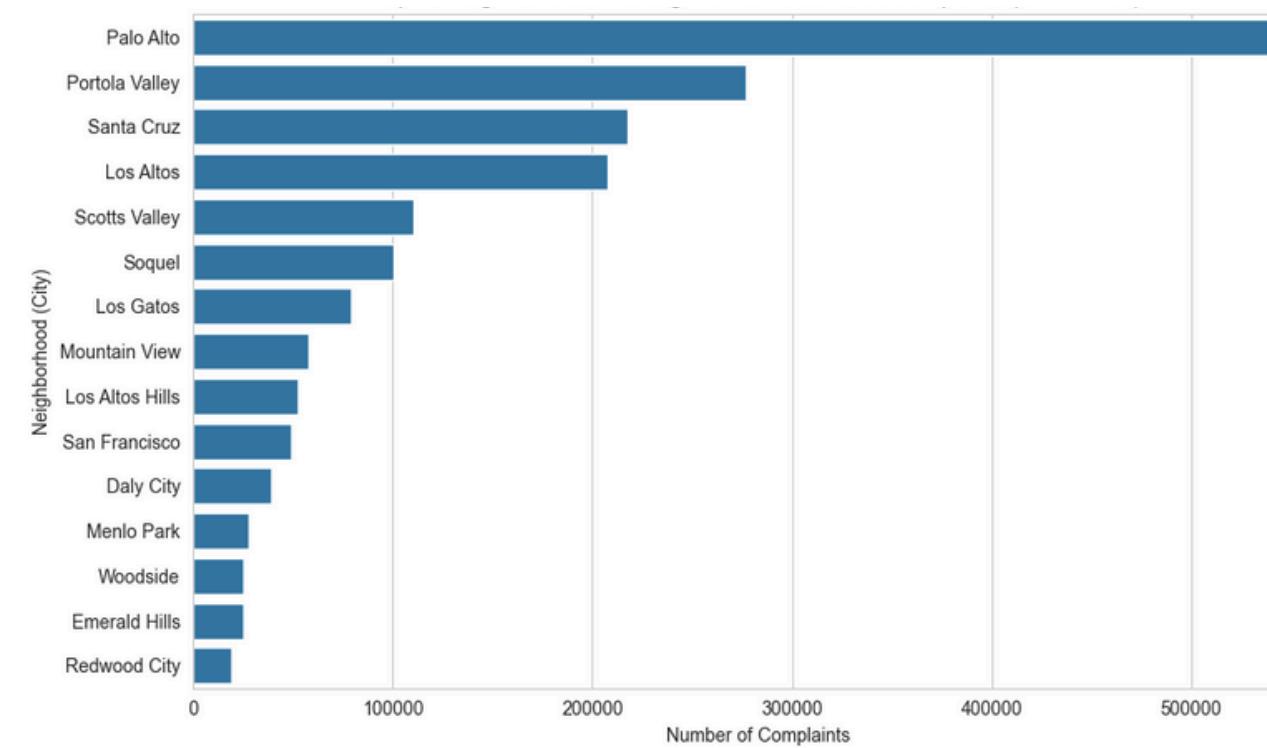
3. ANALYSIS METHODS CONTENT

- Type of Problem: Supervised learning – regression problem (predicting number of night-time complaints).
- Predictors (Features): Aircraft type, aircraft altitude, operation type (arrival/departure), hour of night, neighborhood population, distance to SFO.
- Target Variable: Complaint count per neighborhood (log-transformed for modeling).
- Model Used: CatBoost Regressor – a gradient boosting model that handles both numerical and categorical features, capturing complex non-linear relationships.
- Validation: 5-fold cross-validation to assess model performance (R^2 , MAE).
- Scenario Analysis: Simulated operational changes (e.g., increasing flight altitude) to predict reductions in complaints.

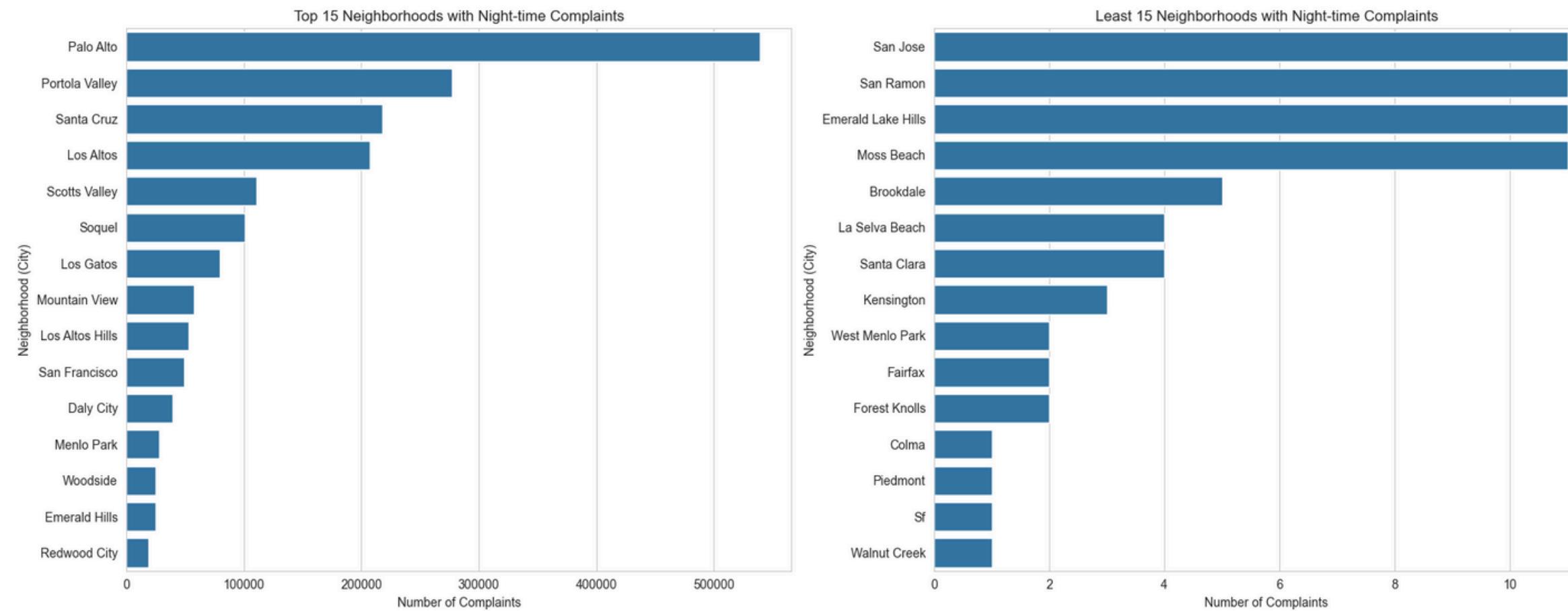


4. RESULTS CONTENT

Result Overview



4.1 COMPLAINT BY CITY



Complaints are not evenly distributed

Highest complaints:

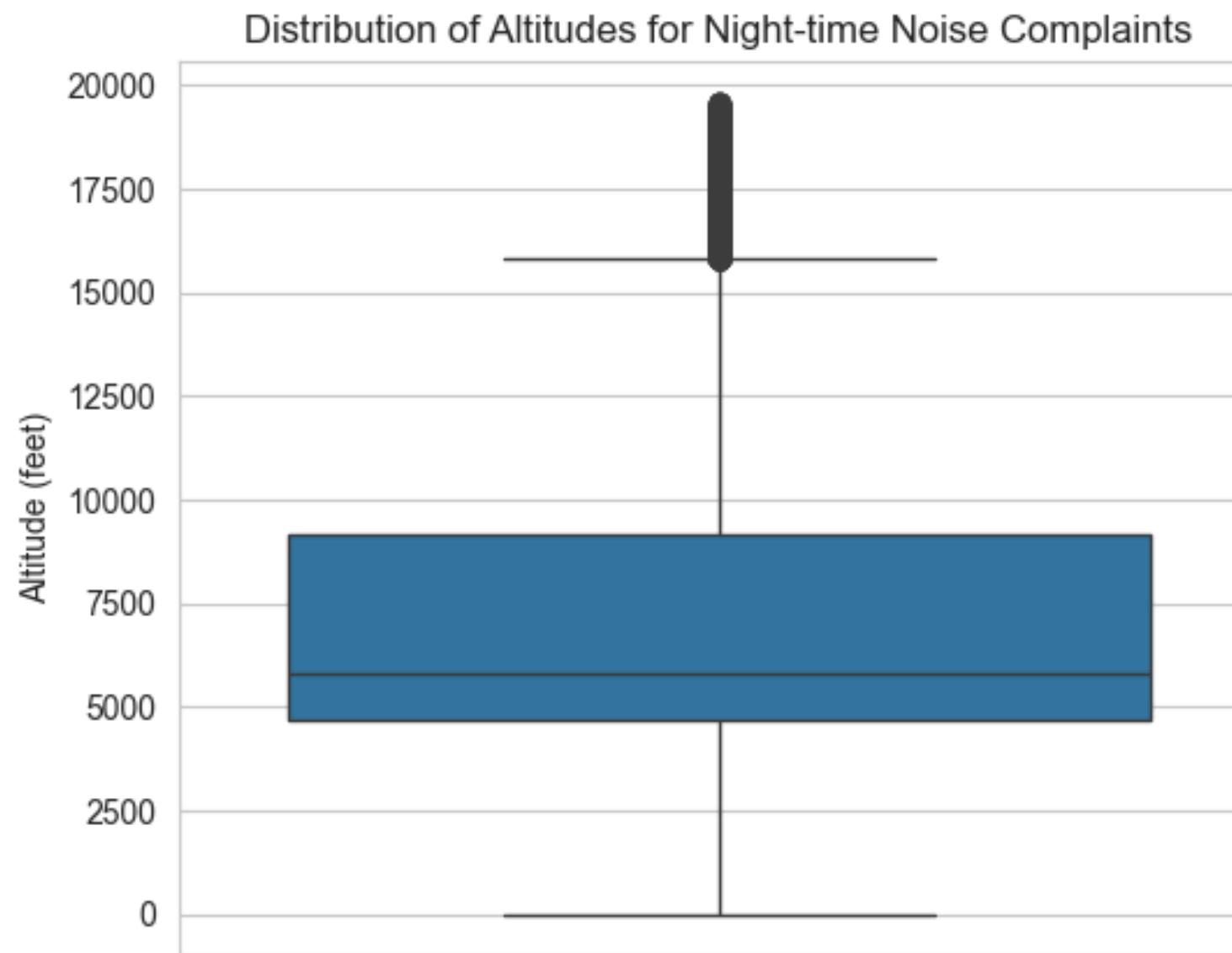
- Palo Alto
- Portola Valley
- Santa Cruz

Least complaints:

- Walnut Creek
- Piedmont
- Foster City

These areas are along major flight paths: Other neighborhoods report very few complaints, Noise impact is highly localized

4.2 COMPLAINT BY ALTITUDES



Most complaints come from flights at: 4,500 to 9,000 feet

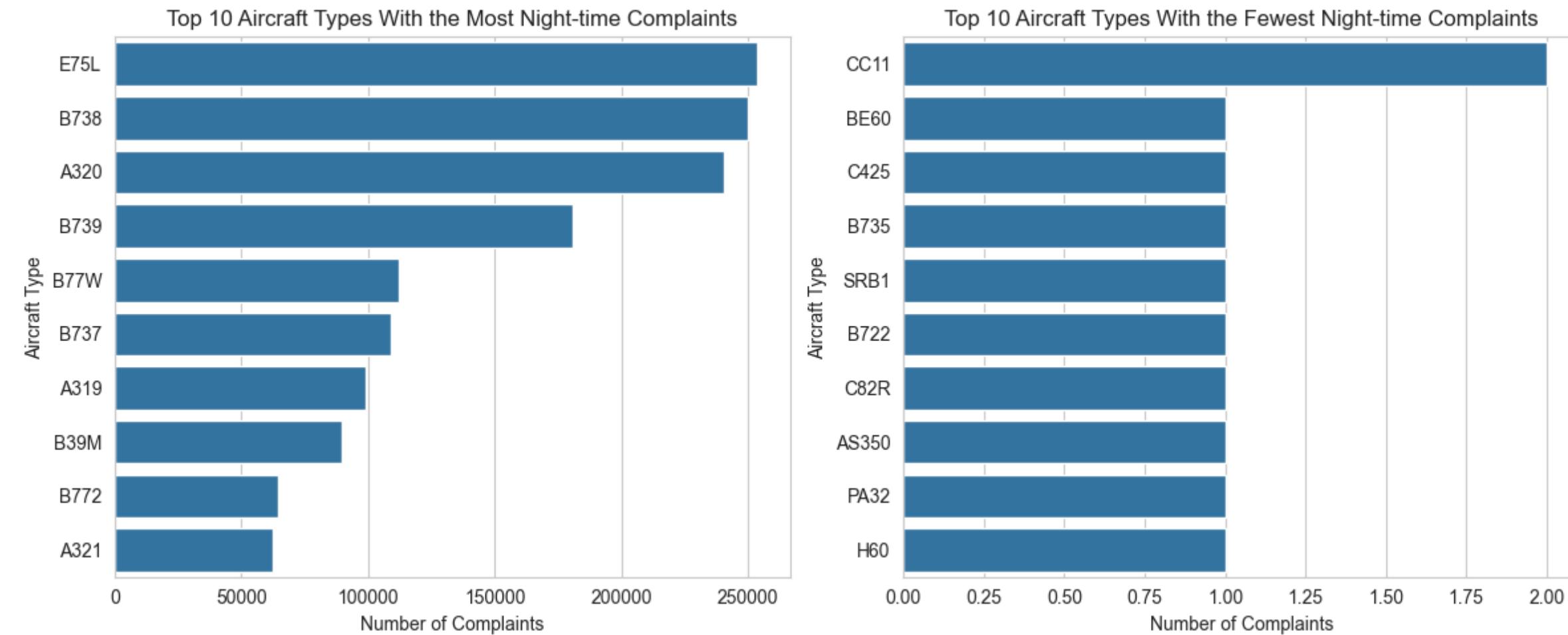
Strong impact in:

- Palo Alto
- Portola Valley
- Santa Cruz

Altitude alone does not explain noise

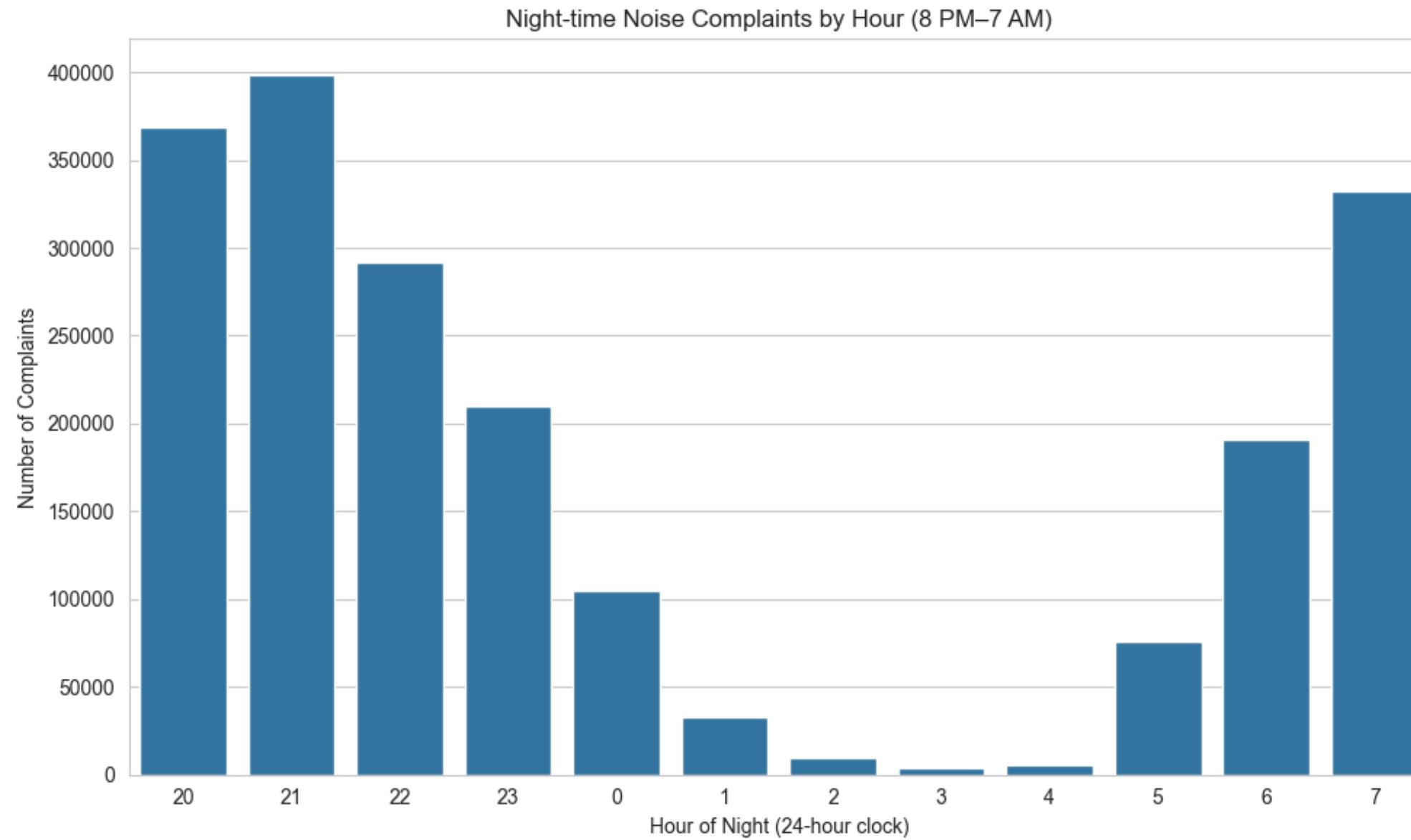
Altitude + flight path + population matter most

4.3 COMPLAINT BY AIRCRAFT TYPE



The majority of night-time complaints come from a few large commercial jets E75L, B738, and A320 each generating close to 250,000 complaints. Other large jets in the top 10 still produce tens of thousands of complaints, while most other aircraft types generate almost no complaints, often fewer than 2. This shows that a small number of aircraft types are responsible for nearly all complaints, while the majority of aircraft contribute minimally.

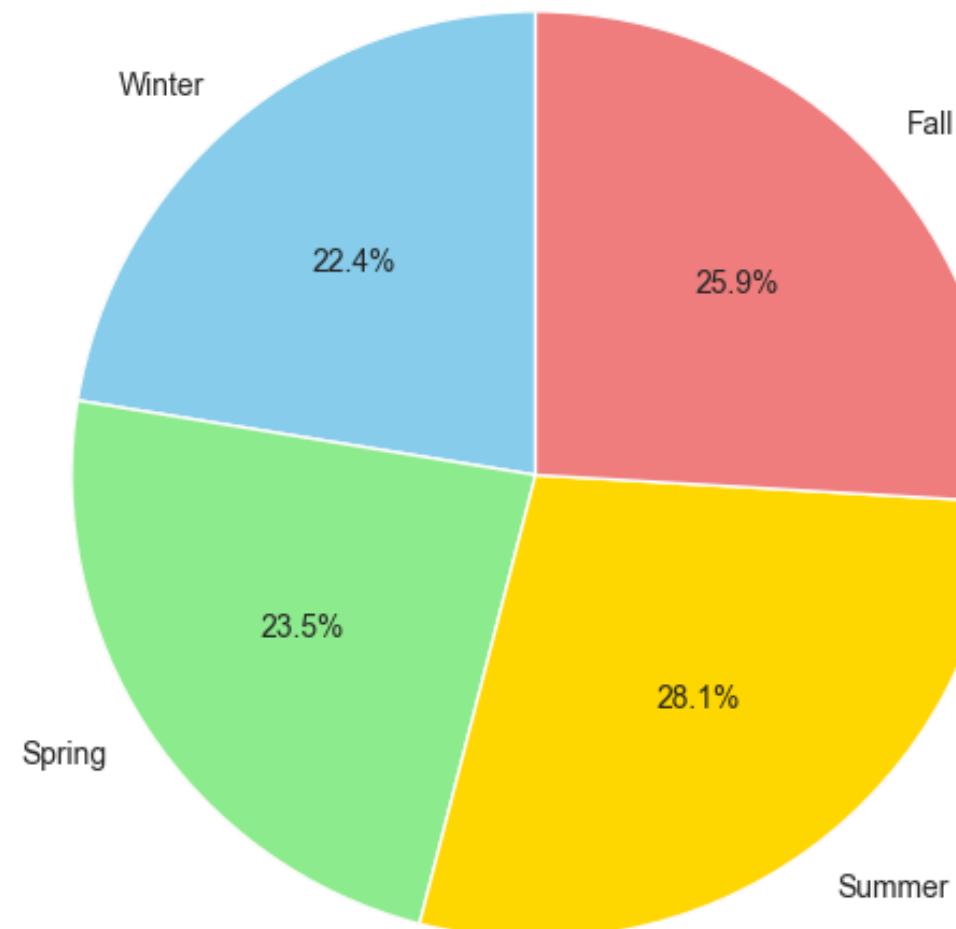
4.4 COMPLAINT BY NIGHT HOURS



The plot revealed that complaints are highest in the early evening (8–9 PM) and early morning (6–7 AM), likely because people are trying to sleep or wake up. Between 2 AM and 4 AM, complaints drop sharply, probably due to both fewer flights operating and most residents being asleep.

4.5 COMPLAINT BY SEASONAL

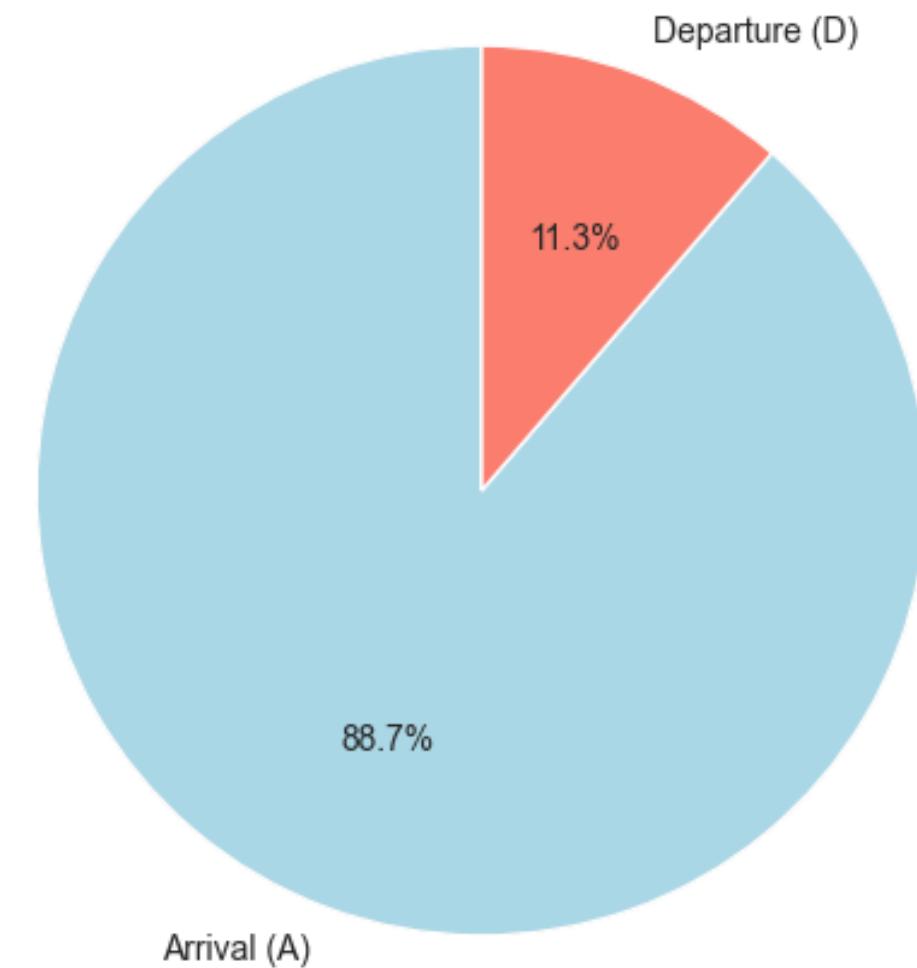
Night-time Noise Complaints by Season (SFO)



- Night-time complaints are highest in Summer (28.1%) and Fall (25.9%).
- Complaints are lowest in Winter (22.4%).
- Warmer months may increase noise awareness because windows are open and residents spend more time at home.
- In Winter, complaints drop as homes are more insulated and outdoor activity is reduced.

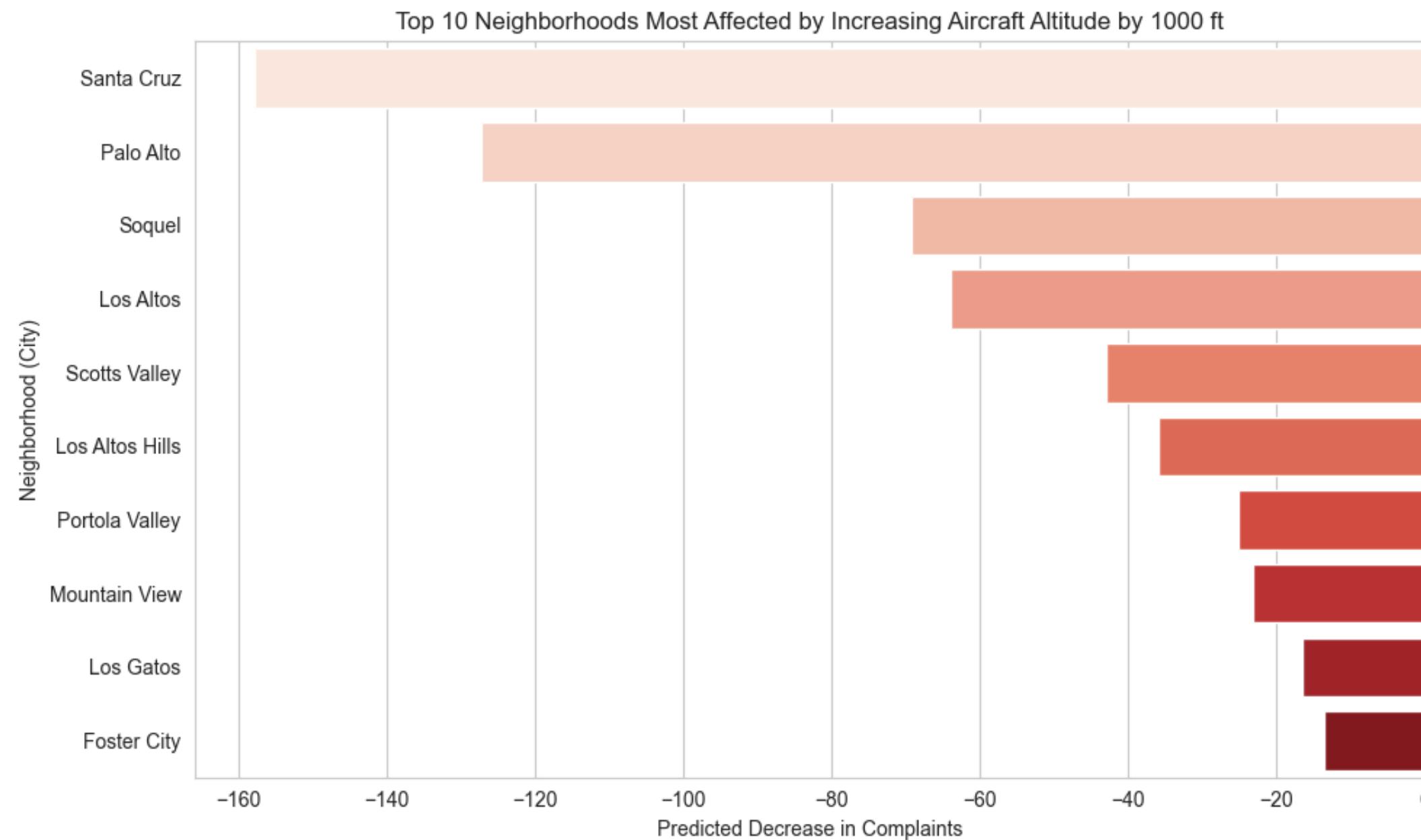
4.6 COMPLAINT BY OPERATION TYPE

Night-time Noise Complaints by Operation Type



The vast majority of night-time complaints (88.7%) come from arriving aircraft, while departures account for only 11.3%. This suggests that arrivals are generally noisier or more disruptive to residents, making them the primary driver of complaints.

4.7 CATBOOST MODEL



- Model Performance:
 - Mean $R^2 = 0.59$
 - Mean MAE = 58 complaints
- Scenario Analysis: Increase aircraft altitude by 1,000 ft
 - Top 10 neighborhoods with predicted complaint reduction
 - Santa Cruz: ~157 fewer complaints
 - Emerald Hills: ~12 fewer complaints

5. CONCLUSION

Key Takeaways:

- Night-time aircraft noise is concentrated in a few neighborhoods near SFO.
- Main factors influencing complaints: aircraft altitude, operation type, time of night, and neighborhood proximity.
- Predictive modeling with CatBoost captured major patterns ($R^2 \approx 0.59$, MAE ≈ 58 complaints).
- Scenario analysis shows increasing flight altitude by 1,000 ft can reduce complaints, especially in Santa Cruz and Palo Alto.
- Limitations: not all disturbances are reported, ZIP code centroids are approximations, and precise flight/noise data is limited.

Implication:

- Findings provide actionable insights for SFO and policymakers to reduce noise and prioritize interventions in the most affected neighborhoods.

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THANK YOU !