

Health Aware Optimized Route Planner for Reduced Urban Hyperlocal Pollution Exposure

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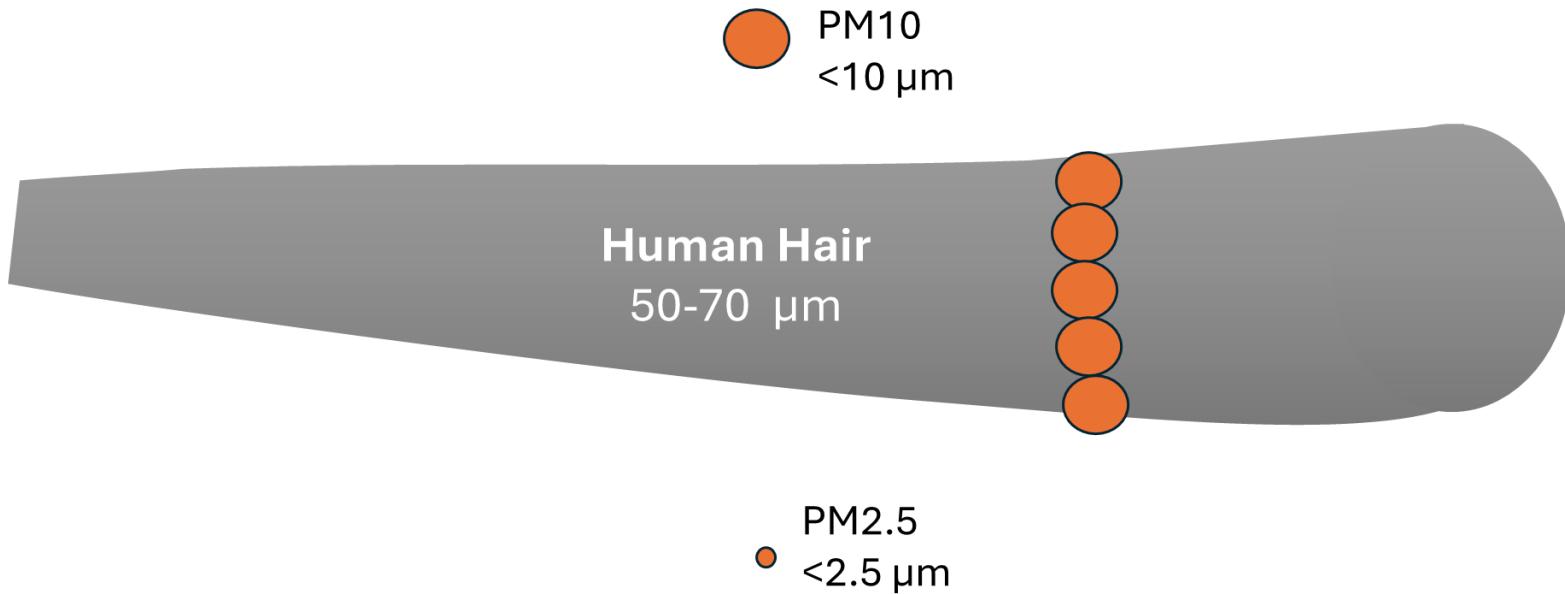
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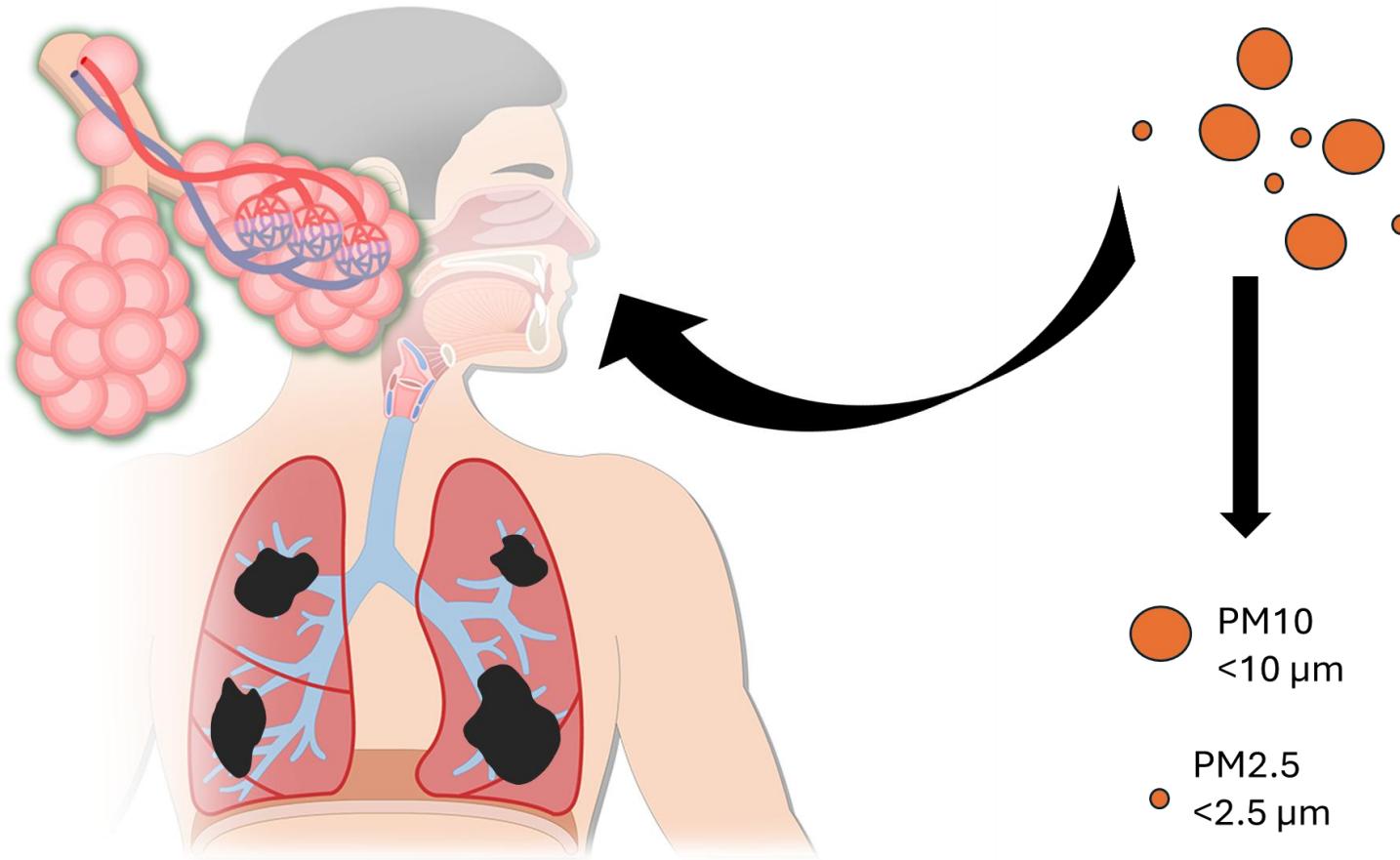
Outline

- **Introduction**
 - **Background & Motivations**
 - Particulate Matter (PM)
 - Motivation
 - GREENROUTER: HEALTH-AWARE ROUTE PLANENR
- **Results and Discussion**
 - Deployment Methodology
 - Experiments
 - Population Vs. Samples
- **Summary & future research**

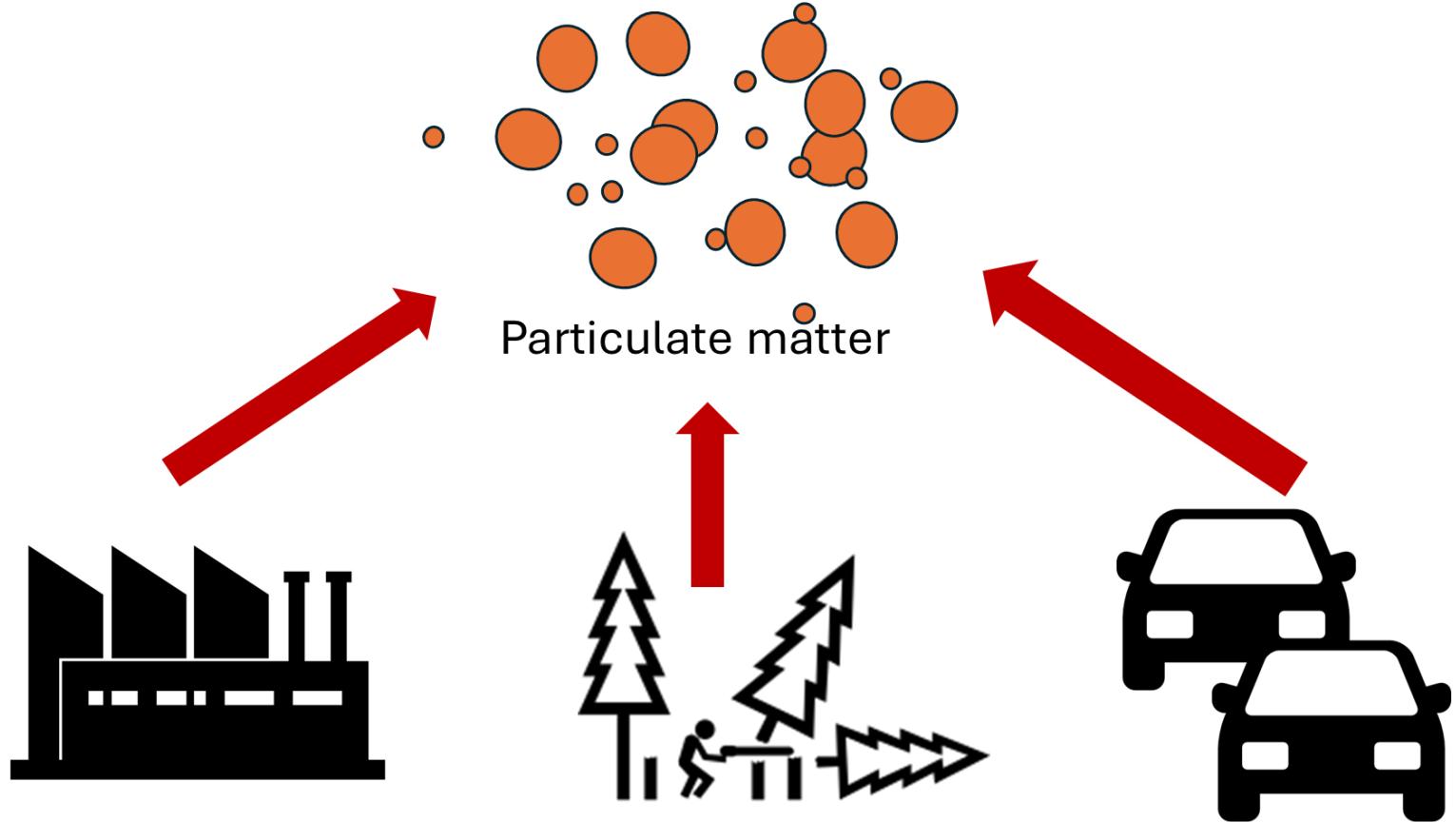
What is Particulate Matter (PM)



PM Deposition in the Respiratory System



PM Source Contribution



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Motivation

Different sizes of Particulate matter (PM)



Affect respiratory health



Pneumonia in children and Cancer development



Reduce PM levels to mitigate health risks

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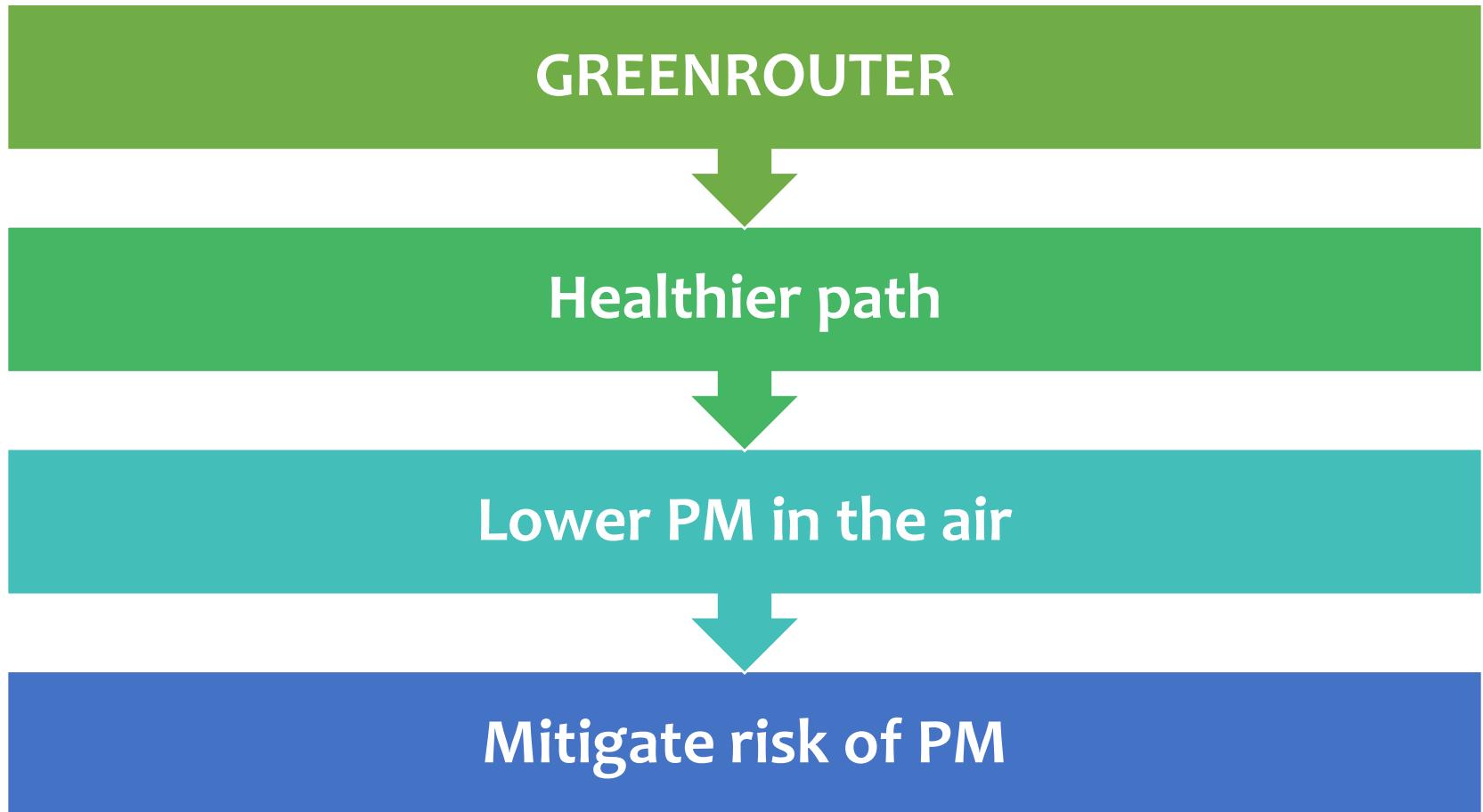
GREENROUTER: HEALTH-AWARE ROUTE PLANNER



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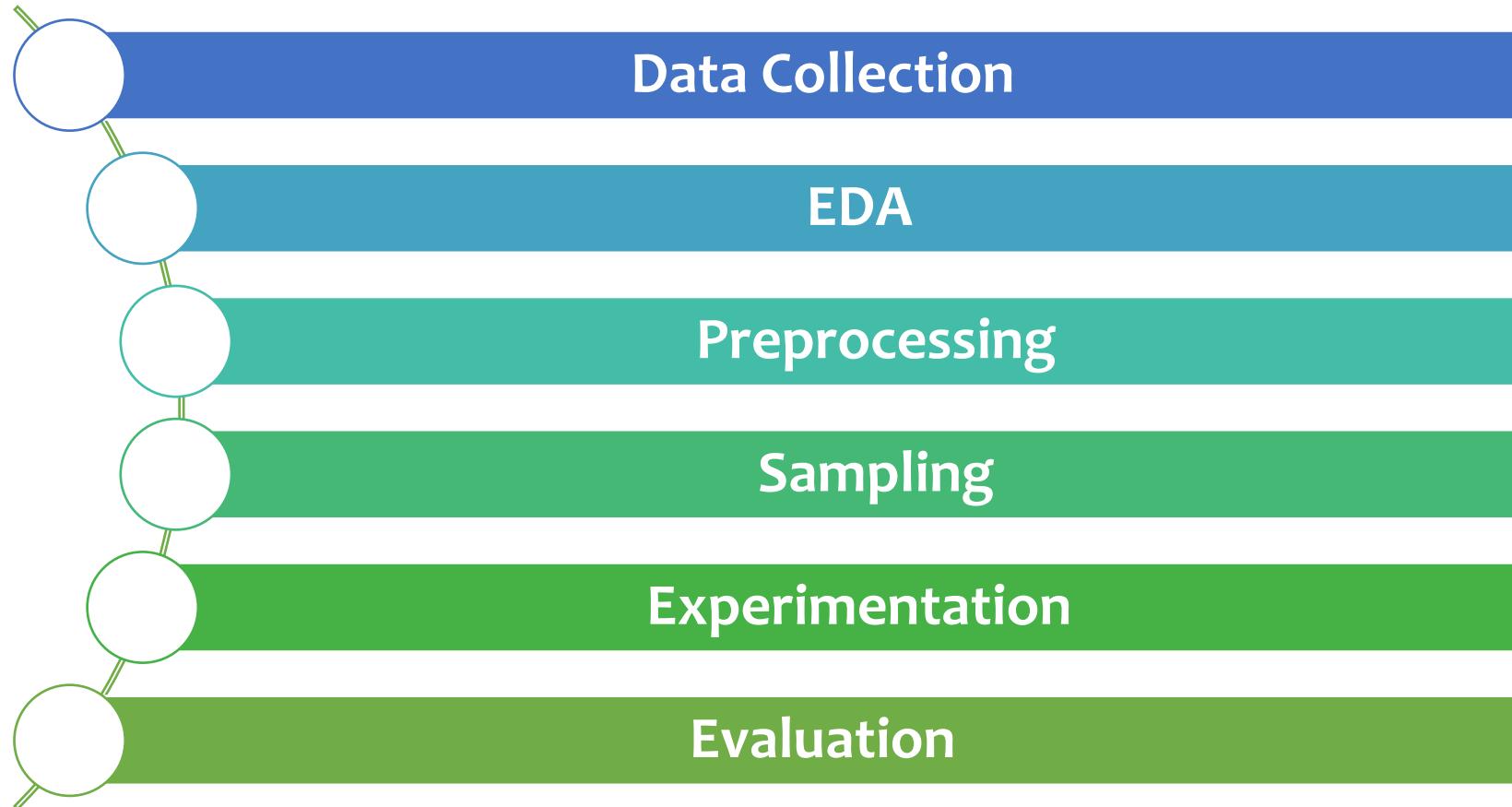
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Deployment Methodology



Data Collection

Hyperlocal Air
Quality data
from NYC

PM 2.5

NO₂

EDA

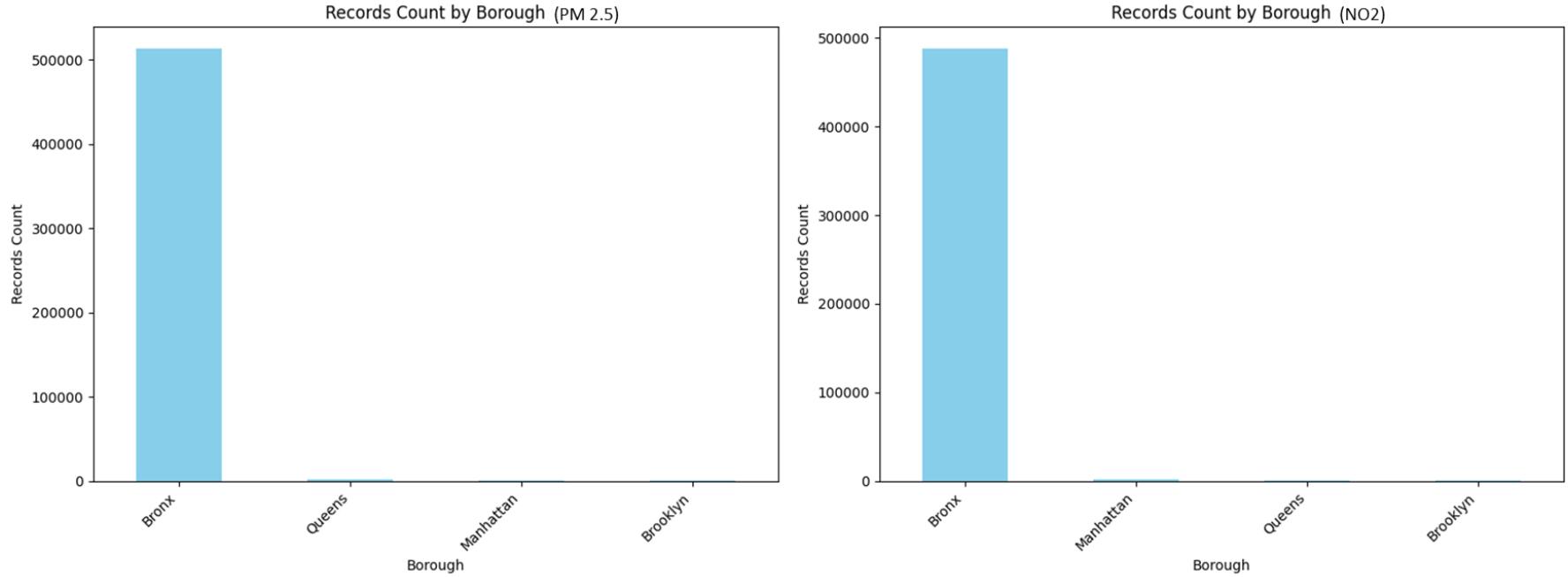
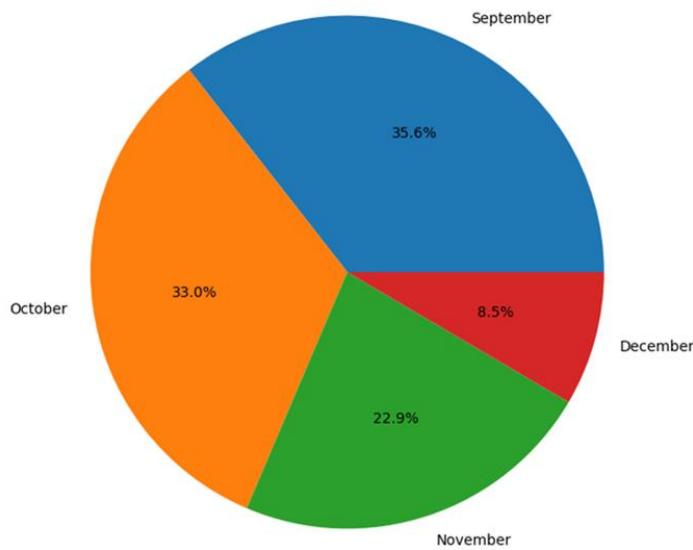


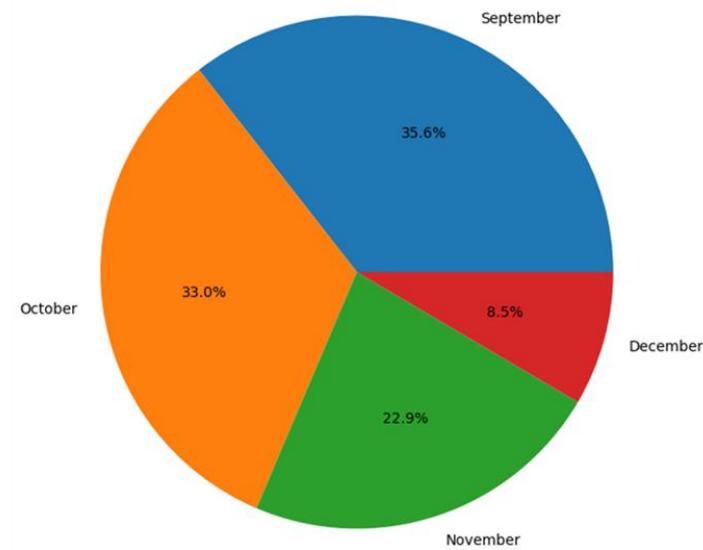
Figure: Distribution of data according to Borough in NYC. Both figures show similar distribution of data, where most of the data is from the Bronx. PM2.5 (99.4%) NO2 (99.2%)

EDA

Records Count by Month (PM 2.5)

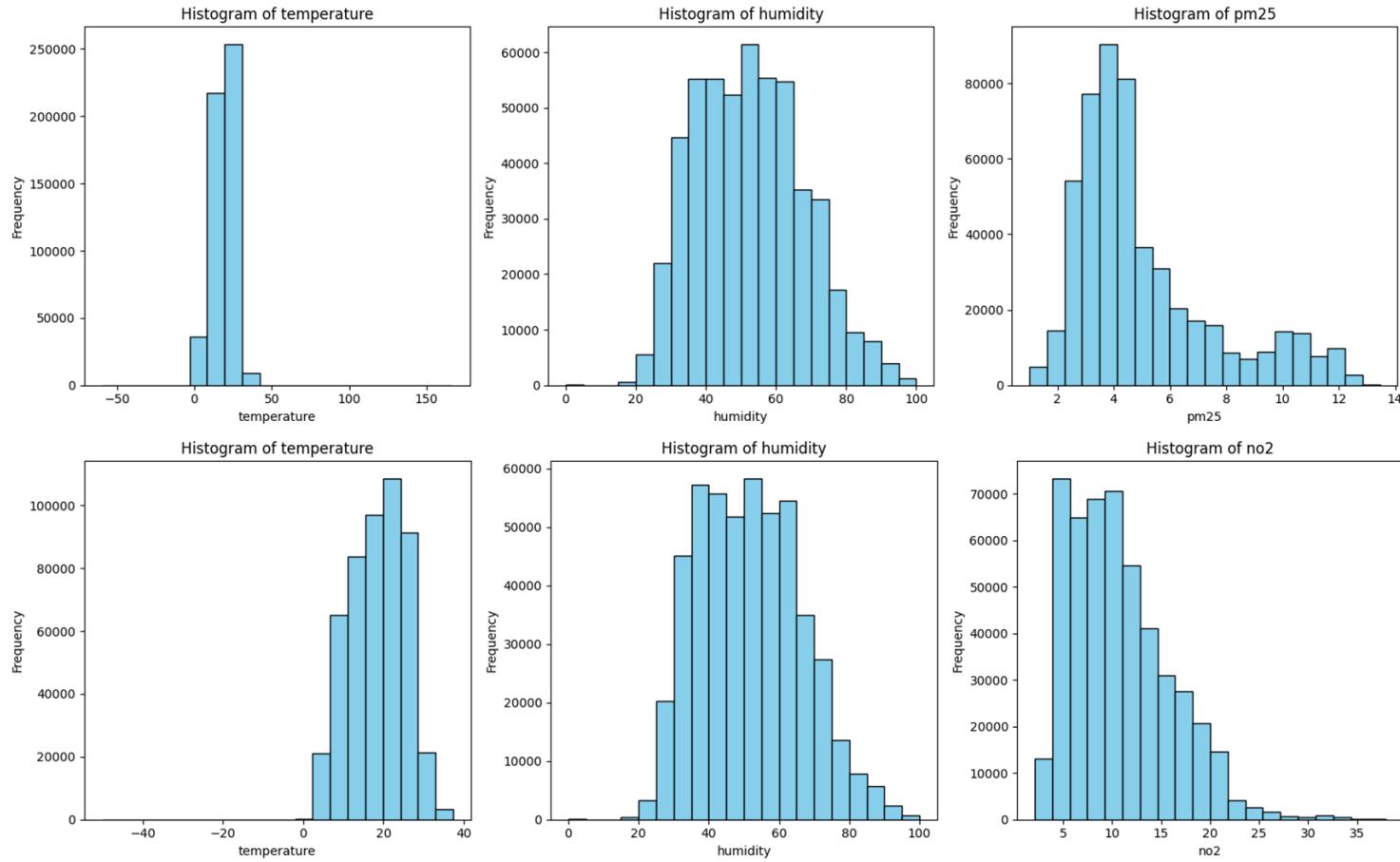


Records Count by Month (NO2)

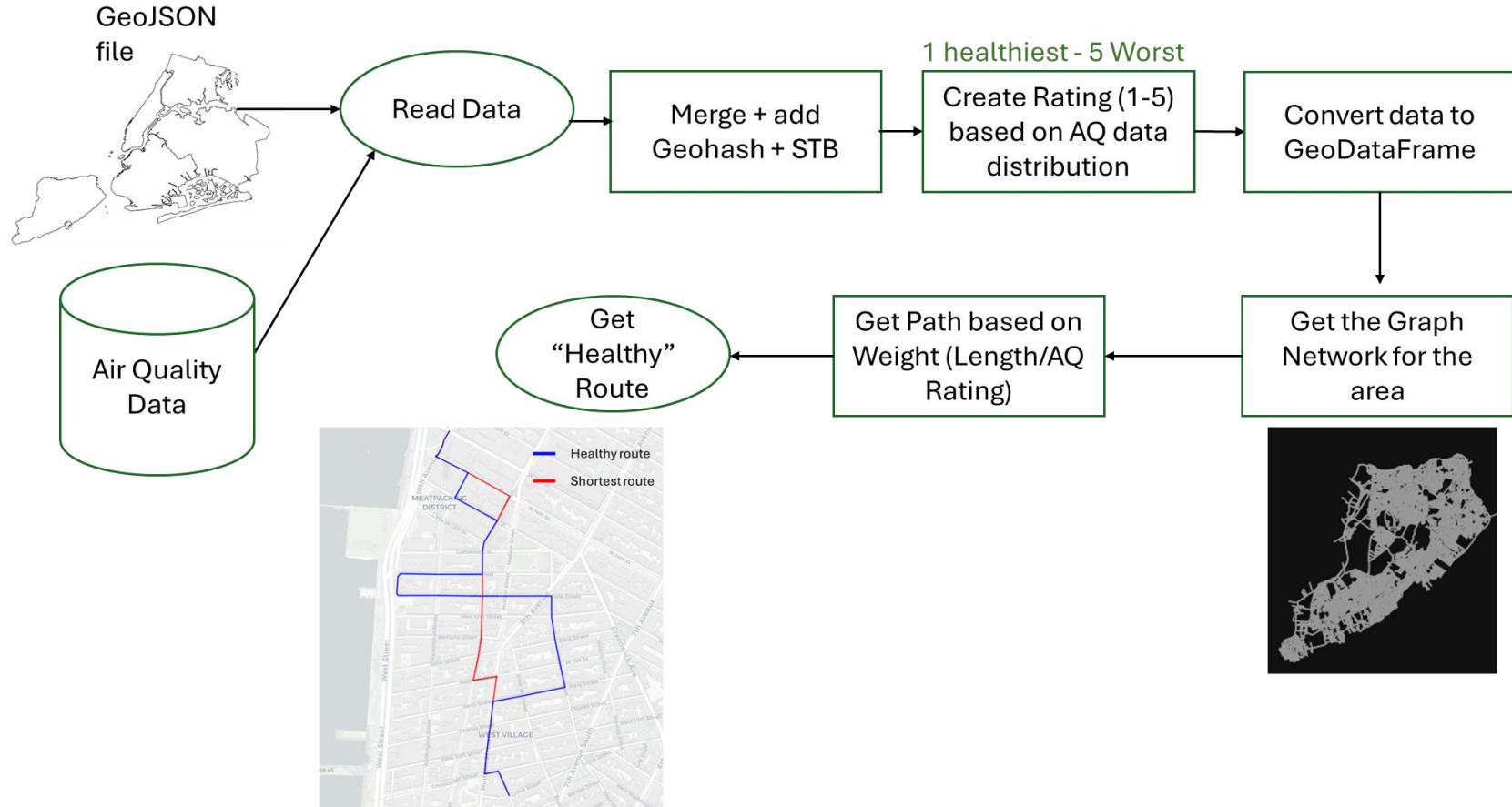


Records collected each month (from September 2021, to December 2021)

EDA



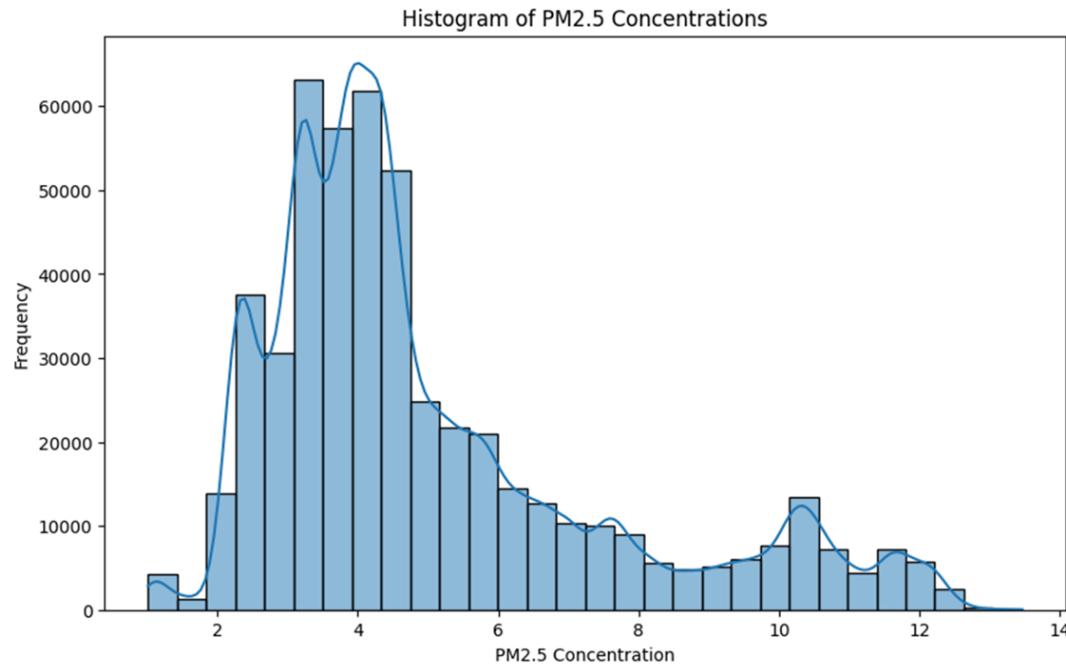
GREENROUTER: Process



GREENROUTER: Rating

- Rating – PM

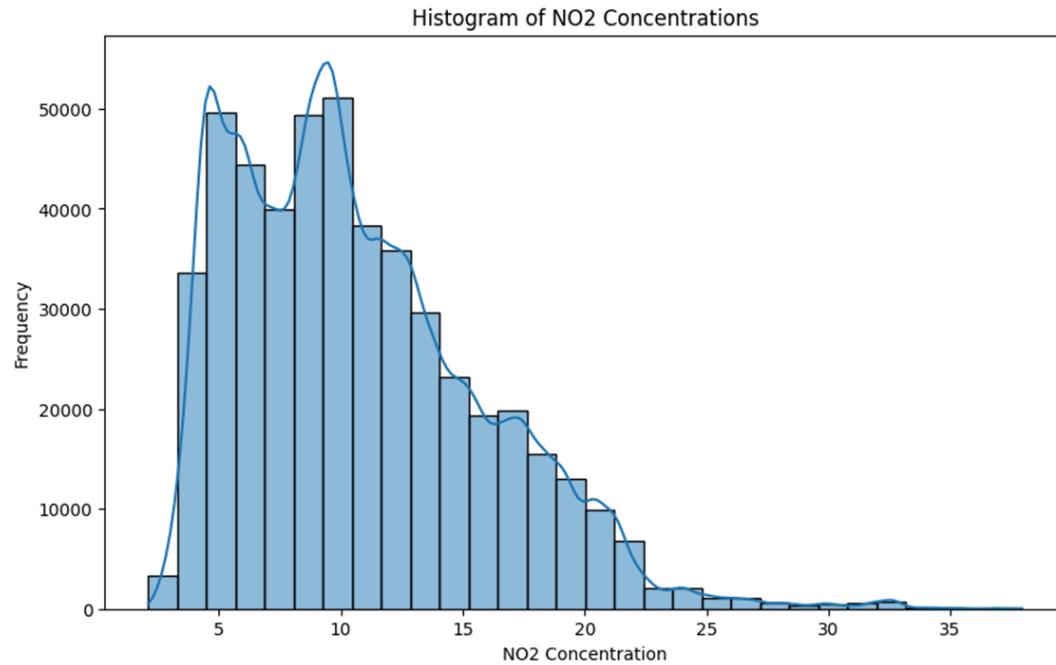
- 1: ≤ 3
- 2: ≤ 6
- 3: ≤ 9
- 4: ≤ 12
- 5: > 12



GREENROUTER: Rating

- Rating – NO2

- 1: ≤ 5
- 2: ≤ 10
- 3: ≤ 15
- 4: ≤ 20
- 5: > 20



GREENROUTER: Sampling

- Stratified Sampling
Based on Geohash

- PM 2.5 → Precision 5
- NO₂ → Precision 4
 - Avoiding sparsity

20%

40%

60%

80%

Experiments

Population
data

Routes
1 and 2

Samples
(40%, 60%,
80%)

Route 2

Samples
(20%)

Routes
1 - 18

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Experiments

Routes used in Experiments		
Route ID	Routing from	Routing to
1	Richard Morris Hunt	Hotel Belleclaire
2	Greenbelt Nature Center	Kids Korral
3	Postcards	Greenwich Village
4	Maison sur les toits	NY Skyride
5	JFK	NBC Studios
6	Wyckoff House Museum	Eleanor Roosevelt High Residence
7	The Frederick Hotel	Rose Garden
8	The South Pole	La Casa de los Tenenbaums
9	Delacorte Musical Clock	Le Carrousel
10	Friends Building	Chelsea Market
11	Grand Central Terminal	Times Square Ball
12	New York Stock Exchange	Madagascar!
13	World of Birds	Butterfly Garden
14	World of Reptiles	Congo Gorilla Forest
15	Brooklyn Bridge	Gapstow Bridge
16	Coney Island Cyclone	Central Park Carousel
17	Times Sqaure	One World Trade Center
18	Manhattan Bridge	Lower East Side Skatepark

Results & Discussion

Optimized less polluted route (green and longer) Vs. distance-based route (red and shorter)



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Results & Discussion – Population Data

Calculating Hausdorff Distance
between shortest path of distance vs
PM Rating - Population

Route ID	Result
1	0.000763589
2	0.000763589

Calculating Hausdorff Distance
between shortest path of distance
vs NO2 Rating - Population

Route ID	Result
1	0.000763589
2	0.000763589

Results & Discussion – Sample Data

Calculating Hausdorff Distance between shortest path of distance vs PM Rating - Samples		
Sample Size	Route ID	Result
40	2	0.006156402
60	2	0.006156402
80	2	0.006156402

Calculating Hausdorff Distance between shortest path of distance vs NO2 Rating - Samples		
Sample Size	Route ID	Result
40	2	0.006156402
60	2	0.006156402
80	2	0.006156402

Results & Discussion – 20% Sample size

Calculating Hausdorff Distance between shortest path of distance vs PM Rating (20% stratified sample)

Route ID	Result
1	0.000763589
2	0.000763589
3	0.000763589
4	0.000763589
5	0.000763589
6	0.000763589
7	0.000763589
8	0.000763589
9	0.000763589
10	0.000763589
11	0.000763589
12	0.000763589
13	0.000763589
14	0.000763589
15	0.000763589
16	0.000763589
17	0.000763589
18	0.000763589

Calculating Hausdorff Distance between shortest path of distance vs NO2 Rating (20% stratified sample)

Route ID	Result
1	0.000763589
2	0.000763589
3	0.000763589
4	0.000763589
5	0.000763589
6	0.000763589
7	0.000763589
8	0.000763589
9	0.000763589
10	0.000763589
11	0.000763589
12	0.000763589
13	0.000763589
14	0.000763589
15	0.000763589
16	0.000763589
17	0.000763589
18	0.000763589

Calculating Hausdorff Distance between shortest path of PM Rating vs NO2 Rating (20% stratified sample)

Route ID	Result
1	0
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
16	0
17	0
18	0

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Concluding remarks

- **Conclusion:**

- Routing engine guiding users based on PM ratings (1-5) to tackle PM pollution.
- Use of shortest path algorithm with rating as the weight
- Identical routes generated from both PM_{2.5} and NO₂ data, with Hausdorff distances of 0

- **Future research:**

- Web Application Integration
- Different Geohash encoding (H3 and S2)
- Use AQ data from the whole year
- Combine AQ data (PM and NO₂) → average rating
- Apply to different cities in the world (high pollution)

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