Study and analysis of the effect ofCovid-19 lockdown on Air Quality in India

Group 9

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Problem statement

- To observe and analyse previous AQI data, improvements over the AQI, measure of significance of the improvements and correlation of the AQI with the pandemic, across cities in India due to the nationwide lockdown enforced.

Aims

- To find out which cities are safe to live in based on AQI(air quality index) and the probable diseases that can occur in the respective city.
- Sorting cities on the basis of AQI for weekly, monthly and lockdown phases with a sub aim of visualizing the data using data visualization techniques to gain insight into the data
- Prediction of AQI of stations in 2020 if the lockdown was not enforced, with the aim of visualizing the changes that have occurred with the lockdown in place.
- Find if the change in AQI levels during the lockdown period was significant in comparison to change in AQI levels during the same time period (March - June) for previous years.
- To test the hypothesis that there exists an implicit relation between the AQI of a city and the number of Covid-19 cases in the same city.

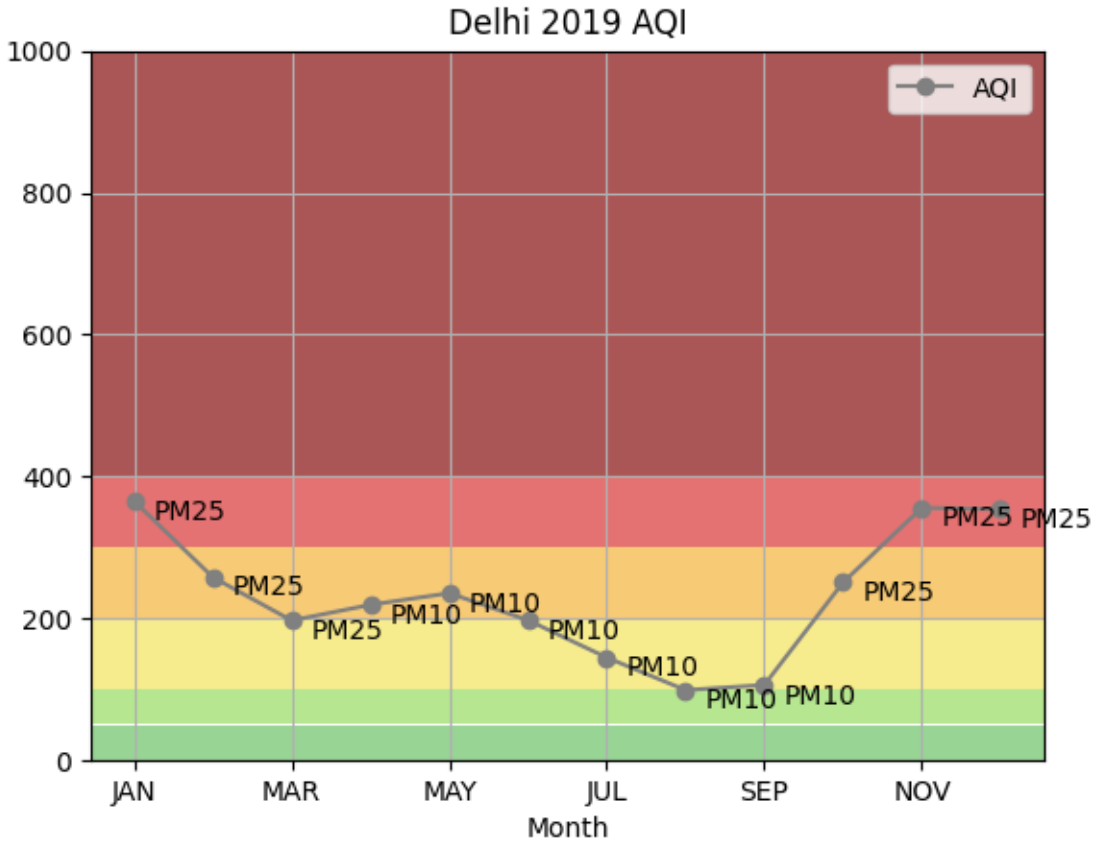
Methodology

- **Aim 1**: Plot average AQI per month and the corresponding prominent air pollutant for the year 2019 across 22 cities. Cross reference the health effects of prominent pollutants with reference 1 and 2.
- **Aim 2**: Plot the AQI per week, month and lockdown phase for prior, during and post lockdown periods across 22 cities.
- **Aim 3**: Train suitable models (SARIMA, LSTM, Mean, Weighted mean and Random walk) to predict the AQI levels during the lockdown period if the lockdown was not enforced for 5 cities.

- **Aim 4**: Use Wilcoxon signed rank test to test whether the change in AQI levels due to lockdown was significant or not.
- **Aim 5**: Use Spearman and Kendall correlation tests to test if there exists a correlation between the total number of positive Covid-19 cases per week and the average AQI value per week for 19 cities.

Results

- **Aim 1**:

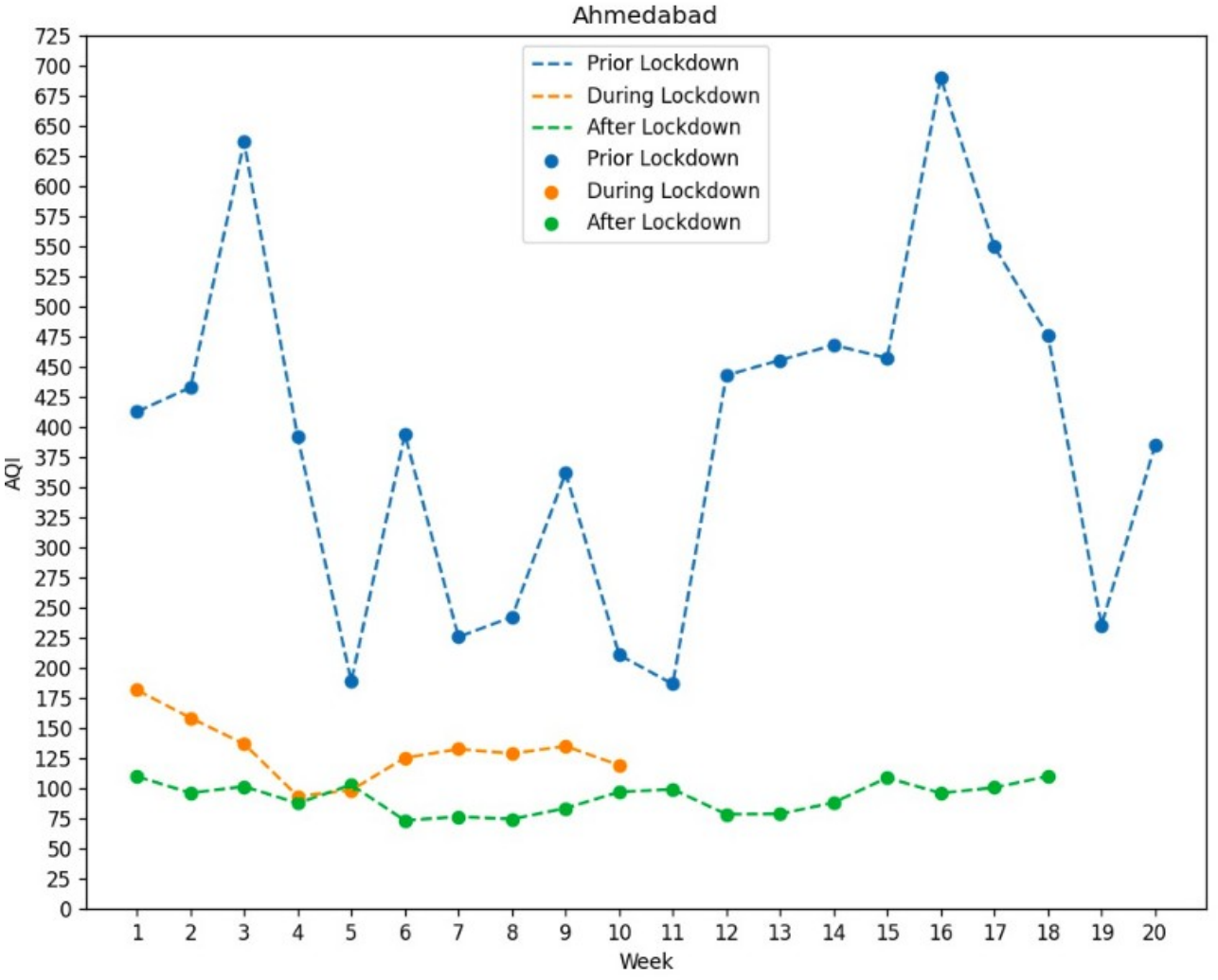


AQI	**Remark**	**Possible Health Impact**
0 - 50	Good	Minimal Impact
51 - 100	Satisfactory	Minor breathing discomfort to sensitive people
101 - 200	Moderate	Breathing discomfort to the people with lungs, asthma and heart diseases
201 - 300	Poor	Breathing discomfort to most people on prolonged exposure
301 - 400	Very Poor	Respiratory illness on prolonged exposure
> 400	Severe	Affects healthy people and seriously impacts those with existing diseases

Pollutant	Health hazards due to poor AQI	Common health effects
Particulate Matter (PM)	Bladder cancer from high exposure Acute myocardial infarctionInflammation in nervous system if it passes through theblood-brain barrier Increases the risk for stroke, Parkinson'sdisease, and neurodevelopmental disorders. Increase of the adherence of virus to respiratorymucus cells and impairment of the resistance ability ofimmune system Higher risk of lung cancer	Decrease in pulmonary function Increase of infections Increase in respiratory symptoms Acute exacerbations of COPD Onset of asthma More hospitalizations Increased respiratory mortality Higher prevalence of childhood asthma
Ozone (O_3)	Increases risk of appendicitis Increases risk of perforated appendicitis	
Nitrogen dioxide (NO_2)	Increases mortality Increases risk of childhood asthma Long exposure increases susceptibility to respiratory infection	
Carbon monoxide (CO)	High concentration reduces the amount of oxygen thatcan be transported in the blood stream to critical organs Can cause dizziness, confusion, unconsciousnessConcern for people with some type of heart disease	

- A clear distinction can be seen between two different group of cities, which is lower AQI levels are observed across cities in the Indian peninsula (due to climate conditions).
- A plausible theory over choosing a safer city to live in on the basis of AQI would be to not constraint ourselves to the AQI values only but rather consider the prominent pollutant which dictates the AQI in the city.

- **Aim 2**:


Ahmedabad
Prior Lockdown
During Lockdown
After Lockdown
Prior Lockdown
During Lockdown
After Lockdown
AQI
Week
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
450
475
500
525
550
575
600
625
650
675
700
725
1
2
3
4
5
6
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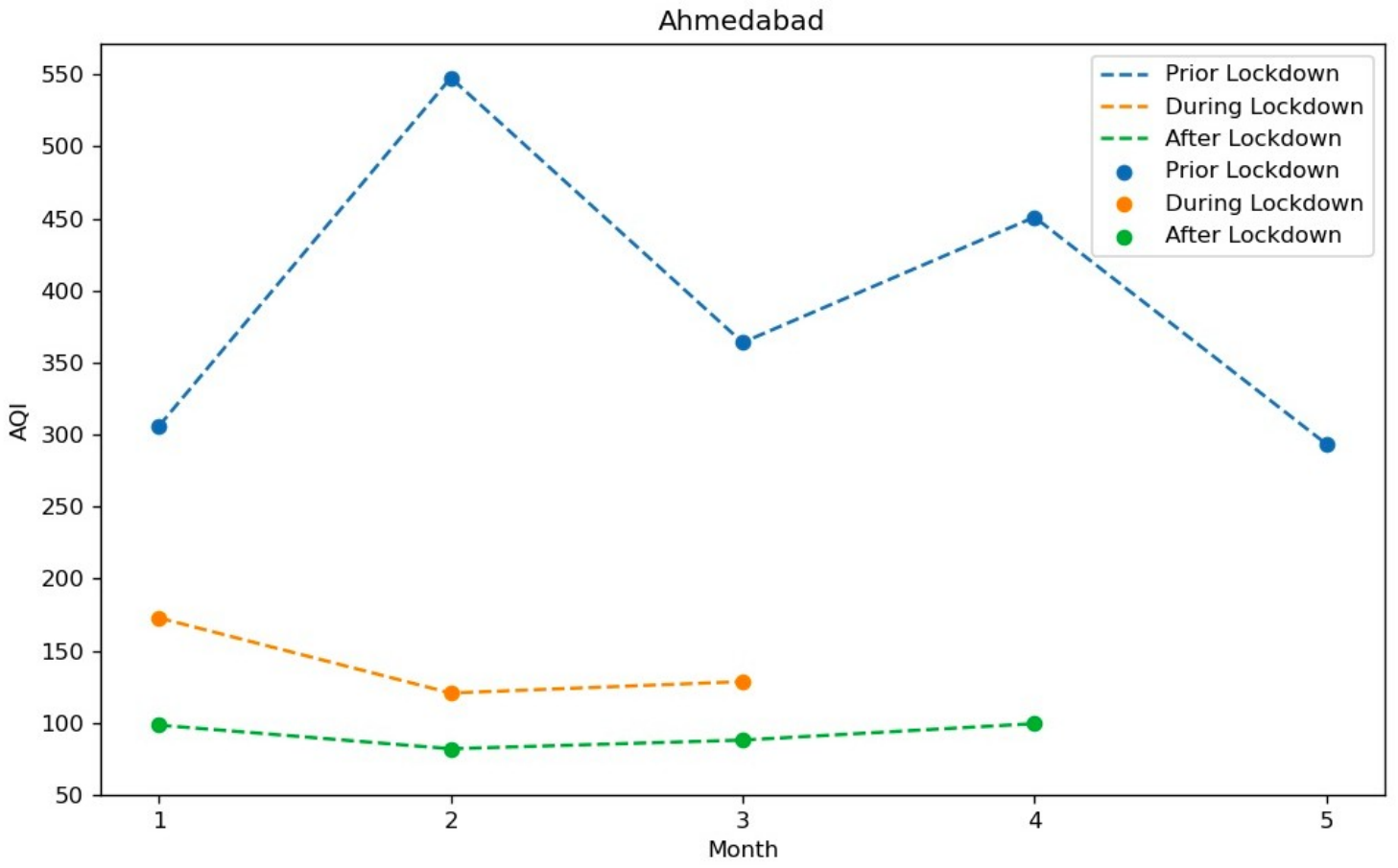
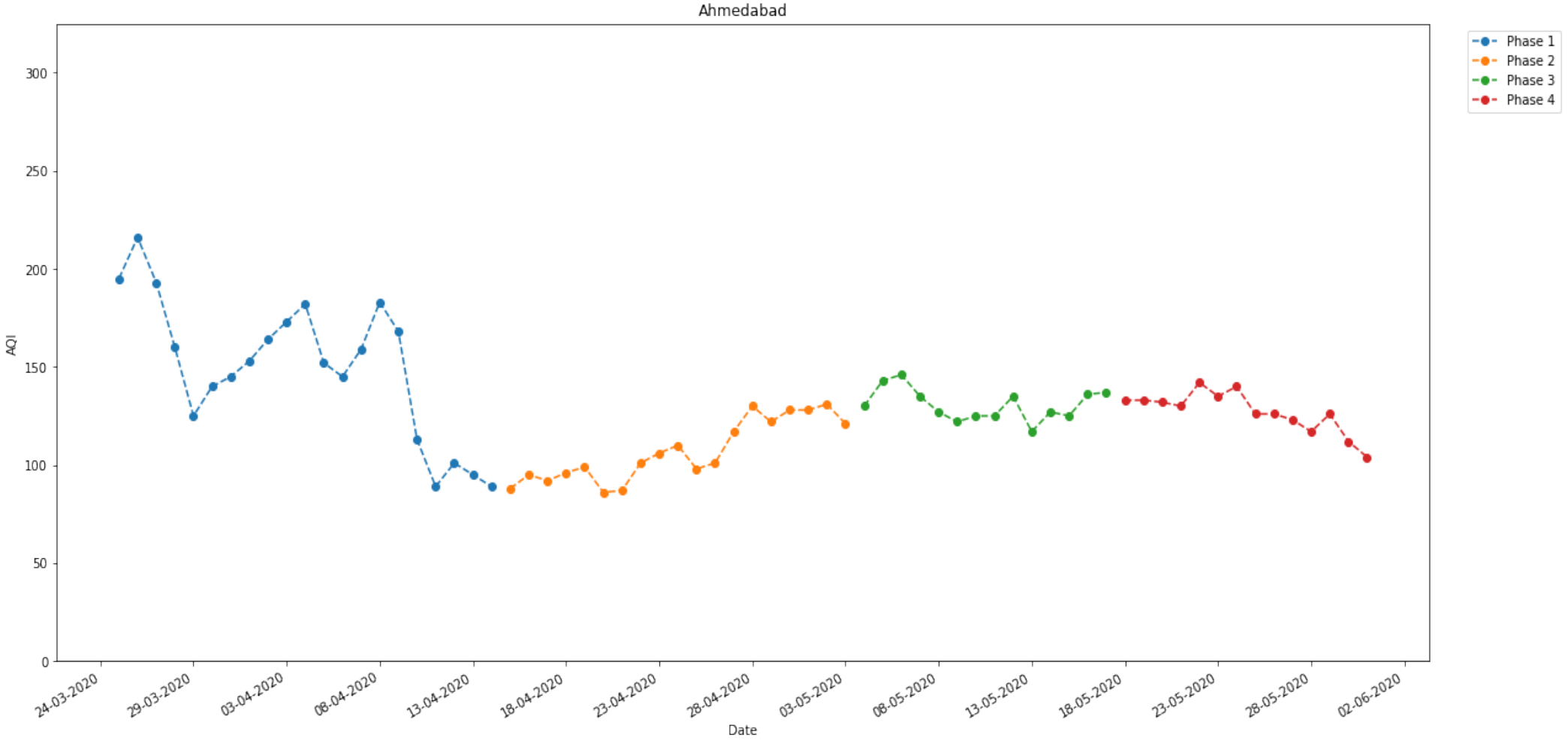
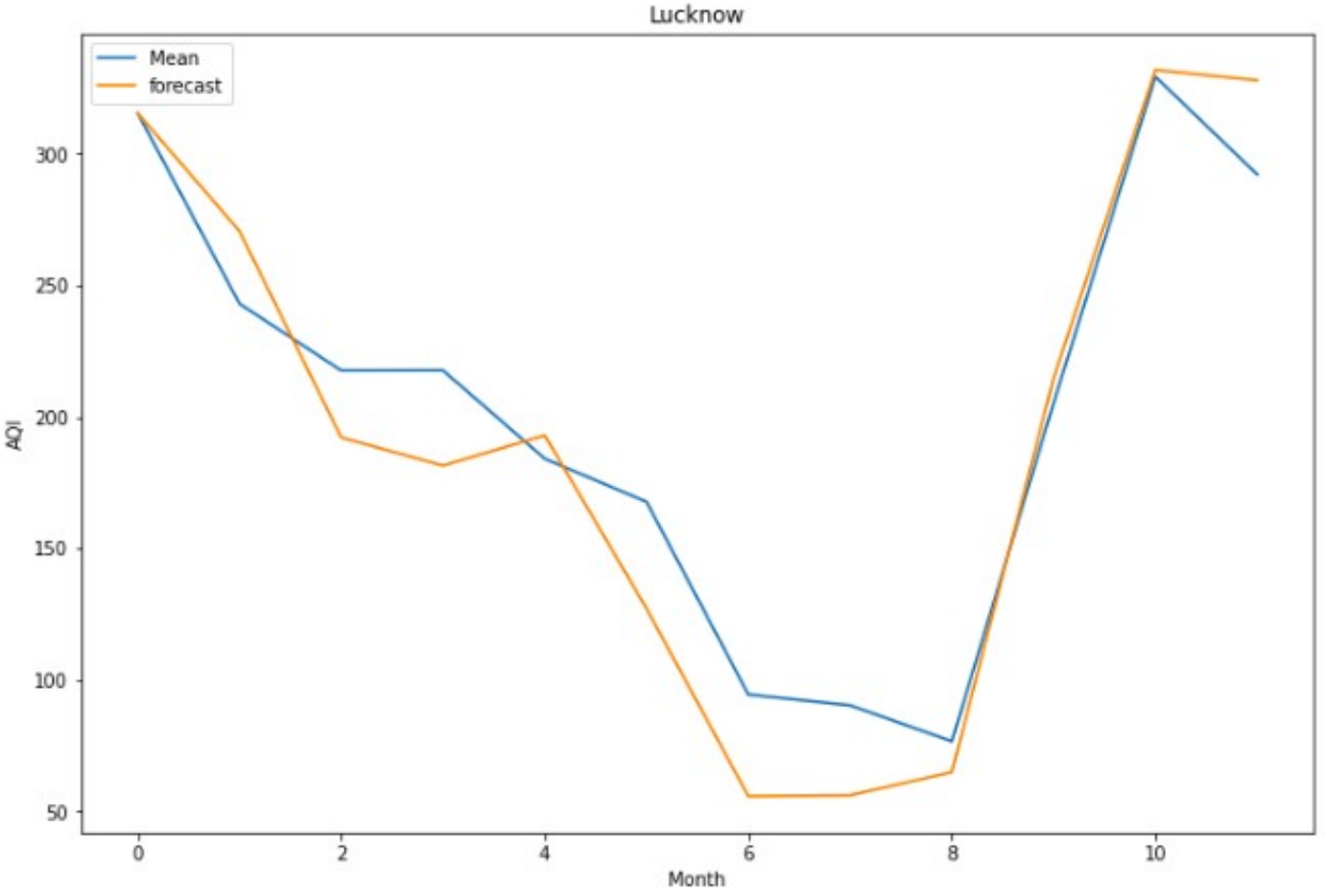
19
20

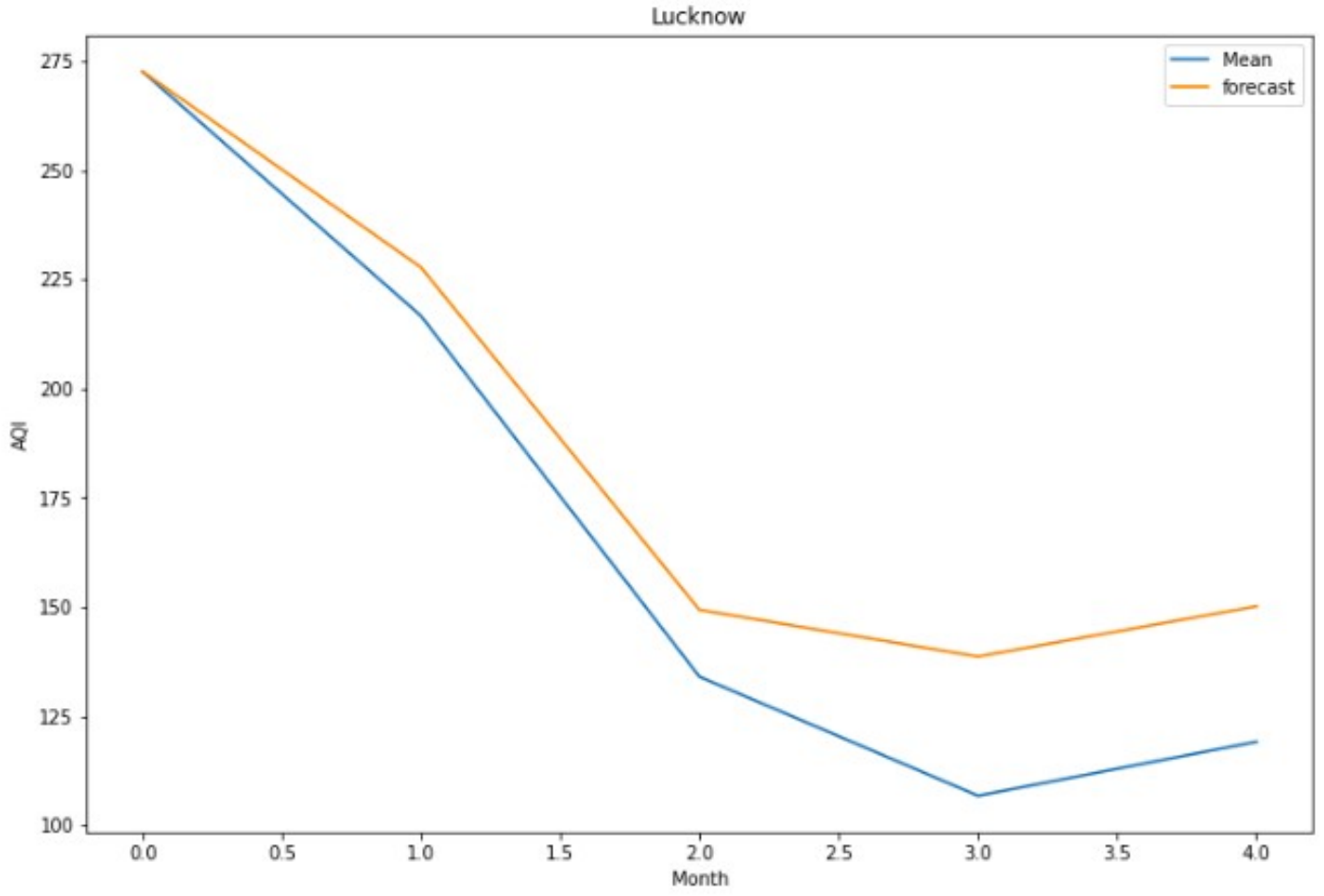

Ahmedabad
AQI
Month
550
500
450
400
350
300
250
200
150
100
50
1
2
3
4
5
Prior Lockdown
During Lockdown
After Lockdown
Prior Lockdown
During Lockdown
After Lockdown


Ahmedabad
Phase 1
Phase 2
Phase 3
Phase 4
AQI
300
250
200
150
100
50
0
24-03-2020
29-03-2020
03-04-2020
08-04-2020
13-04-2020
18-04-2020
23-04-2020
28-04-2020
03-05-2020
08-05-2020
13-05-2020
18-05-2020
23-05-2020
28-05-2020
02-06-2020
Date

- AQI values during and after lockdown lies below 200 for all the cities.
- Some of the cities show increase in AQI in post lockdown period. These cities are Amritsar, Lucknow, Ujjain, Visakhapatnam.
- Most of the southern cities have similar AQI values while northern cities show larger variance. Southern cities like Visakhapatnam, Thiruvananthapuram, Hyderabad, Coimbatore etc. northern cities like Ahmedabad, Lucknow, Delhi, Guwahati etc.
- We can also conclude that during lockdown and some weeks of post lockdown since the AQI values are below 200 for all the cities we can say that the air quality of India overall was cleaner at that time.

- **Aim 3**:


Lucknow
Mean
forecast
AQI
300
250
200
150
100
50
0
2
4
6
8
10
Month


Lucknow
Mean
forecast
AQI
Month
275
250
225
200
175
150
125
100
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

- **Aim 4**:
- The Wilcoxon signed rank test was performed over the five cities. The p-values observed had values of 0.125, 0.875, 0.25, 0.844 and 0.062 for cities Lucknow, Hyderabad, Delhi, Bangalore and Chennai respectively.
- Though the change in AQI levels in Chennai were near significant, in general the change in AQI levels during the lockdown period were statistically insignificant.

- **Aim 5**:

City	Correlation	Method
Ahmedabad	0.34	kendall
Amritsar	-0.03	kendall
Bengaluru	-0.18	spearman
Brajrajnagar	-0.53	spearman
Chennai	0.45	kendall
Coimbatore	-0.29	spearman
Delhi	0.03	kendall
Hyderabad	-0.52	spearman
Jaipur	-0.48	spearman
Kolkata	0.07	kendall
Lucknow	0.04	kendall
Mumbai	0.28	kendall
Patna	-0.63	spearman
Pithampur	-0.19	spearman
Talcher	0.16	kendall
Thiruvananthapuram	0.05	kendall
Ujjain	0.09	kendall
Visakhapatnam	-0.06	kendall

- **Aim 5**:
- There is no correlation between the AQI and Covid cases as most of the correlation values are near 0. There are some cities which shows some correlation which are Brajrajnagar (-0.53), Hyderabad (-0.52), Patna (-0.63).

References

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