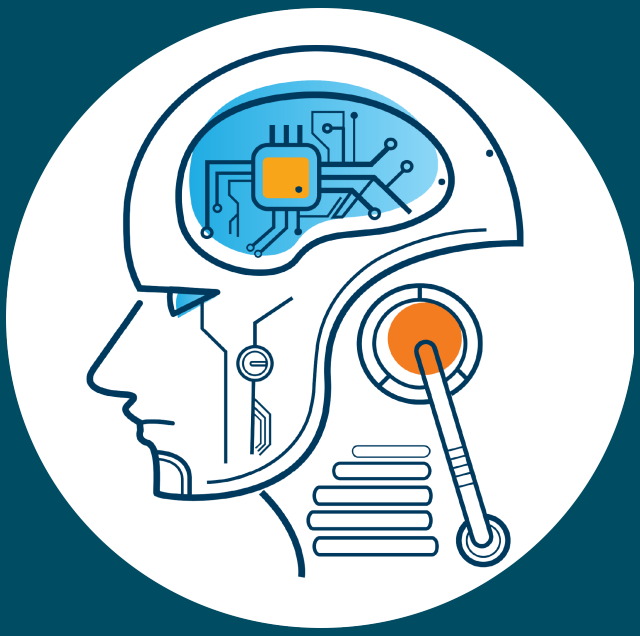
JJAIBOT to Help Combat Air Pollution

A Sustainable Vision for New Delhi's Pollution Problem



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Air Pollution in New Delhi

India's capital is the most polluted city in the world

2.2 million children in Delhi have irreversible lung damage due to the poor quality of the air. In addition, research shows that pollution can lower children's immune system and increase the risks of cancer, epilepsy, diabetes and even adult-onset diseases like multiple sclerosis.

A dense toxic smog in New Delhi blocks out the sun. The Air Quality Index(AQI) level at 100 is considered as normal, but in Delhi the AQI is 267, (https://aqicn.org/city/delhi/) which is considered as unhealthy and fall under “poor” range. The air quality in Delhi has deteriorated to such a level that it is hazardous to health. Air pollution in India is estimated to kill about 2.5 million people every year; it is the fifth largest killer in India.

Poor air quality is a cause of reduced lung capacity, headaches, sore throats, coughs, fatigue, lung cancer, and early death. 2.2 million children in Delhi have irreversible lung damage due to the poor quality of the air. In addition, research shows that pollution can lower children's immune system and increase the risks of cancer, epilepsy, diabetes and even adult-onset diseases like multiple sclerosis.

The state-run Central Pollution Control Board’s air quality index, which shows the concentration of poisonous particulate matter known as PM 2.5, hit 500 about 14 times the US government-recommended level of 35.

Toxic air is choking New Delhi, closing schools and colleges, forcing cars off the road and prohibiting planes from landing at the airport. The pollution is so bad that it can be seen from space. The 20 million residents of New Delhi, one of the world’s most polluted cities, have suffered for weeks under a toxic haze that's up to 10 times worse than the upper limits of what's considered healthy.

"Delhi has become worse than narak (hell)"
– Supreme Court of India

JJAIBOT & Climate Change

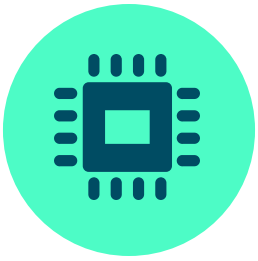
JJAIBOT improves weather forecasting and prediction of extreme events

CLIMATE CHANGE

As the climate changes, accurate projections are increasingly important. However, climate models often produce very different predictions, largely because of how data is broken down into discrete parts, how processes and systems are paired, and because of the large variety of spatial and temporal scales. Most Climate Change reports are based on many climate models and show the range of predictions, which are then averaged out.

PREDICTION

Averaging them out, however, means that each climate model is given equal weight. AI is helping to determine which models are more reliable by giving added weight to those whose predictions eventually prove to be more accurate, and less weight to those performing poorly. This will help improve the accuracy of climate change projections.



JJAIBOT

JJAIBOT can improve weather forecasting and the prediction of extreme events. That's because JJAIBOT can incorporate much more of the real-world complexity of the climate system, such as atmospheric and ocean dynamics and ocean and atmospheric chemistry, into its calculations. This sharpens the precision of weather and climate modeling, making simulations more useful for decision-makers.

JJAIBOT can forecast air pollution, track pollution sources and produce potential strategies to deal with it. It can determine if, for example, it would be more effective to restrict the number of drivers in order to reduce pollution in a particular area.

Gathering Air Pollution Data

Smart sensors, machine learning, predictive analytics and other technologies can all be used to gather this vital information.

Gathering data about specific sources of pollution can help deduce how exactly to cut back on emissions. We then analyze the historical and forecast data.

Volunteers

Volunteers in New Delhi put on backpacks armed with sensors and walked the streets measuring air quality levels.

Traffic Detectors

We gather data from millions of signals every hour that record the flow of traffic across the city. Most of the inputs come from Inductive-Loop Traffic Detectors embedded on streets. Every time a vehicle passes over one, two pieces of data are recorded: the time and place, and the amount of time the sensor was depressed. The first tells us when and how many vehicles are travelling. The second tells us the speed at which a vehicle is moving (the longer the sensor is depressed, the slower the traffic).

Weather & Government APIs

We gather data from World Weather Online, Time & Date, satellite imagery and other Government private APIs.

Air Quality Data

Our air quality data is derived from monitoring stations that collect hourly PM 2.5 AQI (Air Quality Index) data through an API. PM 2.5 refers to the mixture of solid particles and liquid droplets found in the air. PM 2.5 consists of particles smaller than 2.5 μm in aerodynamic diameter. The air quality data is updated every hour. We use geographic data from OSM (OpenStreetMap) to generate a "geographic abstraction" for each monitoring station automatically. The geographic abstraction is used to describe the neighborhood environment for a given location. For example, we compute the built environment, including the length of various road types, the point number of various locations types, area of open spaces, and so on. Then we build geo-context by selecting important features based on the air quality data. We create a fishnet of grid points across New Delhi. With the geo-context, we are able to compute PM2.5 values for the locations in the fishnet that do not have monitoring stations.

Processing Air Quality Data

Forecasting air pollution using either statistical or deep learning models

JJAIBOT uses adaptive machine learning mechanism to train those models and adjust the parameters for each model based on different conditions (i.e. temperature, wind speed/strength, geographic) and selects the optimized one with best performance for each specific situation.

MODEL

We use Encoder - Decoder model that is prominent in Natural Language Processing problems. Besides that, since the collected data are represented as time series or hourly timesteps, we apply Recurrent Neural Networks (RNN) with Long Short-Term Memory units to the prediction model. However, forecasting PM2.5 AQI values is not an easy problem since air pollution may be impacted by many factors and it does not firmly relate to the past repetitive patterns. For training, ADAM algorithm is used as the gradient-based optimizer for faster convergence and lower error ratios. We use a combination of multiple RNN layers model, MAE loss function, and transfer method for outstanding prediction results.

CLEAN

Spark is used to clean irrelevant data, fulfill missing elements, join data from various resources to one jointly dataset, and transform context features into vectors, in which, each vector corresponds to one hour timestep.

TRAIN

We train the model, capture learned weights and create the validation set. According to the collected datasets, we found that in a short period ($\leq$ 5 hours), PM2.5 AQI values fluctuate slightly due to the similarity in meteorological conditions. Therefore, we focus on forecasting long-term state of air pollution ($\geq$ 8 hours). Our encoder-decoder networks for building prediction machines with time series data is very effective and our proposed model shows significant results in prediction PM2.5 AQI of long future based on historical meteorological data. However, to enhance the accuracy of the prediction machine, the model needs to be evaluated more in the future.

Clearing the Air

Through conservation and innovations like JJAIBOT, people around the world will be able to breathe cleaner, healthier air.

FINAL WORD

Governments can use air quality data and forecasts, such as the information from JJAIBOT, to alert people when air quality is bad and advise them to wear masks, avoid certain areas or take other precautions. Based on air quality forecasts, governments and business can also adjust emissions levels to ensure that the air stays at a healthy level.

Technological innovations are transforming how we live, learn and work.