Avoiding European Union yearly air pollutants limits

Deep Learning Artificial intelligence long-term predictions

Long Term Prediction of NO2 KPI of European Commission reference

In recent years, the concentrations of air pollutants have reached critical values in the majority of industrialized cities over the world. These pollutants are dangerous for people's health and the environment. The European Union has set limits for the concentration of the yearly mean value of NO2 which must not exceed 40 μg/m3. The solution developed provides accurate long-term prediction up to 180 days in advance, of the progressive mean value of NO2 with a precision needed to enable decision makers to perform corrections.

		Air Quality Directive		WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration	Comments	Concentration	Comments
$PM_{2.5}$	One day			25 μg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 μg/m³	The target value has become a limit value since 1 January 2015	10 μg/m³	
PM_{10}	One day	Limit value, 50 μg/m³	Not to be exceeded on more than 35 days per year.	50 μg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calendar year	Limit value, 40 μg/m³ (*)		20 μg/m³	
O_3	Maximum daily 8-hour mean	Target value, 120 μg/m³	Not to be exceeded on more than 25 days per year, averaged over three years	100 μg/m³	
NO_2	One hour	Limit value, 200 μg/m³ (*)	Not to be exceeded more than 18 times a calendar year	200 μg/m³ (*)	
NO_2	Calendar year	Limit value, 40 μg/m³		40 μg/m³	

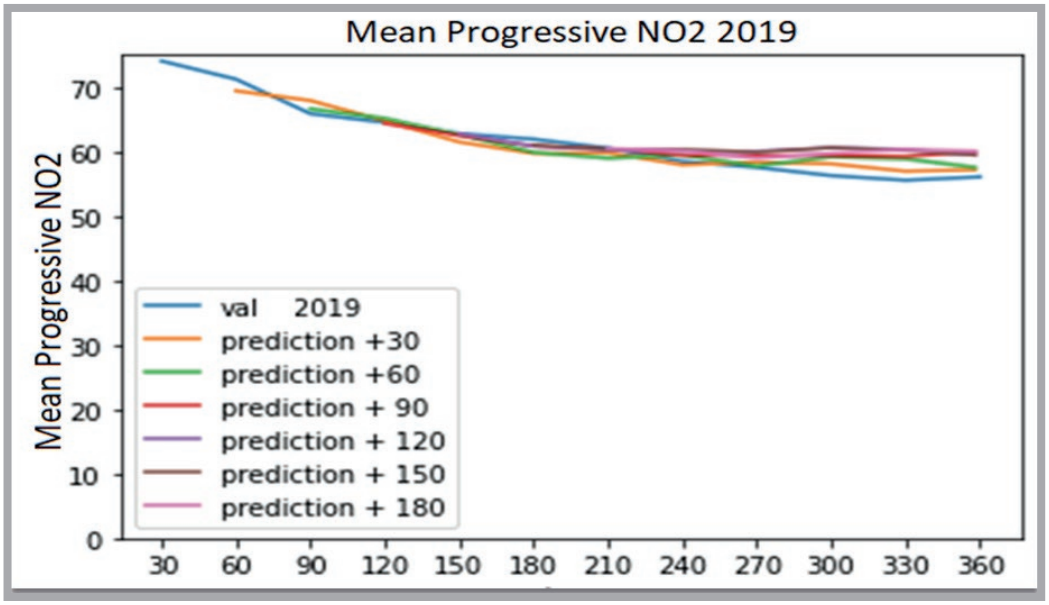
In detail this solution:

- is based on data from a set of **Internet of Things (IoT) sensors** taking into account measures of: pollutants, traffic flow, weather and environmental variables directly acquired on the field.
- the machine learning **AI predictive models** are able to achieve results in this field.
- performs **predictions from 30 days up to 6 months** in the future from the present moment.
- **allows** the realization of **NO2 monitoring dashboards** and solutions for computing and predicting progressive mean value of the pollutant to enable **decision makers** to perform corrections in time to avoid overcome the **EU target limits**.

The Metropolitan **City of Florence** since 2014 **did not respected the limit** imposed by the European Union for the mean yearly value concentration of **NO2 of 40 μg/m3** that is assessed in the critical points of the cities, the major roads.

Since it is a long-term average, it is particularly **complex to correct by imposing last minute traffic restrictions**, even a drastic total closure for a number of days risks to create a marginal reduction on the progressive mean or on the yearly mean value. On the other hand, the effects of **strategic modifications** on the road network that led to a **marginal reduction** on the immediate can be **difficult to monitor**.

There is an extensive literature addressing the problem of air pollution prediction, but the majority of the work are based on short-term periods of hours or at most a couple of days. The presented solution has been used to **monitor the effects of long-term strategies** to reduce the mean yearly value concentration of NO2 providing the **predictions up to 180 days in advance.**



For the problem of **long-term prediction** the AI based solution provides state of the art results with a **mean absolute error of 1.21 µg/m3** for the 30 days ahead prediction up to 2.37 µg/m3 for the 180 ahead prediction **relating on data directly acquired on the territory**. The resulting solution is based on deep learning techniques based on LSTM. The precision in terms of MAPE is of 2.2% for 30 days prediction, and 8% for 180 day predictions.

With Snap4City platform it is possible to get data acquired by the IoT sensors on the territory and elaborate in real time using the AI models developed for the long-term prediction of NO2 concentration. The predictions can be used to develop monitoring dashboard decision makers.

The main component of the dashboard is the trend based on the AI predictions up to 180 days in advance from the current day. In Red are reported the actual mean progressive values of NO2 and in blue the predicted values 30, 60, 90, … 180 days in advance. In green the EU limit of 40 µg/m3.

Extended version accessible from: https://www.snap4city.org/804
Contact: https://www.snap4city.org
Partners: Snap4City, TRAFAIR CEF
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Prediction Performance

Progressive Mean predicted NO2 time trend

8% of error in predicting NO2 progressive mean 180 days in advance

Monitoring Dashboards

Available as a service