Air pollutant modeling using Recurrent Deep Networks

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Introduction

In this work, a Recurrent Neural Network LSTM is used for predicting the concentrations of hourly airborne pollutants concentrations, PM10 (breathable particulate matter of 10 micrometers), which have a behavior highly nonlinear, being extremely difficult to model it accurately [1]. The data are from RAMA (Red Automática de Monitoreo Atmosférico, México city), and from MACAM II-RM (Red de Monitoreo Automático, ciudad de Santiago, Chile). Both cities present very high pollution, due to the high emission of particulate matter, especially in winter. This is a case where Artificial Neural Networks have found important applications.

Background

In certain applications, such as time-series forecasting, the correct output depends on the output at previous steps, or on the temporal context of the data. There are two basics approaches for dealing with time-series data: standard feedforward networks or recurrent networks. The first one type of network computes an analytic function on the current input data, but have no intrinsic capability to remember past history. To provide time context, it can be encoded externally and presented to the network. A more direct method of including temporal information is the recurrent network. This type of network is “recurrent” in the sense that it can reuse past states as inputs to predict next or future states. That is to say, they have memory, which allows past behaviors to be incorporated into future behaviors, which contain feedback connections, enabling them to encode temporal context internally [2], (like Jordan network or Elman network). A Long-Short Term Memory (LSTM) network is a kind of artificial neural network used in the fields of artificial intelligence and deep learning for time-series prediction.

Data and Results

The data was extracted from the RAMA and MACAM II networks. For the RAMA network, six monitoring stations were considered in this study, with PM10 hourly data, from the years 2010 to 2018. In turn, three monitoring stations were considered from the MACAM II-RM network and for the years 1997 to 2019 with PM10 hourly data.

We have implemented two networks model for both databases: LSTM and LSTM-ACO (for Ant Colony Optimization). The model presented is robust for metropolises such as Santiago de Chile and Mexico City, with urban and climatic differences.

To evaluate the performance of a deep recursive memory network (LSTM), the metrics of precision, recall, F1-score, accuracy and the confusion matrix can be used.

Preliminary results show good performance for both networks implemented.

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References

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