Recurrent Neural Network (RNN), Long short-term memory (LSTM) for Aerosol Optical Depth (AOD) using NASA's MERRA-2 Reanalysis

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Predication of temporal trends of aerosol optical depth (AOD) within the numerical climate models with enabled chemistry module is very challenging and computationally expensive. In this work, new predication model is introduced based on artificial neural networks (ANN) in order to estimate average AOD over Egypt. Long short-term memory (LSTM) algorithm which is artificial recurrent neural network (RNN) architecture, is selected to construct the predication model. Seven input datasets for LSTM algorithm are from NASA's Modern-Era Retrospective analysis for Research and Applications, Version 2 (MERRA-2) reanalysis within period (1980-2017). The seven variables are pressure (PR), temperature (T), wind speed (W), dust surface particulate matter (PM2.5), surface (SO2) and (SO4) concentrations and (CO) concentration. AOD is the output of the trained and validated model. Effects of changing the number of both hidden layers and number of neurons per layers were evaluated.

The results of increasing the number of neurons per one hidden layer revealed that increasing the number of neurons leads to three main finding (a) leads to faster convergence of loss function. (b) Produces more realistic AOD estimation (c) RMSE is reduced by increasing number of neurons. It was also found that, the model with one hidden layer and 50 neurons is the best model setup with RMSE (0.06).

However, our studies showed also that increasing the number of hidden layers has no dominant effect on model RNN performance. The proposed LSTM model showed a very high level of accuracy with percentage 99.94 %. Future work can include more variables that has direct effect on AOD calculations. Both ensemble algorithms and different datasets can have more positive impact on the current proposed model.

Keywords: AOD, LSTM, MERRA-2

