

Artificial Intelligence Applications in the Atmospheric Environment: Status and Future Trends

Kostas D. Karatzas

Informatics Applications and Systems Group, Dept. of Mechanical Engineering, Aristotle
University of Thessaloniki, Greece.

Extended Abstract

The problem of assessing, managing and forecasting air pollution (AP) has been in the top of the environmental agenda for decades, and contemporary urban life has made this problem more intense and severe in terms of quality of life degradation. A number of computational methods have been employed in an effort to model and simulate air quality (AQ). Air pollution is related to various substances, is affected by physical and chemical mechanisms of various spatial and temporal scales, and is regulated in terms of target values that are different to each other. Thus, AP requires for computational and knowledge management tools that are able to deal with its complex (and exiting from the scientific point of view) nature. Moreover, such methods should be able to deal with missing observation data, data of mixed nature (be it nominal, categorical, binary or other), and imitate the behavior and the "intelligence" of the phenomena that need to be modeled and simulated. This means that deterministic modeling, employing fluid mechanics, atmospheric chemistry and physics (the "traditional way for modeling AQ") are not able to "catch" all the aspects of the AP problem. Other methods should be employed, that are able to deal with knowledge extraction and management, and are able to map knowledge into the "intelligence" of the algorithms that they apply. On this basis, Artificial Intelligence should be used. This is a thesis recognized already from the 90ties, where the first sets of scientific publications in areas like neural networks and fuzzy logic have appeared with applications in AQ.

In the first era of AI applications to AP problems, a variety of methods was tested, with the aim to investigate existing observation data (available in the form of time series), and forecast parameters of interest (i.e. concentrations). Such methods included Artificial Neural Networks, Decision Trees, and Fuzzy Logic algorithms (to name some of the most representative ones). Then, the effort was also to extract knowledge and thus reveal interrelationships between parameters of interest (i.e. meteorological dependencies of concentrations, relations between pollutants,

etc). On this basis, methods like principal component analysis were also applied. In a step to further investigate relationships, understand mechanisms of pollution and forecast the behavior of pollutants, additional (supervised and unsupervised) algorithms of AI were employed. These included methods like Self Organizing Maps and Clustering. In parallel, there was an effort to formally represent the knowledge that is being made available (or is being extracted) from the AQ field. This is where AI communicated to software engineering methods like Ontologies and Semantic Web languages.

Future trends involve the automation of the processes of knowledge extraction and representation, in order to deal with data being available sporadically and dynamically, as in the case of a mobile user. In addition, contemporary, personalized electronic information services, call for methods that may support environment related decision on the basis of "negotiations" made on the fly (by applying AI methods like agents). Moreover, research work is undertaken on the methods applied for feature selection in order to "feed" the AI algorithms. This selection is now based on the usage of various methods that screen all available (or the most promising) feature combinations, with the aid of genetic algorithms, information gain criteria and multiple regression schemes (to name just some of the existing or emerging methods in this area). In this presentation, issues related to the past, present and future of AI applications in the AQ field are going to be addressed.