

Chapter 47

Application of Biologically Inspired Techniques for Industrial and Environmental Research via Air Quality Monitoring Network

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ABSTRACT

Industrial and environmental research will always involve the study of the cause-effect relationship between the emissions and the surrounding environment. Qualitative and mixed methods researchers have employed a variety of Information and Communication Technology (ICT) tools, simulated or virtual environments, information systems, information devices, and data analysis tools in this field. Machine-enhanced analytics has enabled the identification of aspects of interest such as correlations and anomalies from large datasets. Chemical facilities have high risks to originate air emission events. Based on an available air-quality monitoring network, the data integration technologies are applied to identify the scenarios of the possible emission source and the dynamic pollutant monitor result, so as to timely and effectively support diagnostic and prognostic decisions. In this chapter, the application of artificial neural networks for such applications have been developed according to the real application purpose. It includes two stages of modeling and optimization work: 1) the determination of background normal emission rates from multiple emission sources and 2) single-objective or multi-objective optimization for impact scenario identification and quantification. They have the capability to identify the potential emission profile and spatial-temporal characterization of pollutant dispersion for a specific region, including reverse estimation of the air quality issues. The methodology provides valuable information for accidental investigations and root cause analysis for an emission event; meanwhile, it helps evaluate the regional air quality impact caused by such an emission event as well. Case studies are employed to demonstrate the efficacy of the developed methodology.

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INTRODUCTION

Biologically inspired techniques or biologically inspired algorithms is a category of algorithms that imitate the way nature performs. This category has been quite popular, since numerous problems can be solved without rigorous mathematical approaches. They have included the methodologies of artificial neural networks (ANN), genetic algorithms (GA), evolutionary algorithms (EA), particle swarm optimization (PSO), ant colony optimization (ACO), fuzzy logic (FL) and the other methods. This chapter aims to provide their potential application in the industrial and environmental research. Actually we will always involve the study of the cause-effect relationship between the emission and the surrounding environment. With the collection and representation of information in a range of ways, software tools have been created to manage and store this data. This data management enables more efficient searching ability of various types of electronic and digitized information. Various technologies have made the work of research more efficient. Biological inspired data mining techniques have been intensively used in different data mining applications such as data clustering, classification, association rules mining, sequential pattern mining, outlier detection, feature selection, and information extraction in healthcare and bioinformatics. The results of the qualitative or mixed methods research may be integrated to reach the research target. Right now, a lot of software tools are available for the analysis to identify patterns and represent new meanings. The programs extend the capabilities of the researcher in terms of information coding and meaning-making. Machine-enhanced analytics has enabled the identification of aspects of interest such as correlations and anomalies from large datasets. Industrial operations always need large amounts of chemicals and fuels in the processing of manufacturing. It have high risks to originate air emission events. Based on an available air-quality monitoring network, the data integration technologies will be applied to identify the scenarios of the possible emission source and their impact to the environment, so as to timely and effectively support diagnostic and prognostic decisions. In this chapter, the application of biologically inspired techniques for such applications have been developed according to the real application purpose. They will have the capability to identify the potential emission profile and spatial-temporal characterization of pollutant dispersion for a specific region, including reversely estimation of the air quality issues. It provides valuable information for accidental investigations and root cause analysis for an emission event; meanwhile, it helps evaluate the regional air quality impact caused by such an emission event as well. Case studies are employed to demonstrate the efficacy of the developed methodology.

BACKGROUND

Biological inspired data mining techniques have been intensively used in different data mining applications such as data clustering, classification, association rules mining, sequential pattern mining, outlier detection, feature selection, and information extraction in healthcare and bioinformatics. The techniques include neural networks, fuzzy logic system, genetic algorithms, ant colony optimization, particle swarm optimization, artificial immune system, culture algorithm, social evolution, and artificial bee colony optimization. A huge increase in the number of papers and citations in the area has been observed in the previous decade, which is clear evidence of the popularity of these techniques. These have included the adoption of such kind of methodologies in the research field of polarization-difference imaging for observation through scattering media (Rowe, Pugh, Tyo, & Engheta, 1995), biologically inspired self-

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