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OmniMetrics
Part II: Applications of neural networks (Ma_NN) in Environmetrics[#]

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(Dedicated to Dr. Y Anjaneyulu, Professor& Director, Trent Lott Geospatial & Visualisation Research Center, Jackson State University, Jackson MS)

ABSTRACT

What the environment and system now are,in fact, a result of yotta_consequences of hexa-micro_processes and peta-macro_processes over, of course,finite (13.7 billion years) time in 5% of universe. The known chemical, biological and meteorological micro processes and their interaction are non-stationary and densely networked. Thus, even in twenty first century, the phenomenon poses a hurdle to model from first principles. Mathematical neural networks (Ma_NNs), data driven suite of algorithms are a subset of nature inspired approaches (Eman)which brought renaissance in computational environmental science during the last quarter century.

Particulate matter (PM10, PM5 and PM2.5), also concerned with health hazards, ishard to model in air. The complexity arises due to variability of meteorological factors and topographic influences. Different species of PM10 in Italy was modelled with Elman-NN. RBF and SLP were successful in forecasting PM2.5. The performance of mechanistic models for NO_x is poor, while MLP was successful. Operational intricacies of surrounding industries affect SO_2 emission in addition to metrological scenario. NNs yielded better results compared to statistical approach. NH_3, SO_2 and aerosols are modelled successfully with SLP. Aerosols, containing different metal species and particles originating from road dust, industrial/biogenic emission, are classifiedforminor particles by ART-2a-NN. The maximum emission of NH_3 from manure storage is modelled with NNs and the number of inputs is less compared to Michaelis-Menten model. Here, mechanistic models are inadequate while MLR fails. Electronic nose, developed for pollen detection uses NNs. Compared to PCA, NNs achieved subtle distinction of major classes. Further, they enabled partial resolution of even classes.

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The ground water quality with rain-water infiltration and extraction of knowledge from use of ground water/land was modelled withSOM-NN. NNs performed better than ARIMA in hydrology and management of flood/watershed. A complex urban and rural water resource management with 1200 subsystems and 100,000 variables necessitated the use of NNs and fuzzy inferencesystem (FIS). The turbidity and color of treated drinking water was predicted with NNs. Transportable NN model was developed for annual water supply. The optimum amount of alum in drinking water treatment plants (DWTPs) in Australia is estimated with NNs. Employing NNs, Chlorcast models residual chlorine in drinking water tank and distribution system in Sanite-Foy with success in real time.

In effluent of waste water treatment plant (WWTP), MLP estimates the concentration of nitrogen as ammonia better than activated sludge model (ASM-1). Recurrent NN is used in modelling and control of combined sewer systems (CSS) in WWTP, Washington. The activation/deactivation of pumps in WWTP (which were earlier managed by human operators)are planned through NNs,. A plant in Taiwan uses a multi-objective control strategy involving NN, fuzzy logic and genetic algorithm (GA). Two single layer perceptron (SLP-) NNs in sequence are used in WWTP operation, one to control the plant and the other to monitor critical parameters. BOD and SS in treatment plant in different locations are studied as NN time series models.

The soil surface, a heterogeneous medium of chemicals, is the terrain platform for life of animals and humans. The composition and quality of soil is also at stake due to anthropogenic and non-anthropogenic reasons. The increase in concentrations of pollutants in sub- and deep- surface of soil is mainly due to drainage of domestic/ untreated industrial wastes. The distribution over wider surface is a consequence of streams, floods, riverine flows etc. The model independent paradigm, neural networks, is a versatile tools to predict the coming up scenario and has been used to implement control measures in keeping health of soil to derive quality foods, medicinal plants and edible weeds etc.

Keywords: Particular matter (PMx), Water sources, Potable water, Pollution, Waste_ water_treatment_plant, Environmetrics, Neural networks, Persistent organic pollutants, Pristine environ ment, Oil spills, rain fall, floods, ground water, soil, Environmental protection agency.