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New Computational Intelligence model for predicting evaporation rates for saline water

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Abstract

In this study we introduce a new idea of utilizing algorithms from the Computational Intelligence community in building accurate models for saline water evaporation rates. Three experimental methods were used to measure the evaporation rate for different brine concentrations, different water and air temperatures, and different air velocities. A large set of experimental data was collected and then used in creating these models. Two algorithms were applied in the learning process: neural network (NN) with a gradient-descent algorithm, and a hybrid system composed of NN trained by a genetic algorithm (GA). Each algorithm was allowed to use the same training time. The resulting models show excellent accuracy compared to the state-of-the-art models existing in the literature.

Keywords: Water salinity; Neural network; Genetic algorithm; Computational Intelligence

1. Introduction

Computational Intelligence is a fairly new category of algorithms in the Artificial Intelligence community covering fairly new fields like evolutionary computing, fuzzy computing and artificial neural networks [23]. These algorithms are proven in wide area of applications to be very practical and useful to solve real world problems where deterministic solutions are hard to obtain. In many situations, researchers try different combinations of the above three disciplines to create a much powerful tools than each one separately.

In this paper we are proposing a new hybrid system that combines the power of both Artificial Neural Networks (NNs) and Genetic Algorithms (GA) to tackle the problem of approximating the

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behavior of evaporation rate for saline water. In the next section we describe the main idea behind simple Neural Networks and Genetic Algorithms. We followed that by describing how researchers managed to combine both techniques together for different range of problems. Section 3 details the water evaporation rate prediction problem. The section continues to talk about different factors to be considered when building water evaporation model. The section also addresses the historical attempts researchers did to solve such problem. Section 4 describes experimental sets and procedures under which we managed to collect real data about saline water evaporation rate under different attribute variations. Section 5 shows our proposed algorithm to tackle such problem. Section 6 explains two sets of experiments where we applied our model against others to empirically show its superiority. Finally, Section 7 concludes the paper.

2. Neural networks and genetic algorithms

Neural networks (NN) are algorithms designed to model the way in which the human brain performs ordinary learning tasks, while genetic algorithms (GA) are type of algorithms, which mimic the species biological evolution process by evolving a population of potential solutions to a specific problem according to the Darwinian principle of natural selection. Neural networks works well on learning the behavior of complex systems where many factors interact with each other. On the other hand, genetic algorithms do an excellent job in optimization problems where regular deterministic approaches fail. The following subsections introduce both techniques for the reader.

2.1. Neural networks

NNs are distributed systems with massive interconnection (i.e. topology) between large numbers of simple processing units (neurons) as shown in Fig. 1. Those simple processing units store experiences, learned so far, and make it available for use later. Most artificial neurons are simple summing programs. They take the sum of their input activations, and then, depending on their internal state, activate their output. The NN is judged on its ability to successfully produce a correct output given a certain set of inputs. NNs are helpful for solving behavior-modeling problems that are difficult for traditional computer science approaches. The potential of the NNs to provide significant advances in the application of modeling engineering problems rests on their ability to model complex physical phenomena, even in the presence of noisy data, and on their ability to tackle nonlinear problems. There are different type of neural networks in the literatures differs in topologies used to interconnect the neurons or the training algorithms used to train the network.

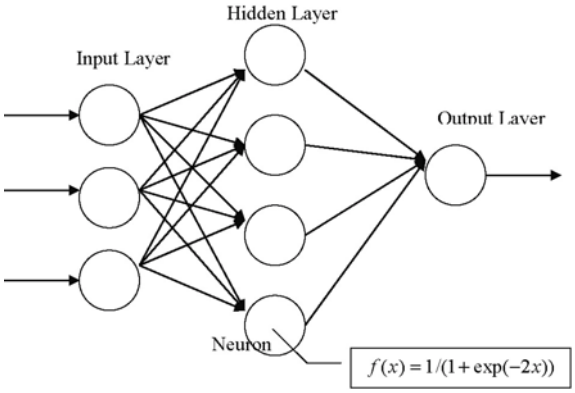

Fig. 1. Deed-forward neural network example.

2.2. Genetic algorithms

GAs are computer algorithms that use similar biological evolutionary operators like selection, mutation, and crossover to evolve set of potential solutions for an optimization problem. They work on a population of candidate solutions (called