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Analysis & Applications of Soft Computing Techniques in Electrical Power System

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ABSTRACT

Soft Computing is a relatively new computing paradigm bestowed with tools and techniques for handling real world problems. The main components of this computing paradigm are neural networks, fuzzy logic and evolutionary computation. Each and every component of the soft computing paradigm operates either independently or in coalition with the other components for addressing problems related to modeling, analysis and processing of data. An overview of the essentials and applications of the soft computing paradigm is presented in this chapter with reference to the functionalities and operations of its constituent components. Neural networks are made up of interconnected processing nodes/neurons, which operate on numeric data. These networks posses the capabilities of adaptation and approximation. The varied amount of uncertainty and ambiguity in real world data are handled in a linguistic framework by means of fuzzy sets and fuzzy logic. Hence, this component is efficient in understanding vagueness and imprecision in real world knowledge bases. Genetic algorithms, simulated annealing algorithm and ant colony optimization algorithm are representative evolutionary computation techniques, which are efficient in deducing an optimum solution to a problem, thanks to the inherent exhaustive search methodologies adopted. Of late, rough sets have evolved to improve upon the performances of either of these components by way of approximation techniques. These soft computing techniques have been put to use in wide variety of problems ranging from scientific to industrial applications. Notable among these applications include image processing, pattern recognition, data mining, artificial intelligence etc.

Keywords: Soft Computing, Fuzzy Logic, Neuro Computing.

INTRODUCTION

Soft computing techniques have been studied for many years and achieving computational performance. The achievements benefits include massive fast speed, high fault tolerance and adaptive capability. The soft computing techniques include ANN, fuzzy logic, and particle swarm etc.

Artificial neural networks (ANN) applications to power systems can be categorized as regression, classification and combinatorial optimization. Applications including relapse incorporate transient solidness examination, load anticipating, consonant assessment Applications including characterizations incorporate symphonious burden ID, static and elements investigation. The area of combinational enhancement incorporates unit responsibility and capacitor control Artificial neural network are comprised of basic profoundly interconnected handling units called neurons every one of which perform accumulation of its contributions from different neurons and age of a result from the totaled information sources.

An association between a couple of neurons has a related mathematical strength called synaptic weight. The advancement of ANN includes two stages: preparing or learning stage and testing stage. Preparing of ANN is finished by giving the network models called preparing designs. During preparing, the synaptic loads get adjusted to show for that issue. As the network has taken in the issue it could be tried with new obscure examples and its effectiveness can be checked. Contingent on the preparation Imparted, ANN can be delegated directed ANN and solo ANN.

The administered ANN requires the arrangements of information sources and the results for its preparation. During the preparation, the result from the ANN is contrasted and the ideal result (target) and the distinction (blunder) is decreased by utilizing some learning calculation. This preparing is rehashed till the genuine result secures an adequate level. Regulated ANN might be a feed forward or non repetitive network like Multi Layer Perceptron (MLP), Functional Link Net and Radial Basis Function, or a criticism or intermittent ANN. The limit of variation to system information and the office to perform new undertakings are a portion of the benefits of these strategies. ANNs are equal designs that generally require modest quantities of memory and handling time. ANNs can store information in a dispersed design and thus have a high adaptation to non-critical failure. Learning calculations used to prepare ANNs can be managed or solo. In administered learning calculations, information and result matches are outfitted and the association loads are changed regarding the mistake among wanted and acquired yield.

The artificial neural network which doesn't need a manager or instructor for preparing is known as solo ANN. In serious or unaided learning units of the result layer seek the opportunity to answer a given info design. The instances of solo learning are Kohonen's Self-arranging Feature Map and Adaptive Resonance Theory. The back spread learning calculation is the most often involved strategy in preparing the networks, and proposed as an electrical burden estimating approach in this paper. For the culmination of the paper, the back engendering calculation will be presented momentarily. The back propagation learning calculation is a speculation of the Widrow-Hoff blunder remedy rule. The first Widrow-Hoff method framed a blunder signal, which is the contrast between what the result is and what it was assume to be, i.e., the reference or target yield. Synaptic qualities, or loads, were changed with respect to the blunder times the information signal, which lessens the mistake toward the angle. In a multi-facet network containing stowed away units, that is to say, units that are neither information nor yield units, the issue is significantly more troublesome. The blunder sign can be shaped as in the past, however numerous neurotransmitters can bring about the mistake, in addition to the ones at the result units. We can't straightforwardly process the blunder signal for buried units since we not have the foggiest idea about the objective results of the secret units.

APPLICATIONS TO POWER SYSTEMS

A few critical highlights of neural networks strategies are advancing as a visual demonstration progressively, conveyed memory, adaptation to internal failure and smooth corruption, constant example acknowledgment, clever affiliation and union. Load determining is a reasonable issue for ANN application because of the accessibility of verifiable burden information on the utility data sets.

ANN plans utilizing perceptron network have been fruitful in present moment as well as long haul load determining with amazing precision. A joined utilization of Unsupervised and regulated learning was finished for momentary burden determining. The heap information were broke down and the heap designs were characterized. The ongoing burden is impacted by the past burdens and the example in which the ongoing burden is incorporated. The absolute number of preparing models relies upon as far as possible and presumptions, on the network design and the normal outcome blunder.

The growing experience of the neural network is performed for various conditions of the outside network, as the conditions of the inside network are constantly known. A multi-facet neural network with a backpropagation learning calculation was utilized. Load Flow: LF is an unquestionable necessity for settling countless power system issues. Load stream strategy in view of MLP model with genuine and receptive burden requests at load Buses as data sources. The result hubs gave ∂ at all PQ transports. Load determining: Load estimating is a reasonable issue for ANN application because of the accessibility of verifiable burden information on the utility data sets.

ANN plans utilizing perceptron network have been fruitful in present moment as well as longterm load guaging with great precision. A joined utilization of Unsupervised and regulated learning was finished for transient burden guaging. The heap information were investigated and the heap designs were arranged. The ongoing burden is impacted by the past burdens and the example in which the ongoing burden is incorporated.

NEURAL NETWORKS

A neural network is a powerful data-modeling tool that is able to capture and represent complex input/output relationships similar to a human brain. Artificial neural networks resemble the human brain in the following two ways:

• A neural network acquires knowledge through learning.
• A neural network's knowledge is stored within inter-neuron connection strengths known as synaptic weights.

The true power and advantage of neural networks lie in their ability to represent both linear and non-linear relationships and in their ability to learn these relationships directly from the data being modeled.

Artificial Neural Network

An artificial neural network as the name suggests, is an equal and layered interconnected construction of countless artificial neurons, every one of which comprises a rudimentary computational crude. The circulated portrayal of the interconnections through huge parallelism accomplished out of the intrinsic network structure, presents to such networks properties of agile debasement and adaptation to internal failure. These network structures vary starting with one then onto the next in the geography of the basic interconnections as well as on the objective issue they are put to. Since the substance of neural network activity depends on the way of behaving of human cerebrum, these networks require a type of preparing or learning skill. Once these are prepared with the various parts of the main concern, they can be utilized to take care of comparable issues given the colossal speculation abilities inserted in that. Contingent upon the sort of learning technique embraced, different neural network models have advanced occasionally [haykin99, kumar2004]. In the most broad structure, an artificial neural network is a layered design of neurons. It involves seven fundamental parts [kumar2004],viz.

(i) neurons,

(ii) activation state vector,

(iii)activation function,

(iv) connection topology,

(v) activity aggregation rule,

(vi) learning rule and

(vii) environment.

these components are discussed in the following sections

APPLICATIONS OF SOFT COMPUTING

The field of soft computing has been successfully applied in a variety of real life applications. Notable among these include image preprocessing and enhancement, pattern recognition, image segmentation, image analysis and understanding, image mining, information processing, networking,

VLSI system design and testing, engineering design, information retrieval etc. The following sections illustrate the notable applications of the soft computing paradigm to image processing, pattern recognition and information processing.

Soft computing applications to image processing and pattern recognition

Neural networks have often been employed by researchers for dealing with the daunting tasks of extraction, classification of relevant object specific information from redundant image information bases, segmentation of image data and identification and recognition on objects from an image. Several attempts have also been reported where self-organizing neural network architectures are used for object extraction and pattern recognition.

OTHER SOFT COMPUTING APPLICATIONS

Recently, soft computing tools are being widely used in the domain of data mining and bioinformatics. In data mining, genetic algorithms, neural networks and fuzzy logic are widely used in solving many problems of optimization, feature selection, classification and clustering [Bigus96, Cox2005, Bandyopadhyay2005]. In the domain of bioinformatics, soft computing tools have been used for sequence alignment, fragment assembly, gene and promoter identification, phylogenetic tree analysis, prediction of gene regulatory network, protein structure and function prediction, protein classification, molecule design and docking, to name just a few [Bandyopadhyay2007a, Bandyopadhyay2007b]. Web intelligence is another recent area that has seen a spurt of successful application of soft computing tools [Bandyopadhyay2007a].

ANN Applications To Power Systems

Several key features of neural networks techniques are learning by example in real time, distributed memory, fault tolerance and graceful degradation, real time pattern recognition, intelligent association and synthesis.

Load forecasting is a suitable problem for ANN application due to the availability of historical load data on the utility databases. ANN schemes using perceptron network have been successful in short-term as well as long-term load forecasting with impressive accuracy. A combined use of Unsupervised and supervised learning was done for short-term load forecasting. The load data were analyzed and the load patterns were classified. The current load is affected by the past loads and the pattern in which the current load is included.

The total number of training examples depends on the mentioned limits and assumptions, on the network architecture and the expected result error. The learning process of the neural network is performed for different states of the external network, as the states of the internal network are always known. A multi-layer neural network with a backpropagation learning algorithm was used.

Load Flow:

LF is a must for solving a large number of power system problems. Load flow method based on MLP model with real and reactive load demands at load Buses as inputs. The output nodes provided $|V|$ and ∂ at all PQ buses.

Load forecasting:

Load forecasting is a suitable problem for ANN application due to the availability of historical load data on the utility databases. ANN schemes using perceptron network have been successful in short-term as well as longterm load forecasting with impressive accuracy. A combined use of Unsupervised and supervised learning was done for short-term load forecasting. The load data were

analyzed and the load patterns were classified. The current load is affected by the past loads and the pattern in which the current load is included.

Power System Voltage Stability and Voltage Control are emerging as major problems in the day-to-day operation of stressed power systems. For secure operation and control of power systems under normal and contingency conditions it is essential to provide solutions in real time to the operator in Energy Control Center (ECC). The artificial neural networks (ANN) are emerging as an artificial intelligence tool, which give fast, though approximate, but acceptable solutions in real time as they mostly use parallel processing technique for computation. The solutions thus obtained can be used as a guide by the operator in ECC for power system control.

Actuarial Science

Actuarial science is the discipline that applies mathematical and statistical methods to evaluate risk in the insurance and finance industries. Actuarial science includes a number of interrelating subjects, including probability, mathematics, statistics, finance, economics, financial economics, and computer programming. Historically, actuarial science used deterministic models in the construction of tables and premiums.

Data Mining

Data mining is a subfield of computer science which is the computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems. The overall goal of the data mining process is to extract information from a data set and transform it into an understandable structure for further use. 3.8 Environmental Engineering Environmental engineering is the integration of science and engineering principles to improve the natural environment like air, water, and/or land resources, to provide healthy water, air, and land for human habitation like house or home and for other organisms, and to remediate pollution sites.

Fault-Tolerance

Fault-tolerance is the property that enables a system to continue operating properly in the event of the failure of some of its components. If its operating quality decreases at all, the decrease is proportional to the severity of the failure, as compared to a naïvely-designed system in which even a small failure can cause total breakdown. Fault-tolerance is particularly sought-after in high-availability or life-critical systems.

Feature Selection in machine learning and statistics

Feature selection, also known as variable selection, attribute selection or variable subset selection, is the process of selecting a subset of relevant features for use in model construction. Feature selection techniques are a subset of the more general field of feature extraction. Feature extraction creates new features from functions of the original features, whereas feature selection returns a subset of the features.

Image Processing

In imaging science, image processing is any form of signal processing for which the input is an image, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal processing techniques to it

Industrial Machineries

Industries machineries are tool that consists of one or more parts, and uses energy to achieve a particular goal. Machines are usually powered by mechanical, chemical, thermal, or electrical means, and are frequently motorized. This is used in mechanical engineering.

Materials Engineering

Materials engineering is an interdisciplinary field applying the properties of matter to various areas of science and engineering. This scientific field investigates the relationship between the structure of materials at atomic or molecular scales and their macroscopic properties. It incorporates elements of applied physics and chemistry.

Power Quality Improvement

The power quality is a major issue in a power system. It is important to develop the equipment that can mitigate the problem of poor power quality generated by non linear loads such as adjustable speed drives, traction drives and power converters have contributed for the deterioration of the power quality and this has resulted in to a great economic loss. Because of poor power quality many damages to the system, and causes economical impact on the utilities and customers. The power filters which reduced or mitigated the problems of harmonics. The harmonics distortion caused by non-linear load and saturation of magnetization of transformer. The current generated by such load which interacts with power system impedance which causes rise to harmonics. Increase of power losses, and malfunction in communication system due to degradation of power quality at the consumer's terminal.

Voltage collapse study aimed to maximize the loading capability of a particular transmission line. Traditionally shunt and series compensators are used to improve transfer capability of a transmission line. To provide steady state voltage control as well as to minimize transmission losses and enhance power system stability by used of reactive power control method. At present different FACTS devices such as Dstatcom, Dvr, Tcsc and Upfc are used to mitigate the power quality problems such as voltage sag, voltage swell. The FACTS devices control the voltage magnitude and phase angle, at chosen buses or line impedances. The artificial neural network detects the power quality problem which applies to Facts devices to mitigate voltage sags or voltage swell.

CONCLUSION

Artificial neural networks have been effective for learning functional mappings between input and output variables. This is done by adjusting weights of a set of interconnected neurons by learning rules. The multilayered perceptron model (MLP) in ANN is applied for applications to power system. The back propagation technique has been applied for training. Over conventional computing system ANN has variety of advantages. These papers reviews and provide solutions to various power system problems which compared and analyzed with ANN. The brief overview of ANN with modeling and simulation are also presented in this paper. Therefore it can be concluded that artificial neural network is suitable for determining the observability of power system . Applications of the soft computing paradigm is presented in this chapter. This computing framework is essentially built around several intelligent tools and techniques. Notable among them are the neural networks, fuzzy sets, fuzzy logic, genetic algorithms and rough sets. These tools form the backbone of this widely used computing paradigm meant for analysis and understanding of knowledge bases.

Neural networks are used for the analysis of numeric data. These networks comprise interconnected processing units or nodes in different topologies depending on the problem at hand. Fuzzy sets and fuzzy logic deal with the uncertainties inherent in data under consideration by representing the degree of vagueness in terms of linguistic information. Genetic algorithm, simulated annealing algorithm and ant colony optimization algorithm are random search techniques meant for arriving at

an optimum probable solution to a problem. Rough sets also handle the underlying uncertainties in data without even requiring any a priori information regarding the data content and distribution. These techniques are applied extensively in a wide variety of engineering and scientific problems with astounding results.

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