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ARTIFICIAL INTELLIGENCE IN POWER SYSTEMS

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Abstract: *In today's world we require a continuous & definitive supply of electricity for proper functioning in modern and advanced society. AI (AI) may be a field that was found on the idea of human intelligence where AI precisely simulates natural intelligence. AI (Artificial Intelligence) is the mixture of expert task, mundane task and formal task. Power Systems were used from the late 19th century and that they are one among the essential needs that we'd like in our modern, developing day to day life. Power systems are used for transmission and delivering the electricity to all or any machines. AI (Artificial Intelligence) plays a serious role in power systems where they solve different problems in power systems like scheduling, calculating, statistics, forecast. As AI (Artificial Intelligence) was being developed in several fields we could see the impact that it made on the facility systems also, the humanly solved mathematical functions were solved by machines and every one the tasks are performed by the machines.AI techniques became popular for solving different problems in power systems like control, planning, scheduling, forecast, etc. These techniques can affect difficult tasks faced by applications in modern large power systems with even more interconnections installed to satisfy increasing load demand. The appliance of those techniques has been successful in many areas of power grid engineering.*

Keywords - *AI, Artificial Neural Network, Genetic Algorithms, Power Systems, symbolic logic.*

I. INTRODUCTION

Power Systems

An electric power grid may be a network of electrical components wont to supply, transmit and use electrical power. Power systems engineering may be a subdivision of EE that deals with the generation, transmission, distribution and utilization of electrical power and therefore the electrical devices connected to such systems like generators, motors and transformers.

Artificial Intelligence

Commonly, AI is understood to be the intelligence exhibited by machines and software, for instance, robots and computer programs. The term usually wants to describe the project of developing systems equipped with the intellectual processes, features and characteristics of humans, just like the ability to think, reason, find the meaning, generalize, distinguish, learn from past experience or rectify their mistakes. Artificial general intelligence (AGI) is that the intelligence of a hypothetical machine or computer, which may accomplish any intellectual assignment successfully, which a person's being, can accomplish.

AI in Power Systems

Power system analysis by conventional techniques becomes harder because of: (i) Complex, versatile and enormous amounts of data, which is employed in calculation, diagnosis and learning. (ii) Increase within the computational period of time and accuracy thanks to extensive and vast system data handling.

The modern power grid operates on the brink of the bounds thanks to the ever-increasing energy consumption and therefore the extension of currently existing electrical transmission networks and features. This example requires a less conservative power grid operation and control function, which is feasible only by continuously checking the system states during a far more detailed manner than it had been necessary. Sophisticated computer tools are now the first tools in solving the difficult problems that arise in the areas of power grid planning,

operation, diagnosis and style. Among these computer tools, AI has grown predominantly in recent years and has been applied to varied areas of power systems.

II. PROBLEMS IN POWER GRID PROTECTION

The problems result mainly from the trade-off between the safety demand (no false trippings), and therefore the reform the speed of operation and the dependability (no missing operations) requirements. The safer is that the relay (both the algorithm and its particular settings), the more it tends to misoperate or operate slowly. In addition, the other way around, the faster is that the relay, the more it tends to work falsely. The issues listed below reflect the present practice in power grid protection.

There are two ways to mitigate the matter of limited recognition power of the classical relaying principles. One among them is to enhance and extend the measurements available to a given relay (for example, optical CTs for improvement and substation integration for extension). The second way is to enhance the popularity process itself supported what's already available and either look for the new relaying principles, or apply several of known principles in one relay to improve the popularity, or apply correction of the CT and CVT transient error, or improve a kind of fault determination by using of the ANNs classifier, or use self-organizing algorithms like ANNs to seek out automatically a protection principle.

It always takes certain time to estimate the standards signals accurately enough to base the tripping decision on them. They are measured either fast or accurately. There is no perfect digital measuring algorithm that solves this documented conflict between the speed and therefore the accuracy. Either certain pre-filtering is applied, or the essential algorithm uses longer data window; or certain post-filtering is used (or even a mixture of those three means). There is always a level of uncertainty within the estimate of the standards signal at the beginning of a disturbance when the relay operation is usually wanted. In some situations, although imprecise, the worth of the standards signal enables solid decision, but is other cases, like a fault at the top of the protection zone, the relay must await more precise estimate of the standards signals.

III. AI TECHNIQUES

3.1. Artificial Neural Networks (ANN)

Artificial Neural Networks are biologically inspired systems which convert a group of inputs into a group of outputs by a network of neurons, where each neuron produces one output as a function of inputs. A fundamental neuron is often considered as a processor which makes an easy non linear operation of its inputs producing a single output.

They are classified by their architecture: number of layers and topology: connectivity pattern, feedforward or recurrent.

Input Layer: The nodes are input units which don't process the info and knowledge but distribute this data and knowledge to other units.

Hidden Layers: The nodes are hidden units that aren't directly evident and visual . they supply the networks the power to map or classify the nonlinear problems.

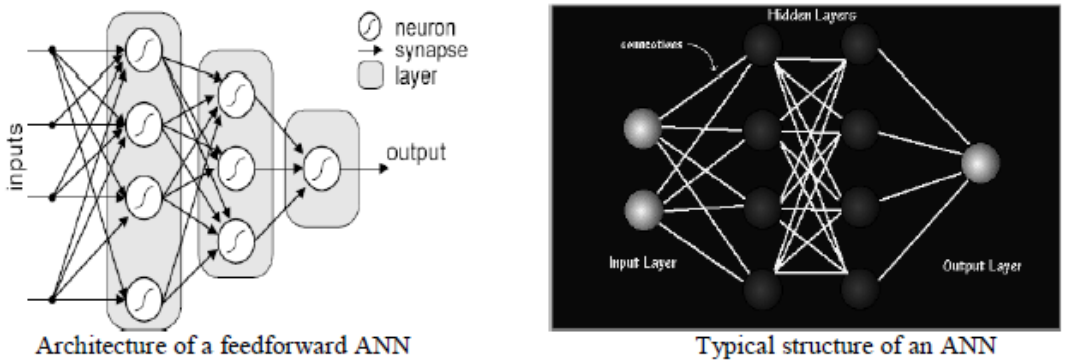
Output Layer: The nodes are output units, which encode possible values to be allocated to the case under consideration.

Advantages:

- Speed of processing.
- They are doing not need any appropriate knowledge of the system model.
- They need the power to handle situations of incomplete data and knowledge, corrupt data.
- They're fault tolerant.
- ANNs are fast and robust. They possess brains and adapt to the info.
- They need the potential to generalize.

Disadvantages:

- Large dimensionality.
- Results are always generated albeit the input file is unreasonable.
- they're not scalable i.e. once an ANN is trained to try to do a certain task, it's difficult to increase for other tasks without retraining the neural network.



Architecture of a feedforward ANN — Typical structure of an ANN

Figure 1:- Architecture & Typical structure of ANN

Applications:

Power system problems concerning encoding of an unspecified nonlinear function are appropriate for ANNs. ANNs are often particularly useful for problems, which require quick results, like those in real time operation. This is often due to their ability to quickly generate results after obtaining a group of inputs. 1.4. How ANNs are often utilized in power systems: As ANNs operate biological instincts and perform biological evaluation of world problems, the problems in generation, transmission and distribution of electricity are often fed to the ANNs in order that an appropriate solution is often obtained. Given the constraints of a practical transmission and distribution system, the precise values of parameters are often determined. For instance , Page 1 the worth of inductance, capacitance and resistance during a transmission line are often numerically calculated by ANNs taking in various factors like environmental factors, unbalancing conditions, and other possible problems. Also the values of resistance, capacitance and inductance of a cable are often given as inputs and a combined, normalized value of the parameters are often obtained. During this way electrical phenomenon and proximity effects are often reduced to a particular extent.

3.2 Genetic Algorithms (GA)

Genetic algorithm is an optimization technique that supports the study of survival and natural genetics. Its fundamentals is that the fittest individual of a population has the very best probability and possibility for survival. Genetic algorithms give a worldwide technique supporting biological metaphors.

The Genetic algorithm are often differentiated from other optimization methods by:

3.2.1 Genetic algorithm works on the coding of the variables set rather than the particular variables.

3.2.2 Genetic algorithms look for optimal points through a population of possible solution points, and not one point.

3.2.3 Genetic algorithms use only objective function information.

3.2.4 Genetic algorithm uses probability transition laws, not the deterministic laws

A genetic algorithm springs from an elementary model of population genetics. it's the subsequent components:

(i) Chromosomal representation of the variable describing a private .

(ii) An initial population of people .

(iii) An evaluation function which plays the environment's part, ranking the individuals in terms of their fitness which is their ability to survive.

(iv) Genetic operators which determine the configuration of a replacement population generated from the previous one by a procedure.

(v) Values for the parameters that the GA uses. Applications: Areas of applications in power systems include:

- Planning – turbine positioning, reactive power optimization, network feeder routing, and capacitor placement.
- Operation – Hydrothermal plant coordination, maintenance scheduling, loss minimization, load management, control FACTS.
- Analysis – Harmonic distortion reduction, filter design, load frequency control, load flow.

As genetic algorithms support the principle of survival of fittest, several methods for increasing the efficiency of power grid processes and increasing power output are often proposed. Out of those methods, using genetic

algorithms, the simplest method which withstands all constraints is often selected because it is that the best method among the proposed methods (survival of fittest).
Consider a practical cable. If any fault occurs within the cable, the fault detector detects the fault and feeds it to the fuzzy system. Only three line currents are sufficient to implement this system and therefore the angular difference between fault and prefault current phases are used as inputs to the fuzzy system. The fuzzy system is employed to get the crisp output of the fault type. Fuzzy systems are often generally used for fault diagnosis.
Artificial Neural Networks and Expert systems are often wont to improve the performance of the road. The environmental sensors sense the environmental and atmospheric conditions and provide them as input to the expert systems. The expert systems are computer programs written by knowledge engineers, which give the worth of line parameters to be deployed because of the output. The ANNs are trained to vary the values of line parameters over the given ranges supporting the environmental conditions.
Training algorithm has got to tend to ANN. After training is over, neural network is tested and therefore the performance of updated trained neural network is evaluated. If performance isn't up to the specified level, some variations are often done like varying number of hidden layers, varying number of neurons in each layer. The processing speed is directly proportional to the amount of neurons. These networks take different neurons for various layers and different activation functions between input and hidden layer and hidden and output layer to get the specified output. During this way the performance of the cable are often improved.

3. Expert Systems

An expert system obtains the knowledge of a person's expert during a narrow specified domain into a machine implementable form. Expert systems are computer programs, which have proficiency and competence during a particular field. this data is usually stored separately from the program's procedural part and should be stored in one among the various forms, like rules, decision trees, models, and frames. They're also called as knowledge based systems or rule based systems. Expert systems use the interface mechanism and knowledge to unravel problems which cannot be or difficult to be solved by human skill and intellect.

Many areas of applications in power systems match the skills of expert systems like decision making, archiving knowledge, and solving problems by reasoning, heuristics and judgment. Expert systems are especially useful for these problems when an outsized amount of knowledge and knowledge must be processed during a short period of your time. Since expert systems are basically computer programs, the method of writing codes for these programs is easier than actually calculating and estimating the worth of parameters utilized in generation, transmission and distribution. Any modifications even after design are often easily done because they are computer programs. Virtually, estimation of those values are often done and further research for increasing the efficiency of the method are often also performed.

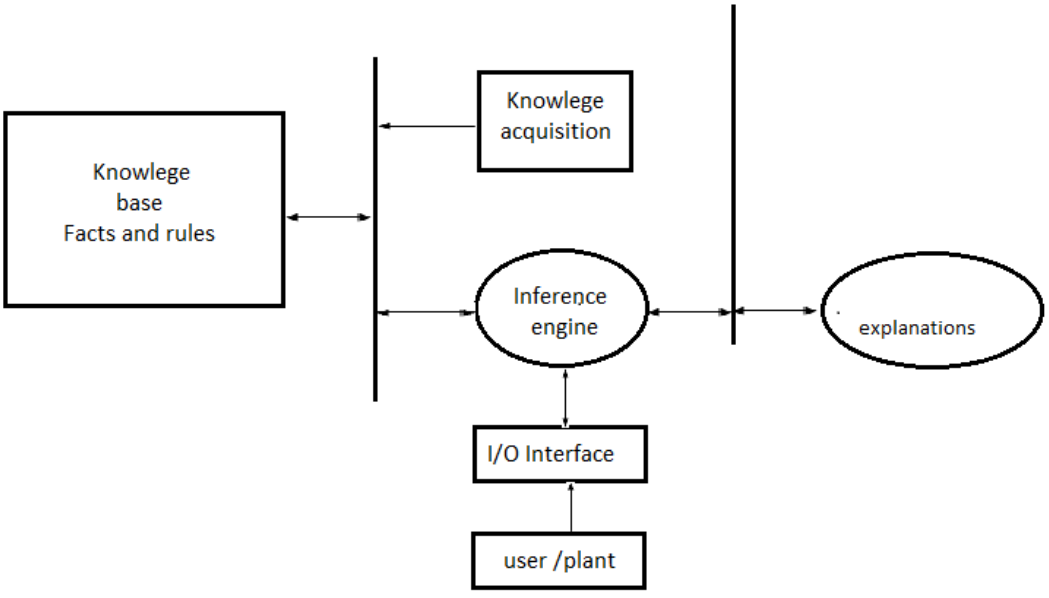


Figure 2: Structure of Expert System.

4. Symbolic logic

Symbolic logic or Fuzzy systems are logical systems for standardization and formalization of approximate reasoning. it's almost like human deciding with a capability to produce exact and accurate solutions from certain or maybe approximate information and data. The reasoning in symbolic logic is analogous to human reasoning. symbolic logic is that the way like which human brain works, and that we can use this technology in machines in order that they will perform somewhat like humans.

Fuzzification provides superior expressive power, higher generality and an improved capability to model complex problems at low or moderate solution cost. Symbolic logic allows a specific level of ambiguity throughout an analysis. Because this ambiguity can specify available information and minimize problem complexity, symbolic logic is beneficial in many applications.

For power systems, fuzzy logic is suitable for applications in many areas where the available information involves uncertainty. for instance , a drag might involve logical reasoning, but are often applied to numerical, aside from symbolic inputs and outputs. symbolic logic provide the conversions from numerical to symbolic inputs, and back again for the outputs.

Fuzzy logic are often used for designing the physical components of power systems. they will be used in anything from small circuits to large mainframes. they will be wont to increase the efficiency of the components utilized in power systems. As most of the info utilized in power grid analysis are approximate values and assumptions, symbolic logic are often of great use to derive a stable, exact and ambiguity free output.

Figure 3: Fuzzy logic

IV. CONCLUSION

The importance of the utilization of the AI tools has been felt altogether in the areas of the facility Systems and therefore the need is emphasized. The easiness is evaluating the vague or no crisp concepts and therefore the ability of these techniques to find out thanks to the technological improvement elevated the effect of those soft computing techniques. The main feature of power grid design and planning is reliability. Conventional techniques don't fulfill the probabilistic essence of power systems. This results in an increase in operating and maintenance costs. Tons of research is yet to be performed to perceive full advantages of this upcoming technology for improving the efficiency of electricity market, investment and particularly power systems, which use renewable energy resources for operation.

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