

Comparative study of soft-computing methodologies and its medical applications.

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Abstract:

Soft-Computing (SC) exemplifies the vague elucidation for almost all computational tasks, but still it is said to be the epitome of various schemas such as Fuzzy Logic (FL), Neural Networks (NN), and Genetic Algorithms (GA) for manipulating data. SC schemas can be combined, which we have termed as Combined Schema. There is a gradual, yet study growth in the arena of bio-informatics, biochemistry, various engineering and science domain, with the aid of this combined schema through analysis and various technical computations. The main perspective of this paper is to have a study of various SC methodologies with its application. In recent years, most of the medical developments are carried off by the computational methodologies such as soft computing, which act as a basis for the practice of modern medicine. The search rate of MEDLINE projects that, more than 65% of FL with NN, less than 25% of GA with NN and less than 5% of GA with FL, which is also predicted by the fact that most of the medical searches in MEDLINE are being made on the basis of SC methodologies

Keywords: Soft-computing, Fuzzy logic, Neural networks, Genetic algorithm.

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Introduction

Neural network

Neural network [NN] is a hub or collection of artificial neurons which are interconnected. The information is processed either through mathematical model or through computational model [4,13]. For example - to recognize a character from a sentences or paragraph, a group of (input) neurons are activated.

This activation is performed by the pixel that is present in the sentences. Once transformation is performed, the input neurons are transferred to other neurons until the output is found, which recognizes a character from a group of sentences.

Fuzzy Logic

Fuzzy logic [FL] is a system that formulates inexact reasoning; this is taken into account as a vital part in a universe of uncertainty. Linguistic variable is the core part of any fuzzy logic application [3,14]. For example – if pollution is a linguistic variable with values such as less, medium, dense.

The value dense/medium/less represents a value from a group of possible values, such as 219 $\mu\text{g}/\text{m}^3$ (micrograms per cubic meter air) is a possible outcome for dense in an available set of values. This draws one to a fact that data compression is a part of linguistic variables.

Genetic algorithm

Genetic algorithm [GA] was evolved through Darwin's "survival of fittest". GA belongs to the package of evolutionary algorithms [EA]. It is used for optimization problems through techniques such as selection, mutation etc... [5,13] GA, is the best quoted for its large search arena and for its optimized solutions by Salvatore Mangano [16].

Motivation

SC is considered to be the basic term for taking up many real world vague situations. Its primary perspective is to handle the precision level, approximation of certainty and robust solutions. SC is a hub of methodologies such as FL, NN and GA [2,16]. Many upcoming domains made a collaborative technique of combining these methodologies as combined NN with FL, combined GA with FL, and combined GA with NN. Its major strength lies in handling many hard core problems with improved as well as new solutions. SC methodologies [11] has paved the way for a major transformation in the field of medicine and knowledge engineering. Many developers had a novel view of exploring knowledge engineering [1] which would provide a new dimension to medicine and provides path for new technologies [10].

Now-a-days there is a less emphasis towards the importance given for the knowledge of medicine and for its support system. Complex medical information were scrutinized with the aid of either SC techniques [11,16] or combined SC techniques [i.e. Combined Schema] For example, For any

control system one may find optimized solution with GA or to derive parameters one may go with NN or even a combined schema can be used.

Collaborative methodologies and its applications

Many data were viewed on MEDLINE and searched with the aid of keywords. As a first part of the work the data were filtered based on [2] SC-based technology then it was classified and grouped [9] on basis of similarity. By using the linguistic patterns and based on the methodologies, the classification was done. The grouping was a collaborative technique of SC methodologies such as NN with FL, GA with FL, GA with NN and their results are being evaluated in result and discussion section below.

The Collaborative technique did not exist before 2000, but last 5-10 years can be termed as the budding year for this, as most of the papers and studies [11,14] had reflected this combination of methodology or technique.

Collaborative NN with FL

Collaborative NN with FL, can be categorized either as FL handled by NN or vice-versa. For any problem to be deciphered such as evaluation of strategies, performance, [3] are framed by FL into a rule set. Those rule set along with fuzzy algorithm is used to alter the parameters of NN and can be used to upgrade their performance. The Collaborative FL-NN always enhances the rate of learning for NN. On the other side for the Collaboration of NN-FL [4,13] comes handy for a generalized network called an adaptive network- based fuzzy inference system, which has input/output layer, layer for differentiation, normalization and for computation separately. This system also has the ability to approximate non-linear functions, due to which it is termed as universal estimator.

Collaborative GA with NN

Many innovative adaptive system are generated from this Collaboration [11], as NN aids learning for a system where as GA plays a vital role for optimizing a system. Past research [13] projects that, either NN with GA can be collaborated sequentially using sustainable approach or simultaneously using Collaboration approach. The data are preprocessed using GA and trained by NN in sustainable approach, where as in Collaboration approach both [GA-NN] are integrated into an individual system. In which [4] NN finds an optimal solution and this is enhanced into an optimized solution by GA, in a number of ways such as GA finds the structural parameters, where as a network's training and its fitness are done by neural learning. A lot of researchers [12,13] have been impressed by this Collaboration approach and number of systems has adapted this methodology.

Collaborative GA with FL

Collaborative GA with FL can be generalized as either GA handled by FL or FL handled by GA. By combining GA with FL, [5] one can enhance the adaptability of the system through

its rule sets and various algorithms. Once the enhancement is done, one can indirectly increase the speed of convergence and its efficiency. On the other type of Collaboration of FL with GA, [3,5] where one can perceive that all the fuzzy based systems are completely handled by GA and it also projects the best rule base.

The resources of GA are controlled with the aid of improvised heuristic rules by FL [13,14]. Most of the GA with FL application projects that FL systems are handled by GA's and it also handles rules and its sets used by fuzzy controller [12].

Collaborative schema in medical domain

Medical domain is a magnified field with different areas of specializations as Analytical science [AS], Quantifiable science [QS], Fundamental science [FS]. All Collaborative methodologies can be indulged on medical domain. Each of these areas can be classified further.

Table1 depicts the search as FL with NN, GA with NN in the computing arena of the medical field. The rate of comparison for the use of SC in medicine for FL with NN is one of the most used with more than 65%, secondly GA with NN <25% and FL with GA is merely <5%. This easily drags us, to the fact that FL with NN application has been widely used in all the branches of medicine in last few years.

Fundamental Science [FS]

FS is alleged to be apt for all Collaborative schemas in SC and use of this schema in FS is increasing gradually. For example, in the field of biochemistry, most of the chemical reactions are carried off with genes or enzymes activities. It is more difficult to exercise and reproduce many ideas using mathematical prototype, [6] therefore FL with NN, GA with NN [13] are applied in various area of domain such as Biochemistry, Informatics, Bio-engineering, these are some of the arena where this collaborative schema have been applied.

Analytical Science [AS]

Early (stage) treatment, gradually reduces the death rate of an infected person, for which AS plays a vital role. A reliable methodology for diagnosis is required for early treatment. For diagnosing any diseases, medical image analysis is required, which includes magnetic resonance imaging [MRI], ultrasound.

Most of the SC application search is made in the perspective of radiology. Collaborative FL-NN [7] application is the most widely used methodology for segmenting images, to find the vague data.

In recent years many researchers have adapted this collaboration for solving analytical science related problems [3,4,14]. The implementation of [11] SC-methodologies in AS, where FL with NN takes the lead with more number of applications followed by GA with NN and a very few of GA with FL applications.

Quantifiable Science [QS]

The search made in MEDLINE database indicated that more than 40% of Collaborative schemas are being implemented towards quantifiable science. It also indicates, [8] the Collaborative FL with NN is the most desired methodologies in neurology, cardiology, anesthesiology and physical medicine.

In one of the study [13,15] functional magnetic resonance imaging data was analyzed for NN with GA network, which was compared with Kohonen's SOM. There is an adequate improvement in the performance for both fuzzy logic and neural network with Kohonen's SOM.

Results and Discussion

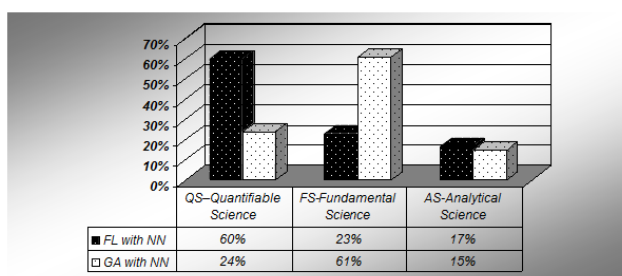
In the comparison [table 1/graph 1] more than 65% of the system comes under the collaboration of FL with NN, more than 25% of the working protocol comes under the collaboration of GA with NN and less than 5% of the model comes under the collaboration of GA with FL.

For the collaboration of FL with NN, the distributions of the prototype in the medical domain are QS-60%, FS- 23%, AS-17% and this collaboration is considered as the best collaboration in most of the researcher's perspective. On the other hand GA with NN has different distribution criteria for FS 61%, QS 24%, AS 15%.

Table1: Comparative study of the collaborative schema.

Collaborative Schema	QS-Quantifiable Science	FS-Fundamental Science	AS-Analytical Science
FL with NN	60%	23%	17%
GA with NN	24%	61%	15%

The emerging data is that, the collaboration FL with GA was not applied to medical field yet. Most of the researcher's flows are towards the utilization of NN with FL and even the publications prove this decision.



Graph 1: Representation of collaborative schema

Conclusion

The collaborative methodologies are considered to be a budding technique and it also paves the way for new studies in all disciplines.

The tribulations of medicine may also lead the path for new SC methods, where these collaborative techniques can be applied. In future, there is an inclination of enhancing the existing collaborative techniques.

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