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

Priya Govindarajan, Ravichandran K.S

Department of Computer Science and Engineering, Sastra University, India.

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 steady 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.

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 µg/m³ (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 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.

Table 1 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
carry 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
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%.

Table 1: Comparative study of the collaborative schema.

<table>
<thead>
<tr>
<th>Collaborative Schema</th>
<th>QS—Quantifiable Science</th>
<th>FS—Fundamental Science</th>
<th>AS—Analytical Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>FL with NN</td>
<td>60%</td>
<td>23%</td>
<td>17%</td>
</tr>
<tr>
<td>GA with NN</td>
<td>24%</td>
<td>61%</td>
<td>15%</td>
</tr>
</tbody>
</table>

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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*Correspondence to:
Priya Govindarajan
Department of Computer Science and Engineering
Sastra University
India.