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A Fuzzy expert system for diagnosis of Multiple Sclerosis and Brain Tumor diseases

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ABSTRACT: The application of expert systems in medical diagnosis is very interesting and it creates considerable importance systems of diagnosis. The proposed system can help doctors and patients in providing decision support system, interactive training tools and expert skills. The system constitutes part of intelligent system for diagnosis of neurological diseases that used in one of the great hospital in Tehran. All of the neurological diseases diagnosis have been investigated in this project .
Keywords: expert system; medical diagnosis; artificial inteligence; patient; neurooglical diseases, fuzzy cognitive

INTRODUCTION

Relies on computer methods are increasingly used to enhance the quality and accuracy in the diagnosis. Artificial Intelligence (AI) is the part of computer science focusing on creating system that can mimic on behaviors that humans consider as intelligence. Investigators are creating systems which can simulate human thought, understand and countless other masterpieces never before possible[1].

The expert system

Affiliation to specialist human brain can be minimized if their expertise can be transferred into a computer system. The system dealing with the problem of neurological disease diagnosis is an expert system. An expert system is a system that professional human knowledge captured in a computer to solve problems that ordinarily require human expertise. Expert system sought and utilizes relevant information from available knowledge bases in order to make recommendations[2]. This expert system is implemented in CLIPS programming environment (C Language Integrated Production System). This programming tool is designed to help professionals in the accurate diagnosis of neurological diseases. CLIPS program is used by reason of the low cost, the expandability and the flexibility[3].

Physician's medical knowledge needed to develop an expert system. This knowledge is collected in two steps. In the first step, the medical background of neurological diseases is recorded through the creation of personal questions and answers between physicians and patients. In the second step, a set of rules is created where each rule contains in IF part that has the symptoms and in THEN part that has the disease that should be recognized. The inference engine is a mechanism through which selection rules can be concluded. It is based on a pattern matching algorithm whose main purpose is to associate the facts (input data) with applicable rules from the knowledge base. Finally, the result obtained by the inference engine is a required neurological disease[2].

This expert system covers the following neurological diseases: Multiple sclerosis (MS). Brain tumors.

Multiple sclerosis is a chronic, often disabling disease that attacks the central nervous system (CNS), which is made up of the brain, spinal cord, and optic nerves. Symptoms may be mild, such as numbness in the limbs, or severe, such as paralysis or loss of vision. The progress, severity, and specific symptoms of MS are unpredictable and vary from one person to another[5].

After strokes, brain tumors are the most common cause of death in neurological patients. Brain tumor, is an intracranial solid neoplasm (abnormal growth of cells) within the brain or the central spinal canal. A brain tumor caused by the uncontrolled division of glial cells is called Glioblastoma, and has four stages according to the severity. Stage IV is the last and most life threatening stage. In order to determine the stage and type of the tumor a surgical biopsy is erformed[6].

The offered expert system performs many helpful functions. It will conclude the above neurological diseases diagnosis based on answers of the user (physician) to specific question that the system asks the user. The questions provide the system for explanation for the symptoms of the patient help the expert system for

diagnosis the disease by inference engine. For each case, it stores the facts and the conclusion of the inference of the system, and the user in data base. It processes the data base in order to extract rules, which complete the knowledge base[1].

This expert system consists of four parts:
knowledge-base;
database;
inference engine;
user interface.

Implementatio

In the present project, the problem of the neurology diseases are dealt by use of rule based systems methodology. One of the best methods of representation of knowledge in the expert systems is using the productive representation as the CLIPS (production system). CLIPS keeps in memory a fact list, a rule list, and an agenda with activations of rules. Facts in CLIPS are simple expressions consisting of fields in parentheses. Groups of facts in CLIPS, usually follow a fact-template, should be easy to organize and thus we can design simple rules that apply to them[3].

In the article, due to limitations in the available material, we have only part of the program and output (results).

```
(defrule Main menu(not (iffoundChoice ?))
=>
(printout t crlf crlf crlf
" patient suspected to Which disease. " crlf crlf
" 1.) Multiple sclerosis (MS) " crlf
" 2.) Brain Tumors" crlf
" 3.) EXIT THE SYSTEM" crlf crlf
"Please select the number: " crlf crlf
 (assert (iffoundChoice (read))))
;; Rules Multiple sclerosis (MS)
;;------------------R0------------------
(defrule Multiple sclerosis (MS)
(iffoundChoice 1)
?retractCh1 <- (iffoundChoice 1)
(not (ifYesNochoise ?))
=>
(retract ?retractCh1)
(printout t crlf crlf " Do your eyes sometimes be blurred? (yes | no) " crlf " Your answer: " )
(assert (ifYesNochoise (read))))
;;------------------R1------------------
(defrule Multiple sclerosis (MS)1
(ifYesNochoise yes)
?retractChy <- (ifYesNochoise yes)
(not (ifYesNochoise1 ?))
=>
(retract ?retractChy)
(printout t crlf crlf crlf " Do you have double vision or strabismus?
 (Yes | No) " crlf " Your answer: " )
(assert (ifYesNochoise1 (read))))
;;------------------R2------------------
(defrule Multiple sclerosis (MS)2
(ifYesNochoise1 yes)
?retractChy <- (ifYesNochoise1 yes)
(not (ifYesNochoise2 ?))
=>
(retract ?retractChy)
(printout t crlf crlf " Do you suffer from dizziness and imbalance? (Yes | No) " crlf
" Your answer: " )
(assert (ifYesNochoise1 (read))))
;;------------------R3------------------
(defrule Multiple sclerosis (MS)3
```

```
(ifYesNochoise2 yes)
?retractChy <- (ifYesNochoise1 yes)
=>
(retract ?retractChy)
.
(printout t crlf crlf crlf" Your disease is suspected to Multiple Sclerosis.
Be recommended to do MRI or CT_SCAN  . " crlf
crlf "                    Thank you for using my Program...
"crlf crlf ))
```

User interface

Interaction between the system and the user is done through the User Interface. The user interface is represented as a menu which displays the 2 kind of neurological diseases to the user (physician). When the system is started a main menu is displayed on the screen which suggests the user to choose one of the options that is high occurrence. When the patient suffered from some of failure in the extremities, user will choose number one from the menu. Then the expert system asks the user for patient symptoms. The user answers with a simple yes or no. Finally, the system informs the user that patient suspected to X disease and more test and review should be done.

Patient suspected to which disease.
1.) Multiple sclerosis (MS)
2.) Brain Tumors
3.) Exit the system
Please select the number: 1
Do your eyes sometimes be blurred? (yes | no)
Your answer: yes
Do you have double vision or strabismus? (Yes | No)
Your answer: yes
Do you suffer from dizziness and imbalance? (Yes | No)
Your answer: yes
Your disease is suspected to Multiple Sclerosis. Be recommended to do MRI or CT_SCAN
Thank you for using my Program...

Figure 1. A sample of the system result

Using Fuzzy Cognitive

Fuzzy Cognitive (FC) is a soft computing technique for modeling complex systems following an approach similar to human reasoning . FC successfully represent knowledge and human experience, introducing concepts to represent the essential elements and the cause and effect relationships among the concepts to model the behavior of any system. Medical Decision Support Systems are complex systems that can be decomposed to subsystems and elements, where many factors have to be taken into consideration that may be complementary, contradictory, and competitive; these factors influence each other and determine the overall clinical decision with varying degrees. Here a Medical Decision Support System based on an appropriate FC architecture is proposed and developed.

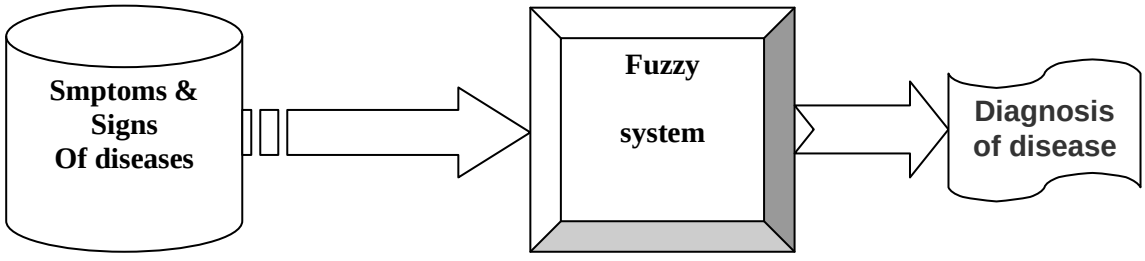

Figure 2. logic Model of diagnosis disease

basic concepts of Fuzzy System

We model the concepts of critical issues related to the rules and using the flowing (1):

IF x(1) is A(1) , ... , x(n) is A(n) THEN y(1) = B(1) (1)

All membership functions are types of triangular encountering but the number they are variables in the different nature of the natural parameters such as body temperature is originated. The most important reasons for using fuzzy systems are:

Excessive complexity of the real world that ultimately led to a description or approximation for a system model is fuzzy.

Need to formulate a model for human knowledge to the legal form and lawful way Insert true the system[7].

In this article fuzzy logic used to help new way in diagnosis of some diseases with neurological signs and syptoms in patient that has been produced to build the fuzzy model of the ten that mark the disease can be helpful in the diagnosis For each of the two disease but that used are not main signs of disease (decisive signs) and are also so most of the other symptoms that can be useful among the 34 known neurological disease the 232 entrance sign to be determined and diagnose disease, so we considered the following procedure to define fuzzy expert system :

A defining input – output set that couples the input - output normalized to accept.
Production if - then Fuzzy logic based on the input – output pair.
Create fuzzy rule base.
Manufacturing system based on fuzzy logic rules.

Input-output parametrs in fuzzy system

To distinguish these two diseases, There are 20 kinds of signs or symptoms. The signs are part of the 232 entries in the system database for the 34 signs of neurological disease. The encoded signs is from 101 to 332. The user(Physician) can select any of the 20 codes to identify disease. The symptoms of the two diseases, along with their codes have been in tables (1) and tables (2). the number of entries required for diagnosis is 10-11 pcs.

In this system we use from Max-Product for Fuzzy inference engine, singleton Fuzzifier, center average DeFuzzifier and multiplication for algebraic t-norm and max for s-norm as follows:

Cycle of brain tumor diagnosis is:

Rule(2)

IF { x(1)=116 & x(2)=211 & x(3)=303 & x(4)=277
& x(5)=153 & x(6)=166 & x(7)=202 & x(8)=317
& x(9)=130 & x(10)=222 }
Then y=brain tumor

Cycle of Multiple sclorosis (MS) diagnosis is:

Rule(2)

IF { x(1)=319 & x(2)=110& x(3)=202 & x(4)=307
& x(5)=244 & x(6)=209 & x(7)=283 & x(8)=159
& x(9)=239 & x(10)=151 & x(11)=174 }
Then y= Multiple sclorosis (MS)

Table1. Signs and Symptoms of Brain Tumor

Symptoms	Code of symptom In data base
headache	116
Dilated pupils	211
Nauseated	303
vomiting	277
Decreased libido	153
Squint	166
Blurred vision	202
Distraction	317
Numbness in limbs	130
Anesthesia	222

Table 2. Signs and Symptoms of MS: (Multiple sclorosis or Progressive dementia)

Symptoms	Code of symptom in data base
Patient age is between 20 to 35	319
Existence a family history of MS	110
Visual impairment	202
Pins and needles in face	307
Pins and needles in extremities of the body	244
Paralysis of eye movements	209
Insufficiency in the passing urine and fecal	283
Visible plaques on CT scan of brain	159
Plaques visible on MRI of brain (part of ventricle)	239
High level of gamma-globin in cerebrospinal test	151
Depression	174

CONCLUSION

The system constitutes part of intelligent system of diagnosis of neurological diseases. The present expert system is evolving and increasing efficiency for all neurological diseases. Therefore the work was aimed to design a system for the diagnosis of Neurological diseases using FC(Fuzzy Cognitive) which is, a successful application of Lotfizadeh's fuzzy set theory. It is a reasonable tool for dealing with uncertainty and imprecision and the knowledge of a physician can be modelled using an FC. Usefulness and power of a FC depends on its knowledge base which consists of a data base and a rule base. It is observed that the performance of a FC mainly depends on its rule base, and optimizing the membership function distributions stored in the data base is a fine tuning process.

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